Mendocino County Fish & Game Project Proposal Summary Sheet
(This must be the first page of the submitted proposal)

1. Contractor: Reef Check California

2. Type of Contractor: _____

3. Taxpayer/Organizational ID/EID Number: _____

4. Street Mailing Address: 19275 S. Harbor Drive

5. City, State, Zip Code: Fort Bragg, CA, 95437

6. Contact Person: Anna Neumann

7. Telephone Number: 805-458-4902

8. Email address: aneumann@reefcheck.org

9. Website address(es): reefcheck.org

10. Project Title: Reef Check California: Sub-tidal Marine Protected Area Monitoring of Mendocino County's Rocky Reefs

11. Fish and Game Code Section 13103 Category: 13103 (i)

12. Amount Requested ($): 10,000

13. Objectives: The project aims to complete 15 sub-tidal scuba surveys with volunteer divers in Mendocino County,plus additional measurements of red abalone. Volunteers will be trained or re-certified in one of four trainings offered in the Fort Bragg area. Data will be collected on dives organized by Reef Check California and data will be complied and made available to the public, the Department of Fish and Wildlife and other relevant management agencies. See reference material for more detail.

14. Specie(s) Benefited: 35 species of fish, 33 species of invertebrates, 5 species of algae

15. Work Schedule: March - November 2017

16. Site Location (include reference to nearest city, town, and/or prominent landmark:
Point Arena MPA, Van Damme SMCA, Russian Gulch SMCA, Point Cabrillo MPA, 10 Mile MPA Caspar Cove, Mendocino Headlands, See reference materials for more details.

17. Site Location – GPS Coordinates: See reference material for GPS coordinates

18. **We would also like to be considered for funding** from the Ft. Bragg-based Salmon Restoration Association http://www.salmonrestoration.com/ (*for salmon habitat enhancement/restoration, salmon conservation, or salmon education projects*). _____ YES X No.

Please also fill out the following, if applicable:

19. Stream: _____

20. Tributary to: _____

21. Major Drainage System: _____

The deadline for receiving proposals is 5:00pm, December 31, 2016.

Proposals must be submitted by email as a PDF, .DOC, .DOCX, .TXT, or ZIP file to the Commission at: mendofishgamecommission@gmail.com. **Applicants must also mail or hand-deliver eight double-sided copies** to the Commission c/o County Planning & Building Services.

Grant applicants are encouraged to attend the Tuesday, January 17, 2017 meeting of the Commission, location to be announced, beginning 5:00pm, to make a brief (5 minute) presentation regarding their proposal.

Applicants without personal computers or internet access to the Commission website can request assistance from County branch libraries in Ukiah, Ft. Bragg, Willits, Coast Community (Pt. Arena), and Round Valley (Covelo) to download and print the application materials. *Note: County library personnel can also assist with scanning and emailing completed proposals.*

For additional information, please call Fish and Game Commission at (707) 234-6094, or email the Commission at mendofishgamecommission@gmail.com.

Reef Check California

2017 Marine Protected Area monitoring

Proposal to the Mendocino County Fish and Game Commission

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 reefs. Reef Check's mission is to empower people to save our reefs and oceans, stimulating action through a combination of education, training, and targeted collaborations. Our volunteers in more than 90 nations around the world work to monitor vital coral and temperate reef habitats, providing essential data needed for informed marine management. In addition, our training and speakers bureaus offer the public a rare window into underwater ecology, building a sense of direct personal investment in the preservation of the world's oceans.

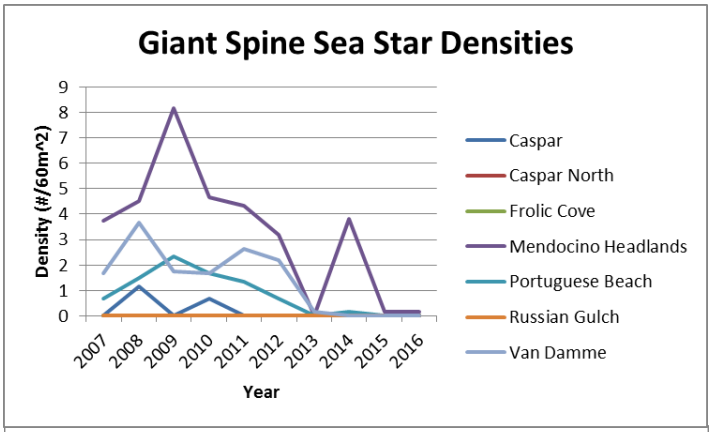
Whether the focus of monitoring is coral or kelp, Reef Check pursues four principle goals:

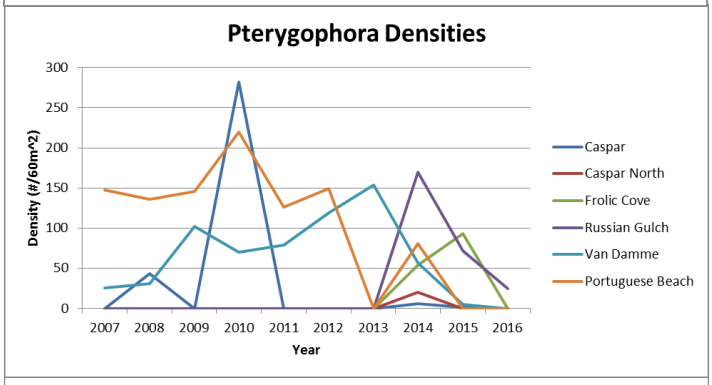
- To educate the public and governments about the value of coral reefs and rocky reef ecosystems and the crisis facing them
- To create a global network of volunteer teams, trained and led by scientists, that regularly monitor and report on reef health using a standard method
- To facilitate collaborative use of reef health information by community groups, governments, universities, and businesses to design and implement ecologically sound and economically sustainable solutions
- To stimulate local action to protect remaining pristine reefs and rehabilitate damaged reefs worldwide

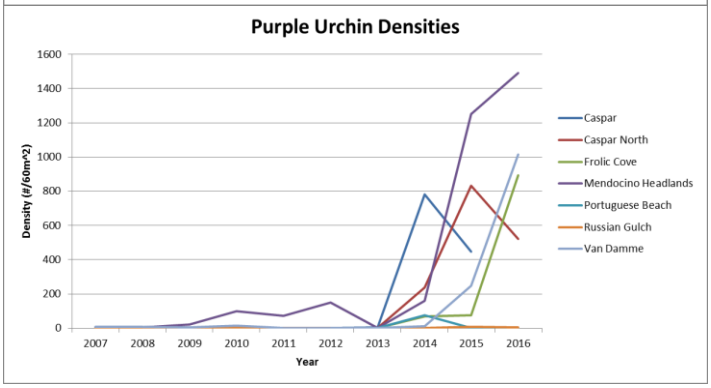
Reef Check California (RCCA), started in 2005, is now the largest statewide citizen-scientist monitoring program for California's marine protected areas (MPA) and nearshore rocky reef ecosystems. RCCA's goal is it to provide scientific information to state marine resource managers, so that they can make informed science-based management decisions. RCCA is truly a community endeavor and the program continues to grow as volunteers, communities and supporters join our ranks and share our mission. We empower California's ocean enthusiasts, through education, training & community engagement, to become active stewards of local ocean resources. Specifically, RCCA uses citizen science, community-based monitoring and data collection to improve marine management and educate the public about the marine environment off our coast. Annually, we train over 250 volunteers and lead them on dives along the entire California coast to scientifically monitor the health of the kelp forest ecosystem. As California has implemented its statewide network of MPAs over the last decade, Reef Check has helped provide the data and community involvement to establish the ecological baselines against which the performance of these MPAs can be evaluated in the future. Subsequently, RCCA has continued to monitor these MPAs every year and is committed to surveying the MPA network for the long-term as the only statewide group monitoring California's reefs and MPAs. With its statewide dataset spanning more than a decade now, RCCA is in a unique position to track the health of the ocean and the performance of MPAs as we continue monitoring for the long-term.

