Reef Check California: Citizen Scientist monitoring of rocky reefs and kelp forests: Creating a baseline for California's South Coast

Final Report

South Coast MPA Baseline Monitoring

2011-2014

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Reef Check California

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List of Acronyms

CIMI-Catalina Island Marine Institute

GLM-General Linear Model

LA/OC- Los Angeles/Orange County

LIMPETS- Long-term Monitoring Program and Experiential Training for Students

MDS-Multi-dimensional Scaling

MLPA-Marine Life Protection Act

MPA-Marine Protected Area

NED- Nearshore Ecosystem Database

PISCO-Partnership for Interdisciplinary Studies of Coastal Oceans

RCCA-Reef Check California

SCSAT-South Coast Science Advisory Team

SCSR- Southern California Study Region

SMCA-State Marine Conservation Area

SMR-State Marine Reserve

UCSB- University of California, Santa Barbara

UPC- Uniform Point Contact

Executive Summary

Marine protected areas (MPAs) were implemented along California's South Coast Study Region (SCSR) in 2012 as a result of the Marine Life Protection Act (MLPA) legislation. A collaborative, comprehensive baseline monitoring program was conducted in order to characterize the marine ecosystems of the region. Reef Check California (RCCA) participated in this monitoring project to survey the rocky reefs and kelp forest in the SCSR to establish a baseline for detecting future effects of MPAs on these communities. RCCA is a program of the Reef Check Foundation that aims to improve marine management in California by providing critically needed data on California's nearshore rocky reef ecosystems through the use of volunteer citizen scientists. RCCA's objectives for the SCSR baseline monitoring were to use highly trained and certified citizen scientists to conduct baseline characterization of the shallow rocky reef and kelp forest ecosystem in the region inside and outside of MPAs and to build capacity for future long-term MPA monitoring by training volunteer citizen scientists. All of RCCA's volunteers go through a rigorous four-day training and annual recertification program. During the two-year baseline monitoring period, RCCA held 15 trainings and recertifications in the SCSR, adding a total of about 100 new volunteer divers to the program. We trained students and instructors from University of California, Santa Barbara (UCSB), the Catalina Island Marine Institute (CIMI), the Aquarium of the Pacific and the Emerald Bay Boy Scout Camp.

RCCA volunteer citizen scientists conduct 18 visual scuba transects at each monitoring site to estimate densities and sizes of important fish, invertebrates and algae and to characterize the physical habitat at the sites. Transects are a 30-meters long and 2-meter wide swath along the rocky reef substrate. Divers count and size key species of fish (35 species), count invertebrates (33 species) and algae (9 species), and estimate the percent cover of substrate types and vertical relief of the seafloor. Over the baseline monitoring period of 2011/2012, RCCA conducted 91 surveys at its long-term monitoring sites in the SCSR. Many of these sites have been surveyed since 2006 or 2007 in order to track marine life populations and in anticipation of the establishment of MPAs in this study region.

The data from these surveys were analyzed at multiple scales to provide baseline characterization of the kelp forest ecosystems at the time of MPA implementation. We characterized the biological community at the Reef Check long-term monitoring sites by summarizing the physical and biological characteristics of each of the sites located in the SCSR. This summary of mean densities will serve as a reference point in the future as long-term monitoring of these sites continues. Several survey sites are highlighted in the report and their ecological community is compared to species densities from the entire SCSR (Figure E 1).

Kelp forest community structure differed significantly along the SCSR mainland coast and Catalina Island during the baseline monitoring period. Four main clusters of sites with similar

fish, invertebrate and algal communities emerged in a multidimensional cluster analysis. These community clusters were distributed along the coast and, in most cases, sites near each other had similar kelp forest communities. Communities with at least 60% similarity were located around Santa Barbara, around Catalina Island, along the Los Angeles/Orange County coast and in Sand Diego (Figure E 2). Only in the Los Angeles/Orange County community smaller groups of sites showed further differentiation in their community structure. Within each community cluster, monitoring sites are located inside and outside of MPAs. Therefore sites are generally well matched and contained very similar communities at the time of MPA implementation and might be well suited for detecting community or population changes in response to management in the future. Species richness differed among the community clusters, with sites in Santa Barbara and San Diego having fewer species on average than sites in the Catalina Island and Los Angeles/Orange County communities. This is due to some of the warmer water species not being present at the Santa Barbara sites and some of the colder water species (e.g., rock fish) not being found in San Diego.

Based on their abundance in RCCA surveys, their presence across the SCSR and their ecological importance we have identified several of the species listed in the SCSR Monitoring Master Plan as good candidates for long-term MPA monitoring indicators. These species are not only abundant throughout the SCSR, several of them are also found in the other MLPA study regions, making it possible to integrate monitoring results across study regions. The following species were selected:

Fish:

- o   Kelp bass
- o   Senorita
- o   Black perch
- o   California sheephead

Invertebrates:

- o   Red urchin
- o   Purple urchin
- o   California spiny lobster
- o   Giant spined star
- o   Wavy and red turban snails

Analysis of temporal trends of the density of the above species at the level of the entire SCSR, as well as within the communities identified along the mainland coast and Catalina Island, did not reveal significant increasing or decreasing population trends for most species over the entire time period that RCCA has monitored sites in southern California (since 2006/07). In general, species showed variability between sites and years, but on a regional level, their populations were stable.

To put the baseline community characterization into a historical perspective, we compared fish densities found at three RCCA sites to data from studies that were conducted in the 1970s at the same sites. The comparison of these sites in southern California shows that several species

declined and that some of the species seen 40 years ago are not found today. Several factors, from natural changes in environmental conditions to overfishing, could have caused these shifts. In the future, the long-term monitoring of MPAs will enable us to decouple the effects of fishing from environmental change and we might be better able to answer what drives changes in population abundance and community structure such as the ones seen over the last 40 years.

The distinct kelp forest communities described by RCCA surveys suggests that long-term monitoring has to be conducted at sites inside and outside of MPAs with in all respective communities because ecological processes and management actions might act differently in different communities. RCCA's baseline data provide a quantitative characterization of species' densities in the respective kelp forest communities that will serve as a reference point for future measures of MPA performance. At the same time, the program has expanded in the region, trained additional citizen scientists and built the capacity for sustained long-term monitoring beyond the initial baseline monitoring program. In fact, the program has continued to monitor its baseline sites in 2013 and 2014, building on its long-term time series of monitoring data throughout the South Coast Study Region and the state.
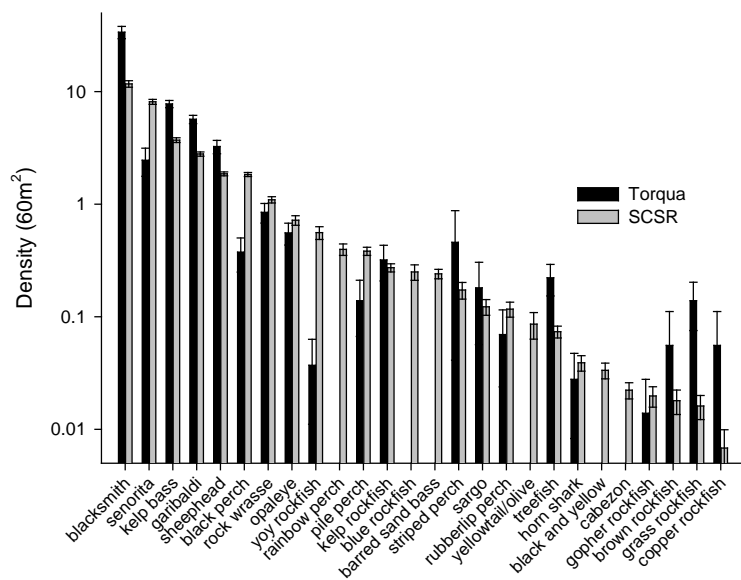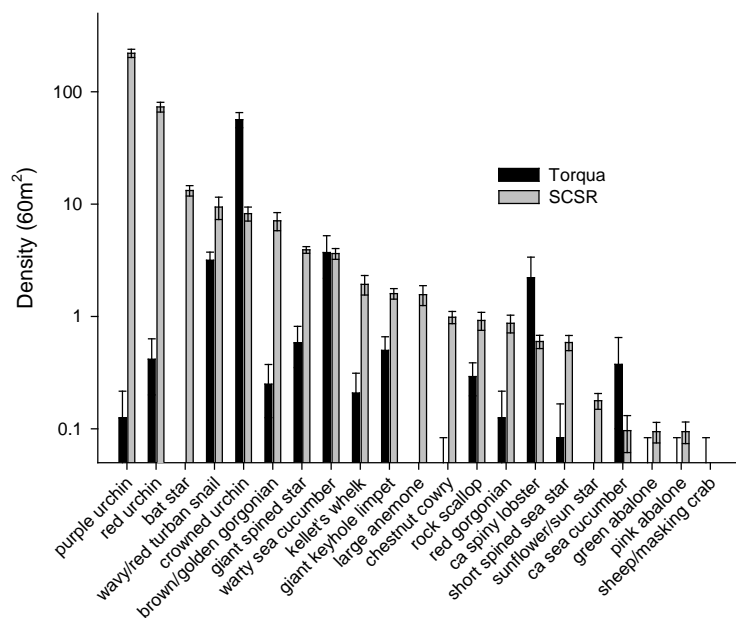
Figure E 1. Invertebrate and fish densities at RCCA's Torqua site at Catalina Island. RCCA data like these are used to describe the kelp forest community at the time of MPA implementation. They provide a reference point for future evaluations of MPA performance. Mean densities (+/- SE) from the baseline monitoring surveys at this site (black bars) are compared to the mean densities for the species across the entire SCSR (gray bars). Y-axis is log transformed to show less abundant species.
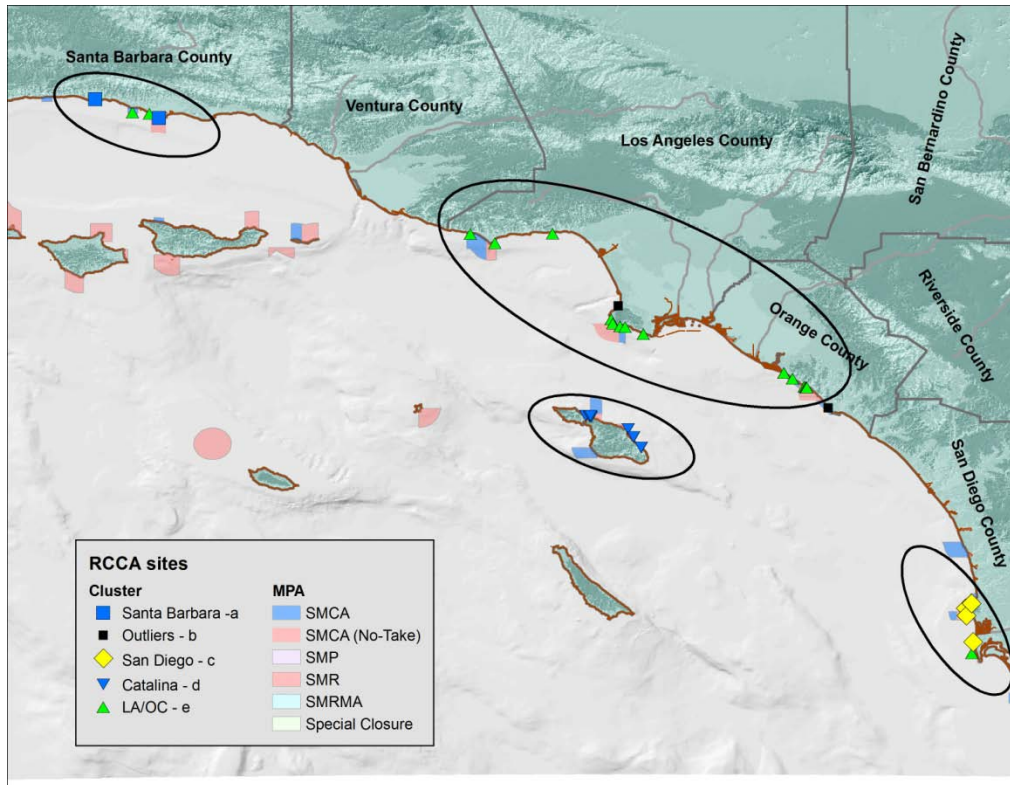
Figure E 2. Ecological communities at RCCA's monitoring sites in the south coast region show a latitudinal distribution along the mainland and Catalina Island. Colored symbols identify sites that are similar to each other at a level of 60% community similarity as identified by a cluster analysis using a Bray-Curtis similarity coefficient. Black ovals show regional clusters. With the exception of a few outliers, sites near each other have similar ecological communities. Data for the cluster analysis were square root transformed and fish, invertebrate and algae data were standardized in order to be analyzed together.

Introduction

Organizational Background

Founded in 1996, the Reef Check Foundation is a California based 501(c)3 non-profit organization dedicated to the conservation of the world's reef ecosystems. Reef Check's mission is to empower local communities to protect and rehabilitate reefs worldwide. It does so through grassroots research, conservation and community education. The Reef Check Foundation works to protect and improve the health and sustainability of the world's reefs through the use of citizen science and community-based conservation – effective and innovative approaches to integrating scientific research, public education and ocean conservation (Freitag and Pfeffer 2013, Thiel et al. 2014, Theobald et al. 2015). Headquartered in southern California, Reef Check has built a global network of volunteers that monitor reefs worldwide through three programs: the *Tropical Reefs Program*, the *Baja California, Mexico Program* and the *California Program*. With an incredibly lean staff of 8 fulltime employees, it coordinates coral reef monitoring worldwide as well as temperate rocky reef monitoring through its Baja and the California programs.

Program Goals and Objectives

Reef Check California (RCCA) is a community-based reef monitoring network. RCCA's goal is to improve marine management in California in two ways: by collecting critically needed data on California's near-shore rocky reef ecosystems through the use of volunteer scuba divers and then making it available to resource managers, universities, researchers and the general public; and by educating and empowering the public to become active stewards of their marine environment. RCCA does this by engaging Californians to participate in scientific monitoring of kelp forests and marine protected areas (MPAs). Through training, surveys and community engagement, RCCA fosters public support of science-based management of marine resources. Reef Check California has been surveying California's near-shore rocky reefs and kelp forests since 2006 and annually monitors about 75 primary sites from Mendocino to San Diego Counties. Survey teams are organized and lead by trained Reef Check staff and sites are surveyed at roughly the same times each year. Before participating in surveys, volunteer divers go through an intensive 32 hour training and are only certified to do transect surveys once they have satisfactorily passed the classroom and field-tests for each transect type. Volunteers must be recertified and tested by RCCA staff each year prior to collecting data. Since the inception of the program RCCA has trained over 1000 divers in California and each year there is a team of about 250 active volunteers composed of newly trained or returning citizen scientists.

SCSR Program Objectives

Reef Check California has surveyed rocky reefs and kelp forests in southern California since 2006 and has up to nine years of data from the MLPA South Coast Study Region (SCSR). The

goal of this baseline monitoring project is to quantify key attributes of species, populations, communities and habitat variables that constitute representative kelp forest ecosystems within and outside of many of the MPAs in the South Coast Study Region. The sampling design, selected response variables (i.e. key species) and analytical approaches are intended to provide scientists, managers, stakeholders and policymakers with a baseline for future assessment of the effectiveness of the SCSR MPAs. Further, the outcomes from this study will also provide recommendations for long-term monitoring metrics and cost-effective survey protocols for the SCSR.

Specific objectives are:

1. Provide a quantitative baseline characterization of the rocky reef and kelp forest ecosystem feature inside and outside of MPAs in the SCSR.
2. Provide pre-MPA implementation data and historical context to ongoing data collection by analyzing RCCA's existing dataset in the context of the new MPAs.
3. Explore the baseline characterizations for potential indicators of the state of the kelp forest ecosystem (i.e. ecosystem indicators) and make recommendations for long-term monitoring.
4. Build capacity for cost-effective, long-term MPA monitoring through the continued involvement of community members in the monitoring of MPAs.
5. Expand existing public online data dissemination and illustration tool (NED) to inform managers, stakeholders, policymakers and the public about the status of the marine environment in the SCSR.

Methods

RCCA's surveys of the rocky reef and kelp forest ecosystem features in the South Coast Study Region (SCSR) ranges in its geographic scope from MPAs in Santa Barbara County in the north to south of the South La Jolla SMR in San Diego. Sites are located inside and outside of MPAs along the mainland coast as well as around the northern Channel Islands and Catalina Island.

Survey site selection

Prior to the baseline monitoring period, RCCA survey sites in the SCSR were selected based on a variety of factors including, but not limited to, the coverage of other monitoring programs (e.g., Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO)) in order to collect monitoring data from sites not previously monitored, local interest by the diving community, historical data or recommendations by resource managers. Other factors were logistic feasibility (i.e. access via shore or commercial dive boat) and the presence of volunteer teams in the region. Priority was given to sites inside and outside of planned or existing MPAs. As the

MLPA planning process was underway in the SCSR (2009-2011) the proposed MPA plans were consulted to identify sites likely to be useful for future MPA monitoring. During the MPA baseline monitoring (2011-2012), additional sites were added inside or outside of MPAs to supplement the monitoring array in regions (e.g., Santa Barbara, San Diego) where sites for MPA/Reference comparison did not exist. For these sites care was taken to choose locations of similar reef habitat inside and outside of MPAs and local experts were consulted if this information was not readily available to RCCA. Sites are sampled at least once a year, or twice a year if ocean conditions and volunteer availability allow. Each site is surveyed during the same time of year (i.e. same month), every year, once it has been established. The purpose of this standardization of sampling time is to reduce inter-annual variability in the data due to seasonal changes in the rocky reef communities. If sites are sampled twice a year, they are sampled during spring and in late summer/fall to capture both prevalent oceanic seasons (i.e. upwelling / non-upwelling) present along the California coast.

Survey Methods

Reef Check California surveys consist of visual surveys performed by scuba divers. At each site, buddy teams of divers conduct eighteen 30 m x 2 m benthic transects, to monitor key species of fishes (35 species), invertebrates (33 species) and algae (5 species & 4 invasive species) and to characterize the reef substrate and relief. RCCA's survey methods are based on visual census survey methods developed by the Partnership of Interdisciplinary Studies of Coastal Oceans (PISCO) and have been modified so that they can be taught in a reasonable amount of time to volunteer suba divers (Gillett et al. 2012). Species are selected because of their ecological or economic importance or because they are of specific management concerns.

Figure 1. Diagram of RCCA transect allocation on a rocky reef. A site consists of six core transects, (black: 3 inshore, 3 offshore), plus an additional twelve randomly placed fish transects (white, 6 in each zone). All transects are 30 meters in length and are placed in an area of about 250 meters of coastline.

A list of the species and the rationale for their selection is provided in Appendix A. Transects are placed parallel to shore, along isobaths in a

stratified random manner across two depth zones. Allocation of transects is stratified into inshore (5 -12m) and offshore (12-20m) strata and in each zone transects are randomly placed on rocky reef substrate. In each stratum, three core transects, consisting of a fish, invertebrate, algae and uniform point contact (UPC) transect are conducted by a dive team on alternate passes along the same transect line. Additionally, six fish transects are placed around the core transects in each stratum. Transects are conducted parallel to shore or along depth isobaths within an area that corresponds to 250 m of coastline and is considered a site (Figure 1).

Along each transect species are identified and counted, and in the case of fish and abalone, sized. Abalone are sized to the nearest centimeter and fish sizes are recorded in three size classes. This approach to sizing fish was changed in 2013 - after completion of the baseline monitoring in the SCSR and based on results from the Central Coast Study Region baseline monitoring - so now fish are sized to the nearest centimeter, as well. This change to the protocol was initiated because it became apparent that larger size classes limit the ability to investigate early signs of MPA effects that are likely to be reflected in changes to population size structures. Going forward, this new protocol will allow us to investigate these changes as we continue long-term monitoring.

Fish sampling

Fish are counted and sized by the lead diver in a buddy team along 18 transects at each sites. Fish are identified to species and their total length is recorded in one of three size categories (Appendix A, effective 1/1/13, divers now record fish sizes to nearest cm total length). Fish are counted by searching along the 30 m long x 2 m wide swath on the substrate and in the bottom 2 meters of the water column. Cracks and crevices in the reef are searched using flashlights but no rocks are moved to during the search.

Invert and algae sampling

Individual invertebrates and algae are counted along six 30 m long x 2 m wide transects at each site. 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 to search for invertebrates. No organisms are removed. If more than 50 individuals of one species are counted, the search for this species is ended and the distance along the transect at which 50 individuals were reached is recorded (sub-sampling).

Physical habitat sampling

The physical characteristics of Reef Check California's monitoring sites are described in terms of reef substrate type, the vertical relief and the percent cover of sessile space-occupying organisms (Appendix A). Variables are measured by uniform point contact surveys of 30 points along six 30 meters long transects at each site. Substrate type is recorded as sand, cobble (0.5 cm - 15 cm diameter), boulder (15 cm - 1 m diameter) or bedrock (> 1 m diameter). Rugosity

(vertical relief) is estimated by determining the greatest height difference that exists within a 1 meter by 0.5 meter box at each point along the transect and recorded as one of four categories (0 cm – 10 cm, 10 cm – 1 m, 1 m – 2 m and > 2 m). The primary biological substrate cover (attached organisms) is described in nine categories of organisms (Appendix A).

The RCCA species list is the same for the entire state allowing for analyses at various spatial scales. A detailed description of Reef Check California's monitoring protocol is provided in Appendix B and the entire monitoring and training manual can be found at: http://reefcheck.org/rcca/monitoring_protocol.php.

Data quality assurance

Data quality assurance is an important aspect of any monitoring program and is an especially critical part of the data collection and management process in a citizen science program, such as RCCA, in which many individuals are involved across a state (Schroeter et al. 2009, Bonter and Cooper 2012, Dickinson and Bonney 2012). Reef Check has built data quality assurance and control mechanisms into its protocol at every step, from the collection in the field to the final public data release. Immediately following each dive, each team member must review their datasheet for completeness and legibility. The team leader verifies this prior to collection of each datasheet and discusses any potential outliers with the team member. Errors in the data or omissions detected at this stage can be corrected by repeating the transect in question. All data are entered into a database through RCCA's online Nearshore Ecosystem Database (NED). This system allows data entry from anywhere and has built-in data checking capabilities identifying outliers (e.g., unusually high counts of a species, species that are not usually found in a given geographic region). Unusual data detected during data entry are flagged for review. Flagged data are discussed with the person that collected the data and then reviewed by RCCA staff. In a third step all data entries are checked by RCCA staff by comparing them to the field datasheets to detect data entry errors. Finally, automated data checks (e.g., outliers, unusual observations and data entry errors) are run on the entire database before the annual release of the database. All of RCCA's data can be viewed and downloaded at: http://data.reefcheck.org. The data collected as part of the SCSR baseline monitoring program, as well as detailed metadata, can also be found at: http://oceanspaces.org/data.

Analytical methods

Baseline characterization of study sites

To characterize the biological communities and populations at the Reef Check survey sites, fish, invertebrate and algae densities are calculated as the mean density and associated standard error for a 60 m^2 area (i.e. area of a transect). For each site, mean densities are calculated

across the two baseline survey years (2011, 2012) and the associated standard error is estimated across all transects from both years. If a site was only surveyed in one of the baseline monitoring years, then the mean represents densities from that year. Sites were surveyed around the same time of year in both years and the mean from both years should therefore represent a better estimate of population densities over the baseline monitoring period than separate means for each year would represent (i.e. increase in replication).

Community structure

To illustrat patterns of community similarity characterizing the region during the baseline characterization and to test for significant differences in community structure among sites inside and outside of MPAs across the study region, we used Bray-Curtis similarity matrices to generate cluster dendrograms and multi-dimensional scaling plots (MDS) in PRIMER. (Clarke 2006). These analyses were conducted for the entire community comprised of the fish, invertebrate and algae assemblages. In order to account for the large differences in the densities of the different taxonomic groups, species' means were weighted by the inverse of the average density of the respective taxonomic group: fishes, invertebrates and algae. This balances the contributions to community patterns between the groups so that the pattern is not dominated by algae which are naturally more common than fish or invertebrates. To insure that the analysis is not biased towards abundant individual species, the weighted data was then square root transformed.

Similarity matrices were calculated using standardized and transformed mean density estimates for each site from the two years sampled. Bray-Curtis similarity indices were calculated for each pair-wise comparison of these mean samples according to the formula:

$$d^{BCS} = 100(1 - \frac{\sum_{k=1}^{n}|y_{i,k} - y_{j,k}|}{\sum_{k=1}^{n}(y_{i,k} + y_{j,k})})$$

Where d^{BCS} is the Bray-Curtis similarity index between the samples i and j, k is an index of the set of species being compared between samples, n is the total number of these species and $y_{i,k}$ is the observed number of species k in sample i. These values range from a value of 100 (all species present in equal abundances) to 0 (no species seen in common between samples). Cluster analysis was performed using the group-average linking method and all distinctions detected between groups were evaluated using the SIMPROV test (P<0.05). MDS plots were then generated to aid in visualizing the similarity of distances among samples. To identify physical variables (i.e., substrate, relief, depth) that correlate with the community differences among sites as identified in the cluster analysis, the BEST routine in PRIMER was used. The variables that showed the highest correlation with the identified site clustering were overlaid

on the MDS plots in bubble graphs to show the geographic distribution of these habitat characteristics and their association with the identified communities.

Temporal trends in long-term data

To investigate temporal trends of population densities and to put densities observed during the baseline monitoring period (2011/12) into a longer-term perspectives, we used RCCA's time series data beginning in 2006/07. To test for significant increases or decreases in population densities of key species within the entire study region, as well as within the communities identified in the cluster analysis, we used a General Linear Model (GLM) in the software SAS 9.3. For this analysis, site and year were treated as fixed factors and the response variable was square root transformed. Further, to compare species richness among the community clusters, we used a similar GLM approach to identify significant differences in species richness. Again, site was treated as fixed factors in this analysis.

Historic comparison

To estimate species densities in the 1970s, we used data from the Channel Islands, Santa Barbara and Palos Verdes in southern California (Ebeling et al. 1980, Stephens et al. 1984). These studies either used repeated annual diver counts or video transects to estimate fish densities in rocky reef habitat over periods of two to seven years. To compare fish densities to RCCA's surveys conducted at the same sites, historic density estimates were converted to the same area as covered by an RCCA transect (60 m^2). Average densities for each species at each site were estimated by weighting annual a survey by the numbers of transects to normalize differences in annual sample size. Stephens et al (1984) conducted timed transects counting along a 3 m swath for 5 min swims. It has been estimated that these transects covered about 100 m^2 (Pondella pers. com.). Therefore, the mean densities were multiplied by 0.6 to generate estimates comparable to RCCA transects. Ebeling et al (1980) collected data using video transects covering about 211 m^2 of rocky reef seafloor each but reported their results as an estimate of fish densities per 1 hectare (10,000 m^2). These numbers were multiplied by 0.006 to generate 60 m^2 estimates for comparison. T-tests of individual species at each site were used to compare historical estimates to the mean densities recorded by RCCA between 2006 and 2011 at those sites. In two of the three comparisons, Reef Check's reef monitoring site is located on the same reef as the historic surveys, and in one case the nearest RCCA site is about one mile south of the historic site (Palos Verdes).

Results and Discussion

Baseline Surveys

Reef Check proposed to survey 40 sites in the SCSR in both 2011 and 2012, respectively, as part of the baseline monitoring program. In 2011, RCCA completed 39 surveys at 33 of its long-term monitoring sites in the SCSR (several sites were surveyed twice) (Figure 2 & Figure 3, Appendix C). Due to the cancelation of a sampling trip late in 2011 during which RCCA's team of volunteer citizen scientists was scheduled to survey four sites along the northern Los Angeles coast, those sites were not surveyed in 2011. Additionally, RCCA was not able to form a collaboration, as proposed, to monitor sites at the Swami's SMCA since the group we hoped to collaborate with did not get funded for the baseline monitoring project. Since it is difficult to reach these sites with commercial charter vessels, and because we had not surveyed them in the past, we decided to focus our efforts elsewhere and not include the Swami's SMCA in our baseline monitoring. In 2012, we completed 52 surveys at 45 sites in the SCSR. In addition to the proposed sites (excluding sites at Swami's SMCA), we also monitored additional sites at the Northern Channel Islands that year. We have continued to monitor the majority of these sites in 2013 and 2014.

Figure 2. Locations of RCCA monitoring sites sampled in 2011 and 2012 in the SCSR. Sites within MPAs are shown in red and sites outside of MPAs are shown in blue. Black outlines indicate areas shown in more detail in Figure 3. MPAs are indicated in either red (SMR) or blue (SMCA).
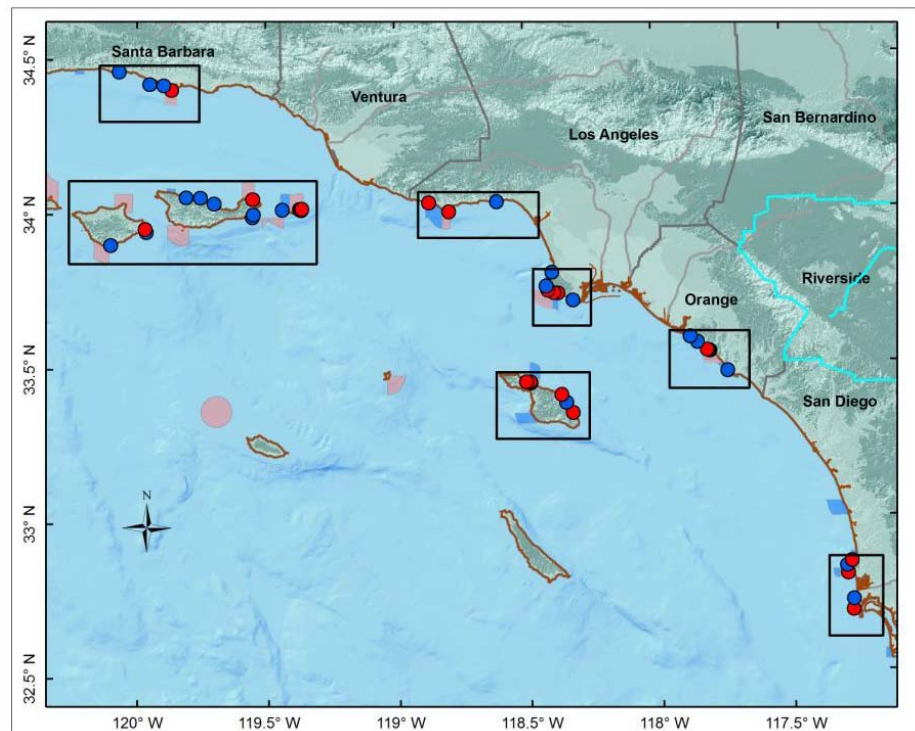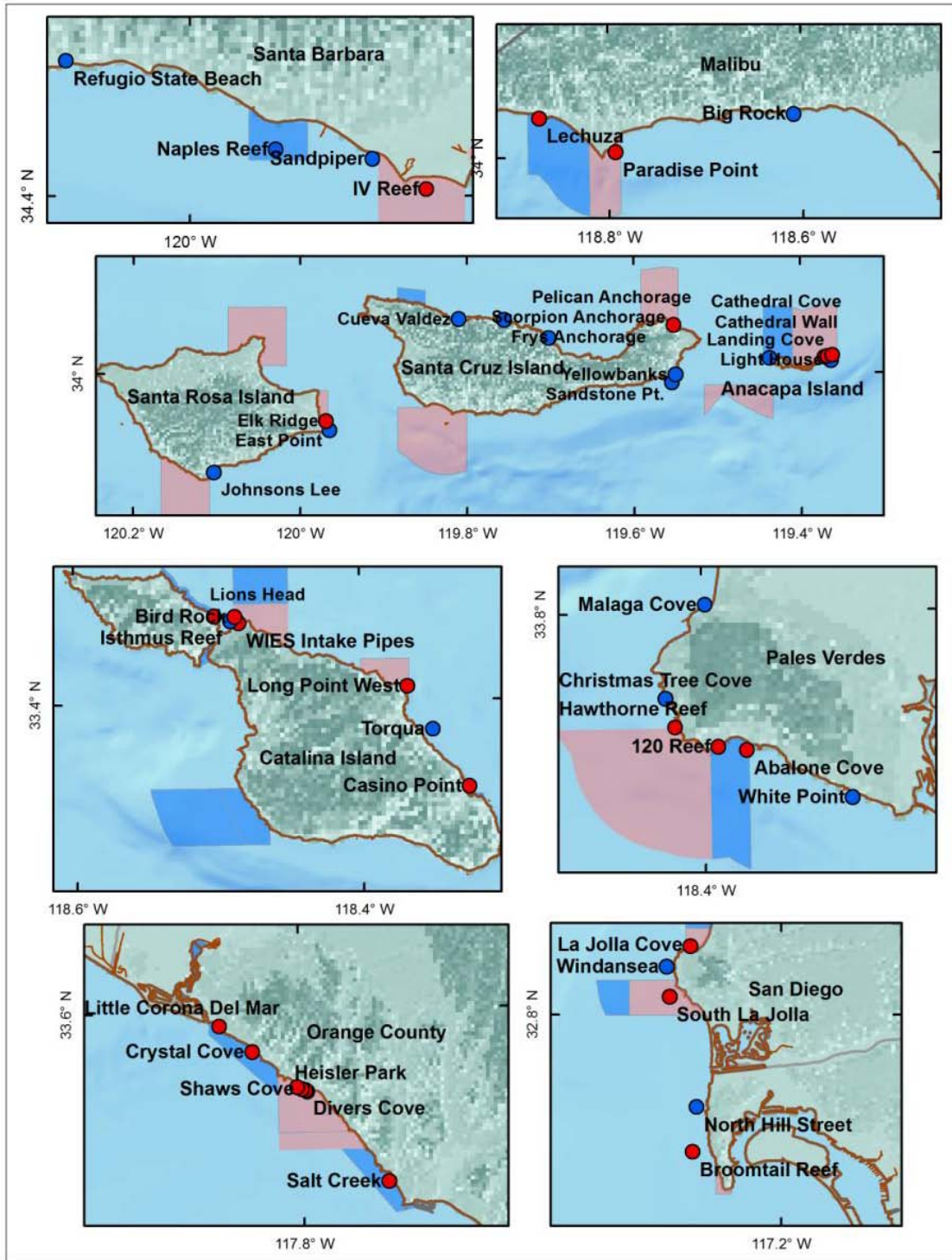
Figure 3. Detailed maps of locations of RCCA monitoring sites sampled in 2011 and 2012 in the SCSR. Sites within MPAs are shown in red and sites outside of MPAs are shown in blue. MPAs are indicated in either red (SMR) or blue (SMCA). Geographic coordinates and the years when sites were surveyed are listed in Appendix C.

The location of RCCA's existing sites in the study region allowed us to contribute to the characterization of the study region as a whole as well as the different biogeographic regions within the south coast. Due to their placement before the MPA implementation and the need for consistency in RCCA long-term monitoring, site locations were not moved in response to the MPA implementation. Fortunately, many of the existing monitoring sites allowed us to monitor inside and out of the new MPAs and several sites were added to accommodate monitoring inside and outside of MPAs where no long-term sites existed. Overall, the monitoring design and the surveyed sites achieved the goal of monitoring inside and outside of MPAs in the different biogeographic regions of southern California. Over the baseline monitoring period, new sites were established in the San Diego area, off Catalina Island and in the Santa Barbara region. Despite the fact that the 16 monitoring sites in the northern Channel Islands were excluded from the proposed baseline monitoring in the South Coast Study Region, RCCA monitored many of these site in 2011 and 2012, and results from these sites are presented in Appendix D, but are not included in the results.

Baseline characterization of study sites

To characterize the biological community at the Reef Check long-term monitoring sites during the baseline monitoring period 2011/12, we summarized the physical and biological characteristics of each of RCCA's sites located in the SCSR. Data from both years are summarized in the tables in Appendix D. The mean values of species densities and their associated error at sites inside and outside of MPAs provide a snapshot of the habitat and ecological community that can be used in the future to evaluate changes in populations and community structure over time. For each site, the mean densities of fish, invertebrate and algae species, as well as the physical substrate and primary substrate cover (i.e. attached organisms), are summarized and a short description of the site is given. To highlight the type of information that is summarized in Appendix D, we have chosen five sites (one from each kelp forest community identified in this report – see below) and described their physical habitat and ecological community based on the survey data from the baseline monitoring period.

Refugio State Beach, located in Santa Barbara County, was established as a Reef Check site in 2006. Refugio was protected as an SMCA from 1998 to 2011, but the MPA was removed when the new South Coast MPAs were implemented on January 1, 2012. Refugio is usually monitored twice a year, depending on conditions. Typically those surveys take place in spring and fall. But due to the shallow depths (average depth of the survey area is 4.4 meters), often this site experiences wave action and low visibility, making it difficult to perform subtidal surveys. Refugio is close to shore and divers access the site by swimming from the beach. The bottom structure is predominantly a low-relief (10 cm to 1 meter) bedrock substrate. The substrate is mostly bare or is covered with brown algal species, red algae or articulated coralline algae. Pterygophora is the dominant macroalgae, although some giant kelp and

southern sea palm are also present. The most common invertebrates are purple urchins, giant spined stars, chestnut cowries and short spined stars (Figure 4). Overall, fish densities during the baseline monitoring years were low compared to means SCSR densities, but young of the year rockfish, black perch and striped perch are the fish most often observed at Refugio State Beach. Surf perch and several rockfish species are also more common at this site than at other sites along the mainland coast of the SCSR (Figure 4). As is typical for sites in the Santa Barbara region, the warmer water species such as blacksmith, senorita, kelp bass and garibaldi are absent or only present in very low destines at this site.
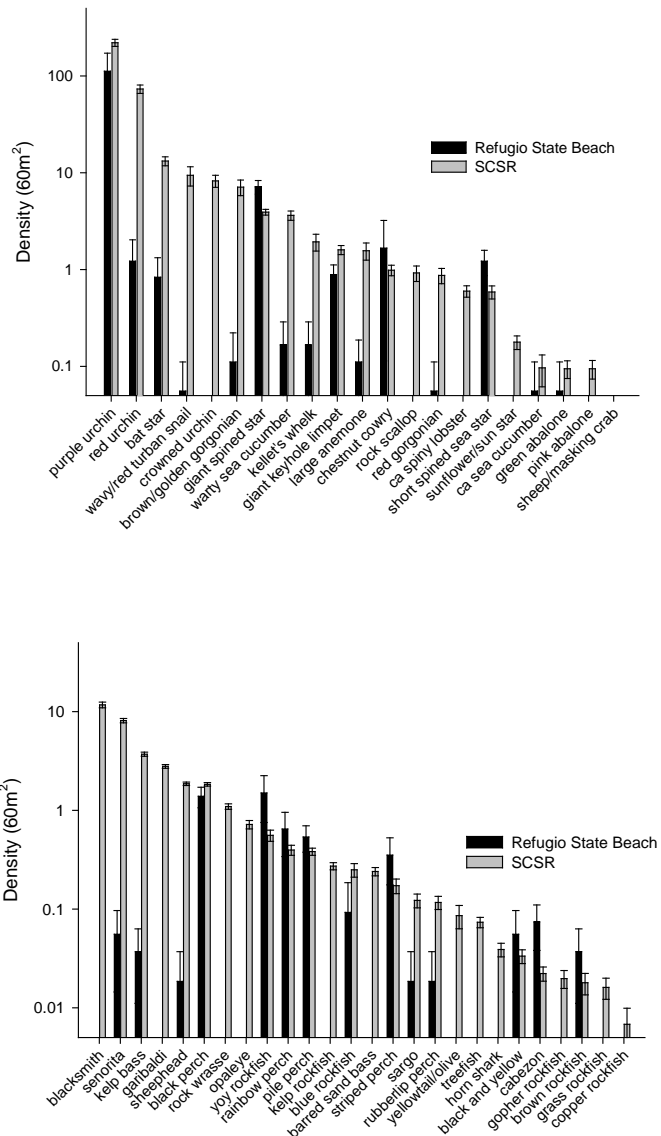
Figure 4. Invertebrate and fish densities at RCCA's Refugio State Beach site. Mean densities (+/- SE) from the baseline monitoring surveys at this site (black bars) are compared to the mean densities for the species across the entire SCSR (gray bars). Y-axis is log transformed to show less abundant species.

Paradise Point, located near Point Dume in Malibu, Los Angeles County, was established as a Reef Check site in 2008 and became part of the Point Dume SMR in 2012. The site is approximately 800 meters from shore and is accessed via boat, typically on a long and productive day called Mega Malibu, where Reef Check teams survey 4 Malibu sites on a

Saturday in September. The underwater structure is interesting as there are long shelves of reef that extend out diagonally from shore, creating small ledges and surfaces where invertebrates and fish tend to accumulate. The average depth of the site is 7.7 meters and the substrate is primarily bedrock with some cobble and some small sand channels. The relief is primarily low-relief (10 cm to 1 meter). The rocky reef is primarily covered in red algae, sessile invertebrates and crustose coralline algae. Macroalgae is present here and pterygophora is the dominant species, although giant kelp and southern sea palm are also observed. Purple urchins are common at this site and red urchin densities are high compared to other sites in the SCSR. Brown and golden gorgonians, anemones and giant spined stars are also common.   Overall, this site has high invertebrate densities compared to other sites in the SCSR (Figure 5). Senorita, blacksmith, California sheephead, black perch and kelp bass are the most observed fish species (Figure 5). This site's invertebrate and fish assemblage is very a typical for sites along the Los Angeles and Orange County coast, making Paradise Point a good example of the species found in this region of the SCSR.
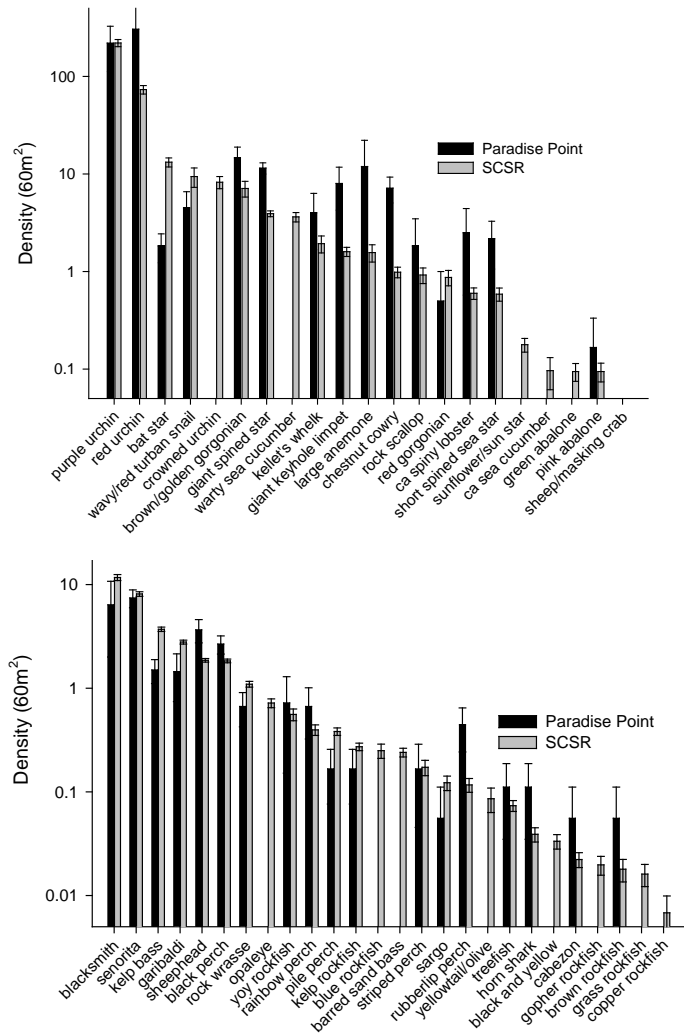
Figure 5. Invertebrate and fish densities at RCCA's Paradise Point site. Mean densities (+/- SE) from the baseline monitoring surveys at this site (black bars) are compared to the mean densities for the species across the entire SCSR (gray bars). Y-axis is log transformed to show less abundant species.

Crystal Cove State Beach, located in Laguna Beach in Orange County, was established as a Reef Check site in 2008. This site is part of the Crystal Cove SMCA and has been protected since 1982. This site consists of two adjacent patch reefs, both with large rocky reef structure, but is completely surrounded by sand. This site is typically accessed from a boat and the average depth is 7.8 meters. The bottom consists mostly of bedrock with some sand. Relief is mostly 10 cm to 1 meter, but there is also a fair amount higher (>1m) relief at this site. The rocky substrate is mostly covered with coralline algae, red and brown algae with some areas of bare rock likely do to sand inundation and abrasion. Laminaria is the dominant macroalgae and giant kelp and southern sea palm are also present. Red urchins are the prevalent invertebrates and brown/golden and red gorgonians are common at this site. Wavy/red turban snails and Kellet's whelks are also present but overall invertebrate densities are low (Figure 6). Blacksmith, senorita, garibaldi, kelp bass and California sheephead are the most common fish and their densities are high compared to other sites in the region (Figure 6).
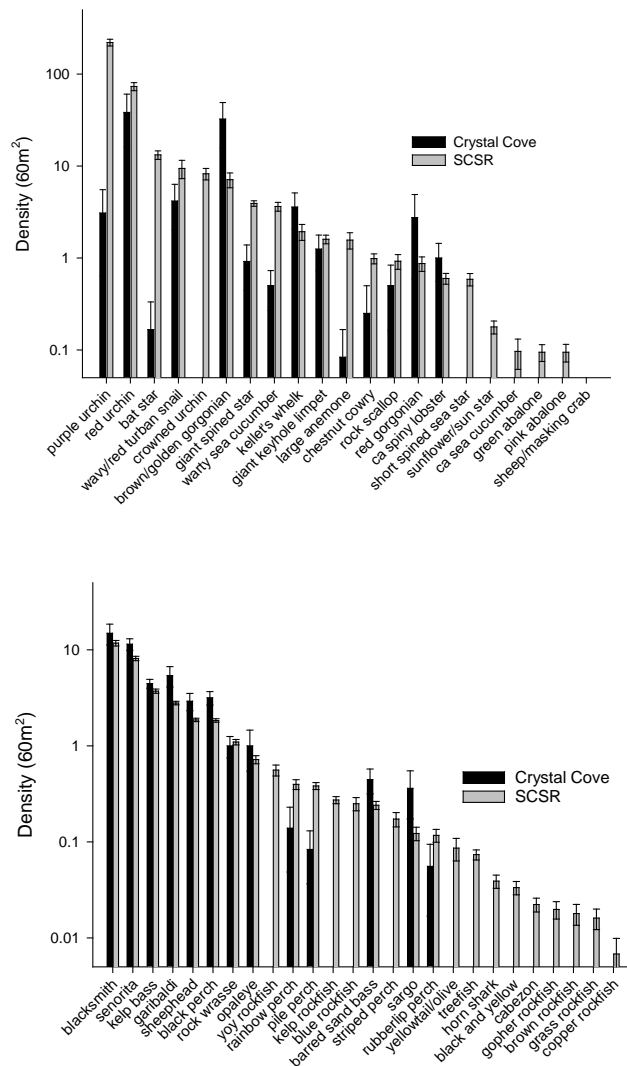
Figure 6. Invertebrate and fish densities at RCCA's Crystal Cove site. Mean densities (+/- SE) from the baseline monitoring surveys at this site (black bars) are compared to the mean densities for the species across the entire SCSR (gray bars). Y-axis is log transformed to show less abundant species.

Torqua, located on the leeward side of Catalina Island between Avalon and Long Point, was established as a Reef Check site in 2008. This site is not protected as an MPA but is used as a reference site for the Long Point SMR and the Casino Point SMCA. Due to the sloping nature of the island, and similar to other Catalina Reef Check sites, survey depths range from 3.5 meters to 17 meters, although the average survey depth is 9.8 meters. This site is accessed via boat and is approximately 200 meters from shore. The bottom structure primarily consists of large rocks piled on top of each other, creating a matrix of holes in which fish and invertebrates accumulate. The substrate is 57% boulder, 16% cobble, 14% bedrock and 10% sand. Boulders and cobble are typical substrate that RCCA sites around Catalina Island. The relief varies, as well, with most of the structure being 10 cm to 1 meter and some flatter (0 cm to 10 cm) and some with higher-relief (1 meter to 2 meters). Kelp and laminaria are the dominant macroalgae, although there is also typically some *Sargassum horner*i present. While purple and red urchins are very uncommon at this site, crowned urchins are the most common invertebrates. Warty sea cucumbers, wavy/red turban snails and California spiny lobsters are denser here than at other sites in the region (Figure 7). Blacksmith, kelp bass, garibaldi, California sheephead are the most common fish species. Blacksmith and kelp bass are more common here than at other sites throughout the SCSR (Figure 7). Like most Reef Check sites in Los Angeles County and Orange County, garibaldi are more common here than in the majority of our South Coast Study Region sites.
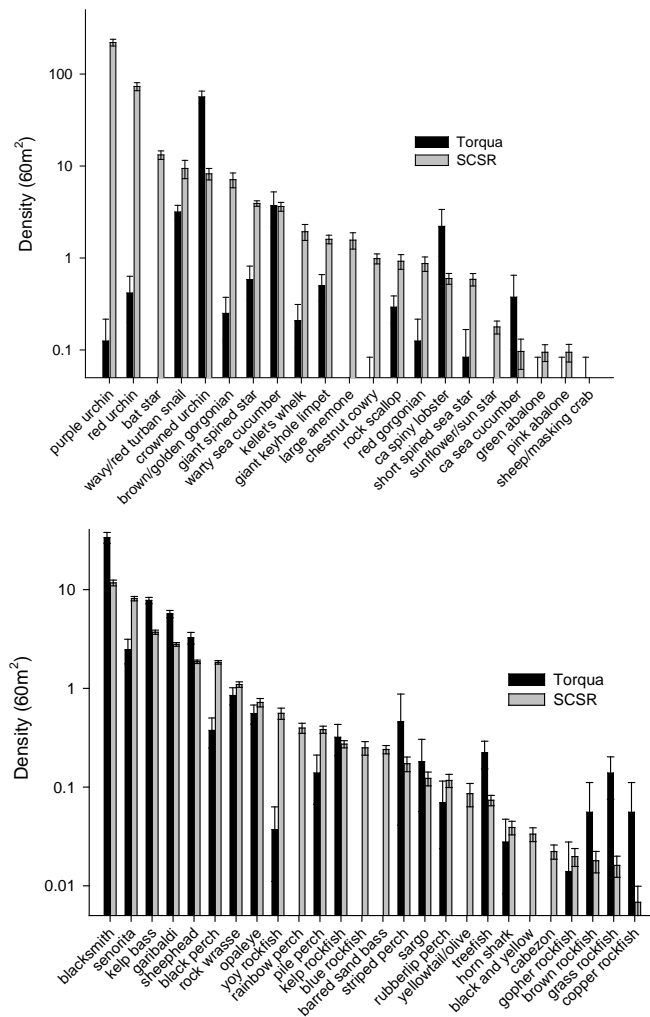
Figure 7. Invertebrate and fish densities at RCCA's Torqua site. Mean densities (+/- SE) from the baseline monitoring surveys at this site (black bars) are compared to the mean densities for the species across the entire SCSR (gray bars). Y-axis is log transformed to show less abundant species.

La Jolla Cove, in San Diego, was established as a Reef Check site in 2007 and is typically monitored in late July and early August. This very popular swimming, diving and kayaking site is part of the Matlahuayl State Marine Reserve, which was implemented January 1, 2012. However, La Jolla Cove was originally created as an ecological reserve by the City of San Diego in 1970. The site is located approximately 400 meters from shore and is accessed via a surface swim from the beach. With an average depth of 11 meters, the bottom structure is predominantly a low-relief (10 cm to 1 meter) bedrock substrate with some long cracks that create pockets where invertebrates tend to accumulate. The substrate also contains a small amount of sand and cobble. The bottom is typically either bare or covered in articulated or crustose coralline algae. Macroalgae is abundant, with primarily laminaria and pterygophora. Giant kelp and southern sea palm are also present in much lower densities. The most common invertebrates are red urchins and purple urchins, but their numbers are low compared to other sites in the SCSR. Kellet's whelk and California spiny lobster are denser at this site than at many of RCCA's southern California survey sites (Figure 8). Pink and green abalone have also been observed on surveys at La Jolla Cove on several occasions. Blacksmith, California sheephead and rock wrasse and are the most abundant fish species. California sheephead and rock wrasses, are more common here than at other sites in the SCSR (Figure 8). However, large fish such as giant sea bass, seven-gill sharks and soup fin sharks have also been observed on Reef Check surveys multiple times at La Jolla Cove.
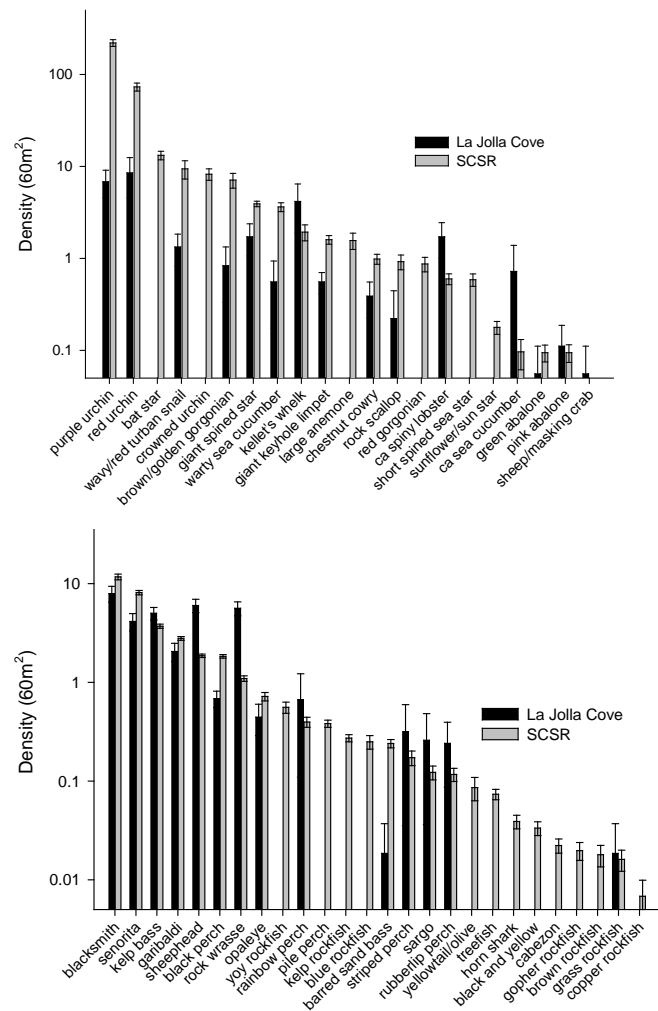
Figure 8. Invertebrate and fish densities at RCCA's La Jolla Cove site. Mean densities (+/- SE) from the baseline monitoring surveys at this site (black bars) are compared to the mean densities for the species across the entire SCSR (gray bars). Y-axis is log transformed to show less abundant species.

Community structure

To characterize community composition and structure of the kelp forest and rocky reef ecosystem and identify significant differences in the communities among sites across the South Coast Study Region, we conducted a cluster analysis of the biological communities including fish, invertebrates and algae using the baseline monitoring data from 2011/12 (Figure 9).
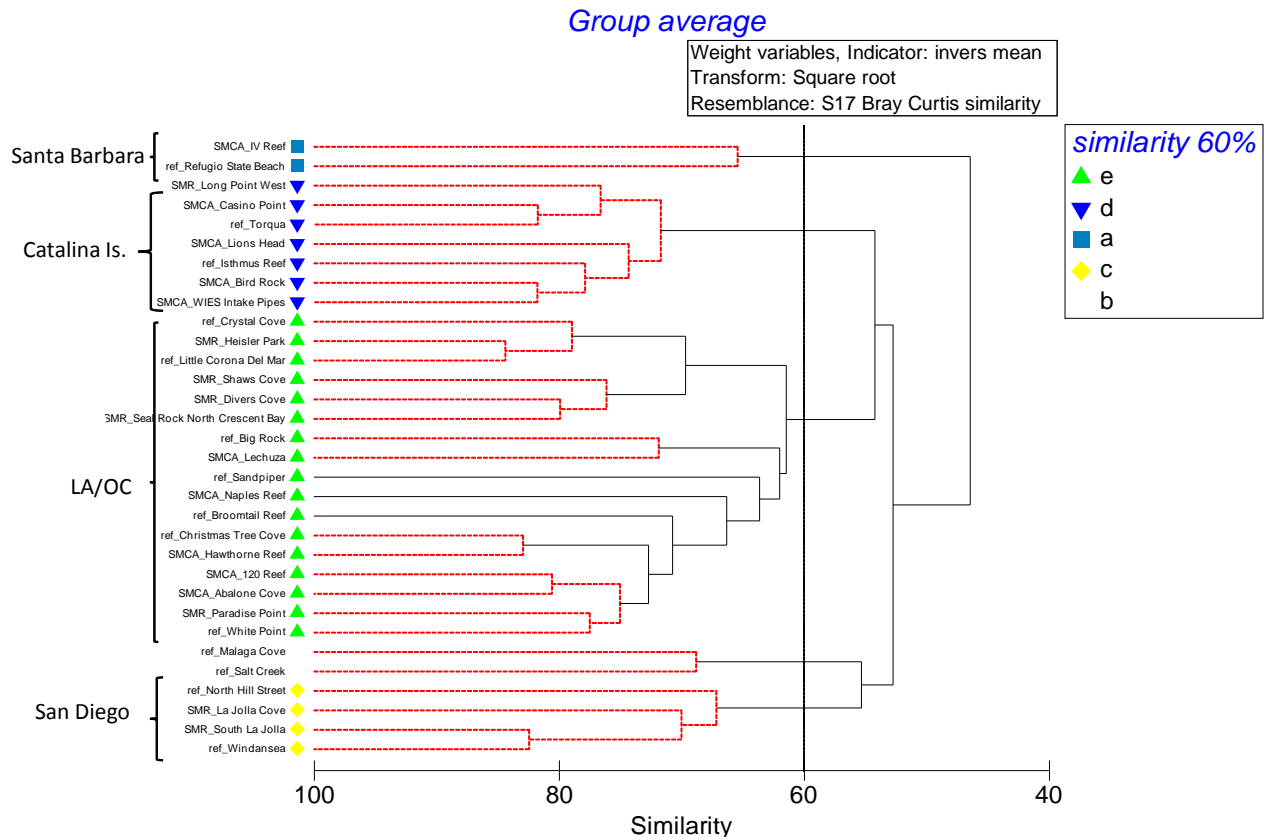
Figure 9. **Kelp forest community clusters identified by a cluster analysis using a Bray-Curtis similarity coefficient.** **Data for the analysis was square root transformed and fish, invert and algae data were standardized in order to be analyzed together.** **Red branches identify sites with no remaining significant community structure (SIMPROF, alpha = 0.05).** **Vertical black line indicates groups of sites with a community similarity of 60%.** **Sites are labeled by their community cluster (60% similarity) and their geographic region is indicated.**

The cluster analysis reveals community structure across the SCSR at around a similarity of 60%. Further structure is detected in some of these groupings when a significance test is performed (red lines in Figure 9, SIMPROF alpha =0.05). At the 60% similarity level, five groups of sites are emerging: Catalina Island sites group by themselves, Orange County and Los Angeles sites group together and San Diego and Santa Barbara sites group in their own respective groups. These groupings are consistent with a latitudinal gradient identified in other study regions and

demonstrate that the community structure supported by the kelp forest ecosystem varies across the study region as expected for such a geographically large area (Figure 10). Three sites do not group with their respective geographic regions and fall within the LA/OC cluster. These
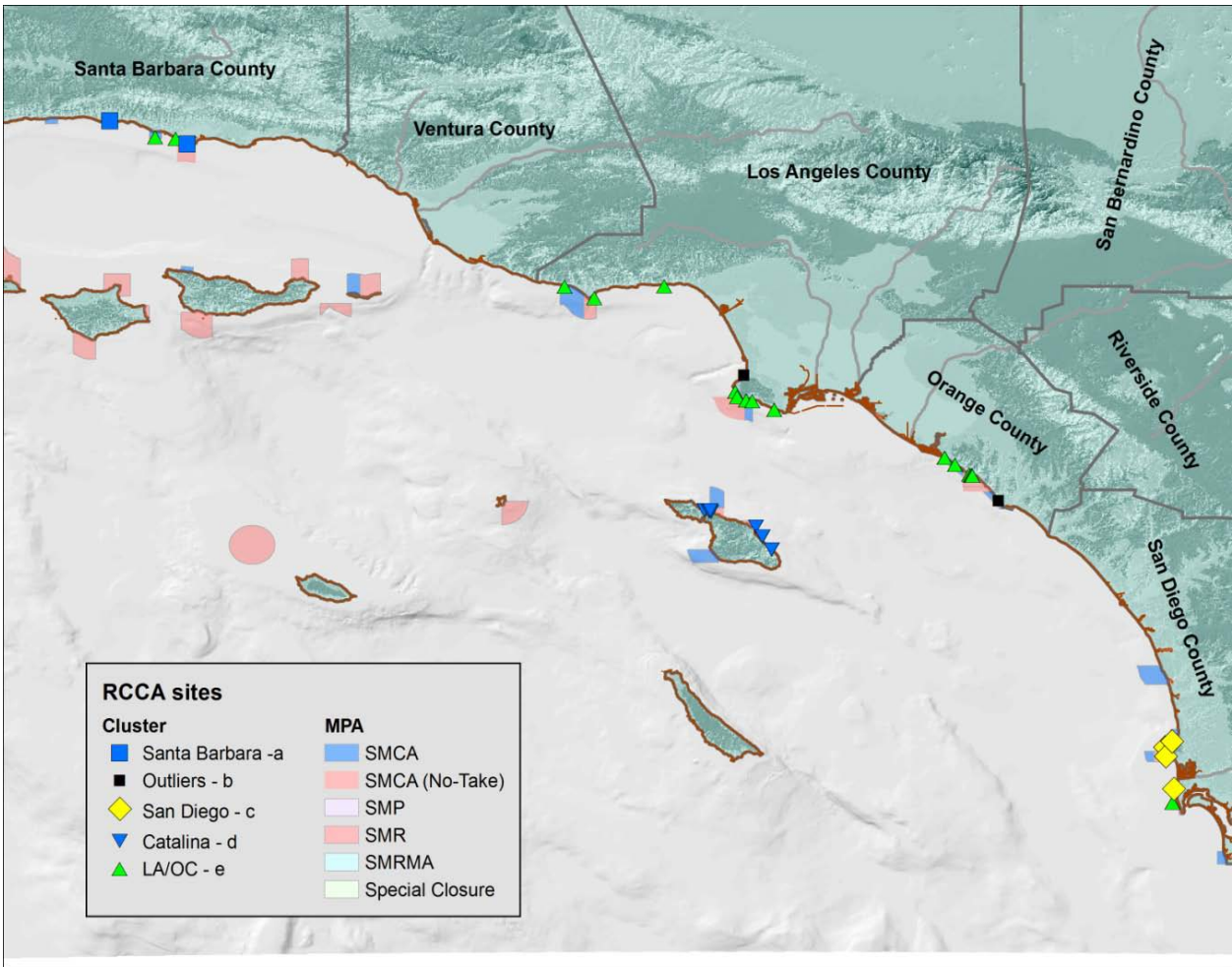
Figure 10. Ecological communities at RCCA sites in the SCSR show a latitudinal distribution along the mainland and Catalina Island. Colored symbols identify sites that are similar to each other at a level of 60% community similarity as identified by a cluster analysis using a Bray-Curtis similarity coefficient. Data for the analysis was square root transformed and fish, invert and algae data were standardized in order to be analyzed together.

sites, two Santa Barbara sites (Sandpiper, Naples Reef) and one San Diego site (Broomtail Reef), are identified as outliers in the cluster analysis (solid black lines in Figure 9). Two of the sites in the LA/OC region cluster by themselves despite not being geographically close to each other (Salt Creek, Malaga Cove).

