INFORMING DECISION-MAKING FOR THE COASTAL HIGHWAY MANAGEMENT PLAN: A BIOLOGICAL SENSITIVITY ASSESSMENT FOR INTERTIDAL AND SHALLOW SUBTIDAL HABITATS ON THE BIG SUR COAST

A report submitted to the Monterey Bay Sactuary Foundation

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I. Executive Summary

Highway 1 along the Big Sur coast of central California is subject to frequent and severe landslides that require timely maintenance, including the removal and disposal of erosion material. The Coastal Highway Management Plan (CHMP) requires a descision framework for deciding whether to dispose of material and how and where to do so. One componene tof that decesion-making framework is the consideration of the ecological impacts to nearshore marine ecosystems, including intertidal and the shallow (< 20 m depth) subtidal habitats and the biological communities they support. Many of these habitats, especially rocky intertidal and subtidal kelp forests, support species-rich biological communities and species of special interest. To help inform this decision-making process, we conducted broad-scale surveys and analyses to develop models aimed at predicting spatial patterns of biological sensitivity to the dumping of erosion materials. With this information, managers can consider the potential impact of dumping erosion materials at potential sites along the coast of the CHMP study region. We also conducted a separate analysis to determine if shallow kelp forests communities in close proximity to sites of substantial extant erosion differed from those at sites more distant from erosion sites.

Our approach to informing the decision-making process included three objectives, including the (1) development of indices of sensitivity of intertidal and shallow (< 20 m depth) subtidal biological communities to the dumping of erosion material in the CHMP study region, (2) development of models based on relationships between habitat variables and biotic communties in order to predict sensitivity of communities in sections of the coast that have not been sampled in this study, and (3) assessment of the differences in subtidal biological communities at sites differing in proximity to point sources of substantial erosion material. Our indicies of biological sensitivity used to characterize the vulnerability of a community to erosion materials are based on several considerations, including the probability of occurrence of one or more species of special interest (e.g., threatened, rare, economically important), the species richness of the community, and the relative abundance of species of particular ecological importance (e.g., biogenic habitat) and the likelihood of prolonged impact (i.e. retention) based on the physical attributes of the environment. These criteria resulted in a gradient of relative sensitivity of biological communities in the intertidal and shallow subtidal habitats of the CHMP study region. We also developed habitat-community models based on empirical relationships between species and communities and attributes of the local environment (e.g., exposure to swell, reef relief, substratum type). In combination, our sensitivity indices and the habitat-community models were used to predict biological communities (and their associated sensitivity) at sites that were not surveyed based on habitat criteria available in a GIS developed by the Monterey bay National Marine Sanctuary. Our comparison of the biological communities at three pair of subtidal sites near and far from point sources of extant erosion did not detect differences in the biological communities related to their proximity to sites of erosion. Two important caveats of these results are that the “near” sites should not be confused with actual sites where erosion occurred, and their distance from sites of erosion likely influenced the extent to which thay may have experienced an impact. Without knowledge of the structure of the biologicl communities at these sites prior to erosion events, it cannot be concluded that they were not influenced by the erosion event.

The results of this study are presented in three formats; (1) this written report that describes our approach, methods and the results of our surveys and the sensitivity models, (2) GIS attribute tables that describe the sensitivity indices and segment attributes for segments that were surveyed and those for which the model was used to predict patterns of sensitivity, and (3) Excel files of appendices of data collected by the subtidal biological surveys.

II. Introduction

The MBNMS and the California Coastal Commission are working closely with the California Department of Transportation (CalTrans) and several other local, state and federal agencies to develop a Corridor Management Plan along the Big Sur coast, as part of the Coast Highway Management Plan (CHMP). Highway 1 along the Big Sur coast is an important, nationally recognized highway. The highway is often subject to delays and closures due to storms, washouts and landslides, and its repair has generated controversy from business leaders, environmental groups, government agencies and local residents. The purpose of the CHMP is to develop sustainable strategies that ensure the safe and efficient operation of the highway while protecting the unique qualities and sensitive terrestrial and marine resources of this remarkable coastline.

Currently, the CHMP lacks a survey of marine resources along typical landslide areas and sites where CalTrans may seek to dispose of rock and soil debris onto the shoreline and into the ocean. Highway 1 management and repair strategies, even with objectives to minimize earthwork impacts and overall disturbances, will continue to require suitable locations for depositing excess material. The handling of material at a landslide site or exporting to a suitable disposal site continues to raise concern about the potential for impacts to shoreline habitats. Evaluating shoreline habitats for sensitivity to these activities is an essential component to determining the effects of landslide material being deposited or redistributed on or near the shoreline. Thus, a survey of the marine resources and an evaluation of the sensitivity of habitats and their associated biological communities will enable decision-makers to avoid disposal at critical, valuable areas and to identify areas with lower resource value that may be suitable for ocean disposal of rock and soil by CalTrans.

There are three separate but linked objectives to this project. (1) to provide a comparision of biological communities at sites in close proximity to landslides vs. more distant reference sites. The goal here is to evaluate the persistent effects of “dumping”. Because of habitat dissimilarities, the utility of the information collected for this objective is very limited. (2) to evaluate the spatial similarities of sites in the region. There are a number of goals here. First, to understand the potential for impact due to dumping we need to understand the biological communities and their commonness or rarity along the coast. Second, we need to understand the relationship between biological communities and physical attributes of the system in order to predict what sort of biological communities might be present in sites that we did not sample. For example, assume that we sampled Site A and Site C within Region 1 of the Big Sur coastline. Also assume we want to know the sensitivity of Site B (nested between A and C) to dumping. Knowing the region, the specific location of the site (between A and C), and its physical attributes allows predition of the likely biological community found at the site. (3) to develop a

model of sensitivity to dumping. Here we use the information collected to provide an index of sensitivity to site segments along the Big Sur Coast. This information is then used to provide layers in a regional GIS framework. The product can then be used to map levels of biological sensitivity to be used to inform decisions concerning ocean disposal along the Big Sur coast. This was done as part of the Coast Highway Management Plan (CHMP) and in collaboration with the Monterey Bay National Marine Sanctuary (MBNMS).

III. Methods

Overview of Methods

We used a combination of quantitative and qualitative sampling and analytical approaches in order to meet the three overall goals of this study, including (1) development of indices of sensitivity of intertidal and shallow (< 20 m depth) subtidal biological communities to the dumping of erosion materials in the CHMP study region, (2) development of models based on relationships between habitat variables and biotic communties in order to predict sensitivity of communities in sections of the coast that were not sampled in this study, and (3) assessment of the differences in biological communities at sites differing in proximity to point sources of substantial erosion materials. Because the methods used to sample and analyze the intertidal and subtidal communities are very different we describe them separately, first with the intertidal followed by the subtidal. The methods used for each are presented first by describing the purpose of the sampling and analyses, then by the sampling sites used for that analysis, and finally by the detailed sampling protocol used to generate the data used for the analyses.

III.A. Intertidal Survey Methods

The intertidal surveys were primarily focused on providing information to inform a model of sensitivity to erosion and dumping material. The data collected for this project were combined with datasets collected in PISCO surveys and integrated into a model of sensitivity. The information for the Big Sur Erosion Study (BSES) results from either a qualitative or quantitative survey. Descriptions of both types of surveys follow. Metadata for the GIS intertidal site attributes are also listed below. Information is included for analysis purposes only from sites that fall within the BSES survey area and are actively monitored by PISCO (through either the Coastal Biodiversity Surveys or other PISCO Surveys), but were not surveyed specifically for the BSES.

III.A.1. Sites Used for Intertidal Quantitative-based Sensitivity Model

Sites where quantitative was conducted were selected to span the BSES area and fill in gaps in the PISCO survey sites.

Quantitative sites surveyed for the BSES included:

Partington Cove

Lucia
Mill Creek
Duck Ponds

Quantitative sites actively monitored by PISCO, but were not surveyed specifically for the BSES:

Stillwater Cove
Carmel Point
Point Lobos
Mal Paso
Soberanes
Andrew Molera
Pacific Valley

In order to compare species richness across these quantitative sites, the following calculations were made:

1. The combined species richness for all Coastal Biodiversity Surveys conducted from Carmel River in the north to Cambria in the south was calculated for the following 9 sites:

   Stillwater Cove
   Point Lobos
   Andrew Molera
   Partington Cove
   Lucia
   Mill Creek (Wild Cattle)
   Duck Ponds
   Cambria
   Point Sierra Nevada

Note that Cambria and Point Sierra Nevada are located adjacent to the survey area, and not included on this report, but were used for this analysis. The cumulative species richness at all sites for all visits was 220.

2. The species richness for each site was separately determined. For sites visited multiple times, the average species richness was determined.
3. The percentage of total species was calculated for each site (site species richness/220).
4. The percentage of total species seen at all 9 sites fell between 24% and 46%. The average percent of species seen was 37%.
5. The sites were then ranked as follows:
6. below average (sites with 0%-32% of species seen)
7. average (sites with 33%-41% of species seen)
8. above average (sites with 42%-100% of species seen)
9. The above rankings are included in the site descriptions for these sites.

In addition to sites that were surveyed for the BSES, there are other PISCO survey sites that fall within the Shoreline layer of the GIS map. For these sites, some additional information regarding species richness and species of special interest is included. Note that species richness information can only be included for sites that are part of the PISCO Coastal Biodiversity Surveys.

III.A.1.1. Protocols Used for Intertidal Quantitative-based Sensitivity Model

Selecting an appropriate location

Within a site, the ideal location to do a comprehensive survey is on a bench that 1) is at least 30m wide, 2) gently slopes from the high to low zone, and most importantly 3) contains a representative sample of the intertidal community of the entire site. If it is not possible to find a contiguous 30m stretch of coastline, the survey can be split between two adjacent benches. When this is done, the survey should be divided as evenly as possible between the two benches.

Set-Up

Once an appropriate area of shoreline has been selected, it is sampled using a series of parallel transect lines extending from the high zone to the low zone. To facilitate the setup of these lines, two permanent 30m horizontal baselines (parallel to the ocean) are first established. The upper baseline is placed in the high zone above the upper limit of the organisms, while the lower baseline, which should be parallel to the upper baseline, is established farther down the shore. Depending on the amount of beach traffic or site regulations, the ends of these lines are permanently marked with either hex or carriage bolts.

Once these two baselines have been established, parallel transect lines are run down the shore every three meters along the upper base line. To insure that these lines are parallel, they should intersect the appropriate meter mark on the lower baseline. In general the transect lines are allowed to follow the contours of the bench. When necessary, rocks are placed along the lines to prevent them from being shifted by heavy winds and a note is made of where each transect crosses the lower baseline.

To facilitate resurveys of the site, a map is drawn of the site showing the location of the bolts relative to notable landmarks or other, pre-existing permanent plots and photographs are also taken. The distance and bearing between the baseline endbolts are measured. When possible, measurements are also taken between the endbolts and any pre-existing permanent plots. Other pertinent information, such as the compass heading of the vertical transects, the sampling interval, weather conditions, site complications, and problems with taxonomic identification, are also recorded.

Point-Contact Surveys

Each vertical transect is sampled using the point intercept method. Ideally 100 points are sampled on each transect line, so the interval between points should be 20cm for a 20m long transect, and 10cm for a 10m long transect. For each point two types of data are collected: data that are used to determine relative abundance (% cover), and data that are used to describe spatial distributions. The relative abundance data are collected by identifying all taxa that fall directly under each point, including rock, sand, and tar. If there is layering, the taxa occupying the different layers are identified and assigned a letter; A for the top layer, B for the second layer, and C for the third. (Note: For this survey, each layer must be a different taxa). If the point falls on an epibiont living on a recognized host species (Table 1.1.1), the epibiont is denoted by the letter E and the host by the letter H. (Note: Designating a species an epibiont/host does not preclude it from also being a layer. For example, if the point hits an epibiotic alga whose holdfast is not under the point, it is recorded as both a canopy (A) and as an epibiont (E). The host would be recorded as canopy (B) and host (H).) Also recorded is whether the species under the point are found in pools, on cobble, or on boulders. A total of up to three taxa are identified under each point.

Table 1.1.1 List of recognized hosts. Although many species are host to a few epibiotic species, for this survey only those species that offer substrate to a multitude of epibiotic species are considered hosts.

Balanus crenatus
Balanus glandula
Bossiella spp
Calliarthron spp
Corallina spp
Dendropoma lituella
Dodecaceria fewkesii
Haliptylon gracile
Jania crassa
Jania tenella
Lithothrix aspergillum
Lottia gigantea
Megabalanus californicus
Mytilus californianus
Mytilus galloprovincialis/trossulus
Petaloconchus montereyensis
Phragmatopoma californica
Pollicipes polymerus
Pseudochama exogyra
Semibalanus cariosus
Serpulorbis squamigerus
Tetraclita rubescens

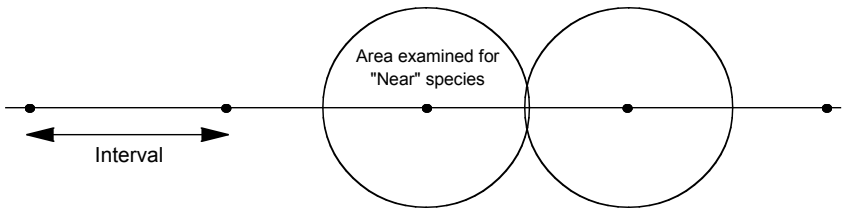
If fewer than three taxa are recorded under a point, then data are collected on the identity of the next one or two species closest to that point (Table 1.1.2). These data are used to describe the spatial distribution of species, and are not used when calculating relative abundances.

Table 1.1.2 Number of 'nearby' species recorded.

Taxa Recorded Under Point	Number of 'Nearby' Species Recorded
One taxa, (can be either an organism or bare space)	Two additional species
Two layers, with the bottom layer being bare space	Two additional species
Two layers, both of which are organisms	One additional species
Epibiont and Host	One additional species
Three layers, with the bottom layer being bare space	One additional species
Three layers, all of which are organisms	No additional species

These 'nearby' species must be different than those found under the point, and must fall within a circle centered over the point with a radius half the length of the sampling interval (Fig. 1.1.1). Closeness is determined by location on the primary substrate. For example, if a frond of *Silvetia* is closer to the point than a barnacle, but its holdfast is farther away, the barnacle is considered the closer species. If all 'nearby' individuals are the same taxa as that found under the point, or there are no other 'nearby' species, 'none' is recorded. If the nearby species is an epibiont on a recognized host (Table 1), the host is denoted by the letter H and the epibiont the letter E. Again, note is made of whether these nearby species are found in pools, on cobble, or on boulders.

Figure 1.1.1 Diagram showing area examined for 'near' species.



Vouchers

When a species cannot be identified in the field, it is assigned an unknown number and a sample of it is collected. Samples are labeled with the date, site, name of sampler, transect line on which it is found, and the unknown number assigned to it. Samples are collected in seawater and are either immediately pressed (algae), and either dessicated or preserved in alcohol (invertebrates).

Intertidal Mobile Invertebrate Quadrat Surveys

Although point-contact surveys are good at determining the abundance of spatially common species, they do not sample rare or spatially uncommon species very well. Because most mobile species are not spatially common, their abundances are determined in 50 x 50 cm quadrats placed at three locations along each transect. Each transect is first divided into three zones; the low zone is the area below the mussels, the mid-zone includes the mussels and the rock weeds (e.g. Silvetia, Pelvetiopsis), and the high zone is the area dominated by barnacles and littorines. Within each zone a quadrat is randomly placed on the transect, and all mobile species found within the quadrat are identified and counted. Sub-sampling may be used when there are more than one hundred individuals of one species in a quadrat. If a quadrat lands in a deep pool or in an area dominated by sand, a new location is selected. The only mobile species not counted are worms, *Neomolgus littoralis*, and amphipods.

Swath Counts

Seastars play an important role in the intertidal community, but often they are also not spatially common. As such, their abundances are measured along a two-meter swath centered over each vertical transect. Within this swath, the abundance and location along the transect (to the nearest 0.5m) of the following seastars are recorded: *Asterina miniata, Dermasterius imbricata, Echinaster* spp, *Evasterias troschelii, Heliaster kubinijii, Henricia leviuscula, Pharia pyramidata, Pisaster ochraceu*s, *Pisaster giganteus,* and *Pycnopodia helianthoides*. Abundance and location are also recorded for individuals of *Cryptochiton stelleri, Haliotis cracherodii,* and *Haliotis rufescens*. The locations of any surge channels or pools that cannot be searched are also noted.

Topography

A three-dimensional map of the study area is created using a rotating laser leveler and a stadia rod to measure the topography of each vertical transect line. Ideally the laser leveler is positioned where the topography of all eleven transects can be measured. However, where this is not possible, and the laser leveler must be repositioned, it is important to make sure that several reference points are measured from both locations. This will ensure that the heights measured from the two locations will be compatible. Measurements are taken along each transect wherever there is a change in height. Thus, measurements are taken infrequently (every few meters) for gradual slopes, but more frequently (tens of centimeters) when necessary to capture the presence

of smaller ridges and pools. These measurements are converted to tidal heights (meters above MLLW) by measuring sea level at low tide. This is done by finding at least three locations that are covered and uncovered by waves for equal amounts of time. The height of these locations, and the time they were measured, are recorded and later converted to tidal height using a tidal table.

III.A.1.2. Analyses Used for Intertidal Quantitative-based Sensitivity Model

As noted above the main goal of the surveys was to provide information for a spatial model of habitat sensitivity. The two major products of this analysis are: 1) a spatially explicit evaluation of communities in the Big Sur region and, 2) a model of biological sensitivity of the entire region broken out by sites.

Spatially explicit evaluation of biological communities

We used cluster analysis to look at the relationships among sites. The idea was to determine whether there was a regional signature to the biological communities that needed to be integrated in the sensitivity model. The intertidal community data are presented in Appendix A.

Sensitivity Model

A model of sensitivity to erosion or dumping spoils was developed using the results of the quantitative surveys. The specific goal was to provide a sensitivity score for spatial segments in the Big Sur area that could be used as part of permiting process for dumping of spoils.

III.A.2. Sites Used for Intertidal Qualitative-based Sensitivity Model

Qualitative surveys were conducted in 30 minutes or less. Access was often restricted to floating by on kayaks or swimming into a site from a boat and climbing onto rocks. General environment conditions were noted and a brief search for species was conducted in a non-specified amount of time. Qualitative surveys were conducted during higher tides than the quantitative surveys; generally 0.0-2.5 feet above mean low low water resulting in an incomplete account of low zone species.

Qualitative sites surveyed for the BSES (some species data exists)

North Wreck Beach
McWay Rocks
Dolan Rock
Salmon Creek

Qualitative sites not surveyed for the BSES (no species data exists)

South Plaskett Rock
Sycamore Draw
Grey Slip

For qualitative sites, no comparison can be made for a degree of similarity (cluster analyses), other than the information provided in the site descriptions.

III.A.3. Methods for Intertidal GIS attribute table

Segment Selection Criteria

The entire PISCO shoreline is separated into over 34,000 sections. Each section designates a change in the aspect of the coastline. These sections were consolidated into a number of segments, which are described by the attributes discussed below. Each of these segments were selected and described by looking at a) the existing Environmental Sensitivity Index (ESI) Shoreline layer on the GIS Project, b) the aerial photos on the GIS Project, c) the photos available on the California Coastline Records project (http://www.californiacoastline.org/), and (in some cases), d) survey data from the actual site.

The primary attribute used to select a segment was the Bench Type. The Bench Type is highly indicative of the species richness of a site. Consolidated bedrock is generally an area of high species richness, boulder/cobble/bedrock is generally an area of moderate species richness, and sand is generally an area of low species richness. After finding a continuous stretch of coastline with the same Bench Type, the Bench Slope, Relief, and Extent for this stretch of coastline was also determined. A segment was created for each area that these 4 attributes were designated with the same description. The descriptions used in the attribute table describe at least 90% of the area in each segment, which means that up to 10% of the area in each segment may have different attributes than those existing on the table. In cases where the segment selected contained fewer than 25 sections, it was considered too small, and these sections were consolidated into a larger segment. Once a segment was designated, it was assigned the next consecutive segment number (running north to south), and the attribute table was filled in, using a combination of photos and survey data, when available.

As a result of the selection criteria, the segments are not uniform with respect to the number of sections they contain. Some segments contained as few as 30-40 sections, and others as many as 800 sections. Segment designation indicated all attributes on the table are identical, therefore it wasn't necessary to divide up a larger segment of 800 or more sections into smaller segments.

Species of special interest not included in the GIS attributes

The following species are included in the report for intertidal sites where they were seen, however they do not appear in the GIS attributes table.

Species	Common name
Lottia gigantea	owl limpet
Pisaster ochraceus	ochre star
Strongylocentrotus	

purpuratus purple urchin

Pisaster ochraceus was included because it is considered and important intertidal predator. *Strongylocentrotus purpuratus* was included because it is considered an important intertidal herbivore. *Lottia gigantea* was included because it is a species sensitive to harvesting.

III.A.4. Intertidal GIS attributes for PISCO Shoreline

1. **segment:** "Segment" - number indicating the intertidal area described, numbered from 1-112. 1 is the northernmost segment, and the numbers increase as you move south along the coast, with 112 being the southernmost segment.
2. **bench_slop:** "Bench Slope" - describes the slope of the coastline
    a. **steep:** at least 90% of the area has a slope greater than 15 degrees
    b. **gradual:** at least 90% of the area has a slope of 0-15 degrees
    c. **unknown:** unable to determine the slope in this segment from photos alone
3. **relief:** "Relief" - describes the rugosity of the intertidal area
    a. **high:** at least 90% of the area consists of extremely uneven terrain, containing many deep cracks and folds, such as in some mixed consolidated bedrock and boulder fields
    b. **moderate:** at least 90% of the area consists of moderately uneven terrain, containing few cracks and folds, such as in boulder or cobble fields and some consolidated bedrock
    c. **low:** at least 90% of the area consists of flat terrain, such as a sandy beach
    d. **unknown:** unable to determine the relief in this segment from photos alone
4. **extent:** "Extent" - describes the length of the intertidal area in the segment from the land to the ocean
    a. **long:** at least 90% of the segment has an length greater than 15 meters
    b. **intermediate:** at least 90% of the segment has an length of 5-15 meters
    c. **short:** at least 90% of the segment has an length less than 5 meters
    d. **unknown:** unable to determine the length of this segment from photos alone
5. **bench_type:** "Bench Type" - describes the geology of the segment
    a. **boulder/cobble/bedrock:** at least 90% of this segment is made up of mixed boulder/cobble fields, with some consolidated bedrock present
    b. **consolidated bedrock:** at least 90% of this segment is made up of consolidated bedrock
    c. **sand:** at least 90% of this segment is made up of sand
    d. **unknown:** unable to determine the bench type in this segment from photos alone
6. **exposure:** "Exposure" - describes the vulnerability of the segment to ocean conditions
    a. **exposed:** at least 90% of the segment experiences heavy wave action and constant current flux
    b. **protected:** at least 90% of the segment experiences little wave action and constricted current flux
7. **postelsia_:** "Postelsia" - describes whether *Postelsia* is located in a given segment
    a. **present:** *Postelsia* has been observed in a given segment
    b. **predicted:** the habitat for *Postelsia* has been observed in a given segment
    c. **unlikely:** the habitat for *Postelsia* has not been observed in a given segment

    d. **unknown:** unable to determine if the habitat for *Postelsia* is located in this segment from photos alone
8. **mussel:** "Mussel Beds" - describes whether Mussel Beds are located in a given segment
    a. **present:** Mussel Beds have been observed in a given segment
    b. **predicted:** the habitat for Mussel Beds has been observed in a given segment
    c. **unlikely:** the habitat for Mussel Beds has not been observed in a given segment
    d. **unknown:** unable to determine if the habitat for Mussel Beds is located in this segment from photos alone
9. **surfgrass:** "Surfgrass" - describes whether Surfgrass is located in a given segment
    a. **present:** Surfgrass has been observed in a given segment
    b. **predicted:** the habitat for Surfgrass has been observed in a given segment
    c. **unlikely:** the habitat for Surfgrass has not been observed in a given segment
    d. **unknown:** unable to determine if the habitat for Surfgrass is located in this segment from photos alone
10. **abalone:** "Abalone" - describes whether species of Abalone are located in a given segment
    a. **present:** Species of Abalone have been observed in a given segment
    b. **predicted:** the habitat for species of Abalone has been observed in a given segment
    c. **unlikely:** the habitat for species of Abalone has not been observed in a given segment
    d. **unknown:** unable to determine if the habitat for species of Abalone is located in this segment from photos alone
11. **Kelp:** describes whether this species is located offshore of a given segment. The existing Kelp layer was used to assign the attributes for this category.
    a. **present:** the existing kelp layer shows that kelp has been observed offshore of a given segment
    b. **unknown:** unable to determine if kelp is located offshore of this segment
12. **Sen_FedSta:** "Biological Sensitivity: Federal or State Protections" – Designates the Biological Sensitivity of a given segment based on the presence of *Postelsia*, Surfgrass, Mussel Beds, and/or Abalone.
    a. **high:** Postelsia, Surfgrass, Abalone, and/or Mussel Beds are designated on the attribute table as either "present" or "predicted" in this segment.
    b. **low:** Postelsia, Surfgrass, Abalone AND Mussel Beds are all designated on the attribute table as "unlikely" in this segment.
    c. **unknown:** Postelsia, Surfgrass, Abalone, and/or Mussel Beds are designated on the attribute table as "unknown" in this segment, and none of the above situations (for high and low designations) apply.
13. **Num_FedSta:** "Numeric Ranking for Federal or State Protections" – Numeric Ranking assigned to the "Biological Sensitivity: Federal or State Protections" category, to be used to calculate the "Overall Biological Sensitivity Ranking"
    a. **0:** This ranking was used for segments with a "low" designation for Biological Sensitivity: Federal or State Protections
    b. **2:** This ranking was used for segments with a "unknown" designation for Biological Sensitivity: Federal or State Protections

c. **4:** This ranking was used for segments with a "high" designation for Biological Sensitivity: Federal or State Protections

14. **Sen_SedSco:** "Biological Sensitivity: Species Sensitive to Sedimentation, Scour and/or Turbidity" – Designates the Biological Sensitivity of a given segment based on the predicted presence and/or abundance of the following species which are sensitive to Sedimentation, Scour, and/or Turbidity:

    Calliarthron spp
    Chondracanthus canaliculatus
    Corallina spp
    Cryptopleura/Hymenena spp
    Encrusting coralline
    Endocladia muricata
    Hildenbrandia/Peyssonnelia spp
    Mazzaella affinis
    Osmundea spectabilis
    Petrocelis spp
    Pollicipes polymerus
    Prionitis lanceolata
    Semibalanus cariosus
    Silvetia compressa

    Strongylocentrotus purpuratus
    Tetraclita rubescens.

    The predicted presence/abundance of these species is related to the bench type of a given segment.

    a. **high:** Bench Type is designated on the attribute table as "consolidated bedrock" in this segment.
    b. **medium:** Bench Type is designated on the attribute table as "boulder/cobble/bedrock" in this segment
    c. **low:** Bench Type is designated on the attribute table "sand" in this segment
    d. **unknown:** Bench Type is designated on the attribute table "unknown" in this segment

15. **Num_SedSco:** "Numeric Ranking for Species Sensitive to Sedimentation, Scour and/or Turbidity" – Numeric Ranking assigned to the "Biological Sensitivity: Species Sensitive to Sedimentation, Scour and/or Turbidity" category, to be used to calculate the "Overall Biological Sensitivity Ranking"

    a. **0:** This ranking was used for segments with a "low" designation for Biological Sensitivity: Species Sensitive to Sedimentation, Scour and/or Turbidity
    b. **1:** This ranking was used for segments with a "unknown" designation for Biological Sensitivity: Species Sensitive to Sedimentation, Scour and/or Turbidity
    c. **2:** This ranking was used for segments with a "medium" designation for Biological Sensitivity: Species Sensitive to Sedimentation, Scour and/or Turbidity
    d. **3:** This ranking was used for segments with a "high" designation for Biological Sensitivity: Species Sensitive to Sedimentation, Scour and/or Turbidity

16. **Sen_ProRec:** "Biological Sensitivity: Species with Prolonged Recovery" - Designates the biological sensitivity of a given segment based on the predicted presence/abundance of the following species with Prolonged Recovery:

    Anthopleura elegantissima
    Fucus spp
    Haliotis cracherodii
    Mytilus californianus
    Pelvetiopsis spp
    Phragmatopoma californica
    Phyllospadix scouleri
    Phylospadix torreyi
    Pisaster ochraceus
    Postelsia palmaeformis

    The predicted presence/abundance of these species is related to the bench type of a given segment.
    a. **high:** Bench Type is designated on the attribute table as "consolidated bedrock" in this segment.
    b. **medium:** Bench Type is designated on the attribute table as "boulder/cobble/bedrock" in this segment
    c. **low:** Bench Type is designated on the attribute table "sand" in this segment
    d. **unknown:** Bench Type is designated on the attribute table "unknown" in this segment
17. **Num_ProRec:** "Numeric Ranking for Species with Prolonged Recovery" - Numeric Ranking assigned to the "Biological Sensitivity: Species with Prolonged Recovery" category, to be used to calculate the "Overall Biological Sensitivity Ranking"
    a. **0:** This ranking was used for segments with a "low" designation for Biological Sensitivity: Species with Prolonged Recovery
    b. **1:** This ranking was used for segments with a "unknown" designation for Biological Sensitivity: Species with Prolonged Recovery
    c. **2:** This ranking was used for segments with a "medium" designation for Biological Sensitivity: Species with Prolonged Recovery
    d. **3:** This ranking was used for segments with a "high" designation for Biological Sensitivity: Species with Prolonged Recovery
18. **Sen_HabEng:** "Biological Sensitivity: Habitat Engineers" - Designates the biological sensitivity of a given segment based on the presence of Surfgrass, and/or Mussel Beds
    a. **high:** Surfgrass, and/or Mussel Beds are designated on the attribute table as either "present" or "predicted" in this segment.
    b. **low:** Surfgrass, AND Mussel Beds are designated on the attribute table as "unlikely" in this segment.
    c. **unknown:** Surfgrass, and/or Mussel Beds are designated on the attribute table as "unknown" in this segment, and none of the above situations (for high and low designations) apply.
19. **Num_HabEng:** "Numeric Ranking for Habitat Engineers" - Numeric Ranking assigned to the "Biological Sensitivity: Habitat Engineers" category, to be used to calculate the "Overall Biological Sensitivity Ranking"

a. **0:** This ranking was used for segments with a "low" designation for Biological Sensitivity: Habitat Engineers
b. **2:** This ranking was used for segments with a "unknown" designation for Biological Sensitivity: Habitat Engineers
c. **4:** This ranking was used for segments with a "high" designation for Biological Sensitivity: Habitat Engineers

20. **Sen_BioRan:** "Biological Sensitivity: Biodiversity Ranking" - Designates the biological sensitivity of a given segment based on the predicted biodiversity.
    a. high: The following combination of attributes apply to this segment: Bench Type is designated as "consolidated bedrock", Extent is either "long" or "intermediate", and Bench Slope is "gradual"
    b. medium: The following combination of attributes apply to this segment: Bench Type is designated as "consolidated bedrock", Extent is either "long" or "intermediate", and Bench Slope is "steep"
    c. low: The following combination of attributes apply to this segment: Bench Type is designated as "consolidated bedrock", and Extent is "short" or "unknown", regardless of Bench Slope. In addition, this designation includes all segments with a Bench Type of "boulder/cobble/bedrock", regardless of the Extent or Bench Slope.
    d. **lowest:** This designation includes all segments with a Bench Type of "sand", regardless of the Extent or Bench Slope.
    e. **unknown:** This designation includes all segments with a Bench Type of "unknown", regardless of the Extent or Bench Slope.
21. **Num_BioRan: "Numeric Ranking for Biodiversity Ranking" - Numeric Ranking** assigned to the "Biological Sensitivity: Biodiversity Ranking" category, to be used to calculate the "Overall Biological Sensitivity Ranking"
    a. **0:** This ranking was used for segments with a "lowest" designation for Biological Sensitivity: Biodiversity Ranking
    b. **1:** This ranking was used for segments with a "low" designation for Biological Sensitivity: Biodiversity Ranking
    c. 2: This ranking was used for segments with a "unknown" designation for Biological Sensitivity: Biodiversity Ranking
    d. 3: This ranking was used for segments with a "medium" designation for Biological Sensitivity: Biodiversity Ranking
    e. 4: This ranking was used for segments with a "high" designation for Biological Sensitivity: Biodiversity Ranking
22. **Num_Total:** "Total Numeric Ranking" – This number is the total sum of the following attributes: Num_FedSta, Num_SedSco, Num_ProRec, Num_HabEng, Num_BioRan. These totals range from 0-18
23. **Over_Rank:** "Overall Biological Sensitivity Ranking" – This is the overall ranking of a given segment, determined by using the "Total Numeric Ranking".
    a. high: Total Numeric Ranking falls between 9-18
    b. medium: Total Numeric Ranking falls between 5-8
    c. low: Total Numeric Ranking falls between 0-4

<u>Additional GIS attributes for PISCO Intertidal Sites</u>

24. **Site:** "Site" - This is the given common name for the locations of intertidal sites that were visited for the BSES.
25. **Type:** "Type" -This is the description of whether scientific data was or was not collected at a site.
    a. **qualitative:** No scientific data was collected
    b. **quantitative:** Scientific data was collected, either through PISCO Coastal Biodiversity Surveys or other PISCO Surveys.
26. **Spec_Rich:** "Species Richness" - This is the number of species found at the sites where PISCO surveys were conducted. Numbers are averaged if the site was sampled more than once. If a site is not part of the PISCO Coastal Biodiversity Surveys, then **unknown** is entered.
27. **Bare_Rock:** "Bare Rock" - The number given is the percent cover of bare rock in the intertidal zone at sites where PISCO surveys were conducted. Numbers are averaged if the site was sampled more than once. If a site is not part of the PISCO Coastal Biodiversity Surveys, then **unknown** is entered.

Status of GIS map

To date, 32,645 of the 34,653 sections have been consolidated into 112 segments, which complete the GIS map. The remaining sections are located south of San Carpoforo Creek, and are not part of the study area.

III.B. Subtidal Survey Methods

For the three key objectives of the study, presented again below, we used quantitative or qualitative sampling methods and analyses. The methods used for each are presented first by describing the purpose of the sampling and analyses, then by the sampling sites used for that analysis, and finally by the detailed sampling protocol used to generate the data used for the analyses.

III.B.1. Comparison of Subtidal Biological Communities in Relation to Their Proximity to Sources of Erosion

Reef habitat and associated biological communities are clearly influenced by the presence of substantial coastal erosion as evidenced by the heavy sediment loads and the negligible abundance of algae, inveretebrate and fish assemblages. To determine how and to what extent biological communities at sites near these point sources of impact are influenced by the nearby presence of these increased erosion materials, we compared the biological communities at sites that differed in proximity to point sources of erosion. Our approach was to identify three sites in close proximity to sites of substantial erosion and three sites paired with these sites more distant from the eroision site. By comparing sites located at different proximities to the erosion site, this approach also allowed us to explore the spatial scope of influence of these erosion events. This subset of survey sites was sampled using methods that allowed more quantitative descriptions and comparisons of the biological communities. The subset of sites was chosen based on their

relative proximity to sites of extant substantial coastal erosion; three ("near") erosion sites (Duck Pond, McWay Rocks and Lucia) and three paired sites more distant ("far") from the erosion sites (Salmon Creek, Partington and Wild Cattle, respectively). The three "near" sites were located within 1 km of the source of erosion. The three-paired "far" sites were located at least 5 km from any potential source of erosion. To further broaden this comparison between sites of differing proximity to erosion sites, we included ten other sites in the Big Sur region where PISCO conducts long-term monitoring of kelp forest communities. These sites ranged from Point Lobos to San Simeon and are listed in the following section in order from northernmost to southernmost (Figure B.1.1). Each of the six subtidal sites used in this comparison (i.e., near and far) was sampled once within a single day and all three near-far paired sites were sampled within the same summer season (June-September) of 2003 and/or 2004.

Figure B.1.1. Map of the three "near" and three "far" sites to sources of erosion, and the PISCO monitoring sites used in the multivariate comparison of subtidal biological communities.

Multivariate analyses of quantitative data

Before comparing the biological communities among the near, far and PISCO sitess, we compared aspects of the reef habitats to determine how similar the reefs were that were used in this comparison. Aspects of the reef habitat that were used in this comparison included the percent cover of bedrock, cobble and sand, and the percent cover of areas of high, moderate, slight, and flat relief. The analysis used for this comparison was the same as that used for the biological communities, described in detail in the following paragraph.

To compare the structure (ie. relative abundance of species) of the algae, invertebrate and fish assemblages as well as the overall community (all three assemblages combined), we used cluster analyses. Cluster analyses were based on the relative density (i.e. number of individuals per transect) of each species of fish, canopy and sub-canopy kelps and mobile invertebrates, and on the relative percent cover of understory algae and sessile invertebrates. Cluster analyses were conducted using PRIMER v6. (Clarke and Gorley 2006). Bray-Curtis similarity measures were calculated between the habitat features and biological communities at individual sites and the resulting similarity matrix was used to cluster sites according to group-average linking. Mean density values were transformed prior to analysis using a fourth-root power transformation to provide for more equal contributions from numerically dominant and rare species. In a cluster analysis that combined both density and percent cover data, all variables were standardized prior to analysis to account for the differing scales of measurement (i.e., each value was divided by the total for that variable across sites resulting in values that are proportions of the total across sites). Differences between the near, far and PISCO site groups were further tested using an ANOSIM test (Clarke and Gorley 2006), which uses site distances computed from the similarity matrix and a resampling procedure to calculate probabilities that sites are distinct according to group status.

III.B.1.1. Sites Used for Comparison of Subtidal Biological Communities

The following sites were used to compare subtidal biological communities in relation to their proximity to point sources of erosion. "Near" sites are near point sources of substantial erosion, whereas "far" sites are more distant or up-current from point sources of substantial erosion.

Quantitative sites surveyed for the BSES:

McWay Rocks ("near")
Partington Cove ("far")
Lucia ("near")
South Mill Creek ("far")
Duck Pond ("near")
Salmon Creek ("far")

Quantitative sites actively monitored by PISCO, but not surveyed specifically for the BSES:

Monastery
Bluefish
Weston

Andrew Molera
Esalen
Big Creek
Lopez Rock
Plaskett Rock
La Cruz
San Simeon

III.B.1.2. Survey Protocols Used for Comparison of Subtidal Biological Communities

The following overview was taken (and slightly modified) from the PISCO website. Successful and efficient surveying of subtidal sites requires careful consideration of logistics and materials. This section gives an overview of the logistical considerations and materials required for conducting the quantitative subtidal surveys.

The sampling of the each site requires effective dive planning such that the divers conduct safe profiles and data are collected efficiently. PISCO has developed well-tested diving profiles and diver allocation plans to implement these survey designs. These dive plans allow us to fully survey a site in one day with four divers dedicated to fish surveys and four other divers dedicated to the algae/invertebrates surveys. Keep in mind that some sites and situations may require adjustments to these general plans.

For fish transects, species identification, quantity, size of all conspicuous fishes encountered, as well as relevant environmental and transect location information, are recorded on standard datasheets for each survey. Algae and invertebrate transects target specific species and are recorded on standard datasheets.

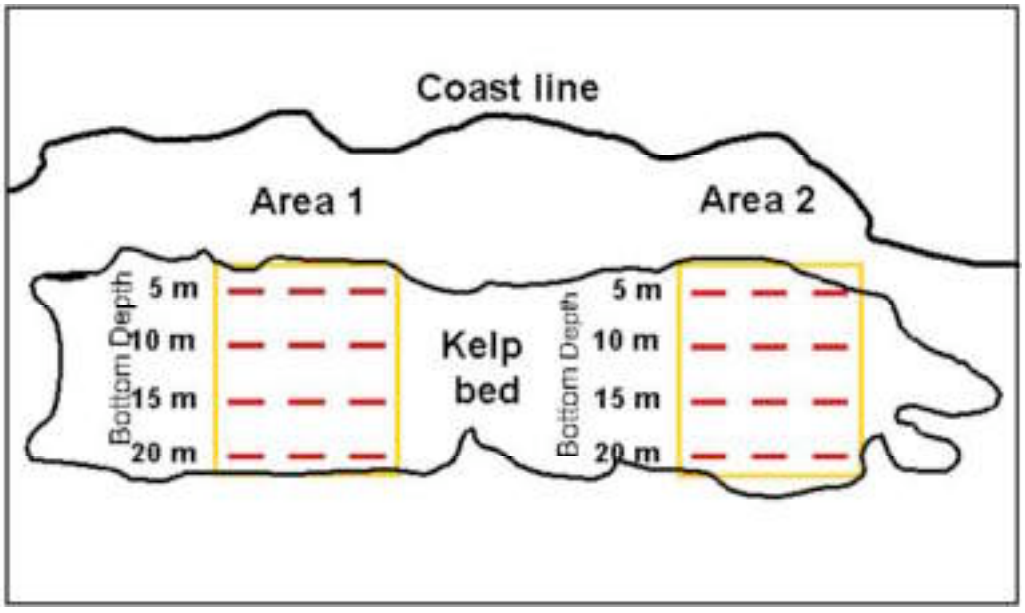


Figure 1.2.1. Dive depths and team allocation to collect fish transect data. Each team consists of two divers. Areas 1 and 2 correspond to different ends of the kelp bed or rocky reef at the study site. (Modified from PISCO.)

Fish Survey Design and Scientific Objectives

At each site, visual surveys by scuba divers are used to quantify the size structure and density of fish populations and the species composition and structure (i.e., relative abundance) of fish assemblages.

To assure that the 3-dimensional habitat created by kelp forests is sampled thoroughly, fish transects are stratified across the face of the reef (alongshore and cross-shore) and vertically through the water column. For this cruise, sampling may be done at a site that lacks substantial kelp cover, possibly because of its proximity to a landslide. In each of the two areas that constitute a site, three transects are sampled in each of four zones (Figure 1.2.1). The zones are stratified to encompass the offshore edge of the reef, the middle of the reef, and as shallow inshore as practical. For example, for a maximum depth of 20 meters (m) the depth zones would be 5, 10, 15, and 20 m. If no appreciable depth stratification is present, then the stratification is based on proximity to the outer edge of the reef and the shore. In each zone, three randomly located transects are sampled along isobaths (constant depth) parallel to shore.

Two portions of the water column (bottom and mid-water) are sampled simultaneously by two divers along each transect. Bottom transects sample the bottom 2 m of the water column, contiguous with the reef surface, and the mid-water transect is located just above and slightly offshore and forward of the bottom transect. The height of the "mid-water" transect varies as a function of 1) bottom depth: 4-6 m above the bottom for bottom depths of 10 m or greater, 2-4 m above the bottom for bottom depths of 6 m or less, and 2) visibility: closer to the bottom if visibility does not allow divers to maintain visual contact.

Both divers in a team conduct their transects identifying, sizing and counting all conspicuous fishes on each 30 m long x 2 m tall x 2 m wide transect. If gender is visually distinguishable (e.g., kelp greenling), this is recorded as well. Divers estimate total length (TL) of small fish (< 15 cm TL) to the nearest cm, and larger fish (> 15 cm) to the nearest 5 cm interval, as they reel out a 30 m tape. Altogether, four divers sample 24 transects (combined "mid-water" and "bottom") at one site within one day.

Logistical overview: there will be two science groups aboard the ship consisting of 4 fish and 4 benthic divers. Both groups will be deployed at each site. Each group will make multiple dives at a site, with a grand total of 24 dives per site. Each site will require an entire day.

Fish survey logistics

For the fish science group: the following text from the PISCO website is intended as an example of how two dive teams can be allocated to sample a complete set of 24 fish transects at one site. A small boat to shuttle dive teams between transect locations will greatly increase the efficiency of diver allocation. PISCO divers currently use these protocols are in central California.

Four divers are needed to complete a fish survey at one site in one day (Figure 1.2.1). One dive team consisting of two divers (team one) will do the deep (20m) and the shallow (5m) transects in both areas. Areas are defined as upcoast and downcoast sections of the same kelp bed or rocky reef (Figure 1.2.1). Team one (two divers) will complete four total dives (160 min bottom time per person per day). Team two (two divers) will do the mid-deep (15m) and mid-shallow (10m) transects in each area during two long (70 min) dives. This requires two total dives for team two (140 min bottom time per person per day).

