Reef Check California Monitoring Protocol 2007

Craig S. Shuman
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Preface

This document summarizes the Reef Check California Monitoring Protocol and the rationale for its development. This document was written as a scientific document to facilitate effective peer review. A detailed training course has been developed to make the program accessible to a broad audience.

1 Introduction

California's nearshore waters host a unique and valuable marine ecosystem, considered to be one of the most productive ocean areas in the world (CDFG 2001). This productivity, coupled with 1000 miles of coastal scenic beauty, drives an ocean economy of approximately $43 billion, the largest in the United States (Kildow and Colgan 2005). The rapid growth of California's human population, together with technological advances in fishing and increases in non-consumptive recreation, has placed growing demands on California's nearshore coastal marine resources.

Charged with protecting these resources, the California State Legislature passed the Marine Life Management Act (MLMA) in 1998 and the Marine Life Protection Act (MLPA) in 1999. The MLMA established a new policy for managing marine fisheries to ensure conservation, sustainable use, and restoration of California's living marine resources, including the conservation of healthy and diverse marine ecosystems (MLMA, Fish and Game Code § 7050 *et seq*, CDFG 2001, Geever and Dart 2003). The MLPA mandated that the state design and manage an improved network of marine protected areas (MPAs) to protect marine life, habitats, ecosystems, and natural heritage (California Fish and Game Code § 2850 *et seq*). Accurate and consistent data describing California's nearshore marine ecosystems are critical to the successful implementation of the MLMA and MLPA, yet the California Department of Fish and Game (CDFG) has expressed concern over the lack of adequate funding for long-term monitoring, management and enforcement in new MPAs (Broddrick 2005).

There is a long history of marine monitoring in California and there are numerous ongoing monitoring efforts led by a combination of government, academic, private, and non-profit institutions -- including those using volunteers (Burcham 2004, Reed et al. 2002, San Diego Oceans Foundation 2005, www.reef.org). The largest and most comprehensive scientific sampling effort in California's nearshore waters was carried out in 2004 by the Cooperative Research and Assessment of Nearshore Ecosystems (CRANE) in combination with the Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO, www.piscoweb.org) and other partners. This sampling effort surveyed 68 sites between Monterey and San Diego including all of the Channel Islands. Despite the scale of this

project, no funding was provided for future data collection efforts (M. Bergen personal comm.). Consequently, there currently is no statewide standardized monitoring program specifically designed to investigate human impacts on California's nearshore ecosystems or to generate the ecological information required for successful management.

2 Background and Goals of the Reef Check California Monitoring Program

The primary objective of the Reef Check California monitoring program is to monitor the effects of human impacts on California's nearshore living marine resources because these are the impacts that can be controlled. Currently, both State and Federal government agencies invest heavily in marine management efforts. Without adequate monitoring, however, it is extremely difficult to determine the efficacy of management actions and the lack of available applied science often leads to insufficient information for decision-makers (Baird *et al.* 2005). When changes are detected, it is equally important to determine the scale of where the change takes place. To do this, it is necessary to use a standardized program over a large geographic area so that results can be compared among different areas.

The Reef Check Foundation has been using scientifically-trained volunteer teams to monitor tropical marine systems for almost ten years. Faced with financial shortages, state and international governments have turned to volunteer monitoring programs to help supplement other data collection efforts. Internationally, the Reef Check coral reef volunteer monitoring program (Hodgson *et al*. 2004) is active in over 80 countries and territories and governments in many of these countries including the Dominican Republic, the Philippines and China are using this volunteer monitoring program to help make management decisions and provide information about management results. In California, and across the nation, numerous volunteer water quality monitoring programs have been used to inform management and regulatory processes (Abramsom *et al*. 2000, US EPA 1997). In addition to providing high quality data, a valuable by-product of including stakeholders in training and implementing marine monitoring is the formation of a new, informed constituency that will support science-based ocean management. Furthermore, this strategy provides a channel for key stakeholders (*e.g.*, recreational divers, fishermen, ocean lovers) to communicate their intimate knowledge of local habitats to the regulatory process.