The South Coast Science Advisory Team (SCSAT) identified five bioregions within the South Coast Study Region: the Northern Mainland, Southern Mainland, West Channel Islands, Mid

Channel Islands and the East Channel Islands (California MLPA Master Plan Science Advisory Team 2009, October 26). The clustering identified based on the Reef Check baseline surveys are is slightly different from the bioregions identified during the MPA design process. The 'South Mainland' region identified by the SCSAT brakes down into a San Diego and Los Angeles/Orange County (LA/OC) cluster in the RCCA data. In this cluster, the OC sites separate slightly from the LA sites and several of the sites in the southern part of the 'North Mainland' region (e.g., Lechuza, Paradise Point., Big Rock) fall within the LA cluster in our analysis. The Reef Check sites near Santa Barbara do not cluster within one group but some group with the LA/OC sites (Sandpiper, Naples Reef) and the other two sites (IV Reef and Refugio Beach) group by themselves. Therefore, the 'North Mainland' region is broken up between the LA/OC and the Santa Barbara cluster in the RCCA data (Figure 9). Catalina Island clusters by itself as suggested in the 'East Channel Island' region identified by the SCSAT. Surveys in the Mid and East Channel Island regions are not included in this analysis.

The groupings identified in the cluster analysis are supported by the multi-dimensional scaling analysis (MDS) (Figure 11). The MDS plot demonstrates that in each regional grouping of sites (i.e. kelp forest community), MPAs, as well as reference sites, are represented. This confirms that reference sites and MPA sites show similar community structures at the onset of protection. Therefore, these long-term monitoring sites are likely to be useful for future evaluation of management regimes. Sites identified as similar and within the same geographic region, but under different management regimes (i.e. SMR, SMCA, no protection), will be useful for identifying future changes in the ecosystems as long-term monitoring continues.
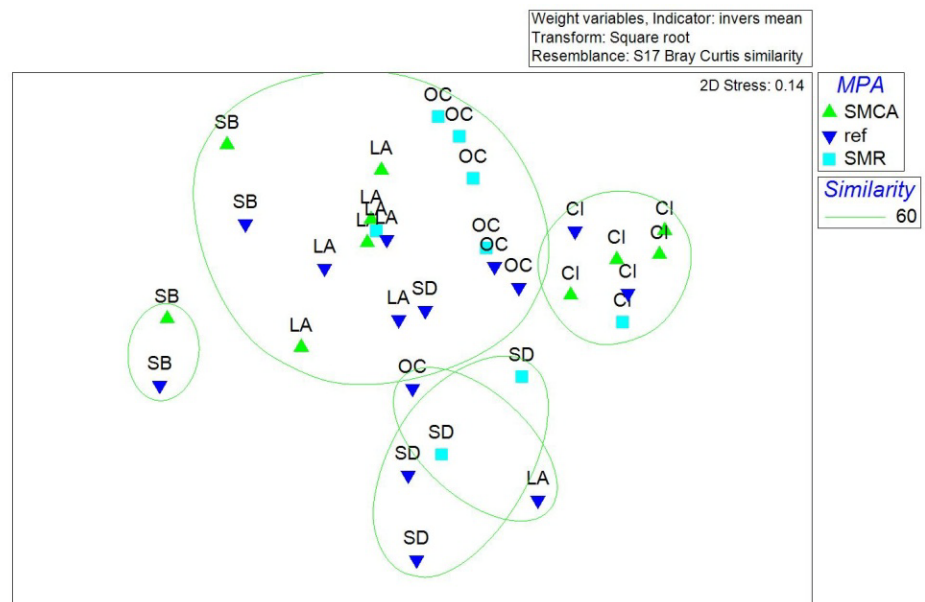
Figure 11. MDS ordination plot of communities using Bray-Curtis similarity based on the square-root transformed taxa. Sites are labeled with their respective management region (symbols) and according to their geographic locations: LA= Los Angeles, OC= Orange County, SB = Santa Barbara County, SD= San Diego County, CI = Catalina Island.

Despite the difference in clustering of the RCCA sites compared to the suggested bioregions by the SCSAT, RCCA's sampling design fulfils the suggested minimum sampling distribution in the South Coast Monitoring Plan of two MPA and two reference sites in each bioregion. Each cluster contains at least two monitoring sites within MPAs and two reference sites in each region. Except for the Santa Barbara cluster, where only one MPA and one reference sites are present, if the two outliers that cluster with LA/OC are not considered (Figure 11). This analysis suggests that most sites are suitably placed for long-term monitoring but that some sites might need to be added in Santa Barbara.

Using the BEST function in Primer, habitat variables that most closely correlate with the identified clusters were determined (Figure 12). The percentage of boulders, sand, moderately high relief (1-2m) and the depth of the sites were most closely correlated with the differences in the kelp forest communities and these variables explained 53% of the community differences. Sites in the Catalina Island cluster were characterized by a high percentage of boulders and sand and relatively high relief compared to sites on the mainland. San Diego sites were deepest with little relief. The two Santa Barbara sites that clustered together were dominated by bedrock and low relief, similar to the sites in the Los Angeles/ Orange county cluster. This might also explain why the two Santa Barbara sites identified as outliers in the cluster analysis (Figure 9) grouped with the LA/OC sites.
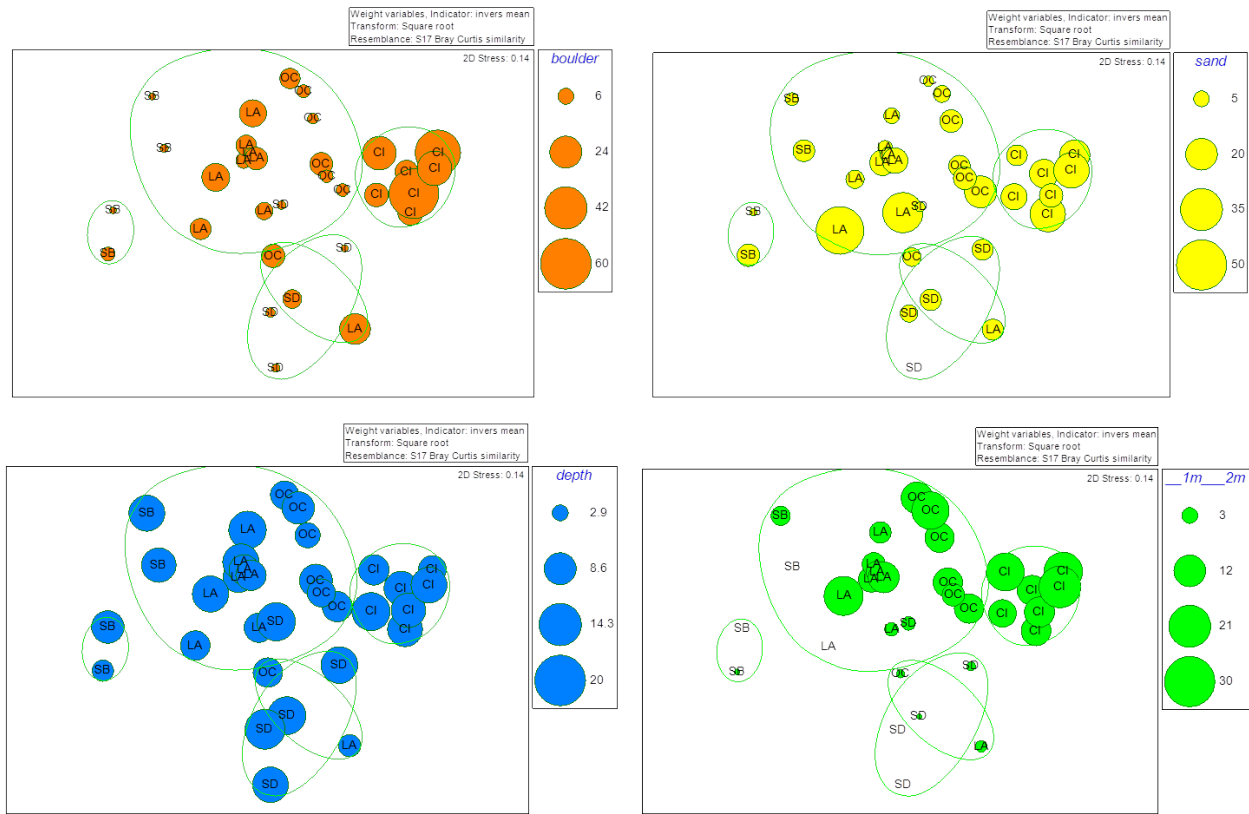
Figure 12. MDS ordination plot of communities using Bray-Curtis similarity based on the square-root transformed taxa. Sites are labeled with their geographic regions: LA= Los Angeles, OC= Orange County, SB = Santa Barbara County, SD= San Diego County, CI = Catalina Island. Four physical habitat variables identified in the BEST routine in Primer correlate with differences between community clusters. For boulders, sand and intermediate relief (1m-2m) the bubble size represents the percentage of that environmental variable recorded during UPC surveys at the respective sites and for depth it represents the average depth of the site. Green lines indicate community clusters of 60% similarity.

When comparing communities using the SIMPROF (alpha = 0.05) routine in Primer to identify clusters without any significant community structure, nine clusters emerge in the SCSR (red branches in Figure 9). In most cases, the significant groupings of sites align with the geographic groupings at a level of 60% similarity. The only geographic group that is broken down further is the Los Angeles/Orange County group of sites. Further, in all of the geographic groupings identified, pairs of reference and MPA sites are present that are not significantly different from each other. Both sites in the Santa Barbara region, IV Reef and Refugio Beach, show no significant difference in their community structure (Figure 9). All sites around Catalina Island show similar community structure and no further clustering among these sites is detected (Figure 9). In the San Diego region, sites within two MPAs and the reference areas cluster

together and one site (Broomtail Reef) is an outlier (Figure 9). In the LA/OC region, five groups of sites without significant community structure emerge (Figure 13). Of these, four of the five groups contain MPAs as well as reference sites, and one group, the Laguna SMR, only contains MPA sites (Figure 13). Two Santa Barbara sites and one San Diego site cluster as outliers within the LA/OC cluster and are significantly different from all other sites.
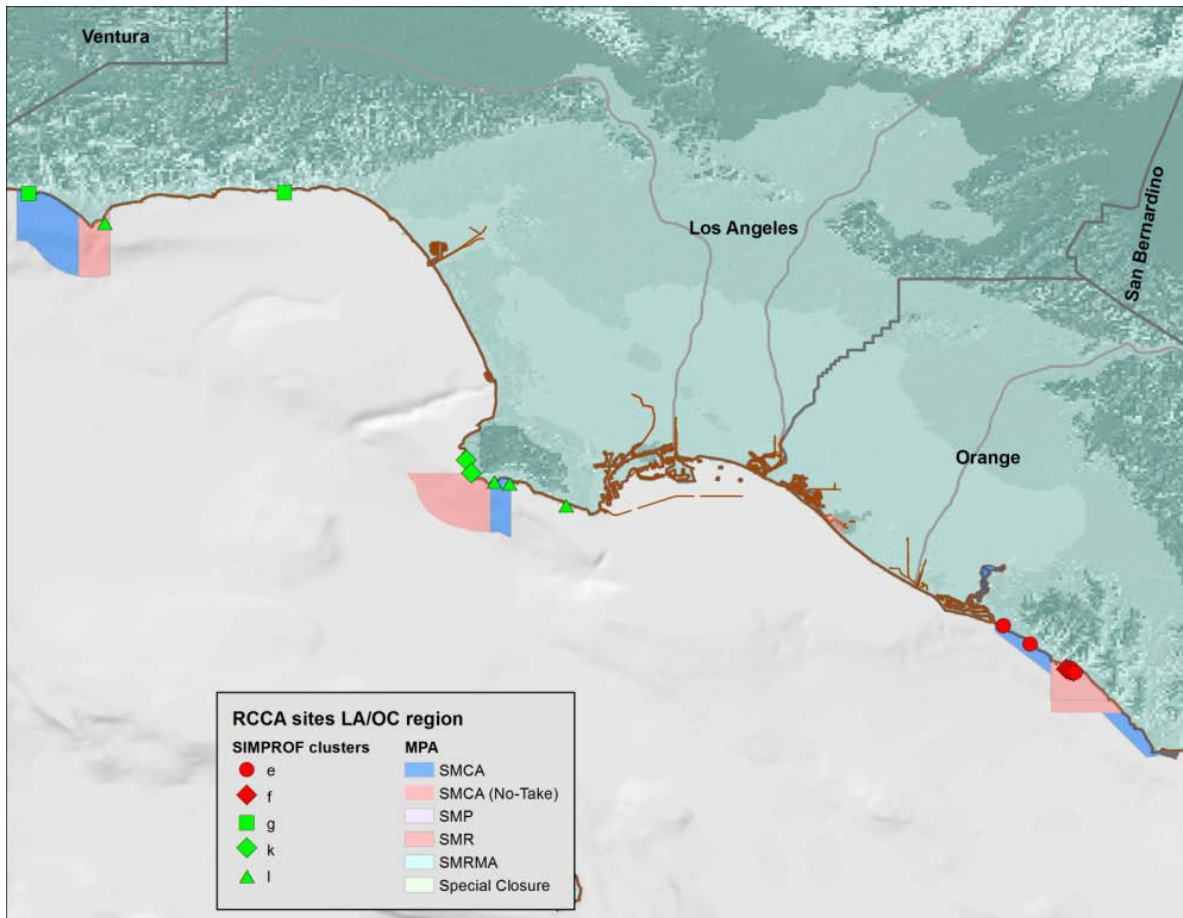
Figure 13.   Reef Check sites in the Los Angeles/ Orange County region. Symbols represent sites without significant difference in community structure (SIMPROF alpha =0.05).   In most cases, sites near to each other have similar ecological communities. Clusters are indentified by their symbols. Sites in Orange County are labeled in red, sites in Los Angeles County are labeled in green.

Regional species densities

To identify which species are numerically dominant in the different communities identified above, we plotted species densities in the different clusters inside and outside of MPAs. This is less to investigate differences between the references sites and MPAs at this spatial scale but rather to demonstrate differences in species composition along the latitudinal gradient along the SCSR mainland coast and at Catalina Island. Comparing the densities of fish species in Figure 14 demonstrates clear differences among the fish communities. Common warmer-water species such as blacksmith, garibaldi and rock wrasse are missing from the Santa Barbara sites in the north. Further, Santa Barbara sites have overall much lower fish densities than the other sites. The LA/OC community has the most evenly distributed species abundances and most of the RCCA's key species are present in this region. In San Diego, the rockfish that are found in the LA/OC and the Catalina clusters are not present. This pattern in species distributions and abundances, with warmer water species missing from Santa Barbara and colder water species missing from the San Diego sites, is consistent with the temperate changes along the latitudinal gradient in the SCSR.

For invertebrates, the overall pattern is similar, with Santa Barbara having the fewest species from the RCCA's target list (Figure 15). Again, some of the otherwise abundant southern species are missing (e.g., crowned urchin). Similarly, San Diego has fewer species than LA/OC and Catalina Island sites while LA/OC is the most species rich.

For algae, all species are present in all four clusters with the exception of pterygophora at the Catalina Island sites. In San Diego, giant kelp is a much less abundant than in the other three regions and, therefore, understory kelps, such as laminaria species and pterygophora, are more abundant (Figure 16).
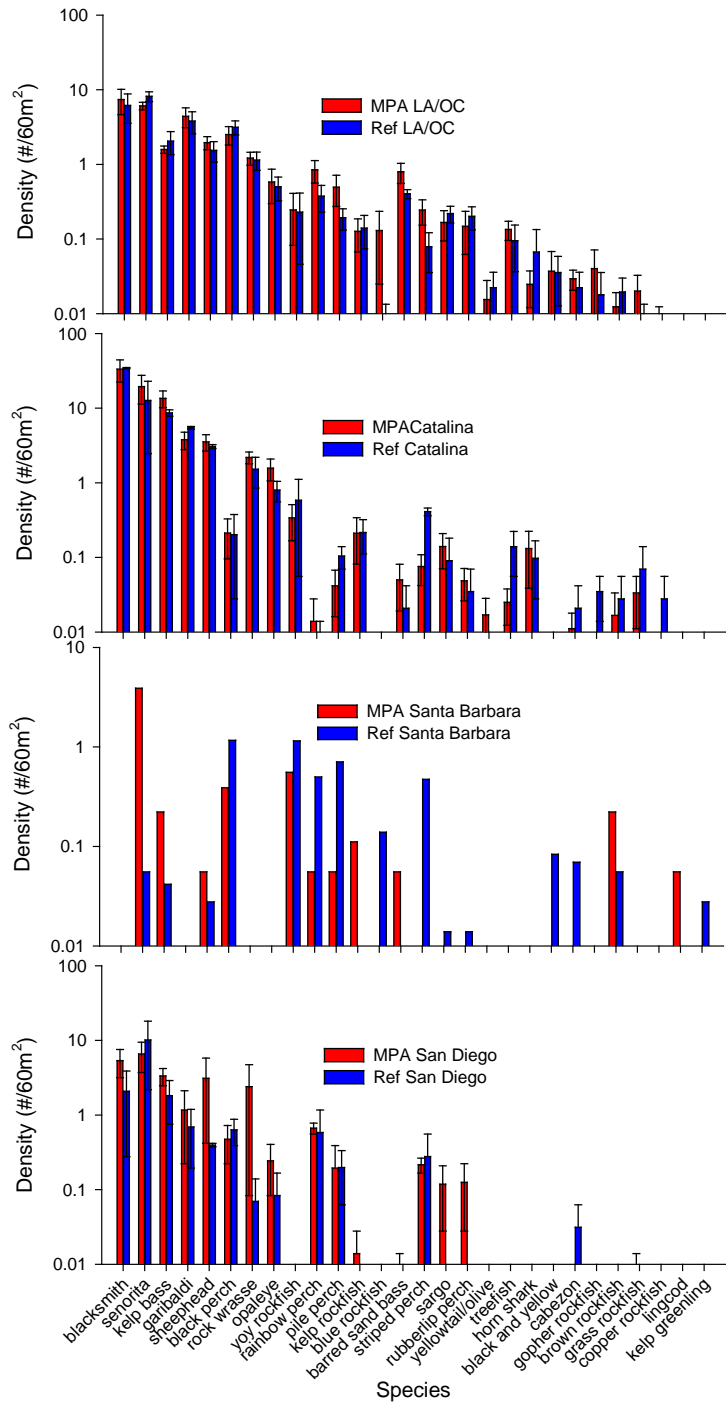
Figure 14. Fish densities inside (red) and outside (blue) of MPAs in the four kelp forest communities identified by cluster analysis in Figure 9. (Error bars indicate standard error among all transects during baseline period). Y-axis is log transformed to show less common species.
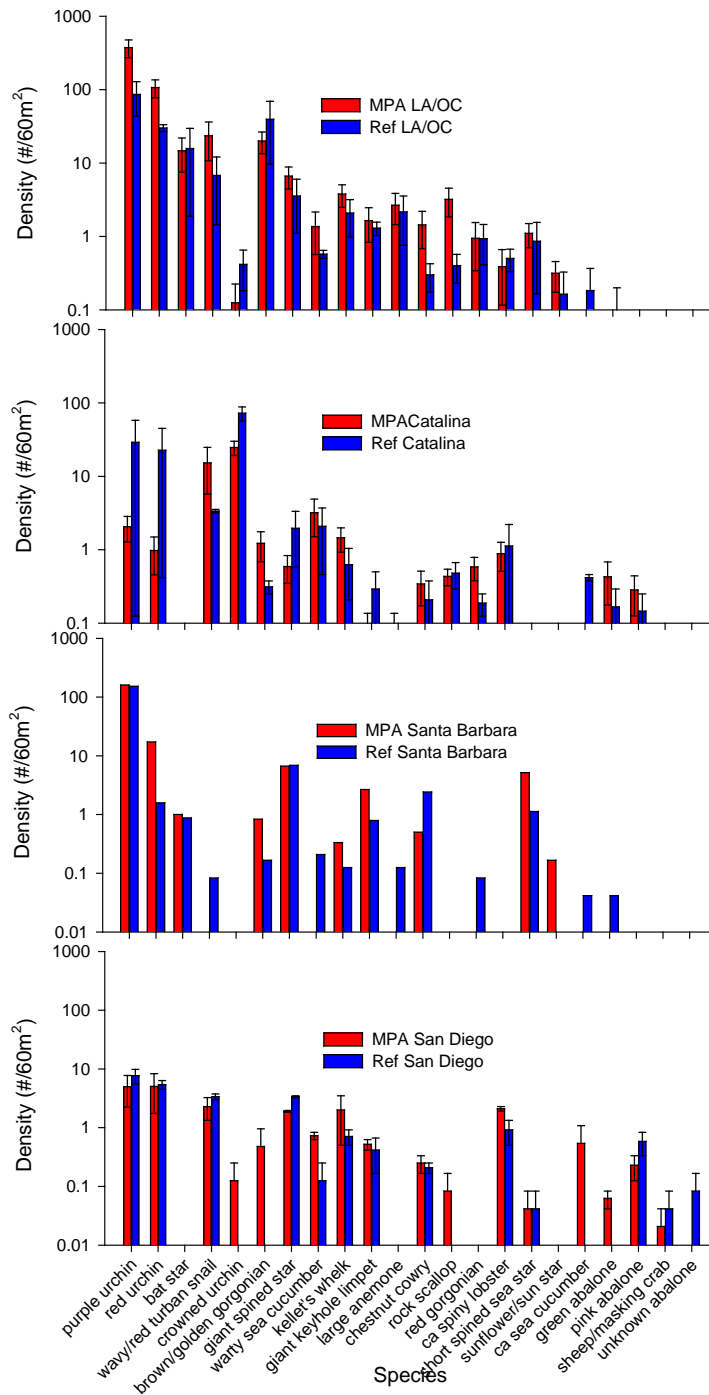
Figure 15. Invertebrate densities inside (red) and outside (blue) of MPAs in the four kelp forest communities identified by cluster analysis in Figure 9. (Error bars indicate standard error among all transects during baseline period). Y-axis is log transformed to show less common species.
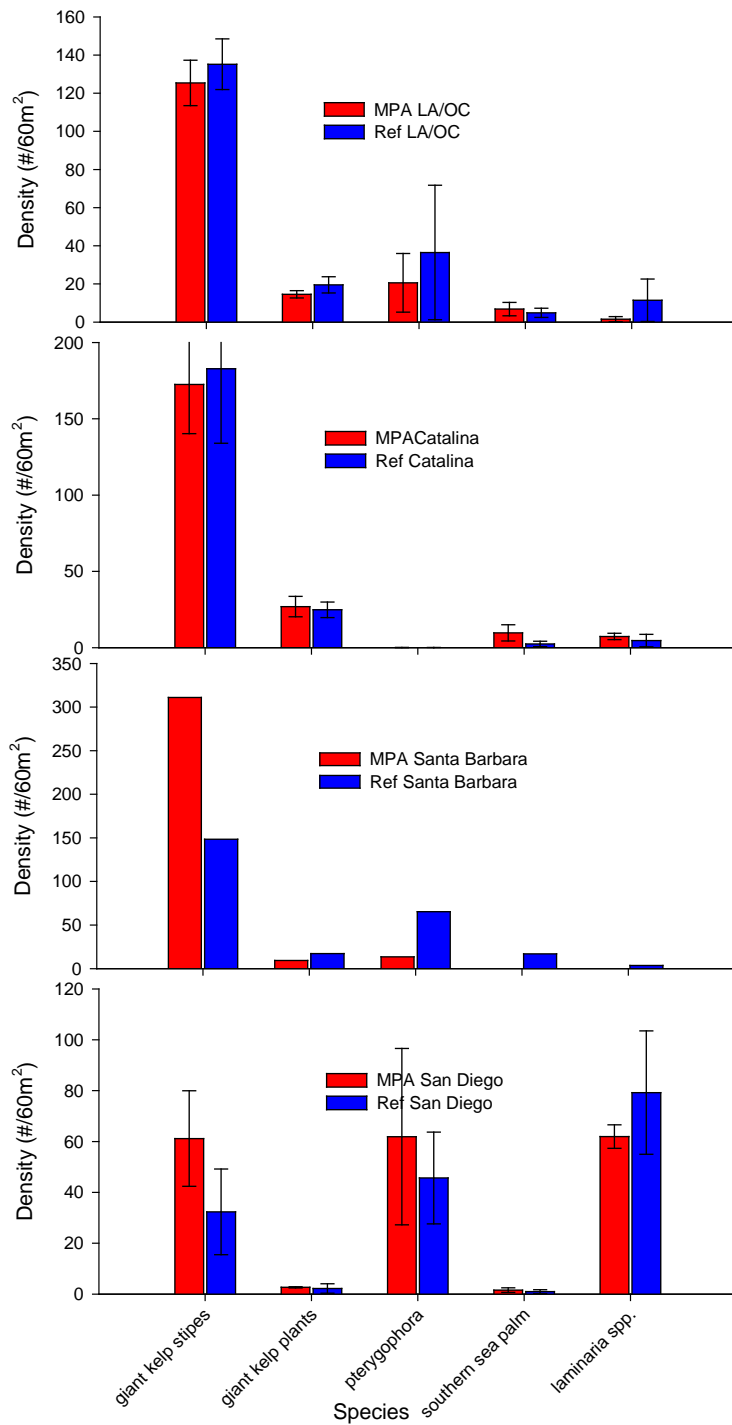
Figure 16. Algae densities inside (red) and outside (blue) of MPAs in the four kelp forest communities identified by cluster analysis in Figure 9. (Error bars indicate standard error among all transects during baseline period.) For giant kelp the mean number of stipes as well as the mean number of plants is shown.

To test whether or not differences in the number of species present in the different clusters might be due to the fact that the LA/OC and Catalina Island clusters have more RCCA survey sites (i.e. species-area curve) than San Diego and especially Sand Barbara (IV Reef and Refugio beach), we used a GLM approach to compare mean number of species per sites between the regions. This test was done for the entire community including fish, invertebrates and algae. The number of species per site was significantly different between the regional clusters ($F_{(3/26)}$ =3.501, P=0.029). The LA/OC and Catalina Island clusters had more species per site than San Diego and Santa Barbara (Figure 17). This suggests that the differences in number of species is not due to a sampling effect, but rather that the LA/OC and Catalina Island clusters are more species rich.
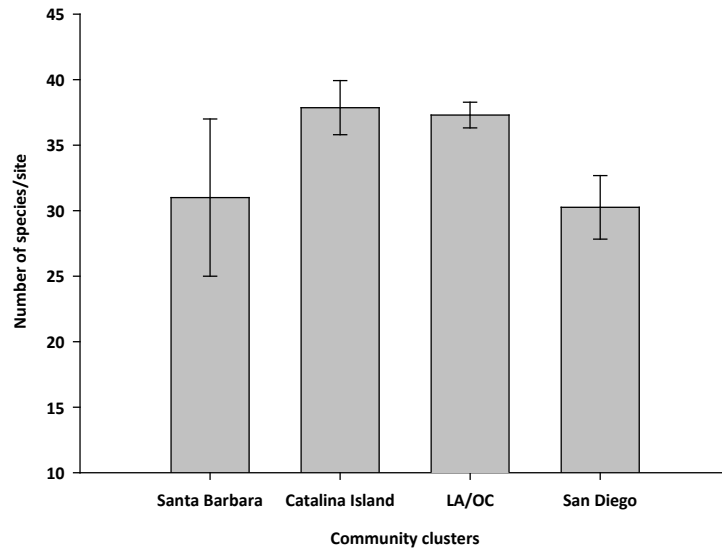
Figure 17. Mean number of species found per sites in the different regional kelp forest communities as identified by cluster analysis in Figure 9. Mean +/- SE are reported.

Species densities inside vs. outside of MPAs

To compare individual species densities at sites inside and out of MPAs that don't show significant community structure (SIMPROF: alpha = 0.05), we used a GLM comparing species densities from 2011 and 2012 surveys at MPA sites and nearby reference sites within the SIMPROF clusters identified above (Figure 9). Overall, only a few species showed significant differences inside vs. outside of MPAs when sites with similar communities are compared (Table 1). Sites inside and outside of MPAs that do not differ in their community compositions and show very few differences in individual species densities during the baseline period make good candidate sites for long-term monitoring. Some sites cluster within a group of sites that are not geographically close to each other and, while the analysis suggest that they could serve as references sites for distant MPAs, these might not be appropriate choices because they will experience very different environmental forces and human impacts over the long-term. A table of the sites and their groupings can be found in Appendix E.

Table 1. Significant results from pair wise comparisons of species densities inside vs. outside of MPAs within communities without significant structure (SIMPROF 0.05). (Clusters: a= Santa Barbara, d= Catalina Island, e= sites in Orange County, k= Palos Verdes, I=Palos Verdes, Malibu). All other pair-wise comparisons of species at sites inside and out of MPAs were not significant.

Species	Cluster	Source	DF	F	P
pterygophora	a	MPA vs. Ref	1	314.25	0.04
CA sea cucumber	d	MPA vs. Ref	1	7.58	0.02
crowned urchin	d	MPA vs. Ref	1	18.67	0.00
gopher rockfish	d	MPA vs. Ref	1	6.23	0.03
red urchin	d	MPA vs. Ref	1	5.61	0.04
sheep/masking crab	d	MPA vs. Ref	1	7.62	0.02
striped perch	d	MPA vs. Ref	1	5.67	0.04
treefish	d	MPA vs. Ref	1	7.71	0.02
barred sand bass	e	MPA vs. Ref	1	10.68	0.03
CA spiny lobster	e	MPA vs. Ref	1	15.02	0.02
rock scallop	e	MPA vs. Ref	1	67.85	0.00
brown/golden gorgonian	k	MPA vs. Ref	1	23.42	0.04
red urchin	k	MPA vs. Ref	1	57.06	0.02
rock wrasse	k	MPA vs. Ref	1	25.05	0.04
brown/golden gorgonian	l	MPA vs. Ref	1	12.99	0.02
CA sea cucumber	l	MPA vs. Ref	1	9.88	0.03

Long-term population tends at Reef Check sites

Reef Check California has monitored many of its core sites in the SCSR since 2006 or 2007. Surveys at these sites were conducted by RCCA citizen scientists on an annual basis and some sites have been surveyed twice a year. In order to put baseline characterization results from 2011 and 2012 into a longer-term context, we have analyzed the trends in the population densities of four fish species with different life histories and exploitation levels and five invertebrate species to identify temporal trends.   The selected species are listed in the monitoring metrics for the rocky reef and kelp forest ecosystem feature in the South Coast Monitoring Plan, either as an indicator for the vital signs or for an ecosystem assessment for this ecosystem. Besides being listed as indicators in the monitoring plan, species where chosen because they were abundant in all community clusters (Figure 14 and Figure 15) and their distribution throughout the other MLPA study regions (Freiwald and Wehrenberg 2013, California Ocean Science Trust and California Department of Fish and Wildlife February 2013). For example, we chose senorita over blacksmith because it is also present in the Central Coast Study Region. Similarly, black perch are relatively abundant in the South Coast Study Region and present in the other regions, as well. Similarly, we chose the giant spined star because it is

ecologically important and present in the other study regions. The two urchin species are also present throughout the state and red urchins are economically important in other regions (e.g., north coast region).

 Based on their ecological and economic importance, their abundance in the different communities identified above, and in references to the metrics identified in the SCSR Monitoring Plan, we have chosen the following species for an analysis of their population trends over years from 2007 to 2012 at sites that RCCA has monitored prior to the baseline monitoring program:

Fish:

- Kelp bass
- Senorita
- Black perch
- California sheephead

Invertebrates:

- California spiny lobsters
- Red urchin
- Purple urchin
- Giant spined star
- Wavy and red turban snails

Choosing abundant species as indicators is critical in order to be able to achieve reliable population density estimates with the survey methods employed by RCCA and other subtidal monitoring programs in the SCSR.

Several rockfish species are listed in the monitoring plan in addition to the above mentioned species, but in the RCCA data many of these seem to be very uncommon throughout the region and, therefore, might not be an easy sample indicator of ecosystem changes in the future. Abalone are also listed in the Monitoring Plan and, while they are uncommon at the RCCA sites at this point, we agree that they should be included as indicators as they have been over-exploited and tracking their population densities will help monitor a potential recovery or further decline.

We used a general linear model (GLM) approach implemented in SAS to identify temporal trends, spatial (sites) effects and their interactions for each of the nine species at the level of the entire SCSR and within the community clusters identified in Figure 9. Graphs are shown as examples of some species.

SCSR level population trends

To investigate regional population trends for the nine selected species for the entire SCSR, we used a GLM approach to test for site and year effects and their interaction. Data were square root transformed for this analysis and site and year were treated as fixed factors. If species show site by year interactions in this analysis, it indicates that there are no clear regional population trends for the species. If no interaction is detected, a significant year effect would identify temporal population trends on a regional scale. Significant site effects would be expected due to the large number of sites across the region and the different species densities identified across the community clusters.

At the level of the entire SRSC, all four fish species, as well as all five invertebrate species, showed a significant site by year interaction in the GLM (Table 3 & Table 2). This suggests that there are no clear regional population trends for any of these species at the level of the entire SCSR.

Table 2. Results from GLM for invertebrate species at the level of the entire SCSR. Significant site by year interactions (bold) indicate no region-wide trends for these species.

Species	Source	DF	F	P
CA spiny lobster	site	46	2.22	0.00
CA spiny lobster	year	1	2.63	0.11
CA spiny lobster	**year*site**	**46**	**2.21**	**0.00**
giant spined star	site	46	3.83	0.00
giant spined star	year	1	0.80	0.37
giant spined star	**year*site**	**46**	**3.81**	**0.00**
purple urchin	site	46	2.29	0.00
purple urchin	year	1	6.45	0.01
purple urchin	**year*site**	**46**	**2.29**	**0.00**
red urchin	site	46	2.26	0.00
red urchin	year	1	0.10	0.75
red urchin	**year*site**	**46**	**2.26**	**0.00**
wavy/red turban snail	site	46	2.51	0.00
wavy/red turban snail	year	1	0.62	0.43
wavy/red turban snail	**year*site**	**46**	**2.52**	**0.00**

Table 3. Results from GLM for fish species at the level of the entire SCSR. Significant site by year interactions (bold) indicate no region-wide trends for these species.

Species	Source	DF	F	P
black perch	site	46	4.00	0.00
black perch	year	1	0.21	0.65
black perch	**year*site**	**46**	**4.00**	**0.00**
kelp bass	site	46	6.44	0.00
kelp bass	year	1	19.84	0.00
kelp bass	**year*site**	**46**	**6.46**	**0.00**
senorita	site	46	8.08	0.00
senorita	year	1	31.41	0.00
senorita	**year*site**	**46**	**8.08**	**0.00**
CA sheephead	site	46	4.82	0.00
CA sheephead	year	1	15.57	0.00
CA sheephead	**year*site**	**46**	**4.81**	**0.00**

Regional population trends

Due to the large geographic area included in the SCSR and the different oceanographic conditions, as well as different fishing regimes in the region, we would not expect population trends to be synchronous throughout the entire SCSR. Therefore, we use the same analytical approach as above to look at population trends within the regional clusters identified by community similarities of 60%. Again, we used a GLM to identify significant site and year effect, as well as their interactions within each cluster. Significant year effects would indicate that population within a cluster show similar dynamics across sites within that cluster. Identifying these trends, if they exist, would put the population densities detected during the baseline monitoring period into a context of the temporal population dynamics.

For fish, most species-cluster combinations showed a significant site by year interaction in the GML, suggesting that there are no cluster-wide trends (Table 4). Only black perch and California sheephead

Table 4. Significant GLM results for four selected fish species within the regional community clusters identified in Figure 9.

Species	Region	Source	DF	F	P
black perch	Santa Barbara	year	1	6.873	0.009
black perch	Catalina	site	6	3.668	0.001
black perch	Catalina	year*site	6	3.670	0.001
black perch	LA/OC	site	15	3.471	0.000
black perch	LA/OC	year	1	22.403	0.000
black perch	LA/OC	year*site	15	3.467	0.000
kelp bass	Santa Barbara	site	1	14.464	0.000
kelp bass	Santa Barbara	year	1	37.608	0.000
kelp bass	Santa Barbara	year*site	1	14.398	0.000
kelp bass	San Diego	site	3	9.896	0.000
kelp bass	San Diego	year	1	20.344	0.000
kelp bass	San Diego	year*site	3	9.900	0.000
kelp bass	Catalina	site	6	10.542	0.000
kelp bass	Catalina	year	1	26.480	0.000
kelp bass	Catalina	year*site	6	10.552	0.000
kelp bass	LA/OC	site	15	2.642	0.001
kelp bass	LA/OC	year	1	17.545	0.000
kelp bass	LA/OC	year*site	15	2.643	0.001
senorita	Santa Barbara	site	1	16.584	0.000
senorita	Santa Barbara	year*site	1	16.590	0.000
senorita	San Diego	site	3	5.860	0.001
senorita	San Diego	year*site	3	5.861	0.001
senorita	Catalina	site	6	10.684	0.000
senorita	Catalina	year*site	6	10.702	0.000
senorita	LA/OC	site	15	3.284	0.000
senorita	LA/OC	year	1	25.370	0.000
senorita	LA/OC	year*site	15	3.281	0.000
CA sheephead	Catalina	site	6	4.314	0.000
CA sheephead	Catalina	year	1	13.571	0.000
CA sheephead	Catalina	year*site	6	4.320	0.000
CA sheephead	LA/OC	site	15	3.551	0.000
CA sheephead	LA/OC	year*site	15	3.545	0.000

did not show a significant site by year interaction in two of the identified clusters (Santa Barbara sheephead: $F_{(1/1)} = 1.3$, P=0.25, black perch: $F_{(1/1)} = 1.55$, P=0.21; San Diego sheephead: $F_{(1/3)} = 1.32$, P=0.27, black perch: $F_{(1/3)} = 0.83$, P=0.48). Of these, black perch in

Santa Barbara show a significant declining trend over the years ($F_{(1/1)}$ = 6.87, P=0.009, Figure 18).   Whereas, for the other three combinations, black perch in San Diego (black perch: $F_{(1/3)}$ = 0.91, P=0.088) and California sheephead in Santa Barbara and San Diego (SB: $F_{(1/1)}$ = 0.80, P=0.37, DS: $F_{(1/3)}$ = 0.87, P=0.38), no significant trend over the years is detected, indicating stable populations (Figure 18).
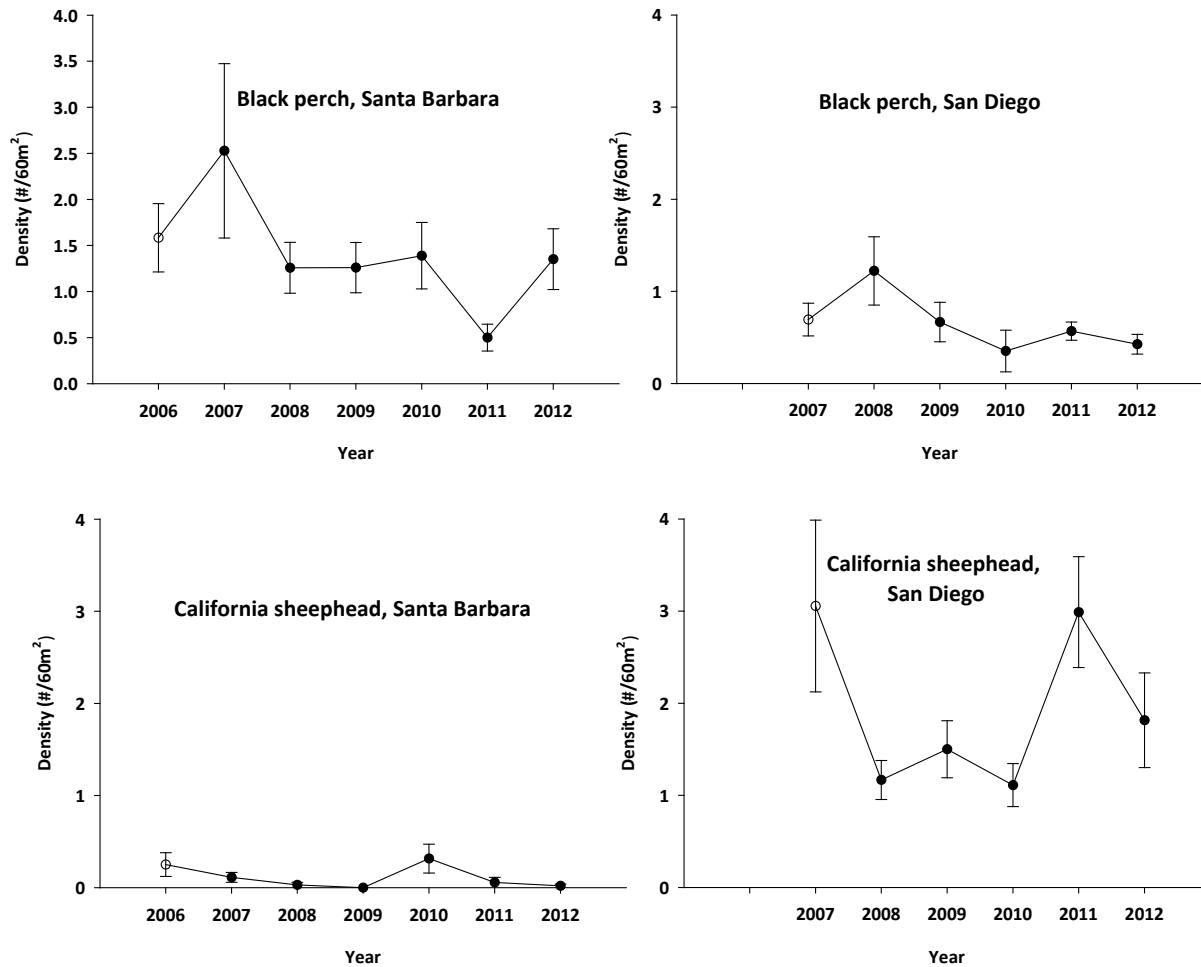
Figure 18. Temporal trends of population densities of black perch and California sheephead in the Santa Barbara and San Diego regions. Annual means +/- SE

Overall, invertebrates show more synchronized population dynamics at the sites within community clusters than the fish populations of the selected species. Of the five selected invertebrates (or species groups), all have no significant site by year interactions in at least one of the four clusters (Table 5). Of the species/cluster combinations in which no interaction was found, only purple urchins show significant year effects in at the Santa Barbara sites, where purple urchins declined in 2012 and in the LA/OC region with an increase in purple urchins in 2011 and 2012 at the RCCA sites. All other species without site by year interactions show no

year effect, indicating stable population levels (Figure 19). Therefore, overall the populations of the selected invertebrates seem to be stable over the monitoring period before MPA implementations. Future changes inside or outside of the MPAs might be evaluated in light of this long-term data.

Table 5. GLM results for invertebrate species in respective community clusters. Species/cluster combinations without significant year by site show regional population dynamics (bold) and their trends are graphed in Figure 19.

Species	Cluster	Source	DF	F	P
CA spiny lobster	c	site	3	3.67	0.01
CA spiny lobster	c	year	1	0.78	0.38
CA spiny lobster	c	year*site	3	3.67	0.01
CA spiny lobster	d	site	6	2.13	0.05
CA spiny lobster	d	year	1	0.02	0.89
CA spiny lobster	**d**	**year*site**	**6**	**2.13**	**0.05**
CA spiny lobster	e	site	15	0.81	0.67
CA spiny lobster	e	year	1	0.27	0.61
CA spiny lobster	**e**	**year*site**	**15**	**0.81**	**0.67**
giant spined star	a	site	1	7.55	0.01
giant spined star	a	year	1	29.05	0.00
giant spined star	a	year*site	1	7.55	0.01
giant spined star	c	site	3	1.76	0.16
giant spined star	c	year	1	2.47	0.12
giant spined star	**c**	**year*site**	**3**	**1.75**	**0.16**
giant spined star	d	site	6	2.27	0.04
giant spined star	d	year	1	0.67	0.41
giant spined star	d	year*site	6	2.27	0.04
giant spined star	e	site	15	2.14	0.01
giant spined star	e	year	1	1.35	0.25
giant spined star	e	year*site	15	2.13	0.01
purple urchin	a	site	1	2.25	0.14
purple urchin	*a*	*year*	*1*	*9.55*	*0.00*
purple urchin	**a**	**year*site**	**1**	**2.26**	**0.14**
purple urchin	c	site	3	3.04	0.03
purple urchin	c	year	1	2.09	0.15
purple urchin	c	year*site	3	3.04	0.03
purple urchin	d	site	6	7.35	0.00
purple urchin	d	year	1	2.93	0.09
purple urchin	d	year*site	6	7.36	0.00
purple urchin	e	site	15	0.88	0.59
purple urchin	*e*	*year*	*1*	*3.35*	*0.07*

purple urchin	**e**	**year*site**	**15**	**0.88**	**0.59**
red urchin	a	site	1	9.27	0.00
red urchin	a	year	1	5.60	0.02
red urchin	a	year*site	1	9.28	0.00
red urchin	c	site	3	1.77	0.16
red urchin	c	year	1	0.72	0.40
red urchin	**c**	**year*site**	**3**	**1.77**	**0.16**
red urchin	d	site	6	6.14	0.00
red urchin	d	year	1	0.39	0.53
red urchin	d	year*site	6	6.15	0.00
red urchin	e	site	15	1.53	0.09
red urchin	e	year	1	2.44	0.12
red urchin	e	year*site	15	1.52	0.09
wavy/red turban snail	a	site	1	1.00	0.32
wavy/red turban snail	a	year	1	0.63	0.43
wavy/red turban snail	**a**	**year*site**	**1**	**1.00**	**0.32**
wavy/red turban snail	c	site	3	3.34	0.02
wavy/red turban snail	c	year	1	9.77	0.00
wavy/red turban snail	c	year*site	3	3.34	0.02
wavy/red turban snail	d	site	6	2.36	0.03
wavy/red turban snail	d	year	1	3.07	0.08
wavy/red turban snail	d	year*site	6	2.36	0.03
wavy/red turban snail	e	site	15	2.36	0.00
wavy/red turban snail	e	year	1	8.56	0.00
wavy/red turban snail	e	year*site	15	2.37	0.00
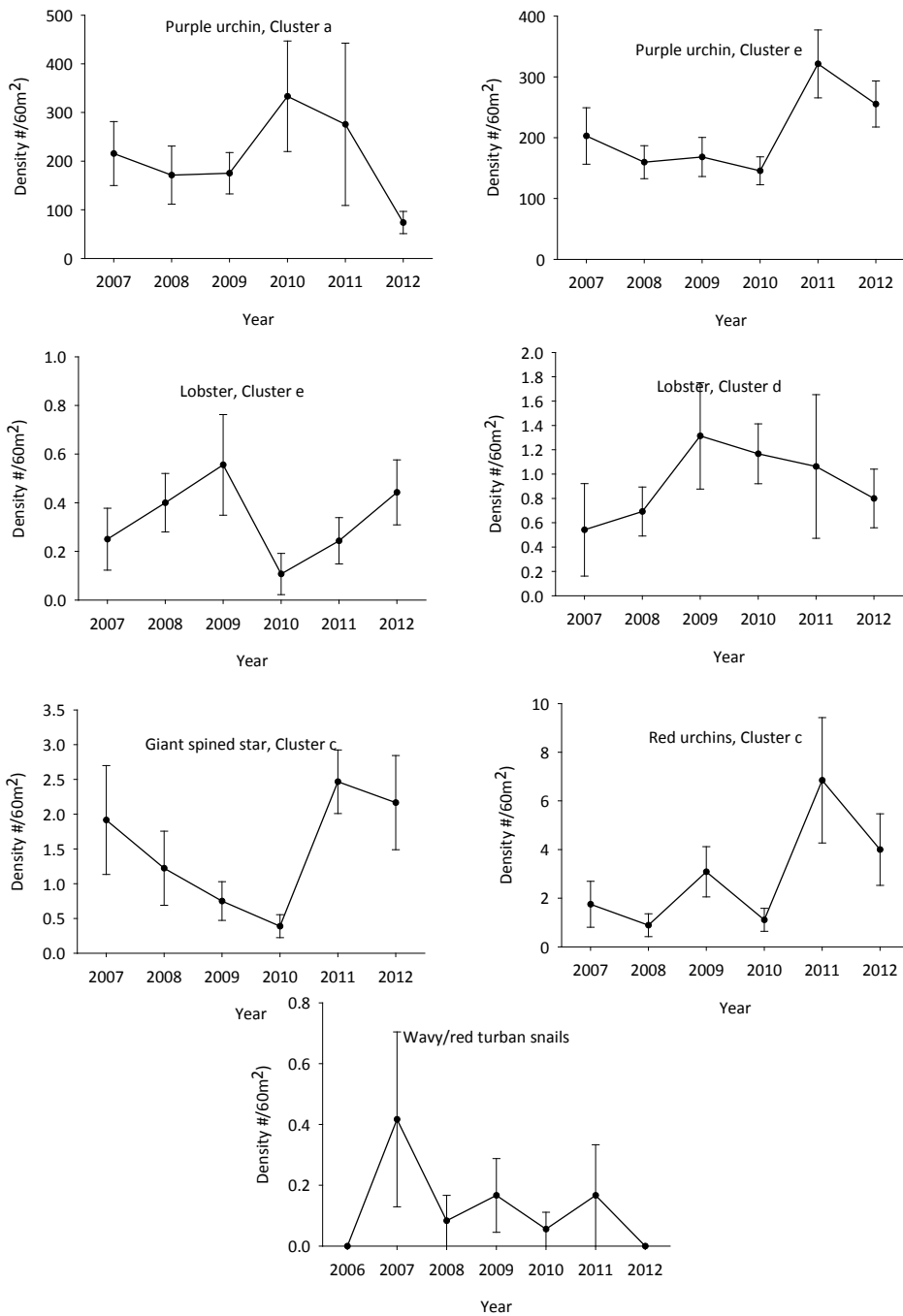
Figure 19. Temporal trends of population densities for invertebrate species in clusters for which they did not show a significant year by site interaction.

Historical Context

Over the last forty years, the ecological communities in California's nearshore environment have changed and declines of many fisheries, and once common species, have been documented. Yet, few, if any, datasets exist that continuously track the abundances of nearshore rocky reef fish species along the coast over this time period. To investigate if rocky reef fish populations have declined along the southern California coast over the last forty years, we have analyzed visual underwater fish survey data from studies conducted in the 1970s and compared the densities found by these studies to the fish densities recorded through Reef Check California (RCCA) surveys conducted at the same sites between 2006 and 2011.

Of the historic studies, two surveys were in southern California's cold water region of the Santa Barbara coast and northern Channel Islands conducted by Ebeling et al. (1980), and one study in southern California's warm water region along the Palos Verdes Peninsula conducted by Stephens et al. (1984). At Palos Verdes, all but two species (California sheephead, rainbow perch) are found at lower densities now than between 1974 and 1981 by Stephens et al. (1984) (Figure 20). Furthermore, some of the species found in the earlier study were absent during the recent surveys: blue rockfish, olive rockfish and brown rockfish. In the Santa Barbara and Channel Island region, the changes between the sites in the 1970 and today are not as clear or dramatic. Some species declined and other increased in abundance over the last forty years and few of the changes were statistically significant (Figure 21).
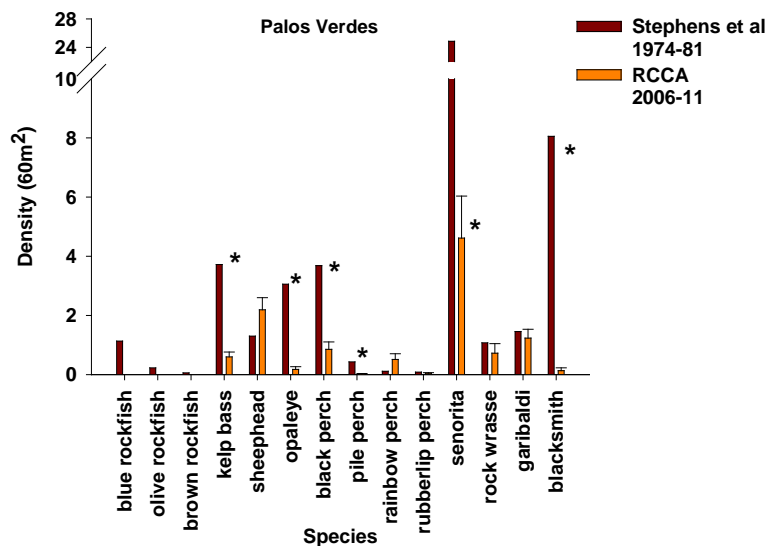
Figure 20. Comparison of Reef Check's data (orange bars) to data from the 1970 (red bars) at Palos Verdes. * indicate significant differences (p<0.05). Error bar are +/- SE
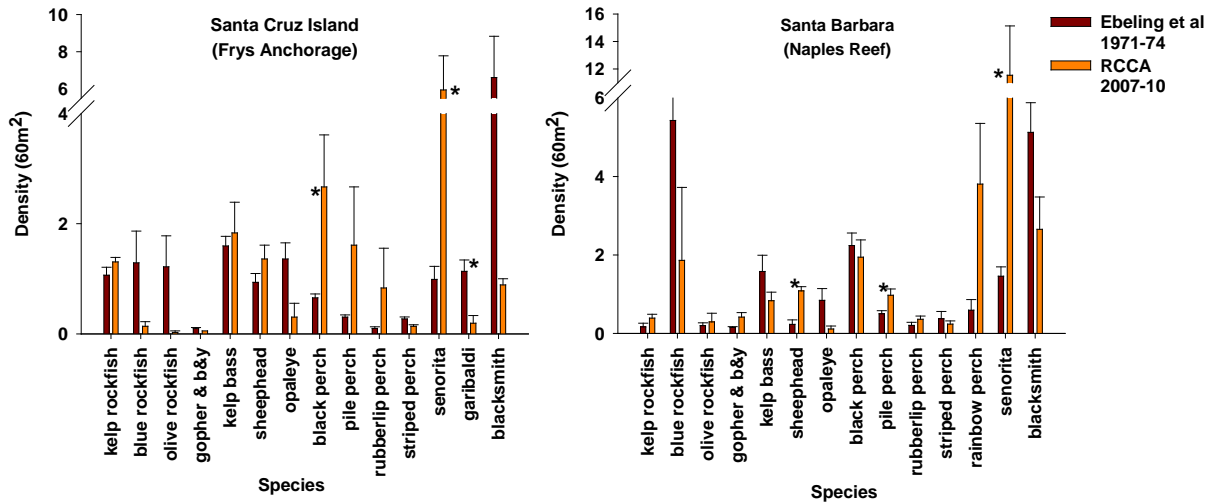
Figure 21. Comparison of Reef Check's data (orange bars) to data from the 1970 (red bars) at the Channel Islands and Santa Barbara coast. * indicate significant differences. Error bar are +/- SE

Some of the differences in population densities can be attributed to the natural variably of local fish populations, while others are probably due to differences in the methodology. Especially, the study by Ebeling et al. (1980) was conducted using video transect and if those methods recorded lower densities than *in situ* counts, comparisons might not reflect the actual changes at those sites. Other changes in population densities can be attributed to climatic changes such as the shift from a cold to a warm water period in the late 1970s. For example, blue rockfish, a cold water species feeding on planktonic organisms, might have responded to the reduced availability of prey during the warmer period. But the fact that most heavily fished species show the strongest declines statewide suggest that changes are also caused by overfishing.