Both teams conduct the bottom and the mid-water transects simultaneously in each depth zone. One diver samples along the bottom while the second diver samples the mid-water just above and slightly ahead of the bottom diver.

Team one has to use NITROX for their deep transects in order to have enough combined dive time for the day. Team one makes four dives (8 cylinders) in one day: deep (20 m) and shallow (5 m) in area one, then deep and shallow in area two. Each dive should take no more than 40 minutes of bottom time.

Team two can use large SCUBA cylinders (108 cubic feet) to complete both of their two depth levels (i.e. mid-deep [15 m] and mid-shallow [10 m]) in one dive. In order to even out the air consumption between the two divers of team two, it is advantageous if they change their transect levels between the two bottom depth levels. So that one diver does the bottom level on the mid-deep transects and the mid-water level on the mid-shallow transects. The second diver does the reverse. For example, in area one both divers begin the mid-deep (15 m) set of three transects, with diver one on the bottom and diver two above and ahead of diver one. Diver two will consume less air due to his shallower depth. Once all three mid-deep transects are done, both divers swim to mid-shallow to do the three transects. Now diver two is on the bottom transect and diver one is on the mid-water transect above and ahead of diver two. Diver one will consume less air due to his shallower depth. The fish science group will use a total of 12 cylinders per day.

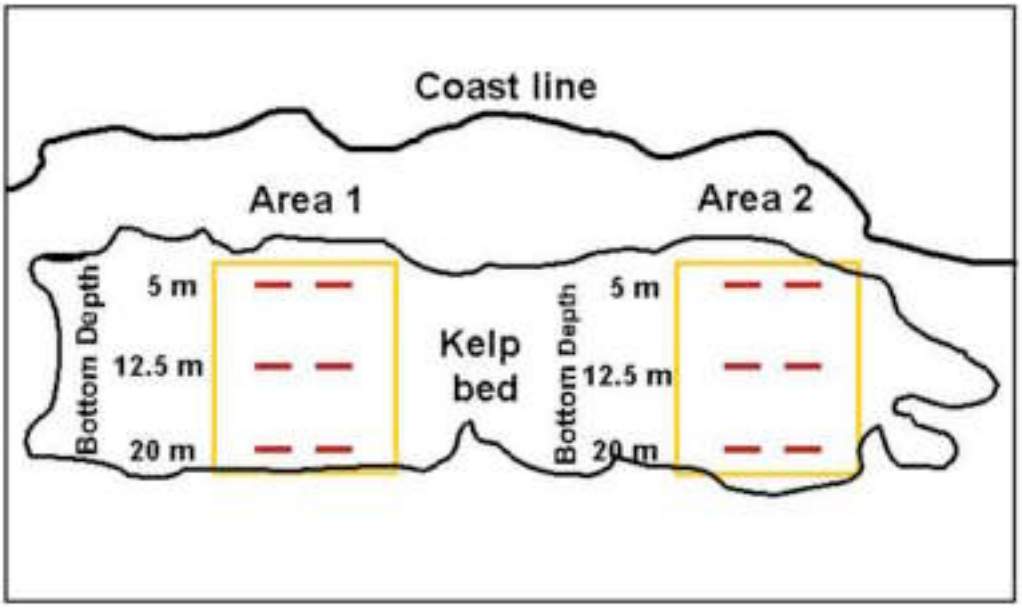


Figure 1.2.2. Dive depths and team allocation to collect invertebrate/algae transect data. Each team consists of two divers. Areas 1 and 2 correspond to different ends of the kelp bed or rocky reef at the study site. (Modified from PISCO.)

Algae and Invertebrate Survey Design and Scientific Objectives

At each monitoring site, visual surveys by scuba divers are used to quantify the size structure and density of macroalgae and invertebrate populations and the species composition and structure (i.e., relative abundance) of their assemblages.

To assure that the entire kelp forest is sampled representatively, benthic transects are stratified across the face of the reef (alongshore and cross-shore). In each of the two areas that constitute a site, two transects are sampled in each of three zones (Figure 1.2.2.). The depth zones are stratified to encompass the offshore edge of the reef, the middle of the reef, and as shallow inshore as practical. For example, for a maximum depth of 20 meters (m) the depth zones would be 5, 12.5, and 20 m. If no appreciable depth stratification is present, then the stratification is based on proximity to the outer edge of the reef and the shore. In each zone, two randomly located transects are sampled along isobaths (constant depth) parallel to shore. Altogether, four divers sample the twelve benthic transects that quantify abundance of invertebrates, algae and substratum characteristics at a site in one day.

Two sampling methods are used to quantify the density and/or cover of algae and invertebrate along each transect. Swaths (belt transects) and uniform point contact (UPC) are used to estimate the density and cover of species, respectively. Each transect is sampled by a pair of divers. One member of the pair focuses on the swath measurements, the other on the UPC. In addition to sampling biotic percent cover, the UPC method is used to estimate the percent cover of substratum type (e.g., sand, cobble, reef, boulder) and relief (e.g., 0-0.1 m, 0.1-1 m, 1-2 m, >2 m).

Swath sampling for algae and invertebrate densities

The purpose of the swath sampling is to estimate the density of conspicuous, solitary and mobile invertebrates as well as specific macroalgae. Individual invertebrates and plants are counted along the entire 30 m long x 2 m wide transect. Typically, a diver slowly swims one direction counting targeted invertebrates and then swims back counting targeted macroalgae. Cracks and crevices are searched and understory algae are pushed aside. No organisms are removed. Any organism with more than half of its body outside the swath is not counted. Transects are divided into three, 10 m segments.

Only *Macrocystis* taller than 1 m are recorded. The number of stipes at 1 m above the substrate on each *Macrocystis* is entered on the datasheet. *Nereocystis*, *Pterygophora*, *Laminaria setchellii*, and *Eisenia arborea* must have stipes > 30 cm to be counted. Only *Cystoseira osmundacea* greater than 6 cm wide are recorded. *Laminaria farlowii* must have a blade greater than 10 cm wide. All *Costaria*, and *Alaria* are counted.

Swath sub-sampling

Very high densities of some species of invertebrates and algae might prohibit enumeration along the entire length of a swath and require some mechanism of sub-sampling. Within each 10 m increment (0-10, 10-20, 20-30 m) of a transect, divers will enumerate organisms until the species threshold abundance (thirty individuals) or the end of the 10 m segment is reached. If the threshold abundance is reached, the diver records the distance along the transect and stops counting that species until the next 10 m segment. This method allows calculation of density estimates based on varying sample area.

Uniform point contact for algae and invertebrate cover

Uniform point contacts (UPCs) are used to estimate the percent cover of species and reef attributes along each 30 m long transect. Divers record three types of information beneath 60-point contacts at every half-meter along the transect: 1) substrate type, 2) physical relief, and 3) percent cover of space-occupying organisms.

The percent cover of space-occupying organisms is estimated by recording what is directly under each point. Any species other than *Laminaria* spp. is recorded. The purpose is to re-create a two-dimensional, "photo style" representation of the percent cover of organisms that are directly attached to the primary substrate. Therefore, epiphytes, epizooids, and mobile organisms are not included. However, algae whose blades are under the point but are attached somewhere else on the primary substrate are included. If points overlay blades of *Laminaria* spp., the blade is pushed aside and the species or substratum beneath it is recorded AND CIRCLED (to indicate that the recorded species was under *Laminaria*). This allows us to include *Laminaria* and not the circled species if we want to calculate the cover of all benthic biota. The UPC species list includes categories for all non-motile, benthic invertebrates and algae.
Reef attributes are also noted for each point. Substrate type is recorded as sand, cobble (≥ 10cm diameter), boulder (10cm - 1 m diameter) or bedrock (≥ 1 m diameter). Physical relief is measured as the greatest vertical relief that exists within a 1-meter wide section across the tape and a 0.5-meter section along that tape that is centered over the appropriate sampling point.

III.B.2. Modelling Methods Used to Predict Sensitivity of Subtidal Communities

To predict the relative sensitivity of shallow (< 20 m depth) subtidal biological communities to erosion materials in sections of the coast throughout the Big Sur coast, we combined three approaches. First, we qualitatively surveyed the subtidal habitats and associated biological communities at 21 sites throughout the CHMP study region. These surveys were combined with the additional 6 sites surveyed quantitatively to directly describe the biological communites and their relative sensitivity at all of these survey sites. Secondly, we examined relationships between habitat variables and biological variables at each survey site to develop predictions of biological sensitivity based on habitat variables. Finally, these predictive models were then used in conjunction with information on nearby survey sites to predict the sensitivity of biological communities to erosion materials at sites that were not directly surveyed. The information collected for all survey sites as well as the predicted sites was used to populate the GIS attribute tables associated with each section of the CHMP study region.

In contrast to the intertidal surveys, the 21 qualitative subtidal survey sites and additional 6 quantitative subtidal survey sites characterized much of the CHMP study region (see sections below). To predict and characterize the relative sensitivity of non-surveyed sites, we first examined the relationships between key geological and oceanographic variables and key characteristics of the biological community at each of the sites surveyed. Predictive environmental variables that were considered in this analysis included (1) reef slope (measured as the distance from the intertidal to the 20 m isobath, in meters), (2) 2-dimensional area of the kelp canopy based on aerial images, (3) the direction of exposure to oceanic swells (northern, southern and western), (4) evidence of extant erosion directly shoreward of the survey site, subjectively categorized as light, moderate and heavy, (5) an index of the relative abundance of species and communities at a site that are susceptible to sediment scour, burial, and/or water column turbidity based on underwater records of the relative presence and size of sediment (four categories) at the survey site, and (6) geology (Franciscan, igneaous or sedimentary rock). Predicted attributes of the biological communities that were included in these analyses were (1) the species richness of algae, invertebrates and fishes, separately, (2) total species richness, and (3) the likelihood of occurrence of subtidal managed species of concern (none likely present, none observed, at least one species observed or likely to be present). The relationship between the above environmental features and the biological response variables were tested for using regression analyses for continuous environmental variables (e.g. reef slope, aerial extent of kelp canopy) and single factor Analyses of Variance (ANOVA) for categorical variables (e.g., exposure, evidence of erosion).

Only those variables that were significantly related to variation in the biological variables among sites were used to predict the biological sensitivity of sites that were not sampled. Species richness of algae was not related to exposure (Figure 2.1), but species richness of invertebrates, fishes, and overall community richness were significantly greater on southern and western-facing exposures than north-facing exposures (Figures 2.2, 2.3, 2.4, respectively). Species richness of algae and fishes did not differ among the rock types (Figures 2.5, 2.6, respectively), but invertebrate species richness and overall species richness (largerly driven by the large number of invertebrate species) were significantly lower on Franciscan rock (Figure 2.7, 2.8, respectively). There was no significant relationship between reef slope and the species richness of algae,

invertebrates or fishes (Figure 2.9). Nor was there a significant relationship between the aerial extent of the kelp canopy and the species richness of algae, invertebrates or fishes, or all species combined (Figure 2.10). There was no difference in species richness of algae, invertebrates, fishes or all species combined among the categories of extent of coastal erosion (Figures 2.11, 2.12, 2.13 and 2.14, respectively). There was no significant difference in the species richness of algae, invertebrates, fishes or all species combined and the estimated relative abundance of species susceptibile to scour or burial (Figures 2.15, 2.16, 2.17, and 2.18, respectively).

In addition to the use of those environmental variables identified above that explained variation in species richness of one or more taxonomic groups (e.g., exposure), we used the sensitivity rankings of nearby surveyed sites to extrapolate to non-surveyed sites. These combined approaches were the basis of the predicted rankings of sensitivity of unsurveyed sites that were incorporated into the GIS attribute tables.

Figure 2.1. Algal species richness and direction of exposure. No significant difference in species richness among exposures.

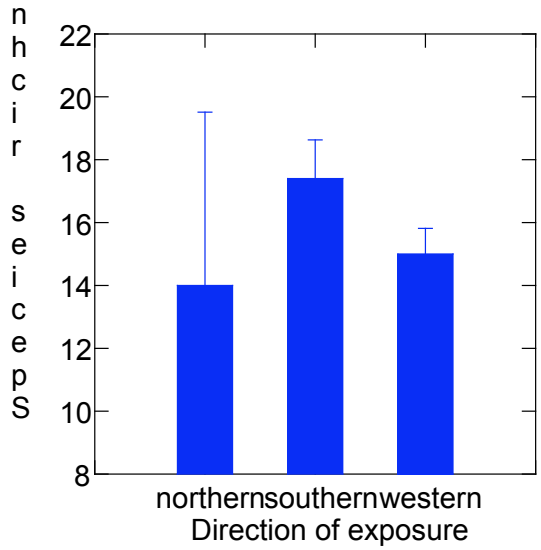


Figure 2.2. Invertebrate species richness and direction of exposure. Species richness was significantly lower on northern exposure than southern and western exposures (p=0.047).

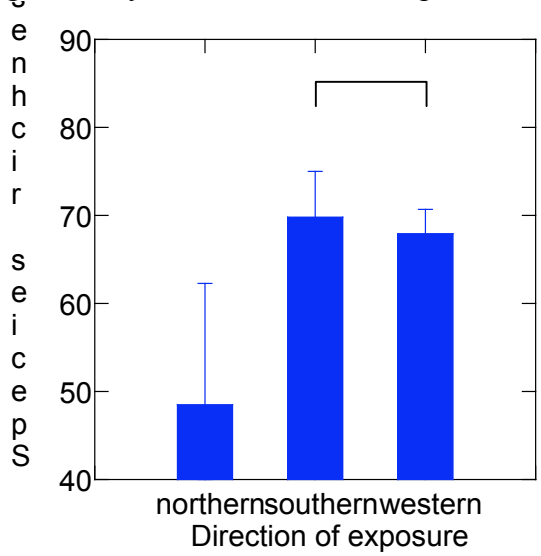


Figure 2.3. Fish species richness and direction of exposure. Species richness was significantly lower on northern exposure than southern and western exposures (p=0.043).

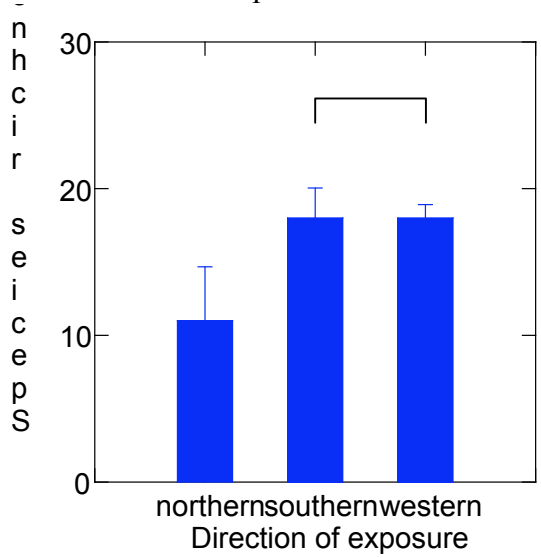


Figure 2.4. Total species richness and direction of exposure. Species richness was significantly lower on northern exposure than southern and western exposures (p=0.008).

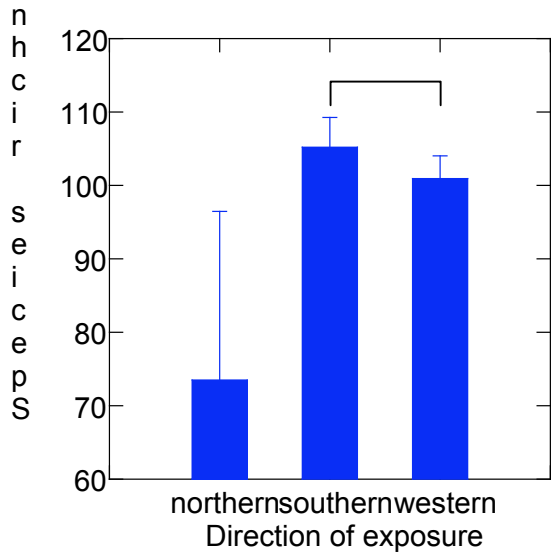


Figure 2.5. Algal species richness and geology. No significant differences in species richness among rock types.

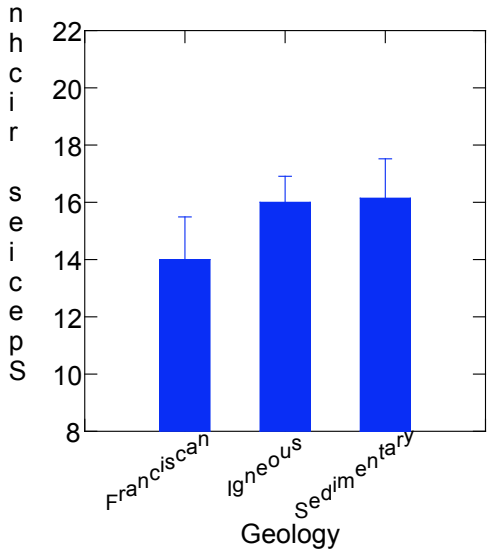


Figure 2.6. Fish species richness and geology. No significant differences in species richness among rock types.

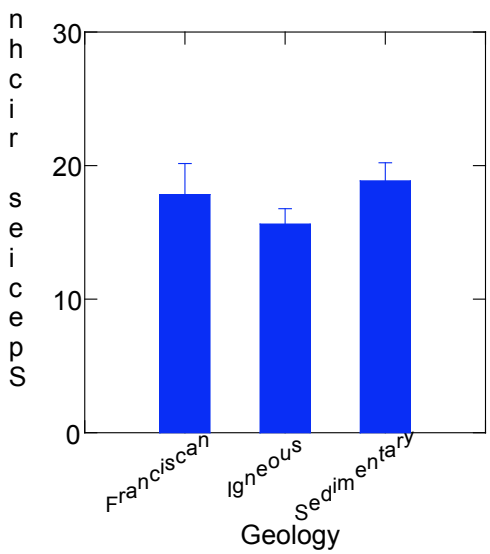


Figure 2.7. Invertebrate species richness and geology. Species richness was significantly lower on Franciscan than sedimentary rock (p=0.020).

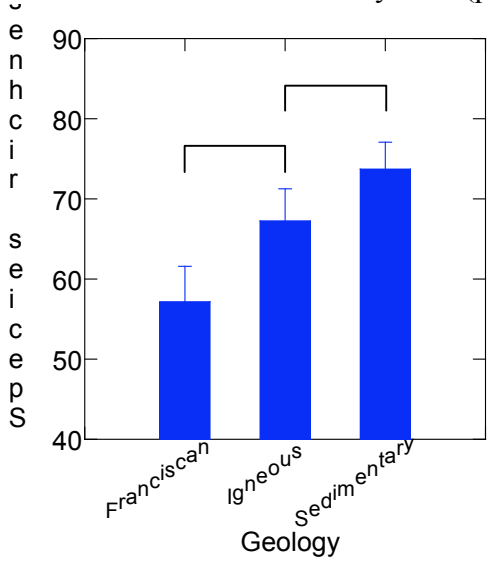


Figure 2.8. Total species richness and geology. Species richness was significantly lower on Franciscan than sedimentary rock (p=0.024).

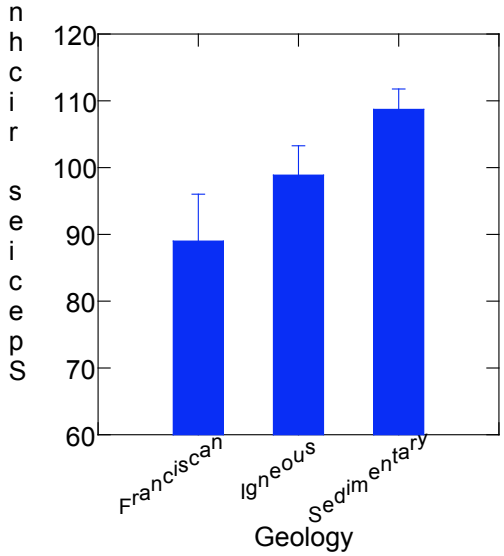


Figure 2.9. Species richness as a function of reef slope (meters). Regression is not significant for any group.

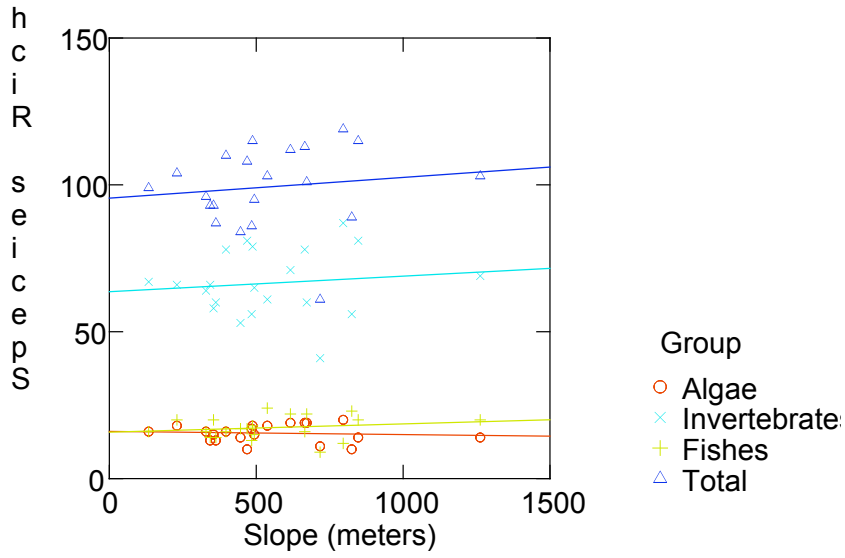


Figure 2.10. Species richness as a function of kelp area (m^2). Regression is not significant for any group

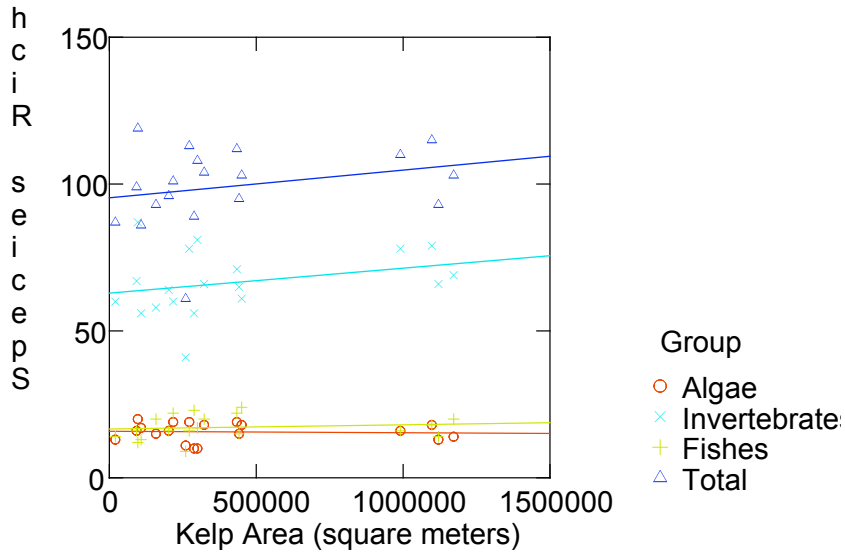


Figure 2.11. Algal species richness and extant erosion. Species richness did not differsignificantly among erosion categories.

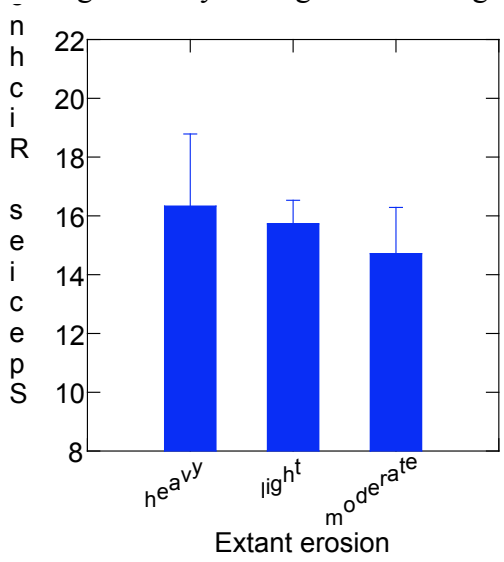


Figure 2.12. Invertebrate species richness and extant erosion. Species richness did not differ significantly among erosion categories.

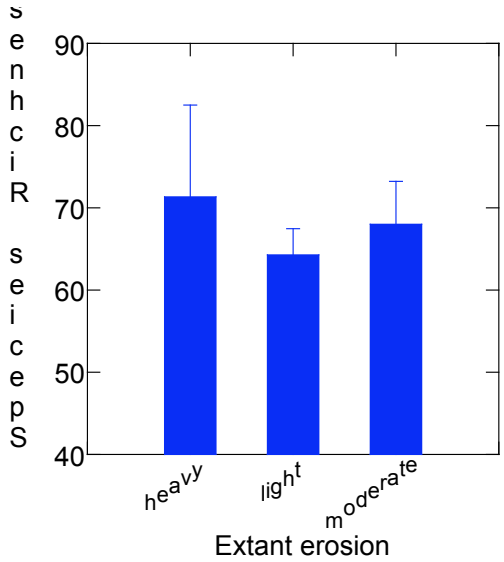


Figure 2.13. Fish species richness and extant erosion. Species richness did not differ significantly among erosion categories.

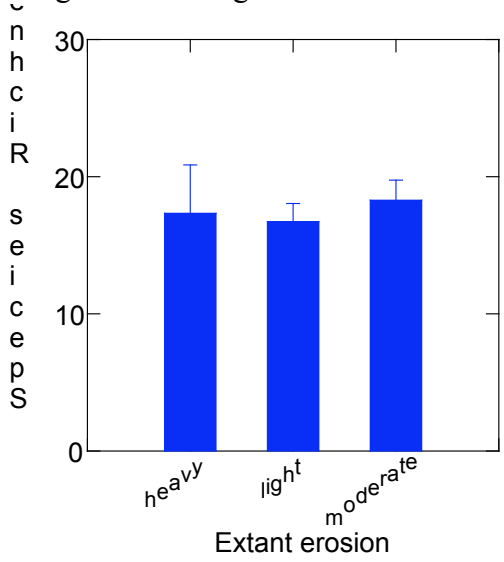


Figure 2.14. Total species richness and extant erosion. Species richness did not differ significantly among erosion categories.

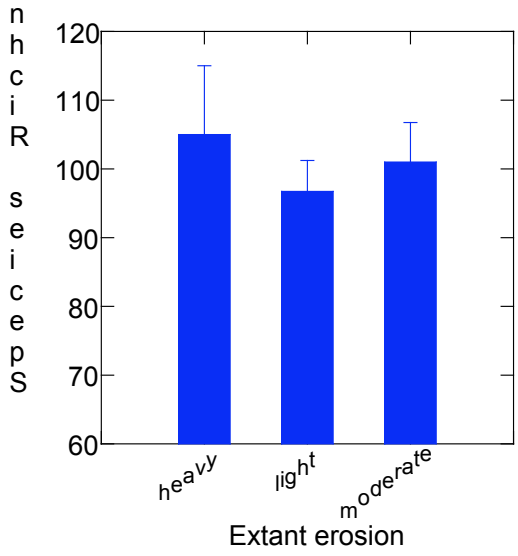


Figure 2.15. Algal species richness and index of susceptibility to scour or burial (0 = the site is not susceptible (i.e. sandy area), 1 = can tolerate moderate sediment loads, 2 = we do not know, 3 = can tolerate only minor sediment loads, and 4 = the site is susceptible). There is no significant difference in species richness among the levels of scour/burial susceptibility.

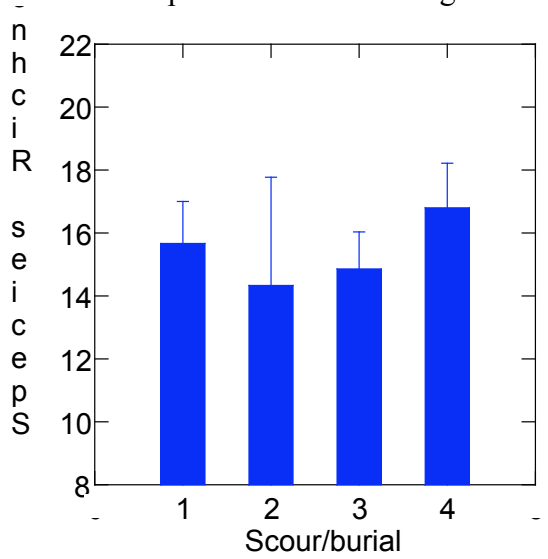


Figure 2.16. Invertebrate species richness and index of susceptibility to scour or burial (0 = the site is not susceptible (i.e. sandy area), 1 = can tolerate moderate sediment loads, 2 = we do not know, 3 = can tolerate only minor sediment loads, and 4 = the site is susceptible). There is no significant difference in species richness among the levels of scour/burial susceptibility ($p=0.073$).

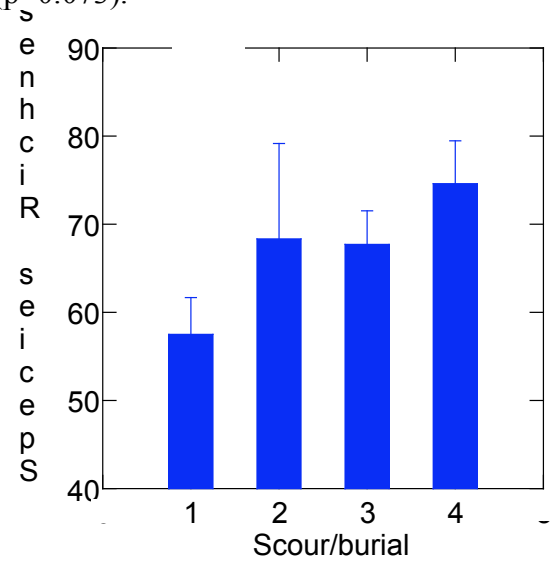


Figure 2.17. Fish species richness and index of susceptibility to scour or burial (0 = the site is not susceptible (i.e. sandy area), 1 = can tolerate moderate sediment loads, 2 = we do not know, 3 = can tolerate only minor sediment loads, and 4 = the site is susceptible). There is no significant difference in species richness among the levels of scour/burial susceptibility

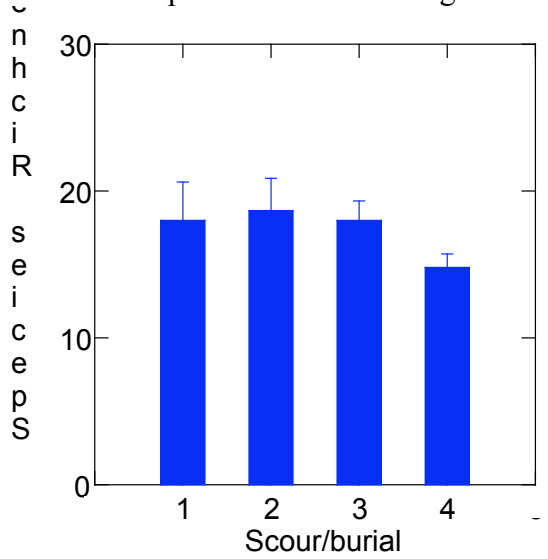
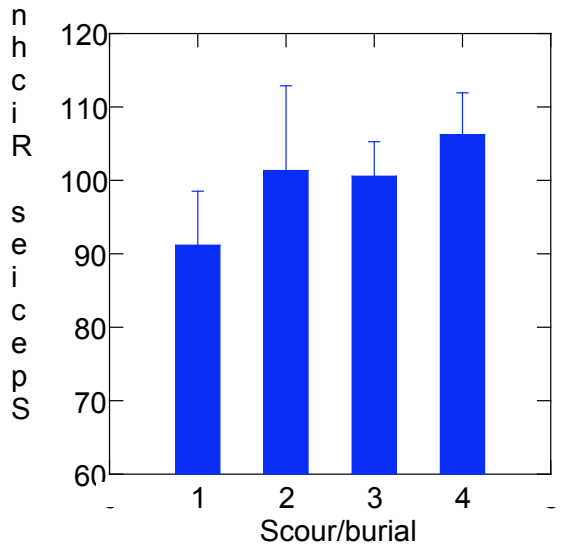


Figure 2.18. Total species richness and index of susceptibility to scour or burial (0 = the site is not susceptible (i.e. sandy area), 1 = can tolerate moderate sediment loads, 2 = we do not know, 3 = can tolerate only minor sediment loads, and 4 = the site is susceptible). There is no significant difference in species richness among the levels of scour/burial susceptibility.



III.B.2.1. Attributes Used for Predictive Sensitivity Modelling and GIS Attribute Tables

The modeling exercise described in the previous section to predict sensitivity of biological communities at sites in the CHMP study region used some of the following habitat and biotic attributes. These attributes are also incorporated into GIS attribute tables for each section of the coast.

1. **Site name**: this refers to the name given to the site surveyed by divers. It may be related to a nearby geographic feature (e.g., point, cape, creek) or a feature of Highway 1 itself (e.g., bridge or mile marker).

2. **Slope**: this refers to the distance from the intertidal to the 20 m isobath. This was calculated using a GIS layer and a straight line based on the compass heading of the transect divers used while conducting the survey. There are an infinite number of lines from shore to the 20 m isobath. We chose to use the line that most closely approximated the one taken by divers.

3. **Transect length**: this refers to the estimated length of a transect covered by the divers. In general, divers began a transect at the outer edge of the kelp bed and swam as shallow as possible, following a compass heading towards shore and through the kelp bed. This was estimated by measuring the distance from the outer edge of the kelp bed to the inner edge of the kelp bed using a GIS layer. In some cases, this may be an underestimate of the actual distance traversed, since during some of the surveys divers were able to swim beyond the inner edge of the kelp bed.

4. **Kelp area**: this refers to an estimate of the surface area (m^2) of canopy cover in the kelp bed. A kelp bed was delineated as a single unit based on a subjective interpretation of kelp canopy cover maps. Kelp canopy cover maps included a composite of 1989, 2002, 2003, and 2004 aerial survey data. Boundaries were then drawn on a map and transcribed to a GIS layer. Bounding areas were created and the kelp cover within these areas was calculated.

5. **Exposure**: this refers to the direction the site generally faces (i.e. southern, western, northern). Central California typically experiences northwestern swell, which impacts northern and western-facing coastline, while southern exposures (e.g., leeward side of a headland or point) are more protected. However, southern swells also occur periodically. Exposure was determined by examining a map of the location.

6. **Creek influence**: this refers to the influence of freshwater input on the survey site. Although there are 26 identified creeks, rivers or other drainages along the area of interest, all but a few are highly seasonal and contribute very little freshwater during majority of the year.
    a. Minimal = not likely influenced by creeks at all
    b. Minor = may be influenced by creeks seasonally, but to small extent
    c. Moderate = likely to be influenced during rainy season, extent unknown

7. **Extant erosion**: this refers to the amount of visible erosion on the cliffs at the survey site. We examined two sets of digital images to evaluate this: the aerial images at the California

Coastal Records Project (http://www.californiacoastline.org/) and shipboard images taken during the surveys.

a. None visible = no sediment or other terrigenous debris visible
b. Light = some terrigenous debris visible, but either small in overall volume or spatially very restricted
c. Moderate = terrigenous debris visible, possibly on shore, at multiple cliff locations or heavy in a few, limited areas
d. Heavy = terrigenous debris visible, on shore, widespread at site, high volume in multiple locations

8. **Geology**: this refers to the geology of the site, which was based on several sources, including: a GIS layer indicating geologic units, discussions with geologists from the California Geological Survey, and direct observation.

a. Unknown = we were not able to identify the geological type of substrate
b. Granitic = granite or a form of granite
c. Franciscan = a relatively weak geologic unit
d. Sedimentary = a relatively weak rock formed by sediment deposits and pressure
e. Igneous = rock formed from a volcanic process

9. **Managed species sensitivity index**: this refers to a numeric score for sites that have one or more species of special concern. Species of concern are those listed under the Endangered Species Act or protected with special status by any state or Federal resource agency (e.g., California Department of Fish and Game, US Fish and Wildlife Service).

a. 0 = all managed species not likely present
b. 2 = managed species not observed
c. 4 = at least one managed species noted

10. **Scour/burial/turbidity sensitivity index**: this refers to a numeric score for sites that contain species and communities susceptible to sediment scour, burial, and/or water column turbidity.

a. 0 = no species susceptible to scour or burial present at the site (i.e. sandy area)
b. 1 = species at the site can tolerate moderate sediment loads
c. 2 = we do not know
d. 3 = species at the site can tolerate only minor sediment loads
e. 4 = many species susceptible to scour or burial present at the site

11. **Prolonged recovery sensitivity index**: this refers to a numeric score indicating whether a site will likely require a long amount of time to return to its pre-impacted state. This prediction is based on the grain size of sand at the site, which indicates whether it is a high-energy site (i.e. large grain size) with tremendous water movement via currents and surge, or if it is a low-energy site (i.e. fine silts and small grain size) that retains terrigenous input.

a. 0 = not likely a prolonged recovery
b. 2 = unknown
c. 4 = likely a prolonged recovery

12. **Biogenic habitat sensitivity index**: this refers to a numeric score indicating the relative degree to which invertebrate taxa provide habitat for other organisms at the site. We selected 28 taxa as representatives, including 3 sponges, the California hydrocoral, Pacific giant scallop, a vermetid gastropod, 4 tube-dwelling annelids, 3 erect bryozoans, and 11 compound tunicates. We then calculated the proportion present at each site. On average, 11.7 of the 28 taxa were present (maximum 17, minimum 7) and none of the sites had 10 or 13 taxa present.

a. 1 = below mean number biogenic taxa (<9 taxa present)
b. 2 = mean number of biogenic taxa (10-12)
c. 3 = unknown number of biogenic taxa
d. 4 = above mean number of biogenic taxa (13-15)
e. 5 = highest number of biogenic taxa (>16)

13. **Relative richness sensitivity index**: this refers to a numeric score indicating the relative number of algal, invertebrate, and fish species or taxa recorded at the site. Mean species/taxon richness was 99 (standard deviation 14).

a. 1 = well below mean (<85)
b. 2 = below the mean (85-95)
c. 3 = mean (96-102)
d. 4 = above the mean (103-113)
e. 5 = well above the mean (>113)

14. **Biodiversity**: this refers to the total number of species/taxa observed during a qualitative subtidal survey. This does not accurately indicate the number of species present, but is instead an indication of the macroscopic, non-cryptic species that were easily observed during a survey by three trained research divers.

15. **Overall score**: this refers to the overall sum of all 5 sensitivity indices. The maximum score possible is 22 and the minimum possible is 0. The actual range of overall scores was from a minimum of 3 to a maximum of 21.

16. **Overall value**: this refers to the relative value of the site as compared to all 21 sites qualitatively surveyed based on the sum score.

a. Lowest = ≤7
b. Low = 8-9
c. Medium = 10-14
d. High = 15-17
e. Highest = 18-21

17. **Bottom type**: this refers to the estimated percent cover of substrate types by three depth categories. Substrate types were sand, gravel (3-8 mm in diameter), cobble (1-10 cm diameter), boulder (0.5-4 m diameter), or bedrock. Depth zones were deep (60-40 ft), mid-deep (40-20 ft), or shallow (<20 ft).

a. Bottom_dp_sand: percent cover of sand in the deep zone
b. Bottom_mid_sand: percent cover of sand in the mid-deep zone
c. Bottom_shal_sand: percent cover of sand in the shallow zone
d. Bottom_dp_gravel: percent cover of gravel in the deep zone

e. Bottom_mid_gravel: percent cover of gravel in the mid-deep zone
f. Bottom_shal_gravel: percent cover of gravel in the shallow zone
g. Bottom_dp_cobble: percent cover of cobble in the deep zone
h. Bottom_mid_cobble: percent cover of cobble in the mid-deep zone
i. Bottom_shal_cobble: percent cover of cobble in the shallow zone
j. Bottom_dp_boulder: percent cover of boulder in the deep zone
k. Bottom_mid_boulder: percent cover of boulder in the mid-deep zone
l. Bottom_shal_boulder: percent cover of boulder in the shallow zone
m. Bottom_dp_bedrock: percent cover of bedrock in the deep zone
n. Bottom_mid_bedrock: percent cover of bedrock in the mid-deep zone
o. Bottom_shal_bedrock: percent cover of bedrock in the shallow zone

18. **Relief**: this refers to the amount of vertical relief at the site by depth zone. There are four bins of vertical relief: 1) 0-10 cm tall, such as flat sandy areas; 2) 0.1-1 m, such as modest amounts of relief from small rocks and boulders; 3) 1-2 m, such as large boulder and bedrock reefs with drop offs; and 4) >2 m, such as large vertical walls on pinnacles. Depth zones were deep (60-40 ft), mid-deep (40-20 ft), or shallow (<20 ft).

a. Relief_deep_0to10: percent vertical relief in the range of 0-10 cm in the deep zone
b. Relief_deep_10to1: percent vertical relief in the range of 0.1-1 m in the deep zone
c. Relief_deep_1to2: percent vertical relief in the range of 1-2 m in the deep zone
d. Relief_deep_>2: percent vertical relief >2 m in the deep zone
e. Relief_mid_0to10: percent vertical relief in the range of 0-10 cm in the mid-deep zone
f. Relief_mid_10to1: percent vertical relief in the range of 0.1-1 m in the mid-deep zone
g. Relief_mid_1to2: percent vertical relief in the range of 1-2 m in the mid-deep zone
h. Relief_mid_>2: percent vertical relief >2 m in the mid-deep zone
i. Relief_shal_0to10: percent vertical relief in the range of 0-10 cm in the shallow zone
j. Relief_shal_10to1: percent vertical relief in the range of 0.1-1 m in the shallow zone
k. Relief_shal_1to2: percent vertical relief in the range of 1-2 m in the shallow zone
l. Relief_shal_>2: percent vertical relief >2 m in the shallow zone

19. **Mpyrifera_aerial**: this refers to surface canopy cover based on a composite view of aerial surveys spanning multiple years (1989, 2002, and 2003). Most canopy cover is *Macrocystis pyrifera* (giant kelp), but other kelps, most notably the bull kelp (*Nereocystis luetkeana*), can also contribute to observed canopy cover. Based upon an examination of the composite maps, one of three attributes was given.

a. Absent = no kelp canopy was present
b. Sparse = kelp canopy is scattered, with numerous gaps
c. Abundant = kelp canopy thick and widespread

20. ***Macrocystis pyrifera* relative abundance**: this refers to the relative density of giant kelp subtidally (i.e. not based on canopy coverage).

a. 1 = rare (1-2 or less than 10% of average)
b. 2 = few (less than average)
c. 3 = average/typical (typical of what was seen across surveyed sites)
d. 4 = abundant (above average abundance)

e. 5 = very abundant (far more abundant >4 times than average)

21. ***Nereocystis luetkeana*** **relative abundance**: this refers to the relative density of bull kelp subtidally (i.e. not based on canopy coverage).

a. 1 = rare (1-2 or less than 10% of average)
b. 2 = few (less than average)
c. 3 = average/typical (typical of what was seen across surveyed sites)
d. 4 = abundant (above average abundance)
e. 5 = very abundant (far more abundant >4 times than average)

22. ***Pterygophora californica*** **relative abundance**: this refers to the relative subtidal density of a stipitate understory kelp.

a. 1 = rare (1-2 or less than 10% of average)
b. 2 = few (less than average)
c. 3 = average/typical (typical of what was seen across surveyed sites)
d. 4 = abundant (above average abundance)
e. 5 = very abundant (far more abundant >4 times than average)

23. ***Phyllospadix*** **spp. percentage**: this refers to the relative percent cover of surfgrass (*Phyllospadix torreyi* or *P. scouleri*) among all algae/plant cover at subtidal depths from 0 to 20 ft.