Project Overview in Detail

RCCA has established a baseline of the ecological conditions of the rocky reefs and kelp forests in every region of California where MPAs have been established according to the Marine Life Protection Act (MLPA). Consequently, the program has continued to monitor the MPAs for the long-term. RCCA is the only program that has continued to monitor its site following the MPA baseline studies in all regions and is currently funded by the state of California to collect long-term ecological data on the MPAs in three of the four MLPA study regions. In the North Coast Study Region (NCSR), which includes Mendocino County, we have just completed the MPA baseline monitoring (2014-2016). As in the other regions, we have built capacity to continue MPA monitoring for the long-term in order to provide the needed data to state agencies so that they can make inform management decisions. Unfortunately, state funding for long-term MPA monitoring in the NCSR will not be available in 2017. We have secured funds to maintain our presence in the NCSR and keep our regional staff as well as volunteer network in Mendocino County (matching funds). A grant from the Mendocino County Fish and Game Commission would allow us to establish an uninterrupted ecological long-term dataset on the MPAs in the NCSR as we have successfully done in all other MLPA regions. With the recent years' dramatic changes to the nearshore ecosystem such as the sea star wasting disease and consequent loss of the kelp forest and explosion of purple urchin population, as well as the clear evidence of lack of food for red abalone populations, it is imperative that we continue to monitor the health of the system. There is no other monitoring program in the NCSR that is poised to conduct continued long-term ecosystem monitoring. A grant from the Mendocino County Fish and Game Commission would fill the gap between the state funded MPA baseline monitoring (2014-16) and the anticipated beginning of the long-term MPA monitoring program in the NCSR in 2018/19. Without continued monitoring we might never know how the recent changes in the kelp forest ecosystem might affect the red abalone populations in the near future or for the long-term.







Work plan

Volunteer Trainings

In 2017, Reef Check California plans to continue to train and recertify citizen science scuba divers in RCCA's protocols. Two community trainings will be held in Fort Bragg; one training will focus on RCCA's standard protocol during which the divers will learn how to conduct subtidal surveys of fish, algae, invertebrates and the benthic habitat. A second training will be held to focus on abalone management and techniques to measure subtidal red abalone. All divers who were trained in previous years will be required to participate in one of the two recertification course offered before being eligible to collect data. In addition to community trainings, divers from Humboldt State University will also be trained on RCCA's protocols as part of an American Academy of Underwater Science certification and will complete their in-water dives and subsequent surveys in Mendocino County.

Surveys

Currently 15 sites are scheduled to be surveyed from May to November using the standard RCCA monitoring protocol and the additional recently developed red abalone size frequency protocol (Table 1). Ten days aboard a chartered dive boat will be required to complete surveys at the following sites: 10 Mile MPA, Westport, N. Caspar, S. Caspar, Point Arena MPA 1, Point Arena MPA 2, Stornetta, Sea Lion Cove Ref and Point Arena Reference.

Site	Lat	Long
10 Mile MPA		
Westport		
Glass Beach	39.4517	-123.815
N. Caspar	39.3644	-123.821
S. Caspar	39.3617	-123.822
Frolic Cove	39.355	-123.824
Russian Gulch	39.328	-123.809
Mendocino Headlands	39.3053	-123.811
Portuguese Beach	39.3032	-123.803
Van Damme	39.2719	-123.796
Point Arena MPA 1	38.9512	-123.744
Point Arena MPA 2	38.9448	-123.741
Stornetta	38.9372	-123.732
Sea Lion Cove Ref	38.9277	-123.735
Point Arena Ref	38.908	-123.719

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. These surveys have been used statewide for MPA monitoring. They have been compared to academic monitoring programs and found to be compatible with the state's needs for scientific monitoring data as recognized in a Memorandum of Understanding between the California Department of Fish and Wildlife and the Reef Check Foundation.

Fish are counted and sized by the divers along 18 transects at each sites. Fish are identified to species and their total length is recorded. Fish are counted by searching along a 30 m long x 2 m wide swath on the substrate and up to 2 meters into the water column. Cracks and crevices in the reef are searched using flashlights but no rocks are moved to during the search.

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 algae. Cracks and crevices are searched and understory algae are pushed aside to search for invertebrates. No organisms are removed.

In addition to these surveys, roving abalone data collection will be conducted. Divers will be equipped with calipers designed by The Nature Conservancy and the Abalone Working Group to take measurements of abalone sizes to the nearest millimeter.

Data is entered in the Nearshore Ecosystem Database and undergoes strict quality assurance and control protocols before being published. Once published data is made available at data.reefcheck.org it is available for public download. All of RCCA's data is also made available to the California Department of Fish and Wildlife and other relevant management agencies.

Timeline

March - May: Training and recertification of citizen science divers
May – November: Sub-tidal surveys conducted
November – December: Data entered into the Nearshore Ecosystem Database

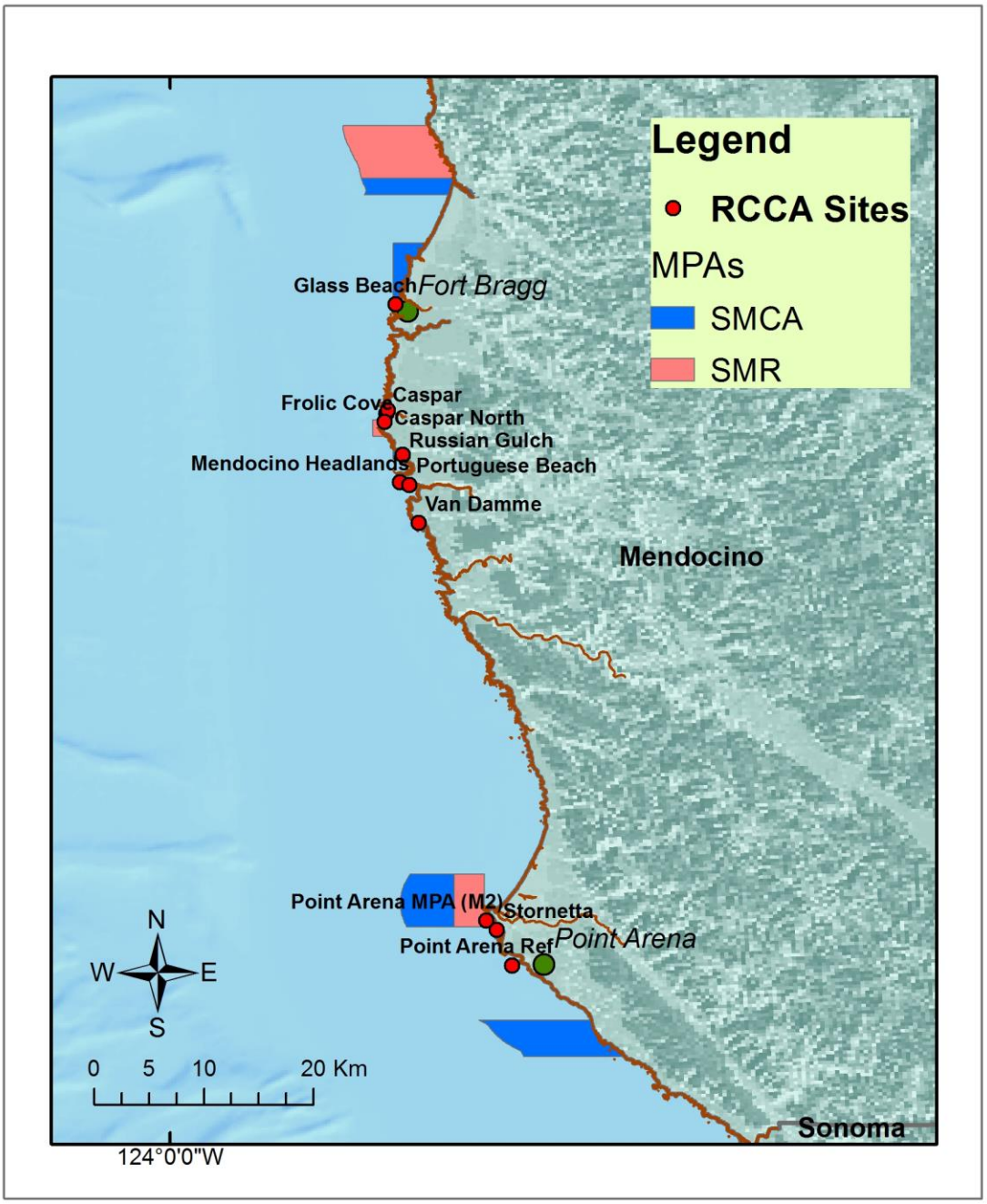
Budget

Item	**cost**
Boat rental	$7,000
Volunteer trainings	$500
Travel	$750
Field supplies	$1,000
Subtotal	**$9,250**
Overhead	$925
Total	**$10,175**