In most cases, we cannot decouple if changes in population densities are primarily driven by fishing pressure, by natural environment change, such as the observed regime shift in 1977, or by anthropogenic environmental impacts such climate change. In order to decouple these, we need control sites that are exposed to the same environmental conditions but released from fishing pressure. Now that the statewide network of marine protected areas is complete, we will have the opportunity to decouple environmental from fishing effects in the future if we continue to monitor inside and outside of the new MPAs. Marine reserves can serve as 'natural experiments' because they are exposed to the same environmental changes (or pollution) but released from fishing pressure that reefs outside of MPAs are exposed to. As populations start to respond to the protection, we will be able to differentiate between changes driven by environmental change versus changes driven by fishing. This is an unprecedented opportunity to study these effects on a large spatial scale for a set of species that is ecologically and

economically important but has been managed poorly in the past. Results from these types of analysis will greatly increase our understanding and inform management, mitigation and conservation approaches in the future.

Capacity building and data dissemination

During the two-year baseline monitoring period, RCCA held 15 trainings throughout San Diego, Orange, Los Angeles and Santa Barbara Counties. In addition to the trainings, we conducted 12 recertification classes for previously trained volunteers. These trainings and recertifications were conducted as community trainings for the general public and as trainings at our partner institutions. We trained students and instructors from University of California, Santa Barbara (UCSB), the Catalina Island Marine Institute (CIMI), the Aquarium of the Pacific and the Emerald Bay Boy Scout Camp. Overall, we trained and recertified 226 volunteer citizen scientists in southern California over the baseline period. Volunteers from each of these trainings and recertifications made up the SCSR teams. A major programmatic success in 2011 and 2012 is the high proportion of retained volunteers (> 50%) from previous years. This trend is telling of the value of the experience volunteers have while being involved in MPA monitoring and it raises the level of proficiency of Reef Check California survey teams (Figure 22). This makes the program more cost effective, productive and reliable, and positions it well for the sustainable long-term monitoring of MPAs. The trainings in the years following the baseline monitoring period have been conducted at the same capacity and with similarly participation in 2013 and 2014.
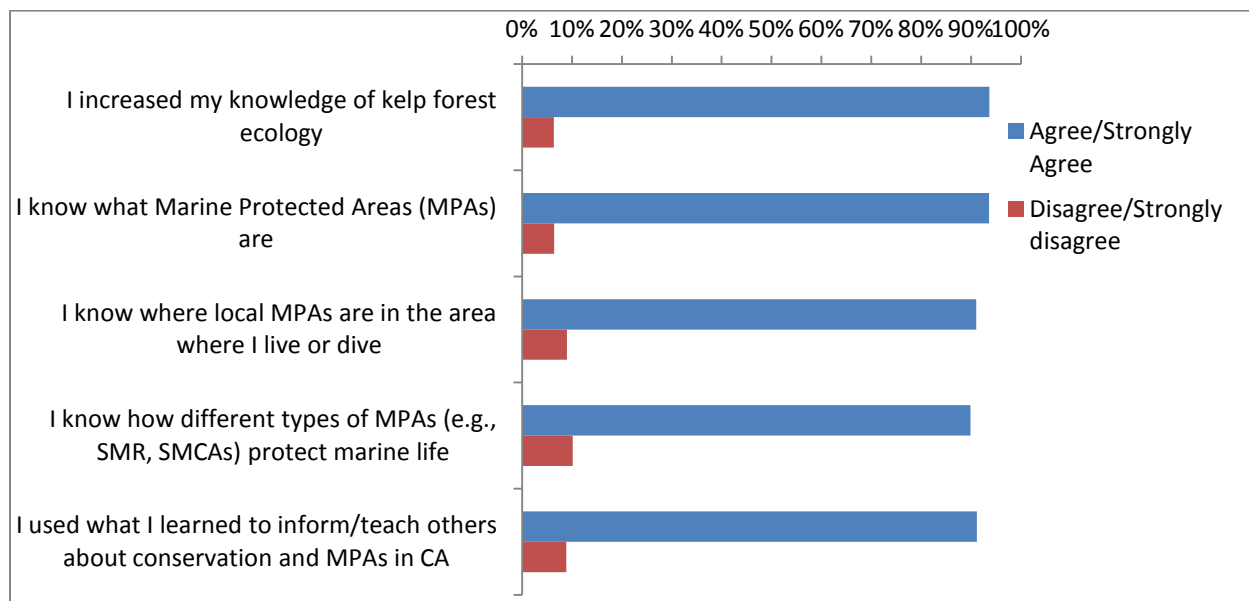
Figure 22. Percentages of volunteers that agree or disagree with statements about their knowledge about MPAs as a result of participating in Reef Check surveys.

In another step to build capacity and increase the availability of monitoring data to the public and interested researchers, we have rebuilt Reef Check's public online data display and distribution system. All of Reef Check's data are now available in a Google Earth-based interface at: http://data.reefcheck.org. Users are now able to view and download data in geographic and temporal contexts and design their own graphs based on sites and species of interest to them (Figure 23). This system makes RCCA's data publically available as soon as they are entered and all quality checks have been performed.
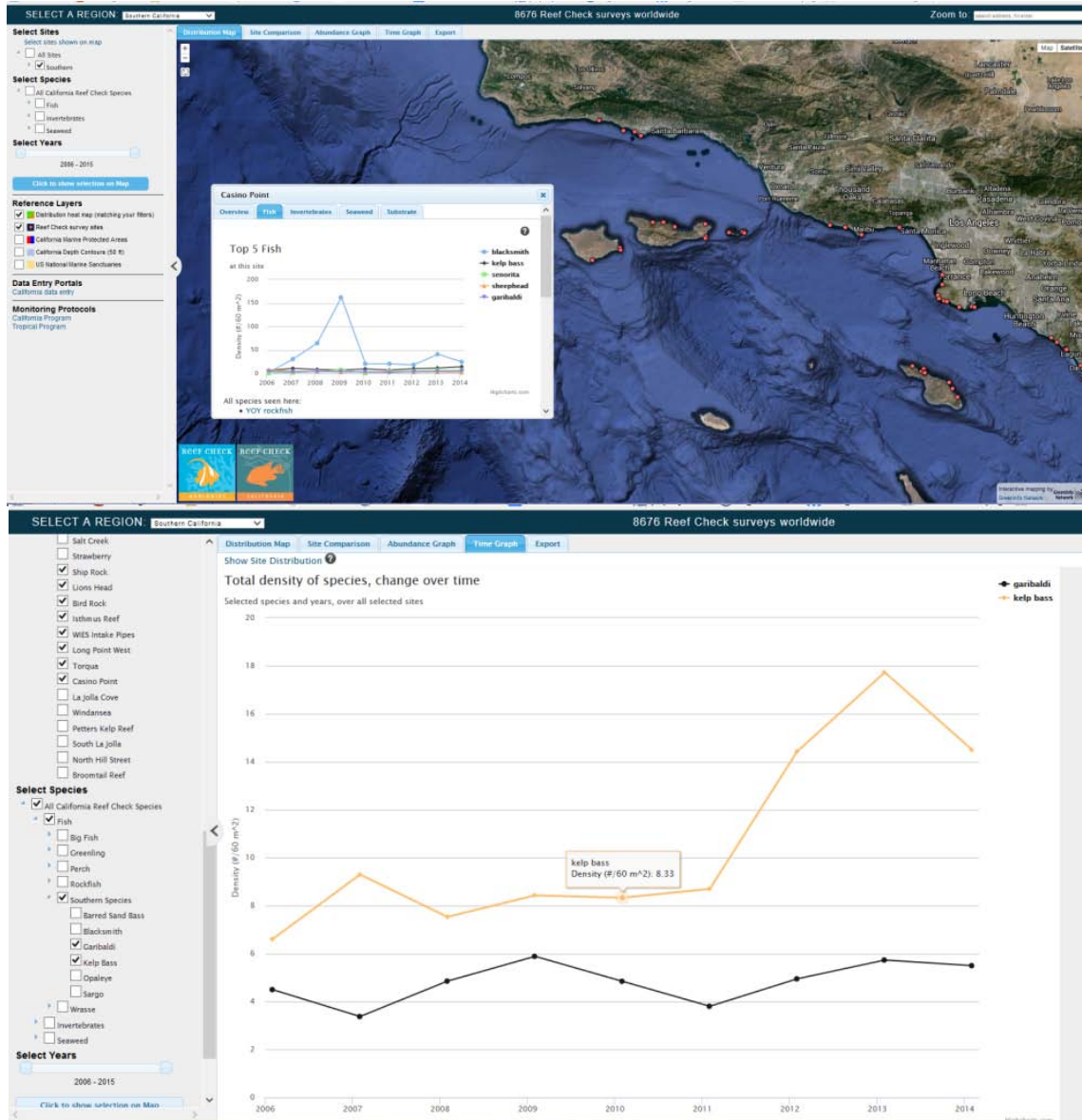
Figure 23. Reef Check's data display and distribution portal. Examples of the available interfaces to display data from individual monitoring sites, species information and regional summaries of temporal trends.

Conclusions

Long-term monitoring considerations and citizen Science MPA monitoring

Ecosystem-based management and conservation approaches, such as marine protected areas (MPAs), require large amounts of ecological data. These data are needed for their implementation, for adaptive management towards their goals and in order to evaluate their achievements or failures. In the South Coast Study Region, RCCA has established a cohesive group of volunteer citizen scientists that has monitored the rocky reef and kelp forest ecosystem since 2006. Many of the volunteers involved in this effort have been working with RCCA since the beginning and therefore, have years of experiences in monitoring. Others are newer and we are constantly adding more individuals and additional partnerships to our monitoring network. Now in its ninth year of long-term data collection in the SCSR, RCCA has built the capacity for continued cost-effective, long-term monitoring.

RCCA's involvement in the SCSR baseline monitoring demonstrates the effectiveness of utilizing southern California's large network of ocean enthusiasts and coastal communities to create citizen scientists for data collection in the region's MPAs and rocky reefs. Of special importance is the inclusion of regionally specific information, knowhow and understanding that locally experienced divers and communities bring to the monitoring effort. In turn, these volunteers and communities become educated in the scientific methods and gain a deeper understanding of their local marine ecosystems that they would not have without participating hands-on in the scientific monitoring of the MPAs.

"Reef Check makes me feel hopeful. It is a great program that
allows the networking of science professionals and people like
myself who want to do something to help."
                    – Bill Field, Avrey & Reese Builders – Reef Check Volunteer

"Reef Check California has taught me to respect the ocean environment
 on a much higher level...The fact that [Reef Check] puts data in the hands
 of policy and law makers so they have the ability to reference it and
 hopefully make informed decisions on marine preservation standards has
 kept me engaged in the program."
– Michelle Hoalton, Vice President of an engineering firm -- Huntington Beach

In contrast to many citizen science programs that have an educational focus, RCCA's goal is to collect and provide scientifically-rigorous data to inform marine management. An important benefit of involving the pubic (i.e. volunteers) in the monitoring of California's MPAs is that

training, education and monitoring provide an avenue for the public to be directly involved in the MPA management process from initial design and implementation to long-term monitoring and ecosystem condition assessment. RCCA's continued engagement of community members in scientific surveys provides an immersion-learning environment in which participants can gain knowledge of the ecosystems off their coast and engage in a meaningful effort to conserve and manage their marine resources.

The identification of four distinct kelp forest communities during the baseline monitoring period suggests that sites inside and outside of MPAs in all these respective communities need to be monitored in the future because distinct kelp forest communities might not respond in the same way to protection. Responses might differ, for example, based on their trophic structure or species interactions, such as predator-prey interactions. Therefore, a standardized monitoring program throughout the South Coast Study Region that samples all kelp forest communities will be required for long-term monitoring. We have not included the RCCA sites from the northern Channel Islands in the analyses in the final report but we have summarized their data in Appendix D. We plan to use data from these sites in an integrative project with the PISCO group at UC Santa Barbara to investigate commonalities and differences in the RCCA and PISCO datasets.

The species identified as potential indicators for MPA long-term monitoring are abundant and easy to identify and, therefore, will be relatively easy to monitor over the long-term. This species list should be augmented with other species based on comparison of RCCA's data with the datasets from the other projects that monitored the same ecosystems. During the baseline monitoring period, RCCA participated in an "expert judgment" workshop on ecosystem assessment in the south coast. Progress towards identifying indicator species was made during this process and this effort might be revisited as part of the integration of RCCA data with other monitoring programs.

The baseline monitoring consortium involved several citizen science monitoring programs alongside academic monitoring programs. In an integrative project, we will investigate different citizen science models and their program goals with respect to their involvement in MPA baseline monitoring and examine their respective monitoring protocols and data quality assurance measures in light of the goals of the MLPA baseline monitoring program. We will focus on three case studies: volunteer divers monitoring rocky reefs with the Reef Check California (RCCA) program, high school students monitoring rocky intertidal and sandy beach ecosystems with the LIMPETS program and commercial fishermen and other volunteers collaborating with researchers to study the California spiny lobster. Through analysis of the experiences from each of these very different projects, and drawing on broader literature focused on citizen science, we will elucidate capacities and potential of citizen science

approaches for MPA monitoring and for building capacity towards sustainable long-term monitoring of MPAs. In two of the three cases, comparison with academic monitoring programs surveying the same ecosystems, kelp forests and rocky intertidal, will inform recommendations for best practices for citizen science MPA monitoring and the creation of a framework of what types of monitoring questions can be addressed by citizen science. Results from this study will be relevant and timely as the monitoring of California's MPAs transitions from baseline to long-term monitoring, and as citizen science continues to becoming more prevalent in California and elsewhere in marine ecosystem monitoring.

Financial Report

Reef Check California budget and actual costs for SCSR baseline monitoring			
Category Reimbursement *(insert rows as needed for additional budget categories)*	**Category Budget**	**Total Cost to Date**	**Remaining Balance**
Salaries	$ 67,084.00	$ 63,368.38	$ 3,715.62
Benefits	$ 14,575.00	$ 15,273.34	$ (698.34)
Supplies	$ 41,625.00	$ 39,426.69	$ 2,198.31
Travel	$ 13,000.00	$ 11,788.76	$ 1,211.24
Other Costs (Contracts)	$ 12,400.00	$ 12,210.51	$ 189.49
Indirect	$ 11,608.00	$ 9,886.52	$ 1,721.48
TOTAL	**$ 160,292.00**	**$ 151,954.20**	**$ 8,337.80**

The above budget and actual costs represents the project expenses as of the end of 2013. The budget represents the current budget after two approved budget change requests and therefore differs from the original budget submitted at the beginning of the project. Budget changes were carried out in February and May of 2012. After these budget adjustments, the current actual costs do not exceed the budgeted cost by more than 10% in any category. Most of the requested funds have been spent as intended and presented in the revised budget. The remaining balance of $8,337.80 was allocated to Salaries and Indirect Costs for the preparation of the final report. We will submit an invoice for this with the final report.

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Appendix A
Reef Check California indicator fish species

Common Name	Scientific Name	Rationale
blacksmith	*Chromis punctipinnis*	C
opaleye	*Girella nigricans*	C, E
garibaldi	*Hypsypops rubicundus*	C, SI
sargo	*Anisotremus davidsoni*	C
black perch	*Embiotoca jacksoni*	C,E
striped seaperch	*Embiotoca lateralis*	C, E
rubberlip seaperch	*Rhacochilus toxotes*	C, E
pile perch	*Rhacochilus vacca*	C, E
rainbow seaperch	*Hypsurus caryi*	C, E
CA sheephead*	*Semicossyphus pulcher*	C, E, EI
rock wrasse	*Halichoeres semicinctus*	C
senorita	*Oxyjulis californica*	C
kelp bass	*Paralabrax clathratus*	C, E
barred sand bass	*Paralabrax nebulifer*	E
cabezon*	*Scorpaenichthys marmoratus*	E
lingcod	*Ophiodon elongatus*	E, SI
giant sea bass†	*Stereolepis gigas*	SI
kelp greenling*	*Hexagrammos decagrammus*	E
rock greenling*	*Hexagrammos lagocephalus*	E
horn shark	*Heterodontus francisci*	EI, E
kelp rockfish*	*Sebastes atrovirens*	E
grass rockfish*	*Sebastes rastrelliger*	E
brown rockfish*	*Sebastes auriculatus*	E
gopher rockfish*	*Sebastes carnatus*	E
black and yellow*	*Sebastes chrysomelas*	E
China rockfish*	Sebastes *nebulosus*	E
yellowtail rockfish & olive	*Sebastes flavidus/Sebastes serranoides*	E
copper rockfish*	*Sebastes caurinus*	E
vermilion rockfish & canary	*Sebastes miniatus/Sebastes pinniger*	E
black rockfish*	*Sebastes melanops*	E
blue rockfish*	*Sebastes mystinus*	E
bocaccio	*Sebastes paucispinis*	E, SI
treefish*	*Sebastes serriceps*	E

* Fin fishes included in the Nearshore Fishery Management Plan (www.dfg.ca.gov/mrd/nfmp/)
† Recorded if identified anywhere on site (on or off transect)
C = commonly observed, **E** = species exploited by recreational and commercial fishing,
EI = ecologically important species, **SI** = species of interest or concern (protected, endangered, overfished, etc.)

Reef Check California indicator invertebrate species

Common Name	Scientific Name	Rationale
red abalone*	*Haliotis rufescens*	E, SI
pinto abalone*	*Haliotis kamtschatkana*	E, SI
flat abalone*	*Haliotis walallensis*	E, SI
black abalone*†	*Haliotis cracherodii*	E, SI
green abalone*	*Haliotis fulgens*	E, SI
pink abalone*	*Haliotis corrugate*	E, SI
white abalone*†	*Haliotis sorenseni*	E, SI
CA spiny lobster	*Panulirus interruptus*	E
CA sea cucumber	*Parastichopus californicus*	E
warty sea cucumber	*Parastichopus parvimensis*	E
bat star	*Patiria miniata*	EI
short spined star	*Pisaster brevispinus*	EI
giant spined star	*Pisaster giganteus*	EI
sunflower star	*Pycnopodia helianthoides, Solaster* spp.	EI
chestnut cowry	*Cypraea spadicea*	E
Kellet's whelk	*Kelletia kelletii*	E
rock crab	*Cancer* spp.	E
sheep and masking crabs	*Loxorhynchus grandis, L. crispatus*	E
wavy and red turban snails	*Lithopoma undosum, L. gibberosum*	E
giant keyhole limpet	*Megathura crenulata*	E
gumboot chiton	*Cryptochiton stelleri*	C, EI
rock scallop	*Crassedoma giganteum*	E
red urchin	*Strongylocentrotus franciscanus*	E, EI
purple urchin	*Strongylocentrotus purpuratus*	EI
crowned urchin	*Centrostephanus coronatus*	C
CA golden and brown gorgonians**	*Muricea californica, M. fruticosa*	C
red gorgonians**	*Lophogorgia* chilensis	C
large anemones**	Order Actinaria	C

* Size estimated to nearest centimeter

** Anemones must be 10 cm or larger (height or width) to be recorded; gorgonians must be 10 cm or greater in height to be counted

All other organisms must be greater than 2.5 cm to be counted

† Recorded if identified anywhere on site (on or off transect)

C = commonly observed, **E** = species exploited by recreational and commercial fishing,

EI = ecologically important species (important to trophic food web), **SI** = species of interest or concern (protected, endangered, overfished, etc.)

Reef Check California indicator algae species

Common Name	Scientific Name	Rationale
giant kelp*	*Macrocystis pyrifera*	C, E, EI
southern sea palm**	*Eisenia arborea*	C, EI
pterygophora**	*Pterygophora californica*	C, EI
bull kelp**	*Nereocystis luetkeana*	C, EI
Laminaria**	*Laminaria* spp.	EI
sargassum[†]	*Sargassum muticum, S. filicinum*	I, EI
Undaria[†]	*Undaria pinnatifida*	I, EI
Caulerpa[†]	*Caulerpa taxifolia*	I, EI

Number of stipes greater than 1 meter per holdfast are recorded
** Must be taller than 30 cm to be recorded
† Recorded if identified anywhere on site (on or off transect)
C = commonly observed, **E** = species exploited by recreational and commercial fishing,
EI = ecologically important species (as food or habitat for the community), **SI** = species of interest or concern
(protected, endangered, overfished, etc.), **I** = invasive

Reef Check California habitat variables

Substrate categories:

- Sand – Grain size less than 0.5 cm (including shell debris, silt and clay)
- Cobble – Grain size 0.5 cm – 15 cm
- Boulder – Rocky substrate ranging in size from 15 cm to 1m in diameter
- Bedrock **–** Rocky substrate larger than 1 meter in diameter
- Other materials such as metal or concrete are recorded as 'other' when encountered

Relief Categories:

Relief is recorded as the distance between the lowest and the highest point of the substrate within a 1 meter by 0.5 meter box at each UPC point along the transect.

- 0 to 10 cm difference between highest and lowest point
- 10 cm to 1 m difference between highest and lowest point
- 1m to 2 m difference between highest and lowest point
- More than 2 m difference between highest and lowest point

Substrate cover categories:

- None - empty substrate
- Brown Seaweed - Any type of the five large kelps that are surveyed on the seaweed transect (giant kelp, bull kelp, Pterygophora, southern sea palm and Laminaria spp.).
- Articulated Coralline Algae
- Other Brown Seaweed - Any other type of brown seaweed including *Sargassum* spp., *Undaria pinnatifida* and *Cystoseira*
- Green Algae - Any type of algae that appears very green in color.
- Red Algae - Any type of algae that appears red in color (other than articulated and crustose coralline algae).
- Crustose Coralline Algae
- Sessile Invertebrates - Includes sponges, anemones, bryozoans, gorgonians, sandcastle worms, barnacles, etc.
- Mobile Invertebrates - Includes sea stars, urchins, sea cucumbers, crabs, limpets, etc.

Seagrasses -Includes surfgrass and eelgrass.

Appendix B
REEF CHECK CALIFORNIA
Monitoring methods

How to Participate in Reef Check California

The Reef Check California Training course is designed to provide participants with the skills required to precisely monitor shallow rocky reefs with the Reef Check California survey protocol. The training program also reviews safe diving practices learned in your SCUBA certification course, techniques of research diving, sampling design, general marine ecology, species identification and discussion about how monitoring helps achieve marine management needs. Trainings include a combination of classroom and field sessions. Following successful completion of the training, all participants will be issued a Reef Check California Certification and will be eligible to obtain a Reef Check California Specialty Certification through NAUI. Data will only be accepted by divers who have met the minimum testing standards and received accreditation from Reef Check.

No prior scientific training is required for participation. However, in order to be eligible to take this course you must meet the following course prerequisites:

• 　　　Proof of dive certification

- • 　　　Minimum of 30 logged lifetime dives
- • 　　　Minimum of 15 logged dives in California or other temperate region with water temperature below 65°F
- • 　　　Minimum of 6 dives within the last year
- • 　　　Minimum age of 16
- • 　　　Completion of liability release
- • 　　　Completed reading of Reef Check California Instruction Manual

Dive Experience

The Reef Check California protocol requires that divers successfully perform multiple tasks underwater. Tasks include hovering motionless near the seafloor (often in an upside down or horizontal position), identifying and counting target organisms and writing these observations on a slate. Multiple tasks often require extra concentration underwater and buoyancy control can easily be lost – even for experienced divers. **This course is designed for experienced divers who have mastered buoyancy and safe diving practices and are comfortable with their equipment.**

Reef Check California Survey Methods

The Reef Check California methodology is based on CRANE (Cooperative Research and Assessment of Nearshore Ecosystems) and PISCO (Partnership for Interdisciplinary Studies of Coastal Oceans) methodologies. Despite the scientific rigor of PISCO surveys, they cover only a small fraction of California's reefs (visit www.piscoweb.org for more information). CRANE was a joint research effort led by the Department of Fish and Wildlife that surveyed 88 sites between Monterey Bay and San Diego, including the Channel Islands. Unfortunately, these sites were all surveyed only once in 2004 and only portions of the sites have been surveyed since. Even with this tremendous effort, a comprehensive

picture of California's rocky reefs is not available due to the gaps in coverage and lack of replication. Through your regular efforts, we can make a difference in areas where government resources fall short!

You will collect many different types of surface and underwater data during your Reef Check California survey. All underwater surveys are based on the transects discussed in Chapter 4. All the datasheets you will use to complete a survey are found in Appendix B. You will be given these sheets on underwater paper for your training and surveys.

Survey Overview
A standard Reef Check California survey will include:

- **Site Description** (1 per site). Anecdotal, observational, historical, geographical and other data should be recorded on the Site Description Form. These data are extremely important when we interpret correlations in Reef Check California survey results. It is very important to describe the physical setting of the site and its position in relation to obvious human influences on the Site Description Form. This assures that data comparisons will be made between similar reef settings (see Chapter 6).

- **Fish Transects** (35 species, 18 transects each survey – 6 core transects and 12 fish-only transects). Divers search for and record the 35 target fish species observed along a transect 30 meters long, 2 meters wide and 2 meters high.

- **Invertebrate Transects** (30 species, 1 order (Actiniaria - anemones) - 6 transects each survey). Using the same 6 core transects as the fish transects, divers search for and record the target invertebrate species along the transect (30 x 2 meters). Note that these transects do not have a height associated with them; all target invertebrates are found only on the bottom.

- **Seaweed Transects** (8 species, 1 genus comprising several species, 6 fixed transects each survey). Target algae species within the 2 m swath along the core transects as well as invasive species that are noted as present or absent anywhere on the site.

- **Substrate Uniform Point Contact transects (UPC)** (6 transects each survey). The same core transects as the fish, invertebrate and seaweed transects are used, but this time, points are sampled at each 1 m interval along the tape. At each point, three types of information will be collected to determine reef substrate composition, organisms that are covering the reef and the rugosity (variation of vertical relief) of the reef.

- **Urchin Size Frequency Survey** (1 per site in fall only). This survey is not associated with a transect but should occur in the immediate vicinity of the core transects.

In total, there are 36 transects at each site: 6 core transects, each consisting of a fish, invertebrate, seaweed and UPC along the same transect tape; and then 12 fish only transects. Urchin surveys are not conducted on transect lines.

The transects should be grouped on the reef as inshore (closer to shore) and offshore (further from shore). Three core transects and 6 fish-only transects should be placed in each reef zone (inshore and offshore). Each transect should follow a predetermined compass heading and a designated depth contour. Transects can be laid one after another on small reefs, however, the transect start and end points **must** be separated by a minimum of a **5 m gap**. There should also be a minimum 5 meter spacing between transects (i.e., all transects should have spacing of 5m on all sides). These 5 meter gaps are necessary to ensure independence between samples (replicates). Due to logistics and safety, reef habitats deeper than **18 m (~60 feet)** will not be sampled. Zones were created to help allocate samples across an entire site providing a representative sample. Restrictive depth categorization for each zone were not used due to the variable topography of California's rocky reefs and logistical feasibility of sampling along fixed depth zones at multiple sites (Schroeder et al., 2002; J. Caselle, personal comm.).

In many cases, it will not be possible to follow a consistent depth contour for multiple transects. This is permissible as long as the transects are separated into outer and inner zones. There may even be some instances where an outer transect is shallower than an inner transect. This is why it is important to note the start and end depth of each transect on your datasheet. **The depth along any individual transect must not vary by more than 4 m (~12 feet) or cover more than 10 continuous meters of sand.** More details on sand in chapter 6.

Visibility must be at least 3 meters to conduct fish surveys. More details on checking visibility in chapter 5.

To keep track of the various transects, a specific numbering scheme must be used for all transects. Core transects shall be numbered 1 – 6 with the outer transects numbered first as 1 -3 (deeper dive first) and the inshore core transects numbered 4 – 6. Fish-only transects shall be numbered 7 – 18 with the offshore fish only transects numbered 7 – 12 (deeper dive first) and the inshore fish only transects numbered 13 – 18 (Figure 5).

Sites should be targeted to be surveyed a minimum of one time per year, preferably twice with a survey in spring and fall. Unless you have a large team, it is not likely you will be able to complete the Reef Check California survey in one day of diving. It is perfectly acceptable to spread the diving out over several days, although we require that all transects be completed within a 4 week time period to minimize temporal variation associated with that survey.
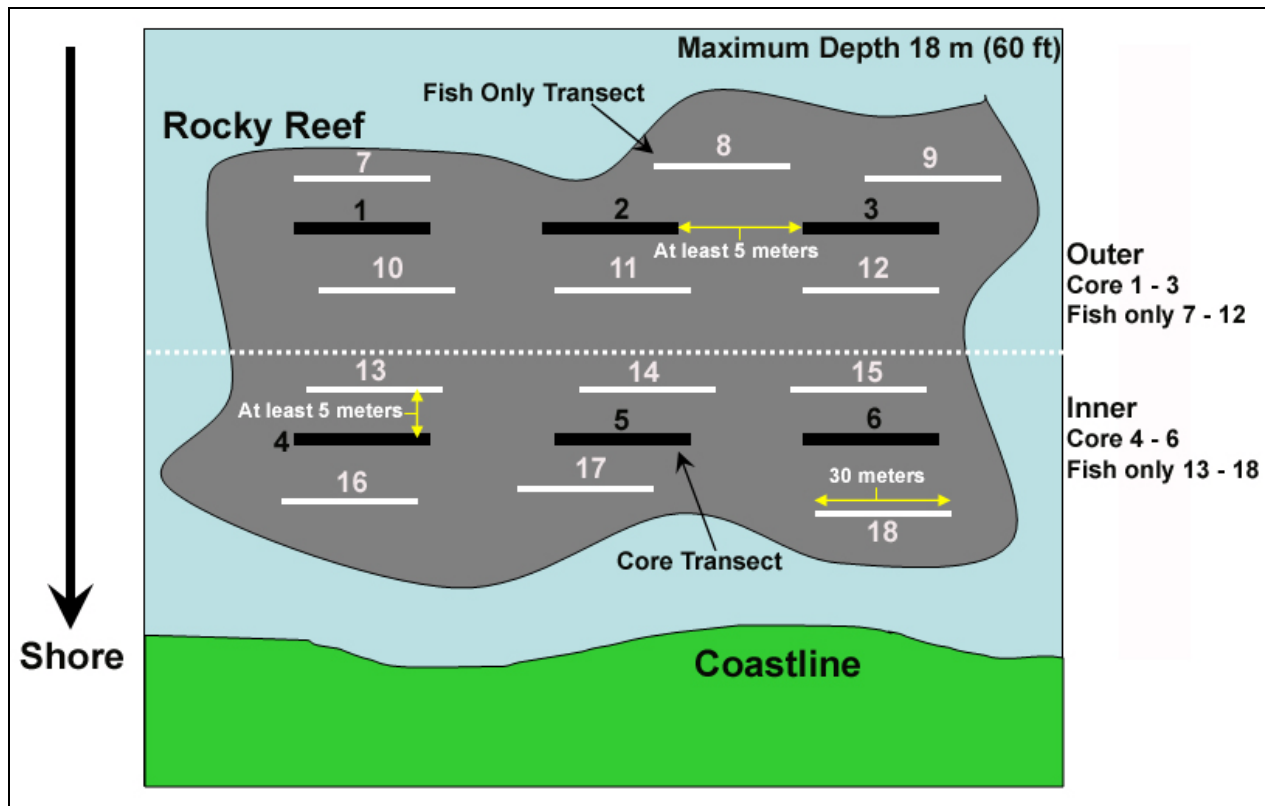
Figure 1. Diagram of transects over a rocky reef. All teams should aim to complete six core transects, which are marked in bold (3 in each zone), plus an additional twelve random fish only transects, which are marked in white (6 in each zone). All transects are 30 meters in length.

Site Selection

Site selection is a critical factor in the success of your surveys. The ultimate goal of Reef Check California is to monitor rocky subtidal communities twice per year along the entire mainland and island coasts. Initially, priority will be given to monitoring sites inside and on the periphery of planned or existing MPAs and at sites recommended by CDFW. Monitoring sites will be selected based on a variety of factors including, but not limited to, logistics, accessibility and presence of volunteer teams. In addition to the criteria listed above, teams are encouraged to adopt their "favorite" dive site as a monitoring location.

For the purposes of Reef Check California, **a site is defined as 250 linear meters of coastline unless distinguished by distinct geological features** (e.g., a bay). When selecting sites it is helpful to first map the area of interest. This will help you to identify the best places to deploy your transects. Due to the importance of long-term monitoring, preference should be given to sites that teams anticipate they can revisit year after year.

With all site selection, however, it is important to remember that a survey is only a sample of the rocky reef environment. The site selected for the survey should be representative of the reef area of interest. For purposes of standardization, surveys of steep walls (drop-offs), pinnacles, and reefs predominantly located in caves or beneath overhangs should be avoided.

Target Species

The Reef Check California protocol was designed to assess the health of rocky reefs and is quite different from many other monitoring protocols. Reef Check California focuses on the abundance of local marine organisms that not only best reflect the condition of the ecosystem, but are easily recognizable. Before selecting the species list, a thorough literature review was conducted in order to determine which species are currently monitored by the numerous existing sampling programs and the criteria the groups used to select their target species (Burcham, 2004; CDFG, 2004b; Carr et al., 2003; Schroder et al., 2002; Davis et al., 1997). In addition, an analysis of the REEF volunteer database (www.reef.org) provided insight into the relative frequency of species encountered by recreational divers in the Monterey/Carmel region (J. Wolfe, personal comm.).

The Reef Check California shallow subtidal species list was compiled using the following criteria:
- Ease of identification
- Species commonly observed by divers in shallow subtidal rocky reef habitat
- Species of special interest or concern (i.e., protected species, species known to be endangered, overfished and/or seriously depleted)
- Species commonly targeted by recreational and commercial fishing activities
- Ecologically important species

For example, the garibaldi was selected because it is commonly observed in Southern California and it is a species of special interest or concern due to its protected status and designation as California's state marine fish. The red urchin, on the other hand, was selected because it is a commercially fished species and is an ecologically important species. Cryptic species are not included because they cannot be surveyed adequately by visual techniques alone (Stephens et al., 2006).

The Reef Check California Protocol survey includes 30 invertebrate species and 1 invertebrate order; 35 fish species; 8 algal species and 1 algal genus (Tables 1 - 3). There are several important points to keep in mind as you learn the taxa:

- Fishes will be recorded to the nearest centimeter and differentiated as juveniles, males and females where appropriate.
- Size estimates will be made of all abalones to the nearest centimeter. If you cannot physically measure an abalone but can clearly identify the species, instead of recording the size in centimeters (e.g. "17") on your datasheet you will record "X" to denote no size was obtained.
- All juvenile or "young-of-the-year" (YOY) rockfish shall be recorded as YOY on your datasheet. They are not sized since YOYs are <10cm.
- Certain species that are difficult to tell apart, like the yellowtail and olive rockfishes, are grouped into a single category. Note: although this will decrease the resolution of the data that is collected, it will increase the precision of counts by minimizing observer error.
- All invertebrates and seaweeds have minimum size requirements. These are described later and noted on all data sheets.
- **DO NOT GUESS!** Bad data are much worse than no data. If you are surveying and are not sure of identification of a species, make notes in the comments section of your datasheet or on your slate and discuss it with your team after the dive. If appropriate (i.e. you have the required license and have a high probability of returning the organism unharmed) and in an area that

does not have restrictions prohibiting take, you can gently bring back sessile invertebrates or algae for ID confirmation after you complete your survey. Be sure to replace anything you take by returning it as close as possible to the location from where it was removed.

Reef Check California will not have separate target species lists for different geographic regions in California. Although we recognize the distinct biological breaks along California's coast and associated differing compositions of species, separate species lists would limit the ability of the monitoring program to detect subtle geographic range shifts in target species. In addition, a single species list permits volunteers trained in any part of California to participate in surveys along the entire coast.

A NOTE ON SAFETY!

Diver safety is our number one priority. Reef Check surveys should NOT be undertaken when weather or sea conditions are unsafe or if a diver does not feel well. In particular, teams should **NEVER** plan any dives that will require **decompression**. Any diver who is not comfortable diving for any reason should **NOT** participate in the diving aspects of the survey.

Invertebrate Transects

Reef Check California Invertebrate Species

Unlike fish, most invertebrates are relatively sedentary (they don't move very much), allowing for careful examination of their features. Some invertebrates will be camouflaged, and thus, difficult to notice, which means that you must know what you are looking for in order to sample well.

The Reef Check California invertebrate species are listed in Table 1 and pictures can be found in Appendix C. More detailed descriptions can be found in the accompanying training materials. Please note the specific measurement requirements for each species and the rationale for its selection.

Table 1. Species and rationale of Reef Check California indicator invertebrate species.

Common Name	Scientific Name	Rationale
red abalone*	*Haliotis rufescens*	E, SI
pinto abalone*	*Haliotis kamtschatkana*	E, SI
flat abalone*	*Haliotis walallensis*	E, SI
black abalone*[†]	*Haliotis cracherodii*	E, SI
green abalone*	*Haliotis fulgens*	E, SI
pink abalone*	*Haliotis corrugate*	E, SI
white abalone*[†]	*Haliotis sorenseni*	E, SI
CA spiny lobster	*Panulirus interruptus*	E
CA sea cucumber	*Parastichopus californicus*	E
warty sea cucumber	*Parastichopus parvimensis*	E
bat star	*Patiria miniata*	EI

short spined star	*Pisaster brevispinus*	EI
giant spined star	*Pisaster giganteus*	EI
sunflower star	*Pycnopodia helianthoides, Solaster* spp.	EI
chestnut cowry	*Cypraea spadicea*	E
Kellet's whelk	*Kelletia kelletii*	E
rock crab	*Cancer* spp.	E
sheep and masking crabs	*Loxorhynchus grandis, L. crispatus*	E
wavy and red turban snails	*Lithopoma undosum, L. gibberosum*	E
giant keyhole limpet	*Megathura crenulata*	E
gumboot chiton	*Cryptochiton stelleri*	C, EI
rock scallop	*Crassedoma giganteum*	E
red urchin	*Strongylocentrotus franciscanus*	E, EI
purple urchin	*Strongylocentrotus purpuratus*	EI
crowned urchin	*Centrostephanus coronatus*	C
CA golden and brown gorgonians**	*Muricea californica, M. fruticosa*	C
red gorgonians**	*Lophogorgia* chilensis	C
large anemones**	Order Actinaria	C

* Size estimated to nearest centimeter
** Anemones must be 10 cm or larger (height or width) to be recorded; gorgonians must be 10 cm or greater in height to be counted
All other organisms must be greater than 2.5 cm to be counted
† Recorded if identified anywhere on site (on or off transect)
C = commonly observed, **E** = species exploited by recreational and commercial fishing,
EI = ecologically important species (important to trophic food web), **SI** = species of interest or concern (protected, endangered, overfished, etc.)

Invertebrate Transect

Individuals of the RCCA invertebrate species list are recorded along a two meters wide (1 meter on either side of the transect line) and 30 meters long transect. Therefore, the total survey area is 30 meters x 2 meters = 60 square meters for each transect. Flashlights are required on the invertebrate surveys to look in cracks and crevices (standardized for all surveys). Flashlights should also be used to verify urchin species, red urchins (*Strongylocentrotus franciscanus*), which can be a dark red, vs. crowned urchins (*Centrostephanus coronatus*), which have a bright blue ring at the base of each spine (Figure 12). Flashlights are also necessary for identifying abalone species.

If you should encounter a large abundance of a particular species, you may subsample. You can stop counting once you have counted 50 individuals of that species ONLY if you record on your datasheet the distance you have traveled along the transect. If, for example, you counted the fiftieth bat star at 10 meters along the transect, you would stop counting and write 50 in the total column and 10 in the distance column. Pay special attention to record the distance traveled when working backwards along the transect line. For example, if you were working backwards along the transect line and recorded 50 bat stars in the first 5 meters, you would record 5 m, not 25 m (which would be your location on the transect line). Only seaweed and invertebrates are subsampled. Fishes are NOT subsampled.

It is important to note that all invertebrates have a minimum size requirement of < 2.5 cm except large anemones and gorgonians, which have a minimum size of 10 cm. Shell lengths of all abalones should be recorded to the nearest centimeter. If you can't physically measure an abalone record "X" on your datasheet in the appropriate species row. In addition, **due to their endangered statuses, white and black abalones should be recorded if they are observed anywhere during the survey (on or off of transect).** If you believe you see one do as much of the following as possible: check for confirmation from your buddy; record whether or not it is on transect; take a photo including the holes, shell and epipodium; and mark the location with a float so GPS coordinates can be taken from the surface.

It is imperative that your sampling is non-invasive. While it is extremely important to look in cracks and under overhangs to search for hidden species such as lobster, it is also important not to move any of the organisms during a survey. Invertebrate surveying is generally most easily performed when the diver adopts a face down, feet up position no more than 3 feet off the bottom.

Starting and ending times should be recorded on the datasheet in the appropriate location. There is no time limit for invertebrate transect; however, they should be performed with a 10 min goal in mind. A note should be made of any rarely sighted animals such as giant octopus, sharks and bat rays. They should be recorded at the bottom of the datasheet under "Comments." See Figure 7 for an example on how to record data on the invertebrate datasheet.

The importance of white and black abalone

On 29 May 2001, the National Marine Fisheries Service (NMFS) listed the white abalone as a federally endangered species under the U.S. Endangered Species Act, making it the first marine invertebrate to be listed. Despite the fact that part of the white abalone fishery has been closed since 1977, densities have continued to fall. Current population estimates indicate that white abalone have declined by as much as 99% since the 1970s (CDFG, 2004). Black abalone became listed as a federally endangered species by NMFS on 13 February 2009. These abalone were harvested early in CA history and commercial harvesting peaked in the 1970s. Much of the loss since the 1980s has been attributed to the disease withering syndrome. The commercial and recreational fisheries closed in 1993 (NOAA, 2004).

Seaweed Transect

Reef Check California Seaweed Species
The Reef Check California seaweed species are listed in Table 2 and pictures can be found in Appendix C. More detailed descriptions can be found in the accompanying training materials. Please note the **specific height requirements for each species** and the rationale for its selection. It is also important to pay special attention to four species of invasive seaweed (*Undaria pinnatifida, Caulerpa taxifolia, Sargassum filicinum* and *S. muticum*). These species should be recorded as present if they are seen anywhere during a survey. If you detect either *Undaria pinnatifida, Caulerpa taxifolia* it is important to document your finding by either taking a picture (above or below water) or taking a sample and sending it to Reef Check Headquarters for identification. **If a sample is removed, be certain not to spread the invasive species.**

Table 2. Species and rationale of Reef Check California indicator seaweed species.

Common Name	Scientific Name	Rationale
giant kelp*	*Macrocystis pyrifera*	C, E, EI
southern sea palm**	*Eisenia arborea*	C, EI
pterygophora**	*Pterygophora californica*	C, EI
bull kelp**	*Nereocystis luetkeana*	C, EI
Laminaria**	*Laminaria* spp.	EI
sargassum†	*Sargassum muticum,* *S. filicinum*	I, EI
Undaria†	*Undaria pinnatifida*	I, EI
Caulerpa†	*Caulerpa taxifolia*	I, EI

Number of stipes greater than 1 meter per holdfast are recorded

** Must be taller than 30 cm to be recorded

† Recorded if identified anywhere on site (on or off transect)

C = commonly observed, **E** = species exploited by recreational and commercial fishing, **EI** = ecologically important species (as food or habitat for the community), **SI** = species of interest or concern (protected, endangered, overfished, etc.), **I** = invasive

Seaweed Transect

Seaweeds, also known as marine algae, are attached directly to the substrate and will be sampled using the same 30 m x 2 m transect that was utilized during the invertebrate transect. Note that four species of invasive algae are observed as "present" or "absent" anywhere near the survey site (on or off transect). All non-invasive species have a minimum height requirement, which can be found on the datasheet. In addition, the number of stipes ("stems") of giant kelp per individual holdfast is recorded. Counting kelp stipes should be done 1m off the bottom and can be easily accomplished by running one's fingers through the kelp stipes counting as you go (Figure 6). For very dense kelp, it may be necessary to count the number of stipes that fit in one "handful" and then count "handfuls" to estimate the total number of stipes per kelp. The seaweed species list and specifics for measurement are listed in Table 2.

Again, subsampling methods will be employed when performing seaweed counts. Once 50 individuals of a species have been counted, record the number and the distance on your data sheet. **Of special note - when subsampling giant kelp, stop counting at 50 individual plants (holdfasts) not 50 stipes.** Starting and ending times should be recorded on the datasheet in the appropriate location. There is no time limit for seaweed transects; however, they should be done with a 10 min goal in mind. See Figure 7 for an example on how to record data on the seaweed datasheet.

Figure 2. Using fingers to count kelp stipes at 1m off the bottom (Photo: C. Shuman).

Invertebrate/Seaweed Data Sheet

SITE Weston Reef   Date 6/5/12   Diver: Joe Diver
Visibility (m) 10   Buddy: Jane Diver

Count all orgs. > 2.5 cm 10 Minute goal (30 x 2 m)	Transect#: 4 Time: Beg 9:35 End 9:45	Dist	30 x 2 m Transect 10 Minute goal	Transect#: 4 Time: Beg 9:47 End 9:55	Dist
Abalones					
red abalone (size cm)	19, 22, 10, X (4)		Bull kelp >30cm		
flat abalone (size cm)	9 (1)				
pinto abalone (size cm)					
green abalone (size cm)			Pterygophora	HT HT HT HT HT HT HT HT HT HT (50)	
pink abalone (size cm)			>30cm		21
Unknown abalone					
CA spiny lobster					
Cucumbers CA sea cucumber			So. sea palm >30cm		
warty sea cucumber					
Sea Stars bat star	(50) HT HT HT HT HT HT HT HT HT HT	13			
short spined sea star					
giant spined star	HT II (7)		Laminaria spp	HT HT III (13)	
sun/sunflower star	II (2)		>30cm >30cm		
Slugs/snails chestnut cowry					
Kellet's whelk					
wavy / red turban snail					
giant keyhole limpet	(3)				
Crabs rock crab			giant kelp	45, 11, 30, 1, 2, 1, 1, 14, 75 1, 1, 2, 13 (13)	
sheep/masking crab					
gumboot chiton	3, 4 (7)				
rock scallop					
large anemone (>10cm)	4, III (7)				
Gorgonians brown/golden gorgonian (>10cm)			>1 m		
red gorgonian (>10 cm)					
Urchins red urchin	6, 3, 11 (20)		# stipes >1m/holdfast		
purple urchin					
crowned urchin					
Black ab (Y/N) N	White ab (Y/N) N				
Other/comments					

*Do not count seaweed used to attach transect

Sargassum muticum Yes____ No ✓
Sargassum filicinum Yes____ No ✓
Undaria Yes____ No ✓
Caulerpa Yes____ No ✓

Subsample abundant organisms: at ~50, stop counting and record distance surveyed along transect (meters)

Reef Check California   RCCA Data Sheets 2011-02-24.xlsx

Figure 3. Example datasheet demonstrating how to record invertebrate and seaweed data during a RCCA survey.

Uniform Point Contact (UPC) Transect

The Uniform Point Contact Survey (UPC) involves collecting three types of data at points spaced in 1 meter intervals along the transect line. The data collected at each point are: 1) substrate type, 2) type of organisms covering the substrate and 3) rugosity or relief. There is a space for each point sample on the UPC datasheet (Appendix B). Record the category codes in the appropriate spaces on the datasheet. Upon completion of the dive, tally up the number of each of the codes in the space provided on your sheet. Check to ensure that substrate, cover and rugosity each total 30 points. There is no time limit for a UPC transect.

Substrate

There are many cases when the substrate type may be ambiguous and you will have to do your best to make an unbiased assessment. Please use the following guidelines to identify substrate types. Note that these may differ from other definitions with which you are already familiar.

Substrate type will be recorded as:

S - Sand/Silt/Clay (< 0.5 cm)

C - Cobble (rock and shell debris, 0.5 cm – 15 cm)

B - Boulder (> 15 cm – 1m diameter)

R - Reef (> 1m diameter)

O - Other (metal, other man-made material etc.)

Cover

Bottom cover will be determined by recording what is directly under each 1 meter point along the transect line. Ten categories will be used to record what percentage of the bottom is occupied by certain individuals. Mobile invertebrates (urchins, sea cucumbers, sea stars, etc.) should be recorded as MI. Invertebrates that cannot change location (sponges, tunicates, scallops, barnacles, etc) should be recorded as SI (Sessile Invertebrates). There are 6 categories of algae that can be covering the bottom (see below for codes). When in doubt about which color the algae is use your flash light. Please note that there are two categories for brown seaweed, Brown Seaweed (B) and Other Brown Seaweed (OB). Category B is used to describe only the five kelps that are counted during an algae transect. The OB category describes any other brown seaweed, including the brown invasives, *Undaria pinnatifida* and *Sargassum* spp. If the point falls upon any part of the alga (blade, stipe, holdfast) it should be recorded. This rule applies to all algae except category B (Brown), which should only be recorded if the point falls directly on its holdfast. Non-attached algae, or drift algae, should be moved when encountered to determine what is below. When long blades of algae are encountered it is important to determine if they are attached to the reef (accomplished by giving a gentle tug). If they are attached they will be counted and if they are not attached they will not be counted. Low profile, fuzz-like growth that you cannot physically grab and remove from the substrate should be disregarded and you should record the dominant feature below it. If the fuzz-like growth is significant enough to grab a piece from the substrate and the color can be determined, record it in the appropriate seaweed category. If the point falls on an empty shell it should be moved to record what is beneath it.

Cover will be recorded as:

N – None.

B – Brown Seaweed. Any type of the five large kelps that are surveyed on the seaweed transect (giant kelp, bull kelp, Pterygophora, southern sea palm and Laminaria spp.).

AC - Articulated Coralline Algae (Figure 8).

OB – Other Brown Seaweed. Any other type of brown seaweed including *Sargassum* spp., *Undaria pinnatifida* and *Cystoseira* (Figure 9).

G – Green Algae. Any type of algae that appears very green in color.

R – Red Algae. Any type of algae that appears red in color (other than articulated and crustose coralline algae).

CC - Crustose Coralline Algae. Only if there are no other organisms present above it (Figure 10).

SI - Sessile Invertebrates. Includes sponges, anemones, bryozoans, gorgonians, sand castle worms, barnacles, etc. (Figure 11).

MI- Mobile Invertebrates. Includes sea stars, urchins, sea cucumbers, crabs, limpets, etc (Figure 12, Figure 13).

SG- Seagrasses. Includes surfgrass and eelgrass.

Figure 4. Different types of articulated coralline algae. The keyhole limpet and purple urchin burrowed in the rock would be recorded as mobile invertebrates (Photos: C. Shuman).

Figure 5. Examples of Other Brown algae (OB) (Photos: D. Richards, M. Schwalbach, and K. A. Miller).

Figure 6. Crustose coralline algae (Photo: C.Wisniewski)

Figure 7. The sponges (top left), bryozoans (top right) and anemone (bottom right) are examples of sessile invertebrates. Although some anemones have the ability to slowly move locations, we will be considering the anemones that we encounter as sessile (Photos: C. Wisniewski)

Figure 8. Urchins are examples of mobile invertebrates. Flashlights help to distinguish between red urchins (left) and crowned urchins (right) which both can look black in color. Red urchins reflect back a red color and crowned urchins have a bright blue ring at the base of the spines. (Photos: C. Wisniewski)

Figure 9. The sea cucumber, keyhole limpet, sea star (left photo) and red abalone (right picture) are examples of mobile invertebrates (Photos: L. Fink and M. Wehrenberg).

Rugosity

Rugosity (vertical relief) will be estimated by determining the greatest vertical relief that exists within a 1 meter by 0.5 meter imaginary box along the tape. The measured section will extend 0.5 m in front of each point and 0.5 m to either side of the tape. The height is estimated as the difference in height between the highest and lowest points within the imaginary 1 m x 0.5 m box in front of you (Figure 14). Four categories will be used to record vertical relief estimates:

Category 0: 0 – 10 cm
Category 1: > 10 cm – 1 m
Category 2: > 1m – 2 m
Category 3: > 2 m

Top View of Transect

1 meter

0.5 meter

Transect line

1 meter

1 meter

Transect line

1 meter

2 meters

Transect line

Head-on view of Transect
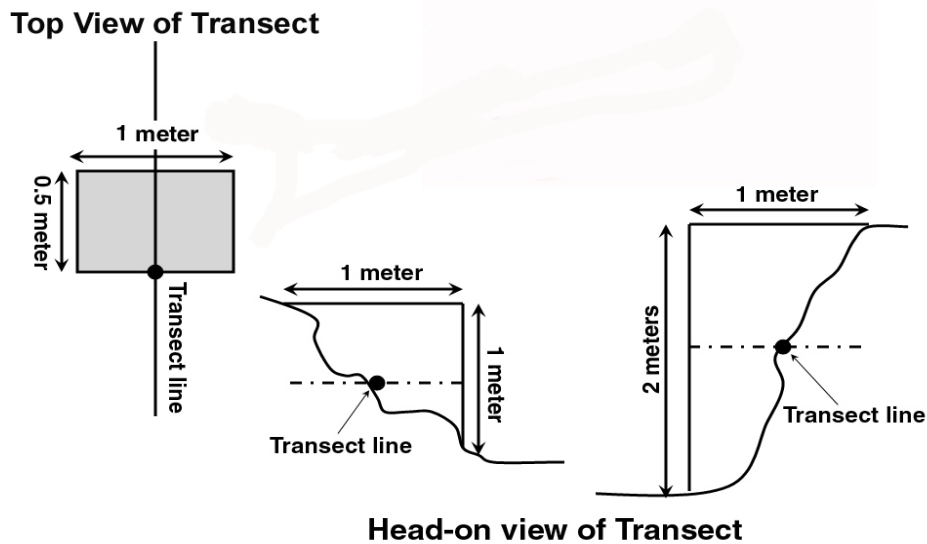
Figure 10. Physical relief is measured as the greatest vertical relief within a 1-meter wide section across the tape and .5-meter section in front of each point

Fish Transect

Reef Check California Fish Species

While the prospect of learning the 35 fish species listed in Table 3 may appear daunting, you will be surprised that with a bit of practice you will soon be a fish identification expert. Underwater fish identification will be eased by considering the following factors: habitat, behavior, size, shape, color and markings.

- **Habitat** - Is the species swimming in the mid-water or hiding under or on a rock? At what depth did you see it?

- **Behavior** - Is the fish schooling or is it alone? Does it immediately swim away when it sees you?

- **Size and shape** - There are several areas on which to focus: the body, mouth, fin shape, color and markings.

- **Body** - Does the fish have a heavy body and large lips? If so, it is probably a rockfish or a sea bass. Does it look eel-like or have an elongated body? If so, it is probably a kelp greenling or lingcod.

- **Mouth** - By looking at the mouth type and shape, you can often determine the food source (e.g., senorita and sheephead).

- **Fin shape** - Examine the tail and dorsal fins of the species of interest. Are they rounded, straight, forked or joined?

- **Color** - Remember that color varies dramatically and is influenced by conditions, especially light levels. The most reliable places to look for colors are the fins. The vermilion rockfish, for example, has dark edges on its fins. It is important to remember that for some species there can be significant variation between males and females (e.g., kelp greenling and sheephead) and between different life phases – juvenile and adult (e.g., sheephead, garibaldi and rockfish).

- **Markings** - Generally more distinctive than colors, markings are the bedrock of any ecologist's fish identification skill set. Pay special attention to stripes (horizontal), bars (vertical) or bands for identifying sea perch and sargo. For identifying yellowtail rockfish, olive rockfish and juvenile garibaldi, on the other hand, it is best to look for spots or blotches. Finally, fine lines or speckles along body are important to consider when identifying striped sea perch and blacksmith.

All Reef Check California fish species are pictured in Appendix C. Additional information can also be found on your flash cards that were included in your supplemental training materials.

Table 3. Species, measurement criteria and rationale of Reef Check California indicator fish species.

Common Name	Scientific Name	Measured Specifics (cm)	Rationale
blacksmith	*Chromis punctipinnis*	<15, 15-30, >30	C
opaleye	*Girella nigricans*	<15, 15-30, >30	C, E
garibaldi	*Hypsypops rubicundus*	Juv, adult, <15, 15-30, >30	C, SI
sargo	*Anisotremus davidsoni*	<15, 15-30, >30	C
black perch	*Embiotoca jacksoni*	<15, 15-30, >30	C,E
striped seaperch	*Embiotoca lateralis*	<15, 15-30, >30	C, E
rubberlip seaperch	*Rhacochilus toxotes*	<15, 15-30, >30	C, E
pile perch	*Rhacochilus vacca*	<15, 15-30, >30	C, E
rainbow seaperch	*Hypsurus caryi*	<15, 15-30, >30	C, E
CA sheephead*	*Semicossyphus pulcher*	Juv, female, male, <15, 15-30, >30	C, E, EI
rock wrasse	*Halichoeres semicinctus*	Juv, female, male, <15, 15-30, >30	C
senorita	*Oxyjulis californica*	<15, 15-30, >30	C
kelp bass	*Paralabrax clathratus*	<15, 15-30, >30	C, E
barred sand bass	*Paralabrax nebulifer*	<15, 15-30, >30	E
cabezon*	*Scorpaenichthys marmoratus*	<30, 30-50, >50	E
lingcod	*Ophiodon elongatus*	<30, 30-50, >50	E, SI
giant sea bass†	*Stereolepis gigas*	None	SI
kelp greenling*	*Hexagrammos decagrammus*	Juv, male, female, <15, 15-30, >30	E
rock greenling*	*Hexagrammos lagocephalus*	<15, 15-30, >30	E
horn shark	*Heterodontus francisci*	<30, 30-50, >50	EI, E
kelp rockfish*	*Sebastes atrovirens*	<15, 15-30, >30	E
grass rockfish*	*Sebastes rastrelliger*	<15, 15-30, >30	E
brown rockfish*	*Sebastes auriculatus*	<15, 15-30, >30	E
gopher rockfish*	*Sebastes carnatus*	<15, 15-30, >30	E
black and yellow*	*Sebastes chrysomelas*	<15, 15-30, >30	E
China rockfish*	Sebastes *nebulosus*	<15, 15-30, >30	E
yellowtail rockfish & olive	*Sebastes flavidus/Sebastes serranoides*	<15, 15-30, >30	E
copper rockfish*	*Sebastes caurinus*	<15, 15-30, >30	E
vermilion rockfish & canary	*Sebastes miniatus/Sebastes pinniger*	<15, 15-30, >30	E
black rockfish*	*Sebastes melanops*	<15, 15-30, >30	E
blue rockfish*	*Sebastes mystinus*	<15, 15-30, >30	E
bocaccio	*Sebastes paucispinis*	<30, 30-50, >50	E, SI
treefish*	*Sebastes serriceps*	Juvenile, Adult, <15, 15-30, >30	E

* Fin fishes included in the Nearshore Fishery Management Plan (www.dfg.ca.gov/mrd/nfmp/)
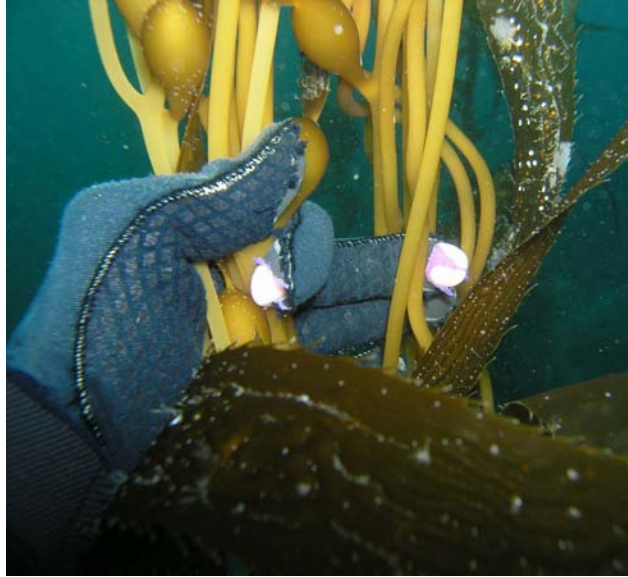
† Recorded if identified anywhere on site (on or off transect)

C = commonly observed, **E** = species exploited by recreational and commercial fishing,

EI = ecologically important species (important to trophic food web), **SI** = species of interest or concern (protected, endangered, overfished, etc.)