Shallow subtidal monitoring has been identified as the highest priority activity by CDFG in the Channel Islands to monitor the newly enacted marine reserve network (CDFG 2004). Effective implementation of the MLPA and MLMA requires that shallow subtidal monitoring be carried out along the entirety of California's coastline. Volunteer programs have been identified as a valuable tool to help meet this need (CDFG 2005).

The Reef Check California volunteer program will provide data on the status of key indicator species living in the nearshore, shallow water ecosystems. By employing a relatively rapid survey protocol, leveraged with man hours from volunteer teams, it will be possible to survey many sites each year. The monitoring results will thus fill geographic and temporal data gaps in existing broad-scale monitoring programs (such as PISCO) and

supplement data collection efforts by geographically-focused programs such as the Kelp Forest Monitoring program in the Channel Islands National Park (Davis *et al*. 1997).

3 Monitoring Program Overview

The Reef Check California protocol is intended as a human impact survey, not a detailed ecological survey, and has been designed to determine the status and trends of key ecosystem features akin to the 'vital signs' monitoring in the Channel Islands National Park (Davis 2005). Consequently, target organisms and methods have been selected to evaluate and monitor direct human impacts to the coastal marine environment resulting from fishing, pollution, global climate change and management activities. In order to maximize comparability with existing data sets and ongoing data collection efforts, the Reef Check California protocol has been designed to match CRANE and PISCO methods as closely as possible.

The Reef Check California monitoring program has been designed to assess how key biotic and abiotic characteristics of coastal rocky reef communities change over time -- including the abundance and relative age distribution of target species. This will permit the evaluation of population and community attributes at sites inside and outside of existing and proposed MPAs. It will also provide insight into and how different sites respond to newly imposed management measures. In addition, this monitoring will facilitate early diagnosis of abnormal changes and help identify their underlying causes.

When designing a monitoring protocol, it is important to match the scientific skills of the intended users with the scientific requirements of the program. By selecting a sub-set of key indicators and requiring rigorous training, testing, and certification, the Reef Check California monitoring protocol has been specifically designed to suit the State's management needs at a level that can effectively utilize the vast resources of volunteer divers.

A standard Reef Check California survey will include:

- Site Description (1 per site) Anecdotal, observational, historical, location, 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.

- Fish Transect (35 species, 18 transects surveyed in spring and fall – 6 core transects and 12 fish only transects) Divers search for and record the 32 target fish species observed along a transect 30 meters long, 2 meters wide and 2 meters high.

- Invertebrate Band Transect (31 species, 1 order (*Actiniaria* - anemones) 6 transects surveyed in spring and fall) Using the same six 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 Band Transect (8 species, 1 genus comprising several species, 6 fixed transects surveyed in spring and fall) Target algae species within the 2m band along the core transects as well as invasive species that are noted as present or absent anywhere on the site.

- Substrate Uniform Point Contact (UPC) (6 transects surveyed in spring and fall) The same core transects as the fish, invertebrate, and seaweed transects are used, but this time, points are sampled at each 1m 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) This survey is not associated with the transect but should occur in the immediate vicinity of the core transects.

3.1 Site Selection, Sampling Frequency, and Replication

The ultimate goal of Reef Check California is to monitor rocky subtidal communities twice per year at regular intervals along the entire mainland and island coasts. Initially, priority will be given to monitoring sites inside and outside of planned or existing MPAs, and at sites recommended by CDFG in Central California. Monitoring sites will be selected based on a variety of factors including, but not limited to, logistic feasibility, accessibility, and presence of volunteer teams.

Fish, invertebrate, algae and substrate data will be collected at a mixture of fixed (permanently marked) and non-fixed transects. Fixed transects will be used to detect change on a small area of the site, while non-fixed transects will be used to characterize a larger area of the site ecosystem.

At core sites, three replicate fixed 30-meter transects will be established in each of two habitat zones (offshore and inshore reef). Due to field logistics and safety, reef habitats deeper then 18 meters (~60') will not be sampled. Restrictive depth categorization will be avoided due to the diverse architecture of California's rocky reefs and logistical feasibility of sampling along fixed depth zones (Schroeder *et al*. 2002, J. Caselle Personal Comm.). Sites will be sampled twice per year -- once in spring/early summer and again in late summer/early fall.