Matching funds

The Nature Conservancy	$	30,000	
Resource Legacy Fund	$	95,000	for statewide program
Ocean Protection Counsel climate change	$	230,000	for statewide program

Map of survey locations



State of California • Natural Resources Agency
DEPARTMENT OF PARKS AND RECREATION
P.O. Box 942896 • Sacramento, CA 94296-0001

Edmund G. Brown Jr., *Governor*
Lisa Ann L. Mangat, *Director*

September 7, 2016

Jan Freiwald
Reef Check Foundation
Long Marine Laboratory
100 Shaffer Rd,
Santa Cruz, CA 95060

Dear Mr. Freiwald:

Enclosed is your executed permit for Reef Check California Statewide Monitoring within selected units of the California State Park System. It is a policy of this office to issue permits annually, so this permit is valid from September 8, 2016 to September 8, 2017. Each year, you may request a renewal of this permit before it expires; we recommend that permit applications be submitted at least 60 days in advance of planned field work. Please consult http://www.parks.ca.gov/?page_id=21557 for guidance on preparing your renewal application.

Please read all of the conditions that apply to this permit very carefully. You are prohibited from conducting any research activities in any park unit until you make contact with the appropriate district permit coordinator (see attached list of contacts) and receive their permission to begin your field work in the park units within their district(s). This is an opportunity for you to inform the district permit coordinator about the specifics of your work and to gain assistance with access to the park units. **Please be aware that the district permit coordinator may apply site-specific restrictions to your permit to protect sensitive areas and resources which could affect the timing or proposed location for some research activities.** All research and collecting activities conducted under your California State Park permit must be consistent with local restrictions applied by the district permit coordinator as they retain final approval authority in all of their park units.

As a reminder, you are required to submit to us a summary report of your activities in the State Park units by September 8, 2017, as well as a final report and any associated data products within one month of their completion.

Best wishes for a successful project.

Sincerely,

N A Ramkishna

Nita Barve
Environmental Scientist | (916) 653-9365
Natural Resources Division
California Department of Parks and Recreation

SPECIAL PERMIT CONDITIONS:

Jan Freiwald, Reef Check Foundation
Reef Check California Statewide Monitoring
Permit valid from 9/08/2016 through 9/08/2017

In addition to the Standard Conditions and Restrictions stated on the Application and Permit to Conduct Scientific Research and Collections, the following conditions are applied:

1) The Permit Holder (and any of his/her field assistants) will make every effort to minimize off-trail impacts (e.g., erosion, trampling of vegetation, and creation of volunteer trails) by utilizing formal trails and roads whenever possible, and when on the beach, by traversing wet sand below the wrack line.

2) The Permit Holder (and his/her field assistants) agrees to abide by all park rules and regulations, including, but not limited to, no-dog and dog-leash requirements, vehicle use restrictions, backcountry access requirements, and posted area closures necessary to protect sensitive species, habitats, or resources.

3) Prior to conducting field work in coastal areas, the Permit Holder (and any of his/her field assistants) will review the two attached brochures, *Western Snowy Plover Sharing the Beach* (http://www.parks.ca.gov/pages/23071/files/ploverpdf.pdf) and *Rules and Guidelines for Protecting the Snowy Plover* (http://www.parks.ca.gov/pages/23071/files/flyerploverhr.pdf). Federally threatened Western Snowy Plovers are small shorebirds that nest and over winter on many Pacific Coast beaches and other coastal areas.

4) Following sampling, and no later than September 8, 2017, the Permit Holder must submit a summary report of activities conducted in the State Park units to:

   Attn: Environmental Program Manager
   Natural Resources Division
   California Department of Parks and Recreation
   P.O. Box 942896
   Sacramento, CA 94296-0001
   nrd.research@parks.ca.gov

   A final report and any associated data products must also be submitted to the above address within one month of their completion.

5) The Permit Holder is responsible for obtaining any additional permits or approvals required for research and collecting activities conducted beyond State Park System boundaries.

6) The Permit Holder (and his/her field assistants) must carry a copy of this permit at all times while conducting field work.

7) This California State Park Permit does not authorize collection of rare, threatened, or endangered plant species protected by California law, nor does it authorize targeted collection of state or federally-listed invertebrates.

Contact List for Parks

You MUST notify the District contacts identified below prior to activities in their respective park units. Two weeks' notice is required. Districts may have particular concerns regarding study design and sampling locations, and they retain final approval authority. Failure to contact may result in loss of sampling opportunity.

CHANNEL COAST DISTRICT
District Office: (805) 585-1850

Alexis Frangis
Alexis.Frangis@parks.ca.gov
(805) 585-1852
Refugio SB

MONTEREY DISTRICT
District Office: (831) 649-2836

Stephen Bachman
Stephen.Bachman@parks.ca.gov
(831) 649-2862
Carmel River SB
Point Lobos SNR

SONOMA-MENDOCINO COAST DISTRICT
Mendocino Sector Office: (707) 937-5804
Russian River Sector: (707) 865-2391

Brendan O'Neil
Brendan.O'Neil@parks.ca.gov
(707) 865-3129
Mendocino Sector
Russian Gulch SP
Van Damme SP
Russian River Sector
Fort Ross SHP
Salt Point SP

ORANGE COAST DISTRICT
District Office: (949) 492-0802

Lana Nguyen
Lana.Nguyen@parks.ca.gov
(949) 201-0884
Crystal Cove SP

State of California - Natural Resources Agency
DEPARTMENT OF PARKS AND RECREATION

APPLICATION AND PERMIT TO CONDUCT SCIENTIFIC RESEARCH AND COLLECTIONS

Note: Edits in red made by DPR on 9.2.2016

☒ NEW ☐ RENEWAL

FOR DEPARTMENT USE ONLY	
APPLICATION NO.	DATE RECEIVED
DISTRICT NAME	CEQA
PERMIT TYPE: ☐ Biological ☐ Geological / Soils ☐ Other: ☐ Summary Report Received	

Instructions: Applications must be TYPED and signed by ~~all participants~~ upon submission. If more space is needed to complete any item, continue on separate sheet(s). Attach to your application: (1) a Curriculum Vitae (CV) or résumé for the Principal Investigator (and for the person overseeing field work, if different from PI); (2) maps, coordinates, and/or GIS files indicating precise locations of proposed work; (3) a full study proposal; and (4) copies of any additional permits required for your research. Complete application packages should be sent to the district office that administers the park unit(s) where the research will take place, or to the Natural Resources Division, Sacramento, for multi-district requests.