SPECIAL NOTE: In addition to the species listed above RCCA also counts "young-of-the-year" (YOY) rockfishes (Figure 15). Another name for these newly born rockfishes is "recruits." Rockfishes have pelagic larvae that are released from the females in the kelp forest and then drift offshore on the currents until they eventually are return into nearshore waters and "recruit" back to the kelp forest to grow into adults. The timing of the release of larvae and the duration of their pelagic stage varies by species. Generally juveniles are released in the early spring to fall and are in the pelagic stage from 1- 6 months depending on the species (Love e al. 2002). It is difficult for even the most highly trained scientists to differentiate YOY rockfish species when they are < 10 cm. As an RCCA certified diver you will be asked to identify small individuals (greater than 2.5 cm) that clearly have a rockfish body shape but with coloration and/or markings that differ from adults and record them as YOY on your datasheet. Even if you can identify YOYs to species do not record them under the respective species but as the YOYs on your datasheet.

Figure 11 Various young-of-the-year (YOY) rockfish species.

In addition to the species descriptions found in the supplemental training materials and in Appendix C, we recommend investing in a quality fish identification guide. Some of our favorites include:

Gotshall, D. W. 2001. Pacific Inshore Fishes, Fourth Edition (Revised). Sea Challengers, Monterey, California.
Allen, L.G., D. J. Pondella II, and M. H. Horn (eds) 2006. The Ecology of Marine Fishes.
California and Adjacent Waters. University of California Press, Berkeley, California.
Eschmeyer, W. N. and E. S. Herald. 1983. A Field Guide to Pacific Coast Fishes North America (A Peterson Field Guide). Houghton Mifflin Co, Boston / New York.
Humann, P. 1996. Coastal Fish Identification Guide: California to Alaska. New World Publications, Jacksonville, Florida.
Love, M. S., M. Yoklavich, and L. Thorsteinson 2002. The Rockfishes of the Northeast Pacific. University of California Press, Berkeley, California.
Love, M. 1996. Probably more than you want to know about the fishes of the Pacific coast. Really Big Press, Santa Barbara, California.

Fish Transects

Visibility check
You must measure visibility to ensure you have the > 3 m visibility required to survey fish. To perform a visibility check, your buddy stays stationary, holds the free end of tape in one hand (preferably wearing

a black glove) and displays their other hand away from their body with their five fingers spread wide. You take the reel end of the tape and swim out until you can no longer make out the individual fingers on your buddy's hand. Then, reel in just slightly so you can clearly see each finger. Record on the datasheet the furthest distance from your buddy at which you can clearly make out each individual finger. If when you enter the water it is obvious that you have > 3 m visibility, then the visibility measurement should be done after you complete your assigned transects. If you have any doubt about the visibility perform the measurement prior to starting the survey and then make sure to move at least 5 m before beginning your transect.

Fish are surveyed along a 30 m transect in an area 2 m across the transect tape and 2 m off the bottom (30 x 2 x 2 m = 120 m3). We require that fish are surveyed while the transect is being deployed in order to minimize disturbance to fish and potential bias to counts. The maximum water column height above the transect to record fish is restricted to 2 m. RCCA divers will swim the fish survey as a buddy team. However, **ONLY** the diver deploying the transect (primary) will be conducting the fish survey count. The diver that is not deploying the transect tape (secondary) shall be responsible for:

- Staying well behind the bubble stream of the first diver and out of that diver's field of vision
- Maintaining close enough contact to assist in an emergency
- Evaluating the survey technique (e.g. speed, ensuring the diver is looking in all crevices as well as surveying the midwater, direction, etc.)

The secondary diver is a crucial part of the quality control program for Reef Check and should make notes on their data board to give feedback to the primary diver on the surface when reviewing the datasheets after the dive.

The first and last things to do during a fish survey are record starting and ending times and depths. When recording fish, swim at an approximate speed of 3 - 6 meters per minute. Flashlights are required on the fish survey, but you must be diligent to only use your flashlight to look in holes and then turn it off, as the light can be an attractant to fish. During your swim, you must observe fish in the water column < 2 m above the substrate and stop to examine the substrate to search for sedentary, solitary and hidden species. Be sure to look in cracks and crevices, but not so much that it takes more than 10 minutes to complete the survey. The time is to be used as a guide to help define your search pattern. Simple flat habitats should be surveyed quicker than highly complex habitats. Finally, remember to never count fish that come from behind you or individuals that you see on subsequent transects that you may have "missed". Divers will also size and record the presence of giant black sea bass (*Stereolepis gigas*) seen anywhere during the survey (on or off transect), though it should be recorded in the comments whether or not it was seen on transect.

Each 30 meter transect should take from 5 to 10 minutes to complete.

For many divers it is helpful to think of your survey as a series of moving windows. Try to maintain a uniform size of your window by using landmarks and by taking mental snapshots of mobile shoaling species in your window. It is helpful to consistently look ahead but not too far ahead (~ 3 m). Remember that your window is constantly moving forward.

If you run into a large school of fish here are some tips to counting:

- Count by twos.

- Estimate an arbitrary portion of school and then the total number by judging how many of those "portions" comprise the school.

The most important part of your survey is that estimates are consistent between different surveys, sites and observers.

Sizing Fish
Before discussing how to size fish underwater, we must have a picture of what we are measuring. For the purposes of Reef Check California, we will be measuring total length, which is simply the total length of a fish from the mouth to the tip of the tail (Figure 16).
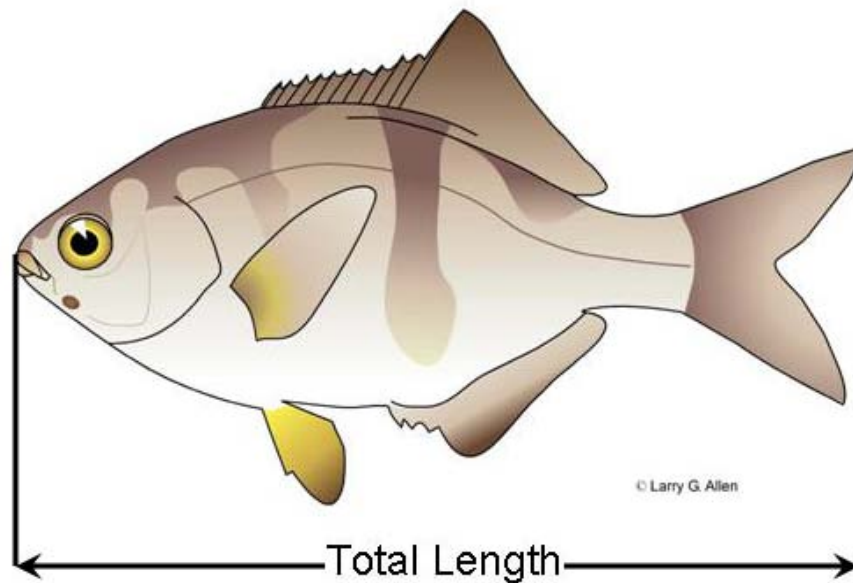
Figure 12. Total length of fish, in this case a pile perch, is measured from mouth to tip of tail (Illustration © Larry G. Allen).

During a RCCA fish transect you will be sizing individual fish to the nearest centimeter. Once you have identified the species of an individual, you will estimate its size. Estimating sizes of moving fish underwater requires much practice and is probably one of the most difficult things you will be tasked with during a survey. Nevertheless, after initial practice, size estimates should become very accurate (see aids to sizing below). The goal is to estimate the size of each individual to the nearest centimeter, but often this can be challenging, especially if schools of fish are present. In this case, it is possible to bracket the size of a group of fish and write down the largest and smallest size and the number of individuals in the group. For example, if a school of 10 blue rockfish is present and the largest fish is 15 cm and the smallest is 9 cm, you would record: 10 blue rockfish 9-15 cm (for details on how to record this on the datasheet, see section: Recording Fish Transect Data). Young-of-the-year rockfish (YOYs) are not sized but their number is recorded under "YOY" on your datasheet.

Quite possibly the single most difficult problem in estimating size underwater is to compensate for the magnifying effect of water. Objects appear to be closer and larger underwater. This phenomenon, known as Snell's Law of Refraction, is caused by the refraction of light moving from one medium (water) to another (air inside your mask), and the differing speed of light in the varying media. The amount of

refraction (i.e., magnification) is affected by depth, available light, turbidity, the distance of the object to your mask faceplate and even the distance of your faceplate to your eye. As a general rule, however, objects appear 33% larger (which is 4/3 magnification) or 25% closer.

There are several specific factors that contribute to an **underestimation of fish size**:

- Low light
- Poor visibility
- Dull body color
- Objects in foreground
- Deep-bodied or "fat" fish. Pay special attention to species with abnormal proportions of length to height (e.g., garibaldi or black sea perch).

Conversely, there are several specific factors that lead to an **overestimation of fish size**:

- Bright light
- Good visibility
- Bright body color
- Objects in background
- Skinny or elongate fish. Pay special attention to species with abnormal proportions of length to height (e.g., lingcod or senorita).

Aids to sizing

Fortunately, there are several tricks you can use to improve your sizing estimates. The most straightforward is to **measure the span of your hand**. Armed with this information you will be able to begin to develop an idea of size underwater. Another trick is to put easy-to-read marks on your **data slate**. This will give you an idea of exact sizes underwater. Further, you can employ a technique called **bracketing** to help you practice. Bracketing works as follows: you identify a fish sitting on a rock and estimate its size while noting the features on the rock at the head and tail of the fish. You then approach the rock, and (if the fish swims away) measure the distance between the features on the rock/substrate.

Another helpful practice is to estimate the size of non-moving objects or organisms (e.g., sea stars, sea cucumbers) then approach them and measure their size with your slate. After you measure, note if your estimate was below or above the measured size and adjust your estimation before you repeat this process. Doing this before every fish transect on your way to the transect start location will greatly increase your ability to estimate fish sizes accurately.

Recording Fish Transect Data

When counting and sizing fish on transect it is important to record and tally data in a standardized way. With each species seen on transect you record the species code in the grey "code" box on the datasheet. The code for each species can be found in the column on the right. Under the code record the size to the nearest centimeter of each fish seen, putting parentheses around the size estimate. If you ever see additional fish of the same size of that particular species you can put tick marks (III) or the actual number seen (3) next to the recorded size. If you see only one fish of a particular size you must put one tick mark next to the size. If it is not possible to record individual sizes of fishes in a large

school, record the size range of the group of fish in parentheses and the number of individuals in that group next to it. There are seven columns on the datasheet for recording individual species during a fish transect. If you find more than seven species on a transect you can split a column by drawing a horizontal line (see Figure 17 for an examples of how to record fish data).

Once you have finished the survey and you are out of the water you must tally up your datasheet. Count the total numbers of individuals of each species and record them in the "transect total" column on the far right of the datasheet. This is also the time to check to make sure that you wrote the correct species codes in the code boxes and to ensure that all sizes and numbers are legible and clear.

Once you have completed your datasheet in this way have it reviewed by another team member and discuss any observations that seem uncommon or unusual to you. Have the reviewer write his/her name in the 'Field QA' field on top of the datasheet after all issues have been discussed and resolved.

Fish Data Sheet - North/Central

Date: 6 5 12   Diver: Joe Diver
SITE: Weston Reef   Visibility (m): 10   Buddy: Jane Diver   Field QA (name): Jane Diver

Transect #4

5 - 10 Minutes | Transect#: 4 | Depth: Beg: 33 ft | End: 37 ft
size in cm: (size) # | Heading: 120 | Time: Beg: 9:35 | End: 9:44

Code: BLU	KR	STP	KGM	LIN	BYR	VCR
(25)3	(32)11	(30)1	(32)1	(55)1	(20)1	(43)1
(20-25) 15	(16)1		(23)1		(27)1	
(37)1	(25)1				(15)1	
(17)1						
(30)1	PIP					
(35)11	(32)1					

Gear / Trash: Hook/Line: 11 (2) | Traps: (Active) ____ | (Lost) ____ | Nets: ____ | Trash: (1)

Comments/Other:

Transect #5

5 - 10 Minutes | Transect#: 5 | Depth: Beg: 38 ft | End: 35 ft
size in cm: (size) # | Heading: 120 | Time: Beg: 9:50 | End: 9:58

Code: KR	SHM	BYR	BLU	OYR	YOY	
(26)1	(45)1	(30)1	(15)1	(32)1	15	
(32)1			(28)1,3	(30)1		

Gear / Trash: Hook/Line: ____ | Traps: (Active) ____ (Lost) ____ | Nets: ____ | Trash: 11 (2)

Comments/Other: 3-4 sea lions swimming around

SPP CODE table

SPP CODE	T#4 totals	T#5 totals
blue rockfish = BLU	23	5
kelp rockfish = KR	4	3
black rockfish = BLK		
gopher rockfish = GOR		
black and yellow = BYR	3	1
olive/yellowtail = OYR		2
copper rockfish = COR		
vermilion/canary = VCR	1	
grass rockfish = GRR		
treefish = TRE (J/A)		
brown rockfish = BRR		
China rockfish = CHR		
YOY rockfish = YOY		15
striped perch = STP	1	
black perch = BLP		
rainbow perch = RAP		
pile perch = PIP	1	
rubberlip perch = RUB		
kelp greenling = KG (M/F/J)	2M	
rock greenling = RG		1M
sheephead = SH (M/F/J)		
senorita = SEN		
rock wrasse = RW (M/F/J)		
kelp bass = KB		
barred sand bass = BSB		
garibaldi = GAR (J/A)		
blacksmith = BS		
opaleye = OPE		
sargo = SAR		
lingcod = LIN	1	
cabezon = CAB		
bocaccio = BOC		
horn shark = HS		
*Giant Sea Bass = GSB		
*note if seen on or off transect		

(Category labels: Rockfish, Perch, Wrasse, Southern Species, Big Fish)

Reef Check California   new fish datasheet_nor-cen_3-7.13.xlsx

Figure 13. Example datasheet, demonstrating how to record fish data during a RCCA survey.

Fishing Gear and Trash Observations

In order to record the amount of marine debris and lost or active fishing gear on rocky reefs, we will count any fishing gear and debris that falls within our 2 meter swath on all fish transects (18 transects). If any part of this gear or trash is within your swath (e.g. the edge of a lobster trap or a piece of monofilament line), it will be counted. Fishing gear that is attached to fish that are recorded on transect (e.g. hook in mouth, trailing line) will also be recorded. Fishing gear and other objects will be broken down into four categories:

Hook and line (recreational fishing tackle) - includes hooks, lures, bobbers, sinkers, fishing rods and fishing line, etc. This category also encompasses boat anchors, anchor line, spear fishing gear, including spears, tips and guns (if gear is recorded it should be noted in the comments section what was found).
Traps - includes both abandoned (recorded as 'lost') and active (recorded as 'active') traps. Broken and deteriorated traps (i.e., parts of traps) will also be counted. Lobster hoop nets will fall into this category since they serve the same purpose as a trap.
Nets - includes full nets or pieces of net material.
Trash - includes anything manmade that was lost or tossed into the ocean and that doesn't fall into one of the fishing gear categories such as plastics, bottles, cans, metal, ropes, etc. (if trash is recorded it should be noted in the comments section what was found).
Each item from the above categories that is encountered on a fish transect will be recorded on the fish data sheet as a tick mark in its respective category (Figure 17). After the dive once you have tallied your fish counts you can tally and circle the total number of each fishing gear and trash observation.

Urchin Size Frequency Survey

Where a sufficient number of urchins are present, 100 individuals of both red and purple urchins should be sized using calipers (Figure 18). **This can be done anywhere at the site and is not associated with a transect. Urchin surveys are performed once per year, during the fall survey only).** It is important that you get a representative sample of the urchins at the site and not just count those that are accessible and of a particular size. You may need to gently clear small plots to ensure you don't double count and to ensure you measure ALL of the first 100 urchins you encounter. If you begin an urchin survey but are not able to count 100 urchins of each species by the end of the dive make sure to turn in your data anyway.

Figure 14. Urchin sizing with calipers (Photo: N. Fash, www.fashpics.com).

Conducting the Surveys and Data Collection

The Forum and Scheduling a Survey

Once you are certified as a Reef Check California diver, you can take part in surveys throughout California. The Reef Check website is the primary tool for you to connect with your fellow divers. The Reef Check California Online Forum (http://forum.reefcheck.org) has been designed to allow you to sign up for as well as schedule survey dives and sort out survey logistics. Each thread in the Forum should pertain to a specific proposed survey location and date. The RCCA Certified Diver Forum is split into two sub-Forums: Nor/Cen California and Southern California. These allow you to quickly focus in on upcoming events in your region. During your course you will automatically be directed to register for the Forum and sign up to receive a weekly digest showing recent posts. You can modify your profile settings by selecting 🖼 User Control Panel. You can modify your digest settings by selecting Digests. You can unsubscribe to the Forum by sending an email with "UNSUBSCRIBE FORUM" in the subject line to rcinfo@reefcheck.org.

- The naming convention for each thread should contain the survey region, site name and date (e.g., Monterey – Breakwater, 10/1/08). You will receive an update from the survey organizer on the Forum about conditions so it is important you check the Forum thread for updates after you are sign up. You will not receive updates to your personal email in most cases. Your Regional Program Manager and Volunteer Coordinator will assist you with overall dive planning. The website allows you to recruit fellow divers to help complete the survey.
- RCCA staff does NOT need to be present for you to conduct a survey though someone must be acting as data captain and will be in charge of overseeing the survey and data collection.

Data Captain

When a survey is being proposed and posted on the Forum it is essential to designate a team leader, also known as the data captain. This individual will coordinate with the Regional RCCA Staff. The Data Captain is responsible for:

- Logistics (checking weather conditions, parking permits, etc.)
- Making sure the team has sufficient blank datasheets to complete a survey
- Team survey assignments, including transect locations
- Collection and review of datasheets after each dive
- Ensuring all data are entered into the online database and the original datasheets are submitted to the Regional Program Manager
- Data Captain's usually have 1 year of survey experience before filling this role. There are numerous planning resources available for the Data Captain that can be obtained by contacting your regional RCCA staff.

Each Diver is Responsible for Their Own Safety!
Every diver must take full responsibility for their own safety at all times, including the decision whether or not to dive. The data captain does not assume responsibility for safety on the survey. Each diver assumes individual responsibility for their own safety at all times.

Site Description Form
The data entered on the Site Description Form helps put the survey data into context – it is therefore essential in helping us interpret what we see underwater. **The Site Description Form (Appendix B) should be started before the survey begins and completed immediately following the dives on the first day of the survey.**

Record the location of your site on the Site Description Form using the following methods:

- Global Positioning System (GPS) – preferred
- Maps or nautical charts
- GIS software such as Google Earth (www.earth.google.com). Google Maps can also generate lat/long coordinates.

Basic Information
Site Name: If you are the first team to survey a location, use the common name used for the site and if there is not one, you can name the site anything you like. Otherwise, you must use the name that was formally given to the site. If you are unsure, please contact the Regional Program Manager to determine if you are the first team to survey a site.

County, City/Island: Please be as descriptive as necessary. If you are located on an island, please record the island name as the city. If the island has a city on it record the city name, island name (Avalon, Santa Catalina).

Latitude/Longitude: Record the coordinates in decimal degrees. Remember, latitude is measured as north and south and longitude is measured as east and west. All surveys in California should be north latitude and west longitude, at least for the next couple million years.

Date: For each survey spanning more than 1 day to complete, record the date you started the first transect and the date the final transect was completed. Each survey should be completed within a **four week** time span from the first to the last transect.

Weather: Indicate the general weather conditions that prevailed over the sampling period. If the surveys were conducted over multiple days, record the weather condition that was most representative of average conditions.

Temperature: Temperature is an important component of any survey. Please record the temperature on the surface and in the water during each survey. Record the 10 m temperature at the end of the first transect at that depth and record the 5 m temperature at the end of the safety stop. A conversion calculator is provided in NED to convert the temperature you record from Fahrenheit to Celsius. If the surveys were conducted over multiple days, use a representative water temperature for the survey period (e.g. an average).

Distance and Depth: The approximate distance from shore and average depth of the site should be recorded in meters. While distance and depth can be extremely variable for a given site, please do your best to estimate a distance and depth that accurately characterizes the reef you are surveying.

Exposure and Storms: When analyzing data, it is important for us to ensure we are comparing reefs of similar types to each other. As you can imagine, highly exposed reefs are likely to exhibit different physical and biological characteristics than fully sheltered reefs. Record whether the site you are surveying is always sheltered, sometimes sheltered or exposed. An example of a reef that is sometimes sheltered would be one that is only exposed to swells and/or storms a certain time of year (i.e. exposed to winter swells out of the north, but sheltered from summer swells out of the south). Recent storms provide additional insight into recent physical disturbances that may have affected your survey site. **Recent is defined as within the previous 4 weeks** and is a storm that was accompanied by significant wind, waves and/or rain.

Transects completed: Ideally, all transects should be completed for each survey and all errors corrected by repeated surveys. If for some reason your team is unable to complete all the required transects or there are errors in the data that could not be corrected, than they should be noted here.

IMPORTANT: Please record the name of the team member who submitted the data (usually the team leader/data captain), the name of the team member who checked the data and list the names and of all team members. **Team members should be indicated by their full name (*e.g.*, John Diver).** Also please be consistent with first name usage (*e.g.*, use full legal name, no nicknames - Bill Golden should be William Golden). **It is extremely important that team member names are recorded and entered consistently and correctly. If not, the names will not match the names of certified divers in our database or you will not be able to enter the data in NED.**

Before You Jump in the Water

Prepare all necessary equipment
Prepare and distribute all equipment used during a Reef Check survey as follows:

GPS or nautical chart: to mark position of survey.

Transect Lines: we recommend using a 30 m fiberglass measuring tape with a hand crank. We also recommend that you wrap a piece of stiff wire around the free end to secure it to kelp or rocks and add small pieces of tape around the transect tape at each meter mark to make the points easier to find during the UPC surveys (Figure 19).

Slates/Underwater Paper: we require that teams use pre-printed underwater paper and the sandwich-type PVC slates.

Pencils: to record data on underwater paper (graphite, golf or plastic pencils work best).

Permanent markers: for labeling slates and equipment.

Buoys: to mark beginning and end of transect line (safety sausages work best though they can be made from empty plastic bottles).

All required gear for safe diving.
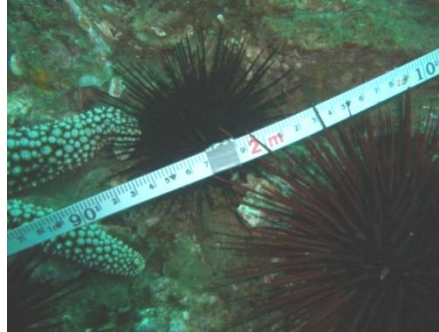
Figure 15 One-meter intervals marked with tape on transect line. This practice is especially important when the transect tape does not have meters marked on both sides (Photo: G. Hodgson).

Prepare datasheets

It is important to complete the Site Description Form including the Global Positioning System (GPS) coordinates of your survey site **prior** to beginning the survey. Record the names of the team leader/data captain and team members as well as the date and site name on the site description sheet.

Prepare the datasheets and ensure that you have sufficient slates and underwater paper for all team members. The number of slates and sheets will depend on the number of people in your team. Datasheets should be allocated prior to the dive and every member should have a datasheet to complete his or her portion of the survey.

It is imperative that you fill out ALL of the descriptive fields on your datasheet:

- Date
- Site name
- Transect number
- Depth start and stop for each transect
- Diver and Buddy names
- Transect start and end times. **All** surveys should be performed anytime 2 hours after sunrise through 2 hours before sunset. If you are using your dive timer instead of a watch, indicate the approximate time of day the transect took place on your datasheet after you surface (see Appendix B).
- Visibility – the distance where one can no longer clearly count your buddy's fingers on an open hand held away from the body (3m visibility is required to conduct fish surveys).

Assign team members to survey tasks

There are many acceptable ways to divide up the survey tasks depending on the skills of the team members and team size. Not all team members will be qualified to complete all types of surveys. Some

team members will feel more comfortable recording fish or invertebrates and others will just want to serve as buddies. Because each team will be different, the data collection strategy should be adjusted to match the ability and experience of the team. The best quality data will be obtained by having an experienced team leader/data captain assign tasks appropriate for each team member. The team leader /data captain must ensure that every team member understands their assignment and is capable of performing out properly. We recommend pairing up experienced Reef Checkers with those with less experience.

Team leaders assign survey tasks to buddy pairs, including transect numbers, potential location, predetermined depth ranges and compass headings.

Each team member must record on their datasheet, as well as notify the team leader, when reliability of data from a transect are in question. When this occurs, the Regional Manager will review the data and consult with the survey team to ensure the validity of the data before including them in the database.

Deploying the Transects

Core Transects

For each of the six core transects (3 inshore and 3 offshore) you will conduct 4 different surveys:

1. Fish
2. Invertebrate
3. Seaweed
4. UPC

Given that you will perform multiple surveys on these transects, we recommend you secure the end of the transect with a wire, a clip or small weight to ensure the transect end does not become free before all the surveys are completed (Figure 20).

Be sure to deploy the transect parallel to the selected depth contour. Please note that it is extremely easy to bias the direction of your transect towards features or fish. Maintaining the pre-assigned compass heading helps minimize bias. If you are deploying a transect on a pre-determined bearing and encounter > 10 m of sand, alter your bearing to get back on to rocky reef substrate. If you do not pass any kelp and/or rocky substrate (bedrock or boulders) coming up through the sand in < 10 m, void the transect and redeploy once you have found the reef again. On the other hand, if you encounter algae emerging from the sand frequently this suggests you are surveying rocky reef habitat that has been recently covered with sand and you should continue your transect according to your heading. If you encounter a very large boulder or anything greater than 4 m tall, alter your course and contour around the object at the average depth of your transect. After going around the object, continue back onto your predetermined heading. If the object you encounter does not cause you a > 4 m depth change, simply stay on bearing and go over the top of it. The fish transect survey window should always be 0 – 2 m off the bottom unless the transect is along a wall in which case the height should be 2 m above the transect line. Although you will be surveying up to 2 m off the bottom you should be located towards the bottom of the survey window remembering to look up frequently to survey midwater species. Should you encounter a large crack or crevice beneath your transect that is too small to swim into, count all organisms within the crack that are also within the 2 m wide swath around the tape. If it is a large enough crevice to swim through and does not change depth more than 4 m, you can follow the contour according to your heading, staying close to the seafloor. Be sure to count only fish found up to 2 m off

the bottom. If the transect is placed under an overhanging ledge, do not count the organisms on the underside or on top of the ledge. Be sure that your deepest transect is no deeper than 18 meters (60 ft).
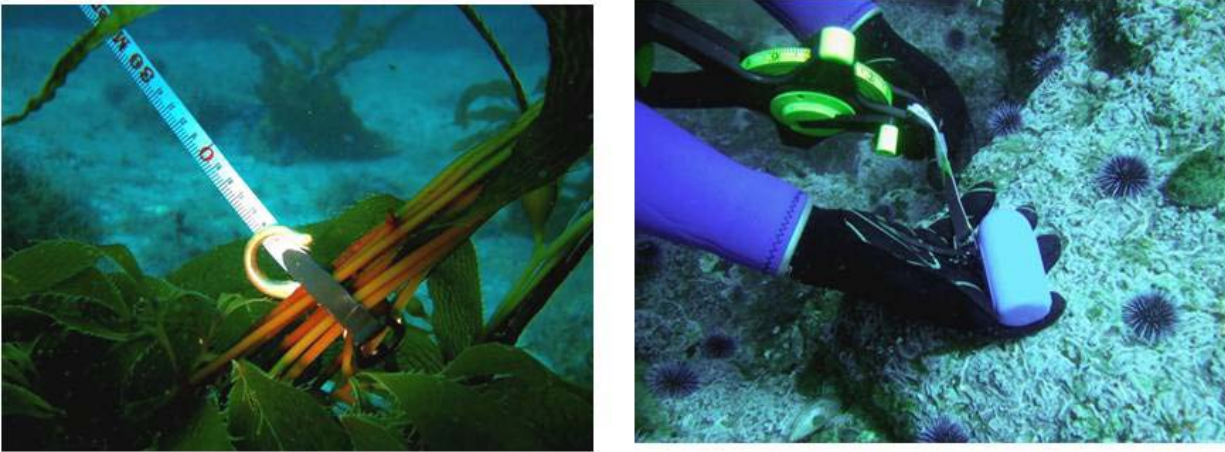
Figure 16. . Two ways of anchoring core transect : either with a clip or with a two pound weight (Photos: N. Flash, www.flashpics.com).

Although there are many acceptable ways for a buddy pair to allocate the tasks to complete a core transect, one of the most common ways used by our divers is shown below. REMEMBER safety is the number one concern when discussing allocation of tasks during a survey and completing the survey underwater. Discuss in detail which tasks will be done by each diver and make sure all proposed actions fall well within safe diving standards of both divers in the buddy team.

Possible Scenario for 1 Core Transect

Pass 1

(1) Diver 1 = Fish →

(2) Diver 2 follows

Pass 2

Diver 1 – UPC ← (1)

← (2)

Diver 2 – Invert

Pass 3

(1)

(2) Diver 2 – Algae →

Diver 2 does Algae. Diver 1 finishes and catches up with diver 2. This diver can help complete the transect by counting giant kelp + stipes for the remainder of the transect if a plan was made prior to the dive or follow diver 2 as a buddy.

Deploying Fish Transects

The core fish transects and all fish only transects will be 30 m in length and will survey an area 2 meters wide by 2 meters high along the transect. Each transect will begin by a buddy pair swimming to their assigned section of the site area. They reach a predetermined depth range at which the transect is deployed at a fixed heading. Ideally, starting points will be randomly selected in an area where you have thirty meters of contiguous rocky reef. It is important that the fish only transects do not overlap and care must be taken to not double count fish that may be following the surveyors.

Twelve gauge copper wire or alligator clips are recommended for temporarily anchoring the end of the transect to a rock or bunch of kelp stipes (Figure 21). This provides enough "hold" to keep the end of the transect affixed for the duration of the survey but allows you to free the end by gently tugging on the transect line. You can then wind up the tape and continue on with the next transect. Caution must be used to not damage any delicate organisms or the transect line with this method.

Figure 17 Twelve gauge wire and alligator clip anchoring Fish Only Transects (Photos: N. Fash, www.fashpics.com and G. Hodgson).

Buddy Pairs

Because fish are easily perturbed, the fish transect is the first survey conducted. Reef Check California divers will swim the fish surveys as a buddy team. However, **ONLY** the diver laying out the transect (primary) will be conducting the fish survey count.

The primary diver shouldn't be much more that a slate's length off the bottom (~35 cm) and the backup diver should be directly above and behind the primary diver's bubble stream. It may be helpful for the backup (secondary) diver to gently touch the primary diver's tank to maintain proper positioning (Figure 22). The backup diver should **NEVER** be in front of the bubble stream of the first diver and in no way interfere with the primary diver's field of vision.

The diver not laying out the transect tape (secondary) shall be responsible for:

- Staying well behind the bubble stream of the primary diver and out of his/her field of vision
- Maintaining close enough contact to assist in an emergency
- Evaluating the survey technique (e.g., speed, direction, depth, search pattern, etc.)

The secondary diver is a crucial part of the quality control program for Reef Check California. He/She should make notes on their slate to give feedback to the primary diver on the surface when reviewing datasheets after the dive.

Figure 18. Divers showing the proper positioning for fish transects. The primary diver is responsible for laying the transect and denoting the survey area while staying close to the bottom. The backup diver is just above the primary diver and just behind the bubble stream (Photo: B. Field).

For the seaweed transects only, teams can elect to split up the species being counted – one buddy would count giant kelp plants and stipes while the other buddy would count all the other seaweed species. After the dive, the buddy team would reconcile their data sheets so all the seaweed data is on one sheet and the other sheet is voided. Or, one person can choose to perform the entire seaweed count on their own. DIVERS ARE NOT ALLOWED TO EACH COUNT ONE SIDE OF THE TRANSECT. When splitting a seaweed survey, divers must pay special attention to ensure subsampling is not done incorrectly.

For invertebrate and UPC transects, one diver **must perform an entire transect individually** – i.e. there is no splitting those counts. An easy method for staying together on the line is to have one buddy do the invertebrate survey while the other follows completing the UPC survey.

Care and Maintenance of Research Equipment: Research equipment is no different than the rest of your gear. Before each dive, be sure it is in working order and rinse it off with fresh water after every dive.

Recording Data and Ensuring Quality

You are becoming part of a unique and dedicated group of individuals. Once you are certified as a Reef Check California diver you will have become a citizen-scientist. The most important things you do as a citizen-scientist is to collect and record data. We have talked about the potential biases that we mitigate through training, practice and standardization and you will be entrusted with the quality of the data you collect. The quality of the data is the foundation of the RCCA program and must be ensured from start to finish. It is your responsibility to not only record accurate data but to record data in a way that ensures that it is entered in the database correctly. Therefore, data has to me recorded in a legible fashion so that other can enter it into the database. It is good practice to have someone else at the survey read your datasheet to insure that all entries are clear and unambiguous.

Datasheets
Site Description Form

Site Description Report

Site Information

			Temperature in Celsius	
Site Name			Air	
City / Island			Surface	
County			5 Meters	
State	California		10 Meters	

Latitude (deg min.min)	North		**Distance in Meters**	
Longitude (deg min.min)	West		Distance from shore	

Dates format (mm/dd/yyyy)

		Average Depth of Site	
Start Date		**Permanent, Random**	
End Date		Transect Type	

Always Sheltered, Sometimes Sheltered, Exposed

Site Exposure

Sunny, Cloudy, Raining

		Recent Storms	Yes / No
Weather			

Transects completed (Yes/No):

Fish			Errors	Yes / No
Invertebrates			Describe Errors	
UPC				
Algae				
Urchin Size				

TEAM INFORMATION

		Team Member	
Submitted by:		Team Member	
Checked by:		Team Member	
Team Member		Team Member	
Team Member		Team Member	
Team Member		Team Member	
Team Member		Team Member	
Team Member		Team Member	

Notes:

Fish Datasheet-Southern

Fish Data Sheet - Southern

Date:_____ Diver:_____

Field QA (name) : _____

SITE:_____ Visibility (m):_____ Buddy:_____

5 - 10 Minutes	Transect#:_____		Depth: Beg:_____ft	End:_____ft			SPP CODE	T#____ totals	T#____ totals
size in cm: (size) #	Heading:_____		Time: Beg:_____	End:_____					
Code:							kelp bass = **KB**		

Southern Species:
- kelp bass = **KB**
- barred sand bass = **BSB**
- garibaldi = **GAR (J/A)**
- blacksmith = **BS**
- opaleye = **OPE**
- sargo = **SAR**

Perch:
- striped perch = **STP**
- black perch = **BLP**
- rainbow perch = **RAP**
- pile perch = **PIP**
- rubberlip perch = **RUB**

Wrasse:
- sheephead = **SH (M/F/J)**
- senorita = **SEN**
- rock wrasse = **RW (M/F/J)**

Rockfish:
- blue rockfish = **BLU**
- kelp rockfish = **KR**
- black rockfish = **BLK**
- gopher rockfish = **GOR**
- black and yellow = **BYR**
- olive/yellowtail = **OYR**
- copper rockfish = **COR**
- vermilion/canary = **VCR**
- grass rockfish = **GRR**
- treefish = **TRE (J/A)**
- brown rockfish = **BRR**
- China rockfish = **CHR**
- YOY rockfish = **YOY**

- kelp greenling = **KG (M/F/J)**
- rock greenling = **RG**

Big Fish:
- lingcod = **LIN**
- cabezon = **CAB**
- bocaccio = **BOC**
- horn shark = **HS**
- *Giant Sea Bass = **GSB**
- *note if seen on or off transect

Gear / Trash: Hook/Line:_____| Traps: (Active) _____| (Lost)_____| Nets: _____| Trash:_____|

Comments/Other:

5 - 10 Minutes	Transect#:_____		Depth: Beg:_____ft	End:_____ft
size in cm: (size) #	Heading:_____		Time: Beg:_____	End:_____
Code:				

Gear / Trash: Hook/Line:_____| Traps: (Active) _____| (Lost)_____| Nets: _____| Trash:_____|

Comments/Other:

Reef Check California

new fish datasheet_south_3.8.13.xlsx

Invertebrate Data Sheet

SITE _____   Date _____   Diver:_____

Visibility (m)_____   Buddy:_____

Count all orgs. > 2.5 cm 10 Minute goal (30 x 2 m)		Transect#:_____ Time: Beg:_____ End:_____	Dist	Transect#:_____ Time: Beg:_____ End:_____	Dist
Abalones	red abalone (size cm)				
	flat abalone (size cm)				
	pinto abalone (size cm)				
	green abalone (size cm)				
	pink abalone (size cm)				
	Unknown abalone				
	CA spiny lobster				
Cucumbers	CA sea cucumber				
	warty sea cucumber				
Sea Stars	bat star				
	short spined sea star				
	giant spined star				
	sun/sunflower star				
Slugs/snails	chestnut cowry				
	Kellet's whelk				
	wavy / red turban snail				
	giant keyhole limpet				
Crabs	rock crab				
	sheep/masking crab				
	gumboot chiton				
	rock scallop				
	large anemone (>10cm)				
Gorgonians	brown/golden gorgonian (>10cm)				
	red gorgonian (>10 cm)				
Urchins	red urchin				
	purple urchin				
	crowned urchin				
	Other/comments				
	Black ab (Y/N)	White ab (Y/N)_____			

Subsample abundant organisms: at ~50, stop counting and record distance surveyed along transect (meters)
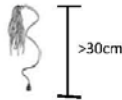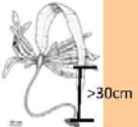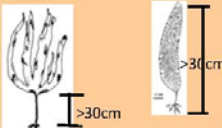
Seaweed Data Sheet

SITE _____ Date _____ Diver:_____

Visibility (m)_____ Buddy:_____

*Do not count seaweed used to attach transect

Invasives seen anywhere at site?

Sargassum muticum Yes_____ No_____   *Undaria* Yes_____ No_____

Sargassum filicinum Yes_____ No_____   *Caulerpa* Yes_____ No_____

30 x 2 m Transect 10 Minute goal time	Transect#:_____ Time: Beg:_____ End:_____	Dist	Transect#:_____ Time: Beg:_____ End:_____	Dist
Bull Kelp >30cm				
Pterygophora >30cm				
Southern Sea Palm >30cm				
Laminaria >30cm >30cm				
giant kelp (>1 m) >1 m				

Subsample abundant organisms: at ~50, stop counting and record distance surveyed along transect (meters)

Comments:_____

_____

UPC Data Sheet

SITE _____ Date _____ Diver: _____

Visibility (m) _____ Buddy: _____

Transect #1 (top)

Time Beg: _____ End: _____ Transect #: _____

#	Sub	Cov	Rel	#	Sub	Cov	Rel
1				16			
2				17			
3				18			
4				19			
5				20			
6				21			
7				22			
8				23			
9				24			
10				25			
11				26			
12				27			
13				28			
14				29			
15				30			

Summary

Sub	Cnt		Cov	Cnt
S			N	
C			B	
B			OB	
R			G	
O			R	
Tot:			AC	
			CC	
Rel	Cnt		SI	
0			MI	
1			SG	
2			Tot:	
3				
Tot:				

Total must = 30

Transect #2 (bottom)

Time Beg: _____ End: _____ Transect #: _____

#	Sub	Cov	Rel	#	Sub	Cov	Rel
1				16			
2				17			
3				18			
4				19			
5				20			
6				21			
7				22			
8				23			
9				24			
10				25			
11				26			
12				27			
13				28			
14				29			
15				30			

Summary

Sub	Cnt		Cov	Cnt
S			N	
C			B	
B			OB	
R			G	
O			R	
Tot:			AC	
			CC	
Rel	Cnt		SI	
0			MI	
1			SG	
2			Tot:	
3				
Tot:				

Total must = 30

Substrate
S = sand (<0.5 cm)
C = cobble (0.5 cm – 15 cm)
B = Boulder (> 15 cm – 1 m)
R = Reef (>1 m)
O = Other (anthropogenic, etc.)

Cover
N = None
B = Brown Seaweed (large kelps on band transect)
OB = Other Brown Seaweed (incl invasives)
G = Green Seaweed
R = Red seaweed (not coralline)
AC = Articulated Coralline
CC = Crustose Coralline
SI = Sessile Invertebrate (sponges, anemones, sandcastle worm etc)
MI = Mobile Invertebrates (sea stars, snails, urchins, cucumbers etc)
SG = Seagrasses (incl surfgrass and eelgrass)

Relief
0 = 0 – 10 cm
1 = >10 cm – 1 m
2 = >1m – 2m
3 = >2m

Max height difference in box
0.5m x 1m in front of point

Total must = 30

1 meter / 0.5 meter — Transect line

Urchin Size Frequency Datasheet

SITE _____   Date _____   Diver:_____

Depth:_____   Visibility (m)_____   Buddy:_____

~100 of each species   Time: Beg:_____   End:_____

Purple urchin test diameter (cm)	Total
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	

Red urchin test diameter (cm)	Total
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
>16	

Comments: _____

_____

_____

_____

Appendix C
Reef check California monitoring sites in SCSR

Survey year indicates the year during the baseline monitoring period that the sites were sampled. If sites were not surveyed during baseline period the survey year indicates when the site was surveyed for the first time.

Site	Survey Year	Latitude	Longitude	County/Island
120 Reef	2011/12	33.73792	-118.39201	Los Angeles
Abalone Cove	2011	33.73615	-118.37632	Los Angeles
Big Rock	2012	34.03517	-118.60809	Los Angeles
Bird Rock	2011/12	33.45080	-118.48754	Catalina Island
Broomtail Reef	2011/12	32.69423	-117.26807	San Diego
Casino Point	2011/12	33.34917	-118.32497	Catalina Island
Cathedral Cove	2011/12	34.01650	-119.36839	Anacapa Island
Cathedral Wall	2011/12	34.01575	-119.37150	Anacapa Island
Christmas Tree Cove	2011/12	33.76040	-118.42105	Los Angeles
Crystal Cove	2011/12	33.57135	-117.84110	Orange
Cueva Valdez	2011/12	34.05500	-119.81000	Santa Cruz Island
Diver's Cove	2011/12	33.54317	-117.79658	Orange
East Point	2012	33.94397	-119.96478	Santa Rosa Island
Elk Ridge	2012	33.95333	-119.96909	Santa Rosa Island
Fry's Anchorage	2011/12	34.05416	-119.75600	Santa Cruz Island
Goldfish Bowl	2011/12	34.01473	-119.43750	Anacapa Island
Hawthorne Reef	2011/12	33.74700	-118.41589	Los Angeles
Heisler Park	2011/12	33.54225	-117.79500	Orange
IV Reef	2012	34.40305	-119.86608	Santa Barbara
Isthmus Reef	2011/12	33.44832	-118.49060	Catalina Island
Johnson's Lee	2012	33.90155	-120.10340	Santa Rosa Island
Judith Reserve	2007	34.02328	-120.44045	San Miguel Island
LA Breakwater	2009	33.71190	-118.24200	Los Angeles
La Jolla Cove	2011/12	32.85217	-117.26987	San Diego
Landing Cove	2012	34.01747	-119.36240	Anacapa Island
Lechuza	2012	34.03403	-118.87132	Los Angeles
Leo Carrillo North	2006	34.04353	-118.94495	Los Angeles
Lighthouse Reef	2011/12	34.01263	-119.36420	Anacapa Island
Lion's Head	2011/12	33.45124	-118.50210	Catalina Island
Little Corona Del Mar	2011/12	33.58980	-117.86870	Orange
Long Point West	2012	33.40840	-118.36740	Catalina Island
Malaga Cove	2011/12	33.80365	-118.39835	Los Angeles
Naples Reef	2012	34.42185	-119.95150	Santa Barbara
North Hill Street	2011	32.72862	-117.26500	San Diego
Paradise Point	2012	34.00413	-118.79290	LA
Pelican Anchorage	2011/12	34.03565	-119.70250	Santa Cruz Island

Petter's Kelp Reef	2010	32.81630	-118.36000	San Clemente Island
Pier 400	2009	33.71630	-118.25800	Los Angeles
Refugio State Beach	2011/12	34.46333	-120.07032	Santa Barbara
Salt Creek	2012	33.47715	-117.72736	Orange
Sandpiper	2012	34.41747	-119.89673	Santa Barbara
Sandstone Point	2011/12	33.99067	-119.55440	Santa Cruz Island
Scorpion Anchorage	2011/12	34.04852	-119.55230	Santa Cruz Island
Seal Rock	2011/12	33.54555	-117.80370	Orange
Shaw's Cove	2011/12	33.54396	-117.79986	Orange
Ship Rock	2007	33.46283	-118.49160	Catalina Island
South La Jolla	2011/12	32.81345	-117.28577	San Diego
Torqua	2011/12	33.38300	-118.35000	Catalina Island
Tyler Bight	2007	34.02737	-120.41402	San Miguel Island
WIES Intake Pipes	2011/12	33.44700	-118.48485	Catalina Island
White Point	2011/12	33.71351	-118.31810	Los Angeles
Windansea	2011/12	32.83660	-117.28800	San Diego
Yellowbanks	2011/12	33.99880	-119.55050	Santa Cruz Island

Appendix D
Summary of species densities at RCCA's southern California sites

Refugio State Beach, located in Santa Barbara County, was established as a Reef Check site in 2006. Refugio was protected as an SMCA from 1998 to 2011, but the MPA was removed when the new South Coast MPAs were implemented on January 1, 2012. The bottom structure is predominantly a low-relief (10 cm to 1 meter) bedrock substrate. The substrate is mostly bare or is covered with brown algal species, red algae or articulated coralline algae. Pterygophora is the dominant macroalgae, although some giant kelp and Southern sea palm are also present. The most common invertebrates are purple urchins, giant spined sea stars, chestnut cowries, red urchins and short spined stars. Overall, fish densities are low but young of the year rockfish, black perch and striped perch are the fish most often observed at Refugio State Beach.

Physical Characteristics and Primary Substrate Cover at Refugio State Beach (2011-2012)

Average depth	4.41 meters

Substrate type	Percentage
Bedrock	79.07%
Boulders	4.63%
Cobble	5.93%
Sand	10%

Relief	Percentage
0-10cm	16.11%
10 cm-1meter	83.52%
1-2meter	0.37%
>2 meters	0%

Substrate Cover	Percentage
Articulated coralline	11.48%
Brown seaweed	10.19%
Crustose coralline	2.96%
Green seaweed	1.48%
Mobile invertebrates	1.48%
None	46.48%
Other brown seaweed	9.26%
Red seaweed	12.04%
Seagrasses	0.19%
Sessile invertebrates	4.44%

Algae densities (60m^2) at Refugio State Beach (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Giant kelp	*Macrocystis pyrifera*	17.67	2.545
Giant kelp Stipes	*Macrocystis pyrifera*	152.94	27.947
Laminaria spp	*Laminaria farlowii, L. setchelii*	2.61	1.138
Pterygophora	*Pterygophora californica*	66.09	28.530
Southern sea palm	*Eisenia arboea*	15.38	8.835

Invertebrate densities (60m^2) at Refugio State Beach (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Purple urchin	*Strongylocentrotus purpuratus*	112.10	60.046
Red urchin	*Strongylocentrotus franciscanus*	1.22	0.807
Bat star	*Patiria miniata*	0.83	0.493
Wavy/red turban snail	*Lithopoma undosum*	0.06	0.056
Crowned urchin	*Centrostephanus coronatus*	0.00	0.000
Brown/golden gorgonian	*Muricea fruticosa, M. californica*	0.11	0.111
Giant spined star	*Pisaster giganteus*	7.17	1.161
Warty sea cucumber	*Parastichopus parvimensis*	0.17	0.121
Kellet's whelk	*Kelletia kelletii*	0.17	0.121
Giant keyhole limpet	*Megathura crenulata*	0.89	0.227
Large anemone	*Anthopleura spp., Metridium spp., Urticina spp.*	0.11	0.076
Chestnut cowry	*Cyoraes soadicea*	1.67	1.553
Rock scallop	*Crassedoma giganteum*	0.00	0.000
Red gorgonian	*Leophogorgia chilensis*	0.06	0.056
CA spiny lobster	*Panulirus interruptus*	0.00	0.000
Short spined sea star	*Pisaster brevispinus*	1.22	0.358
Sunflower/sun star	*Pycnopodia helianthoides, Solaster stimpsoni/dawsoni*	0.00	0.000
CA sea cucumber	*Parastichopus californicus*	0.06	0.056
Sheep/masking crab	*Loxorhynchus grandis, L. crispatus*	0.00	0.000
Green abalone	*Haliotis fulgens*	0.06	0.056
Pink abalone	*Haliotis corrugata*	0.00	0.000
Red abalone	*Haliotis rufescens*	0.00	0.000

Fish Densities (60m^2) at Refugio State Beach (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Blacksmith	*Chromis punctipinnis*	0.00	0.000
Senorita	*Oxyjulis californica*	0.06	0.041
Kelp bass	*Paralabrax clathratus*	0.00	0.000
Garibaldi	*Hypsypops rubicundus*	0.00	0.000
California Sheephead	*Semicossyphus pulcher*	0.02	0.019
Black perch	*Embiotoca jacksoni*	1.39	0.325
Rainbow perch	*Hypsurus caryi*	0.00	0.000
Pile perch	*Rhacochilus vacca*	0.00	0.000
Striped perch	*Embiotoca lateralis*	0.35	0.176
Rubberlip perch	*Rhacochilus toxotes*	0.02	0.019
Rock wrasse	*Halichoeres semicinctus*	0.00	0.000
Opaleye	*Girella nigricans*	0.00	0.000
Barred sand bass	*Paralabrax nebulifer*	0.00	0.000
Sargo	*Anisotermus davidsoni*	0.02	0.019
Young of the year rockfish	*Sebastes spp.*	1.50	0.746
Kelp rockfish	*Sebastes atrovirens*	0.00	0.000
Blue rockfish	*Sebastes mystinus*	0.09	0.093
Yellowtail/olive rockfish	*Sebastes flavidus/serranoides*	0.00	0.000
Treefish	*Sebastes serriceps*	0.00	0.000
Black and yellow rockfish	*Sebastes chrysomelas*	0.06	0.041
Gopher rockfish	*Sebastes carnatus*	0.00	0.000
Brown rockfish	*Sebastes auriculatus*	0.00	0.000
Copper rockfish	*Sebastes caurinus*	0.00	0.000
Rock greenling	*Hexagrammos lagocephalus*	0.00	0.000
Horn shark	*Heterodontus francisci*	0.00	0.000
Cabezon	*Scorpaenichthys marmoratus*	0.00	0.000
Lingcod	*Ophiodon elongatus*	0.00	0.000
Kelp greenling	*Hexagrammos decagrammus*	0.00	0.000

Naples Reef, located in Santa Barbara County, was established as a Reef Check site in 2007 and is part of the Naples SMCA, implemented in 2012. The substrate is primarily bedrock with a relief of 10 cm to 1 meter. Pterygophora and giant kelp are the dominant macroalgae. Red urchins and purple urchins are prevalent and bat stars, large anemones and giant spined sea stars are present. Blue rockfish, senorita, black perch, rainbow perch and blacksmith are the most common fish. Like most Reef Check sites in Channel Islands National Park and Santa Barbara County, rockfish are more common here than in the majority of our coastal sites in Los Angeles, Orange and San Diego counties.

Physical Characteristics and Primary Substrate Cover at Naples Reef (2012)

Average depth	10.57 meters

Substrate type	Percentage
Bedrock	87.78%
Boulders	1.11%
Cobble	7.78%
Sand	3.33%

Relief	Percentage
0-10cm	0.56%
10 cm-1meter	95%
1-2meter	4.44%
>2 meters	0%

Substrate Cover	Percentage
Articulated coralline	3.33%
Brown seaweed	7.22%
Crustose coralline	20%
Green seaweed	3.89%
Mobile invertebrates	11.67%
None	10.56%
Other brown seaweed	1.67%
Red seaweed	31.67%
Sessile invertebrates	10%

Algae densities (60m^2) at Naples Reef (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Giant kelp	*Macrocystis pyrifera*	8.33	4.379
Giant kelp Stipes	*Macrocystis pyrifera*	51.60	18.157
Laminaria spp	*Laminaria farlowii, L. setchelii*	1.83	1.833
Pterygophora	*Pterygophora californica*	118.06	41.275
Southern sea palm	*Eisenia arboea*	0.00	0.000

Invertebrate densities (60m^2) at Naples Reef (2012)

Common name	Scientific name	Mean Density	Std Error
Purple urchin	*Strongylocentrotus purpuratus*	212.32	113.711
Red urchin	*Strongylocentrotus franciscanus*	219.33	110.239
Bat star	*Patiria miniata*	173.21	26.648
Wavy/red turban snail	*Lithopoma undosum*	0.00	0.000
Crowned urchin	*Centrostephanus coronatus*	0.00	0.000
Brown/golden gorgonian	*Muricea fruticosa, M. californica*	0.00	0.000
Giant spined star	*Pisaster giganteus*	10.17	6.263
Warty sea cucumber	*Parastichopus parvimensis*	0.17	0.167
Kellet's whelk	*Kelletia kelletii*	4.17	1.851
Giant keyhole limpet	*Megathura crenulata*	4.00	1.183
Large anemone	*Anthopleura spp., Metridium spp., Urticina spp.*	25.95	8.162
Chestnut cowry	*Cyoraes soadicea*	1.33	0.558
Rock scallop	*Crassedoma giganteum*	0.50	0.342
Red gorgonian	*Leophogorgia chilensis*	0.00	0.000
CA spiny lobster	*Panulirus interruptus*	0.00	0.000
Short spined sea star	*Pisaster brevispinus*	3.00	1.592
Sunflower/sun star	*Pycnopodia helianthoides, Solaster stimpsoni/dawsoni*	0.50	0.224
CA sea cucumber	*Parastichopus californicus*	0.00	0.000
Sheep/masking crab	*Loxorhynchus grandis, L. crispatus*	0.00	0.000
Green abalone	*Haliotis fulgens*	0.00	0.000
Pink abalone	*Haliotis corrugata*	0.00	0.000
Red abalone	*Haliotis rufescens*	0.00	0.000

Fish Densities (60m^2) at Naples Reef (2012)

Common name	Scientific name	Mean Density	Std Error
Blacksmith	*Chromis punctipinnis*	2.61	1.336
Senorita	*Oxyjulis californica*	5.33	1.152
Kelp bass	*Paralabrax clathratus*	0.89	0.241
Garibaldi	*Hypsypops rubicundus*	0.17	0.121
California Sheephead	*Semicossyphus pulcher*	1.72	0.311
Black perch	*Embiotoca jacksoni*	4.83	1.250
Rainbow perch	*Hypsurus caryi*	4.61	1.132
Pile perch	*Rhacochilus vacca*	2.50	0.430
Striped perch	*Embiotoca lateralis*	0.28	0.158
Rubberlip perch	*Rhacochilus toxotes*	0.56	0.283
Rock wrasse	*Halichoeres semicinctus*	0.00	0.000
Opaleye	*Girella nigricans*	0.17	0.090
Barred sand bass	*Paralabrax nebulifer*	0.00	0.000
Sargo	*Anisotermus davidsoni*	0.00	0.000
Young of the year rockfish	*Sebastes spp.*	2.50	0.733
Kelp rockfish	*Sebastes atrovirens*	0.56	0.258
Blue rockfish	*Sebastes mystinus*	6.89	1.514
Yellowtail/olive rockfish	*Sebastes flavidus/serranoides*	0.28	0.135
Treefish	*Sebastes serriceps*	0.11	0.076
Black and yellow rockfish	*Sebastes chrysomelas*	0.28	0.135
Gopher rockfish	*Sebastes carnatus*	0.22	0.129
Copper rockfish	*Sebastes caurinus*	0.11	0.111
Horn shark	*Heterodontus francisci*	0.00	0.000
Cabezon	*Scorpaenichthys marmoratus*	0.11	0.076
Lingcod	*Ophiodon elongatus*	0.06	0.056
Kelp greenling	*Hexagrammos decagrammus*	0.06	0.056

Sandpiper, located in Santa Barbara County, was established in 2012. This site is not an MPA, but is a reference site for nearby Naples SMCA and Campus Point SMCA. Average depth of the site is 10 meters, the substrate is primarily bedrock and the relief is typically 10 cm to 1 meter. The substrate is bare or covered in red algae or sessile invertebrates. The dominant macroalgae is giant kelp. Red urchins and purple urchins are prevalent and bat stars, giant spined sea stars and chestnut cowries are also present. The five most common fish are senorita, kelp bass, California sheephead, blue rockfish and rainbow perch. Like most Reef Check sites in Channel Islands National Park and Santa Barbara County, rockfish are more common here than in the majority of our coastal sites in Los Angeles, Orange and San Diego counties.