24. ***Stylaster californicus*** **relative abundance**: this refers to the relative abundance of the California hydrocoral (*Stylaster californicus*), a fragile and slow-growing species found in high-flow, clear water habitats.

a. Unknown = no information provided
b. Unlikely = *Stylaster* is not likely present based on habitat type or water quality
c. Undetected = *Stylaster* was not observed but may be present
d. Sparse = *Stylaster* was present, but in low numbers
e. Aubundant = *Stylaster* was present in high numbers (relative to this species)

24. ***Strongylocentrotus*** **spp. relative abundance**: this refers to the relative abundance of the sea urchins (*Strongylocentrotus purpuratus* and *S. franciscanus*), a fragile and slow-growing species found in high-flow, clear water habitats.

a. Unknown = no information provided
b. Unlikely = urchins not likely present based on habitat type or water quality
c. Undetected = urchins not observed but may be present
d. Evidence = urchin test(s) observed
e. Sparse = urchins present, but in low numbers
f. Common = urchins present in moderate numbers

25. ***Haliotis*** **spp. relative abundance**: this refers to the relative abundance of abalone species (*Haliotis rufescens*, *H. walallensis*, and *H. kamtschatkana*).

a. Unknown = no information provided
b. Unlikely = abalone not likely present based on habitat type or water quality
c. Undetected = abalone not observed but may be present

d. Evidence = abalone shell(s) observed
e. Sparse = abalone present, but in low numbers
f. Common = abalone present in moderate numbers

26. ***Scorpaenichthys marmoratus*** **relative abundance**: this refers to the relative abundance of adult cabezon (*Scorpaenichthys marmoratus*) observed by divers.

a. 1 = well below mean
b. 2 = below the mean
c. 3 = mean
d. 4 = above the mean
e. 5 = well above the mean

27. ***Ophiodon elongatus*** **relative abundance**: this refers to the relative abundance of adult lingcod (*Ophiodon elongatus*) observed by divers.

a. 1 = well below mean
b. 2 = below the mean
c. 3 = mean
d. 4 = above the mean
e. 5 = well above the mean

28. ***Sebastes carnatus*** **relative abundance**: this refers to the relative abundance of adult gopher rockfish (*Sebastes carnatus*) observed by divers.

a. 1 = well below mean
b. 2 = below the mean
c. 3 = mean
d. 4 = above the mean
e. 5 = well above the mean

29. ***Sebastes chrysomelas*** **relative abundance**: this refers to the relative abundance of adult black-and-yellow rockfish (*Sebastes chrysomelas*) observed by divers.

a. 1 = well below mean
b. 2 = below the mean
c. 3 = mean
d. 4 = above the mean
e. 5 = well above the mean

30. ***Hexagrammos decagrammus*** **relative abundance**: this refers to the relative abundance of adult kelp greenlings (*Hexagrammos decagrammus*) observed by divers.

a. 1 = well below mean
b. 2 = below the mean
c. 3 = mean
d. 4 = above the mean
e. 5 = well above the mean

III.B.2.2. Sites Used for Predictive Sensitivity Modelling

Qualitative subtidal sites surveyed for the BSES

South Malpaso Creek
Granite Canyon Bridge
Castle Rock
North Wreck Beach
Grimes Point
Lafler Rock
Sycamore Draw
Partington Cove
McWay Rocks
South Anderson Landing
Dolan Rock
Lucia
Limekiln
Kirk Creek
South Mill Creek
Tide Rock
South Plaskett Rock
Cape San Martin
Redwood Gulch
North Salmon Creek
Mile 73.5

III.B.2.3. Protocols Used for Predictive Sensitivity Modelling

The purpose of qualitative surveys was to evaluate the relative abundance of major members of the kelp forest community. Three research divers and one videographer qualitatively surveyed the algae (Readdie/Kusic), invertebrates (Lonhart), and fishes (Carr) at each of the 21 qualitative study sites. Sites were surveyed non-destructively, targeting macroscopic algae, invertebrates, and fishes found on primary substrate (e.g., rocks, reef, sand). Starting at the outer edge of the kelp forest, and at a depth of 60 ft (18 m), all species observed were recorded on a data sheet. Using a compass heading into shore, divers swam a transect through the kelp forest, noting species presence through each of the depth zones, continuing to dive as shallow as safety permitted. Species were noted both while swimming above the bottom and while making periodic stops (2-3 minutes) throughout the entire dive. Additional biological features, such as characteristic species groups and assemblages, were also noted.

Divers also recorded physical features of the kelp forest, including bottom type and geology, relief, sediment size, and slope. In general, the survey data were collected within three subtidal depth zones: shallow = 0-5 m (<20 ft); mid-deep = 6-12 m (20-40 ft); and deep = 13-18 m (40-60 ft).

Qualitative survey methods for subtidal algae

Analysis of the qualitative algae surveys included two components, (1) population assessments of the relative abundance of each species among the 21 survey sites, and the presence of the three algae species (*Macrocystis pyrifera, Nereocystis luetkeana* and *Pterygophora californica*) and the surfgrasses (*Phyllospadix* spp.) of particular concern, and (2) a community assessment of the species richness (number of species) of algae at each site.

The following rating system was used to generate the table of relative abundances for algae at qualitative survey sites (Appendix B):

1 = rare (1-2 or less than 10% of average)
2 = few (less than average)
3 = average/typical (typical of what was seen across surveyed sites)
4 = abundant (above average abundance)
5 = very abundant (far more abundant >4 times than average)

For sites with percentages, the ratio of algae to inverts was estimated first and the percentages that made up each of seven general categories of algae were listed, e.g.:

% cover of algae/invertebrates:	60/40
Percent cover of algae:	
Foliose Red	5%
Brown	2%
Green Algae	0%
Red Crust	0%
Corraline Crust	2%
Articulated Coralline	80%
Phyllospadix spp	10%
---	---
Total	60%

Qualitative survey methods for subtidal invertebrates

Analysis of the qualitative invertebrate survey data included two components, (1) population assessments of the relative abundance of each species among the 21 survey sites, and the presence of the three invertbrate taxa of particular concern, including the California hydrocoral (*Stylaster californicus*), red abalone (*Haliotis rufescens*), and red or purple urchins (*Strongylocentrotus* spp.), and (2) a community assessment of the number of invertebrate taxa (i.e. species and higher-order taxonomic classifications) at each site.

Relative abundance data for invertebrate taxa were collected by the same diver (Dr. Steve Lonhart) for all 21 qualitative sites. In the majority of cases, organisms were identified to the level of species. Data sheets included 203 species, 27 "genus only" taxa (e.g., *Toxadocia* sp.,

Aglaophenia spp., or *Haliclona*), and 18 other taxa. This last category consists of organisms that were readily recognizable but the species was unknown. For example, one bryozoan (listed as the "gold crust bryozoan") was common at most sites and consistently different from other crustose byrozoans, but its exact identity remains unknown (i.e. a sample needs to be collected and keyed out in the lab).

During the initial 9 qualitative surveys in 2003, each taxon observed was initially recorded as "present" on the data sheet. During that same dive, the observation could be modified to indicate relative abundance (for the particular species) using the following scoring system:

1 = rare (one or a few observed)
2 = uncommon (less than expected)
3 = common (typical abundance)
4 = abundant (more abundant than expected)
5 = super-abundant (abundance at or near maximum ever observed by Lonhart)
? = this species may have been present; there was some difficulty with the ID

In addition, there were two categories for non-living evidence for the presence of a species: mollusk "shells" and urchin "tests."

This scoring system is subjective and based on the experience of the diver (Lonhart) in central California, which spans 13 years and over 500 scientific dives collecting data on invertebrates in kelp forests.

Data were not collected by depth strata in 2003 (i.e. for North Wreck Beach, Sycamore Draw, Partington Cove, McWay Rocks, Dolan Rock, Lucia, South Mill Creek, South Plaskett Rock, and North Salmon Creek). In 2004, the remaining 12 sites were surveyed by depth strata.

In 2004, the following observation categories were added:

F = relatively few were seen (similar to scoring a 2)
M = a moderate number was observed (similar to scoring a 3)
L = lots were observed (similar to scoring a 4)

If a number was written as text on the data table, it indicates an actual count of individuals rather than a relative abundance score.

All data are presented in Appendix C.

Qualitative survey methods for subtidal fish

Analysis of the qualitative fish surveys included two components, (1) population assessments of the relative abundance of each species among the 21 survey sites, and the presence of the five fish species of particular concern (black and yellow rockfish, gopher rockfish, cabezon, lingcod, and painted greenling), and (2) a community assessment of the species richness (number of species) of fishes at each site.

Relative abundance data for fishes were collected by the same diver (Dr. Mark Carr) for all 21 qualitative sites. To calculate the relative abundance of each species among study sites, the number of individuals of each species was recorded and categorized into five categories of

absolute abundance: 1=1, 2= 2-10, 3= 11-50, 4=51-100, 5> 100. These ranks of absolute abundance of a species were compared among the study sites by ranking their values relative to the mean (and median, both of which were very similar values) across all sites: Relative (among-site) abundance levels: 1= well below the among-site mean, 2= below the among-site mean, 3= at the among-site mean, 4= above the among-site mean, and 5= well above among-site mean. Similarly, to compare species richness among the study sites, the number of species (S) recorded at each site was compared with the overall mean (= 17.3) and median (= 17) species richness among the study sites (range = 9 – 24). To simplify comparison of the relative species richness, each site was ranked in one of the following five categories (1-to-5, with 5 as the highest richness): 1= 9-11 species, 2= 12-14 species, 3= 15-19 species, 4= 20-22 species, 5= 23-25 species). Actual calculations are presented in Appendix D.

IV. RESULTS

IV.A. Overview of Results

The results of the surveys and sensitivity analyses are presented in three formats. First, results are presented for each of the sites that were sampled in the *qualitative* intertidal and subtidal surveys. These results include survey metadata, the conditions experienced at the time of the surveys, an overview of each site, including location, key features of the environment, a description of the geology, oceanography, and an overall ranking of the relative biological sensitivity of the site, including the relative (among sites sampled) species richness and abundance of species of special interest. Second, results are presented for the *quantitative* intertidal and subtidal surveys. These results compare the habitat features and species assemblages observed at the survey sites adjacent to point sources of substantial erosion materials with sites of similar habitat and more distant from sites of erosion, as well as other sites that PISCO has conducted quantitative surveys elsewhere in the CHMP study region. These results indicate how different sites adjacent to erosion areas are from other representative areas of the coast. Third, survey data are presented in appendices to the report (Intertidal - Appendix A, Subtidal - Appendices B, C, D). These appendices are also available as accompanying Excel worksheets. Finally, results of the predictions of biological sensitivity for sites that were not surveyed in the study are incorporated into GIS attribute tables in the accompanying GIS.

IV.B. Qualitative Site Specific Results

IV.B.1. South Malpaso Creek

IV.B.1.1. Survey metadata

Table 1.1. Survey type, date completed, and specific location of sampling conducted at South Malpaso Creek.

Survey type	Date completed	Latitude (N)	Longitude (W)
Intertidal	No data		
Qualitative subtidal	October 4, 2004	36 27.955	121 56.154
Quantitative subtidal	No data		
2003	No data		
Upcoast deep	No data		
Downcoast deep	No data		
2004	No data		
Upcoast deep	No data		
Downcoast deep	No data		

IV.B.1.2. Intertidal survey conditions

No data

IV.B.1.3. Subtidal survey diving conditions

Sea surface— Conditions (wind, waves) were moderate.

Surge— Not recorded.

Visibility— Not recorded.

Depth— The maximum depth was 64 ft.

Transect length (estimated)— 320 m.

Bottom time— 55 minutes.

Water temperature— Not recorded.

Distance from shore to 20 m isobath— 343.2 m. The slope is considered steep.

IV.B.1.4. Site overview

Location

South of Malpaso Creek is located 5 km south of Point Lobos and due west of mile 66.8 on Highway 1.

Environment

In the subtidal, the bottom was large boulders and steep rocky outcrops. The reef formed ridges with boulders and rocks in between.

Biological overview

Divers qualitatively surveyed a kelp bed at South of Malpaso Creek on October 4, 2004. Colonial bryozoans were very common, often forming very large colonies.

IV.B.1.5. Nearshore geology and geography

Proximity to creeks and canyons

The South of Malpaso Creek site is near two drainages: Soberanes Creek (0.4 miles south) (0.4 miles north) and Malpaso Creek (1.67 miles north). Neither creek has any significant impact on the dive site.

Exposure, cliffs, and erosion

South of Malpaso Creek has a western exposure. The cliffs are small and granitic, topped by ice plant and dense vegetation. The terrestrial geology is classified as unconsolidated sediment.

Intertidal geology

No data

Subtidal geology and topography

A large sand field was visible at >80 ft deep. By 60 ft the bottom was mostly large granitic outcrops with high vertical relief.

Table 1.5. South of Malpaso Creek qualitative subtidal survey results for reef type and relief by three depth zones. Percentages for each category are based on *in situ* visual diver estimates and review of underwater video (when available).

Depth	Reef Type				Relief			
(meters)	sand	cobble	boulder	bedrock	0-10 m	10-1 m	1-2 m	>2 m
0-6		10	10	80		10	10	80
6-12	10		20	70	10		10	80
12-18	10		40	50	10		10	80

IV.B.1.6. Nearshore oceanography

South of Malpaso Creek faces the west and is exposed to northwestern swell. To our knowledge, there are no data on nearshore currents at this site.

IV.B.1.7. Biology

Intertidal of South Malpaso Creek –

No data

Subtidal of South Malpaso Creek

Overall subtidal ranking

Combining the five subtidal sensitivity indices, South Malpaso Creek scored 16 of 22 points possible (tied with Granite Canyon Bridge) and is considered a site of high value relative to the 21 sites surveyed qualitatively. The species richness ranks—again, relative to the other 21 sites sampled qualitatively—were 17th (tie) for algae, 10th (tie) for invertebrates, and 17th (tie) for fishes. Complete lists of the species encountered are provided in Appendices B-D.

Subtidal species of concern

At South Malpaso Creek, 11 of the 12 subtidal species of concern were observed (only surfgrass was not; Table 1.7).

Table 1.7: Relative abundance of species of special interest and their rank as compared to all 21 qualitative subtidal survey sites

Species	Category	Relative abundance
Phyllospadix spp.	Habitat forming	Not noted
Macrocystis pyrifera	Burial, turbidity sensitivity	Low
Nereocystis luetkeana	Burial, turbidity sensitivity	Medium
Pterygophora californica	Burial, turbidity sensitivity	Medium
Stylaster californicus	Burial, scour sensitivity	Present
Haliotis rufescens	Burial sensitivity	Present
Strongylocentrotus spp.	Burial sensitivity	Present
Scorpaenichthys marmoratus	Burial sensitivity	Below average
Ophiodon elongatus	Burial sensitivity	Above average
Hexagrammos decagrammus	Burial sensitivity	Well below average
Sebastes carnatus	Burial sensitivity	Well below average
Sebastes chrysomelas	Burial sensitivity	Average

Subtidal algae (Readdie/Kusic)

Kelp canopy surface estimate: 20,226 m^2

a) Shallow subtidal zone (0-20 ft)

Canopy

Macrocystis pyrifera was present in low abundance with plants having 40-60 stipes. *Nereocystis luetkeana* was present in low abundance.

Subcanopy

Laminaria setchellii was present in high abundance.

Understory

Foliose reds were 50% of total understory algae— *Botryoglossum/Cryptopleura/Hymenena, Chondracanthus corymbifera/ exasperata*, and *Rhodomenia/Ozophora* were present in high abundance. *Callophyllis spp, Erythrophyllum delesseriodes*, and *Polysiphonia/ Ceramium* were present in medium abundance. *Pikea/FarLowia* was present in low abundance.
Articulated Corallines were 40% of total understory algae.
Brown algae were 10% of total understory algae— *Cystoseira osmundacea* and *Costaria costata* were present in high abundance.

b) Mid-subtidal zone (20 - 40 ft)

Canopy

Macrocystis pyrifera was present in medium abundance with plants having 10-20 stipes. *Nereocystis luetkeana* was present in high abundance.

Subcanopy

Laminaria setchellii was present in high abundance.
Pterogophora californica was present in medium abundance.

Understory

Foliose reds were 45% of total understory algae— *Botryoglossum/Cryptopleura/Hymenena* were present in high abundance. *Chondracanthus corymbifera/ exasperata* were present in medium abundance. *Callophyllis spp, Opuntiella californica, Pikea/FarLowia*, and *Prionitis spp* were present in low abundance.
Crustose Corallines were 2% of total understory algae.
Articulated Corallines were 45% of total understory algae.
Brown algae were 2% of total understory algae— *Cystoseira osmundacea* and *Desmarestia ligulata var.ligulata* were present in medium abundance. *Dicteoneurum/Dictyoneropsis* was present in low abundance.

c) Deep subtidal zone (40-70 ft)

Canopy

Macrocystis pyrifera was present in low abundance with plants having 13-40 stipes.

Subcanopy

Pterogophora californica was present in high abundance but severely damaged, only the stipes remained.

Understory

Foliose reds were 2% of total understory algae— *Botryoglossum/ Cryptopleura/Hymenena, Chondracanthus corymbifera/exasperata*, and *Rhodomenia/Ozophora spp* were present in medium abundance. *Prionitis spp* was present in low abundance.
Crustose Corallines were 80% of total understory algae.
Articulated Corallines were 20% of total understory algae.

Subtidal invertebrates (Lonhart)

a) Shallow subtidal zone (0-20 ft)

At 14 ft I observed numerous brooding anemones (*Epiactis prolifera*) on the chain bladder kelp (*Cystoseira osmundacea*). There were also several juvenile sunflower stars (*Pycnopodia helianthoides*) and a pale, pink-tentacled species of *Urticina*.

b) Mid-subtidal zone (20 - 40 ft)

This site was very reminiscent of diving at Point Lobos. The heads of the northern staghorn bryozoan (*Heteropora pacifica*) decreased in size as depth decreased. The ridges were covered with the strawberry anemone (*Corynactis californica*) and the orange didemnid was also very common at 24 ft. At 23 ft I observed a moderately sized (about 20 m^2) urchin bed (*Strongylocentrotus purpuratus*) with urchins to 6 cm in diameter.

c) Deep subtidal zone (40 - 60 ft)

The fish-eating anemone (*Urticina piscivora*) was common on the very large boulders. Sand extended out to >80 ft and graded into steep rocky outcrops towards 60 ft. The northern staghorn bryozoan (*Heteropora pacifica*) formed numerous large heads. The ridge of one outcrop crested at 48 ft and was covered with the fluted bryozoan (*Hippodiplosia insculpta*), erect coralline algae, and the southern staghorn bryozoan (*Diaperoecia californica*). Gaps between the reef ridges were filled with boulders.

Subtidal fishes (Carr)

A total of 14 species of fish were encountered at this site, ranking below average relative to the mean and median (17 species) among sites surveyed. The number of rockfish (7) and surfperch (4) species were average for the sites surveyed. Only two of the 5 fish species of concern were encountered here; lingcod were above average site abundance, whereas black and yellow rockfish were at average site abundance, and by their absence, cabezon were below average, and gopher rockfish and kelp greenling were well below average site abundance. Species of particularly high abundance included adult blue and olive rockfish, and juvenile blue, olive, black and bocaccio rockfish, and juvenile and adult painted greenling. No species was of particularly low abundance at this site.

a) Shallow subtidal zone (0-20 ft)

Only four species of fish were encountered in the shallow depth zone, including adult stripe perch, painted greenling, blackeye gobies and juvenile black rockfish.

b) Mid-subtidal zone (20 - 40 ft)

Eight species of fish were encountered in the mid-depth zone, including the adults of blue, kelp, black and yellow rockfish, stripe and pile perch, painted greenling, and blackeye gobies, and juvenile blue, olive, black rockfish and painted greenling.

c) Deep subtidal zone (40 - 60 ft)

Thirteen species of fish were encountered in the deep depth zone, including the adults of blue, olive, kelp, black and yellow, and vermilion rockfish, stripe, rainbow, white and pile perch, lingcod, and blackeye gobies, and juvenile olive and bocaccio rockfish and painted greenling.

IV.B.2. Granite Canyon Bridge

IV.B.2.1. Survey metadata

Table 2.1. Survey type, date completed, and specific location of sampling conducted at Granite Canyon Bridge.

Survey type	Date completed	Latitude (N)	Longitude (W)
Intertidal	No data		
Qualitative subtidal	October 4, 2004	36 26.086	121 55.372
Quantitative subtidal	No data		
2003	No data		
Upcoast deep	No data		
Downcoast deep	No data		
2004	No data		
Upcoast deep	No data		
Downcoast deep	No data		

IV.B.2.2. Intertidal survey conditions

No data

IV.B.2.3. Subtidal survey diving conditions

Sea surface— Conditions (wind, waves) were moderate.

Surge— Not recorded.

Visibility— Not recorded.

Depth— The maximum depth was 63 ft.

Transect length (estimated)— 275 m.

Bottom time— 55 minutes.

Water temperature— Not recorded.

Distance from shore to 20 m isobath— 370.0 m. The slope is considered steep.

IV.B.2.4. Site overview

Location

Granite Canyon Bridge is located 10 km south of Point Lobos and due west of mile 64.4 on Highway 1.

Environment

In the subtidal, the bottom was large boulders and steep granitic outcrops. The reef formed ridges with boulders and rocks in between.

Biological overview

Divers qualitatively surveyed a kelp bed at Granite Canyon Bridge on October 4, 2004. Colonial bryozoans were very common, often forming very large colonies.

IV.B.2.5. Nearshore geology and geography

Proximity to creeks and canyons

The Granite Canyon Bridge site is at Granite Creek, which has only seasonal flow.

Exposure, cliffs, and erosion

Granite Canyon Bridge has a western exposure. The cliffs are small and granitic, topped by ice plant and dense vegetation. The terrestrial geology is classified as igneous and/or metamorphic rock.

Intertidal geology

No data

Subtidal geology and topography

At 60 ft the bottom was a patchwork of granitic boulders, cobble and sand. In spite of its proximity to the South of Malpaso Creek site, Granite Canyon Bridge is different. It also appears to receive more wave energy.

Table 2.5. Granite Canyon Bridge qualitative subtidal survey results for reef type and relief by three depth zones. Percentages for each category are based on *in situ* visual diver estimates and review of underwater video (when available).

Depth	Reef Type				Relief			
(meters)	sand	cobble	boulder	bedrock	0-10 m	10-1 m	1-2 m	>2 m
0-6		20	40	40	10	10	40	40
6-12	10	10	60	20	10	30	40	20
12-18	20	20	30	30	10	20	30	30

IV.B.2.6. Nearshore oceanography

Granite Canyon Bridge faces the west and is exposed to northwestern swell. To our knowledge, there are no data on nearshore currents at this site.

IV.B.2.7. Biology

Intertidal of Granite Canyon Bridge

No data

Subtidal of Granite Canyon Bridge

Overall subtidal ranking

Combining the five subtidal sensitivity indices, Granite Canyon Bridge scored 16 of 22 points possible (tied with South Malpaso Creek) and is considered a site of high value relative to the 21 sites surveyed qualitatively. The species richness ranks—again, relative to the other 21 sites sampled qualitatively—were 16th (tie) for algae, 5th (tie) for invertebrates, and 16th (tie) for fishes. Complete lists of the species encountered are provided in Appendices B-D.

Subtidal species of concern

At Granite Canyon Bridge, 8 of the 12 subtidal species of concern were observed (Table 2.7).

Table 2.7: Relative abundance of species of special interest and their rank as compared to all 21 qualitative subtidal survey sites

Species	Category	Relative abundance
Phyllospadix spp.	Habitat forming	Not noted
Macrocystis pyrifera	Burial, turbidity sensitivity	Low
Nereocystis luetkeana	Burial, turbidity sensitivity	Low
Pterygophora californica	Burial, turbidity sensitivity	Medium
Stylaster californicus	Burial, scour sensitivity	Not noted
Haliotis rufescens	Burial sensitivity	Not noted
Strongylocentrotus spp.	Burial sensitivity	Not noted
Scorpaenichthys marmoratus	Burial sensitivity	Below average
Ophiodon elongatus	Burial sensitivity	Below average
Hexagrammos decagrammus	Burial sensitivity	Average
Sebastes carnatus	Burial sensitivity	Well below average
Sebastes chrysomelas	Burial sensitivity	Average

Subtidal algae (Readdie/Kusic)

Kelp canopy surface estimate: 20,226 m^2

a) Shallow subtidal zone (0-30 ft)

Canopy

Macrocystis pyrifera was present in low abundance.
Nereocystis luetkeana was present in low abundance.

Subcanopy

Pterygophora californica was present in medium abundance
Laminaria setchellii was present in medium abundance.

Understory

Foliose reds were 15% of total understory algae— *Botryoglossum/Cryptopleura/Hymenena, Erythrophyllum delesserioides, Pikea/FarLowia spp*, and *Prionitis spp* were present in medium abundance. *Callophyllis spp, Mazzaella spp*, and *Rhodomenia/Ozophora* spp were present in low abundance.
Red crust was 2% of total understory algae.
Crustose Corallines were 3% of total understory algae.
Articulated Corallines were 3% of total understory algae.
Brown algae were 75% of total understory algae— *Alaria marginata* and *Egregia menziesii* were present in high abundance.

b) Mid-subtidal zone (30 - 40 ft)

Canopy

Macrocystis pyrifera was present in medium abundance with plants having 20 stipes.
Nereocystis luetkeana was present in low abundance.

Subcanopy

Laminaria setchellii was present in low abundance.
Pterogophora californica was present in low abundance.

Understory

Foliose reds were 10% of total understory algae— Bo*tryoglossum/Cryptopleura/Hymenena* were present in high abundance. *Pikea/FarLowia* were present in medium abundance. *Rhodomenia/Ozophora* were present in low abundance.
Crustose Corallines were 70% of total understory algae.
Articulated Corallines were 10% of total understory algae.
Brown algae were 10% of total understory algae— *Desmarestia ligulata* var.*ligulata* was present in medium abundance.

c) Deep subtidal zone (40-60 ft)

Canopy

Macrocystis pyrifera was present in low abundance with plants having 30-40 stipes.

Subcanopy

Pterogophora californica was present in high abundance but severely damaged, only the stipes remained.
Laminaria setchellii was present in low abundance.

Understory

Foliose reds were 10% of total understory algae— *Callophyllis flabellulata* and *Constantinia simplex* were present in high abundance.
Botryoglossum/Cryptopleura/Hymenena, Callophyllis spp, *Opuntiella californica*, and *Weeksia spp* were present in medium abundance.
Crustose Corallines were 40% of total understory algae.

Articulated Corallines were 40% of total understory algae.

Subtidal invertebrates (Lonhart)

a) Shallow subtidal zone (0-20 ft)

At 20 ft there was granite gravel the size of marbles and cobble. The six-rayed star (*Leptasterias hexactis*) and the small, unidentified blood star (*Henricia* sp.) were common in this zone.

b) Mid-subtidal zone (20 - 40 ft)

At 25 ft the bottom was a mix of large boulders, small ridges of reef, and coarse sand. Unlike the Malpaso Creek site, there were very few contiguous colonies of encrusting invertebrates (i.e. bryozoans, tunicates, or sponges), which suggests this site receives higher surge and wave energy.

c) Deep subtidal zone (40 - 60 ft)

This site was not similar to the site south of Malpaso Creek. It was more of a patchwork of very large, broken boulders with coble and sand filling the gaps. In general, the site looked very battered by surge. Barnacles covered the boulders and most of the cobble was bare. Some of the sand patches were >8 m wide. At 45 ft there were high densities of the ornate tubeworm (*Diopatra ornata*).

Subtidal fishes (Carr)

A total of 16 species of fish were encountered at this site, ranking average relative to the mean and median (17 species) among sites surveyed. The number of rockfish (8) and surfperch (5) species were average and above average, respectively for the sites surveyed. Two of the 5 fish species of concern were encountered here; black and yellow rockfish and kelp greenling were at average site abundance. By their absence, cabezon, lingcod, and gopher rockfish were below average site abundance. Species of particularly high abundance included juvenile blue rockfish, adult rubberlip and white perch, and adult senoritas. Above-average numbers of adult blue, olive and grass rockfish, juvenile canary rockfish, adult sheephead and adult stripe perch were observed. Species of particularly low abundance were adult painted greenling.

a) Shallow subtidal zone (0-20 ft)

Only three species of fish were encountered in the shallow depth zone, including the adults of olive and grass rockfish, and stripe perch.

b) Mid-subtidal zone (20 - 40 ft)

Twelve species of fish were encountered in the mid-depth zone, including the adults of blue, olive, kelp, black, black and yellow rockfish, the black, stripe, pile, rubberlip, and white perch, adult kelp greenling and senoritas, and juvenile blue rockfish.

c) Deep subtidal zone (40 - 60 ft)

Twelve species of fish were encountered in the deep depth zone, including the adults of blue, olive, kelp, black, black and yellow, and vermilion rockfish, stripe, pile, and white perch, kelp greenling, sheephead, and juvenile blue and canary rockfish.

IV.B.3. Castle Rock

IV.B.3.1. Survey metadata

Table 3.1. Survey type, date completed, and specific location of sampling conducted at Castle Rock.

Survey type	Date completed	Latitude (N)	Longitude (W)
Intertidal	No data		
Qualitative subtidal	October 4, 2004	36 22 36.85	121 54 26.56
Quantitative subtidal	No data		
2003	No data		
Upcoast deep	No data		
Downcoast deep	No data		
2004	No data		
Upcoast deep	No data		
Downcoast deep	No data		

IV.B.3.2. Intertidal survey conditions

No data

IV.B.3.3. Subtidal survey diving conditions

Sea surface— Conditions (wind, waves) were moderate.

Surge— Not recorded.

Visibility— Not recorded.

Depth— The maximum depth was 51 ft.

Transect length (estimated)— 146 m.

Bottom time— 56 minutes.

Water temperature— Not recorded.

Distance from shore to 20 m isobath— 484.4 m. The slope is considered moderate.

IV.B.3.4. Site overview

Location

North of Bixby Landing is located 9 km north of Point Sur and due west of mile 59.7 on Highway 1.

Environment

In the subtidal, the bottom was largely sand with sporadic boulder outcrops and moderately flat.

Biological overview

Divers qualitatively surveyed a kelp bed at North of Bixby Landing on October 4, 2004. There was a mix of invertebrates and algae on the boulders. Areas that lacked algae were dominated by the honeycomb worm (*Phragmatopoma californica*), which is often found in sandy, high-energy habitats.

IV.B.3.5. Nearshore geology and geography

Proximity to creeks and canyons

The North of Bixby Landing site is equidistant from two drainages: Rocky Creek (0.4 miles north) and Bixby Creek (0.4 miles south). Neither of these creeks has sustained flow, nor do they influence the dive site.

Exposure, cliffs, and erosion

North of Bixby Landing has a northern exposure. The cliffs are steep and appear to be granitic. Vegetation is moderate in a few places, but much of the area is exposed rock. The terrestrial geology is classified as igneous and/or metamorphic rock with parts of Franciscan melange.

Intertidal geology

No data

Subtidal geology and topography

At 60 ft the bottom was mostly sand with 2 m high boulders. The coarse sand was also found on top of the boulders.

Table 3.5. North of Bixby Landing qualitative subtidal survey results for reef type and relief by three depth zones. Percentages for each category are based on *in situ* visual diver estimates and review of underwater video (when available).

Depth	Reef Type				Relief			
(meters)	sand	cobble	boulder	bedrock	0-10 m	10-1 m	1-2 m	>2 m
0-6	10	10	30	50	10	20	50	20
6-12	30		20	50	30	20	40	20
12-18	60		15	25	60	20	20	

IV.B.3.6. Nearshore oceanography

North of Bixby Landing faces the north and is exposed to northwestern swell. To our knowledge, there are no data on nearshore currents at this site.

IV.B.3.7. Biology

Intertidal of Castle Rock –

No data

Subtidal of Castle Rock

Overall subtidal ranking

Combining the five subtidal sensitivity indices, Castle Rock scored 8 of 22 points possible (tied with Lafler Rock) and is considered a site of low value relative to the 21 sites surveyed qualitatively. The species richness ranks—again, relative to the other 21 sites sampled qualitatively—were 5th (tie) for algae, 10th (tie) for invertebrates, and 5th (tie) for fishes. Complete lists of the species encountered are provided in Appendices B-D.

Subtidal species of concern

At Castle Rock, 8 of the 12 subtidal species of concern were observed (Table 3.7).

Table 3.7: Relative abundance of species of special interest and their rank as compared to all 21 qualitative subtidal survey sites

Species	Category	Relative abundance
Phyllospadix spp.	Habitat forming	Not noted
Macrocystis pyrifera	Burial, turbidity sensitivity	Low
Nereocystis luetkeana	Burial, turbidity sensitivity	Medium
Pterygophora californica	Burial, turbidity sensitivity	High
Stylaster californicus	Burial, scour sensitivity	Not noted
Haliotis rufescens	Burial sensitivity	Not noted
Strongylocentrotus spp.	Burial sensitivity	Not noted
Scorpaenichthys marmoratus	Burial sensitivity	Below average
Ophiodon elongatus	Burial sensitivity	Below average
Hexagrammos decagrammus	Burial sensitivity	Average
Sebastes carnatus	Burial sensitivity	Well below average
Sebastes chrysomelas	Burial sensitivity	Below average

Additional comments:

Although urchins were not observed during the dive, they may have been present at very low levels in cryptic habitats. In contrast, it is not likely we missed the presence of surfgrass. The shallow subtidal and low intertidal had high proportions of boulders and cobble (Table 4.1), potentially reducing the ability of surfgrass to persist. Neither the intertidal nor subtidal survey teams noted surfgrass, which is conspicuous when present.

Subtidal algae (Readdie/Kusic)

Kelp canopy surface estimate: 20,226 m^2

a) Shallow subtidal zone (0-20 ft)

Canopy

Macrocystis pyrifera was present in low abundance.
Nereocystis luetkeana was present in medium abundance.

Subcanopy

Pterygophora californica was present in high abundance
Laminaria setchellii was present in high abundance.

Understory

Foliose reds were 45% of total understory algae— *Botryoglossum/Cryptopleura/Hymenena, Callophyllis spp*, and *Plocamium/Microcladia spp* were present in high abundance. *Prionitis spp* and *Rhodomenia/Ozophora* were present in medium abundance. *Gelidium spp, Gracilaria spp,* and *Pikea/Falowii* were present in low abundance.
Articulated Corallines were 20% of total understory algae.
Brown algae were 30% of total understory algae— *Desmarestia ligulata* var. *ligulata* was present in high abundance. *Cystoseira osmundacea*, and *Egregia menziessi* were present in medium abundance. *Desmarestia kurilensis/viridis* was present in low abundance.
Green algae were 5% of total understory algae— *Ulva spp* were present in medium abundance.

b) Mid-subtidal zone (20 - 40 ft)

Canopy

Nereocystis luetkeana was present in low abundance.

Subcanopy

Laminaria setchellii was present in high abundance.
Pterogophora californica was present in high abundance.

Understory

Foliose reds were 45% of total understory algae— *Chondracanthus corymbifera/exasperata* were present in high abundance. Botryo*glossum/Cryptopleura/Hymenena, Callophyllis spp, Fauchea spp, Plocamium/Microcladia spp,* and *Rhodomenia/Ozophora spp* were present in high abundance.
Crustose Corallines were 10% of total understory algae.
Articulated Corallines were 30% of total understory algae.
Brown algae were 5% of total understory algae— *Desmarestia ligulata var ligulata* was present in medium abundance. Cystos*eira osmundacea, Desmarestia kurilensis/viridis, Desmarestia latifrons*, and *Dicteoneurum/Dictyoneropsis* were present in low abundance.
Green algae were 10% of total understory algae— *Ulva spp* were present in medium abundance.

c) Deep subtidal zone- Deepest area at site is 40 ft.

Subtidal invertebrates (Lonhart)

a) Shallow subtidal zone (0-20 ft)

At 17 ft there were a few brooding anemones (*Epiactis prolifera*) on the chain bladder kelp (*Cystoseira osmundacea*), but fewer than seen during the same day at Malpaso Creek and Granite Canyon Bridge. Juvenile sunflower stars (*Pycnopodia helianthoides*) ≤20 cm in diameter were common.

b) Mid-subtidal zone (20 - 40 ft)

The middle zone included orange puffball sponges (*Tethya aurantia*), the giant green anemone (*Anthopleura xanthogrammica*), the gumboot chiton (*Cryptochiton stelleri*) and the orange and white forms of the compound didemnid tunicate.

c) Deep subtidal zone (40 - 60 ft)

The kelp bed here was relatively sparse due to the prevalence of large sand channels and sporadic rocky outcrops. Most of these outcrops reached heights <2 m and were dominated by the stipitate kelp *Pterygophora californica*. The honeycomb worm (*Phragmatopoma californica*), which is well suited to sandy areas with high surge, was very common.

Subtidal fishes (Carr)

A total of 13 species of fish were encountered at this site, ranking it below average relative to the mean and median (17 species) among sites surveyed. The number of rockfish (6) and surfperch (3) species were below and at the average, respectively for the sites surveyed. Only two of the 5 fish species of concern were encountered here; kelp greenling were at average site abundance, whereas black and yellow rockfish and , by their absence, cabezon and lingcod were below average site abundance. By its absence, gopher rockfish was well below the average among sites. Species of particularly high abundance included adult senorita and tubesnout, and juvenile blue and black rockfish. Above average numbers of adult blue rockfish, rubberlip perch and juvenile bocaccio were observed. Species of particularly low abundance were adult pile perch.

a) Shallow subtidal zone (0-20 ft)

Ten species of fish were encountered in the shallow depth zone, including the adults of blue, olive, kelp, and black rockfish, black and stripe perch, kelp greenling, senorita and tubesnout, as well as juvenile blue, black and bocaccio rockfish.

b) Mid-subtidal zone (20 - 40 ft)

Ten species of fish were encountered in the mid-depth zone, including the adults of blue, black and yellow and kelp rockfish, stripe and rubberlip perch, painted and kelp greenling, and senorita, as well as juvenile blue, olive, black and bocaccio rockfish.

c) Deep subtidal zone (40 - 60 ft)

Only adult senorita were recorded in the deep depth zone.

IV.B.4. North Wreck Beach

IV.B.4.1. Survey metadata

Table 4.1. Survey type, date completed, and specific location of sampling conducted at North Wreck Beach.

Survey type	Date completed	Latitude (N)	Longitude (W)
Qualitative intertidal	September 12, 2003	36 13'98	121 48'38
Qualitative subtidal	September 12, 2003	36 13'54.46"	121 48'13.96"
Quantitative subtidal	No data		
2003	No data		
Upcoast deep	No data		
Downcoast deep	No data		
2004	No data		
Upcoast deep	No data		
Downcoast deep	No data		

IV.B.4.2. Intertidal survey conditions

Tide- September 12, 2003: 0.6 at 6:10
Time- Approximately 30 minutes spent at the site for qualitative survey.

IV.B.4.3. Subtidal survey diving conditions

Sea surface— Conditions (wind, waves) were very calm.

Surge— Not recorded.

Visibility— Horizontal visibility was typically >15 feet.

Depth— The maximum depth was 54 ft. Divers were able to swim just behind the breaking waves.

Transect length (estimated)— 271 m.

Bottom time— 50 minutes.

Water temperature— 60 F at the surface and 59 F at 20 ft deep.

Distance from shore to 20 m isobath— 671.8 m. The slope is considered moderately flat.

IV.B.4.4 Site overview

Location

North Wreck Beach is located 1 km south of Pfeiffer Point and due west of mile 46 on Highway 1.

Environment

Wreck Beach is a beach with rocky outcrops of unconsolidated sediment at either end and pockets of boulder and cobble, and is not visible from HWY 1. The intertidal rock is

between 15-45 degrees and exposed to open ocean. Tidepools are present. The upland slope above the site is an active slide at 45-75 degrees with exposed earth, boulders, and cobble. Directly above and around the slide the slope is vegetated with coastal scrub. In the subtidal, the outer/deeper zone consisted of a few high relief (>1 m) boulders amidst a sandy bottom. Many of the rocky outcrops were covered with sand, suggesting there is high wave energy and/or large amounts of sand deposited in this areas. At a depth of 40 ft the bottom a large area of sand dominated. Farther inshore divers encountered increasing amounts of sand and buried rocky reef.

Biological overview

The upland slope above Wreck Beach is an active slide has exposed earth, boulders, and cobble. Directly above and around the slide the slope is vegetated with coastal scrub. High-zone species include the red alga *Endocladia muricata,* barnacle *Chthamalus* spp. brown algae, *Pelvetiopsis* spp. Mid-zone species include the california mussel *Mytilus californianus,* barnacle *Tetraclita rubescen,* and brown algae *Fucus* spp. Low-zone species include coralline algae *Corallina* spp., the ribbon kelp *Alaria marginata* and red algae *Mazzaella* spp. corallines. Divers qualitatively surveyed the northern arc of Wreck Beach on September 12, 2003. The kelp beds at the northern end of Wreck Beach are moderate in size and patchy. The outer edge of kelp bed was 17 m (54 ft) deep. Rocky outcrops were primarily covered with encrusting tunicates.

IV.B.4.5. Nearshore geology and geography

Proximity to creeks and canyons

The northern part of Wreck Beach, which was sampled by divers, is at the base of a large cliff with no visible drainages. We did not observe flowing water. North Wreck Beach is near two drainages: Sycamore Canyon (0.85 miles north), which is normally blocked by Pfeiffer Beach, and has intermittent flow; and the Big Sur River (5 miles north), which has year-round flow into a lagoon that seasonally breaches. Neither of these drainages appears to impact North Wreck Beach.

Exposure, cliffs, and erosion

North Wreck Beach is a beach with rocky outcrops of unconsolidated sediment at either end and pockets of boulder and cobble, and is not visible from HWY 1. The upland slope above the site is an active slide at 45-75 degrees with exposed earth, boulders, and cobble. North Wreck Beach has a southern exposure. The terrestrial geology is classified as unconsolidated sediment and some Franciscan melange.

Intertidal geology

The intertidal rock is between 15-45 degrees and exposed to open ocean. Tidepools are present.

Subtidal geology and topography

Initially divers encountered large rocky outcrops separated by sandy areas. The proportion of sand vs. reef increased as depth decreased. In addition to the sand, there was gravel in the deepest and middle depth zones.

Table 4.5. North Wreck Beach qualitative subtidal survey results for reef type and relief by three depth zones. Percentages for each category are based on *in situ* visual diver estimates and review of underwater video (when available).

Depth	Reef Type				Relief			
(meters)	sand	cobble	boulder	bedrock	0-10 m	10-1 m	1-2 m	>2 m
0-6	50		50		25	25	25	25
6-12	40		25	25	40		60	
12-18	75		25		75			25

IV.B.4.6. Nearshore oceanography

North Wreck Beach faces the south and is partially protected from northwestern swell. To our knowledge, there are no data on nearshore currents at this site. The subtidal sand was very coarse, and gravel in parts, indicative of a high-energy environment.

IV.B.4.7. Biology

Intertidal of North Wreck Beach

Overall intertidal ranking not available, qualitative survey only.

Intertidal species of concern

Five out of seven intertidal species of special interest (see Methods for selection criteria), were present (Table 4.7.1).

Table 4.7.1: Species of special interest present at North Wreck Beach

Species	Common name
Mytilus californianus	California sea mussel
Phyllospadix spp.	surf grass
Lottia gigantea	owl limpet
Pisaster ochraceus	ochre star

Subtidal of North Wreck Beach

Overall subtidal ranking

Combining the five subtidal sensitivity indices, North Wreck Beach scored 10 of 22 points possible (tied with 3 other sites) and is considered a site of medium value relative to the 21 sites surveyed qualitatively. The species richness ranks—again, relative to the other 21 sites sampled qualitatively—were 2nd (tie) for algae, 15th (tie) for invertebrates, and 3rd (tie) for fishes. Complete lists of the species encountered are provided in Appendices B-D.

Subtidal species of concern

At North Wreck Beach, 9 of the 12 subtidal species of concern were observed (Table 4.7.2).

Table 4.7.2: Relative abundance of species of special interest and their rank as compared to all 21 qualitative subtidal survey sites

Species	Category	Relative abundance
Phyllospadix spp.	Habitat forming	Not noted
Macrocystis pyrifera	Burial, turbidity sensitivity	Medium
Nereocystis luetkeana	Burial, turbidity sensitivity	Medium
Pterygophora californica	Burial, turbidity sensitivity	High
Stylaster californicus	Burial, scour sensitivity	Not noted
Haliotis rufescens	Burial sensitivity	Present
Strongylocentrotus spp.	Burial sensitivity	Not noted
Scorpaenichthys marmoratus	Burial sensitivity	Below average
Ophiodon elongatus	Burial sensitivity	Above average
Hexagrammos decagrammus	Burial sensitivity	Average
Sebastes carnatus	Burial sensitivity	Well below average
Sebastes chrysomelas	Burial sensitivity	Average

Subtidal algae (Readdie/Kusic)

Kelp canopy surface estimate: 20,226 m^2

a) Shallow subtidal zone (20-30 ft)

Canopy

Macrocystis pyrifera was present in medium abundance.
Nereocystis luetkeana was present in low abundance.