APPLICANT ORGANIZATION	PHONE NO. (Incl. Area Code)
Reef Check Foundation	(310)305-4622
ORGANIZATION MAILING ADDRESS / CITY / STATE / ZIP CODE	E-MAIL ADDRESS
13723 Fiji Way, B-2 Marina del Rey, CA 90292	california@reefcheck.org

PRINCIPAL INVESTIGATOR (PI) - ATTACH RÉSUMÉ OR CV
(NOTE: Faculty sponsor must sign as PI for student applicants)

NAME	TITLE	CELL PHONE NO. (Incl. Area Code)
Jan Freiwald	Director Reef Check CA	(831) 345-8167
MAILING ADDRESS / CITY / STATE / ZIP CODE		E-MAIL ADDRESS
Long Marine Laboratory, 100 Shaffer Rd, Santa Cruz, CA 95060		jfreiwald@reefcheck.org

PERSON IN DIRECT CHARGE OF FIELD WORK - ATTACH RÉSUMÉ OR CV IF DIFFERENT FROM PI

NAME	TITLE	CELL PHONE NO. (Incl. Area Code)
Dan Abbott	Central Coast Manager	(510)684-7835
MAILING ADDRESS / CITY / STATE / ZIP CODE		E-MAIL ADDRESS
6044 Wenk Ave, Richmond, CA 94804		dabbott@reefcheck.org

ADDITIONAL PARTICIPANTS - ATTACH CONTINUATION SHEETS, IF NECESSARY

	NAME	TITLE	CELL PHONE NO. (Incl. Area Code)
1	Colleen Wisniewski	Southern CA Manager	619-255-9706
	MAILING ADDRESS / CITY / STATE / ZIP CODE		E-MAIL ADDRESS
	4825 Coronado Ave #5, San Diego, CA 92107		colleen@reefcheck.org
2	Anna Neumann	North Coast Manager	(805) 458-4902
	19275 S Harbor Dr, Fort Bragg, CA 95437		aneumann@reefcheck.org
3	Katie Kozma	Volunteer Coordinator	909-838-8120
	13723 Fiji Way, B-2 Marina del Rey, CA 90292		kkozma@reefcheck.org
4			
5			
6			
7			
8			

The Principal Investigator hereby applies to the Department of Parks and Recreation for a permit under Title XIV, California Code of Regulations, Section 4309, and Public Resources Code Section 5001.65, to conduct investigations on lands of the State of California as follows:

STATE PARK UNIT(S) TO BE INCLUDED ON PERMIT	COUNTY(IES)
Russian Gulch State Park	Mendocino
Van Damme State Park	Sonoma
Salt Point State Park	Monterey
Fort Ross State Historic Park	Santa Babara
Carmel River State Beach	Orange
Point Lobos State Natural Reserve	
Refugio State Beach	
Crystal Cove State Park	

1. PROJECT TITLE

Reef Check California Statewide Monitoring

2. PROJECT PURPOSE

Reef Check California educates, trains, and engages ocean users in the collection of scientifically sound data describing the near-shore rocky reef to aid marine management decisions.

3. DESCRIPTION OF PROJECT LOCATION(S) *(Also attach maps, coordinates, and/or GIS files for each distinct location.)*

Russian Gulch 39° 19' 44" N 123° 48'3 2" W
Van Damme 39° 16' 59" N 123° 47' 45" W
Grestle Cove 38° 34' 03" N 123° 17' 20" W
Fort Ross 38° 30' 42" N 123° 14'41" W
North Monastery
South Monastery
Middle Reef (August and May survey) 36° 31.349'N 121° 56.317'W
Weston (August survey only) 36°30'40.32"N 121°56'46.68"W, Limekiln
Refugio 34° 27.663'N 120° 4.012'W
Crystal Cove 33° 34.281'N 117° 50.466'W
See attached site sheets

4. METHOD OF ACCESS *(Describe methods to be used for accessing study sites after arrival at the park unit(s).)*

Middle Reef and Weston will be accessed by boat leaving out of the Monterey Harbor for the Fall survey. Middle Reef will be accessed from Whaler's Cove during the Spring survey. Other sites will be accessed from shore by entering the water from the beach.

5. SUMMARY OF FIELD METHODS AND ACTIVITIES

Underwater Visual Census: non-invasive surveys of fish, invertebrates, and marine macro-algae. See attached protocols for detailed field methods.

6. TYPES OF SPECIMENS TO BE COLLECTED *(List species, quantity, size, and condition.)*

No specimens will be collected.

7. EXPECTED DURATION OF THE PROJECT *(Specify overall project start and end dates and start and end dates of field investigations.)*

Biannual surveys during began in 2006 and will continue indefinitely. Surveys take 1-2 days per site to complete, not to exceed 5 total days for the year.

8. PLACE AT WHICH LABORATORY WORK WILL BE PERFORMED *(Institution, address, and responsible official name, phone number, and e-mail address)*

No laboratory work will be performed.

9. FACILITY THAT HAS AGREED TO CURATE SPECIMENS COLLECTED UNDER THIS PERMIT *(Institution, address, and responsible official name, phone number, and email address)*

No specimens will be collected.

10. LOCATION OF DATA AND DATA PRODUCTS COLLECTED UNDER THIS PERMIT *(Specify institution name and/or website where data, maps, reports, GIS files, photos, and other data products (not specimens) will reside after the project is completed.)*

All data will be entered into Reef Check's Nearshore Ecosystem Database (NED) and will be available through Reef Check's Global Reef Tracker: data.reefcheck.us

NOTE: APPLICATION IS INCOMPLETE UNTIL SIGNED. ~~ALL PARTICIPANTS MUST SIGN ON PAGES 4-5.~~

PERMIT TO CONDUCT SCIENTIFIC RESEARCH AND COLLECTIONS

ALL PARTICIPANTS ~~MUST SIGN~~ & CARRY THIS PERMIT AT ALL TIMES WHILE CONDUCTING FIELD RESEARCH/COLLECTIONS.

STANDARD CONDITIONS AND RESTRICTIONS

The Department of Parks and Recreation desires to further scientific research within its jurisdiction through cooperation and partnerships with researchers to the extent possible within the Department's mission to provide long-term protection and management of ecological processes and natural resource elements.

1. General classroom collection is not allowed under this or any other permit.
2. This permit applies only to non-cultural materials, and is limited to the kind, number, and sizes of specimens described on this form. Archeological and paleontological material may NOT be collected under this permit.
3. The collections shall be used for scientific or interpretive purposes only, and shall not be used for commercial purposes. Collections shall be property of the Department of Parks and Recreation. Curated collections shall be maintained by the Institution listed on page 3, item number 9. Collections can be transferred to another location with prior approval from the Department.
4. The collecting must be done away from roads, trails, and developed areas, unless such localities are specified in the permit. Collection shall be done in an inconspicuous manner, and shall not cause damage to the environment. Because of the scarcity or importance of some specimens, the Department of Parks and Recreation may designate other restrictions necessary for the preservation of the area.
5. Samples collected in areas designated as sensitive may require prior surveys conducted by a State Park resource specialist, and/or a State Park resource specialist may be assigned to the project as a monitor. At the discretion of the responsible approver, the Permittee may be required to schedule surveys and/or reserve a project monitor and pay for the State Park resource specialist's time and expenses should these services be required.
6. The Permittee shall submit a summary of information gathered to the applicable District where the investigations took place, and to the Chief, Natural Resources Division, Department of Parks and Recreation, in Sacramento. The Department further requires that the Permittee make available to the Department any material published as a result of this permit. Upon completion, a copy of such published material shall be submitted to: Natural Resources Division, Department of Parks and Recreation, PO Box 942896, Sacramento, CA 94296-0001.
7. The Permittee is to contact the appropriate District Superintendent (or designee) before beginning any field activities, and to present a copy of this permit, together with evidence of additional licenses and permits, if required.
8. All participants conducting activities approved by this permit shall inspect their shoes, clothing, vehicles, tools, and equipment for the presence of organic matter and soil, and if present, shall clean these items prior to entering and upon leaving the park to minimize potential spread of invasive species.
9. If collections and/or field research are not carried out to the satisfaction of the Department, this permit may be immediately cancelled.
10. All applicable laws and regulations must be observed by participants in exercising the privileges granted in this permit. It is the responsibility of the Permittee to obtain any additional permits or approvals required for research/collection activities, and to know the boundaries and managing authority of specially designated protected areas or sanctuaries.
11. Applicant Organization shall be responsible for any damage to State land or property in connection with the activity for which the Permit is issued.
12. The Permittee, and all participants, are responsible for knowing and complying with all general rules and regulations for use of Department lands as well as any specific conditions or regulations for the permit and subject property.
13. Applicant Organization agrees to comply with the indemnity and insurance requirements of the Indemnity/ Insurance Addendum hereby incorporated by reference as Exhibit A. Activities under this permit shall not commence until proof of the required insurance is submitted to the Department.

~~14.~~ Questions regarding this permit may be directed to the District Superintendent or to the Natural Resources Division.

I have read the Standard Conditions and Restrictions above and agree to comply with any additional special conditions.