Physical Characteristics and Primary Substrate Cover at Sandpiper (2012)

Average depth	9.83 meters

Substrate type	Percentage		Substrate Cover	Percentage
Bedrock	76.67%		Articulated coralline	0.56%
Boulders	1.67%		Brown seaweed	5%
Cobble	12.22%		Crustose coralline	2.22%
Sand	9.44%		Green seaweed	0%
			Mobile invertebrates	2.78%
Relief	**Percentage**		None	43.33%
0-10cm	6.11%		Other brown seaweed	1.11%
10 cm-1meter	93.89%		Red seaweed	31.11%
1-2meter	0%		Sessile invertebrates	13.89%
>2 meters	0%			

Algae densities (60m^2) at Sandpiper (2012)

Common name	Scientific name	Mean Density	Std Error
Giant kelp	*Macrocystis pyrifera*	14.17	3.851
Giant kelp Stipes	*Macrocystis pyrifera*	209.67	87.388
Laminaria spp	*Laminaria farlowii, L. setchelii*	0.50	0.500
Pterygophora	*Pterygophora californica*	0.00	0.000
Southern sea palm	*Eisenia arboea*	0.17	0.167

Invertebrate densities (60m^2) at Sandpiper (2012)

Common name	Scientific name	Mean Density	Std Error
Purple urchin	*Strongylocentrotus purpuratus*	127.72	38.616
Red urchin	*Strongylocentrotus franciscanus*	180.81	76.969
Bat star	*Patiria miniata*	14.17	4.996
Wavy/red turban snail	*Lithopoma undosum*	0.67	0.422
Crowned urchin	*Centrostephanus coronatus*	0.00	0.000
Brown/golden gorgonian	*Muricea fruticosa, M. californica*	2.17	0.872
Giant spined star	*Pisaster giganteus*	10.83	3.146
Warty sea cucumber	*Parastichopus parvimensis*	1.00	0.516
Kellet's whelk	*Kelletia kelletii*	8.00	3.568
Giant keyhole limpet	*Megathura crenulata*	1.00	0.516
Large anemone	*Anthopleura spp., Metridium spp., Urticina spp.*	2.83	2.056
Chestnut cowry	*Cyoraes soadicea*	9.17	3.487
Rock scallop	*Crassedoma giganteum*	0.17	0.167
Red gorgonian	*Leophogorgia chilensis*	0.17	0.167
CA spiny lobster	*Panulirus interruptus*	0.00	0.000
Short spined sea star	*Pisaster brevispinus*	0.67	0.211
Sunflower/sun star	*Pycnopodia helianthoides, Solaster stimpsoni/dawsoni*	0.00	0.000
CA sea cucumber	*Parastichopus californicus*	0.00	0.000
Sheep/masking crab	*Loxorhynchus grandis, L. crispatus*	0.00	0.000
Green abalone	*Haliotis fulgens*	0.00	0.000
Pink abalone	*Haliotis corrugata*	0.00	0.000
Red abalone	*Haliotis rufescens*	0.00	0.000

Fish Densities (60m^2) at Sandpiper (2012)

Common name	Scientific name	Mean Density	Std Error
Blacksmith	*Chromis punctipinnis*	0.06	0.056
Senorita	*Oxyjulis californica*	11.72	4.081
Kelp bass	*Paralabrax clathratus*	0.89	0.279
Garibaldi	*Hypsypops rubicundus*	0.00	0.000
California Sheephead	*Semicossyphus pulcher*	0.89	0.351
Black perch	*Embiotoca jacksoni*	0.17	0.121
Rainbow perch	*Hypsurus caryi*	0.50	0.232
Pile perch	*Rhacochilus vacca*	0.22	0.152
Striped perch	*Embiotoca lateralis*	0.00	0.000
Rubberlip perch	*Rhacochilus toxotes*	0.17	0.167
Rock wrasse	*Halichoeres semicinctus*	0.00	0.000
Opaleye	*Girella nigricans*	0.00	0.000
Barred sand bass	*Paralabrax nebulifer*	0.00	0.000
Sargo	*Anisotermus davidsoni*	0.00	0.000
Young of the year rockfish	*Sebastes spp.*	0.00	0.000
Kelp rockfish	*Sebastes atrovirens*	0.00	0.000
Blue rockfish	*Sebastes mystinus*	0.61	0.354
Yellowtail/olive rockfish	*Sebastes flavidus/serranoides*	0.33	0.198
Treefish	*Sebastes serriceps*	0.00	0.000
Black and yellow rockfish	*Sebastes chrysomelas*	0.06	0.056
Gopher rockfish	*Sebastes carnatus*	0.00	0.000
Brown rockfish	*Sebastes auriculatus*	0.11	0.076
Copper rockfish	*Sebastes caurinus*	0.00	0.000
Horn shark	*Heterodontus francisci*	0.00	0.000
Cabezon	*Scorpaenichthys marmoratus*	0.00	0.000
Lingcod	*Ophiodon elongatus*	0.06	0.056
Kelp greenling	*Hexagrammos decagrammus*	0.00	0.000

IV Reef, located in Santa Barbara County, was established as a Reef Check site in 2006 and is part of the Campus Point SMCA, implemented in 2012. The average depth of the site is 9 meters, the primary substrate is bedrock and relief is mostly 10 cm to 1 meter. The substrate is bare or covered in red algae or brown algal species. Pterygophora and giant kelp are the dominant macroalgae. Purple urchins are prevalent as are red urchins, giant spined sea stars, short spined sea stars and giant keyhole limpets. Fish densities are low, but senorita, young of the year rockfish, black perch, brown rockfish and kelp bass are the most common fish. Like most Reef Check sites in Channel Islands National Park and Santa Barbara County, rockfish are more common here than in the majority of our coastal sites in Los Angeles, Orange and San Diego counties.

Physical Characteristics and Primary Substrate Cover at IV Reef (2011-2012)

Average depth	8.86 meters

Substrate type	Percentage		Substrate Cover	Percentage
Bedrock	73.33%		Articulated coralline	4.44%
Boulders	1.11%		Brown seaweed	7.78%
Cobble	24.44%		Crustose coralline	8.33%
Sand	1.11%		Green seaweed	0%
			Mobile invertebrates	2.22%
Relief	**Percentage**		None	55.56%
0-10cm	16.67%		Other brown seaweed	1.11%
10 cm-1meter	83.33%		Red seaweed	12.78%
1-2meter	0%		Sessile invertebrates	7.78%
>2 meters	0%			

Algae densities (60m^2) at IV Reef (2012)

Common name	Scientific name	Mean Density	Std Error
Giant kelp	*Macrocystis pyrifera*	9.33	4.944
Giant kelp Stipes	*Macrocystis pyrifera*	311.00	41.645
Laminaria spp	*Laminaria farlowii, L. setchelii*	0.00	0.000
Pterygophora	*Pterygophora californica*	13.50	7.393
Southern sea palm	*Eisenia arboea*	0.00	0.000
Bull kelp	*Nereocystis luetkeana*	0.00	0.000

Invertebrate densities (60m^2) at IV Reef (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Purple urchin	*Strongylocentrotus purpuratus*	160.81	45.1489
Red urchin	*Strongylocentrotus franciscanus*	17.20	10.5093
Bat star	*Patiria miniata*	1.00	0.8165
Wavy/red turban snail	*Lithopoma undosum*	0.00	0.0000
Crowned urchin	*Centrostephanus coronatus*	0.00	0.0000
Brown/golden gorgonian	*Muricea fruticosa, M. californica*	0.83	0.8333
Giant spined star	*Pisaster giganteus*	6.67	1.8012
Warty sea cucumber	*Parastichopus parvimensis*	0.00	0.0000
Kellet's whelk	*Kelletia kelletii*	0.33	0.2108
Giant keyhole limpet	*Megathura crenulata*	2.67	1.2561
Large anemone	*Anthopleura spp., Metridium spp., Urticina spp.*	0.00	0.0000
Chestnut cowry	*Cyoraes soadicea*	0.50	0.3416
Rock scallop	*Crassedoma giganteum*	0.00	0.0000
Red gorgonian	*Leophogorgia chilensis*	0.00	0.0000
CA spiny lobster	*Panulirus interruptus*	0.00	0.0000
Short spined sea star	*Pisaster brevispinus*	5.17	0.8724
Sunflower/sun star	*Pycnopodia helianthoides, Solaster stimpsoni/dawsoni*	0.17	0.1667
CA sea cucumber	*Parastichopus californicus*	0.00	0.000
Sheep/masking crab	*Loxorhynchus grandis, L. crispatus*	0.00	0.000
Green abalone	*Haliotis fulgens*	0.00	0.000
Pink abalone	*Haliotis corrugata*	0.00	0.000
Red abalone	*Haliotis rufescens*	0.00	0.000

Fish Densities (60m^2) at IV Reef (2012)

Common name	Scientific name	Mean Density	Std Error
Blacksmith	*Chromis punctipinnis*	0.00	0.000
Senorita	*Oxyjulis californica*	3.89	1.559
Kelp bass	*Paralabrax clathratus*	0.22	0.129
Garibaldi	*Hypsypops rubicundus*	0.00	0.000
California Sheephead	*Semicossyphus pulcher*	0.06	0.056
Black perch	*Embiotoca jacksoni*	0.39	0.183
Rainbow perch	*Hypsurus caryi*	0.00	0.000
Pile perch	*Rhacochilus vacca*	0.06	0.056
Striped perch	*Embiotoca lateralis*	0.00	0.000
Rubberlip perch	*Rhacochilus toxotes*	0.06	0.056
Rock wrasse	*Halichoeres semicinctus*	0.00	0.000
Opaleye	*Girella nigricans*	0.00	0.000
Barred sand bass	*Paralabrax nebulifer*	0.06	0.056
Sargo	*Anisotermus davidsoni*	0.00	0.000
Young of the year rockfish	*Sebastes spp.*	0.56	0.500
Kelp rockfish	*Sebastes atrovirens*	0.11	0.076
Blue rockfish	*Sebastes mystinus*	0.00	0.000
Yellowtail/olive rockfish	*Sebastes flavidus/serranoides*	0.00	0.000
Treefish	*Sebastes serriceps*	0.00	0.000
Black and yellow rockfish	*Sebastes chrysomelas*	0.00	0.000
Gopher rockfish	*Sebastes carnatus*	0.00	0.000
Brown rockfish	*Sebastes auriculatus*	0.22	0.129
Copper rockfish	*Sebastes caurinus*	0.00	0.000
Horn shark	*Heterodontus francisci*	0.00	0.000
Cabezon	*Scorpaenichthys marmoratus*	0.00	0.000
Lingcod	*Ophiodon elongatus*	0.06	0.056
Kelp greenling	*Hexagrammos decagrammus*	0.00	0.000

Cueva Valdez, located on Santa Cruz Island in Channel Islands National Park, was established as a Reef Check site in 2008. The substrate is mostly bedrock, but there is also a fair amount of boulders. The relief is predominantly 10 cm to 1 m and sessile invertebrates and crustose coralline algae covers the substrate. Laminaria is the dominant macroalgae and giant kelp and Southern sea palm are also present. Bat stars are prevalent and purple urchins, red urchins, giant spined sea stars and short spined sea stars are also common. California sheephead, young of the year rockfish, blacksmith, senorita and kelp rockfish are the most prevalent fish species. Like most Reef Check sites in Channel Islands National Park and Santa Barbara County, rockfish are more common here than in the majority of our coastal sites in Los Angeles, Orange and San Diego counties.

Physical Characteristics and Primary Substrate Cover at Cueva Valdez (2011-2012)

Average depth	9.35 meters

Substrate type	Percentage		Substrate Cover	Percentage
Bedrock	45%		Articulated coralline	2.50%
Boulders	23.89%		Brown seaweed	3.89%
Cobble	15.28%		Crustose coralline	23.06%
Sand	15.83%		Green seaweed	3.89%
			Mobile invertebrates	3.89%
Relief	**Percentage**		None	18.33%
0-10cm	1.94%		Other brown seaweed	3.61%
10 cm-1meter	76.39%		Red seaweed	16.11%
1-2meter	15%		Sessile invertebrates	24.72%
>2 meters	6.67%			

Algae densities (60m^2) at Cueva Valdez (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Giant kelp	*Macrocystis pyrifera*	22.33	2.893
Giant kelp Stipes	*Macrocystis pyrifera*	137.75	27.559
Laminaria spp	*Laminaria farlowii, L. setchelii*	45.38	16.537
Pterygophora	*Pterygophora californica*	0.00	0.000
Southern sea palm	*Eisenia arboea*	22.67	4.337

Invertebrate densities (60m^2) at Cueva Valdez (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Purple urchin	*Strongylocentrotus purpuratus*	57.17	40.536
Red urchin	*Strongylocentrotus franciscanus*	12.95	6.185
Bat star	*Patiria miniata*	86.76	10.990
Wavy/red turban snail	*Lithopoma undosum*	0.00	0.000
Crowned urchin	*Centrostephanus coronatus*	0.17	0.167
Brown/golden gorgonian	*Muricea fruticosa, M. californica*	0.08	0.083
Giant spined star	*Pisaster giganteus*	10.17	2.081
Warty sea cucumber	*Parastichopus parvimensis*	1.08	0.514
Kellet's whelk	*Kelletia kelletii*	0.00	0.000
Giant keyhole limpet	*Megathura crenulata*	0.08	0.083
Large anemone	*Anthopleura spp., Metridium spp., Urticina spp.*	0.08	0.083
Chestnut cowry	*Cyoraes soadicea*	0.17	0.112
Rock scallop	*Crassedoma giganteum*	0.33	0.225
Red gorgonian	*Leophogorgia chilensis*	1.75	0.629
CA spiny lobster	*Panulirus interruptus*	0.00	0.000
Short spined sea star	*Pisaster brevispinus*	2.50	1.690
Sunflower/sun star	*Pycnopodia helianthoides, Solaster stimpsoni/dawsoni*	1.50	0.584
CA sea cucumber	*Parastichopus californicus*	0.00	0.000
Sheep/masking crab	*Loxorhynchus grandis, L. crispatus*	0.17	0.167
Green abalone	*Haliotis fulgens*	0.00	0.000
Pink abalone	*Haliotis corrugata*	0.00	0.000
Red abalone	*Haliotis rufescens*	0.08	0.083

Fish Densities (60m^2) at Cueva Valdez (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Blacksmith	*Chromis punctipinnis*	2.97	0.7933
Senorita	*Oxyjulis californica*	1.92	0.8022
Kelp bass	*Paralabrax clathratus*	0.81	0.1481
Garibaldi	*Hypsypops rubicundus*	0.47	0.1161
California Sheephead	*Semicossyphus pulcher*	0.75	0.1457
Black perch	*Embiotoca jacksoni*	3.31	0.5532
Rainbow perch	*Hypsurus caryi*	0.06	0.0387
Pile perch	*Rhacochilus vacca*	1.11	0.2316
Striped perch	*Embiotoca lateralis*	0.22	0.1062
Rubberlip perch	*Rhacochilus toxotes*	0.22	0.0985
Rock wrasse	*Halichoeres semicinctus*	0.22	0.0985
Opaleye	*Girella nigricans*	0.39	0.1396
Barred sand bass	*Paralabrax nebulifer*	0.00	0.0000
Sargo	*Anisotermus davidsoni*	0.58	0.3459
Young of the year rockfish	*Sebastes spp.*	3.72	1.1613
Kelp rockfish	*Sebastes atrovirens*	1.75	0.3070
Blue rockfish	*Sebastes mystinus*	0.64	0.2114
Yellowtail/olive rockfish	*Sebastes flavidus/serranoides*	0.72	0.2890
Treefish	*Sebastes serriceps*	0.06	0.0387
Black and yellow rockfish	*Sebastes chrysomelas*	0.03	0.0278
Gopher rockfish	*Sebastes carnatus*	0.03	0.0278
Brown rockfish	*Sebastes auriculatus*	0.00	0.0000
Copper rockfish	*Sebastes caurinus*	0.03	0.0278
Horn shark	*Heterodontus francisci*	0.00	0.000
Cabezon	*Scorpaenichthys marmoratus*	0.03	0.028
Lingcod	*Ophiodon elongatus*	0.00	0.000
Kelp greenling	*Hexagrammos decagrammus*	0.00	0.000

Fry's Anchorage, located on Santa Cruz Island in Channel Islands National Park, was established as a Reef Check site in 2010. The substrate is mostly bedrock with some boulders and has a relief of 10 cm to 1 m. The substrate is mainly covered in sessile invertebrates (likely urchins) and red algae. The only macroalgae present is Southern sea palm and giant kelp. Purple urchin densities are somewhat high and red urchins, bat stars, giant spined sea stars and chestnut cowries are also present. Blacksmith, senorita, young of the year rockfish, black perch and pile perch are the most common fish species.

Physical Characteristics and Primary Substrate Cover at Frys Anchorage (2011-2012)

Average depth	9.96 meters

Substrate type	Percentage		Substrate Cover	Percentage
Bedrock	57.50%		Articulated coralline	2.50%
Boulders	20.28%		Brown seaweed	6.11%
Cobble	12.50%		Crustose coralline	25%
Sand	9.72%		Green seaweed	0.28%
			Mobile invertebrates	5.28%
Relief	**Percentage**		None	13.89%
0-10cm	0%		Other brown seaweed	0.83%
10 cm-1meter	67.50%		Red seaweed	13.61%
1-2meter	15.56%		Seagrasses	0.28%
>2 meters	16.94%		Sessile invertebrates	32.22%

Algae densities (60m^2) at Frys Anchorage (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Giant kelp	*Macrocystis pyrifera*	16.92	3.12
Giant kelp Stipes	*Macrocystis pyrifera*	94.67	14.61
Laminaria spp	*Laminaria farlowii, L. setchelii*	0.00	0.00
Pterygophora	*Pterygophora californica*	0.00	0.00
Southern sea palm	*Eisenia arboea*	32.42	5.59

Invertebrate densities (60m^2) at Frys Anchorage (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Purple urchin	*Strongylocentrotus purpuratus*	194.23	78.139
Red urchin	*Strongylocentrotus franciscanus*	68.27	34.684
Bat star	*Patiria miniata*	66.49	15.146
Wavy/red turban snail	*Lithopoma undosum*	0.42	0.193
Crowned urchin	*Centrostephanus coronatus*	0.00	0.000
Brown/golden gorgonian	*Muricea fruticosa, M. californica*	0.00	0.000
Giant spined star	*Pisaster giganteus*	12.92	1.626
Warty sea cucumber	*Parastichopus parvimensis*	2.08	0.679
Kellet's whelk	*Kelletia kelletii*	0.33	0.188
Giant keyhole limpet	*Megathura crenulata*	0.50	0.230
Large anemone	*Anthopleura spp., Metridium spp., Urticina spp.*	0.25	0.179
Chestnut cowry	*Cyoraes soadicea*	5.08	1.252
Rock scallop	*Crassedoma giganteum*	0.50	0.417
Red gorgonian	*Leophogorgia chilensis*	4.50	2.120
CA spiny lobster	*Panulirus interruptus*	0.00	0.000
Short spined sea star	*Pisaster brevispinus*	0.00	0.000
Sunflower/sun star	*Pycnopodia helianthoides, Solaster stimpsoni/dawsoni*	1.67	0.482
CA sea cucumber	*Parastichopus californicus*	0.00	0.000
Sheep/masking crab	*Loxorhynchus grandis, L. crispatus*	0.00	0.000
Green abalone	*Haliotis fulgens*	0.00	0.000
Pink abalone	*Haliotis corrugata*	0.00	0.000
Red abalone	*Haliotis rufescens*	0.08	0.083

Fish Densities (60m^2) at Frys Anchorage (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Blacksmith	*Chromis punctipinnis*	5.36	2.047
Senorita	*Oxyjulis californica*	4.53	1.689
Kelp bass	*Paralabrax clathratus*	1.47	0.332
Garibaldi	*Hypsypops rubicundus*	0.22	0.081
California Sheephead	*Semicossyphus pulcher*	1.14	0.208
Black perch	*Embiotoca jacksoni*	3.44	0.532
Rainbow perch	*Hypsurus caryi*	0.33	0.178
Pile perch	*Rhacochilus vacca*	2.28	0.390
Striped perch	*Embiotoca lateralis*	0.11	0.066
Rubberlip perch	*Rhacochilus toxotes*	0.94	0.465
Rock wrasse	*Halichoeres semicinctus*	0.50	0.135
Opaleye	*Girella nigricans*	0.36	0.139
Barred sand bass	*Paralabrax nebulifer*	0.00	0.000
Sargo	*Anisotermus davidsoni*	0.28	0.136
Young of the year rockfish	*Sebastes spp.*	3.44	1.223
Kelp rockfish	*Sebastes atrovirens*	1.17	0.244
Blue rockfish	*Sebastes mystinus*	0.56	0.377
Yellowtail/olive rockfish	*Sebastes flavidus/serranoides*	0.17	0.093
Treefish	*Sebastes serriceps*	0.14	0.071
Black and yellow rockfish	*Sebastes chrysomelas*	0.06	0.039
Gopher rockfish	*Sebastes carnatus*	0.06	0.039
Brown rockfish	*Sebastes auriculatus*	0.00	0.000
Copper rockfish	*Sebastes caurinus*	0.00	0.000
Horn shark	*Heterodontus francisci*	0.03	0.028
Cabezon	*Scorpaenichthys marmoratus*	0.03	0.028
Lingcod	*Ophiodon elongatus*	0.00	0.000
Kelp greenling	*Hexagrammos decagrammus*	0.00	0.000

Scorpion Anchorage, located on Santa Cruz Island in Channel Islands National Park, was established as a Reef Check site in 2008 and is within the boundaries of the Scorpion SMR, implemented in 2003. Bedrock is the dominant substrate and the relief is mainly 10 cm to 1 m. The substrate is either bare or covered in crustose coralline algae. This site can be described as an urchin barren, with very high densities of purple urchins and red urchins. Warty sea cucumbers, bat stars and giant keyhole limpets are also present. Blacksmith, black perch, kelp bass, senorita and blue rockfish are the most prevalent fish species. Like most Reef Check sites in Channel Islands National Park and Santa Barbara County, rockfish are more common here than in the majority of our coastal sites in Los Angeles, Orange and San Diego counties.

Physical Characteristics and Primary Substrate Cover at Scorpion Anchorage (2011-2012)

Average depth	6.37 meters

Substrate type	Percentage
Bedrock	61.94%
Boulders	15.83%
Cobble	4.17%
Sand	18.06%

Relief	Percentage
0-10cm	4.44%
10 cm-1meter	74.17%
1-2meter	16.39%
>2 meters	5%

Substrate Cover	Percentage
Articulated coralline	0.00%
Brown seaweed	0.00%
Crustose coralline	24.72%
Green seaweed	0.0%
Mobile invertebrates	11.39%
None	46.94%
Other brown seaweed	1.11%
Red seaweed	0.56%
Seagrasses	
Sessile invertebrates	15.28%

Algae densities (60m^2) at Scorpion Anchorage (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Giant kelp	*Macrocystis pyrifera*	0.00	0.000
Giant kelp Stipes	*Macrocystis pyrifera*	0.00	0.000
Laminaria spp	*Laminaria farlowii, L. setchelii*	0.00	0.000
Pterygophora	*Pterygophora californica*	0.00	0.000
Southern sea palm	*Eisenia arboea*	0.00	0.000

Invertebrate densities (60m^2) at Scorpion Anchorage (2011- 2012)

Common name	Scientific name	Mean Density	Std Error
Purple urchin	*Strongylocentrotus purpuratus*	965.85	142.856
Red urchin	*Strongylocentrotus franciscanus*	299.36	59.370
Bat star	*Patiria miniata*	17.67	3.918
Wavy/red turban snail	*Lithopoma undosum*	0.17	0.167
Crowned urchin	*Centrostephanus coronatus*	0.00	0.000
Brown/golden gorgonian	*Muricea fruticosa, M. californica*	0.00	0.000
Giant spined star	*Pisaster giganteus*	5.58	1.300
Warty sea cucumber	*Parastichopus parvimensis*	32.98	6.985
Kellet's whelk	*Kelletia kelletii*	0.00	0.000
Giant keyhole limpet	*Megathura crenulata*	8.00	1.308
Large anemone	*Anthopleura spp., Metridium spp., Urticina spp.*	0.50	0.337
Chestnut cowry	*Cyoraes soadicea*	0.42	0.336
Rock scallop	*Crassedoma giganteum*	0.75	0.279
Red gorgonian	*Leophogorgia chilensis*	3.92	1.640
CA spiny lobster	*Panulirus interruptus*	0.67	0.376
Short spined sea star	*Pisaster brevispinus*	0.83	0.747
Sunflower/sun star	*Pycnopodia helianthoides, Solaster stimpsoni/dawsoni*	0.00	0.000
CA sea cucumber	*Parastichopus californicus*	0.08	0.083
Sheep/masking crab	*Loxorhynchus grandis, L. crispatus*	0.00	0.000
Green abalone	*Haliotis fulgens*	0.00	0.000
Pink abalone	*Haliotis corrugata*	0.00	0.000
Red abalone	*Haliotis rufescens*	0.00	0.000

Fish Densities (60m^2) at Scorpion Anchorage (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Blacksmith	*Chromis punctipinnis*	8.44	1.776
Senorita	*Oxyjulis californica*	2.58	0.725
Kelp bass	*Paralabrax clathratus*	2.67	0.685
Garibaldi	*Hypsypops rubicundus*	0.58	0.134
California Sheephead	*Semicossyphus pulcher*	0.56	0.129
Black perch	*Embiotoca jacksoni*	5.42	0.996
Rainbow perch	*Hypsurus caryi*	0.00	0.000
Pile perch	*Rhacochilus vacca*	0.33	0.105
Striped perch	*Embiotoca lateralis*	0.03	0.028
Rubberlip perch	*Rhacochilus toxotes*	0.06	0.039
Rock wrasse	*Halichoeres semicinctus*	0.17	0.063
Opaleye	*Girella nigricans*	0.61	0.200
Barred sand bass	*Paralabrax nebulifer*	0.03	0.028
Sargo	*Anisotermus davidsoni*	0.06	0.056
Young of the year rockfish	*Sebastes spp.*	0.00	0.000
Kelp rockfish	*Sebastes atrovirens*	0.86	0.233
Blue rockfish	*Sebastes mystinus*	1.36	0.775
Yellowtail/olive rockfish	*Sebastes flavidus/serranoides*	0.28	0.172
Treefish	*Sebastes serriceps*	0.11	0.053
Black and yellow rockfish	*Sebastes chrysomelas*	0.00	0.000
Gopher rockfish	*Sebastes carnatus*	0.00	0.000
Brown rockfish	*Sebastes auriculatus*	0.00	0.000
Copper rockfish	*Sebastes caurinus*	0.00	0.000
Horn shark	*Heterodontus francisci*	0.03	0.028
Cabezon	*Scorpaenichthys marmoratus*	0.00	0.000
Lingcod	*Ophiodon elongatus*	0.00	0.000
Kelp greenling	*Hexagrammos decagrammus*	0.00	0.000

Pelican Anchorage, located on Santa Cruz Island in Channel Islands National Park, was established as a Reef Check site in 2006. This site often offers protection from wind and waves and the underwater terrain is sloping, with survey depths ranging from 10 feet to 50 feet. The substrate is primarily bedrock, with some boulders and sand with a relief of 10 cm to 1 m. The substrate is bare or covered in crustose coralline algae or sessile invertebrates. This site can be described as an urchin barren, with very high densities of purple urchins and red urchins. Bat stars, giant spined sea stars and red gorgonians are also present. Blacksmith, black perch, senorita, garibaldi and young of the year rockfish are the most prevalent fish species.

Physical Characteristics and Primary Substrate Cover at Pelican Anchorage (2011-2012)

Average depth	7.52 meters

Substrate type	Percentage
Bedrock	40.56%
Boulders	22.22%
Cobble	15.93%
Sand	21.30%

Relief	Percentage
0-10cm	5.19%
10 cm-1meter	79.81%
1-2meter	13.33%
>2 meters	1.67%

Substrate Cover	Percentage
Articulated coralline	1.11%
Brown seaweed	1.67%
Crustose coralline	27.22%
Green seaweed	0.19%
Mobile invertebrates	4.63%
None	37.78%
Other brown seaweed	1.85%
Red seaweed	0.93%
Sessile invertebrates	24.63%

Algae densities (60m^2) at Pelican Anchorage (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Giant kelp	*Macrocystis pyrifera*	6.61	2.238
Giant kelp Stipes	*Macrocystis pyrifera*	118.33	28.212
Laminaria spp	*Laminaria farlowii, L. setchelii*	0.00	0.000
Pterygophora	*Pterygophora californica*	0.00	0.000
Southern sea palm	*Eisenia arboea*	0.17	0.167

Invertebrate densities (60m^2) at Pelican Anchorage (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Purple urchin	*Strongylocentrotus purpuratus*	607.66	154.761
Red urchin	*Strongylocentrotus franciscanus*	119.63	28.152
Bat star	*Patiria miniata*	34.91	4.550
Wavy/red turban snail	*Lithopoma undosum*	0.00	0.000
Crowned urchin	*Centrostephanus coronatus*	0.00	0.000
Brown/golden gorgonian	*Muricea fruticosa, M. californica*	2.11	2.053
Giant spined star	*Pisaster giganteus*	10.28	2.117
Warty sea cucumber	*Parastichopus parvimensis*	1.06	0.375
Kellet's whelk	*Kelletia kelletii*	0.67	0.343
Giant keyhole limpet	*Megathura crenulata*	1.78	0.482
Large anemone	*Anthopleura spp., Metridium spp., Urticina spp.*	0.11	0.076
Chestnut cowry	*Cyoraes soadicea*	0.89	0.615
Rock scallop	*Crassedoma giganteum*	0.06	0.056
Red gorgonian	*Leophogorgia chilensis*	7.94	2.549
CA spiny lobster	*Panulirus interruptus*	0.00	0.000
Short spined sea star	*Pisaster brevispinus*	1.00	0.723
Sunflower/sun star	*Pycnopodia helianthoides, Solaster stimpsoni/dawsoni*	0.22	0.101
CA sea cucumber	*Parastichopus californicus*	0.22	0.173
Sheep/masking crab	*Loxorhynchus grandis, L. crispatus*	0.00	0.000
Green abalone	*Haliotis fulgens*	0.00	0.000
Pink abalone	*Haliotis corrugata*	0.00	0.000
Red abalone	*Haliotis rufescens*	0.00	0.000

Fish Densities (60m^2) at Pelican Anchorage (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Blacksmith	*Chromis punctipinnis*	5.02	1.651
Senorita	*Oxyjulis californica*	3.44	1.243
Kelp bass	*Paralabrax clathratus*	1.63	0.247
Garibaldi	*Hypsypops rubicundus*	1.98	0.287
California Sheephead	*Semicossyphus pulcher*	0.76	0.145
Black perch	*Embiotoca jacksoni*	3.91	0.618
Rainbow perch	*Hypsurus caryi*	0.06	0.041
Pile perch	*Rhacochilus vacca*	1.17	0.294
Striped perch	*Embiotoca lateralis*	0.09	0.076
Rubberlip perch	*Rhacochilus toxotes*	0.30	0.114
Rock wrasse	*Halichoeres semicinctus*	0.22	0.082
Opaleye	*Girella nigricans*	0.26	0.110
Barred sand bass	*Paralabrax nebulifer*	0.07	0.074
Sargo	*Anisotermus davidsoni*	0.06	0.031
Young of the year rockfish	*Sebastes spp.*	1.74	0.606
Kelp rockfish	*Sebastes atrovirens*	0.96	0.230
Blue rockfish	*Sebastes mystinus*	0.85	0.244
Yellowtail/olive rockfish	*Sebastes flavidus/serranoides*	0.30	0.108
Treefish	*Sebastes serriceps*	0.09	0.040
Black and yellow rockfish	*Sebastes chrysomelas*	0.07	0.036
Gopher rockfish	*Sebastes carnatus*	0.07	0.045
Brown rockfish	*Sebastes auriculatus*	0.09	0.061
Copper rockfish	*Sebastes caurinus*	0.02	0.019
Horn shark	*Heterodontus francisci*	0.00	0.000
Cabezon	*Scorpaenichthys marmoratus*	0.02	0.019
Lingcod	*Ophiodon elongatus*	0.00	0.000
Kelp greenling	*Hexagrammos decagrammus*	0.00	0.000

Big Rock, located in Malibu in Los Angeles County, was established as a Reef Check site in 2007. As the name implies, this area contains some large rocks, some of which reach the surface of the water. The surrounding area is sandy and some of the large rocks have had the sand scoured away from their bases due to the currents that sweep through. The substrate is mostly bedrock with a fair amount of sand and relief is generally 10 cm to 1 m. The substrate is mostly bare with some red algae. The most common macroalgae is giant kelp and there is some pterygophora present. Brown/golden gorgonian densities are high (perhaps due to the currents) and red urchins, purple urchins, rock scallops and warty sea cucumbers are also present. Senorita, black perch, kelp bass, blacksmith and garibaldi are the most common fish.

Physical Characteristics and Primary Substrate Cover at Big Rock (2012)

Average depth	7.42 meters

Substrate type	Percentage		Substrate Cover	Percentage
Bedrock	51.60%		Articulated coralline	5.00%
Boulders	7.22%		Brown seaweed	3.33%
Cobble	8.89%		Crustose coralline	2.22%
Sand	32.22%		Green seaweed	
			Mobile invertebrates	
Relief	**Percentage**		None	43.33%
0-10cm	23.33%		Other brown seaweed	6.66%
10 cm-1meter	72.22%		Red seaweed	26.11%
1-2meter	2.22%		Sessile invertebrates	13%
>2 meters	2.22%			

Algae densities (60m^2) at Big Rock (2012)

Common name	Scientific name	Mean Density	Std Error
Giant kelp	*Macrocystis pyrifera*	18.33	3.639
Giant kelp Stipes	*Macrocystis pyrifera*	166.67	36.106
Laminaria spp	*Laminaria farlowii, L. setchelii*	0.00	0.000
Pterygophora	*Pterygophora californica*	3.33	2.376
Southern sea palm	*Eisenia arboea*	0.17	0.167

Invertebrate densities (60m^2) at Big Rock (2012)

Common name	Scientific name	Mean Density	Std Error
Purple urchin	*Strongylocentrotus purpuratus*	11.33	3.138
Red urchin	*Strongylocentrotus franciscanus*	24.74	10.553
Bat star	*Patiria miniata*	0.00	0.000
Wavy/red turban snail	*Lithopoma undosum*	0.00	0.000
Crowned urchin	*Centrostephanus coronatus*	0.00	0.000
Brown/golden gorgonian	*Muricea fruticosa, M. californica*	156.22	71.928
Giant spined star	*Pisaster giganteus*	0.17	0.167
Warty sea cucumber	*Parastichopus parvimensis*	0.83	0.307
Kellet's whelk	*Kelletia kelletii*	0.00	0.000
Giant keyhole limpet	*Megathura crenulata*	0.67	0.667
Large anemone	*Anthopleura spp., Metridium spp., Urticina spp.*	0.33	0.333
Chestnut cowry	*Cyoraes soadicea*	0.50	0.342
Rock scallop	*Crassedoma giganteum*	1.00	0.516
Red gorgonian	*Leophogorgia chilensis*	0.50	0.342
CA spiny lobster	*Panulirus interruptus*	0.67	0.667
Short spined sea star	*Pisaster brevispinus*	0.00	0.000
Sunflower/sun star	*Pycnopodia helianthoides, Solaster stimpsoni/dawsoni*	0.00	0.000
CA sea cucumber	*Parastichopus californicus*	0.00	0.000
Sheep/masking crab	*Loxorhynchus grandis, L. crispatus*	0.00	0.000
Green abalone	*Haliotis fulgens*	0.00	0.000
Pink abalone	*Haliotis corrugata*	0.00	0.000
Red abalone	*Haliotis rufescens*	0.00	0.000

Fish Densities (60m^2) at Big Rock (2012)

Common name	Scientific name	Mean Density	Std Error
Blacksmith	*Chromis punctipinnis*	1.72	1.722
Senorita	*Oxyjulis californica*	6.83	1.181
Kelp bass	*Paralabrax clathratus*	1.83	0.336
Garibaldi	*Hypsypops rubicundus*	1.61	0.354
California Sheephead	*Semicossyphus pulcher*	0.44	0.246
Black perch	*Embiotoca jacksoni*	3.22	0.645
Rainbow perch	*Hypsurus caryi*	0.56	0.217
Pile perch	*Rhacochilus vacca*	0.39	0.143
Striped perch	*Embiotoca lateralis*	0.22	0.152
Rubberlip perch	*Rhacochilus toxotes*	0.28	0.195
Rock wrasse	*Halichoeres semicinctus*	0.72	0.240
Opaleye	*Girella nigricans*	0.17	0.121
Barred sand bass	*Paralabrax nebulifer*	0.28	0.177
Sargo	*Anisotermus davidsoni*	0.33	0.243
Young of the year rockfish	*Sebastes spp.*	0.94	0.944
Kelp rockfish	*Sebastes atrovirens*	0.11	0.076
Blue rockfish	*Sebastes mystinus*	0.00	0.000
Yellowtail/olive rockfish	*Sebastes flavidus/serranoides*	0.06	0.056
Treefish	*Sebastes serriceps*	0.06	0.056
Black and yellow rockfish	*Sebastes chrysomelas*	0.00	0.000
Gopher rockfish	*Sebastes carnatus*	0.00	0.000
Brown rockfish	*Sebastes auriculatus*	0.06	0.056
Copper rockfish	*Sebastes caurinus*	0.00	0.000
Horn shark	*Heterodontus francisci*	0.33	0.114
Cabezon	*Scorpaenichthys marmoratus*	0.06	0.056
Lingcod	*Ophiodon elongatus*	0.00	0.000
Kelp greenling	*Hexagrammos decagrammus*	0.00	0.000

Lechuza, located in Malibu in Los Angeles County, was established as a Reef Check site in 2007 and is protected as part of the Point Dume SMCA, implemented in 2012. The substrate is a mix of sand and bedrock with a relief of 10 cm to 1 m. The substrate is primarily bare or covered in red algae. The most common macroalgae is giant kelp with some laminaria. Red urchins, purple urchins, bat stars, giant spined sea stars and warty sea cucumbers are the dominant invertebrates. Senorita, rainbow perch, black perch, kelp bass and striped perch are the most common fish species.

Physical Characteristics and Primary Substrate Cover at Lechuza (2012)

Average depth	7.51 meters

Substrate type	Percentage		Substrate Cover	Percentage
Bedrock	39.44%		Articulated coralline	4.44%
Boulders	10.56%		Brown seaweed	5.56%
Cobble	5%		Crustose coralline	1.11%
Sand	45%		Green seaweed	0%
			Mobile invertebrates	1.67%
Relief	**Percentage**		None	45.56%
0-10cm	7.78%		Other brown seaweed	7.22%
10 cm-1meter	92.22%		Red seaweed	23.33%
1-2meter	0%		Sessile invertebrates	11.11%
>2 meters	0%			

Algae densities (60m^2) at Lechuza (2012)

Common name	Scientific name	Mean Density	Std Error
Giant kelp	*Macrocystis pyrifera*	11.17	2.496
Giant kelp Stipes	*Macrocystis pyrifera*	187.50	43.161
Laminaria spp	*Laminaria farlowii, L. setchelii*	2.83	2.136
Pterygophora	*Pterygophora californica*	0.17	0.167
Southern sea palm	*Eisenia arboea*	0.00	0.000

Invertebrate densities (60m^2) at Lechuza (2012)

Common name	Scientific name	Mean Density	Std Error
Purple urchin	*Strongylocentrotus purpuratus*	23.67	8.902
Red urchin	*Strongylocentrotus franciscanus*	30.83	23.964
Bat star	*Patiria miniata*	9.00	7.448
Wavy/red turban snail	*Lithopoma undosum*	0.00	0.000
Crowned urchin	*Centrostephanus coronatus*	0.00	0.000
Brown/golden gorgonian	*Muricea fruticosa, M. californica*	1.50	1.500
Giant spined star	*Pisaster giganteus*	4.33	1.606
Warty sea cucumber	*Parastichopus parvimensis*	0.50	0.500
Kellet's whelk	*Kelletia kelletii*	0.00	0.000
Giant keyhole limpet	*Megathura crenulata*	0.33	0.211
Large anemone	*Anthopleura spp., Metridium spp., Urticina spp.*	0.17	0.167
Chestnut cowry	*Cyoraes soadicea*	0.33	0.333
Rock scallop	*Crassedoma giganteum*	0.50	0.500
Red gorgonian	*Leophogorgia chilensis*	0.00	0.000
CA spiny lobster	*Panulirus interruptus*	0.00	0.000
Short spined sea star	*Pisaster brevispinus*	0.17	0.167
Sunflower/sun star	*Pycnopodia helianthoides, Solaster stimpsoni/dawsoni*	0.00	0.000
CA sea cucumber	*Parastichopus californicus*	0.17	0.167
Sheep/masking crab	*Loxorhynchus grandis, L. crispatus*	0.00	0.000
Green abalone	*Haliotis fulgens*	0.00	0.000
Pink abalone	*Haliotis corrugata*	0.00	0.000
Red abalone	*Haliotis rufescens*	0.00	0.000

Fish Densities (60m^2) at Lechuza (2012)

Common name	Scientific name	Mean Density	Std Error
Blacksmith	*Chromis punctipinnis*	0.00	0.000
Senorita	*Oxyjulis californica*	8.17	2.474
Kelp bass	*Paralabrax clathratus*	1.67	0.554
Garibaldi	*Hypsypops rubicundus*	0.06	0.056
California Sheephead	*Semicossyphus pulcher*	0.67	0.256
Black perch	*Embiotoca jacksoni*	1.83	0.487
Rainbow perch	*Hypsurus caryi*	1.94	0.644
Pile perch	*Rhacochilus vacca*	1.06	0.688
Striped perch	*Embiotoca lateralis*	0.89	0.517
Rubberlip perch	*Rhacochilus toxotes*	0.00	0.000
Rock wrasse	*Halichoeres semicinctus*	0.33	0.181
Opaleye	*Girella nigricans*	0.00	0.000
Barred sand bass	*Paralabrax nebulifer*	0.11	0.111
Sargo	*Anisotermus davidsoni*	0.22	0.152
Young of the year rockfish	*Sebastes spp.*	1.39	1.389
Kelp rockfish	*Sebastes atrovirens*	0.00	0.000
Blue rockfish	*Sebastes mystinus*	0.00	0.000
Yellowtail/olive rockfish	*Sebastes flavidus/serranoides*	0.00	0.000
Treefish	*Sebastes serriceps*	0.00	0.000
Black and yellow rockfish	*Sebastes chrysomelas*	0.00	0.000
Gopher rockfish	*Sebastes carnatus*	0.00	0.000
Brown rockfish	*Sebastes auriculatus*	0.00	0.000
Copper rockfish	*Sebastes caurinus*	0.06	0.056
Horn shark	*Heterodontus francisci*	0.06	0.056
Cabezon	*Scorpaenichthys marmoratus*	0.00	0.000
Lingcod	*Ophiodon elongatus*	0.00	0.000
Kelp greenling	*Hexagrammos decagrammus*	0.00	0.000

Landing Cove, located on Anacapa Island in Channel Islands National Park, was established as a Reef Check site in 2009 and is part of the Anacapa Island SMR, implemented in 2003. Average depth of the site is 11 meters, bedrock is the dominant substrate and relief is 10 cm to 2 meters. The substrate is bare or covered by red algae and articulated coralline algae. Laminaria is very prevalent at this site. Red urchins, purple urchins, warty sea cucumbers, crowned urchins, wavy/red turban snails and giant spined sea stars are also present. California sheephead, black perch, senorita, young of the year rockfish, kelp bass and garibaldi are the most prevalent fish. Like most Reef Check sites in Channel Islands National Park and Santa Barbara County, rockfish are more common here than in the majority of our coastal sites in Los Angeles, Orange and San Diego counties.

Physical Characteristics and Primary Substrate Cover at Landing Cove (2012)

Average depth	10.99 meters

Substrate type	Percentage		Substrate Cover	Percentage
Bedrock	47.22%		Articulated coralline	16.67%
Boulders	20%		Brown seaweed	7.78%
Cobble	22.22%		Crustose coralline	6.11%
Sand	9.44%		Green seaweed	0.56%
			Mobile invertebrates	1.67%
Relief	**Percentage**		None	33.89%
0-10cm	11.11%		Other brown seaweed	2.78%
10 cm-1meter	65.56%		Red seaweed	21.67%
1-2meter	19.44%		Sessile invertebrates	8.89%
>2 meters	3.89%			

Algae densities (60m^2) at Landing Cove (2012)

Common name	Scientific name	Mean Density	Std Error
Giant kelp	*Macrocystis pyrifera*	13.40	2.379
Giant kelp Stipes	*Macrocystis pyrifera*	114.40	35.008
Laminaria spp	*Laminaria farlowii, L. setchelii*	202.56	36.910
Pterygophora	*Pterygophora californica*	3.17	2.040
Southern sea palm	*Eisenia arboea*	32.00	4.865

Invertebrate densities (60m^2) at Landing Cove (2012)

Common name	Scientific name	Mean Density	Std Error
Purple urchin	*Strongylocentrotus purpuratus*	23.09	10.334
Red urchin	*Strongylocentrotus franciscanus*	41.26	17.800
Bat star	*Patiria miniata*	0.00	0.000
Wavy/red turban snail	*Lithopoma undosum*	1.00	0.516
Crowned urchin	*Centrostephanus coronatus*	3.00	2.049
Brown/golden gorgonian	*Muricea fruticosa, M. californica*	0.00	0.000
Giant spined star	*Pisaster giganteus*	1.00	0.516
Warty sea cucumber	*Parastichopus parvimensis*	16.00	4.837
Kellet's whelk	*Kelletia kelletii*	0.00	0.000
Giant keyhole limpet	*Megathura crenulata*	0.17	0.167
Large anemone	*Anthopleura spp., Metridium spp., Urticina spp.*	0.00	0.000
Chestnut cowry	*Cyoraes soadicea*	0.00	0.000
Rock scallop	*Crassedoma giganteum*	0.17	0.167
Red gorgonian	*Leophogorgia chilensis*	0.00	0.000
CA spiny lobster	*Panulirus interruptus*	0.17	0.167
Short spined sea star	*Pisaster brevispinus*	0.00	0.000
Sunflower/sun star	*Pycnopodia helianthoides, Solaster stimpsoni/dawsoni*	0.00	0.000
CA sea cucumber	*Parastichopus californicus*	0.00	0.000
Sheep/masking crab	*Loxorhynchus grandis, L. crispatus*	0.00	0.000
Green abalone	*Haliotis fulgens*	0.00	0.000
Pink abalone	*Haliotis corrugata*	0.00	0.000
Red abalone	*Haliotis rufescens*	0.00	0.000

Fish Densities (60m^2) at Landing Cove (2012)

Common name	Scientific name	Mean Density	Std Error
Blacksmith	*Chromis punctipinnis*	2	1.048
Senorita	*Oxyjulis californica*	1.17	0.519
Kelp bass	*Paralabrax clathratus*	0.44	0.185
Garibaldi	*Hypsypops rubicundus*	0.44	0.121
California Sheephead	*Semicossyphus pulcher*	1.61	0.325
Black perch	*Embiotoca jacksoni*	1.56	0.710
Rainbow perch	*Hypsurus caryi*	0.11	0.111
Pile perch	*Rhacochilus vacca*	0.11	0.076
Striped perch	*Embiotoca lateralis*	0.39	0.183
Rubberlip perch	*Rhacochilus toxotes*	0.11	0.111
Rock wrasse	*Halichoeres semicinctus*	0.11	0.076
Opaleye	*Girella nigricans*	0.44	0.345
Barred sand bass	*Paralabrax nebulifer*	0.00	0.000
Sargo	*Anisotermus davidsoni*	0.00	0.000
Young of the year rockfish	*Sebastes spp.*	0.72	0.360
Kelp rockfish	*Sebastes atrovirens*	0.17	0.090
Blue rockfish	*Sebastes mystinus*	0.00	0.000
Yellowtail/olive rockfish	*Sebastes flavidus/serranoides*	0.00	0.000
Treefish	*Sebastes serriceps*	0.00	0.000
Black and yellow rockfish	*Sebastes chrysomelas*	0.00	0.000
Gopher rockfish	*Sebastes carnatus*	0.00	0.000
Brown rockfish	*Sebastes auriculatus*	0.00	0.000
Copper rockfish	*Sebastes caurinus*	0.00	0.000
Horn shark	*Heterodontus francisci*	0.00	0.000
Cabezon	*Scorpaenichthys marmoratus*	0.00	0.000
Lingcod	*Ophiodon elongatus*	0.00	0.000
Kelp greenling	*Hexagrammos decagrammus*	0.00	0.000

Cathedral Cove, located on Anacapa Island in Channel Islands National Park, was established as a Reef Check site in 2006 and is part of the Anacapa Island SMR, implemented in 2003. This rocky reef is bounded by large expanses of sand on the outer edge of the reef. Average depth of the site is 6.7 meters, substrate is primarily bedrock and ranges from 10 cm to 2 meters in relief. The substrate is bare or covered in red algae and articulated coralline algae. Macroalgae includes a high density of laminaria and also some giant kelp and Southern sea palm. Invertebrates include red urchins, purple urchins, warty sea cucumbers, large anemones and California spiny lobsters. Blacksmith, black perch, senorita, California sheephead and opaleye are the most common fish species.

Physical Characteristics and Primary Substrate Cover at Cathedral Cove (2011-2012)

Average depth	6.77 meters

Substrate type	Percentage		Substrate Cover	Percentage
Bedrock	60.83%		Articulated coralline	17.22%
Boulders	15.56%		Brown seaweed	4.72%
Cobble	5.83%		Crustose coralline	6.67%
Sand	17.78%		Green seaweed	0.56%
			Mobile invertebrates	0.83%
Relief	**Percentage**		None	27.22%
0-10cm	8.06%		Other brown seaweed	6.11%
10 cm-1meter	60%		Red seaweed	23.61%
1-2meter	27.22%		Sessile invertebrates	13.06%
>2 meters	4.72%			

Algae densities (60m^2) at Cathedral Cove (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Giant kelp	*Macrocystis pyrifera*	25.63	4.231
Giant kelp Stipes	*Macrocystis pyrifera*	171.20	26.630
Laminaria spp	*Laminaria farlowii, L. setchelii*	292.19	117.734
Pterygophora	*Pterygophora californica*	0.50	0.500
Southern sea palm	*Eisenia arboea*	22.37	9.215

Invertebrate densities (60m^2) at Cathedral Cove (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Purple urchin	*Strongylocentrotus purpuratus*	48.27	19.444
Red urchin	*Strongylocentrotus franciscanus*	104.57	19.733
Bat star	*Patiria miniata*	0.17	0.112
Wavy/red turban snail	*Lithopoma undosum*	0.42	0.288
Crowned urchin	*Centrostephanus coronatus*	0.42	0.336
Brown/golden gorgonian	*Muricea fruticosa, M. californica*	0.17	0.112
Giant spined star	*Pisaster giganteus*	1.00	0.590
Warty sea cucumber	*Parastichopus parvimensis*	15.83	3.855
Kellet's whelk	*Kelletia kelletii*	0.00	0.000
Giant keyhole limpet	*Megathura crenulata*	0.00	0.000
Large anemone	*Anthopleura spp., Metridium spp., Urticina spp.*	1.50	0.680
Chestnut cowry	*Cyoraes soadicea*	0.75	0.579
Rock scallop	*Crassedoma giganteum*	0.58	0.260
Red gorgonian	*Leophogorgia chilensis*	0.00	0.000
CA spiny lobster	*Panulirus interruptus*	1.50	0.996
Short spined sea star	*Pisaster brevispinus*	0.08	0.083
Sunflower/sun star	*Pycnopodia helianthoides, Solaster stimpsoni/dawsoni*	0.00	0.000
CA sea cucumber	*Parastichopus californicus*	0.08	0.083
Sheep/masking crab	*Loxorhynchus grandis, L. crispatus*	0.00	0.000
Green abalone	*Haliotis fulgens*	0.00	0.000
Pink abalone	*Haliotis corrugata*	0.08	0.083
Red abalone	*Haliotis rufescens*	0.00	0.000

Fish Densities (60m^2) at Cathedral Cove (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Blacksmith	*Chromis punctipinnis*	5.31	1.787
Senorita	*Oxyjulis californica*	2.44	1.276
Kelp bass	*Paralabrax clathratus*	0.64	0.121
Garibaldi	*Hypsypops rubicundus*	1.06	0.182
California Sheephead	*Semicossyphus pulcher*	2.17	0.302
Black perch	*Embiotoca jacksoni*	2.56	0.583
Rainbow perch	*Hypsurus caryi*	0.00	0.000
Pile perch	*Rhacochilus vacca*	0.17	0.075
Striped perch	*Embiotoca lateralis*	0.44	0.135
Rubberlip perch	*Rhacochilus toxotes*	0.03	0.028
Rock wrasse	*Halichoeres semicinctus*	0.47	0.201
Opaleye	*Girella nigricans*	1.28	0.622
Barred sand bass	*Paralabrax nebulifer*	0.00	0.000
Sargo	*Anisotermus davidsoni*	0.00	0.000
Young of the year rockfish	*Sebastes spp.*	0.28	0.202
Kelp rockfish	*Sebastes atrovirens*	0.11	0.066
Blue rockfish	*Sebastes mystinus*	0.22	0.170
Yellowtail/olive rockfish	*Sebastes flavidus/serranoides*	0.06	0.039
Treefish	*Sebastes serriceps*	0.03	0.028
Black and yellow rockfish	*Sebastes chrysomelas*	0.00	0.000
Gopher rockfish	*Sebastes carnatus*	0.00	0.000
Brown rockfish	*Sebastes auriculatus*	0.00	0.000
Copper rockfish	*Sebastes caurinus*	0.00	0.000
Horn shark	*Heterodontus francisci*	0.00	0.000
Cabezon	*Scorpaenichthys marmoratus*	0.03	0.028
Lingcod	*Ophiodon elongatus*	0.00	0.000
Kelp greenling	*Hexagrammos decagrammus*	0.00	0.000

Cathedral Wall, located on Anacapa Island in Channel Islands National Park, was established as a Reef Check site in 2009 and is part of the Anacapa Island SMR, implemented in 2003. Average depth of the site is 6 meters and the substrate is a mix of bedrock and boulders. Relief is 10 cm to 1 m and the substrate is covered in sessile invertebrates, articulated coralline algae or is bare. Laminaria and giant kelp are the dominant macroalgae. Red urchins, purple urchins, warty sea cucumbers, wavy/red turban snails and rock scallops are the prevalent invertebrates. Blacksmith, senorita, opaleye, black perch, kelp bass and California sheephead are the most common fish species.

Physical Characteristics and Primary Substrate Cover at Cathedral Wall (2011-2012)

Average depth	5.80 meters

Substrate type	Percentage	Substrate Cover	Percentage
Bedrock	35.00%	Articulated coralline	18.61%
Boulders	33.06%	Brown seaweed	5.27%
Cobble	19.72%	Crustose coralline	11.38%
Sand	12.22%	Green seaweed	1.67%
		Mobile invertebrates	1.39%
Relief	**Percentage**	None	18.06%
0-10cm	0.00%	Other brown seaweed	8.61%
10 cm-1meter	88.61%	Red seaweed	12.78%
1-2meter	11.39%	Sessile invertebrates	22.22%
>2 meters	0.00%		

Algae densities (60m^2) at Cathedral Wall (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Giant kelp	*Macrocystis pyrifera*	97.19	60.974
Giant kelp Stipes	*Macrocystis pyrifera*	418.24	238.489
Laminaria spp	*Laminaria farlowii, L. setchelii*	157.31	33.008
Pterygophora	*Pterygophora californica*	0.00	0.000
Southern sea palm	*Eisenia arboea*	10.08	3.737

Invertebrate densities (60m^2) at Cathedral Wall (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Purple urchin	*Strongylocentrotus purpuratus*	65.90	17.187
Red urchin	*Strongylocentrotus franciscanus*	152.08	33.245
Bat star	*Patiria miniata*	0.00	0.000
Wavy/red turban snail	*Lithopoma undosum*	2.50	0.793
Crowned urchin	*Centrostephanus coronatus*	0.00	0.000
Brown/golden gorgonian	*Muricea fruticosa, M. californica*	0.00	0.000
Giant spined star	*Pisaster giganteus*	0.50	0.261
Warty sea cucumber	*Parastichopus parvimensis*	12.08	3.374
Kellet's whelk	*Kelletia kelletii*	0.08	0.083
Giant keyhole limpet	*Megathura crenulata*	0.25	0.250
Large anemone	*Anthopleura spp., Metridium spp., Urticina spp.*	0.50	0.195
Chestnut cowry	*Cyoraes soadicea*	0.00	0.000
Rock scallop	*Crassedoma giganteum*	1.33	0.762
Red gorgonian	*Leophogorgia chilensis*	0.08	0.083
CA spiny lobster	*Panulirus interruptus*	0.92	0.417
Short spined sea star	*Pisaster brevispinus*	0.00	0.000
Sunflower/sun star	*Pycnopodia helianthoides, Solaster stimpsoni/dawsoni*	0.00	0.000
CA sea cucumber	*Parastichopus californicus*	0.00	0.000
Sheep/masking crab	*Loxorhynchus grandis, L. crispatus*	0.08	0.083
Green abalone	*Haliotis fulgens*	0.08	0.083
Pink abalone	*Haliotis corrugata*	0.00	0.000
Red abalone	*Haliotis rufescens*	0.00	0.000

Fish Densities (60m^2) at Cathedral Wall (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Blacksmith	*Chromis punctipinnis*	5.11	1.695
Senorita	*Oxyjulis californica*	4.58	2.216
Kelp bass	*Paralabrax clathratus*	0.86	0.285
Garibaldi	*Hypsypops rubicundus*	0.69	0.248
California Sheephead	*Semicossyphus pulcher*	0.86	0.192
Black perch	*Embiotoca jacksoni*	1.47	0.377
Rainbow perch	*Hypsurus caryi*	0.00	0.000
Pile perch	*Rhacochilus vacca*	0.17	0.102
Striped perch	*Embiotoca lateralis*	0.03	0.028
Rubberlip perch	*Rhacochilus toxotes*	0.08	0.047
Rock wrasse	*Halichoeres semicinctus*	0.17	0.085
Opaleye	*Girella nigricans*	1.67	0.631
Barred sand bass	*Paralabrax nebulifer*	0.00	0.000
Sargo	*Anisotermus davidsoni*	0.00	0.000
Young of the year rockfish	*Sebastes spp.*	0.36	0.309
Kelp rockfish	*Sebastes atrovirens*	0.19	0.078
Blue rockfish	*Sebastes mystinus*	0.08	0.083
Yellowtail/olive rockfish	*Sebastes flavidus/serranoides*	0.17	0.075
Treefish	*Sebastes serriceps*	0.00	0.000
Black and yellow rockfish	*Sebastes chrysomelas*	0.00	0.000
Gopher rockfish	*Sebastes carnatus*	0.00	0.000
Copper rockfish	*Sebastes caurinus*	0.00	0.000
Horn shark	*Heterodontus francisci*	0.00	0.000
Cabezon	*Scorpaenichthys marmoratus*	0.00	0.000
Lingcod	*Ophiodon elongatus*	0.00	0.000
Kelp greenling	*Hexagrammos decagrammus*	0.00	0.000

Goldfish Bowl, located on Anacapa Island in Channel Islands National Park, was established as a Reef Check site in 2009 and is part of the Anacapa Island SMCA, implemented in 2003. Average depth of the site is 7.4 meters, substrate is primarily bedrock with a relief of 10 cm to 1 meter. The substrate is either covered in crustose coralline algae or is bare. In general, macroalgae is sparse due to the fact that this site is an urchin barren, but some giant kelp has been observed on surveys. Purple urchin densities are high. Red urchins, bat stars, warty sea cucumbers and wavy/red turban snails are also present. Blacksmith, senorita, California sheephead, black perch and kelp bass are the most common fish species.