Subcanopy

Laminaria setchellii was present in high abundance.
Pterygophora californica was present in medium abundance.

Understory

Foliose reds were present in high abundance— *Botryoglossum/Cryptopleura/ Hymenena, Cryptopleura crispa, Gelidum spp, Gracilaria spp, Mazaella spp, Plocamium pacificum, Plocamium violaceum*, and *Prionitis spp* were present in high abundance.
Chondracanthus corymbifera/ exasperata was present in medium abundance.
Rhodomenia/Ozophora was present in low abundance.
Articulated corallines— *Calliarthron cheilosporioides* was present in high abundance.
Brown algae— *C. osmundacea* was present in high abundance.

b) Mid-subtidal zone (30 - 45 ft)

Canopy

Macrocystis pyrifera was present in medium abundance.
Nereocystis luetkeana (bull kelp) was present in medium abundance.

Subcanopy

Pterygophora californica was present in high abundance
Laminaria setchellii was present in low abundance

Understory

Foliose reds were present in medium abundance— *Botryoglossum/Cryptopleura/ Hymenena, Cryptopleura crispa, Gelidum spp, Gracilaria spp, Mazaella spp, Plocamium pacificum, Plocamium violaceum*, and *Prionitis spp* were present in high abundance.
Chondracanthus corymbifera/ exasperata was present in medium abundance.
Rhodomenia/Ozophora was present in low abundance.
Crustose corallines— *Lithothamnion* sp. was present in high abundance.
Articulated corallines— *Calliarthron cheilosporioides* was present in high abundance.
Brown algae— *C. osmundacea* was present in high abundance.

c) Deep subtidal zone (50 ft)

Canopy

Macrocystis pyrifera was present in medium abundance.

Subcanopy

Pterygophora californica was present in medium abundance.

Understory

Foliose reds were present in high abundance— *Callophyllis spp, Chondracanthus corymbifera/exasperata, Halymenia/Schizymenia,* and *Ptilota/Neotilota* were present in high abundance. Botryoglossum/Cryptopleura/Hymenena was present in medium abundance.
Crustose corallines— *Lithothamnion sp.* was present in low abundance.
Articulated corallines— *Calliarthron cheilosporioides* was present in high abundance.

Brown algae— *Desmerestia latifrons and Desmerestia ligulata var. ligulata* was present in high abundance.

Subtidal invertebrates (Lonhart)

a) Shallow subtidal zone (0-20 ft)

The shallowest zone had several species of hydroids and the golden encrusting bryozoan (species not known) on emergent rocks, while very big mole crabs inhabited the extensive sandy stretches.

b) Mid-subtidal zone (20 - 40 ft)

There was a large sandy zone at 40 ft deep. Many of the rocks were covered with sand and this site appears to have high sand movement.

c) Deep subtidal zone (40 - 60 ft)

Tunicates (e.g., *Distaplia* sp., possibly *Ritterella* spp., possibly *Aplidium* spp. with impregnated sand in the tunic), hydroids, and bryozoans were first noted in the deep zone. Compound tunicates dominated most of the deeper surfaces.

Subtidal fishes (Carr)

A total of 22 species of fish were encountered at this site, ranking above the average species richness relative to the mean and median (17 species) among sites surveyed. The number of rockfish (8) and surfperch (7) species were at and well above the average, respectively, for the sites surveyed. Three of the 5 fish species of concern were encountered here; lingcod were above average site abundance, black and yellow rockfish and kelp greenling were at average site abundance, and, by their absence, cabezon and gopher rockfish were below and well below their average site abundance. Species of particularly high abundance included juveniles of the blue, olive and black, gopher, black and yellow, canary and bocaccio rockfishes, as well as adult rainbow and silver perch, snubnose sculpin and tubesnouts. Above-average numbers of adult olive and vermilion rockfish, as well as adult black, stripe, pile, rubberlip, kelp and silver perch, juvenile painted greenling, adult senorita, and blackeye gobies. Adult kelp rockfish were of particularly low abundance.

a) Shallow subtidal zone (0-20 ft)

Ten species of fish were encountered in the shallow depth zone, including adult black and yellow rockfish, black, stripe, pile, rubberlip, rainbow, and silver perch, painted greenling, and senorita. No juvenile fish were observed.

b) Mid-subtidal zone (20 - 40 ft)

Twelve species of fish were encountered in the mid-depth zone, including adult blue and olive rockfish, stripe, and pile perch, painted greenling, tubesnout, senorita and blackeye gobies, and juvenile blue, olive, black, gopher, black and yellow, and bocaccio rockfish.

c) Deep subtidal zone (40 - 60 ft)

Twenty species of fish were encountered in the deep depth zone, including adult blue, black, olive and vermilion rockfish, black, stripe, pile, rainbow and kelp perch, painted and kelp greenling, lingcod, tubesnout, snubnose sculpin and blackeye gobies, and juvenile blue, olive, black, gopher, black and yellow, canary and bocaccio rockfish, silver perch and painted greenling.

IV.B.5. Grimes Point

IV.B.5.1. Survey metadata

Table 5.1. Survey type, date completed, and specific location of sampling conducted at Grimes Point.

Survey type	Date completed	Latitude (N)	Longitude (W)
Intertidal	No data		
Qualitative subtidal	October 5, 2004	36 12.130	121 44.133
Quantitative subtidal	No data		
2003	No data		
Upcoast deep	No data		
Downcoast deep	No data		
2004	No data		
Upcoast deep	No data		
Downcoast deep	No data		

IV.B.5.2. Intertidal survey conditions

No data

IV.B.5.3. Subtidal survey diving conditions

Sea surface— Conditions (wind, waves) were moderate.

Surge— Not recorded.

Visibility— Not recorded.

Depth— The maximum depth was 65 ft.

Transect length (estimated)— 126 m.

Bottom time— 50 minutes.

Water temperature— Not recorded.

Distance from shore to 20 m isobath— 133.7 m. The slope is considered very steep.

IV.B.5.4. Site overview

Location

Grimes Point is located 5 km north of Partington Point and due west of mile 41.3 on Highway 1.

Environment

In the subtidal, the bottom at 60 ft deep was fine sand with marble-sizd rocks and large reef outcrops. At 40 ft deep the bottom was mostly boulders, but there were also 20 ft high vertical walls at shallower depths.

Biological overview

Divers qualitatively surveyed a kelp bed at Grimes Point on October 5, 2004. There was a mix of invertebrates and algae on the boulders, and this site was very similar to Lafler Rock, which is only 1.5 km to the south. This site is at the northern edge of the Partington Canyon, and depth rapidly increases just outside the kelp beds. The boulders on shore were used as haul-outs by numerous California sea lions (*Zalophus californianus*).

IV.B.5.5. Nearshore geology and geography

Proximity to creeks and canyons

The Grimes Point site is next to the Grimes Canyon drainage (0.1 miles), which lacks sustained flow and has no influence on the dive site.

Exposure, cliffs, and erosion

Grimes Point has a western exposure. The cliffs are very steep and may be granitic. Vegetation is minimal and most of the area is exposed rock. The terrestrial geology is classified as igneous and/or metamorphic rock.

Intertidal geology

No data

Subtidal geology and topography

At 60 ft the bottom was fine with marble-sized rocks and large reef outcrops. At 50 ft deep the boulders were 3-4 m in diameter, and boulders (<3 m) were present up to the intertidal.

Table 5.5. Grimes Point qualitative subtidal survey results for reef type and relief by three depth zones. Percentages for each category are based on *in situ* visual diver estimates and review of underwater video (when available).

Depth	Reef Type				Relief			
(meters)	sand	cobble	boulder	bedrock	0-10 m	10-1 m	1-2 m	>2 m
0-6	10	10	30	50	20	10	10	60
6-12	20		40	40	10	10	40	40
12-18	20		10	70	20	10	10	60

IV.B.5.6. Nearshore oceanography

Grimes Point faces the west and is exposed to northwestern swell. To our knowledge, there are no data on nearshore currents at this site.

IV.B.5.7. Biology

Intertidal of Grimes Point

No data

Subtidal of Grimes Point

Overall subtidal ranking

Combining the five subtidal sensitivity indices, Grimes Point scored 11 of 22 points possible and is considered a site of medium value relative to the 21 sites surveyed qualitatively. The species richness ranks—again, relative to the other 21 sites sampled qualitatively—were 9th (tie) for algae, 9th for invertebrates, and 12th (tie) for fishes. Complete lists of the species encountered are provided in Appendices B-D.

Subtidal species of concern

At Grimes Point, 7 of the 12 subtidal species of concern were observed (Table 5.7).

Table 5.7: Relative abundance of species of special interest and their rank as compared to all 21 qualitative subtidal survey sites

Species	Category	Relative abundance
Phyllospadix spp.	Habitat forming	Not noted
Macrocystis pyrifera	Burial, turbidity sensitivity	Low
Nereocystis luetkeana	Burial, turbidity sensitivity	Not present
Pterygophora californica	Burial, turbidity sensitivity	Low
Stylaster californicus	Burial, scour sensitivity	Not noted
Haliotis rufescens	Burial sensitivity	Not noted
Strongylocentrotus spp.	Burial sensitivity	Not noted
Scorpaenichthys marmoratus	Burial sensitivity	Average
Ophiodon elongatus	Burial sensitivity	Average
Hexagrammos decagrammus	Burial sensitivity	Average
Sebastes carnatus	Burial sensitivity	Average
Sebastes chrysomelas	Burial sensitivity	Above average

Subtidal algae (Readdie/Kusic)

Kelp canopy surface estimate: 20,226 m^2

a) Shallow subtidal zone (0-20 ft)

Canopy

Macrocystis pyrifera was present in low abundance with plants having 20 stipes.

Subcanopy

Laminaria setchellii was present in high abundance.

Understory

Foliose reds were 40% of total understory algae— *Botryoglossum/Cryptopleura/Hymenena, Chondracanthus corymbifera/ exasperata, Rhodomenia/Ozophora spp*, and *Shizymenia/ Halymenia* were present in high abundance. *Callophyllis spp, Erythrophyllum delesserioides, Pikea/Farlowia,* and *Prionitis spp* were present in medium abundance.
Articulated Corallines were 10% of total understory algae.
Brown algae were 50% of total understory algae— *Alaria marginata, Costaria costata, Desmarestia ligulata var. ligulata* and *Egregia menziesii* were present in high abundance.

b) Mid-subtidal zone (20 - 40 ft)

Canopy

Macrocystis pyrifera was present in low abundance with plants having 50 stipes.

Subcanopy

Pterogophora californica was present in low abundance, severely damaged only the stipes remained.

Understory

Foliose reds were 10% of total understory algae— *Chondracanthus corymbifera/ exasperata, Prionitis spp*. and *Rhodomenia/Ozophora spp* were present in medium abundance.
Red crust was 1% of total understory algae
Crustose Corallines were 30% of total understory algae.
Articulated Corallines were 60% of total understory algae.

c) Deep subtidal zone (40-60 ft)

Canopy

Macrocystis pyrifera was present in medium abundance with plants having 50-100 stipes.

Subcanopy

Laminaria setchellii was present in low abundance.
Pterogophora californica was present in low abundance.

Understory

Foliose reds were 30% of total understory algae— *Callophyllis flabellulata, Chondracanthus corymbifera/exasperata, Opuntiella californica, Plocamium/Microcladia, Rhodomenia/Ozophora spp, Shizymenia/ Halymenia*, and *Weeksia spp* were present in medium abundance.
Red crust was 1% of total understory algae.
Crustose Corallines were 30% of total understory algae.
Articulated Corralines were 30% of total understory algae.

Brown algae were 10% of total understory algae— *Desmarestia ligulata var. ligulata* were present in medium abundance.

Subtidal invertebrates (Lonhart)

a) Shallow subtidal zone (0-20 ft)

Compound tunicates were abundant <20 ft deep. Algae, including erect corallines, *Macrocystis*, and *Gigartina*, dominated the shallowest areas. The carnivorous chiton (*Placiphorella velata*) was noted.

b) Mid-subtidal zone (20 - 40 ft)

At 40 ft the red volcano sponge (*Acarnus erithacus*) was common. Boulders at this depth were covered with sponges, orange cup corals (*Balanophyllia elegans*), and several compound tunicates.

c) Deep subtidal zone (40 - 60 ft)

The large reef outcrops at 60 ft were separated by channels of fine-grained sand. At 50 ft the reef was replaced by car-sized boulders covered with colonies of the southern staghorn bryozoan (*Diaperoecia californica*), which was absent from the deeper reefs.

Subtidal fishes (Carr)

A total of 16 species of fish were encountered at this site, around average relative to the mean and median (17 species) among sites surveyed. The number of rockfish (7) and surfperch (3) species were typical for the sites surveyed. All five of the 5 fish species of concern were encountered here; black and yellow rockfish were above average site abundance and cabezon, lingcod, gopher rockfish and kelp greenling were at average site abundance. Species of particularly high abundance included adult rubberlip perch. Above-average numbers of adult blue and vermilion rockfish and blackeye gobies were observed. No species was of particularly low abundance.

a) Shallow subtidal zone (0-20 ft)

Nine species of fish were encountered in the shallow depth zone, including the adults of blue, kelp, black and yellow rockfish, stripe, pile and rubberlip perch, kelp greenling, cabezon, and senorita.

b) Mid-subtidal zone (20 - 40 ft)

Nine species of fish were encountered in the mid-depth zone, including the adults of blue, olive, kelp, gopher, black and yellow, and vermilion rockfish, stripe and rubberlip perch, kelp greenling, and juvenile blue rockfish.

c) Deep subtidal zone (40 - 60 ft)

Twelve species of fish were encountered in the deep depth zone, including the adults of blue, olive, kelp, gopher, black and yellow, and vermilion rockfish, stripe, pile, and rubberlip perch, painted greenling, lingcod, and blackeye goby.

IV.B.6. Lafler Rock

IV.B.6.1. Survey metadata

Table 6.1. Survey type, date completed, and specific location of sampling conducted at Lafler Rock.

Survey type	Date completed	Latitude (N)	Longitude (W)
Intertidal	No data		
Qualitative subtidal	October 5, 2004	36 11.820	121 43.558
Quantitative subtidal	No data		
2003	No data		
Upcoast deep	No data		
Downcoast deep	No data		
2004	No data		
Upcoast deep	No data		
Downcoast deep	No data		

IV.B.6.2. Intertidal survey conditions

No data

IV.B.6.3. Subtidal survey diving conditions

Sea surface— Conditions (wind, waves) were moderate.

Surge— Not recorded.

Visibility— Not recorded.

Depth— The maximum depth was 69 ft.

Transect length (estimated)— 216 m.

Bottom time— 51 minutes.

Water temperature— Not recorded.

Distance from shore to 20 m isobath— 230.0 m. The slope is considered very steep.

IV.B.6.4. Site overview

Location

Lafler Rock is located 4 km north of Partington Point and due west of mile 40.5 on Highway 1.

Environment

In the subtidal, the bottom at the outer edge of the kelp bed was cobble and thick-grained sand interspersed with large (3-4 m) rocky outcrops.

Biological overview

Divers qualitatively surveyed a kelp bed near Lafler Rock on October 5, 2004. Compound tunicates and sponges were common in the rocky crevices created by the jumble of boulders in the middle and shallow zones.

IV.B.6.5. Nearshore geology and geography

Proximity to creeks and canyons

The Lafler Rock site is at the Lafler Canyon drainage (0.1 miles), which has nominal seasonal flow.

Exposure, cliffs, and erosion

Lafler Rock has a western exposure. The cliffs are very steep and high, covered with minimal sediment and sparse vegetation. The terrestrial geology is classified as igneous and/or metamorphic rock.

Intertidal geology

No data

Subtidal geology and topography

At 67 ft the bottom was mostly cobble, coarse-grained sand and 3-4 m high boulders. At 40 ft deep the outcrops were house-sized and separated by boulders. At 16 ft deep there were slabs of reef and little sand.

Table 6.5. Lafler Rock qualitative subtidal survey results for reef type and relief by three depth zones. Percentages for each category are based on *in situ* visual diver estimates and review of underwater video (when available).

Depth	Reef Type				Relief			
(meters)	sand	cobble	boulder	bedrock	0-10 m	10-1 m	1-2 m	>2 m
0-6		20	30	50	10	50	20	20
6-12	10	10	30	50	20	10	35	35
12-18	10	20	30	40	50	20	10	20

IV.B.6.6. Nearshore oceanography

Lafler Rock faces the west and is exposed to northwestern swell. To our knowledge, there are no data on nearshore currents at this site.

IV.B.6.7. Biology

Intertidal of Lafler Rock

No data

Subtidal of Lafler Rock

Overall subtidal ranking

Combining the five subtidal sensitivity indices, Lafler Rock scored 8 of 22 points possible (tied with Grimes Point) and is considered a site of low value relative to the 21 sites surveyed qualitatively. The species richness ranks—again, relative to the other 21 sites sampled qualitatively—were 5th (tie) for algae, 10th for invertebrates, and 5th (tie) for fishes. Complete lists of the species encountered are provided in Appendices B-D.

Subtidal species of concern

At Lafler Rock, 8 of the 12 subtidal species of concern were observed (Table 6.7).

Table 6.7: Relative abundance of species of special interest and their rank as compared to all 21 qualitative subtidal survey sites

Species	Category	Relative abundance
Phyllospadix spp.	Habitat forming	Not noted
Macrocystis pyrifera	Burial, turbidity sensitivity	Low
Nereocystis luetkeana	Burial, turbidity sensitivity	Low
Pterygophora californica	Burial, turbidity sensitivity	Low
Stylaster californicus	Burial, scour sensitivity	Not noted
Haliotis rufescens	Burial sensitivity	Not noted
Strongylocentrotus spp.	Burial sensitivity	Not noted
Scorpaenichthys marmoratus	Burial sensitivity	Above average
Ophiodon elongatus	Burial sensitivity	Average
Hexagrammos decagrammus	Burial sensitivity	Average
Sebastes carnatus	Burial sensitivity	Average
Sebastes chrysomelas	Burial sensitivity	Above average

Subtidal algae (Readdie/Kusic)

Kelp canopy surface estimate: 20,226 m^2

a) Shallow subtidal zone (0-20 ft)

Canopy

Macrocystis pyrifera was present in low abundance with plants having 10-30 stipes.
Nereocystis luetkeana was present in low abundance.

Subcanopy

Pterygophora californica was present in low abundance
Laminaria setchellii was present in medium abundance.

Understory

Foliose reds were 30% of total understory algae— *Botryoglossum/Cryptopleura/Hymenena, Chondracanthus corymbifera/ exasperata, Mazzaella spp*, and *Prionitis spp* were present in high abundance. *Pikea/FarLowia* was present in medium abundance. *Callophyllis spp, Erythrophyllum delesserioides,* and *Platythamnion spp* were present in low abundance.
Red crust was 30% of total understory algae
Crustose Corallines were 10% of total understory algae.
Brown algae were 30% of total understory algae— *Costaria costata, Desmarestia ligulata var ligulata,* and *Egregia menziesii* were present in high abundance. *Alaria marginata* and *Cystoseira osmundacea* were present in low abundance.

b) Mid-subtidal zone (20 - 40 ft)

Canopy

Macrocystis pyrifera was present in low abundance.

Subcanopy

Laminaria setchellii was present in low abundance.
Pterogophora californica was present in low abundance.

Understory

Foliose reds were 5% of total understory algae— *Botryoglossum/Cryptopleura/Hymenena, Chondracanthus corymbifera/ exasperata*, and *Prionitis spp* were present in medium abundance. *Mazzaella spp* and *Pikea/FarLowia* were present in low abundance.
Red crust was 2% of total understory algae
Crustose Corallines were 80% of total understory algae.
Articulated Corallines were 10% of total understory algae.
Brown algae were 2% of total understory algae— *Dictyota binghamiae* was present in medium abundance. *Desmarestia latifrons* was present in low abundance.

c) Deep subtidal zone (40-60 ft)

Canopy

Macrocystis pyrifera was present in low abundance with plants having 3-20 stipes.

Subcanopy

Pterogophora californica was present in low abundance.

Understory

Foliose reds were 55% of total understory algae— *Botryoglossum/Cryptopleura/Hymenena, Callophyllis spp, Rhodomenia/Ozophora spp*, and *Weeksia spp* were present in high abundance. *Callophyllis flabellulata* and *Chondracanthus corymbifera/ exasperata* and *Pikea/Farlowia* were present in medium abundance. *Prionitis spp* was present in low abundance.
Crustose Corallines were 20% of total understory algae.

Articulated Corralines were 20% of total understory algae.
Brown algae were 2% of total understory algae— *Cystoseira osmundacea* was present in medium abundance.

Subtidal invertebrates (Lonhart)

a) Shallow subtidal zone (0-20 ft)

At 16 ft slabs of reef were littered with bowling ball sized rocks, and there was very little sand. The reef had some encrusting corallines and the brooding anemone (*Epiactis prolifera*) attached. At 11 ft the boulders were covered with limpets.

b) Mid-subtidal zone (20 - 40 ft)

At <40 ft the bottom consisted of very large outcrops, some the size of small houses, with some sand but mostly boulders in between, creating a great deal of vertical relief. The pockets of relief created by the piles of boulders were often covered with sponges and tunicates.

c) Deep subtidal zone (40 - 60 ft)

The outer edge of the kelp forest consisted of car-sized outcrops with cobble and coarse-grained sand in between. Kellet's whelk (*Kelletia kelletii*) was seen at 67 ft and egg cases were noted at 56 ft. The cobble was covered with coralline algae and the ornate tubeworm (*Diopatra ornata*) was common. Unlike Granite Canyon and Bixby Landing, the bottom looked relatively undisturbed.

6.2.3) Subtidal fishes (Carr)

A total of 20 species of fish were encountered at this site, ranking above average relative to the mean and median (17 species) among sites surveyed. The number of rockfish (9) and surfperch (3) species were average, respectively, for the sites surveyed. Five of the 5 fish species of concern were encountered here; cabezon and black and yellow rockfish were above average site abundance, whereas lingcod, gopher rockfish and kelp greenling were at average site abundance. Species of particularly high abundance included adult senorita. Above-average numbers of adult and juvenile blue and olive rockfishes, adult copper, tree, and vermilion rockfishes, painted greenling, and sheephead were observed. No species was of particularly low abundance.

a) Shallow subtidal zone (0-20 ft)

Eleven fish species were encountered in the shallow depth zone, including the adults of blue, olive, kelp, black, and black and yellow rockfish, black, stripe and pile perch, kelp greenling, cabezon, and senorita, and juvenile olive rockfish.

b) Mid-subtidal zone (20 - 40 ft)

Fourteen species of fish were encountered in the mid-depth zone, including the adults of blue, olive, kelp, black, gopher, black and yellow and vermilion rockfish, stripe and pile

perch, painted and kelp greenling, lingcod, senorita, and sheephead, and juvenile blue rockfish.

c) Deep subtidal zone (40 - 60 ft)

Fourteen species of fish were encountered in the deep depth zone, including the adults of blue, olive, kelp, black, gopher, tree, copper and vermilion rockfish, stripe and pile perch, painted and kelp greenling, coralline sculpin and blackeye gobies, and juvenile blue and olive rockfish.

IV.B.7. Sycamore Draw

IV.B.7.1. Survey metadata

Table 7.1. Survey type, date completed, and specific location of sampling conducted at Sycamore Draw.

Survey type	Date completed	Latitude (N)	Longitude (W)
Qualitative intertidal	September 15, 2003	36 11'20.78"	121 42'43.18"
Qualitative subtidal	September 15, 2003	36 11'20.78"	121 42'43.18"
Quantitative subtidal	No data		
2003	No data		
Upcoast deep	No data		
Downcoast deep	No data		
2004	No data		
Upcoast deep	No data		
Downcoast deep	No data		

IV.B.7.2. Intertidal survey conditions

Tide- September 15, 2003: 2.0 at 6:49
Time- Approximately 15 minutes spent at the site for a qualitative survey. No access gained on land all viewed from sea.

IV.B.7.3. Subtidal survey diving conditions

Sea surface— Conditions (wind, waves) were calm, overcast and warm.

Surge— Not recorded.

Visibility— Not recorded.

Depth— The maximum depth was 59 ft.

Transect length (estimated)— 94 m.

Bottom time— 54 minutes.

Water temperature— 60 F at 15 ft deep.

Distance from shore to 20 m isobath— 446.3 m. The slope is considered moderate.

IV.B.7.4. Site overview

Location

Sycamore Draw is located 2 km north of Partington Point and due west of mile 39.3 on Highway 1.

Environment

Sycamore Draw is a boulder field bound by steep inaccessible areas. No further information collected. In the subtidal, the bottom had multiple large patches of coarse sand with boulder outcrops in between.

Biological overview

Divers qualitatively surveyed a kelp bed at Sycamore Draw on September 15, 2003. Compound tunicates were very common, but unlike other sites, the colonies were small, likely due to chronic disturbance at the site.

IV.B.7.5.Nearshore geology and geography

Proximity to creeks and canyons

The Sycamore Draw site is just south of the Torre Canyon drainage (0.4 miles north), which has little to no water, but there is a small chronic slide to north, creating milky-colored water.

Exposure, cliffs, and erosion

Sycamore Draw has a western exposure. The highway is well above shore level and the slopes are steep but covered with vegetation. The terrestrial geology is classified as Franciscan melange.

No information available for intertidal.

Intertidal geology

No information available

Subtidal geology and topography

At 65 ft deep the bottom was mostly sand with widely-spaced boulders.

Table 7.5. Sycamore Draw qualitative subtidal survey results for reef type and relief by three depth zones. Percentages for each category are based on *in situ* visual diver estimates and review of underwater video (when available).

Depth	Reef Type				Relief			
(meters)	sand	cobble	boulder	bedrock	0-10 m	10-1 m	1-2 m	>2 m
0-6								
6-12				100		100		
12-18	50			50	50		25	25

IV.B.7.6. Nearshore oceanography

Sycamore Draw faces the west and is exposed to northwestern swell. To our knowledge, there are no data on nearshore currents at this site.

IV.B.7.7. Biology

Intertidal of Sycamore Draw

Overall intertidal ranking not available, qualitative survey only.

Subtidal of Sycamore Draw

Overall subtidal ranking

Combining the five subtidal sensitivity indices, Sycamore Draw scored 9 of 22 points possible and is considered a site of low value relative to the 21 sites surveyed qualitatively. The species richness ranks—again, relative to the other 21 sites sampled qualitatively—were 14th (tie) for algae, 20th for invertebrates, and 10th (tie) for fishes. Complete lists of the species encountered are provided in Appendices B-D.

Subtidal species of concern

At Sycamore Draw, 8 of the 12 subtidal species of concern were observed (Table 7.7).

Table 7.7: Relative abundance of species of special interest and their rank as compared to all 21 qualitative subtidal survey sites

Species	Category	Relative abundance
Phyllospadix spp.	Habitat forming	Not noted
Macrocystis pyrifera	Burial, turbidity sensitivity	Low
Nereocystis luetkeana	Burial, turbidity sensitivity	Medium
Pterygophora californica	Burial, turbidity sensitivity	Medium
Stylaster californicus	Burial, scour sensitivity	Not noted
Haliotis rufescens	Burial sensitivity	Not noted
Strongylocentrotus spp.	Burial sensitivity	Not noted
Scorpaenichthys marmoratus	Burial sensitivity	Below average
Ophiodon elongatus	Burial sensitivity	Above average
Hexagrammos decagrammus	Burial sensitivity	Above average
Sebastes carnatus	Burial sensitivity	Average
Sebastes chrysomelas	Burial sensitivity	Above average

Subtidal algae (Readdie/Kusic)

Kelp canopy surface estimate: 20,226 m^2

a) Shallow subtidal zone (10-20 ft)

Canopy

Macrocystis pyrifera was present in medium abundance.
Nereocystis luetkeana was present in medium abundance.

Subcanopy

Laminaria setchellii was present in high abundance.

Understory

Foliose reds were present in medium abundance— *Callophyllis spp*
Eryhthrophyllum delesserioides, Mazaella spp, and Prionitis spp were present in high abundance. *Cryptopleura ruprechtiana* was present in medium abundance.
Articulated Corallines— *Calliarthron cheilosporioides* was present in high abundance.
Brown algae— *Egregia menziesii* was present in high abundance. *Cystoseira osmundacea* and *Desmerestia latifrons* were present in low abundance.

c) Mid-subtidal zone (30 - 40 ft)

Canopy

Macrocystis pyrifera was present in low abundance.

Subcanopy

Laminaria setchellii was present in high abundance.
Pterygophora californica was present in medium abundance.

Understory

Foliose reds were present in medium abundance— *Chondracanthus corymbifera/ exasperata, Pikea/Farlowia*, and *Rhodomenia/Ozophora* were present in high abundance.
Crustose Corallines— *Lithothamnion sp*. was present in low abundance.
Articulated Corallines— *Calliarthron cheilosporioides* was present in low abundance.
Brown algae—*Desmarestia ligulata var. ligulata* was present in low abundance.

c) Deep subtidal zone (50-60 ft)

Canopy

Macrocystis pyrifera was present in low abundance.

Understory

Foliose reds were present in high abundance— *Chondracanthus corymbifera/ exasperata* and *Rhodomenia/Ozophora* were present in high abundance. *Callophyllis spp* and *Shizymenia/Halymenia* were present in medium abundance.
Crustose Corallines— *Lithothamnion sp*. was present in low abundance.
Articulated Corallines— *Calliarthron cheilosporioides* was present in medium abundance.
Brown algae— *Desmarestia ligulata var. ligulata* was present in low abundance.

Subtidal invertebrates (Lonhart)

a) Shallow subtidal zone (0-20 ft)

At 22 ft semi-fine sand covered most of the rocks. Most of the surfaces were covered with algae instead of invertebrates. A “stalked jellyfish” (*Haliclystus* spp.) was found attached to erect coralline algae at the shallowest part of the dive.

b) Mid-subtidal zone (20 - 40 ft)

The middle zone was extensive at this site because of the shallow slope. Much of the dive was spent a depth of 40 ft. Boulders 1 m in diameter were often covered with a *Ritterella*-like species of colonial tunicate. At 35 ft the bottom was mostly coarse sand with boulders and few stipitate algae. An unidentified species similar to a cluster of puffball sponges was common, as were sand channels filled with the ornate tubeworm (*Diopatra ornata*).

c) Deep subtidal zone (40 - 60 ft)

The outer edge of the kelp bed was about 75 ft, and we swam over a section of sand and boulders widely spaced apart. The deep zone had several large patches of sand. There was also a boulder field with small clumps of invertebrates, mostly sponges, compound tunicates, and bryozoans, that suggested a high species turnover related to high wave energy. Amidst the expanses of sand were car-sized boulders at 46 ft.

Subtidal fishes (Carr)

A total of 17 species of fish were encountered at this site, typical of the mean and median (17 species) among sites surveyed. Likewise, the number of rockfish (9) and surfperch (3) species were average for the sites surveyed. Four of the 5 fish species of concern were encountered here; lingcod, black and yellow rockfish, and kelp greenling were above average site abundance, whereas gopher rockfish were at average site abundance, and cabezon were below average site abundance. Juvenile bocaccio were of particularly high abundance. Adult olive, black and vermilion rockfish, painted greenling, *Gibbonsia*, and blackeye gobies, and juvenile olive, black, gopher and canary rockfish, and stripe perch were above average abundance. No species was of particularly low abundance.

a) Shallow subtidal zone (0-20 ft)

Seven species of fish were encountered in the shallow depth zone, including the adults of blue and kelp rockfish, stripe perch, lingcod, *Gibbonsia*, and juvenile black and bocaccio rockfish.

b) Mid-subtidal zone (20 - 40 ft)

Sixteen species of fish were encountered in the mid-depth zone, including the adults of blue, olive, kelp, black, black and yellow, vermilion and gopher rockfish, stripe, pile and rainbow perch, painted and kelp greenling, lingcod, and juvenile blue and olive rockfish, and stripe perch.

c) Deep subtidal zone (40 - 60 ft)

Thirteen species of fish were encountered in the deep depth zone, including the adults of blue, olive, kelp, black, vermilion and gopher rockfish, stripe and pile perch, painted and kelp greenling, blackeye gobies and juvenile olive, canary, bocaccio and gopher rockfish, and stripe perch.

IV.B.8. Partington Point

IV.B.8.1. Survey metadata

Table 8.1. Survey type, date completed, and specific location of sampling conducted at Partington Point.

Survey type	Date completed	Latitude (N)	Longitude (W)
Quantitative Intertidal	November 23, 2003	36 10.39	121 41.97
Quantitative Intertidal	April 11, 2004	36 10.39	121 41.97
Qualitative subtidal	September 15, 2003	36 10'27.36"	121 41'54.63"
Quantitative subtidal	No data		
2003	No data		
Upcoast deep	No data		
Downcoast deep	No data		
2004	No data		
Upcoast deep	No data		
Downcoast deep	No data		

IV.B.8.2. Intertidal survey conditions

Tide- November 23, 2003: -1.3 at 15:53, April 11, 2004: -0.3 at 11:14
Time- Approximately 6 hours spent at the site for quantitative survey.

IV.B.8.3. Subtidal survey diving conditions

Sea surface— Conditions (wind, waves) were very calm.

Surge— At depth, there was 1-2 ft of surge in the deep and middle zones, and up to 3 ft surge when shallow.

Visibility— Horizontal visibility was typically >15 feet.

Depth— The maximum depth was 59 ft, but most of the dive was spent at depths <30 ft. Divers reached a maximum depth of 59 ft and were able to swim into the cove to 5 ft deep.

Transect length (estimated)— 99 m.

Bottom time— 56 minutes.

Water temperature— 60 F at the surface and 58 F at 16 ft deep.

Distance from shore to 20 m isobath— 362.5 m. The slope is considered steep.

IV.B.8.4. Site overview

<u>Location</u>

Partington Point is located roughly midway between Point Sur to the north and Lopez Point to the south and corresponds to mile 38 on Highway 1.

Environment

Partington Point is in the center of a 6-mile stretch of coastline that consists of metamorphic granitic rocks (Sur complex charnockitic tonalite) that are relatively resistant to erosion. It is also at the head of the Partington Submarine Canyon. Partington Point has a narrow, moderately compressed intertidal bedrock bench and one boulder/cobble beach in the northern cove. In the subtidal, divers encountered a pinnacle with a large vertical face. Once past this pinnacle, the bottom consisted of a low relief (<1 m) boulder field (depth 47 ft). At a depth of 37 ft the bottom consisted of coarse sand. Farther inshore divers encountered high relief pinnacles and large boulders. Partington Point is considered a geologic reference site for the McWay Rocks slide site.

Biological overview

The upland slope between the bench and Highway 1 is 30 to 50 degrees, covered with non-native grasses and coastal scrub. Tidepools are present on the intertidal bench. High-zone species include the red alga *Endocladia muricata,* barnacles *Chthamalus* spp. and *Balanus glandula,* and blue green algae. Mid-zone species include the California sea mussel *Mytilus californianus,* barnacles *Tetraclita rubescens* and *Balanus glandula,* and red algae *Porphyra* spp. Low-zone species include coralline algae *Corallina* spp. and *Calliarthron* spp., the ribbon kelp *Alaria marginata* and encrusting corallines. Bare rock comprised 11-14% of the total cover.

Divers qualitatively surveyed the northern cove of Partington Point on September 15, 2003. The kelp beds around Partington Point are small, scattered, and close to shore. This is likely due to a combination of high wave energy and steep topography precluding persistence of a substantial kelp forest. The outer edge of kelp bed was 18 m (59 ft) deep. The bottom consisted primarily of ornate tubeworm (*Diopatra ornata*) mats, pebbles and coarse sand. Inshore there were high relief pinnacles and large boulders, supporting a dense stipitate kelp (*Laminaria*) understory. The tops and sides of pinnacles were densely covered with encrusting invertebrates. Subcanopy kelps dominated the algal community in Partington Cove. Subcanopy kelps were found beneath a typical canopy (primarily *Macrocystis pyrifera*) and there was a typical understory community on the bottom.

IV.B.8.5. Nearshore geology and geography

Proximity to creeks and canyons

The northern cove of Partington Point, which was sampled by divers, is at the outlet of the Partington Ridge drainage. We did not observe flowing water. This is likely a seasonal drainage with nominal amounts of freshwater input. Partington Point is also near other drainages including: McWay Falls (located 1.85 miles south), the Torre Canyon drainage (1.63 miles north), and the Lafler Canyon drainage (2.45 miles south). None of these drainages appears to impact Partington Point.

Exposure, cliffs, and erosion

Partington Point has a western exposure. The terrestrial geology is classified as igneous and/or metamorphic rock. The bench slope ranges from 15 to 90 degrees, is openly exposed

to the WNW, and there is evidence of boulders and cobble periodically sliding into the cove. The steep cliffs are made of igneous and/or metamorphic rocks. There is little visible soil sliding into the cove.

Intertidal geology

Partington Cove (an area within Partington Point) has a few, relatively small intertidal bedrock benches of metamorphic granitic rock (Sur complex charnockitic tonalite) and is not visible from Highway 1. Tidepools are present on the bench. These intertidal benches are relatively compressed and steep. The upland slope between the bench and Highway 1 is 30 to 50 degrees, covered with non-native grasses and coastal scrub. Northern Partington Point has a beach that consists of igneous and/or metamorphic boulders and cobble, with little to no sand. This is a high wave energy site.

Subtidal geology and topography

Initially divers encountered a large vertical wall. Past this, divers entered an area of low relief (<1 m) characterized as a boulder field. At 37 ft divers noted sand furrows of coarse-grained sand, suggesting a high-wave energy environment. Rocky outcrops were sparse and topped with the stipitate kelp *Pterygophora californica*. Many of the rocky surfaces (which looked granitic) were exposed (i.e. free of epibionts) at 25 ft.

Table 8.5. Partington Point qualitative subtidal survey results for reef type and relief by three depth zones. Percentages for each category are based on *in situ* visual diver estimates and review of underwater video (when available).

Depth	Reef Type				Relief			
(meters)	sand	cobble	boulder	bedrock	0-10 m	10-1 m	1-2 m	>2 m
0-6		20	40	40		25	50	25
6-12	50		50		50		50	
12-18	25		50	25	25		25	50

IV.B.8.6. Nearshore oceanography

Partington Cove and Partington Point face the west and are exposed primarily to northwestern swell. This is also where the southern arm of the Partington Submarine Canyon comes close to shore. To our knowledge, there are no data on nearshore currents at this site. The subtidal sand was very coarse and indicative of a high-energy environment, and sediment retention at this site is likely low.

IV.B.8.7. Biology

Intertidal of Partington Cove

Overall intertidal ranking

Overall, species richness is average for this site. During a survey on November 23, 2003 78 species categories were noted. On April 11, 2004. 74 species categories were noted.

Intertidal species of concern

Seven out of seven intertidal species of special interest (see Methods for selection criteria), were present (Table 8.7.1).

Table 8.7.1: Partington Cove

Species	Common name
Postelsia palmaeformis	sea palm
Phyllospadix spp.	surf grass
Mytilus californianus	california mussel
Strongylocentrotus purpuratus	purple urchin
Pisaster ochraceus	ochre star
Lottia gigantea	owl limpet
Haliotis cracherodii	black abalone

Size distributions for species of special interest:

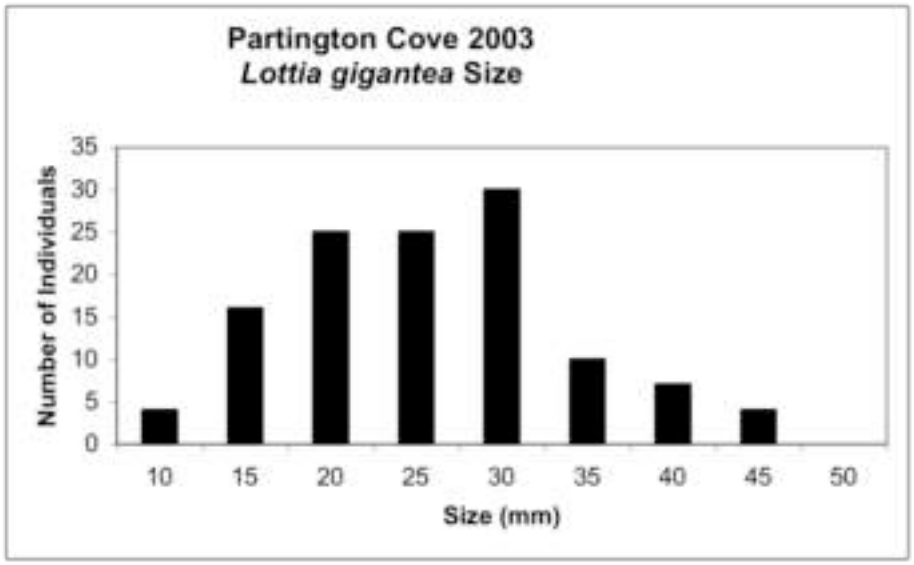


Figure 8.7.1. Size-frequency distribution of owl limpets (*Lottia gigantea*) at Partington Cove in 2003. Owl limpets live in the rocky intertidal and are a species of special interest.

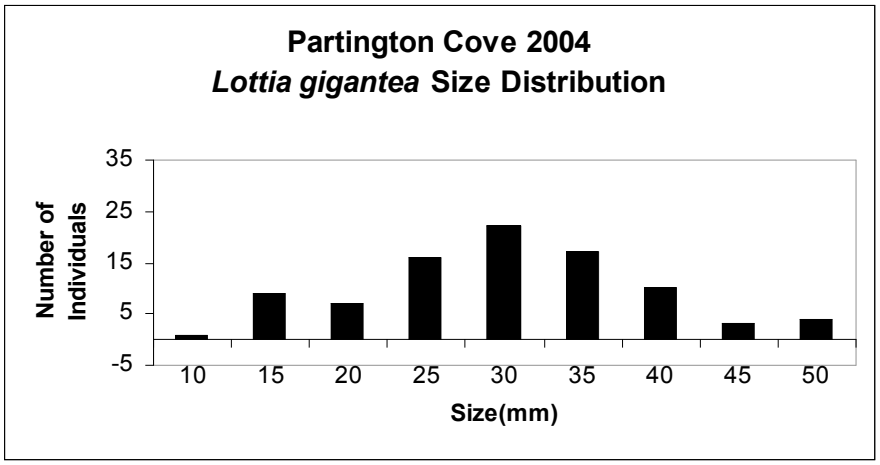


Figure 8.7.2. Size-frequency distribution of owl limpets (*Lottia gigantea*) at Partington Cove in 2004. Owl limpets live in the rocky intertidal and are a species of special interest.

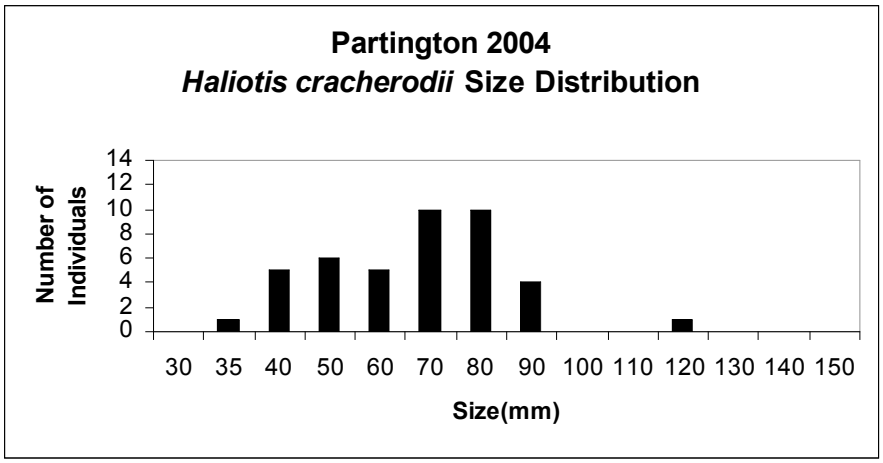


Figure 8.7.3. Size-frequency distribution of black abalone (*Haliotis cracherodii*) at Partington Cove in 2004. Black abalone live in the rocky intertidal and are a species of special interest. Recently their numbers in southern California declined dramatically as a result of commercial and recreational harvesting and the rapid spread of disease (withering foot syndrome). Data collected by Abby Nickels.