PRINCIPAL INVESTIGATOR'S SIGNATURE *(Faculty sponsor must sign for student applicants)*	PRINTED NAME	DATE
▶ Jan Freiwald	Jan Freiwald	8/16/2016
Signature on Behalf of Applicant Organization	Printed Name	Date
Jan Freiwald Digitally signed by Jan Freiwald DN: cn=Jan Freiwald, o, ou, email=freiwald@ucsc.edu, c=US Date: 2016.09.02 14:20:06 -07'00'		

It is the responsibility of the Principal Investigator to ensure that all participants comply with all standard and special conditions and sign DPR 65. It is the responsibility of BOTH the Principal Investigator and responsible DPR approval authority to keep a copy of signatures for all participants on file.

Reef Check Foundation
Jan Freiwald

PERMIT TO CONDUCT SCIENTIFIC RESEARCH AND COLLECTIONS
SPECIAL CONDITIONS

See attached letter & conditions

FOR DEPARTMENT USE (REVIEW/APPROVAL)

REVIEWED BY ► NARambha	DISTRICT ENVIRONMENTAL SCIENTIST NITA BARVE	DATE 09/07/2016
REVIEWED BY ►	DISTRICT SUPERINTENDENT / MANAGER	DATE
DPR APPROVAL SIGNATURE* ► Laurie Archambault	PRINTED NAME / TITLE Laurie J. Archambault/EPM	DATE 9-8-16

**NOTE: If all park units in single DPR District, Superintendent has approval authority. For more than one DPR District, Natural Resources Division EPM must approve.*

PERMIT VALID FROM: 09/08/16 ***TO:*** 09/08/17

Complete Copy (whether approved or denied): 1 ea - District(s) & 1 - Natural Resources Division

EXHIBIT A
DPR 65 – Collection Permit Indemnity/Insurance Addendum

This agreement is an addendum to the scientific collection permit application for Reef Check Foundation. The permit for Reef Check California Statewide Monitoring shall not become effective until the requirements of this addendum are completed.

Indemnity Agreement

Applicant Organization waives all claims and demands against the State, its officers, agents, and/or employees for any and all loss, injury, death or damage caused by, arising out of, or in any way connected with this Permit, use of any access route to the Permit activities, any and all activities conducted under this Permit, or Applicant Organization's exercise of the rights granted by this Permit. Applicant Organization shall protect, save, hold harmless, indemnify, and defend the State, its officers, agents, and/or employees, from and against any and all loss, damage, claims, demands, liability, costs, recoveries, settlements, penalties, fines and expenses, including, without limitation, all legal fees, attorney fees, accounting fees, expert witness fees, consultant fees, interest and expenses related to the response to, settlement, and/or defense of any claims, legal actions, or liability, which may be suffered or incurred by the State, its officers, agents and/or employees, caused by, arising out of, or in any way connected with this Permit, use of any access route to the Permit activities, any and all activities conducted under this Permit, or Applicant's exercise of the rights granted by this Permit, except those arising out of the sole active negligence or willful misconduct of the State. The obligations contained in this Section, including the waiver and indemnity obligations, shall survive termination of this Permit.

Insurance Requirement

This Permit shall not be approved until the Applicant Organization provides the required proof of insurance. Except as otherwise provided, before beginning permit activities, the Applicant Organization shall submit to the District Superintendent or his/her designee an Insurance Accord or Certificate, along with copies of any endorsements, from the Applicant Organization's insurance carrier showing that the Applicant Organization has the required insurance coverage for the permit activity. All insurance companies must carry a rating acceptable to the DGS Office of Risk and Insurance Management. The insurance shall meet the following standard requirements:

All insurance policies shall be underwritten to the satisfaction of the State and shall contain the following special endorsements: (1) The State of California, California Department of Parks and Recreation, its officers, employees, and servants are included as additional insureds but only insofar as operations under this permit are concerned. A copy of the additional insured endorsement for each insurance policy shall be provided to the State. (2) The insurer will not cancel or reduce the insured's coverage during the period that this Permit is in effect without 30 days prior written notice to the State. This cancellation provision shall not be construed to relieve the Applicant of the obligation to maintain all of the required insurance during the entire term of the Permit. (3) Applicant Organization shall be responsible for any deductible or self-insured retention contained within their insurance program.

General Liability: Applicant Organization shall provide to the State a certificate of insurance with the required endorsements as proof of liability insurance coverage. The policy shall cover the period of this Permit and shall be for no less than a Combined Single Limit of $1,000,000 per occurrence and $2,000,000 aggregate for bodily injury and property damage liability. The policy shall include coverage for liabilities arising out of the Permit activities. The policy must include the State of California, California Department of Parks and Recreation, their officers, employees and agents as additional insureds, at no cost to the State.

Workers' Compensation: Applicant Organization shall maintain statutory workers' compensation and employer's liability coverage for all its employees who will be engaged in the performance of the Permit, including special coverage extensions where applicable. Employer's liability limits of $1,000,000 shall be required, and the policy shall include a waiver of subrogation in favor of the State of California. The waiver of subrogation endorsement must be provided with the certificate of insurance.

[over]

Automobile Liability: If motor vehicles are utilized in the permit activities or en route to the permit activities, Applicant Organization shall maintain motor vehicle liability with limits of not less than $1,000,000 per accident for bodily injury and property damage. The policy must include the State of California, California Department of Parks and Recreation, their officers, employees and agents as additional insured, at no cost to State, with respect to liability arising out of all vehicles owned, hired and non-owned.

If Applicant Organization is self-insured in whole or in part as to any of the above described types and levels of insurance coverage, Applicant Organization shall provide the State with written acknowledgment of this fact at the time of the submission of the Permit application. The State may require financial information to justify Applicant Organization's self-insured status. If at any time after the execution of this Permit, Applicant Organization abandons its self-insured status, Applicant Organization shall immediately notify the State of this fact and shall comply with all of the terms and conditions of this Section pertaining to required policies of insurance.

I hereby certify that I am a representative of Applicant Organization authorized to agree to the above indemnification and insurance requirements of this permit.

(Authorized Representative Signature) _____ (Date) _____

(Printed Name) _____ Jan Freiwald Digitally signed by Jan Freiwald DN: cn=Jan Freiwald, o, ou, email=freiwald@ucsc.edu, c=US Date: 2016.09.02 14:32:39 -07'00' (Title) _____

EXHIBIT A
DPR 65 – Collection Permit Indemnity/Insurance Addendum

This agreement is an addendum to the scientific collection permit application for Reef Check Foundation. The permit for Reef Check California Statewide Monitoring shall not become effective until the requirements of this addendum are completed.

Indemnity Agreement

Applicant Organization waives all claims and demands against the State, its officers, agents, and/or employees for any and all loss, injury, death or damage caused by, arising out of, or in any way connected with this Permit, use of any access route to the Permit activities, any and all activities conducted under this Permit, or Applicant Organization's exercise of the rights granted by this Permit. Applicant Organization shall protect, save, hold harmless, indemnify, and defend the State, its officers, agents, and/or employees, from and against any and all loss, damage, claims, demands, liability, costs, recoveries, settlements, penalties, fines and expenses, including, without limitation, all legal fees, attorney fees, accounting fees, expert witness fees, consultant fees, interest and expenses related to the response to, settlement, and/or defense of any claims, legal actions, or liability, which may be suffered or incurred by the State, its officers, agents and/or employees, caused by, arising out of, or in any way connected with this Permit, use of any access route to the Permit activities, any and all activities conducted under this Permit, or Applicant's exercise of the rights granted by this Permit, except those arising out of the sole active negligence or willful misconduct of the State. The obligations contained in this Section, including the waiver and indemnity obligations, shall survive termination of this Permit.