Due to the variability inherent when surveying fish, teams will be required to complete 12 additional fish surveys (6 in each habitat zone) at each site during each sampling period. The fish surveys can be spread over several days as long as the duration does not exceed 6 weeks during each sampling period.

Random transects shall be stratified by habitat (outer reef and inner reef) and should be targeted for replication levels of 18 transects for fish (9 at each habitat zone) 6 transects for invertebrates (3 at each depth zone) and 6 transects for substrate (3 at each depth

zone). Random transects should not be placed in areas where they cover greater than 10 m of sand or where the depth varies by 3 m above or below the starting depth.

Where logistics and resources permit, some teams may adopt permanent transects. Permanent transects will be installed with assistance from Reef Check staff after approval from appropriate agencies. Subsequently, volunteer teams (dive clubs, etc.) will be encouraged to take 'ownership' of specific transects, thereby encouraging regular monitoring of each site.

3.2 Target Species

Due to specific goals and volunteer nature of the Reef Check California program, a set of target species was identified to be monitored. A thorough literature review was performed to determine a base list of species currently monitored and the rationale used to select the target species by the various existing sampling programs (Burcham 2004, CDFG 2004, Carr *et al*. 2003, Davis et al. 1997). In addition, the REEF volunteer database (www.reef.org) was examined to ascertain 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 then compiled based on the following criteria:

- Ease of identification
- 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

Following extensive field testing, the draft species list was revised and the Final Reef Check California species lists were created containing 31 species and 1 order of invertebrates, 35 fish species, 8 species and 1 genus of algae (Tables 1 – 3). As noted in Tables 2 and 3, size estimates will be made of all abalones and fishes will be recorded in size classes and differentiated as juveniles, males and females where appropriate. Size classes were chosen to distinguish between approximate life stages of target species (*e.g*., sexually mature). Juveniles rockfish will be identified when possible; otherwise, they will be lumped into a general juvenile rockfish category.

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

Table 1. Reef Check California seaweed species.

Common Name	Latin Name	Rationale
giant kelp*	*Macrocystis pyrifera*	**C, E, EI**
southern sea palm**	*Eisenia arborea*	**C, EI**
elkhorn kelp**	*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

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

Common Name	Latin 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 corrugata*	**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 *Actiniaria*	**C**

* Size estimated to nearest centimeter
** Must be taller than 10cm to be recorded (or 10cm width for anemones)
† Recorded if identified anywhere on site (on or off transect)
All organisms must be greater than 2.5cm to be counted

C = commonly observed, **E** = species exploited by recreational and commercial fishing, **EI** = ecologically important species (trophically important species), **SI** = species of interest or concern (protected, endangered, overfished, etc.)

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

Common Name	Latin 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*	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 rockfish*	*Sebastes flavidus / Sebastes serranoides*	<15, 15-30, >30	**E**
copper rockfish*	*Sebastes caurinus*	<15, 15-30, >30	**E**
vermillion rockfish and canary rockfish	*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/)

C = commonly observed, **E** = species exploited by recreational and commercial fishing, **EI** = ecologically important species (trophically important species), **SI** = species of interest or concern (protected, endangered, overfished, etc.)

3.3 Uniform Point Contact (UPC) Benthos Sampling

Sessile invertebrates and algae attached directly to the substrate will be sampled at 30 uniformly spaced points at every meter along each 30 meter transect line (no epiphytes, epizooids, or mobile organisms will be sampled). Three types of information will be collected at each point: 1) substrate type, 2) percent cover of space occupying organisms, and 3) substrate relief category. Substrate type will be recorded as:

- Sand/Silt/Clay (< 0.5 cm)
- Cobble (0.5 cm – 15 cm)
- Boulder (> 15 cm – 1 m diameter)
- Bedrock (> 1 m diameter)
- Other (shell debris etc.)