Physical Characteristics and Primary Substrate Cover at Goldfish Bowl (2011-2012)

Average depth	7.41 meters

Substrate type	Percentage		Substrate Cover	Percentage
Bedrock	61.11%		Articulated coralline	0%
Boulders	24.72%		Brown seaweed	0%
Cobble	12.78%		Crustose coralline	42.78%
Sand	1.39%		Green seaweed	0%
			Mobile invertebrates	5.28%
Relief	**Percentage**		None	30.28%
0-10cm	0%		Other brown seaweed	1.67%
10 cm-1meter	69.44%		Red seaweed	1.67%
1-2meter	25.28%		Sessile invertebrates	18.33%
>2 meters	5.8%			

Algae densities (60m^2) at Goldfish Bowl (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Giant kelp	*Macrocystis pyrifera*	3.83	3.833
Giant kelp Stipes	*Macrocystis pyrifera*	67.00	
Laminaria spp	*Laminaria farlowii, L. setchelii*	0.08	0.083
Pterygophora	*Pterygophora californica*	0.00	0.000
Southern sea palm	*Eisenia arboea*	0.50	0.417

Invertebrate densities (60m^2) at Goldfish Bowl (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Purple urchin	*Strongylocentrotus purpuratus*	1027.92	211.935
Red urchin	*Strongylocentrotus franciscanus*	177.17	43.654
Bat star	*Patiria miniata*	38.88	10.651
Wavy/red turban snail	*Lithopoma undosum*	12.05	5.127
Crowned urchin	*Centrostephanus coronatus*	2.92	2.395
Brown/golden gorgonian	*Muricea fruticosa, M. californica*	4.33	1.003
Giant spined star	*Pisaster giganteus*	7.00	2.038
Warty sea cucumber	*Parastichopus parvimensis*	29.66	5.691
Kellet's whelk	*Kelletia kelletii*	0.17	0.112
Giant keyhole limpet	*Megathura crenulata*	0.00	0.000
Large anemone	*Anthopleura spp., Metridium spp., Urticina spp.*	0.33	0.142
Chestnut cowry	*Cyoraes soadicea*	0.00	0.000
Rock scallop	*Crassedoma giganteum*	0.42	0.193
Red gorgonian	*Leophogorgia chilensis*	1.08	0.468
CA spiny lobster	*Panulirus interruptus*	0.00	0.000
Short spined sea star	*Pisaster brevispinus*	0.50	0.359
Sunflower/sun star	*Pycnopodia helianthoides, Solaster stimpsoni/dawsoni*	0.00	0.000
CA sea cucumber	*Parastichopus californicus*	0.00	0.000
Sheep/masking crab	*Loxorhynchus grandis, L. crispatus*	0.00	0.000
Green abalone	*Haliotis fulgens*	0.00	0.000
Pink abalone	*Haliotis corrugata*	0.00	0.000
Red abalone	*Haliotis rufescens*	0.00	0.000

Fish Densities (60m^2) at Goldfish Bowl (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Blacksmith	*Chromis punctipinnis*	13.25	3.510
Senorita	*Oxyjulis californica*	1.81	0.450
Kelp bass	*Paralabrax clathratus*	1.31	0.186
Garibaldi	*Hypsypops rubicundus*	1.28	0.248
California Sheephead	*Semicossyphus pulcher*	1.69	0.290
Black perch	*Embiotoca jacksoni*	1.61	0.348
Rainbow perch	*Hypsurus caryi*	0.00	0.000
Pile perch	*Rhacochilus vacca*	0.22	0.120
Striped perch	*Embiotoca lateralis*	0.06	0.056
Rubberlip perch	*Rhacochilus toxotes*	0.03	0.028
Rock wrasse	*Halichoeres semicinctus*	0.22	0.120
Opaleye	*Girella nigricans*	1.03	0.618
Barred sand bass	*Paralabrax nebulifer*	0.03	0.028
Sargo	*Anisotermus davidsoni*	0.00	0.000
Young of the year rockfish	*Sebastes spp.*	0.53	0.216
Kelp rockfish	*Sebastes atrovirens*	0.42	0.140
Blue rockfish	*Sebastes mystinus*	0.75	0.385
Yellowtail/olive rockfish	*Sebastes flavidus/serranoides*	0.14	0.071
Treefish	*Sebastes serriceps*	0.11	0.053
Black and yellow rockfish	*Sebastes chrysomelas*	0.08	0.061
Gopher rockfish	*Sebastes carnatus*	0.00	0.000
Brown rockfish	*Sebastes auriculatus*	0.03	0.028
Copper rockfish	*Sebastes caurinus*	0.00	0.000
Horn shark	*Heterodontus francisci*	0.00	0.000
Cabezon	*Scorpaenichthys marmoratus*	0.00	0.000
Lingcod	*Ophiodon elongatus*	0.00	0.000
Kelp greenling	*Hexagrammos decagrammus*	0.00	0.000

Lighthouse Reef, located on Anacapa Island in Channel Islands National Park, was established as a Reef Check site in 2008. This is a relatively shallow site, with an average depth of 5 meters. Lighthouse Reef is located on the exposed side of Anacapa Island and is often surgy. Bedrock is the primary substrate type, relief is 10 cm to 1 meter and the substrate is bare or covered by sessile invertebrates. The predominant macroalgae is Southern sea palm, but there is also some kelp present. There are urchin barrens within this site and purple urchin densities are high. Red urchins, giant keyhole limpets, large anemones and bat stars are also present. Blacksmith, opaleye, black perch, senorita and garibaldi are the common fish species.

Physical Characteristics and Primary Substrate Cover at Lighthouse Reef (2011-2012)

Average depth	4.94 meters

Substrate type	Percentage		Substrate Cover	Percentage
Bedrock	80%		Articulated coralline	3.89%
Boulders	7.22%		Brown seaweed	3.61%
Cobble	5.28%		Crustose coralline	19.72%
Sand	7.50%		Green seaweed	0%
			Mobile invertebrates	16.67%
Relief	**Percentage**		None	28.61%
0-10cm	0%		Other brown seaweed	3.33%
10 cm-1meter	68.89%		Red seaweed	3.33%
1-2meter	25.56%		Seagrasses	0.83%
>2 meters	5.56%		Sessile invertebrates	20%

Algae densities (60m^2) at Lighthouse Reef (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Giant kelp	*Macrocystis pyrifera*	11.98	4.924
Giant kelp Stipes	*Macrocystis pyrifera*	61.63	16.952
Laminaria spp	*Laminaria farlowii, L. setchelii*	0.00	0.000
Pterygophora	*Pterygophora californica*	0.58	0.583
Southern sea palm	*Eisenia arboea*	21.70	11.416

Invertebrate densities (60m2) at Lighthouse Reef (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Purple urchin	*Strongylocentrotus purpuratus*	752.64	167.384
Red urchin	*Strongylocentrotus franciscanus*	296.76	113.907
Bat star	*Patiria miniata*	11.33	2.548
Wavy/red turban snail	*Lithopoma undosum*	1.00	0.389
Crowned urchin	*Centrostephanus coronatus*	1.33	0.791
Brown/golden gorgonian	*Muricea fruticosa, M. californica*	0.33	0.333
Giant spined star	*Pisaster giganteus*	1.50	0.571
Warty sea cucumber	*Parastichopus parvimensis*	2.83	0.895
Kellet's whelk	*Kelletia kelletii*	0.00	0.000
Giant keyhole limpet	*Megathura crenulata*	17.83	3.501
Large anemone	*Anthopleura spp., Metridium spp., Urticina spp.*	17.44	7.335
Chestnut cowry	*Cyoraes soadicea*	0.83	0.366
Rock scallop	*Crassedoma giganteum*	0.67	0.310
Red gorgonian	*Leophogorgia chilensis*	0.25	0.250
CA spiny lobster	*Panulirus interruptus*	0.00	0.000
Short spined sea star	*Pisaster brevispinus*	0.00	0.000
Sunflower/sun star	*Pycnopodia helianthoides, Solaster stimpsoni/dawsoni*	0.08	0.083
CA sea cucumber	*Parastichopus californicus*	0.25	0.179
Sheep/masking crab	*Loxorhynchus grandis, L. crispatus*	0.00	0.000
Rock crab	*Cancer spp.*	0.00	0.000
Green abalone	*Haliotis fulgens*	0.00	0.000
Pink abalone	*Haliotis corrugata*	0.00	0.000
Red abalone	*Haliotis rufescens*	0.00	0.000

Fish Densities (60m2) at Lighthouse Reef (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Blacksmith	*Chromis punctipinnis*	24.34	8.185
Senorita	*Oxyjulis californica*	2.74	1.043
Kelp bass	*Paralabrax clathratus*	0.60	0.170
Garibaldi	*Hypsypops rubicundus*	2.74	1.166
California Sheephead	*Semicossyphus pulcher*	0.51	0.144
Black perch	*Embiotoca jacksoni*	3.09	0.622
Rainbow perch	*Hypsurus caryi*	0.06	0.040
Pile perch	*Rhacochilus vacca*	0.29	0.139
Striped perch	*Embiotoca lateralis*	0.06	0.057
Rubberlip perch	*Rhacochilus toxotes*	0.06	0.057
Rock wrasse	*Halichoeres semicinctus*	0.06	0.040
Opaleye	*Girella nigricans*	4.94	1.955
Barred sand bass	*Paralabrax nebulifer*	0.00	0.000
Sargo	*Anisotermus davidsoni*	0.00	0.000
Young of the year rockfish	*Sebastes spp.*	0.63	0.362
Kelp rockfish	*Sebastes atrovirens*	0.20	0.080
Blue rockfish	*Sebastes mystinus*	0.71	0.308
Yellowtail/olive rockfish	*Sebastes flavidus/serranoides*	0.00	0.000
Treefish	*Sebastes serriceps*	0.03	0.029
Black and yellow rockfish	*Sebastes chrysomelas*	0.37	0.101
Gopher rockfish	*Sebastes carnatus*	0.06	0.040
Brown rockfish	*Sebastes auriculatus*	0.00	0.000
Copper rockfish	*Sebastes caurinus*	0.03	0.029
Horn shark	*Heterodontus francisci*	0.06	0.040
Cabezon	*Scorpaenichthys marmoratus*	0.17	0.065
Lingcod	*Ophiodon elongatus*	0.03	0.029
Kelp greenling	*Hexagrammos decagrammus*	0.00	0.000

Paradise Point, located near Point Dume in Malibu, Los Angeles County, was established as a Reef Check site in 2008 and became part of the Point Dume SMR in 2012. The average depth of the site is 7.7 meters and the substrate is primarily bedrock with some cobble and some very small sand channels. The relief is primarily low-relief (10 cm to 1 meter). The substrate is primarily covered in red algae, sessile invertebrates and crustose coralline algae. Macroalgae is present here and pterygophora is the dominant species, although giant kelp and Southern sea palm are also observed. Purple urchin and red urchin densities are somewhat high here. Brown/golden gorgonians, large anemones and giant spined sea stars are also common. Senorita, blacksmith, California sheephead, black perch and kelp bass are the most observed fish species.

Physical Characteristics and Primary Substrate Cover at Paradise Point (2012)

Average depth	7.70 meters

Substrate type	Percentage
Bedrock	88.33%
Boulders	2.22%
Cobble	4.44%
Sand	5%

Relief	Percentage
0-10cm	10%
10 cm-1meter	77.78%
1-2meter	5.56%
>2 meters	6.67%

Substrate Cover	Percentage
Articulated coralline	3.89%
Brown seaweed	9.44%
Crustose coralline	15.56%
Green seaweed	0%
Mobile invertebrates	3.33%
None	16.67%
Other brown seaweed	15%
Red seaweed	18.89%
Sessile invertebrates	17.22%

Algae densities (60m^2) at Paradise Point (2012)

Common name	Scientific name	Mean Density	Std Error
Giant kelp	*Macrocystis pyrifera*	16.50	5.451
Giant kelp Stipes	*Macrocystis pyrifera*	154.17	50.297
Laminaria spp	*Laminaria farlowii, L. setchelii*	0.00	0.000
Pterygophora	*Pterygophora californica*	141.20	33.326
Southern sea palm	*Eisenia arboea*	14.22	13.824

Invertebrate densities (60m^2) at Paradise Point (2012)

Common name	Scientific name	Mean Density	Std Error
Purple urchin	*Strongylocentrotus purpuratus*	219.67	107.503
Red urchin	*Strongylocentrotus franciscanus*	305.67	239.393
Bat star	*Patiria miniata*	1.83	0.601
Wavy/red turban snail	*Lithopoma undosum*	4.50	2.078
Crowned urchin	*Centrostephanus coronatus*	0.00	0.000
Brown/golden gorgonian	*Muricea fruticosa, M. californica*	14.67	4.169
Giant spined star	*Pisaster giganteus*	11.50	1.522
Warty sea cucumber	*Parastichopus parvimensis*	0.00	0.000
Kellet's whelk	*Kelletia kelletii*	4.00	2.324
Giant keyhole limpet	*Megathura crenulata*	8.00	3.751
Large anemone	*Anthopleura spp., Metridium spp., Urticina spp.*	11.92	10.223
Chestnut cowry	*Cyoraes soadicea*	7.17	2.120
Rock scallop	*Crassedoma giganteum*	1.83	1.641
Red gorgonian	*Leophogorgia chilensis*	0.50	0.500
CA spiny lobster	*Panulirus interruptus*	2.50	1.928
Short spined sea star	*Pisaster brevispinus*	2.17	1.108
Sunflower/sun star	*Pycnopodia helianthoides, Solaster stimpsoni/dawsoni*	0.00	0.000
CA sea cucumber	*Parastichopus californicus*	0.00	0.000
Sheep/masking crab	*Loxorhynchus grandis, L. crispatus*	0.00	0.000
Green abalone	*Haliotis fulgens*	0.00	0.000
Pink abalone	*Haliotis corrugata*	0.17	0.167
Red abalone	*Haliotis rufescens*	0.00	0.000

Fish Densities (60m^2) at Paradise Point (2012)

Common name	Scientific name	Mean Density	Std Error
Blacksmith	*Chromis punctipinnis*	6.39	4.387
Senorita	*Oxyjulis californica*	7.44	1.456
Kelp bass	*Paralabrax clathratus*	1.50	0.390
Garibaldi	*Hypsypops rubicundus*	1.44	0.701
California Sheephead	*Semicossyphus pulcher*	3.67	0.929
Black perch	*Embiotoca jacksoni*	2.67	0.530
Rainbow perch	*Hypsurus caryi*	0.67	0.343
Pile perch	*Rhacochilus vacca*	0.17	0.090
Striped perch	*Embiotoca lateralis*	0.17	0.121
Rubberlip perch	*Rhacochilus toxotes*	0.44	0.202
Rock wrasse	*Halichoeres semicinctus*	0.67	0.243
Opaleye	*Girella nigricans*	0.00	0.000
Barred sand bass	*Paralabrax nebulifer*	0.00	0.000
Sargo	*Anisotermus davidsoni*	0.06	0.056
Young of the year rockfish	*Sebastes spp.*	0.72	0.571
Kelp rockfish	*Sebastes atrovirens*	0.17	0.090
Blue rockfish	*Sebastes mystinus*	0.00	0.000
Yellowtail/olive rockfish	*Sebastes flavidus/serranoides*	0.00	0.000
Treefish	*Sebastes serriceps*	0.11	0.076
Black and yellow rockfish	*Sebastes chrysomelas*	0.00	0.000
Gopher rockfish	*Sebastes carnatus*	0.00	0.000
Brown rockfish	*Sebastes auriculatus*	0.06	0.056
Copper rockfish	*Sebastes caurinus*	0.00	0.000
Horn shark	*Heterodontus francisci*	0.11	0.076
Cabezon	*Scorpaenichthys marmoratus*	0.06	0.056
Lingcod	*Ophiodon elongatus*	0.00	0.000
Kelp greenling	*Hexagrammos decagrammus*	0.00	0.000

Yellowbanks, located on Santa Cruz Island in Channel Islands National Park, was established as a Reef Check site in 2008. This tends to be a shallow site with a depth range of 16 feet to 29 feet. Shifting sand has often covered the low-relief reef and the site can look a bit different from year to year, with reef visible one year and buried reef with macroalgae popping up out of the sand the next year. Bedrock and sand make up the substrate and relieve is 10 cm to 1 m. The substrate is bare or covered in articulated coralline algae and crustose coralline algae. Macroalgae includes pterygophora, laminaria and giant kelp. Purple urchin densities are somewhat high and red urchins, warty sea cucumbers, bat stars and wavy/red turban snails are also present. Senorita, kelp bass, black perch, pile perch and blacksmith are the most common fish.

Physical Characteristics and Primary Substrate Cover at Yellowbanks (2011-2012)

Average depth	6.74 meters

Substrate type	Percentage
Bedrock	47.50%
Boulders	6.39%
Cobble	7.78%
Sand	38.33%

Relief	Percentage
0-10cm	1.94%
10 cm-1meter	95.56%
1-2meter	2.22%
>2 meters	0.28%

Substrate Cover	Percentage
Articulated coralline	10.56%
Brown seaweed	4.72%
Crustose coralline	10.56%
Green seaweed	0%
Mobile invertebrates	0.56%
None	52.50%
Other brown seaweed	7.22%
Red seaweed	8.89%
Sessile invertebrates	5%

Algae densities (60m^2) at Yellowbanks (2011- 2012)

Common name	Scientific name	Mean Density	Std Error
Giant kelp	*Macrocystis pyrifera*	15.92	2.234
Giant kelp Stipes	*Macrocystis pyrifera*	128.67	21.099
Laminaria spp	*Laminaria farlowii, L. setchelii*	13.75	3.976
Pterygophora	*Pterygophora californica*	53.21	15.357
Southern sea palm	*Eisenia arboea*	0.00	0.000

Invertebrate densities (60m^2) at Yellowbanks (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Purple urchin	*Strongylocentrotus purpuratus*	192.54	126.059
Red urchin	*Strongylocentrotus franciscanus*	9.98	5.190
Bat star	*Patiria miniata*	2.25	1.053
Wavy/red turban snail	*Lithopoma undosum*	2.25	0.708
Crowned urchin	*Centrostephanus coronatus*	0.00	0.000
Brown/golden gorgonian	*Muricea fruticosa, M. californica*	0.00	0.000
Giant spined star	*Pisaster giganteus*	1.42	0.484
Warty sea cucumber	*Parastichopus parvimensis*	7.33	1.698
Kellet's whelk	*Kelletia kelletii*	1.50	0.515
Giant keyhole limpet	*Megathura crenulata*	1.67	0.555
Large anemone	*Anthopleura spp., Metridium spp., Urticina spp.*	1.00	0.522
Chestnut cowry	*Cyoraes soadicea*	0.00	0.000
Rock scallop	*Crassedoma giganteum*	0.00	0.000
Red gorgonian	*Leophogorgia chilensis*	0.25	0.250
CA spiny lobster	*Panulirus interruptus*	0.00	0.000
Short spined sea star	*Pisaster brevispinus*	0.17	0.112
Sunflower/sun star	*Pycnopodia helianthoides, Solaster stimpsoni/dawsoni*	0.08	0.083
CA sea cucumber	*Parastichopus californicus*	0.00	0.000
Sheep/masking crab	*Loxorhynchus grandis, L. crispatus*	0.00	0.000
Green abalone	*Haliotis fulgens*	0.08	0.083
Pink abalone	*Haliotis corrugata*	0.00	0.000
Red abalone	*Haliotis rufescens*	0.00	0.000

Fish Densities (60m^2) at Yellowbanks (2011- 2012)

Common name	Scientific name	Mean Density	Std Error
Blacksmith	*Chromis punctipinnis*	0.44	0.417
Senorita	*Oxyjulis californica*	8.22	1.907
Kelp bass	*Paralabrax clathratus*	2.06	0.445
Garibaldi	*Hypsypops rubicundus*	0.00	0.000
California Sheephead	*Semicossyphus pulcher*	0.17	0.075
Black perch	*Embiotoca jacksoni*	1.14	0.290
Rainbow perch	*Hypsurus caryi*	0.25	0.223
Pile perch	*Rhacochilus vacca*	0.47	0.197
Striped perch	*Embiotoca lateralis*	0.00	0.000
Rubberlip perch	*Rhacochilus toxotes*	0.03	0.028
Rock wrasse	*Halichoeres semicinctus*	0.19	0.078
Opaleye	*Girella nigricans*	0.36	0.150
Barred sand bass	*Paralabrax nebulifer*	0.00	0.000
Sargo	*Anisotermus davidsoni*	0.00	0.000
Young of the year rockfish	*Sebastes spp.*	0.11	0.087
Kelp rockfish	*Sebastes atrovirens*	0.00	0.000
Blue rockfish	*Sebastes mystinus*	0.00	0.000
Yellowtail/olive rockfish	*Sebastes flavidus/serranoides*	0.00	0.000
Treefish	*Sebastes serriceps*	0.00	0.000
Black and yellow rockfish	*Sebastes chrysomelas*	0.00	0.000
Gopher rockfish	*Sebastes carnatus*	0.00	0.000
Brown rockfish	*Sebastes auriculatus*	0.00	0.000
Copper rockfish	*Sebastes caurinus*	0.00	0.000
Horn shark	*Heterodontus francisci*	0.00	0.000
Cabezon	*Scorpaenichthys marmoratus*	0.03	0.028
Lingcod	*Ophiodon elongatus*	0.00	0.000
Kelp greenling	*Hexagrammos decagrammus*	0.00	0.000

Sandstone Point, located on Santa Cruz Island in Channel Islands National Park, was established as a Reef Check site in 2008. Average depth of the site is 10 meters, bedrock is the dominant substrate and relief is primarily 10 cm to 1 m. The substrate is bare or covered in crustose coralline algae or brown algal species. Urchin densities are high for both purple urchins and red urchins. Chestnut cowries, giant spined sea stars and large anemones are also present. Senorita, opaleye, California sheephead, black perch and kelp bass are the most common fish species.

Physical Characteristics and Primary Substrate Cover at Sandstone Point (2011-2012)

Average depth	9.92 meters

Substrate type	Percentage
Bedrock	67.08%
Boulders	6.25%
Cobble	22.50%
Sand	4.17%

Relief	Percentage
0-10cm	1.25%
10 cm-1meter	97.92%
1-2meter	0.42%
>2 meters	0.42%

Substrate Cover	Percentage
Articulated coralline	3.75%
Brown seaweed	4.17%
Crustose coralline	31.25%
Green seaweed	0%
Mobile invertebrates	2.92%
None	26.25%
Other brown seaweed	16.67%
Red seaweed	1.25%
Seagrasses	0.42%
Sessile invertebrates	13.33%

Algae densities (60m^2) at Sandstone Point (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Giant kelp	*Macrocystis pyrifera*	71.63	43.692
Giant kelp Stipes	*Macrocystis pyrifera*	159.63	53.881
Laminaria spp	*Laminaria farlowii, L. setchelii*	0.00	0.000
Pterygophora	*Pterygophora californica*	115.17	58.979
Southern sea palm	*Eisenia arboea*	0.13	0.125

Invertebrate densities (60m^2) at Sandstone Point (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Purple urchin	*Strongylocentrotus purpuratus*	594.61	236.204
Red urchin	*Strongylocentrotus franciscanus*	526.72	220.297
Bat star	*Patiria miniata*	7.63	4.035
Wavy/red turban snail	*Lithopoma undosum*	1.13	0.479
Crowned urchin	*Centrostephanus coronatus*	0.00	0.000
Brown/golden gorgonian	*Muricea fruticosa, M. californica*	0.13	0.125
Giant spined star	*Pisaster giganteus*	1.88	0.811
Warty sea cucumber	*Parastichopus parvimensis*	0.38	0.183
Kellet's whelk	*Kelletia kelletii*	0.00	0.000
Giant keyhole limpet	*Megathura crenulata*	0.50	0.267
Large anemone	*Anthopleura spp., Metridium spp., Urticina spp.*	1.25	0.675
Chestnut cowry	*Cyoraes soadicea*	5.88	1.837
Rock scallop	*Crassedoma giganteum*	0.13	0.125
Red gorgonian	*Leophogorgia chilensis*	0.00	0.000
CA spiny lobster	*Panulirus interruptus*	0.50	0.378
Short spined sea star	*Pisaster brevispinus*	0.38	0.263
Sunflower/sun star	*Pycnopodia helianthoides, Solaster stimpsoni/dawsoni*	0.13	0.125
CA sea cucumber	*Parastichopus californicus*	0.00	0.000
Sheep/masking crab	*Loxorhynchus grandis, L. crispatus*	0.50	0.267
Green abalone	*Haliotis fulgens*	0.00	0.000
Pink abalone	*Haliotis corrugata*	0.00	0.000
Red abalone	*Haliotis rufescens*	0.50	0.327

Fish Densities (60m^2) at Sandstone Point (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Blacksmith	*Chromis punctipinnis*	0.75	0.750
Senorita	*Oxyjulis californica*	16.08	2.876
Kelp bass	*Paralabrax clathratus*	1.13	0.243
Garibaldi	*Hypsypops rubicundus*	0.17	0.167
California Sheephead	*Semicossyphus pulcher*	1.71	0.406
Black perch	*Embiotoca jacksoni*	1.38	0.355
Rainbow perch	*Hypsurus caryi*	0.04	0.042
Pile perch	*Rhacochilus vacca*	0.13	0.069
Striped perch	*Embiotoca lateralis*	0.04	0.042
Rubberlip perch	*Rhacochilus toxotes*	0.13	0.125
Rock wrasse	*Halichoeres semicinctus*	0.00	0.000
Opaleye	*Girella nigricans*	1.83	0.756
Barred sand bass	*Paralabrax nebulifer*	0.00	0.000
Sargo	*Anisotermus davidsoni*	0.00	0.000
Young of the year rockfish	*Sebastes spp.*	0.04	0.042
Kelp rockfish	*Sebastes atrovirens*	0.00	0.000
Blue rockfish	*Sebastes mystinus*	0.08	0.083
Yellowtail/olive rockfish	*Sebastes flavidus/serranoides*	0.00	0.000
Treefish	*Sebastes serriceps*	0.00	0.000
Black and yellow rockfish	*Sebastes chrysomelas*	0.00	0.000
Gopher rockfish	*Sebastes carnatus*	0.08	0.083
Brown rockfish	*Sebastes auriculatus*	0.00	0.000
Copper rockfish	*Sebastes caurinus*	0.00	0.000
Horn shark	*Heterodontus francisci*	0.00	0.000
Cabezon	*Scorpaenichthys marmoratus*	0.00	0.000
Lingcod	*Ophiodon elongatus*	0.00	0.000
Kelp greenling	*Hexagrammos decagrammus*	0.00	0.000

Elk Ridge, located on Santa Rosa Island in Channel Islands National Park, was established as a Reef Check site in 2007. This site is part of the Skunk Point SMR, implemented in 2003. The rocky reef is surrounded by sand at slightly deeper depths. Average depth of the site is shallow at 6 meters, bedrock is the dominant substrate and relief is 10 cm to 1 m. Substrate is bare or covered in sessile invertebrates or crustose coralline algae. Urchin densities are high here for purple urchins. Red urchins, large anemones, California spiny lobsters and rock scallops are also present. Senorita, black perch, kelp bass, pile perch and young of the year rockfish are the most prevalent fish species. Like most Reef Check sites in Channel Islands National Park and Santa Barbara County, rockfish are more common here than in the majority of our coastal sites in Los Angeles, Orange and San Diego counties.

Physical Characteristics and Primary Substrate Cover at Elk Ridge (2012)

Average depth	6.05 meters

Substrate type	Percentage		Substrate Cover	Percentage
Bedrock	78.89%		Articulated coralline	2.78%
Boulders	0%		Brown seaweed	5%
Cobble	0.56%		Crustose coralline	16.11%
Sand	20.56%		Green seaweed	1.67%
			Mobile invertebrates	7.78%
Relief	**Percentage**		None	17.22%
0-10cm	11.11%		Other brown seaweed	13.33%
10 cm-1meter	88.89%		Red seaweed	13.33%
1-2meter	0%		Seagrasses	1.11%
>2 meters	0%		Sessile invertebrates	21.67%

Algae densities (60m^2) at Elk Ridge (2012)

Common name	Scientific name	Mean Density	Std Error
Giant kelp	*Macrocystis pyrifera*	26.33	5.812
Giant kelp Stipes	*Macrocystis pyrifera*	127.00	26.220
Laminaria spp	*Laminaria farlowii, L. setchelii*	0.00	0.000
Pterygophora	*Pterygophora californica*	19.83	6.421
Southern sea palm	*Eisenia arboea*	0.00	0.000

Invertebrate densities (60m^2) at Elk Ridge (2012)

Common name	Scientific name	Mean Density	Std Error
Purple urchin	*Strongylocentrotus purpuratus*	416.18	227.758
Red urchin	*Strongylocentrotus franciscanus*	97.51	44.318
Bat star	*Patiria miniata*	0.00	0.000
Wavy/red turban snail	*Lithopoma undosum*	0.17	0.167
Crowned urchin	*Centrostephanus coronatus*	0.00	0.000
Brown/golden gorgonian	*Muricea fruticosa, M. californica*	0.00	0.000
Giant spined star	*Pisaster giganteus*	0.17	0.167
Warty sea cucumber	*Parastichopus parvimensis*	0.00	0.000
Kellet's whelk	*Kelletia kelletii*	0.00	0.000
Giant keyhole limpet	*Megathura crenulata*	0.17	0.167
Large anemone	*Anthopleura spp., Metridium spp., Urticina spp.*	1.50	1.118
Chestnut cowry	*Cyoraes soadicea*	0.17	0.167
Rock scallop	*Crassedoma giganteum*	0.67	0.494
Red gorgonian	*Leophogorgia chilensis*	0.00	0.000
CA spiny lobster	*Panulirus interruptus*	1.33	0.803
Short spined sea star	*Pisaster brevispinus*	0.00	0.000
Sunflower/sun star	*Pycnopodia helianthoides, Solaster stimpsoni/dawsoni*	0.00	0.000
CA sea cucumber	*Parastichopus californicus*	0.00	0.000
Sheep/masking crab	*Loxorhynchus grandis, L. crispatus*	0.33	0.333
Green abalone	*Haliotis fulgens*	0.00	0.000
Pink abalone	*Haliotis corrugata*	0.00	0.000
Red abalone	*Haliotis rufescens*	0.00	0.000

Fish Densities (60m^2) at Elk Ridge (2012)

Common name	Scientific name	Mean Density	Std Error
Blacksmith	*Chromis punctipinnis*	0.000	0.000
Senorita	*Oxyjulis californica*	30.000	6.665
Kelp bass	*Paralabrax clathratus*	4.056	1.344
Garibaldi	*Hypsypops rubicundus*	0.000	0.000
California Sheephead	*Semicossyphus pulcher*	0.278	0.226
Black perch	*Embiotoca jacksoni*	5.722	1.163
Rainbow perch	*Hypsurus caryi*	0.333	0.181
Pile perch	*Rhacochilus vacca*	2.944	0.891
Striped perch	*Embiotoca lateralis*	0.222	0.129
Rubberlip perch	*Rhacochilus toxotes*	0.000	0.000
Rock wrasse	*Halichoeres semicinctus*	0.056	0.056
Opaleye	*Girella nigricans*	1.444	1.161
Barred sand bass	*Paralabrax nebulifer*	0.000	0.000
Sargo	*Anisotermus davidsoni*	0.167	0.121
Young of the year rockfish	*Sebastes spp.*	1.944	1.052
Kelp rockfish	*Sebastes atrovirens*	0.333	0.229
Blue rockfish	*Sebastes mystinus*	0.167	0.167
Yellowtail/olive rockfish	*Sebastes flavidus/serranoides*	0.00	0.000
Treefish	*Sebastes serriceps*	0.00	0.000
Black and yellow rockfish	*Sebastes chrysomelas*	0.00	0.000
Gopher rockfish	*Sebastes carnatus*	0.00	0.000
Brown rockfish	*Sebastes auriculatus*	0.00	0.000
Copper rockfish	*Sebastes caurinus*	0.00	0.000
Horn shark	*Heterodontus francisci*	0.00	0.000
Cabezon	*Scorpaenichthys marmoratus*	0.00	0.000
Lingcod	*Ophiodon elongatus*	0.00	0.000
Kelp greenling	*Hexagrammos decagrammus*	0.00	0.000

East Point, located on Santa Rosa Island in Channel Islands National Park, was established as a Reef Check site in 2007. This site is not protected as an MPA, but is a reference site for the adjacent Reef Check site, Elk Ridge which is in the Skunk Point SMR. Average depth of the site is 9 meters, bedrock is the dominant substrate and relief is 10 cm to 1 meter. The substrate is bare or covered in crustose coralline algae. Giant kelp is the primary macroalgae. Purple urchin and red urchin densities are high. Chestnut cowries, rock scallops and bat stars are also present. Senorita, blacksmith, young of the year rockfish, black perch and blue rockfish are the prevalent fish species. Like most Reef Check sites in Channel Islands National Park and Santa Barbara County, rockfish are more common here than in the majority of our coastal sites in Los Angeles, Orange and San Diego counties.

Physical Characteristics and Primary Substrate Cover at East Point (2012)

Average depth	9.03 meters

Substrate type	Percentage
Bedrock	83.33%
Boulders	5%
Cobble	4.44%
Sand	7.22%

Relief	Percentage
0-10cm	0%
10 cm-1meter	97.78%
1-2meter	2.22%
>2 meters	0%

Substrate Cover	Percentage
Articulated coralline	0%
Brown seaweed	5%
Crustose coralline	11.67%
Green seaweed	0.56%
Mobile invertebrates	5%
None	16.67%
Other brown seaweed	0.56%
Red seaweed	5.56%
Sessile invertebrates	55%

Algae densities (60m^2) at East Point (2012)

Common name	Scientific name	Mean Density	Std Error
Giant kelp	*Macrocystis pyrifera*	68.00	21.480
Giant kelp Stipes	*Macrocystis pyrifera*	119.75	25.161
Laminaria spp	*Laminaria farlowii, L. setchelii*	0.00	0.000
Pterygophora	*Pterygophora californica*	0.00	0.000
Southern sea palm	*Eisenia arboea*	1.67	1.476

Invertebrate densities (60m^2) at East Point (2012)

Common name	Scientific name	Mean Density	Std Error
Purple urchin	*Strongylocentrotus purpuratus*	427	220.626
Red urchin	*Strongylocentrotus franciscanus*	167.37	53.176
Bat star	*Patiria miniata*	1.33	0.989
Wavy/red turban snail	*Lithopoma undosum*	0.00	0.000
Crowned urchin	*Centrostephanus coronatus*	0.00	0.000
Brown/golden gorgonian	*Muricea fruticosa, M. californica*	0.00	0.000
Giant spined star	*Pisaster giganteus*	0.67	0.333
Warty sea cucumber	*Parastichopus parvimensis*	0.00	0.000
Kellet's whelk	*Kelletia kelletii*	0.00	0.000
Giant keyhole limpet	*Megathura crenulata*	1.17	0.654
Large anemone	*Anthopleura spp., Metridium spp., Urticina spp.*	2.83	1.195
Chestnut cowry	*Cyoraes soadicea*	5.67	1.801
Rock scallop	*Crassedoma giganteum*	1.67	0.333
Red gorgonian	*Leophogorgia chilensis*	0.00	0.000
CA spiny lobster	*Panulirus interruptus*	0.00	0.000
Short spined sea star	*Pisaster brevispinus*	0.00	0.000
Sunflower/sun star	*Pycnopodia helianthoides, Solaster stimpsoni/dawsoni*	0.00	0.000
CA sea cucumber	*Parastichopus californicus*	0.00	0.000
Sheep/masking crab	*Loxorhynchus grandis, L. crispatus*	1.00	0.365
Green abalone	*Haliotis fulgens*	0.00	0.000
Pink abalone	*Haliotis corrugata*	0.00	0.000
Red abalone	*Haliotis rufescens*	0.00	0.000

Fish Densities (60m^2) at East Point (2012)

Common name	Scientific name	Mean Density	Std Error
Blacksmith	*Chromis punctipinnis*	5.89	4.350
Senorita	*Oxyjulis californica*	14.28	2.874
Kelp bass	*Paralabrax clathratus*	0.78	0.417
Garibaldi	*Hypsypops rubicundus*	0.33	0.114
California Sheephead	*Semicossyphus pulcher*	1.22	0.417
Black perch	*Embiotoca jacksoni*	3.28	1.090
Rainbow perch	*Hypsurus caryi*		
Pile perch	*Rhacochilus vacca*	1.11	0.342
Striped perch	*Embiotoca lateralis*	0.44	0.202
Rubberlip perch	*Rhacochilus toxotes*	0.11	0.076
Rock wrasse	*Halichoeres semicinctus*	0.33	0.280
Opaleye	*Girella nigricans*	0.67	0.302
Barred sand bass	*Paralabrax nebulifer*		
Sargo	*Anisotermus davidsoni*	0.22	0.129
Young of the year rockfish	*Sebastes spp.*	4.28	2.081
Kelp rockfish	*Sebastes atrovirens*	1.06	0.375
Blue rockfish	*Sebastes mystinus*	1.50	1.387
Yellowtail/olive rockfish	*Sebastes flavidus/serranoides*	0.39	0.389
Treefish	*Sebastes serriceps*	0.00	0.000
Black and yellow rockfish	*Sebastes chrysomelas*	0.06	0.056
Gopher rockfish	*Sebastes carnatus*	0.00	0.000
Brown rockfish	*Sebastes auriculatus*	0.00	0.000
Copper rockfish	*Sebastes caurinus*	0.00	0.000
Horn shark	*Heterodontus francisci*	0.00	0.000
Cabezon	*Scorpaenichthys marmoratus*	0.00	0.000
Lingcod	*Ophiodon elongatus*	0.00	0.000
Kelp greenling	*Hexagrammos decagrammus*	0.00	0.000

Johnson's Lee, located on Santa Rosa Island in Channel Islands National Park, was established as a Reef Check site in 2009. Average depth of the site is 9 m, bedrock is the dominant substrate and relief is 10 cm to 1 meter. The substrate is bare or covered with red algae and sessile invertebrates. Macroalgae include giant kelp and laminaria. Red urchins, purple urchins, bat stars, chestnut cowries and giant spined sea stars are the invertebrates most often observed. Senorita, yellowtail/olive rockfish, kelp rockfish, blacksmith and black perch are the prevalent fish species. Like most Reef Check sites in Channel Islands National Park and Santa Barbara County, rockfish are more common here than in the majority of our coastal sites in Los Angeles, Orange and San Diego counties.

Physical Characteristics and Primary Substrate Cover at Johnson's Lee (2012)

Average depth	9.04 meters

Substrate type	Percentage		Substrate Cover	Percentage
Bedrock	81.67%		Articulated coralline	6.67%
Boulders	6.11%		Brown seaweed	6.67%
Cobble	1.11%		Crustose coralline	9.44%
Sand	11.11%		Green seaweed	0%
			Mobile invertebrates	1.11%
Relief	**Percentage**		None	19.44%
0-10cm	3.89%		Other brown seaweed	2.22%
10 cm-1meter	82.22%		Red seaweed	37.78%
1-2meter	13.89%		Sessile invertebrates	16.67%
>2 meters	0%			

Algae densities (60m^2) at Johnson's Lee (2012)

Common name	Scientific name	Mean Density	Std Error
Giant kelp	*Macrocystis pyrifera*	32.78	5.239
Giant kelp Stipes	*Macrocystis pyrifera*	124.08	13.749
Laminaria spp	*Laminaria farlowii, L. setchelii*	24.67	10.230
Pterygophora	*Pterygophora californica*	12.67	5.251
Southern sea palm	*Eisenia arboea*	0.00	0.000

Invertebrate densities (60m^2) at Johnson's Lee (2012)

Common name	Scientific name	Mean Density	Std Error
Purple urchin	*Strongylocentrotus purpuratus*	76.87	46.332
Red urchin	*Strongylocentrotus franciscanus*	125.63	51.342
Bat star	*Patiria miniata*	32.67	3.537
Wavy/red turban snail	*Lithopoma undosum*	0.00	0.000
Crowned urchin	*Centrostephanus coronatus*	0.00	0.000
Brown/golden gorgonian	*Muricea fruticosa, M. californica*	0.17	0.167
Giant spined star	*Pisaster giganteus*	1.50	0.342
Warty sea cucumber	*Parastichopus parvimensis*	0.50	0.342
Kellet's whelk	*Kelletia kelletii*	0.50	0.342
Giant keyhole limpet	*Megathura crenulata*	0.67	0.494
Large anemone	*Anthopleura spp., Metridium spp., Urticina spp.*	1.33	0.843
Chestnut cowry	*Cyoraes soadicea*	5.83	1.778
Rock scallop	*Crassedoma giganteum*	0.67	0.494
Red gorgonian	*Leophogorgia chilensis*	0.00	0.000
CA spiny lobster	*Panulirus interruptus*	0.00	0.000
Short spined sea star	*Pisaster brevispinus*	0.50	0.500
Sunflower/sun star	*Pycnopodia helianthoides, Solaster stimpsoni/dawsoni*	1.00	0.447
CA sea cucumber	*Parastichopus californicus*	0.00	0.000
Sheep/masking crab	*Loxorhynchus grandis, L. crispatus*	0.00	0.000
Green abalone	*Haliotis fulgens*	0.00	0.000
Pink abalone	*Haliotis corrugata*	0.00	0.000
Red abalone	*Haliotis rufescens*	0.17	0.167

Fish Densities (60m^2) at Johnson's Lee (2012)

Common name	Scientific name	Mean Density	Std Error
Blacksmith	*Chromis punctipinnis*	1.50	1.387
Senorita	*Oxyjulis californica*	7.94	2.273
Kelp bass	*Paralabrax clathratus*	0.06	0.056
Garibaldi	*Hypsypops rubicundus*	0.61	0.200
California Sheephead	*Semicossyphus pulcher*	1.17	0.316
Black perch	*Embiotoca jacksoni*	1.22	0.329
Rainbow perch	*Hypsurus caryi*	0.00	0.000
Pile perch	*Rhacochilus vacca*	0.33	0.140
Striped perch	*Embiotoca lateralis*	0.39	0.164
Rubberlip perch	*Rhacochilus toxotes*	0.00	0.000
Rock wrasse	*Halichoeres semicinctus*	0.06	0.056
Opaleye	*Girella nigricans*	0.11	0.076
Barred sand bass	*Paralabrax nebulifer*	0.00	0.000
Sargo	*Anisotermus davidsoni*	0.22	0.222
Young of the year rockfish	*Sebastes spp.*	0.39	0.164
Kelp rockfish	*Sebastes atrovirens*	1.61	0.682
Blue rockfish	*Sebastes mystinus*	0.22	0.101
Yellowtail/olive rockfish	*Sebastes flavidus/serranoides*	2.28	1.773
Treefish	*Sebastes serriceps*	0.17	0.090
Black and yellow rockfish	*Sebastes chrysomelas*	0.28	0.158
Gopher rockfish	*Sebastes carnatus*	0.06	0.056
Brown rockfish	*Sebastes auriculatus*	0.00	0.000
Copper rockfish	*Sebastes caurinus*	0.00	0.000
Horn shark	*Heterodontus francisci*	0.00	0.000
Cabezon	*Scorpaenichthys marmoratus*	0.00	0.000
Lingcod	*Ophiodon elongatus*	0.00	0.000
Kelp greenling	*Hexagrammos decagrammus*	0.00	0.000

Malaga Cove, located in Palos Verdes in Los Angeles County, was established as a Reef Check site in 2006. This area is not protected but is a reference site for Point Vicente SMCA. This is a shallow survey site which ranges from 5 feet to 28 feet with an average of 4.7 meters. The substrate is a mix of bedrock, boulder, cobble and sand and is uniformly 10 cm to 1 m in relief. The substrate is either bare or covered in crustose coralline algae or articulated coralline algae. Giant kelp is the only macroalgae present. The most common invertebrates are wavy/red turban snails, purple urchins, Kellet's whelks, red urchins and California spiny lobster. Fish numbers are low at Malaga Cove, but garibaldi, kelp bass, black perch, rock wrasse and barred sand bass are the most common fish species.

Physical Characteristics and Primary Substrate Cover at Malaga Cove (2011-2012)

Average depth	4.70 meters

Substrate type	Percentage
Bedrock	55.83%
Boulders	22.22%
Cobble	13.06%
Sand	8.89%

Relief	Percentage
0-10cm	0.28%
10 cm-1meter	98.06%
1-2meter	1.67%
>2 meters	0%

Substrate Cover	Percentage
Articulated coralline	20.28%
Brown seaweed	1.67%
Crustose coralline	27.78%
Green seaweed	1.67%
Mobile invertebrates	0.83%
None	30.28%
Other brown seaweed	5.83%
Red seaweed	8.06%
Sessile invertebrates	2.50%

Algae densities (60m^2) at Malaga Cove (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Giant kelp	*Macrocystis pyrifera*	32.51	6.592
Giant kelp Stipes	*Macrocystis pyrifera*	110.18	19.797
Laminaria spp	*Laminaria farlowii, L. setchelii*	0.00	0.000
Pterygophora	*Pterygophora californica*	0.00	0.000
Southern sea palm	*Eisenia arboea*	0.00	0.000

Invertebrate densities (60m^2) at Malaga Cove (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Purple urchin	*Strongylocentrotus purpuratus*	9.67	2.978
Red urchin	*Strongylocentrotus franciscanus*	2.25	0.719
Bat star	*Patiria miniata*	0.00	0.000
Wavy/red turban snail	*Lithopoma undosum*	22.89	4.080
Crowned urchin	*Centrostephanus coronatus*	0.08	0.083
Brown/golden gorgonian	*Muricea fruticosa, M. californica*	0.17	0.167
Giant spined star	*Pisaster giganteus*	0.83	0.345
Warty sea cucumber	*Parastichopus parvimensis*	0.00	0.000
Kellet's whelk	*Kelletia kelletii*	5.83	2.351
Giant keyhole limpet	*Megathura crenulata*	0.17	0.112
Large anemone	*Anthopleura spp., Metridium spp., Urticina spp.*	0.00	0.000
Chestnut cowry	*Cyoraes soadicea*	0.00	0.000
Rock scallop	*Crassedoma giganteum*	0.50	0.337
Red gorgonian	*Leophogorgia chilensis*	0.00	0.000
CA spiny lobster	*Panulirus interruptus*	1.17	0.458
Short spined sea star	*Pisaster brevispinus*	0.08	0.083
Sunflower/sun star	*Pycnopodia helianthoides, Solaster stimpsoni/dawsoni*	0.00	0.000
CA sea cucumber	*Parastichopus californicus*	0.00	0.000
Sheep/masking crab	*Loxorhynchus grandis, L. crispatus*	0.08	0.083
Green abalone	*Haliotis fulgens*	0.17	0.112
Pink abalone	*Haliotis corrugata*	0.00	0.000
Red abalone	*Haliotis rufescens*	0.00	0.000

Fish Densities (60m^2) at Malaga Cove (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Blacksmith	*Chromis punctipinnis*	0.08	0.061
Senorita	*Oxyjulis californica*	0.08	0.061
Kelp bass	*Paralabrax clathratus*	0.86	0.200
Garibaldi	*Hypsypops rubicundus*	1.22	0.196
California Sheephead	*Semicossyphus pulcher*	0.14	0.058
Black perch	*Embiotoca jacksoni*	0.56	0.129
Rainbow perch	*Hypsurus caryi*	0.06	0.039
Pile perch	*Rhacochilus vacca*	0.06	0.039
Striped perch	*Embiotoca lateralis*	0.11	0.066
Rubberlip perch	*Rhacochilus toxotes*	0.03	0.028
Rock wrasse	*Halichoeres semicinctus*	0.44	0.116
Opaleye	*Girella nigricans*	0.14	0.058
Barred sand bass	*Paralabrax nebulifer*	0.17	0.075
Sargo	*Anisotermus davidsoni*	0.00	0.000
Young of the year rockfish	*Sebastes spp.*	0.00	0.000
Kelp rockfish	*Sebastes atrovirens*	0.03	0.028
Blue rockfish	*Sebastes mystinus*	0.00	0.000
Yellowtail/olive rockfish	*Sebastes flavidus/serranoides*	0.00	0.000
Treefish	*Sebastes serriceps*	0.00	0.000
Black and yellow rockfish	*Sebastes chrysomelas*	0.00	0.000
Gopher rockfish	*Sebastes carnatus*	0.00	0.000
Brown rockfish	*Sebastes auriculatus*	0.03	0.028
Copper rockfish	*Sebastes caurinus*	0.00	0.000
Horn shark	*Heterodontus francisci*	0.25	0.083
Cabezon	*Scorpaenichthys marmoratus*	0.03	0.028
Lingcod	*Ophiodon elongatus*	0.00	0.000
Kelp greenling	*Hexagrammos decagrammus*	0.00	0.000

Christmas Tree Cove, located on the Palos Verdes peninsula in Los Angeles County, was established as a Reef Check site in 2007. This area is not protected, but is a reference site for Point Vicente SMR. The substrate is primarily bedrock with some boulders and relief is mostly 10 cm to 1m. The substrate is mostly bare or covered with red algae and crustose coralline algae. Giant kelp is the most abundant macroalgae but Southern sea palm is also present. Purple urchins are by far the most common invertebrates, but bat stars, red urchins, giant spined sea stars and large anemones are also present. Senorita, black perch, sheephead, garibaldi and rainbow perch are the most common fish species.

Physical Characteristics and Primary Substrate Cover at Christmas Tree Cove (2011-2012)

Average depth	10.71 meters

Substrate type	Percentage		Substrate Cover	Percentage
Bedrock	69.39%		Articulated coralline	2.73%
Boulders	18.18%		Brown seaweed	5.15%
Cobble	5.76%		Crustose coralline	16.06%
Sand	6.67%		Green seaweed	3.33%
			Mobile invertebrates	3.94%
Relief	**Percentage**		None	30%
0-10cm	1.82%		Other brown seaweed	14.24%
10 cm-1meter	77.88%		Red seaweed	21.21%
1-2meter	18.18%		Sessile invertebrates	3.33%
>2 meters	2.12%			

Algae densities (60m^2) at Christmas Tree Cove (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Giant kelp	*Macrocystis pyrifera*	33.27	3.790
Giant kelp Stipes	*Macrocystis pyrifera*	161.00	18.350
Laminaria spp	*Laminaria farlowii, L. setchelii*	0.00	0.000
Pterygophora	*Pterygophora californica*	1.73	1.019
Southern sea palm	*Eisenia arboea*	2.55	1.442

Invertebrate densities (60m^2) at Christmas Tree Cove (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Purple urchin	*Strongylocentrotus purpuratus*	167.18	48.430
Red urchin	*Strongylocentrotus franciscanus*	26.99	9.197
Bat star	*Patiria miniata*	70.13	14.499
Wavy/red turban snail	*Lithopoma undosum*	1.55	0.908
Crowned urchin	*Centrostephanus coronatus*	1.36	1.081
Brown/golden gorgonian	*Muricea fruticosa, M. californica*	0.09	0.091
Giant spined star	*Pisaster giganteus*	3.55	0.985
Warty sea cucumber	*Parastichopus parvimensis*	0.45	0.247
Kellet's whelk	*Kelletia kelletii*	0.64	0.279
Giant keyhole limpet	*Megathura crenulata*	0.73	0.469
Large anemone	*Anthopleura spp., Metridium spp., Urticina spp.*	3.00	2.009
Chestnut cowry	*Cyoraes soadicea*	0.00	0.000
Rock scallop	*Crassedoma giganteum*	0.00	0.000
Red gorgonian	*Leophogorgia chilensis*	0.00	0.000
CA spiny lobster	*Panulirus interruptus*	0.27	0.273
Short spined sea star	*Pisaster brevispinus*	0.73	0.506
Sunflower/sun star	*Pycnopodia helianthoides, Solaster stimpsoni/dawsoni*	0.82	0.377
CA sea cucumber	*Parastichopus californicus*	0.00	0.000
Sheep/masking crab	*Loxorhynchus grandis, L. crispatus*	0.00	0.000
Green abalone	*Haliotis fulgens*	0.00	0.000
Pink abalone	*Haliotis corrugata*	0.00	0.000
Red abalone	*Haliotis rufescens*	0.00	0.000

Fish Densities (60m^2) at Christmas Tree Cove (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Blacksmith	*Chromis punctipinnis*	0.06	0.061
Senorita	*Oxyjulis californica*	4.58	1.142
Kelp bass	*Paralabrax clathratus*	0.48	0.124
Garibaldi	*Hypsypops rubicundus*	1.39	0.254
California Sheephead	*Semicossyphus pulcher*	1.73	0.329
Black perch	*Embiotoca jacksoni*	1.91	0.425
Rainbow perch	*Hypsurus caryi*	0.91	0.321
Pile perch	*Rhacochilus vacca*	0.12	0.058
Striped perch	*Embiotoca lateralis*	0.12	0.072
Rubberlip perch	*Rhacochilus toxotes*	0.30	0.220
Rock wrasse	*Halichoeres semicinctus*	0.39	0.189
Opaleye	*Girella nigricans*	0.06	0.042
Barred sand bass	*Paralabrax nebulifer*	0.27	0.090
Sargo	*Anisotermus davidsoni*	0.12	0.084
Young of the year rockfish	*Sebastes spp.*	0.18	0.111
Kelp rockfish	*Sebastes atrovirens*	0.27	0.133
Blue rockfish	*Sebastes mystinus*	0.03	0.030
Yellowtail/olive rockfish	*Sebastes flavidus/serranoides*	0.00	0.000
Treefish	*Sebastes serriceps*	0.30	0.111
Black and yellow rockfish	*Sebastes chrysomelas*	0.06	0.042
Gopher rockfish	*Sebastes carnatus*	0.09	0.067
Brown rockfish	*Sebastes auriculatus*	0.00	0.000
Copper rockfish	*Sebastes caurinus*	0.00	0.000
Horn shark	*Heterodontus francisci*	0.00	0.000
Cabezon	*Scorpaenichthys marmoratus*	0.00	0.000
Lingcod	*Ophiodon elongatus*	0.00	0.000
Kelp greenling	*Hexagrammos decagrammus*	0.00	0.000

Hawthorne Reef, located on the Palos Verdes peninsula in Los Angeles County, was established as a Reef Check site in 2007. This site is protected under the Point Vicente SMCA, which was implemented in 2012. The substrate is primarily bedrock with some cobble and the relief is predominantly 10 cm to 1 m. The substrate is bare or covered in crustose coralline algae or red algae. Urchin numbers are very high at this site. Purple urchins are by far the most common invertebrates, but bat stars, red urchins, giant spined sea stars and brown/golden gorgonians are also present. Senorita, California sheephead, black perch, rock wrasse and garibaldi are the most common fish species.

Physical Characteristics and Primary Substrate Cover at Hawthorne Reef (2011-2012)

Average depth	10.74 meters

Substrate type	Percentage		Substrate Cover	Percentage
Bedrock	74.72%		Articulated coralline	5.83%
Boulders	10%		Brown seaweed	2.50%
Cobble	11.11%		Crustose coralline	17.50%
Sand	4.17%		Green seaweed	1.11%
			Mobile invertebrates	5%
Relief	**Percentage**		None	32.78%
0-10cm	1.39%		Other brown seaweed	11.67%
10 cm-1meter	92.22%		Red seaweed	17.78%
1-2meter	6.39%		Sessile invertebrates	5.83%
>2 meters	0%			

Algae densities (60m^2) at Hawthorne Reef (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Giant kelp	*Macrocystis pyrifera*	21.33	4.182
Giant kelp Stipes	*Macrocystis pyrifera*	128.88	21.865
Laminaria spp	*Laminaria farlowii, L. setchelii*	0.33	0.225
Pterygophora	*Pterygophora californica*	0.00	0.000
Southern sea palm	*Eisenia arboea*	1.75	1.188

Invertebrate densities (60m^2) at Hawthorne Reef (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Purple urchin	*Strongylocentrotus purpuratus*	269.48	126.121
Red urchin	*Strongylocentrotus franciscanus*	65.70	29.819
Bat star	*Patiria miniata*	66.07	14.930
Wavy/red turban snail	*Lithopoma undosum*	1.58	0.712
Crowned urchin	*Centrostephanus coronatus*	0.08	0.083
Brown/golden gorgonian	*Muricea fruticosa, M. californica*	3.67	1.868
Giant spined star	*Pisaster giganteus*	7.25	2.240
Warty sea cucumber	*Parastichopus parvimensis*	0.17	0.167
Kellet's whelk	*Kelletia kelletii*	2.92	1.171
Giant keyhole limpet	*Megathura crenulata*	0.67	0.355
Large anemone	*Anthopleura spp., Metridium spp., Urticina spp.*	2.33	0.995
Chestnut cowry	*Cyoraes soadicea*	0.83	0.661
Rock scallop	*Crassedoma giganteum*	0.00	0.000
Red gorgonian	*Leophogorgia chilensis*	0.00	0.000
CA spiny lobster	*Panulirus interruptus*	0.00	0.000
Short spined sea star	*Pisaster brevispinus*	0.58	0.398
Sunflower/sun star	*Pycnopodia helianthoides, Solaster stimpsoni/dawsoni*	1.08	0.288
CA sea cucumber	*Parastichopus californicus*	0.00	0.000
Sheep/masking crab	*Loxorhynchus grandis, L. crispatus*	0.00	0.000
Green abalone	*Haliotis fulgens*	0.00	0.000
Pink abalone	*Haliotis corrugata*	0.00	0.000
Red abalone	*Haliotis rufescens*	0.00	0.000

Fish Densities (60m^2) at Hathorne Reef (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Blacksmith	*Chromis punctipinnis*	0.67	0.319
Senorita	*Oxyjulis californica*	8.42	1.585
Kelp bass	*Paralabrax clathratus*	0.94	0.191
Garibaldi	*Hypsypops rubicundus*	1.00	0.287
California Sheephead	*Semicossyphus pulcher*	3.03	0.399
Black perch	*Embiotoca jacksoni*	2.50	0.387
Rainbow perch	*Hypsurus caryi*	0.97	0.263
Pile perch	*Rhacochilus vacca*	0.11	0.053
Striped perch	*Embiotoca lateralis*	0.14	0.090
Rubberlip perch	*Rhacochilus toxotes*	0.08	0.083
Rock wrasse	*Halichoeres semicinctus*	1.22	0.329
Opaleye	*Girella nigricans*	0.67	0.225
Barred sand bass	*Paralabrax nebulifer*	0.47	0.189
Sargo	*Anisotermus davidsoni*	0.03	0.028
Young of the year rockfish	*Sebastes spp.*	0.00	0.000
Kelp rockfish	*Sebastes atrovirens*	0.17	0.093
Blue rockfish	*Sebastes mystinus*	0.00	0.000
Yellowtail/olive rockfish	*Sebastes flavidus/serranoides*	0.00	0.000
Treefish	*Sebastes serriceps*	0.11	0.066
Black and yellow rockfish	*Sebastes chrysomelas*	0.06	0.039
Gopher rockfish	*Sebastes carnatus*	0.08	0.047
Brown rockfish	*Sebastes auriculatus*	0.03	0.028
Copper rockfish	*Sebastes caurinus*	0.00	0.000
Rock greenling	*Hexagrammos lagocephalus*	0.00	0.000
Horn shark	*Heterodontus francisci*	0.00	0.000
Cabezon	*Scorpaenichthys marmoratus*	0.03	0.028
Lingcod	*Ophiodon elongatus*	0.00	0.000
Kelp greenling	*Hexagrammos decagrammus*	0.00	0.000

120 Reef, located on the Palos Verdes Peninsula in Los Angeles County, was established as a Reef Check site in 2006. This site is part of the Abalone Cove SMCA, implemented in 2012. The substrate is primarily bedrock with a relief of 10 cm to 1 m. The substrate is bare or covered with crustose coralline algae or sessile invertebrates. The most common macroalgae is pterygophora and there is some giant kelp present. Urchin densities are high at this site – purple urchins and red urchins are prevalent. Bat stars, brown/gold gorgonians and Kellet's whelks are also common. Senorita, black perch, blacksmith, rock wrasse and rainbow perch are the most common fish.