Insurance Requirement

This Permit shall not be approved until the Applicant Organization provides the required proof of insurance. Except as otherwise provided, before beginning permit activities, the Applicant Organization shall submit to the District Superintendent or his/her designee an Insurance Accord or Certificate, along with copies of any endorsements, from the Applicant Organization's insurance carrier showing that the Applicant Organization has the required insurance coverage for the permit activity. All insurance companies must carry a rating acceptable to the DGS Office of Risk and Insurance Management. The insurance shall meet the following standard requirements:

All insurance policies shall be underwritten to the satisfaction of the State and shall contain the following special endorsements: (1) The State of California, California Department of Parks and Recreation, its officers, employees, and servants are included as additional insureds but only insofar as operations under this permit are concerned. A copy of the additional insured endorsement for each insurance policy shall be provided to the State. (2) The insurer will not cancel or reduce the insured's coverage during the period that this Permit is in effect without 30 days prior written notice to the State. This cancellation provision shall not be construed to relieve the Applicant of the obligation to maintain all of the required insurance during the entire term of the Permit. (3) Applicant Organization shall be responsible for any deductible or self-insured retention contained within their insurance program.

General Liability: Applicant Organization shall provide to the State a certificate of insurance with the required endorsements as proof of liability insurance coverage. The policy shall cover the period of this Permit and shall be for no less than a Combined Single Limit of $1,000,000 per occurrence and $2,000,000 aggregate for bodily injury and property damage liability. The policy shall include coverage for liabilities arising out of the Permit activities. The policy must include the State of California, California Department of Parks and Recreation, their officers, employees and agents as additional insureds, at no cost to the State.

Workers' Compensation: Applicant Organization shall maintain statutory workers' compensation and employer's liability coverage for all its employees who will be engaged in the performance of the Permit, including special coverage extensions where applicable. Employer's liability limits of $1,000,000 shall be required, and the policy shall include a waiver of subrogation in favor of the State of California. The waiver of subrogation endorsement must be provided with the certificate of insurance.

[over]

Automobile Liability: If motor vehicles are utilized in the permit activities or en route to the permit activities, Applicant Organization shall maintain motor vehicle liability with limits of not less than $1,000,000 per accident for bodily injury and property damage. The policy must include the State of California, California Department of Parks and Recreation, their officers, employees and agents as additional insured, at no cost to State, with respect to liability arising out of all vehicles owned, hired and non-owned.

If Applicant Organization is self-insured in whole or in part as to any of the above described types and levels of insurance coverage, Applicant Organization shall provide the State with written acknowledgment of this fact at the time of the submission of the Permit application. The State may require financial information to justify Applicant Organization's self-insured status. If at any time after the execution of this Permit, Applicant Organization abandons its self-insured status, Applicant Organization shall immediately notify the State of this fact and shall comply with all of the terms and conditions of this Section pertaining to required policies of insurance.

I hereby certify that I am a representative of Applicant Organization authorized to agree to the above indemnification and insurance requirements of this permit.

(Authorized Representative Signature) Jerry Suarez (Date) 9/02/16

(Printed Name) JERRY SUAREZ (Title) ACCOUNTANT

ACORD®

CERTIFICATE OF LIABILITY INSURANCE

DATE (MM/DD/YYYY): 8/29/2016

THIS CERTIFICATE IS ISSUED AS A MATTER OF INFORMATION ONLY AND CONFERS NO RIGHTS UPON THE CERTIFICATE HOLDER. THIS CERTIFICATE DOES NOT AFFIRMATIVELY OR NEGATIVELY AMEND, EXTEND OR ALTER THE COVERAGE AFFORDED BY THE POLICIES BELOW. THIS CERTIFICATE OF INSURANCE DOES NOT CONSTITUTE A CONTRACT BETWEEN THE ISSUING INSURER(S), AUTHORIZED REPRESENTATIVE OR PRODUCER, AND THE CERTIFICATE HOLDER.

IMPORTANT: If the certificate holder is an ADDITIONAL INSURED, the policy(ies) must be endorsed. If SUBROGATION IS WAIVED, subject to the terms and conditions of the policy, certain policies may require an endorsement. A statement on this certificate does not confer rights to the certificate holder in lieu of such endorsement(s).

PRODUCER	CONTACT NAME: Kathy Macias-Ramirez
Millennium Corporate Solutions License # 0C13480 550 N Brand Blvd #1100 Glendale CA 91203	PHONE (A/C, No, Ext): (626) 275-3000 FAX (A/C, No): (626) 275-0130 E-MAIL ADDRESS: kathym@mcsins.com

INSURER(S) AFFORDING COVERAGE	NAIC #
INSURER A: Ohio Security Ins Company	24082
INSURER B: American Fire & Casualty Ins Co.	24066
INSURER C:	
INSURER D:	
INSURER E:	
INSURER F:	

INSURED

Reef Check Foundation
13723 Fiji Way, B2
Marina Del Rey CA 90292-7275

COVERAGES **CERTIFICATE NUMBER:** 2016 - 2017 **REVISION NUMBER:**

THIS IS TO CERTIFY THAT THE POLICIES OF INSURANCE LISTED BELOW HAVE BEEN ISSUED TO THE INSURED NAMED ABOVE FOR THE POLICY PERIOD INDICATED. NOTWITHSTANDING ANY REQUIREMENT, TERM OR CONDITION OF ANY CONTRACT OR OTHER DOCUMENT WITH RESPECT TO WHICH THIS CERTIFICATE MAY BE ISSUED OR MAY PERTAIN, THE INSURANCE AFFORDED BY THE POLICIES DESCRIBED HEREIN IS SUBJECT TO ALL THE TERMS, EXCLUSIONS AND CONDITIONS OF SUCH POLICIES. LIMITS SHOWN MAY HAVE BEEN REDUCED BY PAID CLAIMS.

INSR LTR	TYPE OF INSURANCE	ADDL INSD	SUBR WVD	POLICY NUMBER	POLICY EFF (MM/DD/YYYY)	POLICY EXP (MM/DD/YYYY)	LIMITS	
A	X COMMERCIAL GENERAL LIABILITY CLAIMS-MADE [X] OCCUR GEN'L AGGREGATE LIMIT APPLIES PER: [X] POLICY [ ] PRO-JECT [ ] LOC OTHER:	X		BKS 17 56401413	3/6/2016	3/6/2017	EACH OCCURRENCE	$ 1,000,000
							DAMAGE TO RENTED PREMISES (Ea occurrence)	$ 100,000
							MED EXP (Any one person)	$ 5,000
							PERSONAL & ADV INJURY	$ 1,000,000
							GENERAL AGGREGATE	$ 2,000,000
							PRODUCTS - COMP/OP AGG	$ 2,000,000
								$
A	AUTOMOBILE LIABILITY ANY AUTO ALL OWNED AUTOS SCHEDULED AUTOS X HIRED AUTOS X NON-OWNED AUTOS			BAS 17 56401413	3/6/2016	3/6/2017	COMBINED SINGLE LIMIT (Ea accident)	$
							BODILY INJURY (Per person)	$
							BODILY INJURY (Per accident)	$
							PROPERTY DAMAGE (Per accident)	$
							HIRED /NON-OWNED AUTO	$ 1,000,000
B	X UMBRELLA LIAB X OCCUR EXCESS LIAB CLAIMS-MADE DED X RETENTION $ -0-			ESA 16 56401413	3/6/2016	3/6/2017	EACH OCCURRENCE	$ 1,000,000
							AGGREGATE	$ 1,000,000
								$
	WORKERS COMPENSATION AND EMPLOYERS' LIABILITY ANY PROPRIETOR/PARTNER/EXECUTIVE OFFICER/MEMBER EXCLUDED? (Mandatory in NH) Y/N [ ] N/A If yes, describe under DESCRIPTION OF OPERATIONS below						PER STATUTE [ ] OTH-ER	
							E.L. EACH ACCIDENT	$
							E.L. DISEASE - EA EMPLOYEE	$
							E.L. DISEASE - POLICY LIMIT	$

DESCRIPTION OF OPERATIONS / LOCATIONS / VEHICLES (ACORD 101, Additional Remarks Schedule, may be attached if more space is required)

The State of California, California Department of Parks and Recreation, its officers, employees, and servants are included as an additional insured as respects to the Agreement for Reef Check California Statewide Monitoring in regards to the insureds operations and only if required by written contract per the attached endorsement. Should any of the above described policies be cancelled before the expiration date thereof, notice will be delivered in accordance with the policy provisions.

CERTIFICATE HOLDER

The State of California
CA Department of Parks & Recreation
Attn: Nita Barve
P.O. Box 942896
Sacramento, CA 94296

CANCELLATION

SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELLED BEFORE THE EXPIRATION DATE THEREOF, NOTICE WILL BE DELIVERED IN ACCORDANCE WITH THE POLICY PROVISIONS.