Additional comments

Placiphorella velata, a carnivorous chiton, was unique to this site and has not been sighted by PISCO at any other central California survey site in the intertidal between 2002 and 2004. In contrast, this species was seen at several of the subtidal sites in 2003 and 2004, but was rare at each.

<u>Subtidal of Partington Point</u>

Overall subtidal ranking

Combining the five subtidal sensitivity indices, Partington Point scored 14 of 22 points possible (tied with 3 other sites) and is considered a site of medium value relative to the 21 sites surveyed qualitatively. The species richness ranks—again, relative to the other 21 sites sampled qualitatively—were 17th (tie) for algae, 15th (tie) for invertebrates, and 17th (tie) for fishes. Complete lists of the species encountered are provided in Appendices B-D.

Subtidal species of concern

At Partington Point, 10 of the 12 subtidal species of concern were observed (only urchins and surfgrass were not; Table 8.7.2).

Table 8.7.2: Relative abundance of species of special interest and their rank as compared to all 21 qualitative subtidal survey sites

Species	Category	Relative abundance
Phyllospadix spp.	Habitat forming	Not noted
Macrocystis pyrifera	Burial, turbidity sensitivity	Medium
Nereocystis luetkeana	Burial, turbidity sensitivity	Low
Pterygophora californica	Burial, turbidity sensitivity	Medium
Stylaster californicus	Burial, scour sensitivity	Stylantheca present
Haliotis rufescens	Burial sensitivity	Present
Strongylocentrotus spp.	Burial sensitivity	Not noted
Scorpaenichthys marmoratus	Burial sensitivity	Average
Ophiodon elongatus	Burial sensitivity	Average
Hexagrammos decagrammus	Burial sensitivity	Above average
Sebastes carnatus	Burial sensitivity	Average
Sebastes chrysomelas	Burial sensitivity	Above average

Additional comments:

Although urchins were not observed during the dive, they may have been present at very low levels in cryptic habitats. In contrast, it is not likely we missed the presence of surfgrass. The shallow subtidal and low intertidal had high proportions of boulders and cobble (Table 4.1), potentially reducing the ability of surfgrass to persist. Neither the intertidal nor subtidal survey teams noted surfgrass, which is conspicuous when present.

Subtidal algae (Readdie/Kusic)

Kelp canopy surface estimate: 20,226 m^2

a) Shallow subtidal zone (20 ft)

Canopy

Nereocystis luetkeana (bull kelp) was present in low abundance.

Subcanopy

Laminaria setchellii was present in high abundance.

Pterygophora californica was present in medium abundance.

Understory

Foliose reds were present in high abundance— *Callophyllis* spp. was present in low abundance. *Chondracanthus corymbifera*/*exasperata* (Turkish towel) was present in high abundance.
Articulated corallines were present in high abundance.
Brown algae— *Cystoseira osmundacea* (chain bladder kelp) and *Laminaria farlowii* (oarweed kelp) were present in medium abundance.

b) Mid-subtidal zone (30 - 45 ft)

Canopy

Macrocystis pyrifera was present in medium abundance.
Nereocystis luetkeana (bull kelp) was present in low abundance.

Subcanopy

Eisenia arborea (southern sea palm) was present in high abundance.
Laminaria setchellii (kelp) was present in high abundance.
Pterygophora californica was present in medium abundance.

Understory

Foliose reds were present in medium abundance— *Rhodymenia*/*Ozophora* were present in high abundance and *Chondracanthus corymbifera*/*exasperata* (Turkish towel) were present in medium abundance.
Crustose corralines— *Lithothamnion* sp. was present in high abundance.
Articulated corallines— *Calliarthron cheilosporioides* was present in low abundance.
Brown algae— *Desmarestia ligulata var. ligulata* (acid kelp) was present in medium abundance.

c) Deep subtidal zone (45 - 60 ft)

Canopy

None noted.

Subcanopy

Laminaria setchellii and Pterygophora californica were present in low abundance.

Understory

Foliose reds were present in high abundance— *Botryoglossum*/*Cryptopleura*, *Hymenena flabelligera*, and *Plocamium pacificum* growing on *Diopatra ornata* were present in high abundance. *Polyneura latissima* and *Shizymenia*/*Halymenia* were present in medium abundance. *Rhodymenia*/*Ozophora* were present in low abundance.
Brown algae— *Desmarestia latifrons* was present in high abundance. *Desmarestia ligulata var. ligulata* was present in low abundance.

Subtidal invertebrates (Lonhart)

a) Shallow subtidal zone (0-20 ft)

The abundance of light bulb tunicates (*Clavelina huntsmani*) increased here and the proliferating anemone (*Epiactis prolifera*) was observed only in this zone. There were also several sponge species, including *Haliclona* spp. and *Ophlitaspongia pennata*.

b) Mid-subtidal zone (20 - 40 ft)

There were numerous clumps of a compound tunicate that resembled *Ritterella pulchra* on the scattered rocky outcrops.

c) Deep subtidal zone (40 - 60 ft)

The ornate tubeworm (*Diopatra ornata*) was common at 59 feet. We encountered a large vertical wall (possibly the southern edge of the cove) that had compound tunicates and numerous opalescent nudibranchs (*Hermissenda crassicornis*). I also noted the golden bryozoan crust and walls covered with the gray didemnid tunicate. Tunicates and sponges (*Craniella arb* and *Polymastia pacifica*) were common.

In an area of low relief (<1 m) characterized as a boulder field, divers observed densely packed light bulb tunicates (*Clavelina huntsmani*), golden tunicates (*Pycnoclavella stanleyi*), red volcano sponges (*Acarnus erithacus*), and the encrusting hydrocoral (*Stylantheca porphyra*) in cracks and crevices. This hydrocoral is often found in areas with high water flow and surge.

Subtidal fishes (Carr)

A total of 14 species of fish were encountered at this site, ranking below average relative to the mean and median (17 species) among sites surveyed. The number of rockfish (7) and surfperch (3) species were typical for the sites surveyed. X of the 5 fish species of concern were encountered here; black and yellow rockfish and kelp greenling were above average site abundance, whereas cabezon, lingcod, and gopher rockfish were at average site abundance. Species of particularly high abundance included juveniles of the olive, black and bocaccio rockfish, and the stripe and pile perch. Above average numbers of adult pile, silver and stripe perch, painted greenling, and juvenile black and yellow rockfish were observed. No species was of particularly low abundance at this site.

a) Shallow subtidal zone (0-20 ft)

Eight species of fish were encountered in the shallow depth zone, including the adults of kelp, black and yellow, and black rockfish, stripe perch, painted and kelp greenling, and juvenile bocaccio and black and yellow rockfish and juvenile stripe and pile perch.

b) Mid-subtidal zone (20 - 40 ft)

Nine species of fish were encountered in the mid-depth zone, including the adult kelp and black and yellow rockfish, stripe, silver and pile perch, cabezon, and juvenile olive, black and yellow, black and bocaccio rockfish and stripe perch.

c) Deep subtidal zone (40 - 60 ft)

Eight species of fish were encountered in the deep depth zone, including the adults of blue, olive, kelp, black and yellow, gopher rockfish, lingcod, painted and kelp greenling, and juvenile blue, olive, gopher, and black rockfish.

IV.B.9. McWay Rocks

IV.B.9.1. Survey metadata

Table 9.1. Survey type, date completed, and specific location of sampling conducted at McWay Rocks.

Survey type	Date completed	Latitude (N)	Longitude (W)
Qualitative Intertidal	August 15, 2003	36 09’75	-121 40’96
Qualitative subtidal	September 15, 2003	36 09’52.33”	-121 40’51.01”
Quantitative subtidal-benthic 2003			
Upcoast deep	September 19, 2003	36 10' 2.05"	-121 41' 7.98"
Downcoast deep	September 19, 2003	36 10' 2.05"	-121 41' 7.98"
Quantitative subtidal-fish 2003			
Upcoast deep	September 19, 2003	36 10' 2.05"	-121 41' 7.98"
Downcoast deep	September 19, 2003	36 10' 2.05"	-121 41' 7.98"

IV.B.9.2. Intertidal survey conditions

Tide- August 8, 2003: 2.3 at 7:45
Time- Approximately 30 minutes were spent at the site for a qualitative overview.

IV.B.9.3. Subtidal survey diving conditions

Sea surface— Conditions (wind, waves) were very calm and overcast.

Surge— Not recorded.

Visibility— Not recorded.

Depth— The maximum depth was 64 ft.

Transect length (estimated)— 139 m.

Bottom time— 46 minutes.

Water temperature— 60 F at 25 ft deep and a thermocline at 56 ft.

Distance from shore to 20 m isobath— 354.6 m. The slope is considered steep.

IV.B.9.4. Site overview

Location

McWay Rocks is located 1.5 km south of Partington Point and due west of mile 36.8 on Highway 1.

Environment

McWay Rocks is an intertidal bedrock bench of sedimentary rock (Cretaceous sandstone) and is visible from HWY 1. The bench slope ranges from 15-40 degrees and is exposed to the NW. Tidepools are present on the bench. The upland slope between the bench and HWY 1 is 60-85 degrees and is exposed rock and grasses. Cyprus trees sit atop the slope. Upcoast of the bench is a pocket beach with the same upland slope configuration. Beyond the pocket beach to the north is an active slide/exposed earth slope with beach/cobble and some boulders below. In the subtidal, the bottom was steep and characterized by large vertical outcrops in the deep section separated by sand-filled "chasms." The sand became coarser with decreasing depth, and cobble increased as we approached shore.

Biological overview

The bench slope ranges from 15-40 degrees and is exposed to the NW. Tidepools are present on the bench. The upland slope between the bench and HWY 1 is 60-85 degrees and is exposed rock and grasses. Cyprus trees sit atop the slope.

High-zone species include barnacle *Chthamalus* spp. Mid-zone species include barnacle *Balanus glandula,* and green algae *Cladophora columbiana*. Low-zone species include brown algae *Postelsia palmiformes,* kelp *Alaria marginata* and red algae *Corallina* spp. Divers qualitatively surveyed a kelp bed at McWay Rocks on September 15, 2003. The outer part of the kelp bed had high vertical relief and rocky surfaces were covered with large bryozoan colonies.

IV.B.9.5. Nearshore geology and geography

Proximity to creeks and canyons

The McWay Rocks site is just north of McWay Falls (0.75 miles south). This creek flows year round into the sandy beach of McWay Cove and likely has no influence on the McWay Rocks site.

Exposure, cliffs, and erosion

McWay Rocks has a western exposure. The highway is well above shore level and the slopes are primarily unconsolidated dirt with some vegetation. The dive site was located just to the north of the massive slide and subsequent roadwork that occurred in 1983. The terrestrial geology is classified as igneous and/or metamorphic rock, but there is also unconsolidated sediment from the landslide. The intertidal bench slope ranges from 15-40 degrees and is exposed to the NW. The upland slope between the bench and HWY 1 is 60-85 degrees and is exposed rock and grasses. Upcoast of the bench is a pocket beach with the same upland slope configuration. Beyond the pocket beach to the north is an active slide/exposed earth slope with beach/cobble and some boulders below.

Intertidal geology

McWay Rocks is an intertidal bedrock bench of sedimentary rock (Cretaceous sandstone) and is visible from HWY 1. Tidepools are present on the bench. These intertidal benches are relatively compressed and steep. Beyond the pocket beach to the north is an active slide/exposed earth slope with beach/cobble and some boulders in the intertidal. This is a high wave energy site.

Subtidal geology and topography

In the deep zone, the bottom was mostly large reef outcrops.

Table 9.5. McWay Rocks qualitative subtidal survey results for reef type and relief by three depth zones. Percentages for each category are based on *in situ* visual diver estimates and review of underwater video (when available).

Depth	Reef Type				Relief			
(meters)	sand	cobble	boulder	bedrock	0-10 m	10-1 m	1-2 m	>2 m
0-6		25	50	25	25		25	50
6-12			50	50			50	50
12-18	20			80	20			80

IV.B.9.6. Nearshore oceanography

McWay Rocks faces the west and is exposed to northwestern swell. To our knowledge, there are no data on nearshore currents at this site.

IV.B.9.7. Biology

Intertidal of McWay Rocks

Overall intertidal ranking

This site was not surveyed, but based on its similarities to Lucia and Partington Pt. we estimate the species richness and composition to be comparable to those two sites and range between 63-75 species categories.

Intertidal species of concern

Three out of seven intertidal species of special interest (see Methods for selection criteria), were present (Table 6.1).

Table 9.7.1: Species of special interest present at McWay Rocks

Species	Common name
Postelsia palmaeformis	sea palm
Mytilus californianus	California sea mussel
Strongylocentrotus purpuratus	purple urchin

Subtidal of McWay Rocks

Overall subtidal ranking

Combining the five subtidal sensitivity indices, McWay Rocks scored 12 of 22 points possible and is considered a site of medium value relative to the 21 sites surveyed qualitatively. The species richness ranks—again, relative to the other 21 sites sampled qualitatively—were 12th (tie) for algae, 17th for invertebrates, and 5th (tie) for fishes. Complete lists of the species encountered are provided in Appendices B-D.

Subtidal species of concern

At McWay Rocks, 9 of the 12 subtidal species of concern were observed (Table 9.7.2).

Table 9.7.2: Relative abundance of species of special interest and their rank as compared to all 21 qualitative subtidal survey sites

Species	Category	Relative abundance
Phyllospadix spp.	Habitat forming	Not noted
Macrocystis pyrifera	Burial, turbidity sensitivity	Low
Nereocystis luetkeana	Burial, turbidity sensitivity	Low
Pterygophora californica	Burial, turbidity sensitivity	Medium
Stylaster californicus	Burial, scour sensitivity	Not noted
Haliotis rufescens	Burial sensitivity	Present
Strongylocentrotus spp.	Burial sensitivity	Not noted
Scorpaenichthys marmoratus	Burial sensitivity	Below average
Ophiodon elongatus	Burial sensitivity	Above average
Hexagrammos decagrammus	Burial sensitivity	Above average
Sebastes carnatus	Burial sensitivity	Above average
Sebastes chrysomelas	Burial sensitivity	Average

Subtidal algae (Readdie/Kusic)

Kelp canopy surface estimate: 20,226 m^2

a) Shallow subtidal zone (15-25 ft)

Canopy

Macrocystis pyrifera was present in low abundance.
Nereocystis luetkeana was present in low abundance.

Subcanopy

Laminaria setchellii was present in low abundance.
Pterygophora californica was present in medium abundance.

Understory

Foliose reds were present in low abundance— *Botryoglossum/Cryptopleura/ Hymenena, Chondracanthus corymbifera/ exasperata, Prionitis spp,* and *Ptilota/Neotilota* were present in high abundance. *Mazaella spp* and *Rhodomenia/Ozophora* were present in medium abundance.
Articulated Corallines— *Calliarthron cheilosporioides* was present in medium abundance.
Brown algae— *Cystoseira osmundacea* was present in low abundance. *Egregia menziesii* was present in high abundance.

b) Mid-subtidal zone (30 - 35 ft)

Canopy

Macrocystis pyrifera was present in medium abundance.
Nereocystis luetkeana (bull kelp) was present in low abundance.

Subcanopy

Pterygophora californica was present in medium abundance.

Understory

Foliose reds were present in low abundance— *Chondracanthus corymbifera/ exasperata* and *Erythrophyllum delesseriodes* were present in high abundance. *Botryoglossum/ Cryptopleura/Hymenena* were present in low abundance. *Mazaella spp* and *Rhodomenia/Ozophora* were present in medium abundance.
Crustose Corallines— *Lithothamnion sp.* was present in low abundance.
Articulated Corallines— *Calliarthron cheilosporioides* was present in low abundance. *Corallina frondescens* was present in high abundances
Brown algae—*Desmarestia ligulata var. ligulata* was present in low abundance.

c) Deep subtidal zone (60 ft)

Canopy

Macrocystis pyrifera was present in low abundance.

Understory

Foliose reds were present in low abundance— *Chondracanthus corymbifera/*

exasperata were present in high abundance. *Botryoglossum/Cryptopleura/ Hymenena, Callophyllis spp, Rhodomenia/Ozophora*, and *Shizymenia/Halymenia* were present in medium abundance.
Articulated Corallines— *Calliarthron cheilosporioides* was present in medium abundance.
Brown algae— *Desmarestia ligulata var. ligulata* was present in low abundance.

Subtidal invertebrates (Lonhart)

a) Shallow subtidal zone (0-20 ft)

At 20 ft the bottom was cobble and coarse sand amidst slabs of reef. Most of the surfaces were dominated by coralline algae and crustose bryozoans. Surfgrass (*Phyllospadix* spp.) was present at depth of 8 ft.

b) Mid-subtidal zone (20 - 40 ft)

The middle zone was not actually the "bottom", since we dove from pinnacle to pinnacle, swimming over sand-filled channels. The pinnacles were covered with the strawberry anemone (*Corynactis californica*). I also noted the white finger sponge (*Toxadocia* sp.).

c) Deep subtidal zone (40 - 60 ft)

The outer edge of the kelp bed was below 60 ft, closer to 70 ft. I noticed a California frog shell (*Bursa californica*) on the sandy floor. A large vertical face (to 20 ft) was covered with bryozoans, particularly very large mounds of the fluted bryozoan (*Hippodiplosia insculpta*). This massive pinnacle was also covered with tunicates, especially the orange and gray morphospecies of the unidentified encrusting didemnid.

6.2.3) Subtidal fishes (Carr)

A total of 20 species of fish were encountered at this site, ranking above average relative to the mean and median (17 species) among sites surveyed. The number of rockfish (10) and surfperch (3) species were above and at the average, respectively, for the sites surveyed. Four of the 5 fish species of concern were encountered here; lingcod, gopher rockfish and kelp greenling were above average site abundance, whereas black and yellow rockfish were at average site abundance and the absence of cabezon was below its average site abundance. Species of particularly high abundance included adult sheephead, and juvenile gopher rockfish and stripe perch. Above average numbers of adult blue, olive, china and tree rockfish, juvenile olive rockfish and bocaccio, adult pile perch, painted greenling, *Gibbonsia*, senorita and blackeye gobies. Adult black rockfish were of particularly low abundance.

a) Shallow subtidal zone (0-20 ft)

Four species of fish were encountered in the shallow depth zone, including the adults of black, stripe and pile perch, and senorita.

b) Mid-subtidal zone (20 - 40 ft)

Fifteen species of fish were encountered in the mid-depth zone, including the adults of blue, olive, kelp, gopher and black and yellow rockfish, stripe and pile perch, painted and kelp

greenling, lingcod, *Gibbonsia*, senorita, sheephead, and juvenile blue, olive, black, gopher and bocaccio rockfish, and stripe perch.

c) Deep subtidal zone (40 - 60 ft)

Seventeen species of fish were encountered in the deep depth zone, including the adults of blue, olive, kelp, gopher, china, tree and vermilion rockfish, stripe and pile perch, painted and kelp greenling, lingcod, senorita, sheephead, and blackeye gobies, and juvenile blue, olive, black, gopher and bocaccio rockfish.

IV.B.10. Anderson Landing

IV.B.10.1. Survey metadata

Table 10.1. Survey type, date completed, and specific location of sampling conducted at Anderson Landing.

Survey type	Date completed	Latitude (N)	Longitude (W)
Intertidal	No data		
Qualitative subtidal	October 5, 2004	36 08.830	121 39.942
Quantitative subtidal	No data		
2003	No data		
Upcoast deep	No data		
Downcoast deep	No data		
2004	No data		
Upcoast deep	No data		
Downcoast deep	No data		

IV.B.10.2. Intertidal survey conditions

No data

IV.B.10.3. Subtidal survey diving conditions

Sea surface— Conditions (wind, waves) were moderate.

Surge— Not recorded.

Visibility— Not recorded.

Depth— The maximum depth was 68 ft.

Transect length (estimated)— 417 m.

Bottom time— 49 minutes.

Water temperature— Not recorded.

Distance from shore to 20 m isobath— 493.4 m. The slope is considered moderate.

IV.B.10.4. Site overview

Location

Anderson Landing is located 5 km north of Partington Point and due west of mile 35.0 on Highway 1.

Environment

In the subtidal, the bottom consisted of large slabs in the outer and central sections of the kelp bed and separated by a sand patch. It was deep (≥60 ft) for much of the dive.

Biological overview

Divers qualitatively surveyed a kelp bed at Anderson Landing on October 5, 2004. The California hydrocoral (*Stylaster californicus*) was on the tops of large reef slabs. The nipple sponge (*Polymastia pacifica*) formed very large rings (to 50 cm) on the tops of large boulders.

IV.B.10.5. Nearshore geology and geography

Proximity to creeks and canyons

The Anderson Landing site is near three drainages: Burns Creek (0.25 miles north), Buck Creek (0.3 miles south), and Hot Springs Canyon (1.3 miles south). None of these creeks has sustained flow, nor do they influence the dive site.

Exposure, cliffs, and erosion

Anderson Landing has a western exposure. The cliffs are short and the rocky base is topped with a thick layer of vegetated sediment. The terrestrial geology is classified as sedimentary rock.

Intertidal geology

No data

Subtidal geology and topography

At 60 ft the bottom consisted of large slabs. The site had a large outer reef and a central reef. A sand patch separated these reefs, both of which were >50 ft deep.

Table 10.5. Anderson Landing qualitative subtidal survey results for reef type and relief by three depth zones. Percentages for each category are based on *in situ* visual diver estimates and review of underwater video (when available).

Depth	Reef Type				Relief			
(meters)	sand	cobble	boulder	bedrock	0-10 m	10-1 m	1-2 m	>2 m
0-6	10	10	10	70	10	10	20	60
6-12	20		20	70	20	10	10	60
12-18	40			60	40	40		60

IV.B.10.6. Nearshore oceanography

Anderson Landing faces the west and is exposed to northwestern swell. To our knowledge, there are no data on nearshore currents at this site.

IV.B.10.7. Biology

Intertidal of Anderson Landing

No data

Subtidal of Anderson Landing

Overall subtidal ranking

Combining the five subtidal sensitivity indices, Anderson Landing scored 17 of 22 points possible and is considered a site of high value relative to the 21 sites surveyed qualitatively. The species richness ranks—again, relative to the other 21 sites sampled qualitatively—were 12th (tie) for algae, 12th for invertebrates, and 16th for fishes. Complete lists of the species encountered are provided in Appendices B-D.

Subtidal species of concern

At Anderson Landing, 9 of the 12 subtidal species of concern were observed (Table 10.7).

Table 10.7: Relative abundance of species of special interest and their rank as compared to all 21 qualitative subtidal survey sites

Species	Category	Relative abundance
Phyllospadix spp.	Habitat forming	Not noted
Macrocystis pyrifera	Burial, turbidity sensitivity	Low
Nereocystis luetkeana	Burial, turbidity sensitivity	Medium
Pterygophora californica	Burial, turbidity sensitivity	Medium
Stylaster californicus	Burial, scour sensitivity	Present
Haliotis rufescens	Burial sensitivity	Not noted
Strongylocentrotus spp.	Burial sensitivity	Not noted
Scorpaenichthys marmoratus	Burial sensitivity	Below average
Ophiodon elongatus	Burial sensitivity	Below average
Hexagrammos decagrammus	Burial sensitivity	Average
Sebastes carnatus	Burial sensitivity	Average
Sebastes chrysomelas	Burial sensitivity	Average

Subtidal algae (Readdie/Kusic)

Kelp canopy surface estimate: 20,226 m^2

a) Shallow subtidal zone (0-20 ft)

Canopy

Macrocystis pyrifera was present in low abundance with plants having 30 stipes.

Nereocystis luetkeana was present in high abundance.

Subcanopy

Laminaria setchellii was present in high abundance.

Understory

Foliose reds— *Botryoglossum/Cryptopleura/Hymenena, Chondracanthus spp, Mazzaella spp.* and *Rhodomenia/Ozophora spp* were present in high abundance. *Callophyllis spp, Erythrophyllum delesserioides, Prionitis spp,* and *Shizymenia/Halymenia* were present in medium abundance.
Brown algae— *Alaria marginata* and *Costaria costata* were present in high abundance.
Egregia *menziesii* was present in medium abundance.

b) Mid-subtidal zone (20 - 40 ft)

Canopy

Macrocystis pyrifera was present in low abundance with plants having 2-4 stipes.
Nereocystis leutkeana was present in low abundance.

Subcanopy

Pterogophora californica was present in medium abundance, with a patchy distribution.
Laminaria setchellii was present in medium abundance, with a patchy distribution.

Understory

Foliose reds were 40% of total understory algae— *Botryoglossum/Cryptopleura/Hymenena* and Prionitis spp were present in high abundance. *Callophyllis spp, Chondracanthus corymbifera/exasperata*, *and Rhodomenia/O*zophora spp were present in medium abundance.
Red crust was 1% of total understory algae
Crustose Corallines were 10% of total understory algae.
Articulated Corallines were 40% of total understory algae.
Brown algae were 5% of total understory algae— *Desmarestia ligulata var. ligulata* was present in high abundance.

c) Deep subtidal zone (40-60 ft)

Canopy

Macrocystis pyrifera was present in medium abundance, with a patchy distribution and plants having 10-30 stipes.

Subcanopy

Laminaria setchellii was present in low abundance.
Pterogophora californica was present in medium abundance.

Understory

Foliose reds were 15% of total understory algae— *Botryoglossum/Cryptopleura/Hymenena,*

Chondracanthus corymbifera/ exasperata, and *Rhodomenia/Ozophora spp* were present in high abundance. *Callophyllis flabellulata, Callophyllis spp*, and *Opuntiella californica* were present in medium abundance. *Plocamium/Microcladia* and *Prionitis spp* were present in low abundance.
Red crust was 1% of total understory algae.
Crustose Corallines were 40% of total understory algae.
Articulated Corralines were 40% of total understory algae.
Brown algae were 1% of total understory algae— *Desmarestia ligulata var. ligulata* was present in medium abundance.

Subtidal invertebrates (Lonhart)

a) Shallow subtidal zone (0-20 ft)

The carnivorous chiton (*Placiphorella velata*) was present in this zone. There was also a hydroid with pink polyps, possibly *Tubularia crocea*. At 12 ft there were stalked tunicates that have not been identified (referred to as ET tunicates) and have only been seen at a handful of other sites.

b) Mid-subtidal zone (20 - 40 ft)

The central reef had large boulders the size of cars. Rings of the nipple sponge (*Polymastia pacifica*) were up to 50 cm in diameter. At 35 ft the stipitate kelp Pterygophora californica was abundant, as was the Monterey stalked tunicate (*Styela montereyensis*). The prostate form of the California hydrocoral (*Stylantheca porphyra*), which genetically is indistinguishable from *Stylaster californicus*, was in a cleft at 29 ft.

c) Deep subtidal zone (40 - 60 ft)

Big slabs of reef were covered with invertebrates, including pink and purple heads of the California hydrocoral (*Stylaster californicus*). The elephant ear tunicate (*Polyclinum planum*) was common. The outer reef was separated from the central reef by large sand channel. The reef was deep (≥60 ft) for over 100 meters.

6.2.3) Subtidal fishes (Carr)

A total of 15 species of fish were encountered at this site, ranking on the low end of the mean (17 species) among sites surveyed. The number of rockfish (8) and surfperch (3) species were average for the sites surveyed. Three of the 5 fish species of concern were encountered here; black and yellow rockfish and gopher rockfish and kelp greenling were at average site abundance, whereas lingcod and cabezon were, by their absence, below their average among sites. Species of particularly high abundance included juvenile blue and olive rockfish and adult senoritas. Above-average numbers of adult blue, black and vermilion rockfish and tubesnout were observed. No species was of particularly low abundance at this site.

a) Shallow subtidal zone (0-20 ft)

Seven species of fish were encountered in the shallow depth zone, including the adults of blue, kelp and black rockfish, black, stripe and pile perch, kelp greenling and tubesnout.

b) Mid-subtidal zone (20 - 40 ft)

Nine species of fish were encountered in the mid-depth zone, including the adults of blue, olive and black rockfish, stripe and pile perch, painted and kelp greenling and senorita. Juvenile blue rockfish were particularly abundant at this site at this depth.

c) Deep subtidal zone (40 - 60 ft)

Ten species of fish were encountered in the deep zone, including 8 species of rockfishes (blue, olive, kelp, black, gopher, black and yellow, vermilion and juvenile bocaccio), stripe perch and adult kelp greenling. Juvenile blue and olive rockfish were particularly abundant at this site at this depth.

IV.B.11. Dolan Rock

IV.B.11.1. Survey metadata

Table 11.1. Survey type, date completed, and specific location of sampling conducted at Dolan Rock.

Survey type	Date completed	Latitude (N)	Longitude (W)
Qualitative intertidal	September 12, 2003	unknown	unknown
Quantitative subtidal	September 12, 2003	36 05'03.38"	121 37'07.95"
Quantitative subtidal	No data		
2003	No data		
Upcoast deep	No data		
Downcoast deep	No data		
2004	No data		
Upcoast deep	No data		
Downcoast deep	No data		

IV.B.11.2. Intertidal survey conditions

Tide- September 12, 2003: 0.6 at 6:10
Time- Approximately 30 minutes spent at the site for qualitative survey.

IV.B.11.3. Subtidal survey diving conditions

Sea surface— No wind, 2-3 ft rolling waves.

Surge— At depth, there was 3-6 ft of surge in the deep and middle zones.

Visibility— Horizontal visibility was typically >15 feet.

Depth— The maximum depth was 63 ft.

Transect length (estimated)— 161 m.

Bottom time— 58 minutes.

Water temperature— Not recorded.

Distance from shore to 20 m isobath— 329 m. The slope is considered steep.

IV.B.11.4. Site overview

Location

Dolan Rock is located 2.5 km north of Big Creek and due west of mile 29.7 on Highway 1.

Environment

Dolan Rock is an area of steep rocky outcrops, boulders, and offshore intertidal reefs visible from HWY 1. The upland slope between the ocean and HWY 1 is 45-60 degrees and vegetated with coastal scrub. In the subtidal, the outer/deeper zone consisted of very large, very high relief (>3 m) pinnacles.

Biological overview

Intertidal high-zone species include the brown algae *Pelvetiopsis* spp., barnacle *Chthamalus* spp. Low-zone species include coralline algae *Corallina* spp. and brown algae *Postelsia palmiformes*. Divers qualitatively surveyed just north of Dolan Rock on September 12, 2003. The kelp bed canopies at Dolan Rock were thick. Outcrops were dominated by encrusting invertebrates, including the California hydrocoral, and several species of compound tunicates.

IV.B.11.5. Nearshore geology and geography

Proximity to creeks and canyons

Dolan Rock is at the base of a moderately large, vegetated cliff with no visible drainages. We did not observe flowing water. Dolan Rock is near Rat Creek (0.45 miles north) but does not appear to have any significant freshwater input.

Exposure, cliffs, and erosion

Dolan Rock has a western exposure. The terrestrial geology is classified as unconsolidated sediment. The upland slope of Dolan Rock between the ocean and HWY 1 is 45-60 degrees.

Intertidal geology

Dolan Rock is an area of steep rocky outcrops, boulders, and offshore intertidal reefs visible from HWY 1.

Subtidal geology and topography

Initially divers encountered massive rocky outcrops with few sandy areas. This site has high relief.

Table 11.5. Dolan Rock qualitative subtidal survey results for reef type and relief by three depth zones. Percentages for each category are based on *in situ* visual diver estimates and review of underwater video (when available).

Depth	Reef Type				Relief			
(meters)	sand	cobble	boulder	bedrock	0-10 m	10-1 m	1-2 m	>2 m
0-6			50	50		20		80
6-12			50	50		20		80
12-18			50	50		20		80

IV.B.11.6. Nearshore oceanography

Dolan Rock faces the west and is exposed to northwestern swell. To our knowledge, there are no data on nearshore currents at this site. The preponderance of filter-feeding invertebrates indicates this site has high water flow.

IV.B.11.7. Biology

Intertidal of Dolan Rock

Overall intertidal ranking

Not available

Intertidal species of concern

One out of seven intertidal species of special interest (see Methods for selection criteria), were present (Table 11.7.1).

Table 11.7.1: Species of special interest present at Dolan Rock

Species	Common name
Postelsia palmaeformis	sea palm

Subtidal of Dolan Rock

Overall subtidal ranking

Combining the five subtidal sensitivity indices, Dolan Rock scored 19 of 22 points possible and is considered a site of highest value relative to the 21 sites surveyed qualitatively. The species richness ranks—again, relative to the other 21 sites sampled qualitatively—were 9th (tie) for algae, 13th for invertebrates, and 12th (tie) for fishes. Complete lists of the species encountered are provided in Appendices B-D.

Subtidal species of concern

At Dolan Rock, 8 of the 12 subtidal species of concern were observed (Table 11.7.2).

Table 11.7.2: Relative abundance of species of special interest and their rank as compared to all 21 qualitative subtidal survey sites

Species	Category	Relative abundance
Phyllospadix spp.	Habitat forming	Not noted
Macrocystis pyrifera	Burial, turbidity sensitivity	Medium
Nereocystis luetkeana	Burial, turbidity sensitivity	Medium
Pterygophora californica	Burial, turbidity sensitivity	Medium
Stylaster californicus	Burial, scour sensitivity	Present
Haliotis rufescens	Burial sensitivity	Shells only
Strongylocentrotus spp.	Burial sensitivity	Tests only
Scorpaenichthys marmoratus	Burial sensitivity	Average
Ophiodon elongatus	Burial sensitivity	Above average
Hexagrammos decagrammus	Burial sensitivity	Average
Sebastes carnatus	Burial sensitivity	Above average
Sebastes chrysomelas	Burial sensitivity	Above average

Subtidal algae (Readdie/Kusic)

Kelp canopy surface estimate: 20,226 m^2

a) Shallow subtidal zone (20-30 ft)

Canopy

Macrocystis pyrifera was present in low abundance.
Nereocystis luetkeana was present in high abundance.

Subcanopy

Laminaria setchellii was present in medium abundance.
Pterygophora californica was present in low abundance.

Understory

Foliose reds were present in high abundance— *Chondracanthus corymbifera/ exasperata, Plocamium pacificum, Prionitis spp, Ptilota/Neotilota,* and *Rhodomenia/Ozophora* were present in high abundance. *Mazaella spp* was present in medium abundance. *Callophyllis spp* was present in low abundance.
Crustose Corallines— Lithothamnion sp. was present in medium abundance.
Articulated Corallines— Calliarthron cheilosporioides was present in high abundance.
Brown algae— *Desmarestia ligulata var. ligulata* was present in high abundance.
Cystoseira osmundacea was present in medium abundance.

b) Mid-subtidal zone (30 - 40 ft)

Canopy

Macrocystis pyrifera was present in high abundance.
Nereocystis luetkeana (bull kelp) was present in medium abundance.

Subcanopy

Laminaria setchellii (kelp) was present in high abundance.
Pterygophora californica was present in high abundance.

Understory

Foliose reds were present in high abundance— *Botryoglossum/Cryptopleura/ Hymenena, Chondracanthus corymbifera/exasperata, Erythrophyllum delesseriodes, Polyneura latissima, Prionitis spp*, and *Rhodomenia/Ozophora* were present in high abundance. *Mazaella spp* was present in medium abundance.
Articulated corallines— *Calliarthron cheilosporioides* was present in high abundance.
Brown algae— *Desmarestia ligulata* var. *ligulata* was present in high abundance.

c) Deep subtidal zone (40 - 60 ft)

Canopy

Macrocystis pyrifera was present in medium abundance.
Nereocystis luetkeana was present in low abundance.

Subcanopy

Pterogophora californica was present in medium abundance
Laminaria setchellii was present in medium abundance

Understory

Foliose reds were present in high abundance— *Botryoglossum/Cryptopleura/ Hymenena, Chondracanthus corymbifera/exasperata, Pikea/Farlowia,* and *Rhodomenia/Ozophora* were present in high abundance. *Callophyllis spp* and *Halymenia/ Schizymenia* was present in medium abundance.
Crustose Corallines— *Lithothamnion sp*. was present in low abundance.
Articulated Corallines- *Calliarthron cheilosporioides* was present in high abundance.
Brown algae— *Desmarestia ligulata* var. *ligulata* was present in high abundance.

Subtidal invertebrates (Lonhart)

a) Shallow subtidal zone (0-20 ft)

The data reported here summarize those actually recorded; the original data sheet and clipboard were ripped off my BC while climbing the swim ladder during a large set of swell. I immediately used a new data sheet to capture my impression of the site. We did not dive very shallow due to the swell.

b) Mid-subtidal zone (20 - 40 ft)

High water flow and vertical walls supported large tunicate colonies (e.g., didemnids, *Cystodytes lobatus*, *Archidistoma* spp.).

c) Deep subtidal zone (40 - 60 ft)

The deep zone had numerous invertebrate species. The white-spotted rose anemone (*Urticina lofotensis*) was abundant and there were large colonies of the northern staghorn bryozoan (*Heteropora pacifica*) and the lacy bryozoan (*Phidolopora pacifica*).

Subtidal fishes (Carr)

A total of 16 species of fish were encountered at this site, ranking average relative to the mean and median (17 species) among sites surveyed (Appendix X). The number of rockfish (8) and surfperch (3) species were average for the sites surveyed. Five of the 5 fish species of concern were encountered here; lingcod, black and yellow rockfish and gopher rockfish were above their average site abundance, whereas cabezon and kelp greenling were at average site abundance. Adult sheephead were of particularly high abundance. Above-average numbers of adult blue, olive, vermilion and tree rockfish, black surfperch, and juveniles of the blue, black and yellow, and gopher rockfishes were observed. No species was of particularly low abundance.

a) Shallow subtidal zone (0-20 ft)

Seven species of fish were encountered in the shallow depth zone, including the adults of the blue, kelp and black rockfish, adult black and stripe perch and senoritas, juvenile blue, black, and gopher rockfish.

b) Mid-subtidal zone (20 - 40 ft)

Twelve species of fish were encountered in the mid-depth zone, including the adults of the blue, olive, kelp, black, black and yellow, gopher and vermilion as well as juvenile blue, black, gopher and black and yellow rockfish, adult stripe and pile perch, painted greenlings, cabezon and senoritas.

c) Deep subtidal zone (40 - 60 ft)

Eleven species of fish were encountered in the deep depth zone, including the adults of the blue, olive, kelp, black, gopher, tree, and vermilion rockfish, stripe and pile perch, painted greenling, lingcod, and sheephead, as well as juvenile blue, kelp, black, and gopher rockfish.

IV.B.12. Lucia

IV.B.12.1. Survey metadata

Table 12.1. Survey type, date completed, and specific location of sampling conducted at Lucia.

Survey type	Date completed	Latitude (N)	Longitude (W)
Quantitative intertidal	April 12, 2004	36 00’863	121 32’430
Qualitative subtidal	September 14, 2003	36 01’06.01”	-121 33’32.83”
Quantitative subtidal-benthic			
2003			
Upcoast deep	September 21, 2003	36 0' 57.61"	-121 33' 52.76"
Downcoast deep	September 21, 2003	36 0' 58.34"	-121 33' 29.97"
2004			
Upcoast deep	June 2, 2004	36 0' 57.61"	-121 33' 52.76"
Downcoast deep	June 2, 2004	36 0' 58.34"	-121 33' 29.97"
Quantitative subtidal-fish			
2003			
Upcoast deep	September 21, 2003	36 0' 57.61"	-121 33' 52.76"
Downcoast deep	September 21, 2003	36 0' 58.34"	-121 33' 29.97"
2004			
Upcoast deep	June 2, 2004	36 0' 57.61"	-121 33' 52.76"
Downcoast deep	June 2, 2004	36 0' 58.34"	-121 33' 29.97"

IV.B.12.2. Intertidal survey conditions

Tide- April 12, 2004: -0.3 at 11:58
Time- Approximately 6 hours spent at the site for quantitative survey.

IV.B.12.3. Subtidal survey diving conditions

Sea surface— Conditions (wind, waves) were calm.

Surge— At depth, there was little surge and no current.

Visibility— Horizontal visibility was typically >15 feet.

Depth— The maximum depth was 52 ft.

Transect length (estimated)— 151 m.

Bottom time— 64 minutes.

Water temperature— 56 F at 30 ft deep.

Distance from shore to 20 m isobath— 1262.4 m. The slope is considered flat.

IV.B.12.4. Site overview

Location

Lucia is located 2 km south of Lopez Point and due west of mile 23.5 on Highway 1.

Environment

Lucia is an intertidal bedrock bench of sedimentary rock located on a rocky headland. The site is visible from HWY 1. The bench slope ranges from 10-60 degrees and is openly exposed to the W. Tidepools are present on the bench. An active slide exists to the north of the site above a stretch of beach bound by boulder/cobble fields. In the subtidal, the bottom was relatively shallow (52 ft) and there was a mix of large boulders, sand patches, and moderate relief.

Biological overview

The upland slope between the bench and HWY 1 is 60-80 degrees and consists of some vertical bare bedrock and some lower angle slopes covered with non-native grasses. A Cormorant colony occupies parts of the rocky headland. High-zone species include diatoms, red alga *Porphyra* spp.*,* barnacles *Chthamalus* spp., *Balanus glandula.* Mid-zone species include the california mussel *Mytilus californianus,* barnacles *Pollicipes polymerus, Semibalanus cariosus,* red algae *Ralfsiaceae*. Low-zone species include red algae *Centroceras/Ceramium/Polysiphonia* spp., *Osmundea spectabilis, Corallina* spp., *Calliarthron* spp. Bare rock comprised 29% of the total cover. Divers qualitatively surveyed the southern edge of the large kelp bed at Lucia on September 14, 2003. This was the only site that clams were noted in the sediment. Sponges and tunicates were common, as were bryozoans and anemones.

IV.B.12.5. Nearshore geology and geography

Proximity to creeks and canyons

Lucia is not near any drainages or creeks, and the only freshwater input is seasonal (runoff).

Exposure, cliffs, and erosion

Lucia has a southern exposure. The cliffs are high with moderate amounts of sediment and vegetation covering the slopes. The terrestrial geology is classified as unconsolidated sediment. Lucia is an intertidal bedrock bench of sedimentary rock located on a rocky headland. The site is visible from HWY 1. The bench slope ranges from 10-60 degrees and is openly exposed to the W. Tidepools are present on the bench. An active slide exists to the north of the site above a stretch of beach bound by boulder/cobble fields.

Intertidal geology

The upland slope between the bench and HWY 1 is 60-80 degrees and consists of some vertical bare bedrock and some lower angle slopes covered with non-native grasses. A

Subtidal geology and topography

The bottom was a mix of boulders, moderate relief, and sand patches.

Table 12.5. Lucia qualitative subtidal survey results for reef type and relief by three depth zones. Percentages for each category are based on *in situ* visual diver estimates and review of underwater video (when available).

Depth	Reef Type				Relief			
(meters)	sand	cobble	boulder	bedrock	0-10 m	10-1 m	1-2 m	>2 m
0-6	25		75		25		40	35
6-12	50		50		50		25	25
12-18	50		50		50	25	25	

IV.B.12.6. Nearshore oceanography

Lucia faces the south, is protected from northwestern swell, and served as the primary anchorage site during most of the research cruise. To our knowledge, there are no data on nearshore currents at this site.

IV.B.12.7. Biology

Intertidal of Lucia

Overall intertidal ranking

Overall, species richness is below average for this site.
During a survey on April 12, 2003 64 species categories were noted.

Intertidal species of concern

Five out of seven intertidal species of special interest (see Methods for selection criteria), were present (Table 6.1).

Table 12.7.1: Species of special interest present at Lucia

Species	Common name
Phyllospadix spp.	surf grass
Mytilus californianus	California sea mussel
Lottia gigantea	owl limpet
Pisaster ochraceus	ochre star
Strongylocentrotus purpuratus	purple urchin

Subtidal of Lucia

Overall subtidal ranking

Combining the five subtidal sensitivity indices, Lucia scored 10 of 22 points possible and is considered a site of medium value relative to the 21 sites surveyed qualitatively. The

species richness ranks—again, relative to the other 21 sites sampled qualitatively—were 14th (tie) for algae, 8th for invertebrates, and 5th (tie) for fishes. Complete lists of the species encountered are provided in Appendices B-D.

Subtidal species of concern

At Lucia, 8 of the 12 subtidal species of concern were observed (Table 12.7.2).