Physical Characteristics and Primary Substrate Cover at 120 Reef (2011-2012)

Average depth	8.01 meters

Substrate type	Percentage		Substrate Cover	Percentage
Bedrock	73.89%		Articulated coralline	2.22%
Boulders	5.74%		Brown seaweed	4.26%
Cobble	7.04%		Crustose coralline	13.70%
Sand	13.15%		Green seaweed	1.30%
			Mobile invertebrates	8.52%
Relief	**Percentage**		None	33.15%
0-10cm	2.96%		Other brown seaweed	11.67%
10 cm-1meter	82.96%		Red seaweed	10.56%
1-2meter	7.78%		Seagrasses	3.33%
>2 meters	6.30%		Sessile invertebrates	11.30%

Algae densities (60m^2) at 120 Reef (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Giant kelp	*Macrocystis pyrifera*	20.83	3.390
Giant kelp Stipes	*Macrocystis pyrifera*	125.29	14.437
Laminaria spp	*Laminaria farlowii, L. setchelii*	13.35	10.638
Pterygophora	*Pterygophora californica*	26.77	7.579
Southern sea palm	*Eisenia arboea*	2.72	1.942

Invertebrate densities (60m^2) at 120 Reef (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Purple urchin	*Strongylocentrotus purpuratus*	337.28	89.062
Red urchin	*Strongylocentrotus franciscanus*	181.07	53.951
Bat star	*Patiria miniata*	23.90	6.031
Wavy/red turban snail	*Lithopoma undosum*	0.61	0.325
Crowned urchin	*Centrostephanus coronatus*	0.17	0.121
Brown/golden gorgonian	*Muricea fruticosa, M. californica*	16.67	5.903
Giant spined star	*Pisaster giganteus*	14.61	2.629
Warty sea cucumber	*Parastichopus parvimensis*	0.83	0.294
Kellet's whelk	*Kelletia kelletii*	14.92	10.203
Giant keyhole limpet	*Megathura crenulata*	1.61	0.784
Large anemone	*Anthopleura spp., Metridium spp., Urticina spp.*	1.17	0.525
Chestnut cowry	*Cyoraes soadicea*	0.28	0.158
Rock scallop	*Crassedoma giganteum*	0.17	0.090
Red gorgonian	*Leophogorgia chilensis*	0.94	0.613
CA spiny lobster	*Panulirus interruptus*	0.06	0.056
Short spined sea star	*Pisaster brevispinus*	3.06	1.238
Sunflower/sun star	*Pycnopodia helianthoides, Solaster stimpsoni/dawsoni*	0.56	0.217
CA sea cucumber	*Parastichopus californicus*	0.00	0.000
Sheep/masking crab	*Loxorhynchus grandis, L. crispatus*	0.00	0.000
Green abalone	*Haliotis fulgens*	0.00	0.000
Pink abalone	*Haliotis corrugata*	0.00	0.000
Red abalone	*Haliotis rufescens*	0.00	0.000

Fish Densities (60m^2) at One Twenty Reef (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Blacksmith	*Chromis punctipinnis*	3.48	1.543
Senorita	*Oxyjulis californica*	6.09	0.771
Kelp bass	*Paralabrax clathratus*	1.11	0.188
Garibaldi	*Hypsypops rubicundus*	1.30	0.188
California Sheephead	*Semicossyphus pulcher*	0.83	0.147
Black perch	*Embiotoca jacksoni*	4.04	0.607
Rainbow perch	*Hypsurus caryi*	1.26	0.412
Pile perch	*Rhacochilus vacca*	0.31	0.123
Striped perch	*Embiotoca lateralis*	0.15	0.085
Rubberlip perch	*Rhacochilus toxotes*	0.04	0.026
Rock wrasse	*Halichoeres semicinctus*	1.94	0.315
Opaleye	*Girella nigricans*	0.17	0.087
Barred sand bass	*Paralabrax nebulifer*	0.39	0.100
Sargo	*Anisotermus davidsoni*	0.04	0.026
Young of the year rockfish	*Sebastes spp.*	0.04	0.026
Kelp rockfish	*Sebastes atrovirens*	0.30	0.086
Blue rockfish	*Sebastes mystinus*	0.15	0.077
Yellowtail/olive rockfish	*Sebastes flavidus/serranoides*	0.00	0.000
Treefish	*Sebastes serriceps*	0.11	0.068
Black and yellow rockfish	*Sebastes chrysomelas*	0.00	0.000
Gopher rockfish	*Sebastes carnatus*	0.00	0.000
Brown rockfish	*Sebastes auriculatus*	0.02	0.019
Copper rockfish	*Sebastes caurinus*	0.00	0.000
Horn shark	*Heterodontus francisci*	0.04	0.026
Cabezon	*Scorpaenichthys marmoratus*	0.06	0.031
Lingcod	*Ophiodon elongatus*	0.00	0.000
Kelp greenling	*Hexagrammos decagrammus*	0.00	0.000

Abalone Cove, located on the Palos Verdes Peninsula in Los Angeles County, was established as a Reef Check site in 2007. This site is part of the Abalone Cove SMCA, implemented in 2012, however it was previously protected as part of the Abalone Cove SMP since 1977. The substrate is mainly bedrock with some boulders and the relief is mostly 10 cm to 1 m. The substrate is bare or covered with brown algae species or sessile invertebrates. Urchin densities are high at this site – purple urchins and red urchins are prevalent. Brown/golden gorgonians, bat stars and giant spined sea stars are also common. Black perch, blacksmith, senorita, garibaldi and opaleye are the most common fish species.

Physical characteristics and primary substrate cover at Abalone Cove (2012)

Average depth	11.41 meters

Substrate type	Percentage		Substrate Cover	Percentage
Bedrock	70%		Articulated coralline	0.6%
Boulders	17.2%		Brown seaweed	3.9%
Cobble	7.8%		Crustose coralline	16.7%
Sand	5%		Green seaweed	2.4%
			Mobile invertebrates	5.0%
Relief	**Percentage**		None	22.2%
0-10cm	0%		Other brown seaweed	21.7%
10 cm-1meter	93%		Red seaweed	10.0%
1-2meter	6%		Sessile invertebrates	20.0%
>2 meters	2%			

Algae densities (60m^2) at Abalone Cove (2012)

Common name	Scientific name	Mean Density	Std Error
Giant kelp	*Macrocystis pyrifera*	12.33	1.201
Giant kelp stipes	*Macrocystis pyrifera*	121.67	21.640
Laminaria spp	*Laminaria farlowii, L. setchelii*	0.33	0.333
Pterygophora	*Pterygophora californica*	6.00	3.697
Southern sea palm	*Eisenia arboea*	2.00	2.00

Invertebrate densities (60m^2) at Abalone Cove (2012)

Common name	Scientific name	Mean Density	Std Error
Purple urchin	*Strongylocentrotus purpuratus*	311.37	239.781
Red urchin	*Strongylocentrotus franciscanus*	96.50	43.889
Bat star	*Patiria miniata*	25.00	3.256
Wavy/red turban snail	*Lithopoma undosum*	0.00	0.000
Crowned urchin	*Centrostephanus coronatus*	0.00	0.000
Brown/golden gorgonian	*Muricea fruticosa, M. californica*	49.38	10.927
Giant spined star	*Pisaster giganteus*	17.33	5.590
Warty sea cucumber	*Parastichopus parvimensis*	0.83	0.654
Kellet's whelk	*Kelletia kelletii*	4.33	1.116
Giant keyhole limpet	*Megathura crenulata*	0.17	0.167
Large anemone	*Anthopleura spp., Metridium spp., Urticina spp.*	0.83	0.477
Chestnut cowry	*Cyoraes soadicea*	0.33	0.333
Rock scallop	*Crassedoma giganteum*	1.00	0.632
Red gorgonian	*Leophogorgia chilensis*	5.67	5.277
CA spiny lobster	*Panulirus interruptus*	0.00	0.000
Short spined sea star	*Pisaster brevispinus*	2.83	1.558
Sunflower/sun star	*Pycnopodia helianthoides, Solaster stimpsoni/dawsoni*	0.83	0.477
CA sea cucumber	*Parastichopus californicus*	0.00	0.000
Sheep/masking crab	*Loxorhynchus grandis, L. crispatus*	0.00	0.000
Green abalone	*Haliotis fulgens*	0.00	0.000
Pink abalone	*Haliotis corrugata*	0.00	0.000
Red abalone	*Haliotis rufescens*	0.00	0.000

Fish Densities (60m^2) at Abalone Cove (2012)

Common name	Scientific name	Mean Density	Std Error
Blacksmith	*Chromis punctipinnis*	6.33	1.950
Senorita	*Oxyjulis californica*	5.61	1.437
Kelp bass	*Paralabrax clathratus*	2.50	0.809
Garibaldi	*Hypsypops rubicundus*	3.39	1.271
California Sheephead	*Semicossyphus pulcher*	1.06	0.274
Black perch	*Embiotoca jacksoni*	7.28	1.381
Rainbow perch	*Hypsurus caryi*	2.28	1.769
Pile perch	*Rhacochilus vacca*	2.06	1.254
Striped perch	*Embiotoca lateralis*	0.44	0.444
Rubberlip perch	*Rhacochilus toxotes*	0.72	0.722
Rock wrasse	*Halichoeres semicinctus*	1.11	0.387
Opaleye	*Girella nigricans*	2.61	0.871
Barred sand bass	*Paralabrax nebulifer*	2.00	0.313
Sargo	*Anisotermus davidsoni*	0.61	0.335
Young of the year rockfish	*Sebastes spp.*	0.06	0.056
Kelp rockfish	*Sebastes atrovirens*	0.50	0.202
Blue rockfish	*Sebastes mystinus*	0.94	0.551
Yellowtail/olive rockfish	*Sebastes flavidus/serranoides*	0.11	0.111
Treefish	*Sebastes serriceps*	0.17	0.090
Black and yellow rockfish	*Sebastes chrysomelas*	0.28	0.135
Gopher rockfish	*Sebastes carnatus*	0.28	0.135
Brown rockfish	*Sebastes auriculatus*	0.00	0.000
Copper rockfish	*Sebastes caurinus*	0.00	0.000
Horn shark	*Heterodontus francisci*	0.00	0.000
Cabezon	*Scorpaenichthys marmoratus*	0.00	0.000
Lingcod	*Ophiodon elongatus*	0.00	0.000
Kelp greenling	*Hexagrammos decagrammus*	0.00	0.000

White Point, located on the Palos Verdes Peninsula in Los Angeles County, was established as a Reef Check site in 2008. Average depth of the site is 8 meters, bedrock is the dominant substrate and relief is mostly 10 cm to 1 meter. The substrate is bare or covered in crustose coralline algae or brown algal species. Macroalgae includes pterygophora and some giant kelp. Purple urchins, red urchins, giant spined sea stars, bat stars and large anemones are the prevalent invertebrates. Senorita, blacksmith, black perch, garibaldi and rock wrasse are the most common fish species.

Physical Characteristics and Primary Substrate Cover at White Point (2011-2012)

Average depth	7.87 meters

Substrate type	Percentage		Substrate Cover	Percentage
Bedrock	64.72%		Articulated coralline	5.56%
Boulders	11.94%		Brown seaweed	6.94%
Cobble	10.28%		Crustose coralline	16.39%
Sand	13.06%		Green seaweed	2.50%
			Mobile invertebrates	4.44%
Relief	**Percentage**		None	36.94%
0-10cm	2.78%		Other brown seaweed	11.39%
10 cm-1meter	80.56%		Red seaweed	10.28%
1-2meter	11.39%		Sessile invertebrates	5.56%
>2 meters	5.28%			

Algae densities (60m^2) at White Point (2012)

Common name	Scientific name	Mean Density	Std Error
Giant kelp	*Macrocystis pyrifera*	11.58	2.116
Giant kelp Stipes	*Macrocystis pyrifera*	97.42	22.912
Laminaria spp	*Laminaria farlowii, L. setchelii*	1.17	1.167
Pterygophora	*Pterygophora californica*	177.46	65.270
Southern sea palm	*Eisenia arboea*	12.38	4.946

Invertebrate densities (60m^2) at White Point (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Purple urchin	*Strongylocentrotus purpuratus*	206.64	62.131
Red urchin	*Strongylocentrotus franciscanus*	37.49	8.428
Bat star	*Patiria miniata*	7.67	1.559
Wavy/red turban snail	*Lithopoma undosum*	0.33	0.256
Crowned urchin	*Centrostephanus coronatus*	0.58	0.583
Brown/golden gorgonian	*Muricea fruticosa, M. californica*	0.25	0.131
Giant spined star	*Pisaster giganteus*	13.08	2.288
Warty sea cucumber	*Parastichopus parvimensis*	0.58	0.229
Kellet's whelk	*Kelletia kelletii*	5.67	1.281
Giant keyhole limpet	*Megathura crenulata*	2.08	0.981
Large anemone	*Anthopleura spp., Metridium spp., Urticina spp.*	7.34	6.809
Chestnut cowry	*Cyoraes soadicea*	0.08	0.083
Rock scallop	*Crassedoma giganteum*	0.25	0.131
Red gorgonian	*Leophogorgia chilensis*	0.00	0.000
CA spiny lobster	*Panulirus interruptus*	0.00	0.000
Short spined sea star	*Pisaster brevispinus*	3.58	1.559
Sunflower/sun star	*Pycnopodia helianthoides, Solaster stimpsoni/dawsoni*	0.00	0.000
CA sea cucumber	*Parastichopus californicus*	0.92	0.830
Sheep/masking crab	*Loxorhynchus grandis, L. crispatus*	0.00	0.000
Green abalone	*Haliotis fulgens*	0.00	0.000
Pink abalone	*Haliotis corrugata*	0.00	0.000
Red abalone	*Haliotis rufescens*	0.00	0.000

Fish Densities (60m^2) at White Point (2012)

Common name	Scientific name	Mean Density	Std Error
Blacksmith	*Chromis punctipinnis*	6.25	2.505
Senorita	*Oxyjulis californica*	9.00	1.377
Kelp bass	*Paralabrax clathratus*	0.94	0.195
Garibaldi	*Hypsypops rubicundus*	2.69	0.583
California Sheephead	*Semicossyphus pulcher*	0.56	0.166
Black perch	*Embiotoca jacksoni*	5.56	0.859
Rainbow perch	*Hypsurus caryi*	0.22	0.098
Pile perch	*Rhacochilus vacca*	0.28	0.102
Striped perch	*Embiotoca lateralis*	0.00	0.000
Rubberlip perch	*Rhacochilus toxotes*	0.33	0.164
Rock wrasse	*Halichoeres semicinctus*	1.42	0.611
Opaleye	*Girella nigricans*	0.50	0.180
Barred sand bass	*Paralabrax nebulifer*	0.50	0.146
Sargo	*Anisotermus davidsoni*	0.19	0.194
Young of the year rockfish	*Sebastes spp.*	0.00	0.000
Kelp rockfish	*Sebastes atrovirens*	0.31	0.137
Blue rockfish	*Sebastes mystinus*	0.00	0.000
Yellowtail/olive rockfish	*Sebastes flavidus/serranoides*	0.06	0.039
Treefish	*Sebastes serriceps*	0.08	0.047
Black and yellow rockfish	*Sebastes chrysomelas*	0.11	0.077
Gopher rockfish	*Sebastes carnatus*	0.00	0.000
Brown rockfish	*Sebastes auriculatus*	0.03	0.028
Copper rockfish	*Sebastes caurinus*	0.00	0.000
Horn shark	*Heterodontus francisci*	0.00	0.000
Cabezon	*Scorpaenichthys marmoratus*	0.06	0.039
Lingcod	*Ophiodon elongatus*	0.00	0.000
Kelp greenling	*Hexagrammos decagrammus*	0.00	0.000

Little Corona Del Mar, located in Orange County, was established as a Reef Check site in 2007. Little Corona Del Mar is currently part of the Crystal Cove SMCA, implemented in 2012, however it had previously been protected as part of the Robert E. Badham SMCA since 1968. Average depth of the site is 7 meters, bedrock is the dominant substrate type and relief is 10 cm to 1 meter. The substrate is bare or covered with crustose coralline algae and articulated coralline algae. Giant kelp is basically the only macroalgae. Invertebrates include purple urchins, wavy/red turban snails, red urchins, brown/golden gorgonians and giant keyhole limpets. Senorita, garibaldi, blacksmith, kelp bass and California sheephead are the most common fish species.

Physical Characteristics and Primary Substrate Cover at Little Corona Del Mar (2011-2012)

Average depth	6.84 meters

Substrate type	Percentage
Bedrock	75%
Boulders	3.75%
Cobble	10.83%
Sand	10.42%

Relief	Percentage
0-10cm	7.50%
10 cm-1meter	86.53%
1-2meter	5.97%
>2 meters	0%

Substrate Cover	Percentage
Articulated coralline	13.61%
Brown seaweed	2.08%
Crustose coralline	23.47%
Green seaweed	0.28%
Mobile invertebrates	1.94%
None	29.72%
Other brown seaweed	9.31%
Red seaweed	9.58%
Sessile invertebrates	10%

Algae densities (60m^2) at Little Corona Del Mar (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Giant kelp	*Macrocystis pyrifera*	25.41	4.246
Giant kelp Stipes	*Macrocystis pyrifera*	136.01	18.564
Laminaria spp	*Laminaria farlowii, L. setchelii*	0.00	0.000
Pterygophora	*Pterygophora californica*	0.00	0.000
Southern sea palm	*Eisenia arboea*	0.50	0.233

Invertebrate densities (60m^2) at Little Corona Del Mar (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Purple urchin	*Strongylocentrotus purpuratus*	41.06	12.045
Red urchin	*Strongylocentrotus franciscanus*	23.14	6.515
Bat star	*Patiria miniata*	0.04	0.042
Wavy/red turban snail	*Lithopoma undosum*	27.84	3.495
Crowned urchin	*Centrostephanus coronatus*	0.25	0.211
Brown/golden gorgonian	*Muricea fruticosa, M. californica*	8.25	1.973
Giant spined star	*Pisaster giganteus*	0.13	0.069
Warty sea cucumber	*Parastichopus parvimensis*	0.54	0.233
Kellet's whelk	*Kelletia kelletii*	0.54	0.307
Giant keyhole limpet	*Megathura crenulata*	1.71	0.406
Large anemone	*Anthopleura spp., Metridium spp., Urticina spp.*	0.17	0.130
Chestnut cowry	*Cyoraes soadicea*	0.67	0.317
Rock scallop	*Crassedoma giganteum*	0.25	0.124
Red gorgonian	*Leophogorgia chilensis*	1.42	1.087
CA spiny lobster	*Panulirus interruptus*	0.54	0.180
Short spined sea star	*Pisaster brevispinus*	0.04	0.042
Sunflower/sun star	*Pycnopodia helianthoides, Solaster stimpsoni/dawsoni*	0.00	0.000
CA sea cucumber	*Parastichopus californicus*	0.00	0.000
Sheep/masking crab	*Loxorhynchus grandis, L. crispatus*	0.00	0.000
Green abalone	*Haliotis fulgens*	0.50	0.181
Pink abalone	*Haliotis corrugata*	0.21	0.104
Red abalone	*Haliotis rufescens*	0.00	0.000

Fish Densities (60m^2) at Little Corona Del Mar (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Blacksmith	*Chromis punctipinnis*	7.89	1.465
Senorita	*Oxyjulis californica*	9.26	1.396
Kelp bass	*Paralabrax clathratus*	2.51	0.317
Garibaldi	*Hypsypops rubicundus*	7.90	0.864
California Sheephead	*Semicossyphus pulcher*	2.11	0.315
Black perch	*Embiotoca jacksoni*	1.90	0.247
Rainbow perch	*Hypsurus caryi*	0.10	0.049
Pile perch	*Rhacochilus vacca*	0.08	0.033
Striped perch	*Embiotoca lateralis*	0.04	0.031
Rubberlip perch	*Rhacochilus toxotes*	0.01	0.014
Rock wrasse	*Halichoeres semicinctus*	2.19	0.272
Opaleye	*Girella nigricans*	0.76	0.261
Barred sand bass	*Paralabrax nebulifer*	0.53	0.099
Sargo	*Anisotermus davidsoni*	0.08	0.043
Young of the year rockfish	*Sebastes spp.*	0.00	0.000
Kelp rockfish	*Sebastes atrovirens*	0.00	0.000
Blue rockfish	*Sebastes mystinus*	0.00	0.000
Yellowtail/olive rockfish	*Sebastes flavidus/serranoides*	0.00	0.000
Treefish	*Sebastes serriceps*	0.01	0.014
Black and yellow rockfish	*Sebastes chrysomelas*	0.00	0.000
Gopher rockfish	*Sebastes carnatus*	0.00	0.000
Brown rockfish	*Sebastes auriculatus*	0.01	0.014
Copper rockfish	*Sebastes caurinus*	0.00	0.000
Horn shark	*Heterodontus francisci*	0.00	0.000
Cabezon	*Scorpaenichthys marmoratus*	0.00	0.000
Lingcod	*Ophiodon elongatus*	0.00	0.000
Kelp greenling	*Hexagrammos decagrammus*	0.00	0.000

Crystal Cove State Beach, located in Laguna Beach in Orange County, was established as a Reef Check site in 2008. This site is part of the Crystal Cove SMCA and has been protected since 1982. The average depth is 7.8 meters and the bottom consists mostly of bedrock with some sand. Relief is mostly 10 cm to 1 meter, but there is also a fair amount of 1 meter to 2 meter relief. The substrate is bare or covered with articulated coralline algae and crustose coralline algae. Laminaria is the dominant macroalgae and giant kelp and Southern sea palm are also present. Red urchins are the prevalent invertebrates and brown/golden gorgonians, wavy/red turban snails, Kellet's whelks and red gorgonians are also present. Blacksmith, senorita, garibaldi, kelp bass and California sheephead are the most common fish. Like most Reef Check sites in Los Angeles County and Orange County, garibaldi are common here.

Physical Characteristics and Primary Substrate Cover at Crystal Cove (2011-2012)

Average depth	7.76 meters

Substrate type	Percentage		Substrate Cover	Percentage
Bedrock	72.78%		Articulated coralline	18.33%
Boulders	3.89%		Brown seaweed	4.17%
Cobble	2.78%		Crustose coralline	12.50%
Sand	20.28%		Green seaweed	
			Mobile invertebrates	0.56%
Relief	**Percentage**		None	29.44%
0-10cm	9.72%		Other brown seaweed	12.22%
10 cm-1meter	74.17%		Red seaweed	11.11%
1-2meter	10.28%		Seagrass	0.56%
>2 meters	5.83%		Sessile invertebrates	11.11%

Algae densities (60m^2) at Crystal Cove (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Giant kelp	*Macrocystis pyrifera*	9.92	2.808
Giant kelp Stipes	*Macrocystis pyrifera*	114.58	22.179
Laminaria spp	*Laminaria farlowii, L. setchelii*	55.98	15.618
Pterygophora	*Pterygophora californica*	0.00	0.000
Southern sea palm	*Eisenia arboea*	8.50	1.865

Invertebrate densities (60m^2) at Crystal Cove (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Purple urchin	*Strongylocentrotus purpuratus*	3.08	2.448
Red urchin	*Strongylocentrotus franciscanus*	38.26	22.213
Bat star	*Patiria miniata*	0.17	0.167
Wavy/red turban snail	*Lithopoma undosum*	4.17	2.156
Crowned urchin	*Centrostephanus coronatus*	0.00	0.000
Brown/golden gorgonian	*Muricea fruticosa, M. californica*	32.43	16.600
Giant spined star	*Pisaster giganteus*	0.92	0.468
Warty sea cucumber	*Parastichopus parvimensis*	0.50	0.230
Kellet's whelk	*Kelletia kelletii*	3.58	1.510
Giant keyhole limpet	*Megathura crenulata*	1.25	0.524
Large anemone	*Anthopleura spp., Metridium spp., Urticina spp.*	0.08	0.083
Chestnut cowry	*Cyoraes soadicea*	0.25	0.250
Rock scallop	*Crassedoma giganteum*	0.50	0.337
Red gorgonian	*Leophogorgia chilensis*	2.75	2.157
CA spiny lobster	*Panulirus interruptus*	1.00	0.444
Short spined sea star	*Pisaster brevispinus*	0.00	0.000
Sunflower/sun star	*Pycnopodia helianthoides, Solaster stimpsoni/dawsoni*	0.00	0.000
CA sea cucumber	*Parastichopus californicus*	0.00	0.000
Sheep/masking crab	*Loxorhynchus grandis, L. crispatus*	0.00	0.000
Green abalone	*Haliotis fulgens*	0.00	0.000
Pink abalone	*Haliotis corrugata*	0.00	0.000
Red abalone	*Haliotis rufescens*	0.00	0.000

Fish Densities (60m^2) at Crystal Cove (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Blacksmith	*Chromis punctipinnis*	14.86	3.651
Senorita	*Oxyjulis californica*	11.44	1.570
Kelp bass	*Paralabrax clathratus*	4.44	0.472
Garibaldi	*Hypsypops rubicundus*	5.39	1.290
California Sheephead	*Semicossyphus pulcher*	2.92	0.594
Black perch	*Embiotoca jacksoni*	3.17	0.505
Rainbow perch	*Hypsurus caryi*	0.14	0.090
Pile perch	*Rhacochilus vacca*	0.08	0.047
Striped perch	*Embiotoca lateralis*	0.00	0.000
Rubberlip perch	*Rhacochilus toxotes*	0.06	0.039
Rock wrasse	*Halichoeres semicinctus*	1.00	0.252
Opaleye	*Girella nigricans*	1.00	0.458
Barred sand bass	*Paralabrax nebulifer*	0.44	0.129
Sargo	*Anisotermus davidsoni*	0.36	0.188
Young of the year rockfish	*Sebastes spp.*	0.00	0.000
Kelp rockfish	*Sebastes atrovirens*	0.00	0.000
Blue rockfish	*Sebastes mystinus*	0.00	0.000
Yellowtail/olive rockfish	*Sebastes flavidus/serranoides*	0.00	0.000
Treefish	*Sebastes serriceps*	0.00	0.000
Black and yellow rockfish	*Sebastes chrysomelas*	0.00	0.000
Gopher rockfish	*Sebastes carnatus*	0.00	0.000
Brown rockfish	*Sebastes auriculatus*	0.00	0.000
Copper rockfish	*Sebastes caurinus*	0.00	0.000
Horn shark	*Heterodontus francisci*	0.00	0.000
Cabezon	*Scorpaenichthys marmoratus*	0.00	0.000
Lingcod	*Ophiodon elongatus*	0.00	0.000
Kelp greenling	*Hexagrammos decagrammus*	0.00	0.000

Seal Rock/North Crescent Bay, located in Orange County, was established as a Reef Check site in 2007. This site is in the Laguna Beach SMR, implemented in 2012 but prior to that was part of an SMCA that was implemented in 1968. Average depth of the site is 7 meters, bedrock is the dominant substrate and relief is 10 cm to 1 meter. Crustose coralline algae and sessile invertebrates cover the substrate. Macroalgae densities are low, but some giant kelp is present. Urchin densities are high here and this site could be considered an urchin barren. Purple urchins, red urchins, wavy/red turban snails, rock scallops and brown/golden gorgonians are prevalent. Garibaldi, senorita, blacksmith, kelp bass and rock wrasse are the most common fish species.

Physical Characteristics and Primary Substrate Cover at Seal Rock/North Crescent Bay (2011-2012)

Average depth	6.97 meters

Substrate type	Percentage		Substrate Cover	Percentage
Bedrock	83.89%		Articulated coralline	7.22%
Boulders	9.72%		Brown seaweed	0.83%
Cobble	4.17%		Crustose coralline	39.72%
Sand	2.22%		Green seaweed	0.56%
			Mobile invertebrates	7.78%
Relief	**Percentage**		None	15.56%
0-10cm	2.50%		Other brown seaweed	4.72%
10 cm-1meter	82.22%		Red seaweed	6.94%
1-2meter	11.94%		Sessile invertebrates	16.67%
>2 meters	3.33%			

Algae densities (60m^2) at Seal Rock/North Crescent Bay site (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Giant kelp	*Macrocystis pyrifera*	5.08	1.658
Giant kelp Stipes	*Macrocystis pyrifera*	58.29	33.706
Laminaria spp	*Laminaria farlowii, L. setchelii*	0.00	0.000
Pterygophora	*Pterygophora californica*	0.00	0.000
Southern sea palm	*Eisenia arboea*	1.00	0.577

Invertebrate densities (60m^2) at Seal Rock/North Crescent Bay (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Purple urchin	*Strongylocentrotus purpuratus*	896.25	167.238
Red urchin	*Strongylocentrotus franciscanus*	102.00	24.405
Bat star	*Patiria miniata*	1.08	0.908
Wavy/red turban snail	*Lithopoma undosum*	22.92	3.437
Crowned urchin	*Centrostephanus coronatus*	0.00	0.000
Brown/golden gorgonian	*Muricea fruticosa, M. californica*	6.42	3.315
Giant spined star	*Pisaster giganteus*	0.33	0.188
Warty sea cucumber	*Parastichopus parvimensis*	1.17	0.458
Kellet's whelk	*Kelletia kelletii*	2.58	1.773
Giant keyhole limpet	*Megathura crenulata*	0.75	0.429
Large anemone	*Anthopleura spp., Metridium spp., Urticina spp.*	3.58	2.221
Chestnut cowry	*Cyoraes soadicea*	2.42	1.448
Rock scallop	*Crassedoma giganteum*	7.25	2.821
Red gorgonian	*Leophogorgia chilensis*	0.33	0.333
CA spiny lobster	*Panulirus interruptus*	0.17	0.167
Short spined sea star	*Pisaster brevispinus*	0.42	0.336
Sunflower/sun star	*Pycnopodia helianthoides, Solaster stimpsoni/dawsoni*	0.00	0.000
CA sea cucumber	*Parastichopus californicus*	0.00	0.000
Sheep/masking crab	*Loxorhynchus grandis, L. crispatus*	0.00	0.000
Green abalone	*Haliotis fulgens*	0.00	0.000
Pink abalone	*Haliotis corrugata*	0.00	0.000
Red abalone	*Haliotis rufescens*	0.00	0.000

Fish Densities (60m^2) at Seal Rock/North Crescent Bay (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Blacksmith	*Chromis punctipinnis*	3	1.046
Senorita	*Oxyjulis californica*	6.72	0.933
Kelp bass	*Paralabrax clathratus*	1.17	0.197
Garibaldi	*Hypsypops rubicundus*	11.81	1.673
California Sheephead	*Semicossyphus pulcher*	1.31	0.284
Black perch	*Embiotoca jacksoni*	0.19	0.104
Rainbow perch	*Hypsurus caryi*	0.00	0.000
Pile perch	*Rhacochilus vacca*	0.00	0.000
Striped perch	*Embiotoca lateralis*	0.03	0.028
Rubberlip perch	*Rhacochilus toxotes*	0.00	0.000
Rock wrasse	*Halichoeres semicinctus*	1.11	0.217
Opaleye	*Girella nigricans*	0.08	0.061
Barred sand bass	*Paralabrax nebulifer*	0.58	0.193
Sargo	*Anisotermus davidsoni*	0.03	0.028
Young of the year rockfish	*Sebastes spp.*	0.00	0.000
Kelp rockfish	*Sebastes atrovirens*	0.00	0.000
Blue rockfish	*Sebastes mystinus*	0.00	0.000
Yellowtail/olive rockfish	*Sebastes flavidus/serranoides*	0.00	0.000
Treefish	*Sebastes serriceps*	0.03	0.028
Black and yellow rockfish	*Sebastes chrysomelas*	0.00	0.000
Gopher rockfish	*Sebastes carnatus*	0.00	0.000
Brown rockfish	*Sebastes auriculatus*	0.00	0.000
Copper rockfish	*Sebastes caurinus*	0.00	0.000
Horn shark	*Heterodontus francisci*	0.03	0.028
Cabezon	*Scorpaenichthys marmoratus*	0.03	0.028
Lingcod	*Ophiodon elongatus*	0.00	0.000
Kelp greenling	*Hexagrammos decagrammus*	0.00	0.000

Shaw's Cove, in Orange County, is part of the Laguna Beach SMR, implemented in 2012, although it has been protected as a SMCA since 1968. Shaw's Cove was established as a Reef Check site in 2010. The substrate consists primarily of 10 cm to 1 m bedrock and is bare, covered in sessile invertebrates or crustose coralline algae. Shaw's Cove has very high urchin densities and can be considered an urchin barren. Purple urchins and red urchins are very prevalent and brown/golden gorgonians, warty sea cucumbers and wavy/red turban snails are also present. Likely as an effect of the high urchin numbers, there is not much macroalgae present although there are small numbers of giant kelp and Southern sea palm. The most common fish species, by far, is the blacksmith but garibaldi, barred sand bass, California sheephead and kelp bass are also present.

Physical Characteristics and Primary Substrate Cover at Shaw's Cove (2011-2012)

Average depth	8.81 meters

Substrate type	Percentage		Substrate Cover	Percentage
Bedrock	85.19%		Articulated coralline	1.67%
Boulders	4.07%		Brown seaweed	1.85%
Cobble	5%		Crustose coralline	27.59%
Sand	5.74%		Green seaweed	
			Mobile invertebrates	9.07%
Relief	Percentage		None	24.44%
0-10cm	7.04%		Other brown seaweed	3.52%
10 cm-1meter	71.48%		Red seaweed	0.74%
1-2meter	16.67%		Sessile invertebrates	31.11%
>2 meters	4.81%			

Algae densities (60m^2) at Shaw's Cove (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Giant kelp	*Macrocystis pyrifera*	11.06	2.218
Giant kelp Stipes	*Macrocystis pyrifera*	79.00	18.157
Laminaria spp	*Laminaria farlowii, L. setchelii*	0.00	0.000
Pterygophora	*Pterygophora californica*	0.00	0.000
Southern sea palm	*Eisenia arboea*	1.17	0.849

Invertebrate densities (60m^2) at Shaw's Cove (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Purple urchin	*Strongylocentrotus purpuratus*	614.39	139.664
Red urchin	*Strongylocentrotus franciscanus*	152.72	42.739
Bat star	*Patiria miniata*	4.72	1.718
Wavy/red turban snail	*Lithopoma undosum*	6.78	1.654
Crowned urchin	*Centrostephanus coronatus*	0.00	0.000
Brown/golden gorgonian	*Muricea fruticosa, M. californica*	49.74	14.544
Giant spined star	*Pisaster giganteus*	2.39	0.537
Warty sea cucumber	*Parastichopus parvimensis*	7.83	2.352
Kellet's whelk	*Kelletia kelletii*	2.28	0.651
Giant keyhole limpet	*Megathura crenulata*	2.06	0.400
Large anemone	*Anthopleura spp., Metridium spp., Urticina spp.*	2.17	0.961
Chestnut cowry	*Cyoraes soadicea*	1.33	0.600
Rock scallop	*Crassedoma giganteum*	1.61	0.436
Red gorgonian	*Leophogorgia chilensis*	0.61	0.389
CA spiny lobster	*Panulirus interruptus*	0.11	0.076
Short spined sea star	*Pisaster brevispinus*	0.67	0.291
Sunflower/sun star	*Pycnopodia helianthoides, Solaster stimpsoni/dawsoni*	0.22	0.222
CA sea cucumber	*Parastichopus californicus*	0.00	0.000
Sheep/masking crab	*Loxorhynchus grandis, L. crispatus*	0.06	0.056
Green abalone	*Haliotis fulgens*	0.00	0.000
Pink abalone	*Haliotis corrugata*	0.00	0.000
Red abalone	*Haliotis rufescens*	0.00	0.000

Fish Densities (60m^2) at Shaw's Cove (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Blacksmith	*Chromis punctipinnis*	33.43	9.518
Senorita	*Oxyjulis californica*	1.37	0.288
Kelp bass	*Paralabrax clathratus*	1.39	0.381
Garibaldi	*Hypsypops rubicundus*	6.69	0.690
California Sheephead	*Semicossyphus pulcher*	1.72	0.236
Black perch	*Embiotoca jacksoni*	0.81	0.179
Rainbow perch	*Hypsurus caryi*	0.06	0.031
Pile perch	*Rhacochilus vacca*	0.37	0.113
Striped perch	*Embiotoca lateralis*	0.06	0.031
Rubberlip perch	*Rhacochilus toxotes*	0.00	0.000
Rock wrasse	*Halichoeres semicinctus*	0.74	0.178
Opaleye	*Girella nigricans*	0.02	0.019
Barred sand bass	*Paralabrax nebulifer*	1.94	0.463
Sargo	*Anisotermus davidsoni*	0.04	0.037
Young of the year rockfish	*Sebastes spp.*	0.00	0.000
Kelp rockfish	*Sebastes atrovirens*	0.00	0.000
Blue rockfish	*Sebastes mystinus*	0.00	0.000
Yellowtail/olive rockfish	*Sebastes flavidus/serranoides*	0.00	0.000
Treefish	*Sebastes serriceps*	0.44	0.160
Black and yellow rockfish	*Sebastes chrysomelas*	0.00	0.000
Gopher rockfish	*Sebastes carnatus*	0.00	0.000
Brown rockfish	*Sebastes auriculatus*	0.00	0.000
Copper rockfish	*Sebastes caurinus*	0.00	0.000
Horn shark	*Heterodontus francisci*	0.00	0.000
Cabezon	*Scorpaenichthys marmoratus*	0.02	0.019
Lingcod	*Ophiodon elongatus*	0.00	0.000
Kelp greenling	*Hexagrammos decagrammus*	0.00	0.000

Diver's Cove, located in Laguna Beach in Orange County, is part of the Laguna Beach SMR, implemented in 2012, although it has been protected as an SMCA since 1968. Diver's Cove was established as a Reef Check site in 2008. This is a shallower Reef Check site with survey depths ranging from 5 feet to 37 feet. The substrate is primarily bedrock with a small amount of sand and the relief is dominantly 10 cm to 1 meter. The substrate is bare or covered in sessile invertebrates and crustose coralline algae. Diver's Cove has very high urchin densities and can be considered an urchin barren. Purple urchins are very prevalent and wavy/red turban snails, red urchins, brown/golden gorgonians and rock scallops are also present. Blacksmith, garibaldi, senorita, rock wrasse and kelp bass are the five most common fish.

Physical Characteristics and Primary Substrate Cover at Diver's Cove

Average depth	5.72 meters

Substrate type	Percentage
Bedrock	83.89%
Boulders	2.78%
Cobble	3.06%
Sand	10.28%

Relief	Percentage
0-10cm	0.56%
10 cm-1meter	88.89%
1-2meter	10.28%
>2 meters	0.28%

Substrate Cover	Percentage
Articulated coralline	8.06%
Brown seaweed	3.89%
Crustose coralline	15.83%
Green seaweed	0.56%
Mobile invertebrates	7.78%
None	21.39%
Other brown seaweed	12.50%
Red seaweed	6.67%
Sessile invertebrates	23.33%

Algae densities (60m2) at Diver's Cove (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Giant kelp	*Macrocystis pyrifera*	12.08	3.320
Giant kelp Stipes	*Macrocystis pyrifera*	114.67	24.677
Laminaria spp	*Laminaria farlowii, L. setchelii*	0.17	0.167
Pterygophora	*Pterygophora californica*	1.17	1.167
Southern sea palm	*Eisenia arboea*	32.33	24.588

Invertebrate densities (60m^2) at Diver's Cove (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Purple urchin	*Strongylocentrotus purpuratus*	772.33	200.376
Red urchin	*Strongylocentrotus franciscanus*	39.68	12.554
Bat star	*Patiria miniata*	0.00	0.00
Wavy/red turban snail	*Lithopoma undosum*	66.92	50.352
Crowned urchin	*Centrostephanus coronatus*	0.92	0.690
Brown/golden gorgonian	*Muricea fruticosa, M. californica*	19.86	8.261
Giant spined star	*Pisaster giganteus*	0.08	0.083
Warty sea cucumber	*Parastichopus parvimensis*	0.33	0.188
Kellet's whelk	*Kelletia kelletii*	2.00	0.896
Giant keyhole limpet	*Megathura crenulata*	0.42	0.193
Large anemone	*Anthopleura spp., Metridium spp., Urticina spp.*	0.92	0.336
Chestnut cowry	*Cyoraes soadicea*	0.33	0.188
Rock scallop	*Crassedoma giganteum*	11.95	5.431
Red gorgonian	*Leophogorgia chilensis*	0.17	0.167
CA spiny lobster	*Panulirus interruptus*	0.67	0.376
Short spined sea star	*Pisaster brevispinus*	0.17	0.167
Sunflower/sun star	*Pycnopodia helianthoides, Solaster stimpsoni/dawsoni*	0.00	0.000
CA sea cucumber	*Parastichopus californicus*	0.00	0.000
Sheep/masking crab	*Loxorhynchus grandis, L. crispatus*	0.00	0.000
Green abalone	*Haliotis fulgens*	0.00	0.000
Pink abalone	*Haliotis corrugata*	0.00	0.000
Red abalone	*Haliotis rufescens*	0.00	0.000

Fish Densities (60m²) at Diver's Cove (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Blacksmith	*Chromis punctipinnis*	7.94	1.962
Senorita	*Oxyjulis californica*	4.56	2.427
Kelp bass	*Paralabrax clathratus*	1.92	0.288
Garibaldi	*Hypsypops rubicundus*	6.89	0.749
California Sheephead	*Semicossyphus pulcher*	1.53	0.310
Black perch	*Embiotoca jacksoni*	1.83	0.540
Rainbow perch	*Hypsurus caryi*	0.00	0.000
Pile perch	*Rhacochilus vacca*	0.14	0.090
Striped perch	*Embiotoca lateralis*	0.19	0.104
Rubberlip perch	*Rhacochilus toxotes*	0.06	0.039
Rock wrasse	*Halichoeres semicinctus*	2.56	0.952
Opaleye	*Girella nigricans*	0.83	0.385
Barred sand bass	*Paralabrax nebulifer*	0.56	0.141
Sargo	*Anisotermus davidsoni*	0.44	0.176
Young of the year rockfish	*Sebastes spp.*	0.00	0.000
Kelp rockfish	*Sebastes atrovirens*	0.00	0.000
Blue rockfish	*Sebastes mystinus*	0.00	0.000
Yellowtail/olive rockfish	*Sebastes flavidus/serranoides*	0.00	0.000
Treefish	*Sebastes serriceps*	0.19	0.087
Black and yellow rockfish	*Sebastes chrysomelas*	0.00	0.000
Gopher rockfish	*Sebastes carnatus*	0.00	0.000
Brown rockfish	*Sebastes auriculatus*	0.00	0.000
Copper rockfish	*Sebastes caurinus*	0.00	0.000
Horn shark	*Heterodontus francisci*	0.00	0.000
Cabezon	*Scorpaenichthys marmoratus*	0.06	0.039
Lingcod	*Ophiodon elongatus*	0.00	0.000
Kelp greenling	*Hexagrammos decagrammus*	0.00	0.000

Heisler Park, established as a Reef Check site in 2008, is located in Laguna Beach in Orange County. This site is now part of the Laguna Beach SMR which was implemented in 2012, however it was protected under the Heisler Park SMCA since 1973. The substrate is primarily bedrock with a relief of 10 cm to 1m and is mostly bare or covered in sessile invertebrates and crustose coralline algae. Macroalgae includes giant kelp with some Southern sea palm and pterygophora. Wavy/red turban snails are very prevalent here and the site also contains purple urchins, red urchins, brown/golden gorgonians and rock scallops. The five most common fish species are blacksmith, garibaldi, senorita, California sheephead and kelp bass.

Physical Characteristics and Primary Substrate Cover at Heisler Park (2011-2012)

Average depth	9.06 meters

Substrate type	Percentage		Substrate Cover	Percentage
Bedrock	68.06%		Articulated coralline	11.94%
Boulders	12.22%		Brown seaweed	2.78%
Cobble	9.72%		Crustose coralline	21.11%
Sand	9.17%		Green seaweed	
			Mobile invertebrates	2.78%
Relief	**Percentage**		None	26.11%
0-10cm	1.39%		Other brown seaweed	5%
10 cm-1meter	82.78%		Red seaweed	6.39%
1-2meter	10.28%		Sessile invertebrates	23.89%
>2 meters	5.56%			

Algae densities (60m^2) at Heisler Park (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Giant kelp	*Macrocystis pyrifera*	18.17	2.809
Giant kelp Stipes	*Macrocystis pyrifera*	137.17	18.281
Laminaria spp	*Laminaria farlowii, L. setchelii*	0.58	0.434
Pterygophora	*Pterygophora californica*	5.61	4.423
Southern sea palm	*Eisenia arboea*	6.27	5.645

Invertebrate densities (60m^2) at Heisler Park (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Purple urchin	*Strongylocentrotus purpuratus*	41.88	11.760
Red urchin	*Strongylocentrotus franciscanus*	26.33	4.591
Bat star	*Patiria miniata*	0.42	0.260
Wavy/red turban snail	*Lithopoma undosum*	107.56	67.938
Crowned urchin	*Centrostephanus coronatus*	0.00	0.000
Brown/golden gorgonian	*Muricea fruticosa, M. californica*	12.33	3.294
Giant spined star	*Pisaster giganteus*	1.25	0.552
Warty sea cucumber	*Parastichopus parvimensis*	0.92	0.313
Kellet's whelk	*Kelletia kelletii*	2.58	0.821
Giant keyhole limpet	*Megathura crenulata*	1.17	0.490
Large anemone	*Anthopleura spp., Metridium spp., Urticina spp.*	1.08	0.468
Chestnut cowry	*Cyoraes soadicea*	0.00	0.000
Rock scallop	*Crassedoma giganteum*	4.58	1.777
Red gorgonian	*Leophogorgia chilensis*	0.00	0.000
CA spiny lobster	*Panulirus interruptus*	0.00	0.000
Short spined sea star	*Pisaster brevispinus*	0.00	0.000
Sunflower/sun star	*Pycnopodia helianthoides, Solaster stimpsoni/dawsoni*	0.00	0.000
CA sea cucumber	*Parastichopus californicus*	0.00	0.000
Sheep/masking crab	*Loxorhynchus grandis, L. crispatus*	0.00	0.000
Green abalone	*Haliotis fulgens*	0.08	0.083
Pink abalone	*Haliotis corrugata*	0.00	0.000
Red abalone	*Haliotis rufescens*	0.00	0.000

Fish Densities (60m^2) at Heisler Park (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Blacksmith	*Chromis punctipinnis*	12.33	4.672
Senorita	*Oxyjulis californica*	6.14	1.219
Kelp bass	*Paralabrax clathratus*	2.17	0.339
Garibaldi	*Hypsypops rubicundus*	7.03	1.625
California Sheephead	*Semicossyphus pulcher*	3.67	0.795
Black perch	*Embiotoca jacksoni*	1.44	0.362
Rainbow perch	*Hypsurus caryi*	0.47	0.364
Pile perch	*Rhacochilus vacca*	0.19	0.143
Striped perch	*Embiotoca lateralis*	0.06	0.039
Rubberlip perch	*Rhacochilus toxotes*	0.00	0.000
Rock wrasse	*Halichoeres semicinctus*	0.97	0.180
Opaleye	*Girella nigricans*	0.89	0.645
Barred sand bass	*Paralabrax nebulifer*	1.14	0.226
Sargo	*Anisotermus davidsoni*	0.06	0.056
Young of the year rockfish	*Sebastes spp.*	0.00	0.000
Kelp rockfish	*Sebastes atrovirens*	0.00	0.000
Blue rockfish	*Sebastes mystinus*	0.00	0.000
Yellowtail/olive rockfish	*Sebastes flavidus/serranoides*	0.03	0.028
Treefish	*Sebastes serriceps*	0.06	0.039
Black and yellow rockfish	*Sebastes chrysomelas*	0.00	0.000
Gopher rockfish	*Sebastes carnatus*	0.00	0.000
Brown rockfish	*Sebastes auriculatus*	0.00	0.000
Copper rockfish	*Sebastes caurinus*	0.00	0.000
Horn shark	*Heterodontus francisci*	0.00	0.000
Cabezon	*Scorpaenichthys marmoratus*	0.00	0.000
Lingcod	*Ophiodon elongatus*	0.00	0.000
Kelp greenling	*Hexagrammos decagrammus*	0.00	0.000

Salt Creek, established as a Reef Check site in 2009, is located in Dana Point. Salt Creek is part of the Dana Point SMCA, established on January 1, 2012 although it had been protected since 1971 as part of the Niguel SMCA. This site is part of a large persistent kelp forest in southern Orange County. The substrate is dominated by bedrock with some boulders, a relief primarily of 10 cm to 1 m and is mostly bare or covered by red algae or articulated coralline algae species. Giant kelp is the prevalent macroalgae and some pterygophora was present. The five most common invertebrates are purple urchins, red urchins, wavy/red turban snails, giant spined snails and chestnut cowries. Fish densities are low here, but kelp bass, sheephead, black perch, garibaldi and blacksmith are the five most common fish.

Physical Characteristics and Primary Substrate Cover at Salt Creek (2012)

Average depth	7.44 meters

Substrate type	Percentage		Substrate Cover	Percentage
Bedrock	71.39%		Articulated coralline	15.28%
Boulders	12.78%		Brown seaweed	7.50%
Cobble	8.89%		Crustose coralline	5.28%
Sand	6.94%		Green seaweed	
			Mobile invertebrates	1.11%
Relief	**Percentage**		None	27.50%
0-10cm	1.11%		Other brown seaweed	7.22%
10 cm-1meter	98.06%		Red seaweed	24.17%
1-2meter	0.83%		Sessile invertebrates	11.94%
>2 meters	0%			

Algae densities (60m^2) at Salt Creek (2012)

Common name	Scientific name	Mean Density	Std Error
Giant kelp	*Macrocystis pyrifera*	75.55	17.263
Giant kelp Stipes	*Macrocystis pyrifera*	210.02	37.886
Laminaria spp	*Laminaria farlowii, L. setchelii*	1.83	1.260
Pterygophora	*Pterygophora californica*	15.25	10.079
Southern sea palm	*Eisenia arboea*	0.42	0.229

Invertebrate densities (60m2) at Salt Creek (2012)

Common name	Scientific name	Mean Density	Std Error
Purple urchin	*Strongylocentrotus purpuratus*	32.47	14.888
Red urchin	*Strongylocentrotus franciscanus*	6.67	2.906
Bat star	*Patiria miniata*	0.17	0.112
Wavy/red turban snail	*Lithopoma undosum*	1.75	0.579
Crowned urchin	*Centrostephanus coronatus*	0.42	0.417
Brown/golden gorgonian	*Muricea fruticosa, M. californica*	0.50	0.337
Giant spined star	*Pisaster giganteus*	1.42	0.260
Warty sea cucumber	*Parastichopus parvimensis*	0.08	0.083
Kellet's whelk	*Kelletia kelletii*	1.08	0.609
Giant keyhole limpet	*Megathura crenulata*	0.75	0.279
Large anemone	*Anthopleura spp., Metridium spp., Urticina spp.*	0.00	0.000
Chestnut cowry	*Cyoraes soadicea*	1.17	0.458
Rock scallop	*Crassedoma giganteum*	0.00	0.000
Red gorgonian	*Leophogorgia chilensis*	0.00	0.000
CA spiny lobster	*Panulirus interruptus*	0.92	0.398
Short spined sea star	*Pisaster brevispinus*	0.00	0.000
Sunflower/sun star	*Pycnopodia helianthoides, Solaster stimpsoni/dawsoni*	0.00	0.000
CA sea cucumber	*Parastichopus californicus*	0.00	0.000
Sheep/masking crab	*Loxorhynchus grandis, L. crispatus*	0.17	0.112
Green abalone	*Haliotis fulgens*	0.08	0.083
Pink abalone	*Haliotis corrugata*	0.25	0.131
Red abalone	*Haliotis rufescens*	0.00	0.000

Fish Densities (60m^2) at Salt Creek (2012)

Common name	Scientific name	Mean Density	Std Error
Blacksmith	*Chromis punctipinnis*	0.97	0.972
Senorita	*Oxyjulis californica*	0.75	0.234
Kelp bass	*Paralabrax clathratus*	1.53	0.415
Garibaldi	*Hypsypops rubicundus*	1.14	0.219
California Sheephead	*Semicossyphus pulcher*	1.39	0.319
Black perch	*Embiotoca jacksoni*	1.36	0.240
Rainbow perch	*Hypsurus caryi*	0.31	0.137
Pile perch	*Rhacochilus vacca*	0.08	0.047
Striped perch	*Embiotoca lateralis*	0.06	0.056
Rubberlip perch	*Rhacochilus toxotes*	0.03	0.028
Rock wrasse	*Halichoeres semicinctus*	0.22	0.081
Opaleye	*Girella nigricans*	0.31	0.104
Barred sand bass	*Paralabrax nebulifer*	0.36	0.127
Sargo	*Anisotermus davidsoni*	0.06	0.056
Young of the year rockfish	*Sebastes spp.*	0.00	0.000
Kelp rockfish	*Sebastes atrovirens*	0.00	0.000
Blue rockfish	*Sebastes mystinus*	0.00	0.000
Yellowtail/olive rockfish	*Sebastes flavidus/serranoides*	0.00	0.000
Treefish	*Sebastes serriceps*	0.03	0.028
Black and yellow rockfish	*Sebastes chrysomelas*	0.00	0.000
Gopher rockfish	*Sebastes carnatus*	0.00	0.000
Brown rockfish	*Sebastes auriculatus*	0.00	0.000
Copper rockfish	*Sebastes caurinus*	0.00	0.000
Rock greenling	*Hexagrammos lagocephalus*	0.00	0.000
Horn shark	*Heterodontus francisci*	0.11	0.066
Cabezon	*Scorpaenichthys marmoratus*	0.00	0.000
Lingcod	*Ophiodon elongatus*	0.00	0.000
Kelp greenling	*Hexagrammos decagrammus*	0.00	0.000

Lion's Head, located near Two Harbors on Catalina Island, was established as a Reef Check site in 2008. This site is part of the Arrow Point to Lion's Head SMCA. Due to the sloping nature of the island, and similar to other Catalina Reef Check sites, survey depths range from 11 feet to 57 feet, although the average survey depth is 6.7 meters. The substrate consists primarily of boulders with a relief of 10 cm to 1 m and is either bare or is covered in crustose coralline algae. Giant kelp is the dominant macroalgae. The five most common invertebrates are wavy/red turban snails, crowned urchins, California spiny lobsters, Kellet's whelks and purple urchins. Blacksmith and kelp bass are very common and garibaldi, senorita and opaleye are also present.

Physical Characteristics and Primary Substrate Cover at Lion's Head (2011-2012)

Average depth	6.67 meters

Substrate type	Percentage		Substrate Cover	Percentage
Bedrock	15%		Articulated coralline	5.83%
Boulders	48.33%		Brown seaweed	10%
Cobble	18.33%		Crustose coralline	39.17%
Sand	18.06%		Green seaweed	0.28%
			Mobile invertebrates	3.89%
Relief	**Percentage**		None	27.22%
0-10cm	15.56%		Other brown seaweed	8.06%
10 cm-1meter	66.11%		Red seaweed	0.28%
1-2meter	17.78%		Seagrasses	0.28%
>2 meters	0.56%		Sessile invertebrates	5%

Algae densities (60m^2) at Lion's Head (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Giant kelp	*Macrocystis pyrifera*	51.44	10.359
Giant kelp Stipes	*Macrocystis pyrifera*	270.96	40.718
Laminaria spp	*Laminaria farlowii, L. setchelii*	0.00	0.000
Pterygophora	*Pterygophora californica*	0.00	0.000
Southern sea palm	*Eisenia arboea*	0.25	0.179

Invertebrate densities (60m^2) at Lion's Head (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Purple urchin	*Strongylocentrotus purpuratus*	2.25	0.730
Red urchin	*Strongylocentrotus franciscanus*	1.08	0.543
Bat star	*Patiria miniata*	0.58	0.313
Wavy/red turban snail	*Lithopoma undosum*	52.92	29.796
Crowned urchin	*Centrostephanus coronatus*	32.66	8.052
Brown/golden gorgonian	*Muricea fruticosa, M. californica*		
Giant spined star	*Pisaster giganteus*	1.50	0.529
Warty sea cucumber	*Parastichopus parvimensis*	1.25	0.818
Kellet's whelk	*Kelletia kelletii*	3.50	2.388
Giant keyhole limpet	*Megathura crenulata*	0.17	0.112
Large anemone	*Anthopleura spp., Metridium spp., Urticina spp.*	0.08	0.083
Chestnut cowry	*Cyoraes soadicea*	0.25	0.179
Rock scallop	*Crassedoma giganteum*	0.08	0.083
Red gorgonian	*Leophogorgia chilensis*	0.08	0.083
CA spiny lobster	*Panulirus interruptus*	2.00	0.718
Short spined sea star	*Pisaster brevispinus*	0.00	0.000
Sunflower/sun star	*Pycnopodia helianthoides, Solaster stimpsoni/dawsoni*	0.00	0.000
CA sea cucumber	*Parastichopus californicus*	0.00	0.000
Sheep/masking crab	*Loxorhynchus grandis, L. crispatus*	0.00	0.000
Green abalone	*Haliotis fulgens*	1.42	0.529
Pink abalone	*Haliotis corrugata*	0.17	0.112
Red abalone	*Haliotis rufescens*	0.00	0.000

Fish Densities (60m^2) at Lion's Head (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Blacksmith	*Chromis punctipinnis*	58.83	13.493
Senorita	*Oxyjulis californica*	6.00	2.217
Kelp bass	*Paralabrax clathratus*	21.80	3.758
Garibaldi	*Hypsypops rubicundus*	7.69	0.881
California Sheephead	*Semicossyphus pulcher*	2.40	0.650
Black perch	*Embiotoca jacksoni*	0.09	0.063
Rainbow perch	*Hypsurus caryi*	0.00	0.000
Pile perch	*Rhacochilus vacca*	0.00	0.000
Striped perch	*Embiotoca lateralis*	0.09	0.048
Rubberlip perch	*Rhacochilus toxotes*	0.00	0.000
Rock wrasse	*Halichoeres semicinctus*	2.86	0.939
Opaleye	*Girella nigricans*	3.14	0.850
Barred sand bass	*Paralabrax nebulifer*	0.00	0.000
Sargo	*Anisotermus davidsoni*	0.17	0.126
Young of the year rockfish	*Sebastes spp.*	0.00	0.000
Kelp rockfish	*Sebastes atrovirens*	0.71	0.274
Blue rockfish	*Sebastes mystinus*	0.00	0.000
Yellowtail/olive rockfish	*Sebastes flavidus/serranoides*	0.03	0.029
Treefish	*Sebastes serriceps*	0.00	0.000
Black and yellow rockfish	*Sebastes chrysomelas*	0.00	0.000
Gopher rockfish	*Sebastes carnatus*	0.00	0.000
Brown rockfish	*Sebastes auriculatus*	0.00	0.000
Copper rockfish	*Sebastes caurinus*	0.00	0.000
Horn shark	*Heterodontus francisci*	0.06	0.040
Cabezon	*Scorpaenichthys marmoratus*	0.00	0.000
Lingcod	*Ophiodon elongatus*	0.00	0.000
Kelp greenling	*Hexagrammos decagrammus*	0.00	0.000

Bird Rock, located near Two Harbors at Catalina Island, was established as a Reef Check site in 2011 and is part of the Blue Cavern Onshore SMCA, implemented in 2012. Average depth of the site is 10 meters and the substrate is a mix of bedrock and cobble. Relief is primarily 10 cm to 1 meter and the substrate is bare or covered with crustose coralline algae or brown algal species. Giant kelp and Southern sea palm are the most prevalent macroalgae. Crowned urchins, wavy/red turban snails, purple urchins, Kellet's whelks and chestnut cowries are the dominant invertebrates. Senorita, kelp bass, blacksmith, garibaldi and California sheephead are the most common fish.