Percent cover of organisms will be estimated by recording what is directly under each 1 m point along the transect line. Five categories will be used to record percent cover of organisms on the substrate:

- None
- Brown Seaweed. Any type of the five large kelps that are surveyed on the band transect (giant kelp, bull kelp, elkhorn kelp, southern sea palm, and *Laminaria* spp.)
- Other Brown Seaweed. Any other types of brown seaweed including *Sargassum* spp. and *Cystoseira* spp.
- Green Algae.
- Red Algae. All non-coralline red species.
- Crustose coralline (only if nothing else above it)
- Sessile Invertebrates. Includes all sessile and mobile invertebrates that cannot be easily moved by the force of water from ones hand (includes sponges, anemones, bryozoans, gorgonians, urchins, etc.)

Non-fixed algae (kelp fronds) shall be moved when encountered to determine what is below. Mobile invertebrate (urchins, sea cucumbers, and seastars, etc.) will only be moved if the force of water from ones hand is sufficient to dislodge the organism, otherwise these species will be categaorized as Sessile Invertebrates.

Rugosity will be estimated by determining the greatest vertical relief that exists within a 1-meter wide section across the tape and 0.5-meter section along that tape. The measured section will extend 0.5 m in front of each point. Four categories will be used to record vertical relief estimates:

- 0 – 10 cm
- >10 cm – 1 m
- >1 m – 2 m
- > 2 m

3.4 Invertebrate Band Transect

The band transect is adapted from the PISCO and CRANE protocols described in Carr *et al.* (2003) and is based on a 30 m long by 2 m wide transect. The purpose of the band transect is to estimate the density of conspicuous, solitary and mobile invertebrates. Individual invertebrates are counted along the entire 30 m x 2 m transect. Flashlights should be used and cracks and crevices should be thoroughly searched and understory algae pushed aside during the search for indicator organisms. No organisms shall be moved for sampling. Species recorded within the swaths are listed in Table 2. Any indicator organism with any part of its body within 1 m of either side of the transect line shall be counted except for red and purple urchins less than 2.5 cm. Small urchins are not counted to maintain consistency with existing sampling programs. A maximum of 50 individuals of each species shall be recorded along each 30 x 2 m transect. If 50 individuals of a given species are recorded, counting of that species will cease and the distance along the transect recorded.

The swath sampling will be performed only by those divers who have demonstrated proficiency in invertebrate species identification and invertebrate band transect methodology and have passed the invertebrate sampling identification and field tests.

3.5 Seaweed Band Transect

The seaweed (macro algae) band transect uses the same 30 x 2 m transect as the invertebrate band transect. The purpose of the seaweed band transect is to measure the density of conspicuous macro algae. Individuals must be present on the transect and meet the minimum size requirements to be recorded as present on the transect. Giant kelp taller than 1meter falling within the 2 meter swath will be recorded as the number of stipes at 1 meter above the substrate per individual holdfast. In cases where stipes from multiple holdfasts are intertwined, the number of holdfasts will be recorded followed by a dash and the number of stipes. All other species must be a minimum of 30 cm to be recorded.

Four invasive species of algae (*Undaria pinnatifida, Caulerpa taxifolia, Sargassum Muticum, S. filicinum*) will also be recorded. These species, however, need not be present on the transect and are not counted, but recorded as present or absent in the study area.

The seaweed band transect will only be performed by divers who have demonstrated a proficiency in species identification and sampling methodology and have passed the seaweed sampling identification and field tests.

3.6 Fish Sampling

The purpose of the fish transects is to provide an estimate of fish density, relative size distribution/age structure and gender (if appropriate). Fish transect sampling will sample only conspicuous species that are found within a 30 x 2 x 2 m transect. Divers will be trained to swim at a constant speed (~3 - 5m/min) and count fish that occur in the survey zone directly in front of them to control for variable visibility conditions. Fish will be sized according to life history stages to generate an estimate of the age structure of the sampled population (Table 3). Divers will look in cracks and crevices, flashlights will be used on the fish transect. In addition, only those fish observed during the fish transect will

be recorded. A comments section will be included in all data sheets for off transect sightings of rare or interesting species. Unlike CRANE, only a bottom transect will be sampled, however, the feasibility of training volunteers to accurately and precisely sample mid-water and surface fish populations along the transect will be evaluated for possible future inclusion in the protocol.