AUTHORIZED REPRESENTATIVE

Margaret Gilmore/NB

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THIS ENDORSEMENT CHANGES THE POLICY. PLEASE READ IT CAREFULLY.

COMMERCIAL GENERAL LIABILITY EXTENSION

This endorsement modifies insurance provided under the following:

COMMERCIAL GENERAL LIABILITY COVERAGE PART

INDEX

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With respect to coverage afforded by this endorsement, the provisions of the policy apply unless modified by the endorsement.

A. NON-OWNED AIRCRAFT

Under Paragraph **2. Exclusions** of **Section I – Coverage A - Bodily Injury And Property Damage Liability,** exclusion **g. Aircraft, Auto Or Watercraft** does not apply to an aircraft provided:

1. It is not owned by any insured;
2. It is hired, chartered or loaned with a trained paid crew;
3. The pilot in command holds a currently effective certificate, issued by the duly constituted authority of the United States of America or Canada, designating her or him a commercial or airline pilot; and
4. It is not being used to carry persons or property for a charge.

However, the insurance afforded by this provision does not apply if there is available to the insured other valid and collectible insurance, whether primary, excess (other than insurance written to apply specifically in excess of this policy), contingent or on any other basis, that would also apply to the loss covered under this provision.

B. NON-OWNED WATERCRAFT

Under Paragraph **2. Exclusions** of **Section I – Coverage A – Bodily Injury And Property Damage Liability,**

Subparagraph **(2)** of exclusion **g. Aircraft, Auto Or Watercraft** is replaced by the following:

This exclusion does not apply to:

(2) A watercraft you do not own that is:

(a) Less than 52 feet long; and

(b) Not being used to carry persons or property for a charge.

C. PROPERTY DAMAGE LIABILITY – ELEVATORS

1. Under Paragraph **2. Exclusions** of **Section I – Coverage A – Bodily Injury And Property Damage Liability,** Subparagraphs **(3), (4)** and **(6)** of exclusion **j. Damage To Property** do not apply if such "property damage" results from the use of elevators. For the purpose of this provision, elevators do not include vehicle lifts. Vehicle lifts are lifts or hoists used in automobile service or repair operations.
2. The following is added to **Section IV – Commercial General Liability Conditions,** Condition **4. Other Insurance,** Paragraph **b. Excess Insurance:**

   The insurance afforded by this provision of this endorsement is excess over any property insurance, whether primary, excess, contingent or on any other basis.

D. EXTENDED DAMAGE TO PROPERTY RENTED TO YOU (Tenant's Property Damage)

If Damage To Premises Rented To You is not otherwise excluded from this Coverage Part:

1. Under Paragraph **2. Exclusions of Section I - Coverage A - Bodily Injury and Property Damage Liability:**

   a. The fourth from the last paragraph of exclusion **j. Damage To Property** is replaced by the following:

   Paragraphs **(1), (3)** and **(4)** of this exclusion do not apply to "property damage" (other than damage by fire, lightning, explosion, smoke, or leakage from an automatic fire protection system) to:

   (i) Premises rented to you for a period of 7 or fewer consecutive days; or

   (ii) Contents that you rent or lease as part of a premises rental or lease agreement for a period of more than 7 days.

   Paragraphs **(1), (3)** and **(4)** of this exclusion do not apply to "property damage" to contents of premises rented to you for a period of 7 or fewer consecutive days.

   A separate limit of insurance applies to this coverage as described in **Section III – Limits of Insurance.**

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b. The last paragraph of subsection **2. Exclusions** is replaced by the following:

Exclusions **c.** through **n.** do not apply to damage by fire, lightning, explosion, smoke or leakage from automatic fire protection systems to premises while rented to you or temporarily occupied by you with permission of the owner. A separate limit of insurance applies to Damage To Premises Rented To You as described in **Section III – Limits Of Insurance.**

2. Paragraph **6.** under **Section III – Limits Of Insurance** is replaced by the following:

6. Subject to Paragraph **5.** above, the Damage To Premises Rented To You Limit is the most we will pay under Coverage **A** for damages because of "property damage" to:

a. Any one premise:

(1) While rented to you; or

(2) While rented to you or temporarily occupied by you with permission of the owner for damage by fire, lightning, explosion, smoke or leakage from automatic protection systems; or

b. Contents that you rent or lease as part of a premises rental or lease agreement.

3. As regards coverage provided by this provision **D. EXTENDED DAMAGE TO PROPERTY RENTED TO YOU (Tenant's Property Damage)** - Paragraph **9.a.** of **Definitions** is replaced with the following:

9.a. A contract for a lease of premises. However, that portion of the contract for a lease of premises that indemnifies any person or organization for damage by fire, lightning, explosion, smoke, or leakage from automatic fire protection systems to premises while rented to you or temporarily occupied by you with the permission of the owner, or for damage to contents of such premises that are included in your premises rental or lease agreement, is not an "insured contract".

E. MEDICAL PAYMENTS EXTENSION

If **Coverage C Medical Payments** is not otherwise excluded, the Medical Payments provided by this policy are amended as follows:

Under Paragraph **1. Insuring Agreement** of **Section I – Coverage C – Medical Payments,** Subparagraph **(b)** of Paragraph **a.** is replaced by the following:

(b) The expenses are incurred and reported within three years of the date of the accident; and

F. EXTENSION OF SUPPLEMENTARY PAYMENTS – COVERAGES A AND B

1. Under **Supplementary Payments – Coverages A** and **B,** Paragraph **1.b.** is replaced by the following:

b. Up to **$3,000** for cost of bail bonds required because of accidents or traffic law violations arising out of the use of any vehicle to which the Bodily Injury Liability Coverage applies. We do not have to furnish these bonds.

2. Paragraph **1.d.** is replaced by the following:

d. All reasonable expenses incurred by the insured at our request to assist us in the investigation or defense of the claim or "suit", including actual loss of earnings up to **$500** a day because of time off from work.

G. ADDITIONAL INSUREDS - BY CONTRACT, AGREEMENT OR PERMIT

1. Paragraph **2.** under **Section II – Who Is An Insured** is amended to include as an insured any person or organization whom you have agreed to add as an additional insured in a written contract, written agreement or permit. Such person or organization is an additional insured but only with respect to liability for "bodily injury", "property damage" or "personal and advertising injury" caused in whole or in part by:

a. Your acts or omissions, or the acts or omissions of those acting on your behalf, in the performance of your on going operations for the additional insured that are the subject of the written contract or written agreement provided that the "bodily injury" or "property damage" occurs, or the "personal and advertising injury" is committed, subsequent to the signing of such written contract or written agreement; or

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b. Premises or facilities rented by you or used by you; or

c. The maintenance, operation or use by you of equipment rented or leased to you by such person or organization; or

d. Operations performed by you or on your behalf for which the state or political subdivision has issued a permit subject to the following additional provisions:

(1) This insurance does not apply to "bodily injury", "property damage", or "personal and advertising injury" arising out of the operations performed for the state or political subdivision;

(2) This insurance does not apply to "bodily injury" or "property damage" included within the "completed operations hazard".

(3) Insurance applies to premises you own, rent, or control but only with respect to the following hazards:

a) The existence, maintenance, repair, construction, erection, or removal of advertising signs, awnings, canopies, cellar entrances, coal holes, driveways, manholes, marquees, hoist away openings, sidewalk vaults, street banners, or decorations and similar exposures; or

(b) The construction, erection, or removal of elevators; or

(c) The ownership, maintenance, or use of any elevators covered by this insurance.

However:

1. The insurance afforded to such additional insured only applies to the extent permitted by law; and

2. If coverage provided to the additional insured is required by a contract or agreement, the insurance afforded to such additional insured will not be broader than that which you are required by the contract or agreement to provide for such additional insured.

With respect to Paragraph **1.a.** above, a person's or organization's status as an additional insured under this endorsement ends when:

(1) All work, including materials, parts or equipment furnished in connection with such work, on the project (other than service, maintenance or repairs) to be performed by or on behalf of the additional insured(s) at the location of the covered operations has been completed; or

(2) That portion of "your work" out of which the injury or damage arises has been put to its intended use by any person or organization other than another contractor or subcontractor engaged in performing operations for a principal as a part of the same project.