Table 12.7.2: Relative abundance of species of special interest and their rank as compared to all 21 qualitative subtidal survey sites

Species	Category	Relative abundance
Phyllospadix spp.	Habitat forming	Not noted
Macrocystis pyrifera	Burial, turbidity sensitivity	Medium
Nereocystis luetkeana	Burial, turbidity sensitivity	Medium
Pterygophora californica	Burial, turbidity sensitivity	Medium
Stylaster californicus	Burial, scour sensitivity	Not noted
Haliotis rufescens	Burial sensitivity	Shell only
Strongylocentrotus spp.	Burial sensitivity	Not noted
Scorpaenichthys marmoratus	Burial sensitivity	Average
Ophiodon elongatus	Burial sensitivity	Below average
Hexagrammos decagrammus	Burial sensitivity	Average
Sebastes carnatus	Burial sensitivity	Average
Sebastes chrysomelas	Burial sensitivity	Average

Subtidal algae (Readdie/Kusic)

Kelp canopy surface estimate: 20,226 m^2

a) Shallow subtidal zone (20-25 ft)

Canopy

Macrocystis pyrifera was present in low abundance.

Subcanopy

Laminaria setchellii was present in high abundance.
Pterygophora californica was present in medium abundance.

Understory

Foliose reds were present in high abundance— *Botryoglossum/Cryptopleura/ Hymenena* and *Prionitis spp* were present in high abundance. *Chondracanthus corymbifera/ exasperata* were present in medium abundance.
Crustose Corallines- *Lithothamnion sp.* was present in high abundance.
Articulated Corallines— *Calliarthron cheilosporioides* was present in high abundance.
Brown algae— *Desmarestia ligulata var. ligulata* was present in medium abundance.

b) Mid-subtidal zone (30 - 40 ft)

Canopy

Macrocystis pyrifera was present in medium abundance.
Nereocystis luetkeana (bull kelp) was present in medium abundance.

Subcanopy

Pterygophora californica was present in medium abundance.

Understory

Foliose reds were present in high abundance— *Botryoglossum/Cryptopleura/ Hymenena* were present in high abundance. *Chondracanthus corymbifera/ exasperata* were present in medium abundance. *Callophyllis spp* and *Mazzaella sanguinea* were present in low abundance.
Crustose Corallines- *Lithothamnion sp.* was present in high abundance.
Articulated Corallines— *Calliarthron cheilosporioides* was present in high abundance.
Brown algae—*Desmarestia ligulata var. ligulata* was present in high abundance.

c) Deep subtidal zone (50 ft)

Canopy

Macrocystis pyrifera was present in medium abundance.
Nereocystis luetkeana was present in low abundance.

Subcanopy

Laminaria setchellii was present in low abundance.
Pterogophora californica was present in medium abundance.

Understory

Foliose reds were present in high abundance— *Chondracanthus corymbifera/ exasperata, Plocamium pacificum, Plocamium violaceum, Ptilota/Neotilota*, and *Rhodomenia/Ozophora* were present in high abundance. *Botryoglossum/Cryptopleura/ Hymenena, Halymenia/Schizymenia* and *Polyneura latissima* were present in medium abundance. *Callophyllis spp* was present in low abundance.
Crustose Corallines— *Lithothamnion sp*. was present in low abundance.
Articulated Corallines- *Calliarthron cheilosporioides* was present in medium abundance.
Brown algae— *Desmarestia ligulata var. ligulata* was present in medium abundance.

Subtidal invertebrates (Lonhart)

a) Shallow subtidal zone (0-20 ft)

We dove to about 8 ft deep and noted an interesting mix of vertical relief from very large boulders and sandy patches. The brooding anemone (*Epiactis prolifera*) was observed at a depth of 10 ft.

b) Mid-subtidal zone (20 - 40 ft)

This area had an interesting series of "ledges" at 37 ft, which were covered with encrusting compound tunicates and hydroids.

c) Deep subtidal zone (40 - 60 ft)

This is an extensive kelp bed over a shallow-sloping section of the coast. We did not reach depths >52 ft. Infaunal clams with long siphons (to 5 cm above the sand/gravel) were noted at depth. Most of the reef was covered with tunicates, including the gray didemnid and several other compound tunicate species. The short-spined star (*Pisaster brevispinus*) was particularly common, and this species is more typical of sandy areas than rocky reefs.

6.2.3) Subtidal fishes (Carr)

A total of 20 species of fish were encountered at this site, ranking above avergae relative to the mean and median (17 species) among sites surveyed. The number of rockfish (10) and surfperch (3) species were above and at the average, respectively, for the sites surveyed. Four of the 5 fish species of concern were encountered here; cabezon, black and yellow rockfish, gopher rockfish and kelp greenling were at average site abundance, whereas lingcod, by its absence, were below average site abundance. Species of particularly high abundance included adult black rockfish and coralline sculpins, as well as juvenile black rockfish, gopher rockfish and cabezon. Above average numbers of adult grass rockfish, pile and rainbow perch, painted greenling, snubnose sculpin, *Gibbonsia*, and juvenile bocaccio were observed. No species was of particularly low abundance at this site.

a) Shallow subtidal zone (0-20 ft)

Ten fish species were encountered in the shallow depth zone, including the adults of blue, kelp, black, black and yellow, and grass rockfish, stripe, pile and rainbow perch, and juvenile blue, black and gopher rockfish, pile perch and cabezon.

b) Mid-subtidal zone (20 - 40 ft)

Thirteen species of fish were encountered in the mid-depth zone, including the adults of blue, kelp, black, and black and yellow rockfish, stripe, pile and rainbow perch, painted and kelp greenling, cabezon and *Gibbonsia*, and juvenile blue, black, gopher and canary rockfish, painted greenling and cabezon.

c) Deep subtidal zone (40 - 60 ft)

Fourteen species of fish were encountered in the deep zone, including the adults of blue, kelp, black, gopher and vermilion rockfish, stripe and rainbow perch, painted greenling, coralline and snubnose sculpin, and blackeye gobies, and juvenile blue, olive, black, gopher and bocaccio rockfish, painted greenling and cabezon.

IV.B.13. Limekiln

IV.B.13.1. Survey metadata

Table 13.1. Survey type, date completed, and specific location of sampling conducted at Limekiln.

Survey type	Date completed	Latitude (N)	Longitude (W)
Intertidal	No data		
Qualitative subtidal	October 6, 2004	36 00.357	121 31.124
Quantitative subtidal	No data		
2003	No data		
Upcoast deep	No data		
Downcoast deep	No data		
2004	No data		
Upcoast deep	No data		
Downcoast deep	No data		

IV.B.13.2. Intertidal survey conditions

No data

IV.B.13.3. Subtidal survey diving conditions

Sea surface— Conditions (wind, waves) were moderate.

Surge— Not recorded.

Visibility— Not recorded.

Depth— The maximum depth was 44 ft.

Transect length (estimated)— 197 m.

Bottom time— 50 minutes.

Water temperature— Not recorded.

Distance from shore to 20 m isobath— 796.0 m. The slope is considered moderately flat.

IV.B.13.4. Site overview

Location

Limekiln is located 5 km south of Lopez Point and due west of mile 20.8 on Highway 1.

Environment

In the subtidal, the bottom was reef surrounded by sand. At 40 ft deep the bottom was relatively flat, with sand furrows separating boulders (3-4 m). At 20 ft deep there was a ridge that rose 5-10 ft above the bottom.

Biological overview

Divers qualitatively surveyed a small kelp bed at Limekiln on October 6, 2004. The deep zone was only 43 to 40 ft deep (shallow relative to most sites). The ornate tubeworm (*Diopatra ornata*) surrounded the reefs. The site had relatively few encrusting invertebrates and generally had an "old" look; rocks were covered with fine sediment and detritus.

IV.B.13.5. Nearshore geology and geography

Proximity to creeks and canyons

The Limekiln site is near Limekiln Creek (0.25 miles north), which may flow through the beach. The nearshore waters at the creek are clear, but there is a sediment-laden cove to the north, which is influenced by the slide at Pitkins Curve.

Exposure, cliffs, and erosion

Limekiln has a southern exposure. The cliffs are short and covered with gray-green sediment and vegetation. There is ample evidence of chronic but small input of sediment from land to sea. The terrestrial geology is classified as igneous and/or metamorphic rock.

Intertidal geology

No data

Subtidal geology and topography

Beyond the outer edge of the reef was a large sand field with a few small rocky outcrops. This was a relatively flat and shallow site. Sand grain size was medium. There were few boulders until a depth of 30 ft. At <20 ft deep cobble was noted.

Table 13.5. Limekiln qualitative subtidal survey results for reef type and relief by three depth zones. Percentages for each category are based on *in situ* visual diver estimates and review of underwater video (when available).

Depth	Reef Type				Relief			
(meters)	sand	cobble	boulder	bedrock	0-10 m	10-1 m	1-2 m	>2 m
0-6	10	10	30	50	30	10	40	20
6-12	30		20	50	30	20	30	20
12-18	70		10	20	70	15	15	

IV.B.13. 6. Nearshore oceanography

Limekiln faces the south and is partially protected from northwestern swell. To our knowledge, there are no data on nearshore currents at this site.

IV.B.13.7. Biology

Intertidal of Limekiln

No data

Subtidal of Limekiln

Overall subtidal ranking

Combining the five subtidal sensitivity indices, Limekiln scored 14 of 22 points possible and is considered a site of medium value relative to the 21 sites surveyed qualitatively. The species richness ranks—again, relative to the other 21 sites sampled qualitatively—were 1st for algae, 1st for invertebrates, and 20th for fishes. Complete lists of the species encountered are provided in Appendices B-D.

Subtidal species of concern

At Limekiln, 10 of the 12 subtidal species of concern were observed (only *Stylaster* and abalone were not; Table 13.7).

Table 13.7: Relative abundance of species of special interest and their rank as compared to all 21 qualitative subtidal survey sites

Species	Category	Relative abundance
Phyllospadix spp.	Habitat forming	Low
Macrocystis pyrifera	Burial, turbidity sensitivity	Low
Nereocystis luetkeana	Burial, turbidity sensitivity	High
Pterygophora californica	Burial, turbidity sensitivity	Low
Stylaster californicus	Burial, scour sensitivity	Not noted
Haliotis rufescens	Burial sensitivity	Not noted
Strongylocentrotus spp.	Burial sensitivity	Present
Scorpaenichthys marmoratus	Burial sensitivity	Average
Ophiodon elongatus	Burial sensitivity	Below average
Hexagrammos decagrammus	Burial sensitivity	Average
Sebastes carnatus	Burial sensitivity	Well below average
Sebastes chrysomelas	Burial sensitivity	Below average

Subtidal algae (Readdie/Kusic)

Kelp canopy surface estimate: 20,226 m^2

a) Shallow subtidal zone (0-20 ft)

Canopy

Macrocystis pyrifera was present in low abundance with plants having 15 stipes.

Nereocystis luetkeana was present in high abundance.

Subcanopy

Laminaria setchellii was present in medium abundance.
Pterygophora californica was present in low abundance.

Understory

Foliose reds were 20% of total understory algae— Botryoglossum/Cryptopleura/Hymenena, Chondracanthus corymbifera/ exasperata, Pikea/Farlowia, and Ptilota/Neoptilota were present in high abundance. Callophyllis spp, Erythrophyllum delesserioides, Gelidium spp, Mazzaella spp, Prionitis spp, and Rhodomenia/Ozophora spp were present in medium abundance.
Articulated Corallines were 70% of total understory algae.
Brown algae were 5% of total understory algae— Desmarestia ligulata var ligulata was present in high abundance. Alaria marginata, Cystoseira osmundacea, and Egregia menziesii were present in medium abundance.
Phyllospadix spp. was 5% of total understory.

b) Mid-subtidal zone (20 - 40 ft)

Canopy

Macrocystis pyrifera was present in low abundance with plants having 30-40 stipes.
Nereocystis leutkeana was present in medium abundance.

Subcanopy

Pterogophora californica was present in low abundance.
Laminaria setchellii was present in low abundance.

Understory

Foliose reds were 15% of total understory algae— *Botryoglossum/Cryptopleura/Hymenena, Polysiphonia/Ceramium* and *Rhodomenia/Ozophora* were present in high abundance. *Callophyllis flabellulata, Chondracanthus corymbifera/ exasperata, Constantinia spp, Fauchea spp, Opuntiella californica, Pikea/Farlowii* and *Plocamium/Microcladia* were present in medium abundance.
Red crust was 5% of total understory algae
Crustose Corallines were 10% of total understory algae.
Articulated Corallines were 70% of total understory algae.

Subtidal invertebrates (Lonhart)

a) Shallow subtidal zone (0-20 ft)

There was a minor ridge at 20 ft and a drop off to 25 ft. The rocks and boulders were covered with fine sediment, giving an appearance of an "old" site with reduced water flow. Patches of cobble became more common and stands of the stipitate kelp (*Pterygophora californica*) were interspersed with red volcano sponges (*Acarnus erithacus*). At 11 ft we

encountered surf grass (*Phyllospadix* sp.). Many of the rocks were covered with erect coralline algae but I did not observe any six-rayed stars (*Leptasterias hexactis*).

b) Mid-subtidal zone (20 - 40 ft)

At 39 ft the sharpnose crab (*Scyra acutifrons*) was commonly seen on a vertical wall, with most 5 cm in length. This will also had numerous leafy hornmouths (*Ceratostoma foliatum*). This area had several car-sized boulders with sandy furrows in between, and was relatively flat. By 31 ft the bottom consisted of low-lying slabs covered with the nipple sponge (*Polymastia pacifica*) and sand channels filled with the ornate tubeworm (*Diopatra ornata*). This stretch of bottom to 30 ft had few boulders and low relief. Tunicates were not as common as at other sites. The section of reef from 30 to 20 ft deep was especially long.

c) Deep subtidal zone (40 - 60 ft)

This was a small kelp bed below two retaining walls constructed along Highway 1. On the outer edge of the kelp bed was a large field of sand with very few rocks and little kelp. The sand was a medium grain size and furrows were evident at a depth of 43 ft. The reef itself was surrounded by the ornate tubeworm (*Diopatra ornata*) and the deep zone was only from 43-40 ft.

Subtidal fishes (Carr)

A total of 12 species of fish were encountered at this site, ranking it below average relative to the mean and median (17 species) among sites surveyed. The number of rockfish (4) and surfperch (3) species were well below and at the average, respectively, for the sites surveyed. Three of the 5 fish species of concern were encountered here; only cabezon and kelp greenling were at average site abundance. Cabezon and lingcod were below average site abundance. By its absence, gopher rockfish were far below average abundance relative to other sites. Species of particularly high abundance included adult rubberlip perch and blue rockfish only. Species of particularly low abundance were adult olive, kelp, and black rockfish.

a) Shallow subtidal zone (0-20 ft)

Three species of fish were encountered in the shallow depth zone, including the adults of stripe perch, kelp greenling and cabezon.

b) Mid-subtidal zone (20 - 40 ft)

Ten species of fish were encountered in the mid-depth zone, including the adults of blue, olive, black and yellow, and kelp rockfish, pile and rubberlip perch, painted and kelp greenling, tubesnout and blackeye gobies, and juvenile blue and olive rockfish.

c) Deep subtidal zone (40 - 60 ft)

Three species of fish were encountered in the deep depth zone, including the adults of blue and black and yellow rockfish, and juvenile olive rockfish.

IV.B.14. Kirk Creek

IV.B.14.1. Survey metadata

Table 14.1. Survey type, date completed, and specific location of sampling conducted at Kirk Creek.

Survey type	Date completed	Latitude (N)	Longitude (W)
Intertidal	No data		
Qualitative subtidal	October 6, 2004	35 59.150	121 29.957
Quantitative subtidal	No data		
2003	No data		
Upcoast deep	No data		
Downcoast deep	No data		
2004	No data		
Upcoast deep	No data		
Downcoast deep	No data		

IV.B.14.2. Intertidal survey conditions

No data

IV.B.14.3. Subtidal survey diving conditions

Sea surface— Conditions (wind, waves) were moderate.

Surge— Not recorded.

Visibility— Not recorded.

Depth— The maximum depth was 52 ft.

Transect length (estimated)— 368 m.

Bottom time— 44 minutes.

Water temperature— Not recorded.

Distance from shore to 20 m isobath— 665.1 m. The slope is considered moderately flat.

IV.B.14.4. Site overview

Location

Kirk Creek is located 12 km north of Cape San Martin and due west of mile 18.9 on Highway 1.

Environment

In the subtidal, the bottom was a mix of sand and boulders (1-3 m) and moderately flat. At 25 ft deep there were several large outcrops of reef, with walls to 20 ft high.

Biological overview

Divers qualitatively surveyed a kelp bed at Kirk Creek on October 6, 2004. This site was similar to areas along Cannery Row in Monterey Bay, with rocks covered by colonial cup corals (*Astrangia lajollaensis*), white barnacles, and strawberry anemones.

IV.B.14.5. Nearshore geology and geography

Proximity to creeks and canyons

The Kirk Creek site is a the mouth of Kirk Creek, which is spring-like near the upper intertidal, where rocks are greenish due to algal or diatom growth.

Exposure, cliffs, and erosion

Kirk Creek has a western exposure. The cliffs are short, gently sloped, and heavily vegetated, with little rock exposed. The terrestrial geology is classified as unconsolidated sediment.

Intertidal geology

No data

Subtidal geology and topography

At 53 ft the there was a large sand channel and boulders (1-3 m) that were not granite. A second sand channel was at 16 ft deep, and the sand was very fine grained at 13 ft deep.

Table 14.5. Kirk Creek qualitative subtidal survey results for reef type and relief by three depth zones. Percentages for each category are based on *in situ* visual diver estimates and review of underwater video (when available).

Depth	Reef Type				Relief			
(meters)	sand	cobble	boulder	bedrock	0-10 m	10-1 m	1-2 m	>2 m
0-6	40		20	20	40	30	30	
6-12	20		20	60	30	10	40	20
12-18	60		30	10	70	20	10	

IV.B.14.6. Nearshore oceanography

Kirk Creek faces the west and is exposed to northwestern swell. To our knowledge, there are no data on nearshore currents at this site.

IV.B.14.7. Biology

Intertidal of Kirk Creek

No data

Subtidal of Kirk Creek

Overall subtidal ranking

Combining the five subtidal sensitivity indices, Kirk Creek scored 21 of 22 points possible and is considered a site of highest value relative to the 21 sites surveyed qualitatively. The species richness ranks—again, relative to the other 21 sites sampled qualitatively—were 2nd (tie) for algae, 5th (tie) for invertebrates, and 12th (tie) for fishes. Complete lists of the species encountered are provided in Appendices B-D.

Subtidal species of concern

At Kirk Creek, 9 of the 12 subtidal species of concern were observed (only urchins and surfgrass were not; Table 14.7).

Table 14.7: Relative abundance of species of special interest and their rank as compared to all 21 qualitative subtidal survey sites

Species	Category	Relative abundance
Phyllospadix spp.	Habitat forming	Not noted
Macrocystis pyrifera	Burial, turbidity sensitivity	Medium
Nereocystis luetkeana	Burial, turbidity sensitivity	Low
Pterygophora californica	Burial, turbidity sensitivity	High
Stylaster californicus	Burial, scour sensitivity	Not noted
Haliotis rufescens	Burial sensitivity	Present
Strongylocentrotus spp.	Burial sensitivity	Not noted
Scorpaenichthys marmoratus	Burial sensitivity	Below average
Ophiodon elongatus	Burial sensitivity	Above average
Hexagrammos decagrammus	Burial sensitivity	Above average
Sebastes carnatus	Burial sensitivity	Above average
Sebastes chrysomelas	Burial sensitivity	Above average

Subtidal algae (Readdie/Kusic)

Kelp canopy surface estimate: 20,226 m^2

a) Shallow subtidal zone (0-20 ft)

Canopy

Nereocystis luetkeana was present in low abundance, having some dense patches.

Subcanopy

Laminaria setchellii was present in high abundance.
Pterygophora californica was present in high abundance.

Understory

Foliose reds— *Botryoglossum/Cryptopleura/Hymenena, Chondracanthus corymbifera/ exasperata, Plocamium/ Microcladia*, and *Prionitis spp* were present in high abundance. Cal*lophyllis spp, Gracilaria spp, Mazaella spp, Pikea/Farlowia, Polysiphonia/Ceramium,* and *Rhodomenia/Ozophora spp* were present in medium abundance. *Cryptopleura crispa, Erythrophyllum delesserioides* and *Ptilota/Neoptilota* were present in low abundance.
Brown algae— *Cystoseira osmundacea* was present in medium abundance. *Egregia menziesii* was present in low abundance.

b) Mid-subtidal zone (20 - 40 ft)

Canopy

Macrocystis pyrifera was present in medium abundance with plants having 10-40 stipes.

Subcanopy

Pterogophora californica was present in low abundance.

Understory

Foliose reds were 70% of total understory algae— C*hondracanthus corymbifera/ exasperata* and *Rhodomenia/Ozophora* were present in high abundance. *Callophyllis flabellulata, Opuntiella californica, Polysiphonia/ Ceramium, Prionitis spp, Shizymenia/Halymenia*, and *Weeksia spp.* were present in medium abundance.
Crustose Corallines were 20% of total understory algae.
Articulated Corallines were 10% of total understory algae.

d) Deep subtidal zone (40-50 ft)

Canopy

Macrocystis pyrifera was present in medium abundance, with plants having 20-40 stipes.
Nereocystis luetkeana was present in medium abundance.

Subcanopy

Pterogophora californica was present in high abundance.

Understory

Foliose reds were 80% of total understory algae— *Callophyllis flabellulata, Chondracanthus corymbifera/ exasperata*, and *Rhodomenia/Ozophora spp* were present in high abundance. *Polysiphonia/Ceramium, Ptilota/ Neoptilota, Shizymenia/ Halymenia*, and *Weeksia spp* were present in medium abundance.
Crustose Corallines were 10% of total understory algae.
Articulated Corralines were 5% of total understory algae.

Subtidal invertebrates (Lonhart)

a) Shallow subtidal zone (0-20 ft)

At 18 ft the stipitate kelp (*Pterygophora californica*) dominated the bottom. Between the stipes were anemones (*Anthopleura* spp.). There was a fine-grained sand channel at 16 ft.

b) Mid-subtidal zone (20 - 40 ft)

At 40 ft the bottom included long (10 m) stretches of sand and a few basketball-sized rocks with stipitate kelp (*Pterygophora californica*). At 34 ft there was a 3 m high vertical wall covered with small white barnacles. This began a section with large reef slabs. At 30 ft there was a 25 ft high house-sized pinnacle. One vertical wall was covered with the strawberry anemone (*Corynactis californica*).

c) Deep subtidal zone (40 - 60 ft)

We did not drop in at the other edge of the kelp bed, but instead hit a sand channel at 53 ft. Boulders 1-3 m in diameter were covered with stipitate kelp (*Pterygophora californica*) and sand filled the flat spaces between. The rocks were not granitic and were covered with a detrital film.

Subtidal fishes (Carr)

A total of 16 species of fish were encountered at this site, ranking average relative to the mean and median (17 species) among sites surveyed. The number of rockfish (7) and surfperch (5) species were average and above average, respectively, for the sites surveyed. Five of the 5 fish species of concern were encountered here; lingcod, black and yellow rockfish, gopher rockfish and kelp greenling were all above average site abundance, whereas cabezon were below average site abundance. Species of particularly high abundance included adult kelp perch and juvenile pile perch. Above-average numbers of adult blue rockfish and juvenile canary rockfish, adult rainbow and black perch, painted greenling, and blackeye gobies were observed. No species was of particularly low abundance at this site.

a) Shallow subtidal zone (0-20 ft)

Eight species of fish were encountered in the shallow depth zone, including the adults of kelp and black and yellow rockfish, black, stripe, pile and kelp perch, painted and kelp greenling.

b) Mid-subtidal zone (20 - 40 ft)

Twelve species of fish were encountered in the mid-depth zone, including the adults of blue, kelp, gopher, and black and yellow rockfish, black, stripe, pile, and rainbow perch, painted and kelp greenling, lingcod and blackeye gobies, and juvenile olive rockfish.

c) Deep subtidal zone (40 - 60 ft)

Thirteen species of fish were encountered in the deep depth zone, including the adults of blue, olive, kelp, black, and gopher rockfish, black, stripe and kelp perch, painted and kelp greenling, lingcod, and blackeye gobies, and juvenile blue, olive and canary rockfish.

IV.B.15. South Mill Creek /Mill Creek

IV.B.15.1. Survey metadata

Table 15.1. Survey type, date completed, and specific location of sampling conducted at Wild Cattle/Mill Creek.

Survey type	Date completed	Latitude (N)	Longitude (W)
Quantitative Intertidal	November 22, 2003	35 58’783	35 58’783
Quantitative Intertidal	April 10, 2003	121 29’430	121 29’430
Qualitative subtidal	September 14, 2003	35 58’55.82”	121 29’35.58”
Quantitative subtidal-benthic			
2003			
Downcoast deep	September 20, 2003	35 58' 33.96"	-121 29' 36.13"
2004			
Upcoast deep	July 21, 2004	35 58' 33.96"	-121 29' 36.13"
Upcoast deep	August 21, 2004	35 58' 33.96"	-121 29' 36.13"
Downcoast deep	July 21, 2004	35 58' 33.96"	-121 29' 36.13"
Downcoast deep	August 21, 2004	35 58' 33.96"	-121 29' 36.13"
Quantitative subtidal-fish			
2003			
Upcoast deep	September 20, 2003	35 58' 33.96"	-121 29' 36.13"
Downcoast deep	September 20, 2003	35 58' 33.96"	-121 29' 36.13"
2004			
Upcoast deep	August 21, 2004	35 58' 33.96"	-121 29' 36.13"
Upcoast deep	September 23, 2004	35 58' 33.96"	-121 29' 36.13"
Downcoast deep	September 23, 2004	35 58' 33.96"	-121 29' 36.13"

IV.B.15.2. Intertidal survey conditions

Tide- November 22, 2003: -1.9 at 15:07, April 10, 2004: -0.3 at 9:43
Time- Approximately 6 hours spent at the site for each quantitative survey.

IV.B.15.3. Subtidal survey diving conditions

Sea surface— Conditions (wind, waves) were very calm.

Surge— Not recorded.

Visibility— Not recorded.

Depth— The maximum depth was 55 ft.

Transect length (estimated)— 154 m.

Bottom time— 50 minutes.

Water temperature— 55 F at 35 ft deep.

Distance from shore to 20 m isobath— 825.1 m. The slope is considered moderately flat.

IV.B.15.4. Site overview

Location

South Mill Creek is located 12 km north of Cape San Martin and due west of mile 18.5 on Highway 1.

Environment

Mill Creek is an intertidal bedrock bench of sedimentary rock (Franciscan melange) and is clearly visible from HWY 1. The bench slope ranges from 5 to 10 degrees and is openly exposed to the W. A clear, shallow, perennial stream flows out approximately 200 meters north of the site. The outflow area consists of boulders, cobble and sand overlaying bedrock and offshore intertidal rocks. In the subtidal, the bottom was coarse sand at 55 ft deep. The sand became finer with decreasing depth, and was silt-like at 34 ft deep.

Biological overview

The upland slope between the bench and HWY 1 is 50 to 75 degrees with some non-native grasses and coastal scrub and areas of exposed cobble and earth slides. Tidepools are present on the bench. High-zone species include the red alga *Endocladia muricata,* barnacle *Chthamalus* spp. Mid-zone species include the california mussel *Mytilus californianus,* red algae *Mastocarpus papillatus* and *Petrocelis* spp., and green algae *Cladophora columbiana*. Low-zone species include red algae *Cryptopleura/Hymenena* spp., *Mazzaella* spp, surf grass *Phyllospadix scouleri* and colonial worm *Phragmatopoma californica.* Bare rock comprised 20-22% of the total cover. Divers qualitatively surveyed a kelp bed at South Mill Creek on September 14, 2003. The outer part of the kelp bed had more vertical relief, clearer water, and more of the substrate was dominated by a wider array of species. At a depth of 27 ft, the bottom type transitioned to more sand and water clarity was lower.

IV.B.15.5. Nearshore geology and geography

Proximity to creeks and canyons

The South Mill Creek site is near two drainages: Wild Cattle Creek (0.85 miles south) and Mill Creek (0.45 miles north), but neither creek appears to have any significant impact on the site.

Exposure, cliffs, and erosion

South Mill Creek has a western exposure. The highway is close to shore level and the slopes are primarily unconsolidated dirt with some vegetation. The terrestrial geology is classified as unconsolidated sediment. Mill Creek is an intertidal bedrock bench of sedimentary rock (Franciscan melange) and is clearly visible from HWY 1. The bench slope ranges from 5 to 10 degrees and is openly exposed to the W. The upland slope between the bench and HWY 1 is 50 to 75 degrees. There is little visible soil sliding into the cove.

Intertidal geology

Mill Creek is an intertidal bedrock bench of sedimentary rock (Franciscan melange). The bench slope ranges from 5 to 10 degrees and is openly exposed to the W. Tidepools are present on the bench. A clear, shallow, perennial stream flows out approximately 200 meters north of the site. The outflow area consists of boulders, cobble and sand overlaying bedrock and offshore intertidal rocks.

Subtidal geology and topography

In the deep zone, the bottom was coarse sand at 55 ft deep.

Table 15.5. South Mill Creek qualitative subtidal survey results for reef type and relief by three depth zones. Percentages for each category are based on *in situ* visual diver estimates and review of underwater video (when available).

Depth	Reef Type				Relief			
(meters)	sand	cobble	boulder	bedrock	0-10 m	10-1 m	1-2 m	>2 m
0-6	50		50		75	25		
6-12	30		35	35	30		30	30
12-18	25		25	25	25			75

IV.B.15.6. Nearshore oceanography

South Mill Creek faces the west and is exposed to northwestern swell. To our knowledge, there are no data on nearshore currents at this site.

IV.B.15.7. Biology

Intertidal of Wild Cattle/Mill Creek

Overall intertidal ranking

Overall, species richness is above average for this site.
During a survey on November 22, 2003 100 species categories were noted. On April 10, 2004 92 species categories were noted.

Intertidal species of concern

Seven out of seven intertidal species of special interest (see Methods for selection criteria), were present (Table 6.1).

Table 15.7.1: Species of special interest present at Wild Cattle/Mill Creek

Species	Common name
Postelsia palmaeformis	sea palm
Phyllospadix spp.	surf grass
Mytilus californianus	california mussel
Pisaster ochraceus	ochre star
Lottia gigantea	owl limpet
Haliotis cracherodii	black abalone
Strongylocentrotus purpuratus	purple urchin

Size distributions for species of special interest:

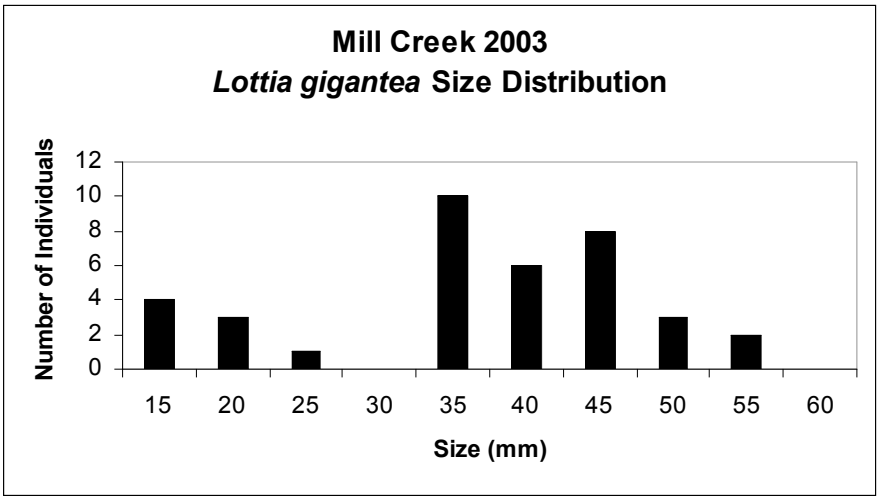


Figure 15.7.1. Size-frequency distribution of owl limpets (*Lottia gigantea*) at Mill Creek in 2003. Owl limpets live in the rocky intertidal and are a species of special interest.

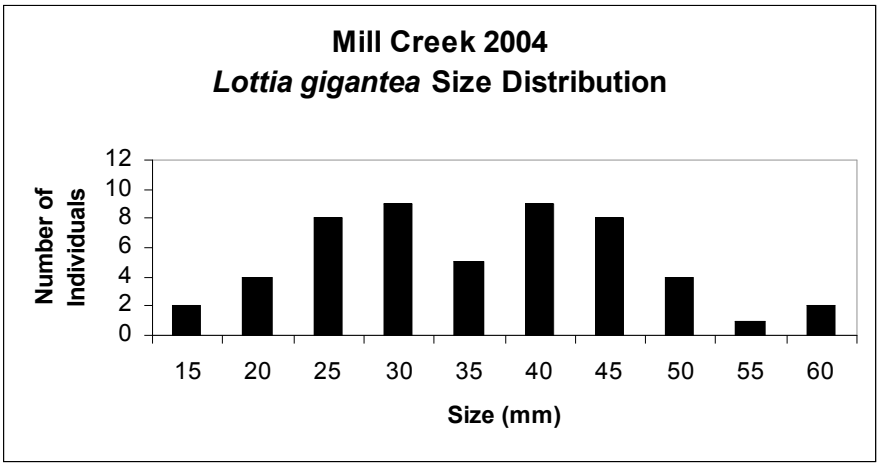


Figure 15.7.2. Size-frequency distribution of owl limpets (*Lottia gigantea*) at Mill Creek in 2004. Owl limpets live in the rocky intertidal and are a species of special interest.

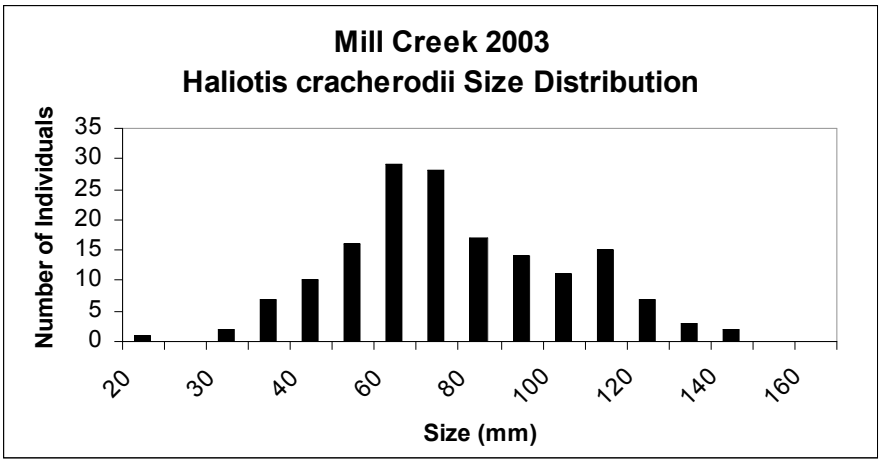


Figure 15.7.3. Size-frequency distribution of black abalone (*Haliotis cracherodii*) at Mill Creek in 2003. Black abalone live in the rocky intertidal and are a species of special interest. Recently their numbers in southern California declined dramatically as a result of commercial and recreational harvesting and the rapid spread of disease (withering foot syndrome). Data collected by Maya George.

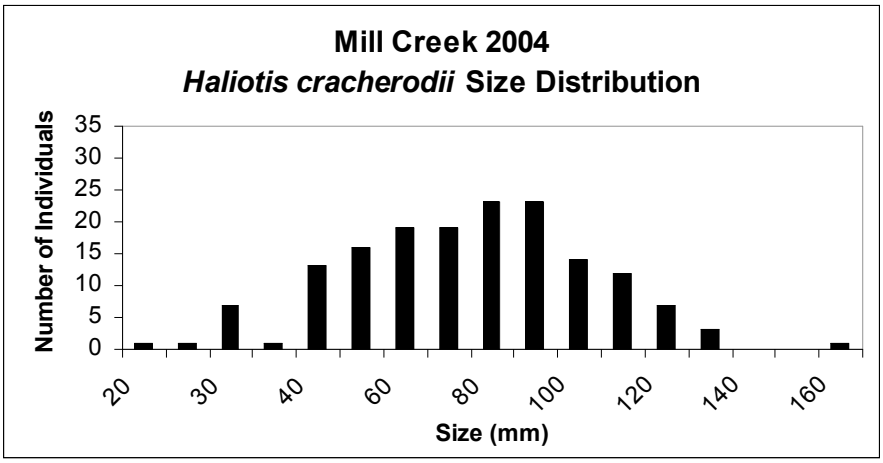


Figure 15.7.4. Size-frequency distribution of black abalone (*Haliotis cracherodii*) at Mill Creek in 2004. Black abalone live in the rocky intertidal and are a species of special interest. Recently their numbers in southern California declined dramatically as a result of commercial and recreational harvesting and the rapid spread of disease (withering foot syndrome). Data collected by Maya George.

Subtidal of South Mill Creek

Overall subtidal ranking

Combining the five subtidal sensitivity indices, South Mill Creek scored 10 of 22 points possible and is considered a site of medium value relative to the 21 sites surveyed qualitatively. The species richness ranks—again, relative to the other 21 sites sampled qualitatively—were 20th (tie) for algae, 18th (tie) for invertebrates, and 2nd for fishes. Complete lists of the species encountered are provided in Appendices B-D.

Subtidal species of concern

At South Mill Creek, 8 of the 12 subtidal species of concern were observed (Table 15.7.2).

Table 15.7.2: Relative abundance of species of special interest and their rank as compared to all 21 qualitative subtidal survey sites

Species	Category	Relative abundance
Phyllospadix spp.	Habitat forming	Not noted
Macrocystis pyrifera	Burial, turbidity sensitivity	Medium
Nereocystis luetkeana	Burial, turbidity sensitivity	Low
Pterygophora californica	Burial, turbidity sensitivity	Medium
Stylaster californicus	Burial, scour sensitivity	Not noted
Haliotis rufescens	Burial sensitivity	Not noted
Strongylocentrotus spp.	Burial sensitivity	Not noted
Scorpaenichthys marmoratus	Burial sensitivity	Average
Ophiodon elongatus	Burial sensitivity	Above average
Hexagrammos decagrammus	Burial sensitivity	Average
Sebastes carnatus	Burial sensitivity	Average
Sebastes chrysomelas	Burial sensitivity	Average

Subtidal algae (Readdie/Kusic)

Kelp canopy surface estimate: 20,226 m^2

a) Shallow subtidal zone (25 ft)

Canopy

Nereocystis luetkeana was present in low abundance.

Subcanopy

Pterygophora californica was present in medium abundance.

Understory

Foliose reds were present in medium abundance— *Rhodomenia/Ozophora* was present in medium abundance. *Botryoglossum/Cryptopleura/Hymenena* were present in low abundance.
Articulated Corallines— *Calliarthron cheilosporioides* was present in low abundance.
Brown algae— *Desmarestia latifrons* was present in high abundance.

b) Mid-subtidal zone (30 - 40 ft)

Canopy

Macrocystis pyrifera was present in medium abundance.
Nereocystis luetkeana (bull kelp) was present in low abundance.

Subcanopy

Pterygophora californica was present in medium abundance.

Understory

Foliose reds were present in medium abundance— *Rhodomenia/Ozophora* was present in high abundance. *Chondracanthus corymbifera/ exasperata* were present in medium abundance. *Botryoglossum/Cryptopleura/Hymenena* and *Callophyllis spp* were present in low abundance.
Articulated Corallines— *Calliarthron cheilosporioides* was present in low abundance.
Brown algae—*Desmarestia ligulata var. ligulata* was present in low abundance.

c) Deep subtidal zone (50 ft)

Canopy

Macrocystis pyrifera was present in medium abundance.
Nereocystis luetkeana was present in medium abundance.

Subcanopy

Laminaria setchellii was present in low abundance

Understory

Foliose reds were present in high abundance— *Callophyllis spp, Chondracanthus corymbifera/ exasperata, Ptilota/Neotilota*, and *Rhodomenia/Ozophora* were present in high abundance. *Halymenia/Schizymenia* were present in medium abundance.
Botryoglossum/Cryptopleura/Hymenena were present in low abundance.
Crustose Corallines— *Lithothamnion sp*. was present in high abundance.
Articulated Corallines- *Calliarthron cheilosporioides* was present in medium abundance.
Brown algae— *Desmarestia ligulata var. ligulata* was present in medium abundance.

Subtidal invertebrates (Lonhart)

a) Shallow subtidal zone (0-20 ft)

No data were recorded specifically for this depth.

b) Mid-subtidal zone (20 - 40 ft)

The sand switched from coarse to fine sand at 41 ft and the reef had a higher sediment load. At 34 ft there were fields of the nipple sponge (*Polymastia pacifica*) covered with fine silt. I also noted lots of sea lemons (*Anisodoris nobilis*) on the reef. At 27 ft there was an abrupt change from high relief reef and clear water to low relief and more sand and lower visibility.

c) Deep subtidal zone (40 - 60 ft)

We descended to 55 ft and a coarse sandy bottom. Sponges and tunicates were common on the rocky reef, forming very large colonies. Several invertebrates were observed on a large vertical face.

Subtidal fishes (Carr)

A total of 22 species of fish were encountered at this site, ranking above average relative to the mean and median (17 species) among sites surveyed. The number of rockfish (9) and surfperch (5) species were at and above average, respectively, for the sites surveyed. X of the 5 fish species of concern were encountered here; (cabezon, lingcod, black and yellow rockfish, gopher rockfish and kelp greenling) were far above average site abundance, (cabezon, lingcod, black and yellow rockfish, gopher rockfish and kelp greenling) were above average site abundance, (cabezon, lingcod, black and yellow rockfish, gopher rockfish and kelp greenling) were at average site abundance, and (cabezon, lingcod, black and yellow rockfish, gopher rockfish and kelp greenling) were below average site abundance. Species of particularly high abundance included juvenile kelp, gopher, canary and bocaccio rockfish, juvenile painted greenling, and adult *Gibbonsia* and tubesnout. Species of above average abundance included adult vermilion rockfish, juvenile blue and olive rockfish, adult black, rainbow and kelp perch, painted greenling, snubnose sculpin and blackeye gobies. Only adult olive rockfish were of particularly low abundance.

a) Shallow subtidal zone (0-20 ft)

Only five species of fish were encountered in the shallow depth zone, including adult stripe and pile perch, and juveniles of the black and gopher rockfish and black perch.

b) Mid-subtidal zone (20 - 40 ft)

Twelve species of fish were encountered in the mid-depth zone, including the adults of blue, kelp, black and yellow rockfish, black, stripe, and pile perch, painted greenling, cabezon, coralline and snubnose sculpin, *Gibbonsia* and tubesnout. Juveniles of blue, olive and gopher rockfish were observed.

c) Deep subtidal zone (40 - 60 ft)

Fifteen species of fish were encountered in the deep depth zone, including the adults of blue, kelp, black, gopher, black and yellow, and vermilion rockfish, stripe, pile and rainbow perch, painted and kelp greenling, lingcod, and blackeye gobies. Juveniles of blue, olive, canary, bocaccio and gopher rockfish and painted greenling were observed.

IV.B.16. Tide Rock

IV.B.16.1. Survey metadata

Table 16.1. Survey type, date completed, and specific location of sampling conducted at Tide Rock.

Survey type	Date completed	Latitude (N)	Longitude (W)
Intertidal	No data		
Qualitative subtidal	November 8, 2004	35 56’38.21”	121 28’54.66”
Quantitative subtidal	No data		
2003	No data		
Upcoast deep	No data		
Downcoast deep	No data		
2004	No data		
Upcoast deep	No data		
Downcoast deep	No data		

IV.B.16.2. Intertidal survey conditions

No data

IV.B.16.3. Subtidal survey diving conditions

Sea surface— Conditions (wind, waves) were moderate.

Surge— Not recorded.

Visibility— Not recorded.

Depth— The maximum depth was 61 ft.

Transect length (estimated)— 160 m.

Bottom time— 61 minutes.

Water temperature— 58 F.

Distance from shore to 20 m isobath— 616.3 m. The slope is considered moderately flat.

IV.B.16.4. Site overview

Location

Tide Rock is located 9 km north of Cape San Martin and due west of mile 15.7 on Highway 1.

Environment

In the subtidal, the bottom at 58 ft deep was a mix of large boulders with cobble and rocks in between. From 50 to 40 ft deep there was a long stretch of low relief boulders and sand channels. At 19 ft deep there was bare cobble between low relief boulders.