Physical Characteristics and Primary Substrate Cover at Bird Rock (2011-2012)

Average depth	9.65 meters

Substrate type	Percentage		Substrate Cover	Percentage
Bedrock	49.44%		Articulated coralline	8.06%
Boulders	12.5%		Brown seaweed	2.50%
Cobble	20.28%		Crustose coralline	38.61%
Sand	16.39%		Green seaweed	0.83%
			Mobile invertebrates	2.22%
Relief	**Percentage**		None	23.33%
0-10cm	30.56%		Other brown seaweed	9.44%
10 cm-1meter	54.17%		Red seaweed	9.72%
1-2meter	10.83%		Sessile invertebrates	5.28%
>2 meters	4.44%			

Algae densities (60m2) at Bird Rock (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Giant kelp	*Macrocystis pyrifera*	28.64	6.239
Giant kelp Stipes	*Macrocystis pyrifera*	182.43	22.711
Laminaria spp	*Laminaria farlowii, L. setchelii*	8.18	3.311
Pterygophora	*Pterygophora californica*	0.18	0.182
Southern sea palm	*Eisenia arboea*	18.83	5.121

Invertebrate densities (60m^2) at Bird Rock (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Purple urchin	*Strongylocentrotus purpuratus*	4.42	2.334
Red urchin	*Strongylocentrotus franciscanus*	0.83	0.613
Bat star	*Patiria miniata*	0.00	0.000
Wavy/red turban snail	*Lithopoma undosum*	10.42	2.420
Crowned urchin	*Centrostephanus coronatus*	37.90	15.222
Brown/golden gorgonian	*Muricea fruticosa, M. californica*	0.42	0.417
Giant spined star	*Pisaster giganteus*	0.58	0.193
Warty sea cucumber	*Parastichopus parvimensis*	0.75	0.392
Kellet's whelk	*Kelletia kelletii*	1.33	0.772
Giant keyhole limpet	*Megathura crenulata*	0.25	0.179
Large anemone	*Anthopleura spp., Metridium spp., Urticina spp.*	0.00	0.000
Chestnut cowry	*Cyoraes soadicea*	0.92	0.830
Rock scallop	*Crassedoma giganteum*	0.50	0.261
Red gorgonian	*Leophogorgia chilensis*	0.17	0.167
CA spiny lobster	*Panulirus interruptus*	0.17	0.167
Short spined sea star	*Pisaster brevispinus*	0.00	0.000
Sunflower/sun star	*Pycnopodia helianthoides, Solaster stimpsoni/dawsoni*	0.00	0.000
CA sea cucumber	*Parastichopus californicus*	0.00	0.000
Sheep/masking crab	*Loxorhynchus grandis, L. crispatus*	0.00	0.000
Green abalone	*Haliotis fulgens*	0.17	0.167
Pink abalone	*Haliotis corrugata*	0.83	0.575
Red abalone	*Haliotis rufescens*	0.00	0.000

Fish Densities (60m^2) at Bird Rock (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Blacksmith	*Chromis punctipinnis*	10.11	3.754
Senorita	*Oxyjulis californica*	42.97	6.792
Kelp bass	*Paralabrax clathratus*	16.69	2.503
Garibaldi	*Hypsypops rubicundus*	2.53	0.366
California Sheephead	*Semicossyphus pulcher*	2.28	0.585
Black perch	*Embiotoca jacksoni*	0.03	0.028
Rainbow perch	*Hypsurus caryi*	0.00	0.000
Pile perch	*Rhacochilus vacca*	0.11	0.066
Striped perch	*Embiotoca lateralis*	0.00	0.000
Rubberlip perch	*Rhacochilus toxotes*	0.00	0.000
Rock wrasse	*Halichoeres semicinctus*	2.11	1.333
Opaleye	*Girella nigricans*	1.94	0.505
Barred sand bass	*Paralabrax nebulifer*	0.17	0.167
Sargo	*Anisotermus davidsoni*	0.03	0.028
Young of the year rockfish	*Sebastes spp.*	0.53	0.474
Kelp rockfish	*Sebastes atrovirens*	0.11	0.087
Blue rockfish	*Sebastes mystinus*	0.00	0.000
Yellowtail/olive rockfish	*Sebastes flavidus/serranoides*	0.00	0.000
Treefish	*Sebastes serriceps*	0.03	0.028
Black and yellow rockfish	*Sebastes chrysomelas*	0.00	0.000
Gopher rockfish	*Sebastes carnatus*	0.00	0.000
Brown rockfish	*Sebastes auriculatus*	0.00	0.000
Copper rockfish	*Sebastes caurinus*	0.00	0.000
Horn shark	*Heterodontus francisci*	0.50	0.180
Cabezon	*Scorpaenichthys marmoratus*	0.03	0.028
Lingcod	*Ophiodon elongatus*	0.00	0.000
Kelp greenling	*Hexagrammos decagrammus*	0.00	0.000

Isthmus Reef is located on the west end of Catalina Island, near Two Harbors and was established as a Reef Check site in 2007. This is not a protected area, although it's adjacent to the Blue Caverns SMCA and is therefore used as a reference site for this MPA.   The site is a ridge of reef that rises to within 3-4 meters of the surface of the water. The substrate is dominated by bedrock with some boulders, a relief mostly between 10 cm to 1 m and is primarily covered with crustose coralline algae and brown algae species. Giant kelp and southern sea palm are the prevalent algal species. The five most common invertebrates are crowned urchins, purple urchins, red urchins, wavy/turban snails and giant spined sea stars. Senorita, kelp bass, blacksmith, garibaldi and sheephead are the most common fish.

Physical Characteristics and Primary Substrate Cover at Isthmus Reef (2011-2012)

Average depth	7.88 meters

Substrate type	Percentage
Bedrock	48.89%
Boulders	26.48%
Cobble	15%
Sand	8.52%

Relief	Percentage
0-10cm	8.70%
10 cm-1meter	70.37%
1-2meter	17.22%
>2 meters	3.70%

Substrate Cover	Percentage
Articulated coralline	5.37%
Brown seaweed	4.63%
Crustose coralline	39.44%
Green seaweed	1.67%
Mobile invertebrates	1.67%
None	14.26%
Other brown seaweed	19.26%
Red seaweed	6.48%
Sessile invertebrates	7.22%

Algae densities (60m^2) at Isthmus Reef (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Giant kelp	*Macrocystis pyrifera*	29.91	6.075
Giant kelp Stipes	*Macrocystis pyrifera*	194.11	38.544
Laminaria spp	*Laminaria farlowii, L. setchelii*	0.39	0.389
Pterygophora	*Pterygophora californica*	0.11	0.111
Southern sea palm	*Eisenia arboea*	4.17	1.169

Invertebrate densities (60m^2) at Isthmus Reef (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Purple urchin	*Strongylocentrotus purpuratus*	73.91	48.9768
Red urchin	*Strongylocentrotus franciscanus*	40.25	16.1317
Bat star	*Patiria miniata*	0.00	0.0000
Wavy/red turban snail	*Lithopoma undosum*	4.28	1.1794
Crowned urchin	*Centrostephanus coronatus*	86.46	17.3566
Brown/golden gorgonian	*Muricea fruticosa, M. californica*	0.39	0.1833
Giant spined star	*Pisaster giganteus*	3.17	0.6117
Warty sea cucumber	*Parastichopus parvimensis*	0.39	0.1432
Kellet's whelk	*Kelletia kelletii*	1.00	0.4573
Giant keyhole limpet	*Megathura crenulata*	0.11	0.0762
Large anemone	*Anthopleura spp., Metridium spp., Urticina spp.*	0.00	0.0000
Chestnut cowry	*Cyoraes soadicea*	0.44	0.1847
Rock scallop	*Crassedoma giganteum*	0.72	0.2532
Red gorgonian	*Leophogorgia chilensis*	0.17	0.1213
CA spiny lobster	*Panulirus interruptus*	0.06	0.0556
Short spined sea star	*Pisaster brevispinus*	0.00	0.0000
Sunflower/sun star	*Pycnopodia helianthoides, Solaster stimpsoni/dawsoni*	0.00	0.0000
CA sea cucumber	*Parastichopus californicus*	0.61	0.3889
Sheep/masking crab	*Loxorhynchus grandis, L. crispatus*	0.06	0.0556
Green abalone	*Haliotis fulgens*	0.22	0.1726
Pink abalone	*Haliotis corrugata*	0.33	0.1400
Red abalone	*Haliotis rufescens*	0.00	0.0000

Fish Densities (60m^2) at Isthmus Reef (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Blacksmith	*Chromis punctipinnis*	38.46	6.262
Senorita	*Oxyjulis californica*	22.44	3.380
Kelp bass	*Paralabrax clathratus*	10.74	1.454
Garibaldi	*Hypsypops rubicundus*	5.70	0.729
California Sheephead	*Semicossyphus pulcher*	2.65	0.339
Black perch	*Embiotoca jacksoni*	0.02	0.019
Rainbow perch	*Hypsurus caryi*	0.00	0.000
Pile perch	*Rhacochilus vacca*	0.09	0.066
Striped perch	*Embiotoca lateralis*	0.44	0.240
Rubberlip perch	*Rhacochilus toxotes*	0.02	0.019
Rock wrasse	*Halichoeres semicinctus*	2.00	0.400
Opaleye	*Girella nigricans*	0.91	0.470
Barred sand bass	*Paralabrax nebulifer*	0.06	0.056
Sargo	*Anisotermus davidsoni*	0.00	0.000
Young of the year rockfish	*Sebastes spp.*	1.31	0.759
Kelp rockfish	*Sebastes atrovirens*	0.15	0.097
Blue rockfish	*Sebastes mystinus*	0.00	0.000
Yellowtail/olive rockfish	*Sebastes flavidus/serranoides*	0.00	0.000
Treefish	*Sebastes serriceps*	0.06	0.041
Black and yellow rockfish	*Sebastes chrysomelas*	0.00	0.000
Gopher rockfish	*Sebastes carnatus*	0.04	0.037
Brown rockfish	*Sebastes auriculatus*	0.00	0.000
Copper rockfish	*Sebastes caurinus*	0.00	0.000
Horn shark	*Heterodontus francisci*	0.17	0.058
Cabezon	*Scorpaenichthys marmoratus*	0.04	0.026
Lingcod	*Ophiodon elongatus*	0.00	0.000
Kelp greenling	*Hexagrammos decagrammus*	0.00	0.000

WIES Intake Pipes was established as a Reef Check site in 2007 and is located at the Wrigley Institute for Environmental Science near the town of Two Harbors at Catalina Island. WIES Intake Pipes is part of the Blue Caverns SMCA, established in 2012. Due to the sloping nature of the island, and similar to other Catalina Reef Check sites, survey depths range from 11 feet to 60 feet, although the average survey depth is 10.52 meters. The substrate is a mix of bedrock, boulder and sand, the relief varies from 0 cm to 2 m and is bare or covered by crustose coralline algae or brown algae species. Southern sea palms and giant brown kelp are the most common macroalgae. Crowned urchins are very prevalent and warty sea cucumbers, purple urchins, brown/golden gorgonians and red gorgonians. Fish are plentiful here and blacksmith are abundant. Senorita, kelp bass, California sheephead and garibaldi are also common.

Physical Characteristics and Primary Substrate Cover at WIES Intake Pipes (2011-2012)

Average depth	10.52 meters		

Substrate type	Percentage	Substrate Cover	Percentage
Bedrock	32.50%	Articulated coralline	3.61%
Boulders	27.78%	Brown seaweed	8.06%
Cobble	14.17%	Crustose coralline	34.17%
Sand	25%	Green seaweed	0%
		Mobile invertebrates	0.83%
Relief	**Percentage**	None	35.56%
0-10cm	21.39%	Other brown seaweed	7.78%
10 cm-1meter	57.50%	Red seaweed	4.72%
1-2meter	20.56%	Sessile invertebrates	5.28%
>2 meters	0.56%		

Algae densities (60m^2) at WIES Intake Pipes (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Giant kelp	*Macrocystis pyrifera*	24.84	6.699
Giant kelp Stipes	*Macrocystis pyrifera*	192.91	33.819
Laminaria spp	*Laminaria farlowii, L. setchelii*	9.67	2.748
Pterygophora	*Pterygophora californica*	0.00	0.000
Southern sea palm	*Eisenia arboea*	25.83	4.507

Invertebrate densities (60m^2) at WIES Intake Pipes (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Purple urchin	*Strongylocentrotus purpuratus*	2.92	1.069
Red urchin	*Strongylocentrotus franciscanus*	0.09	0.091
Bat star	*Patiria miniata*	0.00	0.000
Wavy/red turban snail	*Lithopoma undosum*	0.64	0.364
Crowned urchin	*Centrostephanus coronatus*	21.04	5.732
Brown/golden gorgonian	*Muricea fruticosa, M. californica*	2.09	0.744
Giant spined star	*Pisaster giganteus*	0.18	0.122
Warty sea cucumber	*Parastichopus parvimensis*	9.67	1.978
Kellet's whelk	*Kelletia kelletii*	0.55	0.282
Giant keyhole limpet	*Megathura crenulata*	0.00	0.000
Large anemone	*Anthopleura spp., Metridium spp., Urticina spp.*	0.18	0.182
Chestnut cowry	*Cyoraes soadicea*	0.00	0.000
Rock scallop	*Crassedoma giganteum*	0.82	0.553
Red gorgonian	*Leophogorgia chilensis*	1.09	0.899
CA spiny lobster	*Panulirus interruptus*	0.67	0.432
Short spined sea star	*Pisaster brevispinus*	0.00	0.000
Sunflower/sun star	*Pycnopodia helianthoides, Solaster stimpsoni/dawsoni*	0.00	0.000
CA sea cucumber	*Parastichopus californicus*	0.00	0.000
Sheep/masking crab	*Loxorhynchus grandis, L. crispatus*	0.00	0.000
Green abalone	*Haliotis fulgens*	0.36	0.203
Pink abalone	*Haliotis corrugata*	0.45	0.247
Red abalone	*Haliotis rufescens*	0.00	0.000

Fish Densities (60m^2) at WIES Intake Pipes (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Blacksmith	*Chromis punctipinnis*	61.58	12.201
Senorita	*Oxyjulis californica*	34.75	6.340
Kelp bass	*Paralabrax clathratus*	18.03	2.330
Garibaldi	*Hypsypops rubicundus*	2.33	0.361
California Sheephead	*Semicossyphus pulcher*	6.92	0.750
Black perch	*Embiotoca jacksoni*	0.33	0.215
Rainbow perch	*Hypsurus caryi*	0.00	0.000
Pile perch	*Rhacochilus vacca*	0.00	0.000
Striped perch	*Embiotoca lateralis*	0.17	0.167
Rubberlip perch	*Rhacochilus toxotes*	0.06	0.056
Rock wrasse	*Halichoeres semicinctus*	1.97	0.606
Opaleye	*Girella nigricans*	1.81	0.663
Barred sand bass	*Paralabrax nebulifer*	0.06	0.056
Sargo	*Anisotermus davidsoni*	0.11	0.066
Young of the year rockfish	*Sebastes spp.*	0.92	0.605
Kelp rockfish	*Sebastes atrovirens*	0.08	0.047
Blue rockfish	*Sebastes mystinus*	0.00	0.000
Yellowtail/olive rockfish	*Sebastes flavidus/serranoides*	0.06	0.056
Treefish	*Sebastes serriceps*	0.03	0.028
Black and yellow rockfish	*Sebastes chrysomelas*	0.00	0.000
Gopher rockfish	*Sebastes carnatus*	0.00	0.000
Brown rockfish	*Sebastes auriculatus*	0.08	0.061
Copper rockfish	*Sebastes caurinus*	0.00	0.000
Horn shark	*Heterodontus francisci*	0.03	0.028
Cabezon	*Scorpaenichthys marmoratus*	0.03	0.028
Lingcod	*Ophiodon elongatus*	0.00	0.000
Kelp greenling	*Hexagrammos decagrammus*	0.00	0.000

Long Point West, established as a Reef Check site in 2010, became part of the Long Point SMR in 2012. Long Point West is located on Catalina on the leeward side and at the widest point of the island. It's on the western side of the point and tidal currents here can be strong. Due to the sloping nature of the island, and similar to other Catalina Reef Check sites, survey depths range from 11 feet to 60 feet, although the average survey depth is 10.6 meters. The substrate is a mix of cobble, sand and bedrock, relief is primarily 10 cm to 1 m and is mostly bare or covered with brown algae or sessile invertebrates. Giant kelp is the most prevalent macroalgae and some laminaria is present. Crowned urchins and wavy/red turban snails are the most common invertebrates, but California spiny lobsters, warty sea cucumbers and Kellet's whelks are also present. Blacksmith, senorita, garibaldi, kelp bass and sheephead are the most common fish.

Physical Characteristics and Primary Substrate Cover at Long Point West (2012)

Average depth	10.06 meters

Substrate type	Percentage		Substrate Cover	Percentage
Bedrock	20%		Articulated coralline	2.78%
Boulders	15%		Brown seaweed	3.33%
Cobble	39.44%		Crustose coralline	30%
Sand	25%		Green seaweed	0.56%
			Mobile invertebrates	3.33%
Relief	**Percentage**		None	32.78%
0-10cm	23.89%		Other brown seaweed	17.78%
10 cm-1meter	62.22%		Red seaweed	3.33%
1-2meter	10.56%		Sessile invertebrates	6.11%
>2 meters	3.33%			

Algae densities (60m2) at Long Point West (2012)

Common name	Scientific name	Mean Density	Std Error
Giant kelp	*Macrocystis pyrifera*	14.17	5.108
Giant kelp Stipes	*Macrocystis pyrifera*	73.83	28.991
Laminaria spp	*Laminaria farlowii, L. setchelii*	6.17	3.619
Pterygophora	*Pterygophora californica*	0.00	0.000
Southern sea palm	*Eisenia arboea*	0.17	0.167

Invertebrate densities (60m^2) at Long Point West (2012)

Common name	Scientific name	Mean Density	Std Error
Purple urchin	*Strongylocentrotus purpuratus*	0.33	0.211
Red urchin	*Strongylocentrotus franciscanus*	0.00	0.000
Bat star	*Patiria miniata*	0.00	0.000
Wavy/red turban snail	*Lithopoma undosum*	6.33	2.076
Crowned urchin	*Centrostephanus coronatus*	25.17	13.727
Brown/golden gorgonian	*Muricea fruticosa, M. californica*	0.17	0.167
Giant spined star	*Pisaster giganteus*	0.50	0.224
Warty sea cucumber	*Parastichopus parvimensis*	0.83	0.477
Kellet's whelk	*Kelletia kelletii*	0.83	0.307
Giant keyhole limpet	*Megathura crenulata*	0.00	0.000
Large anemone	*Anthopleura spp., Metridium spp., Urticina spp.*	0.17	0.167
Chestnut cowry	*Cyoraes soadicea*	0.50	0.342
Rock scallop	*Crassedoma giganteum*	0.50	0.342
Red gorgonian	*Leophogorgia chilensis*	0.83	0.401
CA spiny lobster	*Panulirus interruptus*	1.50	1.310
Short spined sea star	*Pisaster brevispinus*	0.00	0.000
Sunflower/sun star	*Pycnopodia helianthoides, Solaster stimpsoni/dawsoni*	0.00	0.000
CA sea cucumber	*Parastichopus californicus*	0.00	0.000
Sheep/masking crab	*Loxorhynchus grandis, L. crispatus*	0.00	0.000
Green abalone	*Haliotis fulgens*	0.17	0.167
Pink abalone	*Haliotis corrugata*	0.00	0.000
Red abalone	*Haliotis rufescens*	0.00	0.000

Fish Densities (60m^2) at Long Point West (2012)

Common name	Scientific name	Mean Density	Std Error
Blacksmith	*Chromis punctipinnis*	17.59	4.642
Senorita	*Oxyjulis californica*	8.41	2.037
Kelp bass	*Paralabrax clathratus*	2.65	0.549
Garibaldi	*Hypsypops rubicundus*	3.35	1.014
California Sheephead	*Semicossyphus pulcher*	2.53	0.501
Black perch	*Embiotoca jacksoni*	0.00	0.000
Rainbow perch	*Hypsurus caryi*	0.00	0.000
Pile perch	*Rhacochilus vacca*	0.00	0.000
Striped perch	*Embiotoca lateralis*	0.00	0.000
Rubberlip perch	*Rhacochilus toxotes*	0.12	0.081
Rock wrasse	*Halichoeres semicinctus*	0.88	0.296
Opaleye	*Girella nigricans*	0.76	0.304
Barred sand bass	*Paralabrax nebulifer*	0.00	0.000
Sargo	*Anisotermus davidsoni*	0.00	0.000
Young of the year rockfish	*Sebastes spp.*	0.18	0.176
Kelp rockfish	*Sebastes atrovirens*	0.00	0.000
Blue rockfish	*Sebastes mystinus*	0.00	0.000
Yellowtail/olive rockfish	*Sebastes flavidus/serranoides*	0.00	0.000
Treefish	*Sebastes serriceps*	0.00	0.000
Black and yellow rockfish	*Sebastes chrysomelas*	0.00	0.000
Gopher rockfish	*Sebastes carnatus*	0.00	0.000
Brown rockfish	*Sebastes auriculatus*	0.00	0.000
Copper rockfish	*Sebastes caurinus*	0.00	0.000
Horn shark	*Heterodontus francisci*	0.06	0.059
Cabezon	*Scorpaenichthys marmoratus*	0.00	0.000
Lingcod	*Ophiodon elongatus*	0.00	0.000
Kelp greenling	*Hexagrammos decagrammus*	0.00	0.000

Torqua, located on the leeward side of Catalina Island between Avalon and Long Point, was established as a Reef Check site in 2008. This site is not protected as an MPA and it is a reference site for Casino Point SMCA. Due to the sloping nature of the island, and similar to other Catalina Reef Check sites, survey depths range from 12 feet to 55 feet, although the average survey depth is 9.8 meters. The bottom structure primarily consists of large rocks piled on top of each other, creating a matrix of holes in which fish and invertebrates accumulate. The substrate is mostly boulder with some cobble and bedrock and the relief is mostly 10 cm to 1 meter. Kelp and laminaria are the dominant macroalgae. Crowned urchins are the most common invertebrates and warty sea cucumbers, wavy/red turban snails, California spiny lobsters and giant spined sea stars are also present. Blacksmith, kelp bass, garibaldi, California sheephead and senorita are the fish species most often recorded on surveys. Like most Reef Check sites in Los Angeles County and Orange County, garibaldi are common here.

Physical Characteristics and Primary Substrate Cover at Torqua (2011-2012)

Average depth	9.78 meters

Substrate type	Percentage		Substrate Cover	Percentage
Bedrock	14.58%		Articulated coralline	0.70%
Boulders	57.50%		Brown seaweed	5.70%
Cobble	16.67%		Crustose coralline	41.86%
Sand	10.97%		Green seaweed	0%
			Mobile invertebrates	0.28%
Relief	**Percentage**		None	17.25%
0-10cm	12.08%		Other brown seaweed	23.50%
10 cm-1meter	77.08%		Red seaweed	3.48%
1-2meter	10.83%		Sessile invertebrates	7.23%
>2 meters	0%			

Algae densities (60m^2) at Torqua (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Giant kelp	*Macrocystis pyrifera*	19.75	2.002
Giant kelp Stipes	*Macrocystis pyrifera*	133.96	9.483
Laminaria spp	*Laminaria farlowii, L. setchelii*	8.75	3.875
Pterygophora	*Pterygophora californica*	0.00	0.000
Southern sea palm	*Eisenia arboea*	0.71	0.359

Invertebrate densities (60m^2) at Torqua (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Purple urchin	*Strongylocentrotus purpuratus*	0.13	0.092
Red urchin	*Strongylocentrotus franciscanus*	0.42	0.216
Bat star	*Patiria miniata*	0.00	0.000
Wavy/red turban snail	*Lithopoma undosum*	3.17	0.570
Crowned urchin	*Centrostephanus coronatus*	56.55	8.697
Brown/golden gorgonian	*Muricea fruticosa, M. californica*	0.25	0.124
Giant spined star	*Pisaster giganteus*	0.58	0.232
Warty sea cucumber	*Parastichopus parvimensis*	3.71	1.526
Kellet's whelk	*Kelletia kelletii*	0.21	0.104
Giant keyhole limpet	*Megathura crenulata*	0.50	0.159
Large anemone	*Anthopleura spp., Metridium spp., Urticina spp.*	0.00	0.000
Chestnut cowry	*Cyoraes soadicea*	0.04	0.042
Rock scallop	*Crassedoma giganteum*	0.29	0.095
Red gorgonian	*Leophogorgia chilensis*	0.13	0.092
CA spiny lobster	*Panulirus interruptus*	2.21	1.164
Short spined sea star	*Pisaster brevispinus*	0.08	0.083
Sunflower/sun star	*Pycnopodia helianthoides, Solaster stimpsoni/dawsoni*	0.00	0.000
CA sea cucumber	*Parastichopus californicus*	0.38	0.275
Sheep/masking crab	*Loxorhynchus grandis, L. crispatus*	0.04	0.042
Green abalone	*Haliotis fulgens*	0.04	0.042
Pink abalone	*Haliotis corrugata*	0.04	0.042
Red abalone	*Haliotis rufescens*	0.00	0.000

Fish Densities (60m^2) at Torqua (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Blacksmith	*Chromis punctipinnis*	33.79	4.246
Senorita	*Oxyjulis californica*	2.46	0.688
Kelp bass	*Paralabrax clathratus*	7.78	0.567
Garibaldi	*Hypsypops rubicundus*	5.68	0.479
California Sheephead	*Semicossyphus pulcher*	3.25	0.442
Black perch	*Embiotoca jacksoni*	0.38	0.126
Rainbow perch	*Hypsurus caryi*	0.00	0.000
Pile perch	*Rhacochilus vacca*	0.14	0.072
Striped perch	*Embiotoca lateralis*	0.46	0.417
Rubberlip perch	*Rhacochilus toxotes*	0.07	0.046
Rock wrasse	*Halichoeres semicinctus*	0.85	0.167
Opaleye	*Girella nigricans*	0.56	0.122
Barred sand bass	*Paralabrax nebulifer*	0.00	0.000
Sargo	*Anisotermus davidsoni*	0.18	0.124
Young of the year rockfish	*Sebastes spp.*	0.04	0.026
Kelp rockfish	*Sebastes atrovirens*	0.32	0.112
Blue rockfish	*Sebastes mystinus*	0.00	0.000
Yellowtail/olive rockfish	*Sebastes flavidus/serranoides*	0.00	0.000
Treefish	*Sebastes serriceps*	0.22	0.069
Black and yellow rockfish	*Sebastes chrysomelas*	0.00	0.000
Gopher rockfish	*Sebastes carnatus*	0.01	0.014
Brown rockfish	*Sebastes auriculatus*	0.06	0.056
Copper rockfish	*Sebastes caurinus*	0.06	0.056
Horn shark	*Heterodontus francisci*	0.03	0.020
Cabezon	*Scorpaenichthys marmoratus*	0.00	0.000
Lingcod	*Ophiodon elongatus*	0.00	0.000
Kelp greenling	*Hexagrammos decagrammus*	0.00	0.000

Casino Point, located near the town of Avalon on Catalina Island, was established as a Reef Check site in 2006. Casino Point became part of the Casino Point SMCA in 2012, but it had been treated as a de facto MPA since 1964. Due to the sloping nature of the island, and similar to other Catalina Reef Check sites, survey depths range from 16 feet to 60 feet, although the average survey depth is 11.75 meters. The substrate is primarily cobble and bedrock, but also has a fair amount of boulders and sand. Relief is mostly 10 cm to 1 m, but there are also portions of 1m to 2 m. The substrate is bare or covered by crustose coralline algae or brown algal species. Giant brown kelp and laminaria are prevalent and most common invertebrates are crowned urchins, wavy/red turban snails, warty sea cucumbers, brown/golden gorgonians and red urchins. Blacksmith are dominant fish, but kelp bass, senorita, California sheephead and rock wrasse are also present.

Physical Characteristics and Primary Substrate Cover at Casino Point (2011-2012)

Average depth	11.75 meters

Substrate type	Percentage		Substrate Cover	Percentage
Bedrock	34.58%		Articulated coralline	3.61%
Boulders	13.19%		Brown seaweed	2.50%
Cobble	37.78%		Crustose coralline	22.78%
Sand	13.61%		Green seaweed	0.28%
			Mobile invertebrates	1.11%
Relief	**Percentage**		None	31.39%
0-10cm	2.08%		Other brown seaweed	20.28%
10 cm-1meter	82.08%		Red seaweed	9.72%
1-2meter	9.03%		Sessile invertebrates	8.33%
>2 meters	6.81%			

Algae densities (60m^2) at Casino Point (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Giant kelp	*Macrocystis pyrifera*	16.50	2.095
Giant kelp Stipes	*Macrocystis pyrifera*	142.71	15.496
Laminaria spp	*Laminaria farlowii, L. setchelii*	12.27	3.657
Pterygophora	*Pterygophora californica*	0.21	0.208
Southern sea palm	*Eisenia arboea*	3.29	1.597

Invertebrate densities (60m^2) at Casino Point (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Purple urchin	*Strongylocentrotus purpuratus*	0.38	0.132
Red urchin	*Strongylocentrotus franciscanus*	2.88	0.710
Bat star	*Patiria miniata*	0.00	0.000
Wavy/red turban snail	*Lithopoma undosum*	6.08	1.635
Crowned urchin	*Centrostephanus coronatus*	6.42	1.628
Brown/golden gorgonian	*Muricea fruticosa, M. californica*	2.96	0.731
Giant spined star	*Pisaster giganteus*	0.17	0.078
Warty sea cucumber	*Parastichopus parvimensis*	3.50	0.761
Kellet's whelk	*Kelletia kelletii*	1.08	0.288
Giant keyhole limpet	*Megathura crenulata*	0.00	0.000
Large anemone	*Anthopleura spp., Metridium spp., Urticina spp.*	0.04	0.042
Chestnut cowry	*Cyoraes soadicea*	0.04	0.042
Rock scallop	*Crassedoma giganteum*	0.33	0.187
Red gorgonian	*Leophogorgia chilensis*	0.67	0.354
CA spiny lobster	*Panulirus interruptus*	0.08	0.083
Short spined sea star	*Pisaster brevispinus*	0.00	0.000
Sunflower/sun star	*Pycnopodia helianthoides, Solaster stimpsoni/dawsoni*	0.00	0.000
CA sea cucumber	*Parastichopus californicus*	0.00	0.000
Sheep/masking crab	*Loxorhynchus grandis, L. crispatus*	0.00	0.000
Green abalone	*Haliotis fulgens*	0.04	0.042
Pink abalone	*Haliotis corrugata*	0.00	0.000
Red abalone	*Haliotis rufescens*	0.00	0.000

Fish Densities (60m^2) at Casino Point (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Blacksmith	*Chromis punctipinnis*	19.46	5.059
Senorita	*Oxyjulis californica*	4.88	0.948
Kelp bass	*Paralabrax clathratus*	8.78	0.815
Garibaldi	*Hypsypops rubicundus*	2.97	0.337
California Sheephead	*Semicossyphus pulcher*	3.51	0.365
Black perch	*Embiotoca jacksoni*	0.61	0.113
Rainbow perch	*Hypsurus caryi*	0.07	0.041
Pile perch	*Rhacochilus vacca*	0.10	0.097
Striped perch	*Embiotoca lateralis*	0.13	0.048
Rubberlip perch	*Rhacochilus toxotes*	0.07	0.036
Rock wrasse	*Halichoeres semicinctus*	3.13	0.350
Opaleye	*Girella nigricans*	0.19	0.065
Barred sand bass	*Paralabrax nebulifer*	0.03	0.020
Sargo	*Anisotermus davidsoni*	0.39	0.224
Young of the year rockfish	*Sebastes spp.*	0.07	0.050
Kelp rockfish	*Sebastes atrovirens*	0.14	0.050
Blue rockfish	*Sebastes mystinus*	0.01	0.014
Yellowtail/olive rockfish	*Sebastes flavidus/serranoides*	0.00	0.000
Treefish	*Sebastes serriceps*	0.07	0.030
Black and yellow rockfish	*Sebastes chrysomelas*	0.01	0.014
Gopher rockfish	*Sebastes carnatus*	0.00	0.000
Brown rockfish	*Sebastes auriculatus*	0.00	0.000
Copper rockfish	*Sebastes caurinus*	0.00	0.000
Horn shark	*Heterodontus francisci*	0.01	0.014
Cabezon	*Scorpaenichthys marmoratus*	0.00	0.000
Lingcod	*Ophiodon elongatus*	0.00	0.000
Kelp greenling	*Hexagrammos decagrammus*	0.00	0.000

La Jolla Cove, in San Diego, was established as a Reef Check site in 2007 and is part of the Matlahuayl State Marine Reserve, implemented January 1, 2012. However, La Jolla Cove was originally created as an ecological reserve by the City of San Diego in 1970. The bottom structure is predominantly a low-relief (10 cm to 1 meter) bedrock substrate. The bottom is typically bare or covered in articulated coralline algae or crustose coralline algae. Macroalgae is abundant, with primarily laminaria and pterygophora. Giant kelp and southern sea palm are also present in much lower densities. The most common invertebrates are red urchins, purple urchins, Kellet's whelk, California spiny lobster and giant spined stars. Blacksmith, kelp bass, California sheephead, rock wrasse and garibaldi are the fish most often recorded.

Physical Characteristics and Primary Substrate Cover at La Jolla Cove (2011-2012)

Average depth	11.02 meters

Substrate type	Percentage
Bedrock	82.16%
Boulders	1.18%
Cobble	7.45%
Sand	8.82%

Relief	Percentage
0-10cm	6.67%
10 cm-1meter	92.35%
1-2meter	0.98%
>2 meters	0%

Substrate Cover	Percentage
Articulated coralline	28.43%
Brown seaweed	4.12%
Crustose coralline	12.55%
Green seaweed	0%
Mobile invertebrates	0.59%
None	28.04%
Other brown seaweed	10%
Red seaweed	13.53%
Sessile invertebrates	2.75%

Algae densities (60m^2) at La Jolla Cove (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Giant kelp	*Macrocystis pyrifera*	2.83	0.872
Giant kelp Stipes	*Macrocystis pyrifera*	41.47	7.875
Laminaria spp	*Laminaria farlowii, L. setchelii*	57.41	8.075
Pterygophora	*Pterygophora californica*	29.01	8.132
Southern sea palm	*Eisenia arboea*	3.06	0.830

Invertebrate densities (60m^2) at La Jolla Cove (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Purple urchin	*Strongylocentrotus purpuratus*	6.83	2.271
Red urchin	*Strongylocentrotus franciscanus*	8.52	3.961
Bat star	*Patiria miniata*	0.00	0.000
Wavy/red turban snail	*Lithopoma undosum*	1.33	0.505
Crowned urchin	*Centrostephanus coronatus*	0.00	0.000
Brown/golden gorgonian	*Muricea fruticosa, M. californica*	0.83	0.500
Giant spined star	*Pisaster giganteus*	1.72	0.656
Warty sea cucumber	*Parastichopus parvimensis*	0.56	0.381
Kellet's whelk	*Kelletia kelletii*	4.17	2.277
Giant keyhole limpet	*Megathura crenulata*	0.56	0.145
Large anemone	*Anthopleura spp., Metridium spp., Urticina spp.*	0.00	0.000
Chestnut cowry	*Cyoraes soadicea*	0.39	0.164
Rock scallop	*Crassedoma giganteum*	0.22	0.222
Red gorgonian	*Leophogorgia chilensis*	0.00	0.000
CA spiny lobster	*Panulirus interruptus*	1.72	0.722
Short spined sea star	*Pisaster brevispinus*	0.00	0.000
Sunflower/sun star	*Pycnopodia helianthoides, Solaster stimpsoni/dawsoni*	0.00	0.000
CA sea cucumber	*Parastichopus californicus*	0.72	0.666
Sheep/masking crab	*Loxorhynchus grandis, L. crispatus*	0.06	0.056
Green abalone	*Haliotis fulgens*	0.06	0.056
Pink abalone	*Haliotis corrugata*	0.11	0.076
Red abalone	*Haliotis rufescens*	0.00	0.000

Fish Densities (60m^2) at La Jolla Cove (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Blacksmith	*Chromis punctipinnis*	7.94	1.457
Senorita	*Oxyjulis californica*	4.15	0.829
Kelp bass	*Paralabrax clathratus*	5.02	0.730
Garibaldi	*Hypsypops rubicundus*	2.06	0.431
California Sheephead	*Semicossyphus pulcher*	6.02	0.927
Black perch	*Embiotoca jacksoni*	0.69	0.129
Rainbow perch	*Hypsurus caryi*	0.67	0.557
Pile perch	*Rhacochilus vacca*		
Striped perch	*Embiotoca lateralis*	0.31	0.280
Rubberlip perch	*Rhacochilus toxotes*	0.24	0.154
Rock wrasse	*Halichoeres semicinctus*	5.63	0.907
Opaleye	*Girella nigricans*	0.44	0.156
Barred sand bass	*Paralabrax nebulifer*	0.02	0.019
Sargo	*Anisotermus davidsoni*	0.26	0.223
Young of the year rockfish	*Sebastes spp.*	0.00	0.000
Kelp rockfish	*Sebastes atrovirens*	0.00	0.000
Blue rockfish	*Sebastes mystinus*	0.00	0.000
Yellowtail/olive rockfish	*Sebastes flavidus/serranoides*	0.00	0.000
Treefish	*Sebastes serriceps*	0.00	0.000
Black and yellow rockfish	*Sebastes chrysomelas*	0.00	0.000
Gopher rockfish	*Sebastes carnatus*	0.00	0.000
Brown rockfish	*Sebastes auriculatus*	0.00	0.000
Copper rockfish	*Sebastes caurinus*	0.00	0.000
Horn shark	*Heterodontus francisci*	0.00	0.000
Cabezon	*Scorpaenichthys marmoratus*	0.00	0.000
Lingcod	*Ophiodon elongatus*	0.00	0.000
Kelp greenling	*Hexagrammos decagrammus*	0.00	0.000

Windansea is located in San Diego, near La Jolla, was established as a Reef Check site in 2011. This site is not in an MPA, although it is adjacent to the South La Jolla State Marine Reserve and therefore is used as a references site for this MPA. The average depth of the site is 12.73 meters. The substrate is dominated by bedrock with a small amount of sand, a relief primarily between 10 cm to 1 m and is mostly bare or covered by articulated coralline algae or crustose coralline algae. Laminaria and pterygophora are the prevalent algal species. The five most common invertebrates are red urchins, purple urchins, wavy/red turban snails, giant spined sea stars and California spiny lobster. Senorita, kelp bass, rainbow perch, striped perch and sheephead are the most common fish.

Physical Characteristics and Primary Substrate Cover at Windansea (2011-2012)

Average depth	12.73 meters

Substrate type	Percentage		Substrate Cover	Percentage
Bedrock	85.83%		Articulated coralline	23.33%
Boulders	2.22%		Brown seaweed	3.33%
Cobble	5.83%		Crustose coralline	15%
Sand	6.11%		Green seaweed	0%
			Mobile invertebrates	0%
Relief	**Percentage**		None	35.28%
0-10cm	2.22%		Other brown seaweed	3.06%
10 cm-1meter	97.78%		Red seaweed	15%
1-2meter	0%		Sessile invertebrates	5%
>2 meters	0%			

Algae densities (60m^2) at Windansea (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Giant kelp	*Macrocystis pyrifera*	4.08	0.811
Giant kelp Stipes	*Macrocystis pyrifera*	49.17	12.473
Laminaria spp	*Laminaria farlowii, L. setchelii*	54.96	10.765
Pterygophora	*Pterygophora californica*	27.60	4.341
Southern sea palm	*Eisenia arboea*	1.75	1.081

Invertebrate densities (60m^2) at Windansea (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Purple urchin	*Strongylocentrotus purpuratus*	5.58	1.893
Red urchin	*Strongylocentrotus franciscanus*	6.33	2.813
Bat star	*Patiria miniata*	0.00	0.000
Wavy/red turban snail	*Lithopoma undosum*	3.75	0.946
Crowned urchin	*Centrostephanus coronatus*	0.00	0.000
Brown/golden gorgonian	*Muricea fruticosa, M. californica*	0.00	0.000
Giant spined star	*Pisaster giganteus*	3.25	0.592
Warty sea cucumber	*Parastichopus parvimensis*	0.25	0.179
Kellet's whelk	*Kelletia kelletii*	0.92	0.379
Giant keyhole limpet	*Megathura crenulata*	0.17	0.112
Large anemone	*Anthopleura spp., Metridium spp., Urticina spp.*	0.00	0.000
Chestnut cowry	*Cyoraes soadicea*	0.25	0.250
Rock scallop	*Crassedoma giganteum*	0.00	0.000
Red gorgonian	*Leophogorgia chilensis*	0.00	0.000
CA spiny lobster	*Panulirus interruptus*	1.33	0.482
Short spined sea star	*Pisaster brevispinus*	0.08	0.083
Sunflower/sun star	*Pycnopodia helianthoides, Solaster stimpsoni/dawsoni*	0.00	0.000
CA sea cucumber	*Parastichopus californicus*	0.00	0.000
Sheep/masking crab	*Loxorhynchus grandis, L. crispatus*	0.08	0.083
Green abalone	*Haliotis fulgens*	0.00	0.000
Pink abalone	*Haliotis corrugata*	0.33	0.142
Red abalone	*Haliotis rufescens*	0.00	0.000

Fish Densities (60m^2) at Windansea (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Blacksmith	*Chromis punctipinnis*	0.28	0.278
Senorita	*Oxyjulis californica*	18.06	3.653
Kelp bass	*Paralabrax clathratus*	2.89	0.619
Garibaldi	*Hypsypops rubicundus*	0.19	0.104
California Sheephead	*Semicossyphus pulcher*	0.42	0.161
Black perch	*Embiotoca jacksoni*	0.39	0.121
Rainbow perch	*Hypsurus caryi*	1.17	0.471
Pile perch	*Rhacochilus vacca*	0.33	0.159
Striped perch	*Embiotoca lateralis*	0.56	0.556
Rubberlip perch	*Rhacochilus toxotes*	0.00	0.000
Rock wrasse	*Halichoeres semicinctus*	0.14	0.071
Opaleye	*Girella nigricans*	0.17	0.167
Barred sand bass	*Paralabrax nebulifer*	0.00	0.000
Sargo	*Anisotermus davidsoni*	0.00	0.000
Young of the year rockfish	*Sebastes spp.*	0.00	0.000
Kelp rockfish	*Sebastes atrovirens*	0.00	0.000
Blue rockfish	*Sebastes mystinus*	0.00	0.000
Yellowtail/olive rockfish	*Sebastes flavidus/serranoides*	0.00	0.000
Treefish	*Sebastes serriceps*	0.00	0.000
Black and yellow rockfish	*Sebastes chrysomelas*	0.00	0.000
Gopher rockfish	*Sebastes carnatus*	0.00	0.000
Brown rockfish	*Sebastes auriculatus*	0.00	0.000
Copper rockfish	*Sebastes caurinus*	0.00	0.000
Horn shark	*Heterodontus francisci*	0.00	0.000
Cabezon	*Scorpaenichthys marmoratus*	0.00	0.000
Lingcod	*Ophiodon elongatus*	0.00	0.000
Kelp greenling	*Hexagrammos decagrammus*	0.00	0.000

South La Jolla was established as a Reef Check site in 2011 and is part of the South La Jolla SMR, effective in 2012. Average depth of the site is 11.64 meters. The substrate is dominated by flat bedrock – relief is almost exclusively 10 cm to 1 m. Red algae, crustose coralline algae and articulated coralline algae cover the substrate. Pterygophora and giant kelp are the dominant macroalgae. The five most common invertebrates are wavy/red turban snails, purple urchins, California spiny lobsters, giant spined sea stars and red urchins. Senorita, blacksmith and kelp bass are common and rainbow perch and California sheephead are also present.

Physical Characteristics and Primary Substrate Cover at South La Jolla (2011-2012)

Average depth	11.64 meters

Substrate type	Percentage		Substrate Cover	Percentage
Bedrock	76.39%		Articulated coralline	18.33%
Boulders	8.33%		Brown seaweed	3.33%
Cobble	6.11%		Crustose coralline	19.72%
Sand	9.17%		Green seaweed	0.28%
			Mobile invertebrates	0.56%
Relief	**Percentage**		None	30%
0-10cm	0%		Other brown seaweed	4.17%
10 cm-1meter	99.72%		Red seaweed	21.11%
1-2meter	0.28%		Sessile invertebrates	2.50%
>2 meters	0%			

Algae densities (60m^2) at South La Jolla (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Giant kelp	*Macrocystis pyrifera*	2.42	1.190
Giant kelp Stipes	*Macrocystis pyrifera*	88.38	33.340
Laminaria spp	*Laminaria farlowii, L. setchelii*	66.54	15.759
Pterygophora	*Pterygophora californica*	96.57	17.255
Southern sea palm	*Eisenia arboea*	0.67	0.355

Invertebrate densities (60m^2) at South La Jolla (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Purple urchin	*Strongylocentrotus purpuratus*	2.25	1.262
Red urchin	*Strongylocentrotus franciscanus*	1.75	0.906
Bat star	*Patiria miniata*	0.00	0.000
Wavy/red turban snail	*Lithopoma undosum*	3.25	1.109
Crowned urchin	*Centrostephanus coronatus*	0.25	0.250
Brown/golden gorgonian	*Muricea fruticosa, M. californica*	0.00	0.000
Giant spined star	*Pisaster giganteus*	1.83	0.716
Warty sea cucumber	*Parastichopus parvimensis*	0.83	0.562
Kellet's whelk	*Kelletia kelletii*	0.50	0.289
Giant keyhole limpet	*Megathura crenulata*	0.42	0.193
Large anemone	*Anthopleura spp., Metridium spp., Urticina spp.*	0.00	0.000
Chestnut cowry	*Cyoraes soadicea*	0.17	0.112
Rock scallop	*Crassedoma giganteum*	0.00	0.000
Red gorgonian	*Leophogorgia chilensis*	0.00	0.000
CA spiny lobster	*Panulirus interruptus*	1.92	0.733
Short spined sea star	*Pisaster brevispinus*	0.08	0.083
Sunflower/sun star	*Pycnopodia helianthoides, Solaster stimpsoni/dawsoni*	0.00	0.000
CA sea cucumber	*Parastichopus californicus*	0.00	0.000
Sheep/masking crab	*Loxorhynchus grandis, L. crispatus*	0.00	0.000
Green abalone	*Haliotis fulgens*	0.08	0.083
Pink abalone	*Haliotis corrugata*	0.33	0.256
Red abalone	*Haliotis rufescens*	0.00	0.000

Fish Densities (60m^2) at South La Jolla (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Blacksmith	*Chromis punctipinnis*	3.17	1.409
Senorita	*Oxyjulis californica*	9.44	3.182
Kelp bass	*Paralabrax clathratus*	2.47	0.511
Garibaldi	*Hypsypops rubicundus*	0.22	0.090
California Sheephead	*Semicossyphus pulcher*	0.42	0.134
Black perch	*Embiotoca jacksoni*	0.22	0.081
Rainbow perch	*Hypsurus caryi*	0.78	0.517
Pile perch	*Rhacochilus vacca*	0.39	0.309
Striped perch	*Embiotoca lateralis*	0.17	0.116
Rubberlip perch	*Rhacochilus toxotes*	0.03	0.028
Rock wrasse	*Halichoeres semicinctus*	0.08	0.061
Opaleye	*Girella nigricans*	0.08	0.083
Barred sand bass	*Paralabrax nebulifer*	0.00	0.000
Sargo	*Anisotermus davidsoni*	0.03	0.028
Young of the year rockfish	*Sebastes spp.*	0.00	0.000
Kelp rockfish	*Sebastes atrovirens*	0.03	0.028
Blue rockfish	*Sebastes mystinus*	0.00	0.000
Yellowtail/olive rockfish	*Sebastes flavidus/serranoides*	0.00	0.000
Treefish	*Sebastes serriceps*	0.00	0.000
Black and yellow rockfish	*Sebastes chrysomelas*	0.00	0.000
Gopher rockfish	*Sebastes carnatus*	0.00	0.000
Brown rockfish	*Sebastes auriculatus*	0.00	0.000
Copper rockfish	*Sebastes caurinus*	0.00	0.000
Horn shark	*Heterodontus francisci*	0.00	0.000
Cabezon	*Scorpaenichthys marmoratus*	0.00	0.000
Lingcod	*Ophiodon elongatus*	0.00	0.000
Kelp greenling	*Hexagrammos decagrammus*	0.00	0.000

North Hill Street, located off Sunset Cliffs in San Diego, was established as a Reef Check site in 2007.   Like most San Diego area sites, depth ranges are relatively minimal and here they range from 29 feet to 49 feet. This site is part of a persistent large kelp bed in the Point Loma area, although the kelp tends to be in the deeper edges of this site. The substrate is bedrock and cobble, with no sand and relief is almost universally 10 cm to 1 m. The substrate is bare or covered with articulated coralline algae or crustose coralline algae. Laminaria and pterygophora are the most prevalent macroalgae. Purple urchins, red urchins, giant spined sea stars, wavy/red turban snails and pink abalone are the five most common invertebrates. Blacksmith, senorita, garibaldi, black perch and kelp bass are the most abundant fish.

Physical Characteristics and Primary Substrate Cover at North Hill Street (2011)

Average depth	10.4 meters

Substrate type	Percentage		Substrate Cover	Percentage
Bedrock	90%		Articulated coralline	36.67%
Boulders	1.67%		Brown seaweed	1.67%
Cobble	8.33%		crustose coralline	19.44%
Sand			Green seaweed	
			Mobile invertebrates	1.67%
Relief	**Percentage**		None	20.56%
0-10cm	2.78%		Other brown seaweed	3.33%
10 cm-1meter	97.22%		Red seaweed	14.44%
1-2meter	0%		Sessile invertebrates	2.22%
>2 meters	0%			

Algae densities (60m^2) at North Hill Street (2011)

Common name	Scientific name	Mean Density	Std Error
Giant kelp	*Macrocystis pyrifera*	0.33	0.211
Giant kelp Stipes	*Macrocystis pyrifera*	15.50	12.500
Laminaria spp	*Laminaria farlowii, L. setchelii*	103.51	20.649
Pterygophora	*Pterygophora californica*	63.72	3.196
Southern sea palm	*Eisenia arboea*	0.17	0.167

Invertebrate densities (60m^2) at North Hill Street (2011)

Common name	Scientific name	Mean Density	Std Error
Purple urchin	*Strongylocentrotus purpuratus*	9.83	6.750
Red urchin	*Strongylocentrotus franciscanus*	4.50	2.766
Bat star	*Patiria miniata*	0.00	0.000
Wavy/red turban snail	*Lithopoma undosum*	3.00	0.775
Crowned urchin	*Centrostephanus coronatus*	0.00	0.000
Brown/golden gorgonian	*Muricea fruticosa, M. californica*	0.00	0.000
Giant spined star	*Pisaster giganteus*	3.50	1.285
Warty sea cucumber	*Parastichopus parvimensis*	0.00	0.000
Kellet's whelk	*Kelletia kelletii*	0.50	0.342
Giant keyhole limpet	*Megathura crenulata*	0.67	0.333
Large anemone	*Anthopleura spp., Metridium spp., Urticina spp.*	0.00	0.000
Chestnut cowry	*Cyoraes soadicea*	0.17	0.167
Rock scallop	*Crassedoma giganteum*	0.00	0.000
Red gorgonian	*Leophogorgia chilensis*	0.00	0.000
CA spiny lobster	*Panulirus interruptus*	0.50	0.342
Short spined sea star	*Pisaster brevispinus*	0.00	0.000
Sunflower/sun star	*Pycnopodia helianthoides, Solaster stimpsoni/dawsoni*	0.00	0.000
CA sea cucumber	*Parastichopus californicus*	0.00	0.000
Sheep/masking crab	*Loxorhynchus grandis, L. crispatus*	0.00	0.000
Rock crab	*Cancer spp.*	0.00	0.000
Green abalone	*Haliotis fulgens*	0.00	0.000
Pink abalone	*Haliotis corrugata*	0.83	0.833
Red abalone	*Haliotis rufescens*	0.00	0.000

Fish Densities (60m^2) at North Hill Street (2011)

Common name	Scientific name	Mean Density	Std Error
Blacksmith	*Chromis punctipinnis*	3.88	1.387
Senorita	*Oxyjulis californica*	2.19	2.188
Kelp bass	*Paralabrax clathratus*	0.75	0.250
Garibaldi	*Hypsypops rubicundus*	1.19	0.458
California Sheephead	*Semicossyphus pulcher*	0.38	0.155
Black perch	*Embiotoca jacksoni*	0.88	0.340
Rainbow perch	*Hypsurus caryi*	0.00	0.000
Pile perch	*Rhacochilus vacca*	0.06	0.063
Striped perch	*Embiotoca lateralis*	0.00	0.000
Rubberlip perch	*Rhacochilus toxotes*	0.00	0.000
Rock wrasse	*Halichoeres semicinctus*	0.00	0.000
Opaleye	*Girella nigricans*	0.00	0.000
Barred sand bass	*Paralabrax nebulifer*	0.00	0.000
Sargo	*Anisotermus davidsoni*	0.00	0.000
Young of the year rockfish	*Sebastes spp.*	0.00	0.000
Kelp rockfish	*Sebastes atrovirens*	0.00	0.000
Blue rockfish	*Sebastes mystinus*	0.00	0.000
Yellowtail/olive rockfish	*Sebastes flavidus/serranoides*	0.00	0.000
Treefish	*Sebastes serriceps*	0.00	0.000
Black and yellow rockfish	*Sebastes chrysomelas*	0.00	0.000
Gopher rockfish	*Sebastes carnatus*	0.00	0.000
Brown rockfish	*Sebastes auriculatus*	0.00	0.000
Copper rockfish	*Sebastes caurinus*	0.00	0.000
Horn shark	*Heterodontus francisci*	0.00	0.000
Cabezon	*Scorpaenichthys marmoratus*	0.06	0.063
Lingcod	*Ophiodon elongatus*	0.00	0.000
Kelp greenling	*Hexagrammos decagrammus*	0.00	0.000

Broomtail Reef, located off Point Loma in San Diego County, was established as a Reef Check site in 2007. This tends to have a relatively flat terrain with some small cracks where invertebrates can accumulate as well as a few pinnacles that extend about 20 feet from the bottom. Average depth is 12 meters, substrate is primarily bedrock and relief is typically 10 cm to 1 meter. The substrate is mostly covered in crustose coralline algae, articulated coralline algae and red algae. Macroalgae present includes laminaria, pterygophora and Southern sea palm. Purple urchins are prevalent, as are red urchins, giant spined sea stars, giant keyhole limpets and wavy/red turban snails. Senorita, blacksmith, kelp bass, California sheephead and rainbow perch are the most common fish.

Physical Characteristics and Primary Substrate Cover at Broomtail Reef (2011-2012)

Average depth	11.88 meters

Substrate type	Percentage		Substrate Cover	Percentage
Bedrock	93.89%		Articulated coralline	21.67%
Boulders	1.67%		Brown seaweed	3.33%
Cobble	2.22%		Crustose coralline	25.83%
Sand	1.94%		Green seaweed	0.00%
			Mobile invertebrates	0.83%
Relief	**Percentage**		None	14.44%
0-10cm	19.72%		Other brown seaweed	2.22%
10 cm-1meter	78.10%		Red seaweed	19.17%
1-2meter	2.22%		Sessile invertebrates	12.50%
>2 meters				

Algae densities (60m^2) at Broomtail Reef (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Giant kelp	*Macrocystis pyrifera*	7.33	2.057
Giant kelp Stipes	*Macrocystis pyrifera*	132.08	42.984
Laminaria spp	*Laminaria farlowii, L. setchelii*	86.46	24.008
Pterygophora	*Pterygophora californica*	29.82	10.284
Southern sea palm	*Eisenia arboea*	17.11	10.224

Invertebrate densities (60m^2) at Broomtail Reef (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Purple urchin	*Strongylocentrotus purpuratus*	187.96	53.581
Red urchin	*Strongylocentrotus franciscanus*	8.83	2.584
Bat star	*Patiria miniata*		
Wavy/red turban snail	*Lithopoma undosum*	1.92	0.484
Crowned urchin	*Centrostephanus coronatus*	1.00	1.000
Brown/golden gorgonian	*Muricea fruticosa, M. californica*	0.33	0.188
Giant spined star	*Pisaster giganteus*	7.00	1.624
Warty sea cucumber	*Parastichopus parvimensis*	0.42	0.193
Kellet's whelk	*Kelletia kelletii*	1.17	0.842
Giant keyhole limpet	*Megathura crenulata*	2.58	0.657
Large anemone	*Anthopleura spp., Metridium spp., Urticina spp.*	0.00	0.000
Chestnut cowry	*Cyoraes soadicea*		0.000
Rock scallop	*Crassedoma giganteum*	0.17	0.112
Red gorgonian	*Leophogorgia chilensis*		0.000
CA spiny lobster	*Panulirus interruptus*	0.75	0.494
Short spined sea star	*Pisaster brevispinus*	0.00	0.000
Sunflower/sun star	*Pycnopodia helianthoides, Solaster stimpsoni/dawsoni*	0.00	0.000
CA sea cucumber	*Parastichopus californicus*	0.00	0.000
Sheep/masking crab	*Loxorhynchus grandis, L. crispatus*	0.00	0.000
Green abalone	*Haliotis fulgens*	0.00	0.000
Pink abalone	*Haliotis corrugata*	0.17	0.112
Red abalone	*Haliotis rufescens*	0.00	0.000

Fish Densities (60m^2) at Broomtail Reef (2011-2012)

Common name	Scientific name	Mean Density	Std Error
Blacksmith	*Chromis punctipinnis*	5.36	3.051
Senorita	*Oxyjulis californica*	17.78	6.576
Kelp bass	*Paralabrax clathratus*	2.94	0.530
Garibaldi	*Hypsypops rubicundus*	1.33	0.345
California Sheephead	*Semicossyphus pulcher*	2.75	0.613
Black perch	*Embiotoca jacksoni*	1.72	0.358
Rainbow perch	*Hypsurus caryi*	2.25	0.667
Pile perch	*Rhacochilus vacca*	0.33	0.149
Striped perch	*Embiotoca lateralis*	0.03	0.028
Rubberlip perch	*Rhacochilus toxotes*	0.33	0.113
Rock wrasse	*Halichoeres semicinctus*	0.53	0.129
Opaleye	*Girella nigricans*	0.19	0.143
Barred sand bass	*Paralabrax nebulifer*	0.00	0.000
Sargo	*Anisotermus davidsoni*	0.14	0.114
Young of the year rockfish	*Sebastes spp.*	0.19	0.194
Kelp rockfish	*Sebastes atrovirens*	0.56	0.312
Blue rockfish	*Sebastes mystinus*	0.00	0.000
Yellowtail/olive rockfish	*Sebastes flavidus/serranoides*	0.00	0.000
Treefish	*Sebastes serriceps*	0.03	0.028
Black and yellow rockfish	*Sebastes chrysomelas*	0.06	0.056
Gopher rockfish	*Sebastes carnatus*	0.06	0.039
Brown rockfish	*Sebastes auriculatus*	0.03	0.028
Copper rockfish	*Sebastes caurinus*	0.03	0.028
Horn shark	*Heterodontus francisci*	0.00	0.000
Cabezon	*Scorpaenichthys marmoratus*	0.03	0.028
Lingcod	*Ophiodon elongatus*	0.00	0.000
Kelp greenling	*Hexagrammos decagrammus*	0.00	0.000

Appendix E
Community clusters

Reef Check sites that were surveyed as part of the baseline monitoring project the SCSR and their assignment to different kelp forest communities based on a cluster analysis using a Bray-Curtis similarity coefficient. Data for the analysis was square root transformed and fish, invert and algae data were standardized in order to be analyzed together. Community similarities were determined at two levels. First, communities without any further significant community structure were identified sung the SIMPROF routine (SIMPROF cluster, alpha = 0.05). Second, sites were identified that showed 60% similarity in the cluster analysis (60% similarity cluster).

Site	Region	SIMPROF cluster	60% similarity cluster	MPA/Ref
IV Reef	Santa Barbara	a	a	MPA
Refugio State Beach	Santa Barbara	a	a	ref
La Jolla Cove	San Diego	c	c	MPA
South La Jolla	San Diego	c	c	MPA
North Hill Street	San Diego	c	c	ref
Windansea	San Diego	c	c	ref
Bird Rock	Catalina Island	d	d	MPA
Casino Point	Catalina Island	d	d	MPA
Lion's Head	Catalina Island	d	d	MPA
Long Point West	Catalina Island	d	d	MPA
WIES Intake Pipes	Catalina Island	d	d	MPA
Isthmus Reef	Catalina Island	d	d	ref
Torqua	Catalina Island	d	d	ref
Heisler Park	Orange	e	e	MPA
Crystal Cove	Orange	e	e	ref
Little Corona Del Mar	Orange	e	e	ref
Diver's Cove	Orange	f	e	MPA
Seal Rock	Orange	f	e	MPA
Shaw's Cove	Orange	f	e	MPA
Lechuza	Los Angeles	g	e	MPA
Big Rock	Los Angeles	g	e	ref
Broomtail Reef	San Diego	j	e	ref
Hawthorne Reef	Los Angeles	k	e	MPA
Christmas Tree Cove	Los Angeles	k	e	ref
120 Reef	Los Angeles	l	e	MPA
Abalone Cove	Los Angeles	l	e	MPA
Paradise Point	Los Angeles	l	e	MPA
White Point	Los Angeles	l	e	ref