Fish sampling will have a greater level of replication (12 additional transects) than the other surveys. This is because the 6 core transects assess a relatively small area of habitat (120 m^3 for each transect) limiting the likelihood of gathering data on rare species and limiting the representativeness of the subsample of habitats at the site.

Fish sampling will only be performed by divers who have demonstrated a proficiency in species identification, sampling methods and have passed the fish sampling identification and field tests.

3.7 Urchin Size Frequency Survey

Urchin sizing will be performed twice per year in sites with sufficient urchin densities. Unlike urchin counting along the band transect, individuals will be moved for sizing to ensure an accurate representation of urchins from the population is measured. It is very important that all individual urchins are represented in proportion to their abundance so care must be given to size all urchins in a given area. Urchin sizing is not restricted to the transect area, but should be performed in close proximity to the permanent transect location. Urchin test size, not spine width, will be measured to the nearest centimeter. A total of 100 individuals of each red and purple urchins shall be measured. Crowned urchins will not be measured.

4 Diver Training

To ensure the protocol is consistently applied by multiple divers and individual divers over time a comprehensive diver training and testing program will be the cornerstone of the Reef Check California program. While anyone may participate in Reef Check California training programs, only divers with an established record of diving and who have completed the training and demonstrated proficiency in survey methods and species identification will be eligible to contribute data to the database.

Diver requirements include:

- minimum of 30 logged lifetime dives, 15 of which must be in temperate waters below 68° F
- minimum of 6 dives within previous 12 months
- Completion of written and field tests on safety, buoyancy, survey methods, invertebrate and fish taxonomy, substrate sampling, fish sizing and quality assurance

Data will only be accepted from divers who complete the required training and testing and have demonstrated proficiency in data collection activities. A tiered approach will enable volunteers with differing abilities to participate in the program without adversely affecting

sampling accuracy and precision. Training materials, activities and duration will be based on current scientific (Syms and Caselle 2003) and volunteer training programs (Hill 2005). Training will consist of classroom training focusing on general ecology of target species, species identification, biological sampling theory, and specific sampling techniques. One pool dive will be required to ensure proficiency with sampling methods and diving competency and a minimum of 6 training dives in the field (or equivalent experience) and successful completion of a proficiency exam will be required to attain certification at each level. A one-day annual training workshop will be required of all divers to maintain their accreditation.

5 Scientific Review and Field Testing

A panel of scientific, agency, and recreational diving experts was convened to review the draft protocol to ensure the sampling design, methods, and species list were scientifically sound and appropriate for volunteers. Extensive field testing was employed to evaluate the feasibility of the monitoring program and assess the ability of volunteer divers to implement the protocol in a variety of different locations and conditions. Field testing occurred in Monterey, San Luis Obispo, Santa Cruz Island, Santa Barbara, Palos Verdes, and Santa Catalina Island and employed over 20 divers encompassing a range of diving and research abilities. In addition to protocol modifications, field testing was used to help evaluate what level of training and testing will be required of volunteer divers. Following field testing and scientific review, the program was reevaluated to determine how best to be implemented in its final form.

List of reviewers:

Dr. Richard Ambrose	UCLA-Director Environmental Science and Engineering Program
Mike Anghera	UCLA Dive Safety Officer
Dr. Mary Bergen	CA Dept. of Fish and Game- Marine Region Environmental Scientist
Dirk Burcham	California Coastkeeper Alliance- Catalina Conservancy Divers
Dr. Mark Carr	UCSC-PISCO
Dr. Jennifer Caselle	UCSB-PISCO
Gary Davis	National Park Service-Visiting Chief Scientist for Ocean Programs
Tom Ford	Santa Monica Baykeeper- Director of Kelp Restoration
Amanda Jensen	UCSC-PISCO Research Diver
Dr. Kathy Ann Miller	UC Berkeley, University Herbarium
David Osorio	CA Dept. of Fish and Game- Marine Biologist
Dr. Dan Pondella	Occidental College – Director Vantuna Research Group
Dr. Pete Raimondi	UCSC-PISCO
Dr. Donna Schroeder	UCSB – Marine Science Institute
Dr. John Stephens	Vantuna Research Group
John Ugoretz	CA Dept. of Fish and Game- Nearshore Ecosystem / MLPA Coordinator

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