Biological overview

Divers qualitatively surveyed a large, wide kelp bed at Tide Rock on November 8, 2004. Unlike the Redwood Gulch and 73.5 mile marker sites, the Tide Rock site had an abundance of compound tunicates, and especially a *Ritteralla*-like species.

IV.B.16.5. Nearshore geology and geography

Proximity to creeks and canyons

The Tide Rock site is near two drainages: Wild Cattle Creek (0.65 miles north), which has nominal to no flow, and Prewitt Creek(s) (1.3 miles south), which may have moderate flow seasonally. Neither of these creeks has sustained flow, nor do they influence the dive site.

Exposure, cliffs, and erosion

Tide Rock has a western exposure. The cliffs are short and all sediment with moderate amounts of vegetation. The terrestrial geology is classified as unconsolidated sediment.

Intertidal geology

No data

Subtidal geology and topography

At 58 ft deep there was a mix of large boulders with coarse sand, cobble and rocks in between. From 50 to 40 ft deep there was a long stretch of low relief boulders and sand channels. At 19 ft deep there was bare cobble and gravel between low relief boulders.

Table 16.5. Tide Rock qualitative subtidal survey results for reef type and relief by three depth zones. Percentages for each category are based on *in situ* visual diver estimates and review of underwater video (when available).

Depth	Reef Type				Relief			
(meters)	sand	cobble	boulder	bedrock	0-10 m	10-1 m	1-2 m	>2 m
0-6		30	60	10	40	40	20	
6-12	10	10	20	60	20	10	20	50
12-18	30	10	20	40	20	10	20	50

IV.B.16.6. Nearshore oceanography

Tide Rock faces the west and is exposed to northwestern swell. To our knowledge, there are no data on nearshore currents at this site.

IV.B.16.7. Biology

Intertidal of Tide Rock

No data

Subtidal of Tide Rock

Overall subtidal ranking

Combining the five subtidal sensitivity indices, Tide Rock scored 15 of 22 points possible and is considered a site of high value relative to the 21 sites surveyed qualitatively. The species richness ranks—again, relative to the other 21 sites sampled qualitatively—were 2nd (tie) for algae, 7th for invertebrates, and 3rd (tie) for fishes. Complete lists of the species encountered are provided in Appendices B-D.

Subtidal species of concern

At Tide Rock, 9 of the 12 subtidal species of concern were observed (Table 16.7).

Table 16.7: Relative abundance of species of special interest and their rank as compared to all 21 qualitative subtidal survey sites

Species	Category	Relative abundance
Phyllospadix spp.	Habitat forming	Low
Macrocystis pyrifera	Burial, turbidity sensitivity	High
Nereocystis luetkeana	Burial, turbidity sensitivity	Medium
Pterygophora californica	Burial, turbidity sensitivity	High
Stylaster californicus	Burial, scour sensitivity	Not noted
Haliotis rufescens	Burial sensitivity	Not noted
Strongylocentrotus spp.	Burial sensitivity	Not noted
Scorpaenichthys marmoratus	Burial sensitivity	Above average
Ophiodon elongatus	Burial sensitivity	Above average
Hexagrammos decagrammus	Burial sensitivity	Above average
Sebastes carnatus	Burial sensitivity	Above average
Sebastes chrysomelas	Burial sensitivity	Above average

Subtidal algae (Readdie/Kusic)

Kelp canopy surface estimate: 20,226 m^2

a) Shallow subtidal zone (0-30 ft)

Canopy

Macrocystis pyrifera was present in low abundance.
Nereocystis luetkeana was present in medium abundance.

Subcanopy

Pterygophora californica was present in high abundance.
Laminaria setchellii was present in high abundance.

Understory

Foliose reds were 80% of total understory algae— *Botryoglossum/Cryptopleura/Hymenena, Callophyllis spp, Chondracanthus corymbifera/exasperata, Mazzaella spp, Plocamium/Microcladia*, and *Ptilota/Neotilota* were present in high abundance. *Erythrophyllum delesserioides* was present in medium abundance. *Shizymenia/Halymenia* were present in low abundance.
Crustose Corallines were 10% of total understory algae.
Articulated Corallines were 10% of total understory algae.
Brown algae were 2% of total understory algae— *Desmarestia ligulata var. ligulata* was present in medium abundance.
Phyllospadix spp. was 2% of total understory.

b) Mid-subtidal zone (30 - 40 ft)

Canopy

Macrocystis pyrifera was present in high abundance with plants having 2-10 stipes..
Nereocystis luetkeana was present in low abundance.

Subcanopy

Pterogophora californica was present in high abundance.
Laminaria setchellii was present in low abundance.

Understory

Foliose reds were 20% of total understory algae— *Botryoglossum/Cryptopleura/Hymenena, Callophyllis spp, Chondracanthus corymbifera/ exasperata, Cryptopleura crispa, Mazzaella spp, Pikea/FarLowia spp, Plocamium/Microcladia, Prionitis spp, Ptilota/Neotilota,* and *Rhodomenia/Ozophora* were present in high abundance. *Gymnogongrus chiton, Opuntiella californica, Shizymenia/Halymenia,* and *Weeksia spp*. were present in medium abundance. *Constantinia simplex* was present in low abundance.
Crustose Corallines were 10% of total understory algae.
Articulated Corallines were 70% of total understory algae.
Brown algae were 2% of total understory algae— *Desmarestia ligulata* was present in medium abundance.

c) Deep subtidal zone (40-60 ft)

Canopy

Macrocystis pyrifera was present in high abundance with plants having 10-20 stipes.

Subcanopy

Pterogophora californica was present in low abundance.
Pleurophycus gardneri was present in low abundance.

Laminaria setchellii was present in low abundance.

Understory

Foliose reds were 60% of total understory algae— *Botryoglossum/Cryptopleura/Hymenena, Chondracanthus corymbifera/ exasperata,* and *Rhodomenia/Ozophora* were present in high abundance. *Callophyllis flabellulata* was present in medium abundance. *Opuntiella californica* was present in low abundance.
Crustose Corallines were 10% of total understory algae.
Articulated Corralines were 20% of total understory algae.
Brown algae were 10% of total understory algae— *Desmarestia ligulata var.firma* was present in medium abundance. *Cystoseira osmundacea* was present in low abundance.

Subtidal invertebrates (Lonhart)

a) Shallow subtidal zone (0-20 ft)

At 19 ft cobble was very common between low relief boulders.

b) Mid-subtidal zone (20 - 40 ft)

After diving for 30 min we finally reached 40 ft deep. The nipple sponge (*Polymastia* pacifica), orange cup corals (*Balanophyllia elegans*), and the sand-impregnated compound tunicate (*Archidistoma psammion*) were abundant. At 25 ft stipitate kelps (*Pterygophora californica* and *Laminaria setchellii*) were very thick.

c) Deep subtidal zone (40 - 60 ft)

Unlike the Redwood Gulch and 73.5 mile marker sites, there was less gravel at this site. Most of the reef in this zone was large boulders and cobble or rock debris filling in the gaps. Tunicates (e.g., *Ritteralla* spp.) were on the tops of boulders and were more abundant than at the Redwood Gulch and 73.5 mile marker sites. From 50 to 40 ft deep there was a long stretch of low-lying boulders and sand filled channels.

Subtidal fishes (Carr)

A total of 22 species of fish were encountered at this site, ranking above average relative to the mean and median (17 species) among sites surveyed. The number of rockfish (8) and surfperch (7) species were at and well above average, respectively, for the sites surveyed. All five of the five fish species of concern were encountered here and all five species were above the average site abundance. Species of particularly high abundance included adult black perch, sheephead and tubesnout. Species of above average abundance included adult blue, olive, kelp, black, tree and vermilion rockfish, as well as pile, rubberlip, rainbow, kelp and white perch. Adult painted greenling and senorita were also above average abundance. No species was of particularly low abundance at this site.

a) Shallow subtidal zone (0-20 ft)

Fourteen species of fish were encountered in the shallow depth zone, including the adults of blue, olive, black, kelp, and black and yellow rockfish, black, stripe, pile and kelp perch, painted and kelp greenling, senorita, sheephead and tubesnout. No juveniles were observed.

b) Mid-subtidal zone (20 - 40 ft)

Fourteen species of fish were encountered in the mid-depth zone, including the adults of blue, olive, black, kelp, gopher, vermilion and black and yellow rockfish, black, stripe, pile and white perch, painted and kelp greenling, and lingcod. No juveniles were observed.

c) Deep subtidal zone (40 - 60 ft)

Eighteen species of fish were encountered in the deep depth zone, including the adults of blue, olive, black, kelp, gopher, vermilion and black and yellow rockfish, black, stripe, pile, rubberlip, and kelp perch, painted and kelp greenling, lingcod, cabezon, sheephead and tubesnout. No juveniles were observed.

IV.B.17. South Plaskett Rock

IV.B.17.1. Survey metadata

Table 17.1. Survey type, date completed, and specific location of sampling conducted at South Plaskett Rock.

Survey type	Date completed	Latitude (N)	Longitude (W)
Qualitative intertidal	September 13, 2003	35 54. 44	121 28.29
Qualitative subtidal	September 13, 2003	35 53'57.48"	121 27'59.72"
Quantitative subtidal	No data		
2003	No data		
Upcoast deep	No data		
Downcoast deep	No data		
2004	No data		
Upcoast deep	No data		
Downcoast deep	No data		

IV.B.17.2. Intertidal survey conditions

Tide- September 13, 2003: 2.0 at 6:49
Time- Approximately 30 minutes spent at the site for qualitative survey.

IV.B.17.3. Subtidal survey diving conditions

Sea surface— Not recorded.

Surge— Not recorded.

Visibility— Not recorded.

Depth— The maximum depth was 71 ft, but most of the dive was spent at depths >40 ft.

Transect length (estimated)— 128 m.

Bottom time— 37 minutes.

Water temperature— 51 F at 60 ft deep.

Distance from shore to 20 m isobath— 717.3 m. The slope is considered moderately flat.

IV.B.17.4. Site overview

Location

South Plaskett Rock is located 1 km north of Cape San Martin and due west of mile 12.3 on Highway 1.

Environment

South Plaskett Rock is a boulder field with some cobble bound by sand/cobble pocket coves and steep bluffs and is visible from HWY 1. The intertidal area is between 5-15 degrees and

is openly exposed to the ocean. The upland slope is between 30-60 degrees with patches of active sliding exposed earth and areas of coastal scrub. No further information collected. In the subtidal, the bottom was a gravel bed at 61 ft deep. At South Plaskett Rock itself there was a large murky cloud of water generated by sediment input from land.

Biological overview

No information available for the intertidal. Divers qualitatively surveyed a kelp bed north of South Plaskett Rock on September 13, 2003. The water was clearer at this location than just to the south. The kelp bed canopies at this site were thick. Diversity was low at this site and the species that were present were not abundant.

IV.B.17.5. Nearshore geology and geography

Proximity to creeks and canyons

South Plaskett Rock is at the base of a marine terrace large, highly vegetated at the top and with steep but short, rocky cliffs. We did not observe flowing water. South Plaskett Rock is near two drainages: Willow Creek (1.2 miles south) and Plaskett Creek (1 mile north). Neither creek appears to have any significant impact on the site.

Exposure, cliffs, and erosion

South Plaskett Rock has a northern exposure. The terrestrial geology is classified as Franciscan melange. The intertidal area is between 5-15 degrees and is openly exposed to the ocean. The upland slope is between 30-60 degrees.

Intertidal geology

South Plaskett Rock is a boulder field with some cobble bound by sand/cobble pocket coves and steep bluffs.

Subtidal geology and topography

A gravel bed was present at 61 ft deep.

Table 17.5. South Plaskett Rock qualitative subtidal survey results for reef type and relief by three depth zones. Percentages for each category are based on *in situ* visual diver estimates and review of underwater video (when available).

Depth	Reef Type				Relief			
(meters)	sand	cobble	boulder	bedrock	0-10 m	10-1 m	1-2 m	>2 m
0-6								
6-12		50	50		50			50
12-18			80	20			50	50

IV.B.17.6. Nearshore oceanography

South Plaskett Rock faces the north and is exposed to northwestern swell. To our knowledge, there are no data on nearshore currents at this site.

IV.B.17.7. Biology

Intertidal of South Plaskett Rock

No information available-qualitative survey only.

Subtidal of South Plaskett Rock

Overall subtidal ranking

Combining the five subtidal sensitivity indices, South Plaskett Rock scored 3 of 22 points possible and is considered a site of lowest value relative to the 21 sites surveyed qualitatively. The species richness ranks—again, relative to the other 21 sites sampled qualitatively—were 19th (tie) for algae, 21st for invertebrates, and 21st for fishes. Complete lists of the species encountered are provided in Appendices B-D.

Subtidal species of concern

At South Plaskett Rock, 8 of the 12 subtidal species of concern were observed (Table 17.7).

Table 17.7: Relative abundance of species of special interest and their rank as compared to all 21 qualitative subtidal survey sites

Species	Category	Relative abundance
Phyllospadix spp.	Habitat forming	Not noted
Macrocystis pyrifera	Burial, turbidity sensitivity	Low
Nereocystis luetkeana	Burial, turbidity sensitivity	High
Pterygophora californica	Burial, turbidity sensitivity	High
Stylaster californicus	Burial, scour sensitivity	Not noted
Haliotis rufescens	Burial sensitivity	Not noted
Strongylocentrotus spp.	Burial sensitivity	Not noted
Scorpaenichthys marmoratus	Burial sensitivity	Below average
Ophiodon elongatus	Burial sensitivity	Below average
Hexagrammos decagrammus	Burial sensitivity	Well below average
Sebastes carnatus	Burial sensitivity	Below average
Sebastes chrysomelas	Burial sensitivity	Well below average

Subtidal algae (Readdie/Kusic)

Kelp canopy surface estimate: 20,226 m^2

a) Mid-subtidal zone (40-50 ft)

Canopy

Nereocystis luetkeana (bull kelp) was present in high abundance.

Subcanopy

Pterygophora californica was present in high abundance.

Understory

Foliose reds were present in medium abundance— *Rhodomenia/Ozophora* was present in high abundance. *Botryoglossum/Cryptopleura/Hymenena* were present in medium abundance.
Articulated corallines— *Calliarthron cheilosporioides* was present in medium abundance.
Brown algae— *Dictyota binghamiae* was present in high abundance. *Desmarestia ligulata* var. *ligulata* was present in medium abundance.

b) Deep subtidal zone (60 ft)

Canopy

Macrocystis pyrifera was present in low abundance.
Nereocystis luetkeana was present in high abundance.

Subcanopy

Pterogophora californica was present in high abundance
Laminaria setchellii was present in low abundance
Pleurophycus gardneri was present in high abundance

Understory

Foliose reds were present in low abundance— *Pikea/Farlowia, Plocamium pacificum, and Ptilota/Neotilota* were present in high abundance. *Halymenia/Schizymenia, Polyneura latissima*, and *Rhodomenia/Ozophora* were present in medium abundance.
Botryoglossum/Cryptopleura/ Hymenena were present in low abundance.
Crustose Corallines— *Lithothamnion sp*. was present in low abundance.
Articulated Corallines- *Calliarthron cheilosporioides* was present in meium abundance.
Brown algae— *Desmarestia ligulata* var. *ligulata* was present in medium abundance.

<u>Subtidal invertebrates</u> (Lonhart)

a) Shallow subtidal zone (0-20 ft)

Most of the dive was spent at deeper depths.

b) Mid-subtidal zone (20 - 40 ft)

There were relatively few invertebrates, and no white-spotted rose anemones (*Urticina lofotensis*) were seen. The orange cup coral (*Balanophyllia elegans*) and orange puffball sponge (*Tethya aurantia*) were common.

c) Deep subtidal zone (40 - 60 ft)

I noted a relatively rare sea cucumber (*Psolus chitonoides*) and several sponges and bryozoans. This appears to be a high-energy site, and there was a gravel bed at 61 ft. The rocks were covered with tunicates (e.g., *Ritterella* spp. and *Metandrocarpa taylori*).

Subtidal fishes (Carr)

A total of 9 species of fish were encountered at this site, ranking far below the average relative to the mean and median (17 species) among sites surveyed. The number of rockfish (6) and surfperch (1) species were below and well below site averages, respectively. Only one of the 5 fish species of concern was encountered here; gopher rockfish were at below-average site abundance and, by their absence, all four other species were well below their average abundance among the surveyed sites. The only species of particularly high abundance were juvenile blue and olive rockfish. The only species of above average abundance were adult blue and juvenile gopher and bocaccio rockfish. Adult black rockfish and pile perch were of particularly low abundance.

a) Shallow subtidal zone (0-20 ft)

Only six species of fish were encountered in the shallow depth zone, including adult kelp rockfish and stripe perch, and juvenile blue, olive, black, and gopher rockfish.

b) Mid-subtidal zone (20 - 40 ft)

Only six species of fish were encountered in the mid-depth zone, including adult stripe perch, painted greenling, and juvenile blue, black, bocaccio and gopher rockfish.

c) Deep subtidal zone (40 - 60 ft)

Eight species of fish were encountered in the deep depth zone, including adult blue, olive and gopher rockfish and stripe perch, painted greenling and kelp sculpin, as well as juvenile blue, olive, black, bocaccio and gopher rockfish.

IV.B.18. Cape San Martin

IV.B.18.1. Survey metadata

Table 18.1. Survey type, date completed, and specific location of sampling conducted at Cape San Martin.

Survey type	Date completed	Latitude (N)	Longitude (W)
Intertidal	No data		
Qualitative subtidal	October 6, 2004	35 52.746	121 27.354
Quantitative subtidal	No data		
2003	No data		
Upcoast deep	No data		
Downcoast deep	No data		
2004	No data		
Upcoast deep	No data		
Downcoast deep	No data		

IV.B.18.2. Intertidal survey conditions

No data

IV.B.18.3. Subtidal survey diving conditions

Sea surface— Conditions (wind, waves) were moderate.

Surge— Not recorded.

Visibility— Not recorded.

Depth— The maximum depth was 70 ft.

Transect length (estimated)— 217 m.

Bottom time— 54 minutes.

Water temperature— Not recorded.

Distance from shore to 20 m isobath— 468.9 m. The slope is considered moderate.

IV.B.18.4. Site overview

Location

South of Cape San Martin is located 1 km south of Cape San Martin and due west of mile 10.6 on Highway 1.

Environment

In the subtidal, the bottom was gravel with marble-sized rocks, with furrows 1 m apart and 15 cm tall. At 57 ft there were big boulders (3-4 m). At 26 ft deep there were still very large boulders (3-4 m) with gravel between large slabs of reef.

Biological overview

Divers qualitatively surveyed a kelp bed at South of Cape San Martin on October 6, 2004. The relative amount of encrusting invertebrate cover was low and dominated by crustose bryozoans.

IV.B.18.5. Nearshore geology and geography

Proximity to creeks and canyons

The South of Cape San Martin site is near Willow Creek (0.5 miles north). This creek may provide seasonal input of freshwater, but it probably does not impact the dive site.

Exposure, cliffs, and erosion

South of Cape San Martin has a western exposure. The cliffs are steep, vegetation is moderate, part of the area is exposed rock, and there are at least two sediment slides just north of the dive site. The terrestrial geology is classified as unconsolidated sediment.

Intertidal geology

No data

Subtidal geology and topography

At the outer edge of the kelp bed the bottom was gravel with marble-sized rocks, with furrows 1 m apart and 15 cm tall. At 57 ft there were big boulders (3-4 m). At 26 ft deep there were still very large boulders (3-4 m) with gravel between large slabs of reef.

Table 18.5. South of Cape San Martin qualitative subtidal survey results for reef type and relief by three depth zones. Percentages for each category are based on *in situ* visual diver estimates and review of underwater video (when available).

Depth	Reef Type				Relief			
(meters)	sand	cobble	boulder	bedrock	0-10 m	10-1 m	1-2 m	>2 m
0-6		30	50	20	30	30	30	10
6-12	20	10	30	40	30	10	20	40
12-18	30	10	20	40	50	20		30

IV.B.18.6. Nearshore oceanography

South of Cape San Martin faces the north and is exposed to northwestern swell. To our knowledge, there are no data on nearshore currents at this site.

IV.B.18.7. Biology

Intertidal of Cape San Martin

No data

Subtidal of Cape San Martin

Overall subtidal ranking

Combining the five subtidal sensitivity indices, Cape San Martin scored 14 of 22 points possible and is considered a site of medium value relative to the 21 sites surveyed qualitatively. The species richness ranks—again, relative to the other 21 sites sampled qualitatively—were 20th (tie) for algae, 2nd (tie) for invertebrates, and 10th (tie) for fishes. Complete lists of the species encountered are provided in Appendices B-D.

Subtidal species of concern

At Cape San Martin, 8 of the 12 subtidal species of concern were observed (Table 18.7).

Table 18.7: Relative abundance of species of special interest and their rank as compared to all 21 qualitative subtidal survey sites

Species	Category	Relative abundance
Phyllospadix spp.	Habitat forming	Not noted
Macrocystis pyrifera	Burial, turbidity sensitivity	Low
Nereocystis luetkeana	Burial, turbidity sensitivity	High
Pterygophora californica	Burial, turbidity sensitivity	Low
Stylaster californicus	Burial, scour sensitivity	Not noted
Haliotis rufescens	Burial sensitivity	Not noted
Strongylocentrotus spp.	Burial sensitivity	Not noted
Scorpaenichthys marmoratus	Burial sensitivity	Average
Ophiodon elongatus	Burial sensitivity	Below average
Hexagrammos decagrammus	Burial sensitivity	Above average
Sebastes carnatus	Burial sensitivity	Above average
Sebastes chrysomelas	Burial sensitivity	Average

Subtidal algae (Readdie/Kusic)

Kelp canopy surface estimate: 20,226 m^2

a) Shallow subtidal zone (0-20 ft)

Canopy

Nereocystis luetkeana was present in high abundance.

Subcanopy

Laminaria setchellii was present in high abundance.
Pterygophora californica was present in high abundance.

Understory

Foliose reds were 70% of total understory algae— *Botryoglossum/Cryptopleura/Hymenena, Callophyllis flabellulata, Callophyllis spp, Chondracanthus corymbifera/exasperata, Erythrophyllum delesserioides, Mazaella spp, Pikea/Farlowia,* and *Rhodomenia/Ozophora spp* were present in high abundance.
Crustose Corallines were 10% of total understory algae.
Articulated Corallines were 10% of total understory algae.
Brown algae were 10% of total understory algae— *Alaria marginata* was present in medium abundance.

b) Mid-subtidal zone (20 - 40 ft)

Canopy

Macrocystis pyrifera was present in medium abundance with plants having 30-60 stipes.

Subcanopy

Pterogophora californica was present in low abundance, with a combination of healthy and damaged plants, only the stipes remained..
Laminaria setchellii was present in medium abundance.

Understory

Foliose reds were 10% of total understory algae— *Rhodomenia/Ozophora* were present in high abundance. *Callophyllis flabellulata* was present in medium abundance.
Botryoglossum/Cryptopleura/ Hymenena were present in low abundance.
Red Crust was 10% of total understory algae.
Crustose Corallines were 70% of total understory algae.
Articulated Corallines were 10% of total understory algae.

c) Deep subtidal zone (40-50 ft)

Canopy

Macrocystis pyrifera was present in low abundance, with plants having 7-30 stipes.
Nereocystis luetkeana was present in medium abundance.

Subcanopy

Pterogophora californica was present in low abundance, with a combination of healthy and damaged plants, only the stipes remained.
Laminaria setchellii was present in medium abundance.

Understory

Foliose reds were 2% of total understory algae— *Callophyllis flabellulata* and *Rhodomenia/Ozophora* were present in medium abundance.
Crustose Corallines were 95% of total understory algae.
Articulated Corralines were 2% of total understory algae.

Subtidal invertebrates (Lonhart)

a) Shallow subtidal zone (0-20 ft)

The shallow zone was mostly large boulders, often 2-3 m in diameter. One particularly large boulder was covered with the worm snail (*Petaloconchus montereyensis*). There were also several patches of a relatively rare purple bryozoan (*Lichenopora novae-zealandiae*) at 16 ft.

b) Mid-subtidal zone (20 - 40 ft)

At 30 ft the stipitate kelp (*Pterygophora californica*) zone began. A 5 cm patch of a purple bryozoan (*Lichenopora novae-zealandiae*) was at 36 ft. At 26 ft I found several polyceratid flatworms (*Eurylepta californica*) in one 50x50 cm area.

c) Deep subtidal zone (40 - 60 ft)

The bottom at the outer edge of the kelp bed consisted of coarse-grained gravel including rocks the size of marbles (all grey colored) and furrows spaced 1 m apart to a height of 15 cm. This area was nearly devoid of macroscopic organisms. At 57 ft car-sized boulders appeared and the ornate tubeworm (*Diopatra ornata*) filled in the gaps. A large section of this zone was a 45 ft.

Subtidal fishes (Carr)

A total of 17 species of fish were encountered at this site, ranking average relative to the mean and median (17 species) among sites surveyed. The number of rockfish (10) and surfperch (3) species were above and at the average, respectively for the sites surveyed. Four of the 5 fish species of concern were encountered here; gopher rockfish and kelp greenling were above average site abundance, cabezon, and black and yellow rockfish were at average site abundance, whereas lingcod, by their absence, were below average site abundance. Tubesnout was the only species of particularly high abundance. Adult blue, olive, black, grass copper and vermilion rockfish were above average abundance, as were juvenile canary rockfish and adult black perch. No species was of particularly low abundance at this site.

a) Shallow subtidal zone (0-20 ft)

Eight species of fish were encountered in the shallow depth zone, including the adults of blue, kelp, black, grass, and black and yellow rockfish, black, stripe, and pile perch. No juvenile fishes were observed.

b) Mid-subtidal zone (20 - 40 ft)

Thirteen species of fish were encountered in the mid-depth zone, including the adults of blue, olive, kelp, black, black and yellow, and vermilion rockfish, black, stripe, and pile perch, painted and kelp greenling, cabezon, and tubesnout. No juvenile fishes were observed.

c) Deep subtidal zone (40 - 60 ft)

Fifteen species of fish were encountered in the deep depth zone, including the adults of blue, olive, kelp, black, black and yellow, gopher, copper, and vermilion rockfish, black, stripe, and pile perch, painted and kelp greenling, and tubesnout, as well as juvenile blue and canary rockfish.

IV.B.19. Duck Pond

IV.B.19.1. Survey metadata

Table 19.1. Survey type, date completed, and specific location of sampling conducted at Duck Pond

Survey type	Date completed	Latitude (N)	Longitude (W)
Quantitative Intertidal	November 24, 2003	35 51'55	121 25'34
Qualitative subtidal	No data		

IV.B.19.2. Intertidal survey conditions

Tide- November 24, 2003: -1.5 AT 16:42
Time- Approximately 6 hours spent at the site for the quantitative survey.

IV.B.19.3. Subtidal survey diving conditions

No data

IV.B.19.4 Site overview

Location

No data

Environment

Duck Ponds is an extensive stretch of both natural and rip rap boulders clearly visible from HWY 1. The intertidal area slopes 5-10 degrees and is openly exposed to the west. Down coast of the survey site the slope is partially retained with wire caged rock blocks. Upcoast of the survey site two drainage pipes run down the length of the slope.

Biological overview

The upland slope between the intertidal and HWY 1 is 50-70 degrees and is currently all exposed earth/rock slide. Tidepools are not present on the bench. High-zone species include the red alga Porphyra spp., *Bangia* spp, blue-green algae, and diatoms. Mid-zone species include green algae *Ulva* spp., red algae *Mazzaella affinis, Petrocelis* spp. *Ralfsiaceae*. Low-zone species include red algae *Corallina* spp., *Palmaria mollis, Mazzaella* spp., and kelp *Alaria marginata.* Bare rock comprised 41% of the total cover.

IV.B.19.5 Nearshore geology and geography

Proximity to creeks and canyons

No data

Exposure, cliffs, and erosion

The upland slope between the intertidal and HWY 1 is 50-70 degrees and is currently all exposed earth/rock slide. The intertidal area slopes 5-10 degrees and is openly exposed to the west.

Intertidal geology

Duck Ponds is an extensive stretch of both natural and rip rap boulders clearly visible from HWY 1. Down coast of the survey site the slope is partially retained with wire caged rock blocks.

Subtidal geology and topography

No data

IV.B.19.6. Nearshore oceanography

No data

IV.B.19.7. Biology

Intertidal of Duck Ponds

Overall intertidal ranking

Overall, species richness is below average for this site. During a survey on November 24, 2003 53 species categories were noted.

Intertidal species of concern

Two out of seven intertidal species of special interest (see Methods for selection criteria), were present (Table 19.7).

Table 19.7: Species of special interest present at Duck Pond

Species	Common name
Mytilus californianus	california mussel
Strongylocentrotus purpuratus	purple urchin

IV.B.20. Grey Slip

IV.B.20.1. Survey metadata

Table 20.1. Survey type, date completed, and specific location of sampling conducted at Grey Slip

Survey type	Date completed	Latitude (N)	Longitude (W)
Qualitative intertidal	September 13, 2003	35 51. 40	121 25.34

IV.B.20.2. Intertidal survey conditions

Tide- September 13, 2003: 2.0 at 6:49
Time- Approximately 30 minutes spent at the site for qualitative survey.

IV.B.20.3. Subtidal survey diving conditions

No subtidal survey

IV.B.20.4. Site overview

Location

No data

Environment

Grey Slip is primarily unconsolidated boulders and cobbles with interstitial coarse sand and is visible from HWY 1. The intertidal area is steep and inaccessible at 45 degrees and openly exposed to the ocean. The upland slope is an active slide at 60-75 degrees with exposed earth and boulder/cobble and no vegetation. Some steep rocky outcrops exist north of the site.

Biological overview

No information available

IV.B.20.5. Nearshore geology and geography

Proximity to creeks and canyons

No data

Exposure, cliffs, and erosion

The intertidal area is steep and inaccessible at 45 degrees and openly exposed to the ocean. The upland slope is an active slide at 60-75 degrees with exposed earth and boulder/cobble and no vegetation. Some steep rocky outcrops exist north of the site.

Intertidal geology

The intertidal area is steep and inaccessible at 45 degrees and openly exposed to the ocean.

IV.B.20.6. Nearshore oceanography

No information available

IV.B.20.7. Biology

Intertidal of Grey Slip

No information available

IV.B.21. Redwood Gulch

IV.B.21.1. Survey metadata

Table 21.1. Survey type, date completed, and specific location of sampling conducted at Redwood Gulch.

Survey type	Date completed	Latitude (N)	Longitude (W)
Intertidal	No data		
Qualitative subtidal	November 8, 2004	35 49’58.22”	121 23’53.79”
Quantitative subtidal	No data		
2003	No data		
Upcoast deep	No data		
Downcoast deep	No data		
2004	No data		
Upcoast deep	No data		
Downcoast deep	No data		

IV.B.21.2. Intertidal survey conditions

No data

IV.B.21.3. Subtidal survey diving conditions

Sea surface— Conditions (wind, waves) were moderate.

Surge— Not recorded.

Visibility— Not recorded.

Depth— The maximum depth was 63 ft.

Transect length (estimated)— 142 m.

Bottom time— 65 minutes.

Water temperature— Not recorded.

Distance from shore to 20 m isobath— 487.4 m. The slope is considered moderate.

IV.B.21.4. Site overview

Location

Redwood Gulch is located 10 km south of Cape San Martin and due west of mile 5.6 on Highway 1.

Environment

In the subtidal, the bottom was gravel and similar to the 73.5 mile marker site. At 57 ft deep there were some large boulders (3-4 m) with gravel in between. At 40 ft deep very large

outcrops (4-5 m) provided high relief. There was no continuous reef, and at 23 ft deep the bottom was a boulder and rubble field.

Biological overview

Divers qualitatively surveyed a kelp bed at Redwood Gulch on November 8, 2004. Unlike many sites, this one was not dominated by compound tunicates, but rather had a high number of hydroids. Sponges were common, but several of the more common tunicates were absent or at low densities.

IV.B.21.5. Nearshore geology and geography

Proximity to creeks and canyons

The Redwood Gulch site is at the mouth of Redwood Gulch and is near Alder Creek (1.25 miles north). There is little evidence for persistent, detectable freshwater input to the dive site.

Exposure, cliffs, and erosion

Redwood Gulch has a western exposure. The cliffs are tall and steep. Vegetation is moderate and sediment is visible throughout. It appears this may have been a slide in the recent past, and material likely continues to slide into the intertidal. The terrestrial geology is classified as unconsolidated sediment.

Intertidal geology

No data

Subtidal geology and topography

At 57 ft the bottom was mostly gravel with boulders (3-4 m). At 40 ft deep very large outcrops (4-5 m) provided high relief and coarse-grained sand was in between. There was no continuous reef, and at 23 ft deep the bottom was a boulder and rubble field.

Table 21.5. Redwood Gulch qualitative subtidal survey results for reef type and relief by three depth zones. Percentages for each category are based on *in situ* visual diver estimates and review of underwater video (when available).

Depth	Reef Type				Relief			
(meters)	sand	cobble	boulder	bedrock	0-10 m	10-1 m	1-2 m	>2 m
0-6		20	40	40	20	20	60	
6-12	20	10	35	35	30	20	20	30
12-18	20	10	20	50	30		20	50

IV.B.21.6. Nearshore oceanography

Redwood Gulch faces the west and is exposed to northwestern swell. To our knowledge, there are no data on nearshore currents at this site.

IV.B.21.7. Biology

Intertidal of Redwood Gulch

No data

Subtidal of Redwood Gulch

Overall subtidal ranking

Combining the five subtidal sensitivity indices, Redwood Gulch scored 13 of 22 points possible and is considered a site of medium value relative to the 21 sites surveyed qualitatively. The species richness ranks—again, relative to the other 21 sites sampled qualitatively—were 5th (tie) for algae, 4th for invertebrates, and 9th for fishes. Complete lists of the species encountered are provided in Appendices B-D.

Subtidal species of concern

At Redwood Gulch, 9 of the 12 subtidal species of concern were observed (Table 21.7).

Table 21.7: Relative abundance of species of special interest and their rank as compared to all 21 qualitative subtidal survey sites

Species	Category	Relative abundance
Phyllospadix spp.	Habitat forming	Low
Macrocystis pyrifera	Burial, turbidity sensitivity	Low
Nereocystis luetkeana	Burial, turbidity sensitivity	Medium
Pterygophora californica	Burial, turbidity sensitivity	Medium
Stylaster californicus	Burial, scour sensitivity	Not noted
Haliotis rufescens	Burial sensitivity	Not noted
Strongylocentrotus spp.	Burial sensitivity	Not noted
Scorpaenichthys marmoratus	Burial sensitivity	Average
Ophiodon elongatus	Burial sensitivity	Average
Hexagrammos decagrammus	Burial sensitivity	Above average
Sebastes carnatus	Burial sensitivity	Average
Sebastes chrysomelas	Burial sensitivity	Above average

Subtidal algae (Readdie/Kusic)

Kelp canopy surface estimate: 20,226 m^2

a) Shallow subtidal zone (0-20 ft)

Canopy

Macrocystis pyrifera was present in low abundance.
Nereocystis luetkeana was present in high abundance.

Subcanopy

Laminaria setchellii was present in high abundance.

Understory

Foliose reds were 45% of total understory algae— *Botryoglossum/Cryptopleura/Hymenena, Callophyllis spp, Chondracanthus corymbifera/exasperata*, and *Rhodomenia/Ozophora* were present in high abundance. *Mazaella spp* and *Shizymenia/Halymenia* were present in medium abundance.
Crustose Corallines were 45% of total understory algae.
Brown algae were 10% of total understory algae— *Cystoseira osmundacea* was present in high abundance.
Phyllospadix spp. was 2% of total understory.

b) Mid-subtidal zone (20 - 40 ft)

Canopy

Macrocystis pyrifera was present in low abundance.
Nereocystis luetkeana was present in medium abundance.

Subcanopy

Pterogophora californica was present in medium abundance.
Laminaria setchellii was present in medium abundance.

Understory

Foliose reds were 40% of total understory algae— *Botryoglossum/Cryptopleura/Hymenena, Callophyllis flabellulata, Callophyllis spp, Constantinia simplex, Loranthophycus californicus,* and *Rhodoptilum plumosum* were present in high abundance. *Opuntiella californica, Plocamium/Microcladia, Polyneura latissima, Prionitis spp, Rhodomenia/Ozophora, Shizymenia/Halymenia* and *Weeksia spp* were present in medium abundance. *Chondracanthus corymbifera/ exasperata* were present in low abundance.
Red Crust was 2% of total understory algae.
Crustose Corallines were 20% of total understory algae.
Articulated Corallines were 40% of total understory algae.
Brown algae were 2% of total understory algae— *Dictyota binghamiae* was present in high abundance. *Cystoseira osmundacea* and *Desmarestia ligulata var.firma* were present in medium abundance.

c) Deep subtidal zone (40-60 ft)

Canopy

Macrocystis pyrifera was present in medium abundance.

Subcanopy

Pterogophora californica was present in low abundance.
Laminaria setchellii was present in low abundance.

Understory

Foliose reds were 30% of total understory algae— *Botryoglossum/Cryptopleura/Hymenena, Callophyllis flabellulata, Callophyllis spp*, and *Loranthophycus californicus* were present in high abundance. *Opuntiella californica, Plocamium/Microcladia, Rhodoptilum plumosum, Rhodomenia/Ozophora, Shizymenia/Halymenia* and *Weeksia spp* were present in med abundance. *Polyneura latissima* was present in low abundance.
Red crust was 10% of total understory algae.
Crustose Corallines were 30% of total understory algae.
Articulated Corralines were 30% of total understory algae.
Brown algae were 2% of total understory algae— *Desmarestia ligulata var.firma* and *Dictyota binghamiae* were present in medium abundance.

Subtidal invertebrates (Lonhart)

a) Shallow subtidal zone (0-20 ft)

At 20 ft erect coralline algae dominated, and the stalked Monterey tunicate (*Styela montereyensis*) was the most common tunicate.

b) Mid-subtidal zone (20 - 40 ft)

At 40 ft boulders 5-8 m long were common and they provided a great deal of vertical relief. The reef was not continuous. Unlike similar sites, tunicates did not dominate among invertebrates, but hydroids were very common. By 23 ft the bottom was mostly boulders 1-3 m diameter and rubble in between.

c) Deep subtidal zone (40 - 60 ft)

Similar to the site at mile marker 73.5, this site had a gravel bottom at the outer edge of the kelp bed. Boulders were few and 3-4 m in diameter.

Subtidal fishes (Carr)

A total of 18 species of fish were encountered at this site, ranking average relative to the mean and median (17 species) among sites surveyed. The number of rockfish (8) and surfperch (4) species were average for the sites surveyed. All five of the 5 fish species of concern were encountered here; cabezon and black and yellow rockfish were above average site abundance, whereas lingcod, gopher rockfish and kelp greenling were at average site abundance. Only sheephead were of particularly high abundance, whereas species of above average abundance included adult blue, black, grass and vermilion rockfish, juvenile vermilion rockfish, and adult black perch and coralline sculpin. No species was of particularly low abundance at this site.

a) Shallow subtidal zone (0-20 ft)

Seven species of fish were encountered in the shallow depth zone, including the adults of blue, olive, black, kelp, and grass rockfish, black, stripe and kelp perch. No juveniles were observed.

b) Mid-subtidal zone (20 - 40 ft)

Fifteen species of fish were encountered in the mid-depth zone, including the adults of blue, olive, black, kelp, grass, gopher, black and yellow, and vermilion rockfish, black, stripe, white and pile perch, painted and kelp greenling, and lingcod. No juveniles were observed.

c) Deep subtidal zone (40 - 60 ft)

Twenty species of fish were encountered in the deep depth zone, including the adults of blue, olive, black, kelp, gopher, black and yellow, tree, and vermilion rockfish, black, stripe, rubberlip, rainbow, kelp and pile perch, painted and kelp greenling, lingcod, sheephead, tubesnout and cabezon. No juveniles were observed.

IV.B.22. North Salmon Creek

IV.B.22.1. Survey metadata

Table 22.1. Survey type, date completed, and specific location of sampling conducted at North Salmon Creek.

Survey type	Date completed	Latitude (N)	Longitude (W)
Intertidal	No data		
Qualitative subtidal	September 14, 2003	35 48’36.02”	121 22’19.24”
Quantitative subtidal-benthic			
2003			
Upcoast deep	September 17, 2003	35 48' 36.01"	-121 22' 45.82"
Downcoast deep	September 17, 2003	35 48' 29.86"	-121 22' 33.01"
2004			
Upcoast deep	June 3, 2004	35 48' 29.16"	-121 22' 29.88"
Downcoast deep	June 3, 2004	35 48' 29.86"	-121 22' 33.01"
Quantitative subtidal-fish			
2003			
Upcoast deep	September 17, 2003	35 48' 36.01"	-121 22' 45.82"
Downcoast deep	September 17, 2003	35 48' 29.86"	-121 22' 33.01"
2004			
Upcoast deep	June 3, 2004	35 48' 29.16"	-121 22' 29.88"

IV.B.22.2. Intertidal survey conditions

No data

IV.B.22.3. Subtidal survey diving conditions

Sea surface— Conditions (wind, waves) were calm.

Surge— At depth, there was no surge in the deep and middle zones, and up to 2 ft surge when shallow.

Visibility— 10 ft.

Depth— The maximum depth was 60 ft.

Transect length (estimated)— 163 m.

Bottom time— 61 minutes.

Water temperature— 58 F at 20 ft deep.

Distance from shore to 20 m isobath— 537.7 m. The slope is considered moderate.

IV.B.22.4. Site overview

Location

North of Salmon Creek is located 7 km north of Ragged Point and due west of mile 2.9 on Highway 1.

Environment

In the subtidal, the bottom was gravel and small cobble at 60 ft deep. North of Salmon Creek also had boulder fields and sand-filled channels.

Biological overview

Divers qualitatively surveyed a kelp bed at North of Salmon Creek on September 14, 2003. Qualitatively, this site was reminiscent of diving along San Simeon Point, which is to the south.

IV.B.22.5. Nearshore geology and geography

Proximity to creeks and canyons

North of Salmon Creek is adjacent to a small headland. North of Salmon Creek is near Salmon Creek (0.5 miles south) but the creek, which may flow year-round, appears to have no significant impact on the site.

Exposure, cliffs, and erosion

North of Salmon Creek has a western exposure. The terrestrial geology is classified as unconsolidated sediment.

Intertidal geology

No data

Subtidal geology and topography

In the deep zone, the bottom was gravel and small cobble at 60 ft deep.

Table 22.5. North of Salmon Creek qualitative subtidal survey results for reef type and relief by three depth zones. Percentages for each category are based on *in situ* visual diver estimates and review of underwater video (when available).

Depth	Reef Type				Relief			
(meters)	sand	cobble	boulder	bedrock	0-10 m	10-1 m	1-2 m	>2 m
0-6			100			100		
6-12	25		50	25	25	50	25	
12-18	50		50		25	50		

IV.B.22.6. Nearshore oceanography

North of Salmon Creek faces the west and is exposed to northwestern swell. To our knowledge, there are no data on nearshore currents at this site.

IV.B.22.7. Biology

Intertidal of North Salmon Creek

No data

Subtidal of North Salmon Creek

Overall subtidal ranking

Combining the five subtidal sensitivity indices, North Salmon Creek scored 10 of 22 points possible and is considered a site of medium value relative to the 21 sites surveyed qualitatively. The species richness ranks—again, relative to the other 21 sites sampled qualitatively—were 5th (tie) for algae, 14th for invertebrates, and 1st for fishes. Complete lists of the species encountered are provided in Appendices B-D.

Subtidal species of concern

At North Salmon Creek, 8 of the 12 subtidal species of concern were observed (Table 22.7).

Table 22.7: Relative abundance of species of special interest and their rank as compared to all 21 qualitative subtidal survey sites

Species	Category	Relative abundance
Phyllospadix spp.	Habitat forming	Not noted
Macrocystis pyrifera	Burial, turbidity sensitivity	Medium
Nereocystis luetkeana	Burial, turbidity sensitivity	Medium
Pterygophora californica	Burial, turbidity sensitivity	Medium
Stylaster californicus	Burial, scour sensitivity	Not noted
Haliotis rufescens	Burial sensitivity	Not noted
Strongylocentrotus spp.	Burial sensitivity	Not noted
Scorpaenichthys marmoratus	Burial sensitivity	Average
Ophiodon elongatus	Burial sensitivity	Above average
Hexagrammos decagrammus	Burial sensitivity	Below average
Sebastes carnatus	Burial sensitivity	Above average
Sebastes chrysomelas	Burial sensitivity	Average

Subtidal algae (Readdie/Kusic)

Kelp canopy surface estimate: 20,226 m^2

a) Shallow subtidal zone (20-30 ft)

Canopy

Macrocystis pyrifera was present in medium abundance.
Nereocystis luetkeana was present in medium abundance.

Subcanopy

Laminaria setchellii was present in medium abundance.
Pterygophora californica was present in low abundance.

Understory

Foliose reds were present in high abundance— *Chondracanthus corymbifera/ exasperata, Plocamium pacificum, Prionitis spp, Ptilota/Neotilota*, and *Rhodomenia/Ozophora* were present in high abundance. *Mazaella spp* was present in medium abundance. *Callophyllis spp* was present in low abundance.
Crustose Corallines— *Lithothamnion sp*. was present in medium abundance.
Articulated Corallines— *Calliarthron cheilosporioides* was present in high abundance.
Brown algae— *Desmarestia ligulata var. ligulata* was present in high abundance.
Cystoseira osmundacea was present in medium abundance.

b) Mid-subtidal zone (30 - 45 ft)

Canopy

Macrocystis pyrifera was present in medium abundance.
Nereocystis luetkeana (bull kelp) was present in medium abundance.

Subcanopy

Pterygophora californica was present in high abundance.

Understory

Foliose reds were present in low abundance— *Botryoglossum/Cryptopleura/ Hymenena, Polyneura latissima*, and *Rhodomenia/Ozophora* were present in high abundance. *Callophyllis spp* and *Chondracanthus corymbifera/ exasperata* were present in medium abundance. *Rhodymenia rhizoides* was present in low abundance.
Crustose Corallines— *Lithothamnion sp*. was present in high abundance.
Articulated Corallines— *Calliarthron cheilosporioides* was present in medium abundance.
Brown algae— *Egregia menziesii* was present in high abundance. *Desmarestia ligulata var. ligulata* was present in medium abundance.

c) Deep subtidal zone (60 ft)

Canopy

Macrocystis pyrifera was present in medium abundance.
Nereocystis luetkeana was present in medium abundance.

Subcanopy

Pterogophora californica was present in medium abundance
Laminaria setchellii was present in low abundance

Understory

Foliose reds were present in low abundance— *Erythrophyllum delesseriodes, Halymenia/Schizymenia, Polysiphonia/Ceramium*, and *Rhodomenia/Ozophora* were present in high abundance. *Callophyllis spp* and *Polyneura latissima* were present in medium abundance.
Crustose Corallines— *Lithothamnion sp*. was present in medium abundance.
Articulated Corallines- *Calliarthron cheilosporioides* was present in medium abundance.
Brown algae— *Desmerestia ligulata var. firma* was present in high abundance.
Desmarestia ligulata var. ligulata was present in medium abundance.

Subtidal invertebrates (Lonhart)

a) Shallow subtidal zone (0-20 ft)

The bottom consisted of boulders with gravel and small cobble between. Several large (to 4 cm) forms of the unidentified *Henricia* sp. were noted, which was unusual since it is normally a small species.

b) Mid-subtidal zone (20 - 40 ft)

There was more surge in the middle zone, and an increase in the number and types of compound tunicates (e.g., *Ritterella rubra*, *Archidistoma*-like sp.).

c) Deep subtidal zone (40 - 60 ft)

The bottom at 60 ft was gravel and small cobble. On the reefs I found sponges and bryozoans. I noted several interesting mollusks, including a species of three-winged murex (*Pteropurpura macroptera*), the California frog shell (*Bursa californica*), and Kellet's whelk (*Kelletia kelletii*). Sand channels were filled with the ornate tubeworm (*Diopatra ornata*).

Subtidal fishes (Carr)

A total of 24 species of fish were encountered at this site, ranking the absolute highest species richness relative to the mean and median (17 species) among sites surveyed. The number of rockfish (12) and surfperch (4) species were well above and at the average, respectively, for the sites surveyed. All five of the 5 fish species of concern were encountered here; lingcod, juvenile cabezon and gopher rockfish were above average site abundance, adult cabezon and black and yellow rockfish were at average site abundance, whereas kelp greenling were below average site abundance. Species of particularly high abundance included adult copper rockfish and blackeye gobies, and juvenile tree and vermilion rockfish, bocaccio, stripe and rainbow perch. Above average numbers of adult black and brown rockfish, juvenile blue, black, gopher, black and yellow rockfish, adult rubberlip perch, coralline sculpin, tubesnout, and adult and juvenile painted greenling. Species of particularly low abundance were adult pile perch.

a) Shallow subtidal zone (0-20 ft)

Only three species of fish were encountered in the shallow depth zone, including the adults of the stripe perch and painted and kelp greenling. No juvenile or adult rockfish were observed in the shallow zone.

b) Mid-subtidal zone (20 - 40 ft)

Eighteen species of fish were encountered in the mid-depth zone, including the adults of blue, olive, kelp, black, gopher, black and yellow, and vermilion rockfish, black, stripe, rainbow and rubberlip perch, painted greenling, cabezon, snubnose sculpin, tubesnout, and blackeye gobies, as well as juvenile olive, tree, black and yellow, bocaccio and black rockfish, stripe perch, and painted greenling.

c) Deep subtidal zone (40 - 60 ft)

Sixteen species of fish were encountered in the deep depth zone, including the adults of blue, olive, kelp, black, gopher, black and yellow, brown, and copper rockfish, stripe perch, painted greenling, lingcod, and blackeye gobies, as well as juvenile blue, olive, canary, bocaccio, vermilion and gopher rockfish, stripe perch, cabezon, and painted greenling.

IV.B.23. 73.5 mile marker

IV.B.23.1. Survey metadata

Table 23.1. Survey type, date completed, and specific location of sampling conducted at 73.5 mile marker.

Survey type	Date completed	Latitude (N)	Longitude (W)
Intertidal	No data		
Qualitative subtidal	November 8, 2004	35 47'15.30"	121 20'30.51"
Quantitative subtidal	No data		
2003	No data		
Upcoast deep	No data		
Downcoast deep	No data		
2004	No data		
Upcoast deep	No data		
Downcoast deep	No data		

IV.B.23.2. Intertidal survey conditions

No data

IV.B.23.3. Subtidal survey diving conditions

Sea surface— Conditions (wind, waves) were moderate.

Surge— Not recorded.

Visibility— Not recorded.

Depth— The maximum depth was 57 ft.

Transect length (estimated)— 220 m.

Bottom time— 58 minutes.

Water temperature— Not recorded.

Distance from shore to 20 m isobath— 847.1 m. The slope is considered moderately flat.

IV.B.23.4. Site overview

Location

The 73.5 mile marker site is located 17 km south of Cape San Martin and due west of 73.5 mile marker on Highway 1.

Environment

In the subtidal, the bottom was dark gravel with furrows to 20 cm high and boulders (1-3 m). There were also low-lying slabs that looked like worn granite.

Biological overview

Divers qualitatively surveyed a kelp bed at the 73.5 mile marker site on November 8, 2004. Of the encrusting invertebrates present, the density of colonies was low. Relative to other sites, this was poor for invertebrate cover.

IV.B.23.5. Nearshore geology and geography

Proximity to creeks and canyons

The 73.5 mile marker site is near two drainages: Salmon Creek (1.75 miles north), which maybe not be limited to seasonal flow, and San Carpoforo Creek (2.0 miles south), which has a very large creek bed but not much surface water. It is very unlikely that either of these creeks has any influence on the dive site.

Exposure, cliffs, and erosion

The 73.5 mile marker site has a western exposure. The cliffs are tall and steep. Vegetation is only at the top and most of the area is exposed rock. The terrestrial geology is classified as unconsolidated sediment.

Intertidal geology

No data

Subtidal geology and topography

At the outer edge of the kelp bed the bottom was dark gravel in 20 cm high furrows, indicative of high energy. There were small to medium sized (1-3 m) boulders and large, low-lying slabs at 40 ft deep. At 10 ft deep there was coarse sand and gravel.

Table 23.5. The 73.5 mile marker site: qualitative subtidal survey results for reef type and relief by three depth zones. Percentages for each category are based on *in situ* visual diver estimates and review of underwater video (when available).

Depth	Reef Type				Relief			
(meters)	sand	cobble	boulder	bedrock	0-10 m	10-1 m	1-2 m	>2 m
0-6	10	10	20	60	20	40	40	
6-12	20	10	20	50	30	10	30	30
12-18	30	10	20	40	30	10	40	20

IV.B.23.6. Nearshore oceanography

The 73.5 mile marker site faces the west and is exposed to northwestern swell. To our knowledge, there are no data on nearshore currents at this site.

IV.B.23.7. Biology

Intertidal of 73.5 mile marker

No data

Subtidal of 73.5 mile marker

Overall subtidal ranking

Combining the five subtidal sensitivity indices, 73.5 mile marker scored 14 of 22 points possible and is considered a site of medium value relative to the 21 sites surveyed qualitatively. The species richness ranks—again, relative to the other 21 sites sampled qualitatively—were 14th (tie) for algae, 2nd (tie) for invertebrates, and 5th (tie) for fishes. Complete lists of the species encountered are provided in Appendices B-D.

Subtidal species of concern

At 73.5 mile marker, 9 of the 12 subtidal species of concern were observed (Table 23.7).

Table 23.7: Relative abundance of species of special interest and their rank as compared to all 21 qualitative subtidal survey sites

Species	Category	Relative abundance
Phyllospadix spp.	Habitat forming	Not noted
Macrocystis pyrifera	Burial, turbidity sensitivity	Low
Nereocystis luetkeana	Burial, turbidity sensitivity	Low
Pterygophora californica	Burial, turbidity sensitivity	Medium
Stylaster californicus	Burial, scour sensitivity	Not noted
Haliotis rufescens	Burial sensitivity	Not noted
Strongylocentrotus spp.	Burial sensitivity	Present
Scorpaenichthys marmoratus	Burial sensitivity	Above average
Ophiodon elongatus	Burial sensitivity	Below average
Hexagrammos decagrammus	Burial sensitivity	Average
Sebastes carnatus	Burial sensitivity	Above average
Sebastes chrysomelas	Burial sensitivity	Well below average

Subtidal algae (Readdie/Kusic)

Kelp canopy surface estimate: 20,226 m^2

a) Shallow subtidal zone (0-20 ft)

Canopy

Macrocystis pyrifera was present in low abundance.
Nereocystis luetkeana was present in low abundance.

Subcanopy

Laminaria setchellii was present in high abundance.
Pterygophora californica was present in high abundance.

Understory

Foliose reds were 40% of total understory algae— *Botryoglossum/Cryptopleura/Hymenena, Callophyllis spp, Chondracanthus corymbifera/exasperata, Prionitis spp, Ptilota/Neotilota spp,* and *Rhodomenia/Ozophora spp* in high abundance.
Red Crust was 10% of total understory algae.
Crustose Corallines were 10% of total understory algae.
Articulated Corallines were 30% of total understory algae.
Brown algae were 5% of total understory algae— *Cystoseira osmundacea* and *Egregia menziessi* in medium abundance.

b) Mid-subtidal zone (20 - 40 ft)

Canopy

Macrocystis pyrifera was present in low abundance with plants having 6-30 stipes.
Nereocystis luetkeana was present in low abundance.

Subcanopy

Pterogophora californica was present in low abundance, with a combination of healthy and damaged plants, only the stipes remained..
Laminaria setchellii was present in low abundance.

Understory

Foliose reds were 45% of total understory algae— *Botryoglossum/Cryptopleura/Hymenena, Callophyllis spp, Opuntiella californica, Prionitis spp*, and *Rhodomenia/Ozophora* were present in high abundance. *Chondracanthus corymbifera/ exasperata, Ptilota/Neotilota*, and *Shizymenia/Halymenia* were present in medium abundance.
Red Crust was 2% of total understory algae.
Crustose Corallines were 2% of total understory algae.
Articulated Corallines were 45% of total understory algae.
Brown algae were 2% of total understory algae— *Desmarestia ligulata var ligulata* was present in high abundance. *Cystoseira osmundacea* and *Dictyota binghamiae* were present in medium abundance.
Phyllospadix spp. was 2% of total understory.

c) Deep subtidal zone (40-50 ft)

Canopy

Macrocystis pyrifera was present in low abundance, with plants having 20-40 stipes.

Subcanopy

Pterogophora californica was present in medium abundance but severely damaged, only the stipes remained.

Understory

Foliose reds were 50% of total understory algae— *Rhodomenia/Ozophora* were present in high abundance. *Opuntiella californica* was present in medium abundance. *Ahnfeltia spp* and *Plocamium/Microcladia* were present in low abundance.
Red crust was 2% of total understory algae.
Crustose Corallines were 40% of total understory algae.
Articulated Corralines were 2% of total understory algae.

Subtidal invertebrates (Lonhart)

a) Shallow subtidal zone (0-20 ft)

The brooding anemone (*Epiactis prolifera*) was common in the shallow zone. Overall, this site was not good for invertebrates.

b) Mid-subtidal zone (20 - 40 ft)

The reef may have been made of granite, but it was not clear. There were low-lying slabs with smooth surfaces. At 9 m deep erect coralline algae dominated the reef. Unlike most other sites, the stipitate kelp (*Pterygophora californica*) was sparse.

c) Deep subtidal zone (40 - 60 ft)

The bottom at the outer edge of the kelp bed was dark colored gravel with furrows to 20 cm high. Boulders were 1-4 m in diameter. Most of the rocky surfaces had barren areas and there were few high-density invertebrates.

Subtidal fishes (Carr)

A total of 20 species of fish were encountered at this site, ranking above average relative to the mean and median (17 species) among sites surveyed. The number of rockfish (8) and surfperch (5) species were at and above average, respectively, for the sites surveyed. Three of the 5 fish species of concern were encountered here; cabezon and gopher rockfish were above average site abundance, kelp greenling were at average site abundance, lingcod were below average site abundance and black and yellow, by their absence, were well below the average among sites. Species of particularly high abundance included adult black and brown rockfish, black, rubberlip and rainbow perch, sheephead and tubesnout. Above average numbers of adult blue, olive, tree, and vermilion rockfish, senorita, wolf eel and painted greenlings were observed. No species was of particularly low abundance.

a) Shallow subtidal zone (0-20 ft)

Only six species of fish were encountered in the shallow zone, including the adults of black, stripe and pile perch, kelp greenling and cabezon, and tube snout. No juvenile or adult rockfish were observed in the shallow zone.

b) Mid-subtidal zone (20 - 40 ft)

Eighteen species of fish were encountered in the mid-depth zone, including the adults of blue, olive, kelp, black, gopher, brown and vermilion rockfish, black, stripe, rainbow and

pile perch, painted and kelp greenling, cabezon, senorita, sheephead, tubesnout and a wolf eel. No juvenile fishes were observed.

c) Deep subtidal zone (40 - 60 ft)

Seventeen fish species were encountered in the deep depth zone, including the adults of blue, olive, kelp, black, gopher, tree, and vermilion rockfish, black, stripe, rainbow, rubberlip and pile perch, painted and kelp greenling, cabezon, senorita and sheephead. No juvenile fishes were observed.

IV.C. Intertidal Quantitative Survey Analyses

Site Groupings

Below is a dendrogram labeled "Group Average" (Figure C.1), which represents the relative similarity between Coastal Biodiversity Sites located from Point Reyes to Point Conception. Cluster analyses were conducted on quantitative density data for all species found at the sites. The sites listed on this graph are numbered south to north. The following sites described in this report are represented on the graph:

Stillwater
Point Lobos
Andrew Molera
Mill Creek
Partington Cove
Lucia

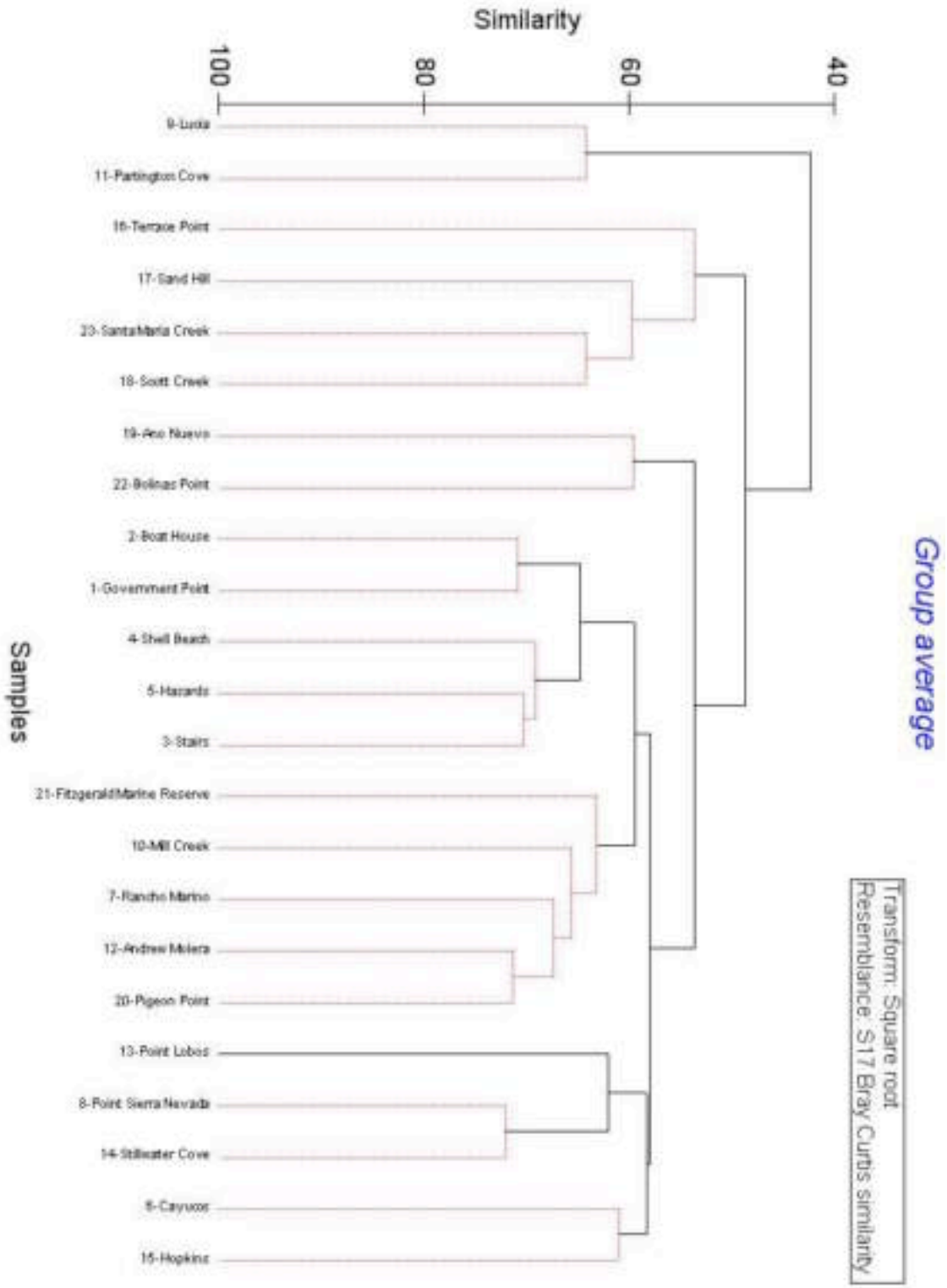


Figure C.1 “Group Average”. Relative similarity between Intertidal Coastal Biodiversity Sites located from Point Reyes to Point Conception.

IV.D. Comparison of Subtidal Biological Communities in Relation to Their Proximity to Sources of Erosion

The comparison of habitat characteristics (relative abundance of types and relief of substrate) using a cluster analysis indicated that the three near-erosion sites fell within the same cluster at 78% similarity (Figure D.1). The key habitat attributes that contributed to the similarity of these sites were the low relative abundance of bedrock, the high relative abundance of boulders (< 1 m diameter) and lower topographical relief. However, this cluster also included a non-erosion PISCO site (Lopez Rock) and no significant differences were found between the near-erosion site group and either of the "far" or PISCO site groups using an ANOSIM test. Thus, while aspects of habitat were particularly similar among the three "near" sites in close proximity to sources of substantial erosion, these habitats did not differ substantially from all other ("far" and PISCO) sites used in this comparison.

The comparison of community structure (i.e. relative abundance of species) based on all species (algae, invertebrtaes, fishes) indicated that communities at "near erosion sites" were no different from all other sites as evidenced by the fact that they did not cluster separately from either the "far" or PISCO sites (Figure D.2). Instead "near" sites grouped closely with the nearest "far" site (e.g., Duck Pond with Salmon Creek) or with the nearest PISCO sites (e.g., McWay Rocks with Esalen and Big Creek). These patterns indicate that some regional processes or conditions had greater influences on patterns of community structure than factors related to the proximity of communities to point sources of erosion. When cluster analyses were conducted individually on the constituent species assemblages (relative abundance of fish species, mobile invertebrates and kelps, or percent cover of other algae and sessile invertebrates - Figures D.3-5) a similar pattern of regional differences characterizing site similarities was apparent. ANOSIM tests for each of these data type analyses found no significant differences between "near" and "far" or PISCO site groupings.

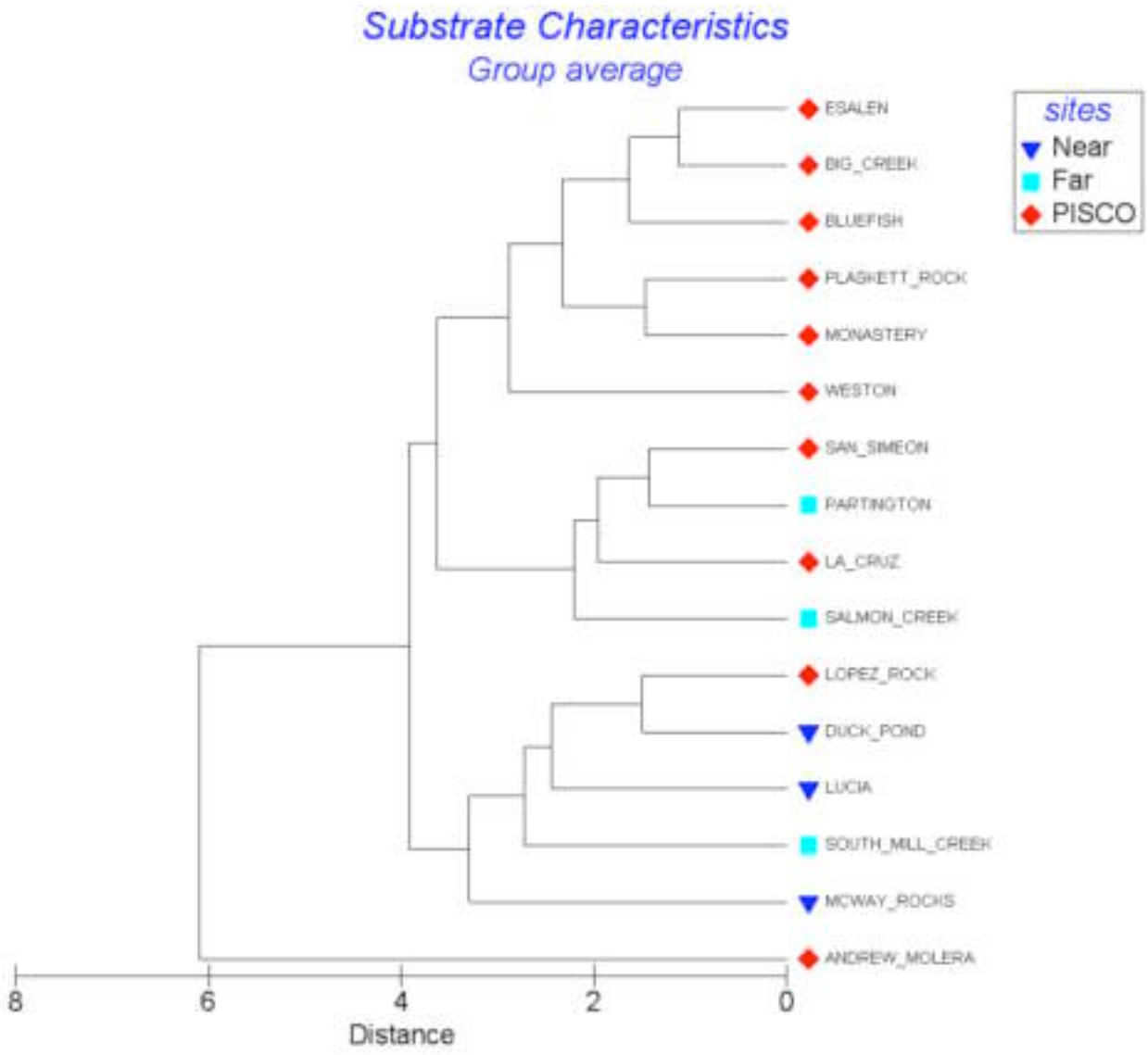


Figure D.1. Cluster analysis of substrate characteristic variables (percent cover of bedrock, cobble, sand; and percent cover of areas of high, moderate, slight, and flat relief). Distance between sites is based on Euclidean distance measures, and sites are clustered according to group average linking.

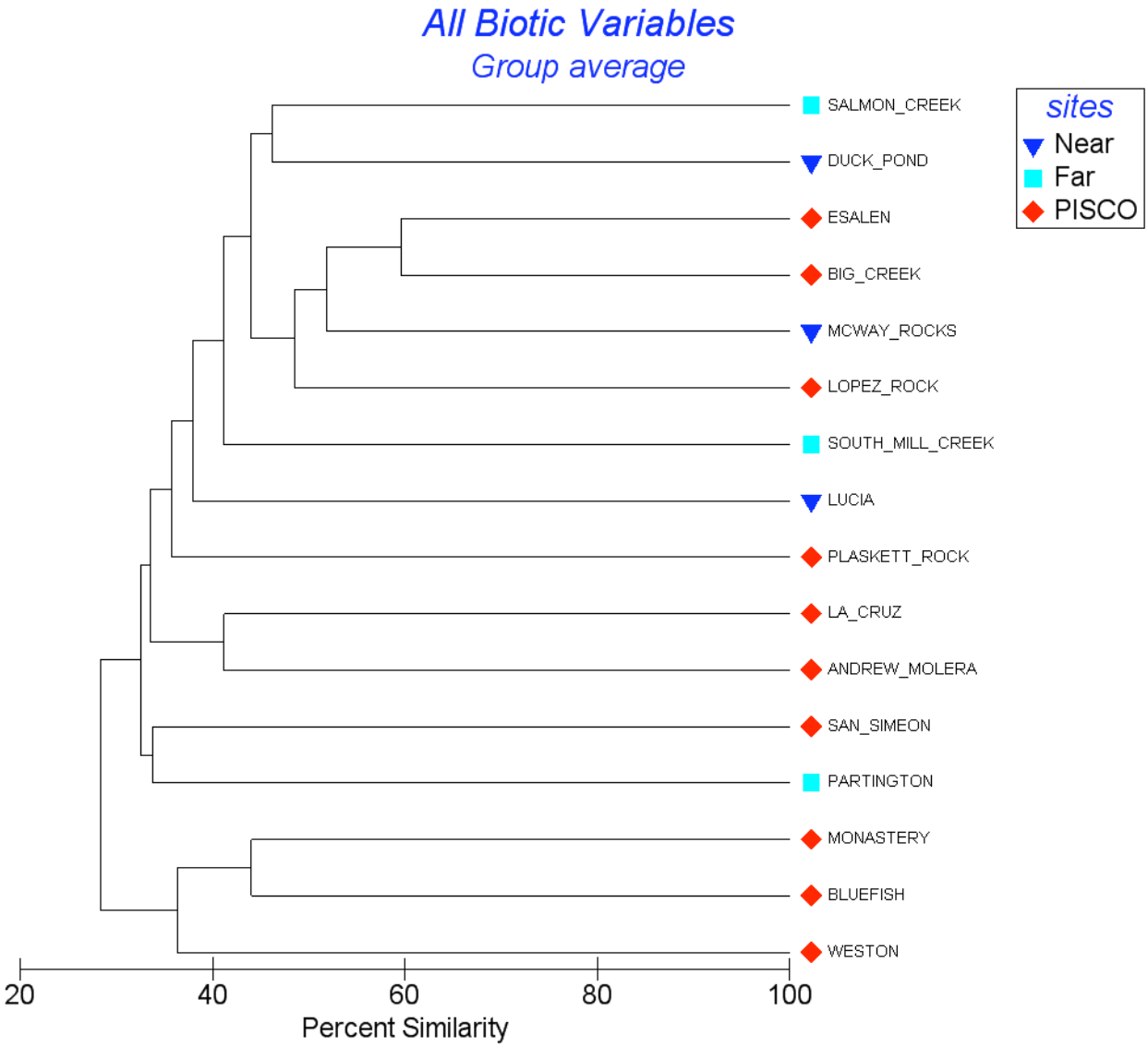


Figure D.2. Cluster analysis of all density and percent cover variables (fish, invertebrate, kelp and understory algae). Percent similarity between sites is based on Bray Curtis similarity measures, and sites are clustered according to group average linking.

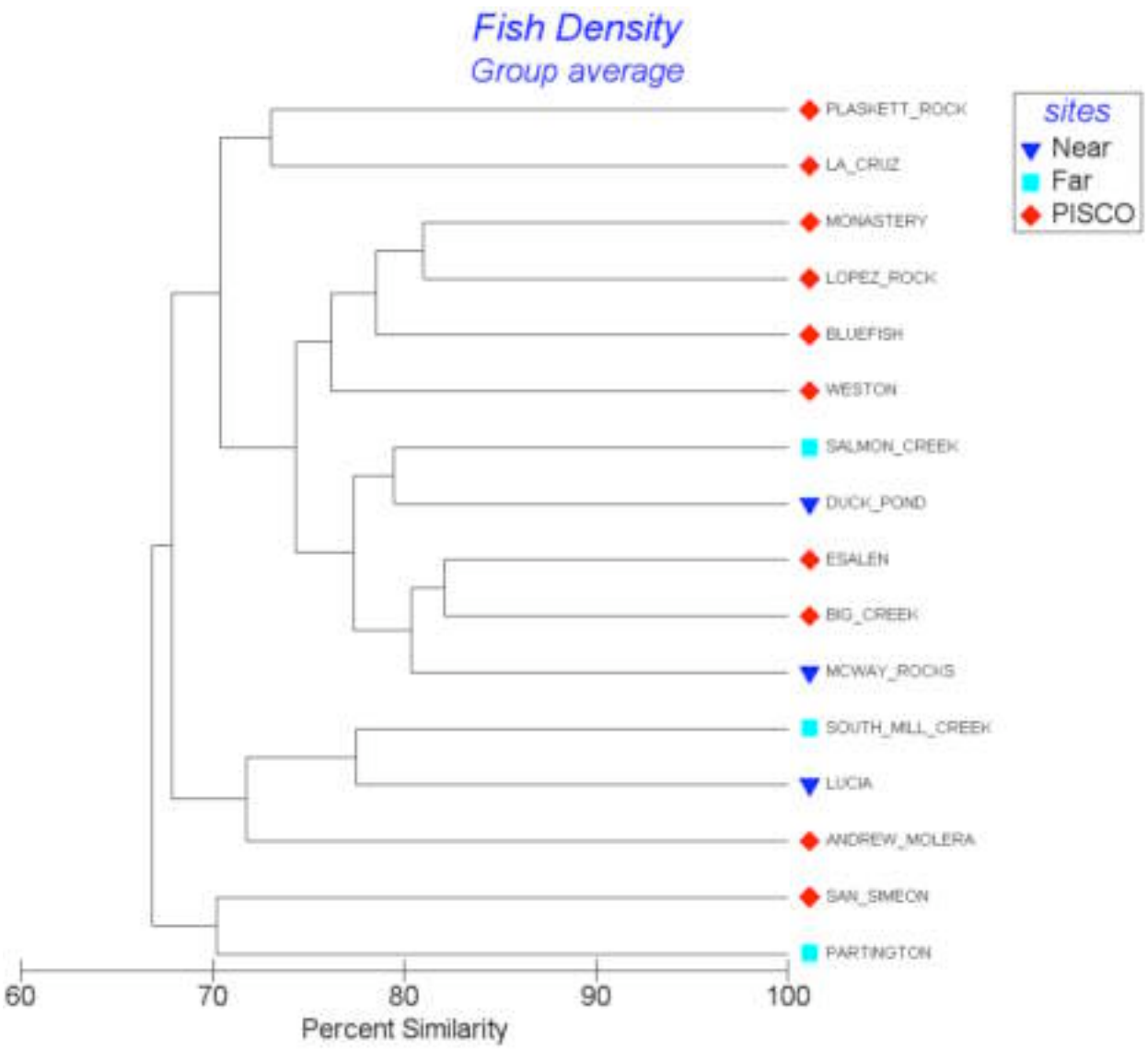


Figure D.3. Cluster analysis of all fish species density variables. Percent similarity between sites is based on Bray Curtis similarity measures, and sites are clustered according to group average linking.

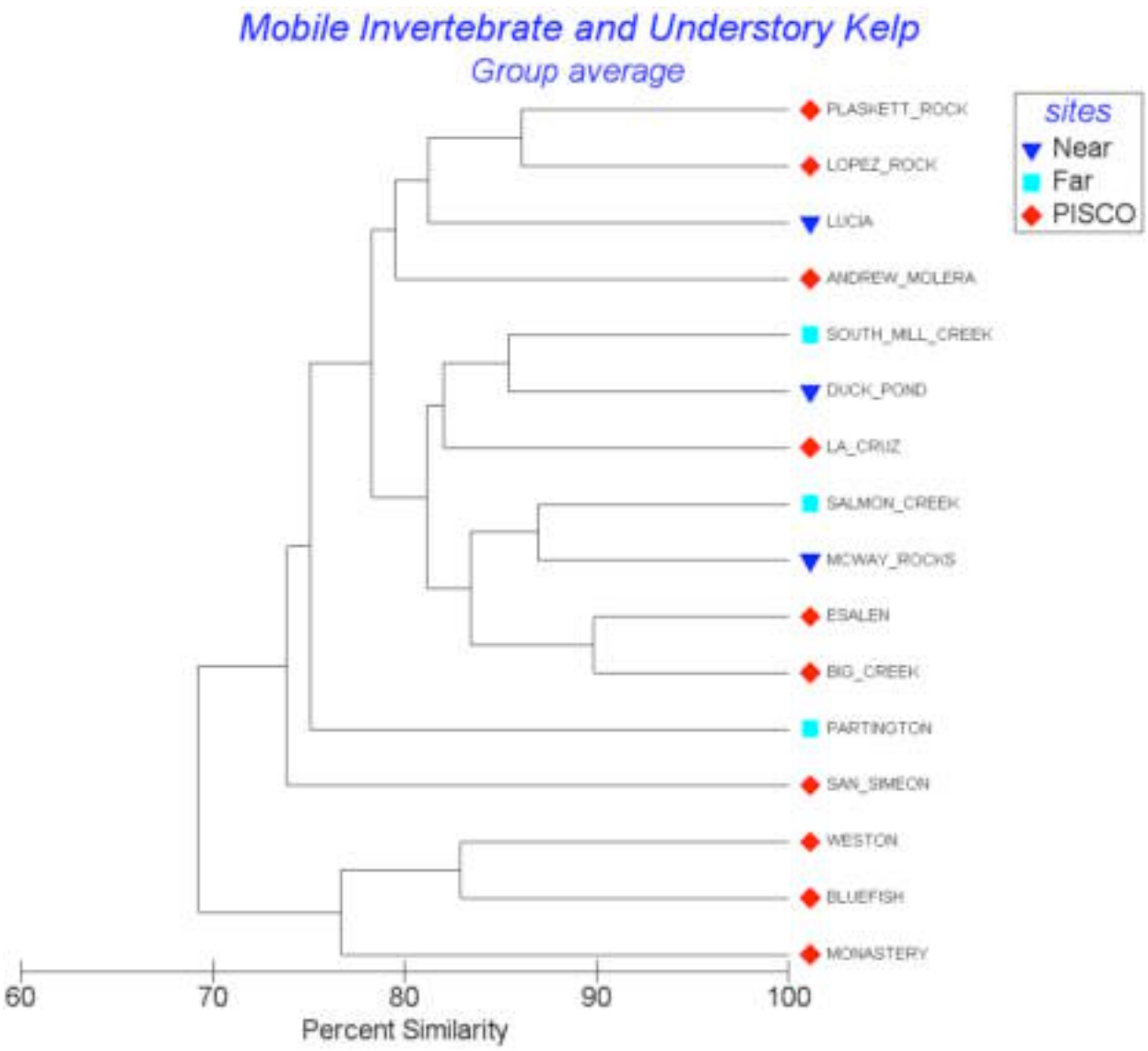


Figure D.4. Cluster analysis of all mobile invertebrate, canopy and sub-canopy kelp species density variables. Percent similarity between sites is based on Bray Curtis similarity measures, and sites are clustered according to group average linking.

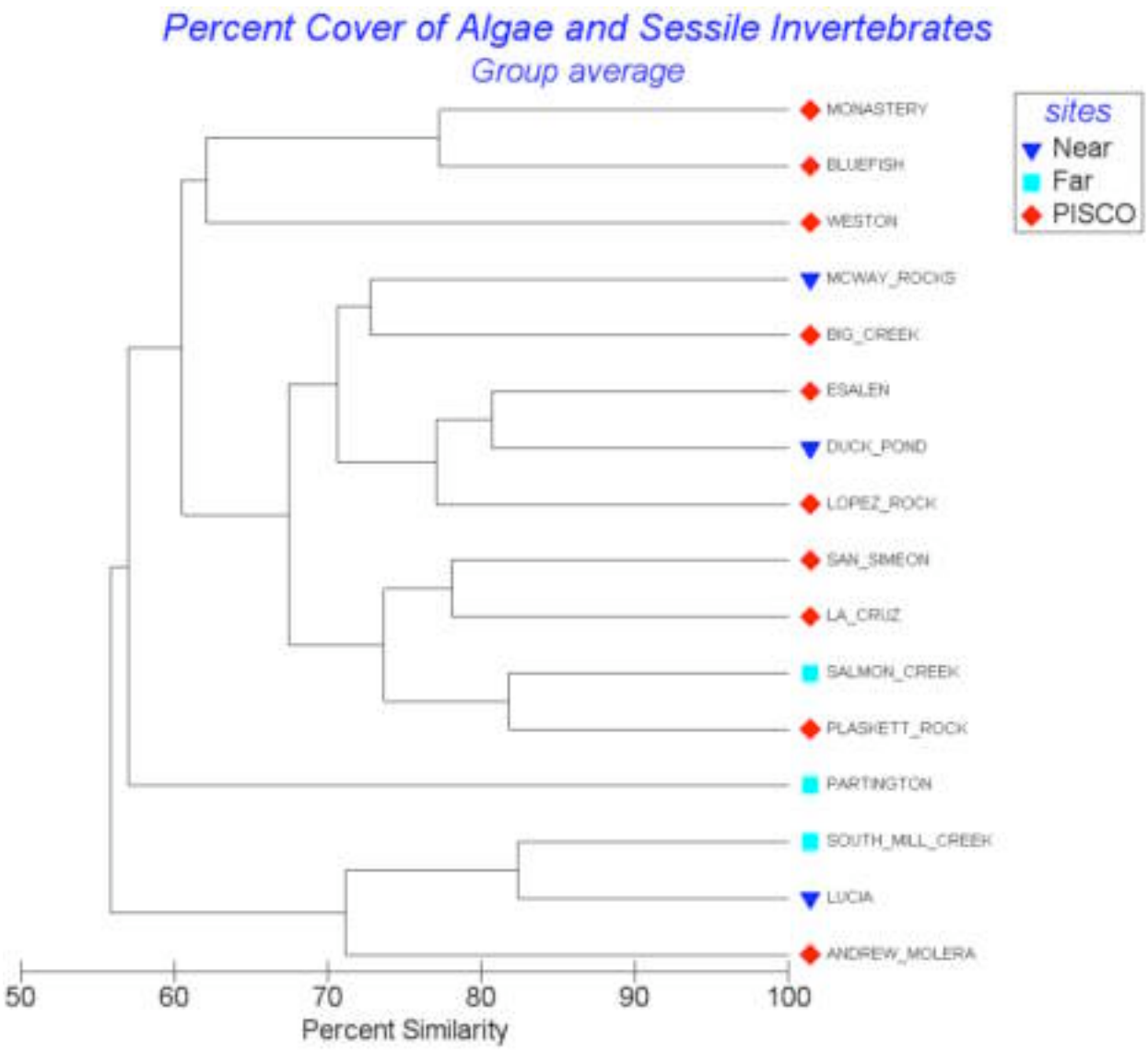


Figure D.5. Cluster analysis of percent cover variables for all sessile invertebrate and understory algal species. Percent similarity between sites is based on Bray Curtis similarity measures, and sites are clustered according to group average linking.

V. Conclusions

The three overall goals of this study, included the (1) development of indices of sensitivity of intertidal and shallow (< 20 m depth) subtidal biological communities to the dumping of erosion materials in the CHMP study region, (2) development of models based on relationships between habitat variables and biotic communties in order to predict sensitivity of communities in sections of the coast that were not sampled in this study, and (3) assessment of the differences in biological communities at sites differing in proximity to point sources of substantial erosion materials. Our indicies of biological sensitivity used to characterize the vulnerability of a community to erosion material are based on three considerations; the presence of one or more species of special interest (e.g., threatened, rare, economically important), the species richness of the community, and the relative abundance of species of particular ecological importance (e.g., biogenic habitat) and the likelihood of prolonged exprosure (i.e. retention) to the impact based on the physical attributes of the environment. These criteria resulted in a gradient of relative sensitivity of biological communities in the intertidal and shallow subtidal habitats of the CHMP study region. We also developed habitat-community models based on empirical relationships between species and communities and attributes of the local environment (e.g., exposure to swell, reef relief, substratum type). In combination, our sensitivity indices and habitat-community models were used to predict biological communities (and their associated sensitivity) at sites that were not surveyed based on habitat criteria available in a GIS developed by the Monterey bay National Marine Sanctuary.

There are two important caveats associated with these predictions. First, they are only as precise as the spatial resolution of the surveys and the habitat information on which they are based. For example, we conducted surveys in a portion of an intertidal reef or kelp forest and extrapolated those results across the spatial extent of the intertidal reef of subtidal forest/reef complex on which the sampling occurred. But these intertidal and shallow reef habitats are very heterogeneous and the accuracy of the predicted patterns of sensitivity are constrained at these smaller spatial scales. Secondly, and a product of this first source of error, is that our estimates of sensitivity are likely to be conservative (i.e. over-estimates of sensitivity). This is because poor habitats that support insensitive communities (e.g., few species of speecieal interest, low species richness) are relatively easy to both identify and predict (vast expanses of sand bottom), whereas higher quality habitats that might support sensitive species are far more variable, but are more often given higher sensitivity scores because of the likelihood of sensitive species anywhere within the segment that is being predicted. Ultimately, the utility of our approach would benefit from two future efforts, (1) testing the accuracy of our predictions by sampling predicted communities and their associated sensitivity at previously unsampled sites in the CHMP, and (2) examining more closely the finer spatial scale of habitat and community heterogeneity to determine the lower spatial bounds of our capacity to infer levels of sensitivity. Nonetheless, we are confident that the predictions created by this process provide a far more informed understanding of the patterns of biological sensitivity to erosion materials than existed previously.

Our comparison of the biological communities at three pair of sites near and far from point sources of extant erosion did not detect differences in the biological communities related to their proximity to sites of erosion. Two important caveats of these results are that the “near” sites

should not be confused with actual sites where erosion occurred, and their distance from sites of erosion likely influenced the extent to which thay may have experienced an impact. Without knowledge of the structure of the biologicl communities at these sites prior to erosion events, it cannot be concluded that they were not influenced by the erosion event. This study would have benefited from such pre-erosion information that would allow a more comprehensive analysis in the form of a Before-After-Impact-Control design. To better estimate the spatial scope of influence of erosion events, more spatially intensive surveys (i.e. with more survey sites and greater spatial resolution along a distance gradient from the erosion site) would provide more precise estimates.