With respect to Paragraph **1.b.** above, a person's or organization's status as an additional insured under this endorsement ends when their written contract or written agreement with you for such premises or facilities ends.

With respects to Paragraph **1.c.** above, this insurance does not apply to any "occurrence" which takes place after the equipment rental or lease agreement has expired or you have returned such equipment to the lessor.

The insurance provided by this endorsement applies only if the written contract or written agreement is signed prior to the "bodily injury" or "property damage".

We have no duty to defend an additional insured under this endorsement until we receive written notice of a "suit" by the additional insured as required in Paragraph **b.** of Condition **2. Duties In the Event Of Occurrence, Offense, Claim Or Suit** under **Section IV – Commercial General Liability Conditions.**

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2. With respect to the insurance provided by this endorsement, the following are added to Paragraph **2. Exclusions** under **Section I - Coverage A - Bodily Injury And Property Damage Liability:**

This insurance does not apply to:

a. "Bodily injury" or "property damage" arising from the sole negligence of the additional insured.

b. "Bodily injury" or "property damage" that occurs prior to you commencing operations at the location where such "bodily injury" or "property damage" occurs.

c. "Bodily injury", "property damage" or "personal and advertising injury" arising out of the rendering of, or the failure to render, any professional architectural, engineering or surveying services, including:

(1) The preparing, approving, or failing to prepare or approve, maps, shop drawings, opinions, reports, surveys, field orders, change orders or drawings and specifications; or

(2) Supervisory, inspection, architectural or engineering activities.

This exclusion applies even if the claims against any insured allege negligence or other wrongdoing in the supervision, hiring, employment, training or monitoring of others by that insured, if the "occurrence" which caused the "bodily injury" or "property damage", or the offense which caused the "personal and advertising injury", involved the rendering of, or the failure to render, any professional architectural, engineering or surveying services.

d. "Bodily injury" or "property damage" occurring after:

(1) All work, including materials, parts or equipment furnished in connection with such work, on the project (other than service, maintenance or repairs) to be performed by or on behalf of the additional insured(s) at the location of the covered operations has been completed; or

(2) That portion of "your work" out of which the injury or damage arises has been put to its intended use by any person or organization other than another contractor or subcontractor engaged in performing operations for a principal as a part of the same project.

e. Any person or organization specifically designated as an additional insured for ongoing operations by a separate **ADDITIONAL INSURED – OWNERS, LESSEES OR CONTRACTORS** endorsement issued by us and made a part of this policy.

3. With respect to the insurance afforded to these additional insureds, the following is added to **Section III – Limits Of Insurance:**

If coverage provided to the additional insured is required by a contract or agreement, the most we will pay on behalf of the additional insured is the amount of insurance:

a. Required by the contract or agreement; or

b. Available under the applicable Limits of Insurance shown in the Declarations;

whichever is less.

This endorsement shall not increase the applicable Limits of Insurance shown in the Declarations.

H. PRIMARY AND NON-CONTRIBUTORY ADDITIONAL INSURED EXTENSION

This provision applies to any person or organization who qualifies as an additional insured under any form or endorsement under this policy.

Condition **4. Other Insurance of SECTION IV – COMMERCIAL GENERAL LIABILITY CONDITIONS** is amended as follows:

a. The following is added to Paragraph **a. Primary Insurance:**

If an additional insured's policy has an Other Insurance provision making its policy excess, and you have agreed in a written contract or written agreement to provide the additional insured coverage on a primary and noncontributory basis, this policy shall be primary and we will not seek contribution from the additional insured's policy for damages we cover.

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b. The following is added to Paragraph **b. Excess Insurance:**

When a written contract or written agreement, other than a premises lease, facilities rental contract or agreement, an equipment rental or lease contract or agreement, or permit issued by a state or political subdivision between you and an additional insured does not require this insurance to be primary or primary and non-contributory, this insurance is excess over any other insurance for which the additional insured is designated as a Named Insured.

Regardless of the written agreement between you and an additional insured, this insurance is excess over any other insurance whether primary, excess, contingent or on any other basis for which the additional insured has been added as an additional insured on other policies.

I. ADDITIONAL INSUREDS - EXTENDED PROTECTION OF YOUR "LIMITS OF INSURANCE"

This provision applies to any person or organization who qualifies as an additional insured under any form or endorsement under this policy.

1. The following is added to Condition **2. Duties In The Event Of Occurrence, Offense, Claim or Suit:**

An additional insured under this endorsement will as soon as practicable:

a. Give written notice of an "occurrence" or an offense that may result in a claim or "suit" under this insurance to us;

b. Tender the defense and indemnity of any claim or "suit" to all insurers whom also have insurance available to the additional insured; and

c. Agree to make available any other insurance which the additional insured has for a loss we cover under this Coverage Part.

d. We have no duty to defend or indemnify an additional insured under this endorsement until we receive written notice of a "suit" by the additional insured.

2. The limits of insurance applicable to the additional insured are those specified in a written contract or written agreement or the limits of insurance as stated in the Declarations of this policy and defined in **Section III – Limits of Insurance** of this policy, whichever are less. These limits are inclusive of and not in addition to the limits of insurance available under this policy.

J. WHO IS AN INSURED - INCIDENTAL MEDICAL ERRORS / MALPRACTICE
WHO IS AN INSURED - FELLOW EMPLOYEE EXTENSION - MANAGEMENT EMPLOYEES

Paragraph **2.a.(1)** of **Section II - Who Is An Insured** is replaced with the following:

(1) "Bodily injury" or "personal and advertising injury":

(a) To you, to your partners or members (if you are a partnership or joint venture), to your members (if you are a limited liability company), to a co-"employee" while in the course of his or her employment or performing duties related to the conduct of your business, or to your other "volunteer workers" while performing duties related to the conduct of your business;

(b) To the spouse, child, parent, brother or sister of that co-"employee" or "volunteer worker" as a consequence of Paragraph **(1) (a)** above;

(c) For which there is any obligation to share damages with or repay someone else who must pay damages because of the injury described in Paragraphs **(1) (a)** or **(b)** above; or

(d) Arising out of his or her providing or failing to provide professional health care services. However, if you are not in the business of providing professional health care services or providing professional health care personnel to others, or if coverage for providing professional health care services is not otherwise excluded by separate endorsement, this provision (Paragraph **(d)**) does not apply.

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Paragraphs **(a)** and **(b)** above do not apply to "bodily injury" or "personal and advertising injury" caused by an "employee" who is acting in a supervisory capacity for you. Supervisory capacity as used herein means the "employee's" job responsibilities assigned by you, includes the direct supervision of other "employees" of yours. However, none of these "employees" are insureds for "bodily injury" or "personal and advertising injury" arising out of their willful conduct, which is defined as the purposeful or willful intent to cause "bodily injury" or "personal and advertising injury", or caused in whole or in part by their intoxication by liquor or controlled substances.

The coverage provided by provision **J.** is excess over any other valid and collectable insurance available to your "employee".

K. NEWLY FORMED OR ADDITIONALLY ACQUIRED ENTITIES

Paragraph **3.** of **Section II - Who Is An Insured** is replaced by the following:

3. Any organization you newly acquire or form and over which you maintain ownership or majority interest, will qualify as a Named Insured if there is no other similar insurance available to that organization. However:

a. Coverage under this provision is afforded only until the expiration of the policy period in which the entity was acquired or formed by you;

b. Coverage **A** does not apply to "bodily injury" or "property damage" that occurred before you acquired or formed the organization; and

c. Coverage **B** does not apply to "personal and advertising injury" arising out of an offense committed before you acquired or formed the organization.

d. Records and descriptions of operations must be maintained by the first Named Insured.

No person or organization is an insured with respect to the conduct of any current or past partnership, joint venture or limited liability company that is not shown as a Named Insured in the Declarations or qualifies as an insured under this provision.

L. FAILURE TO DISCLOSE HAZARDS AND PRIOR OCCURRENCES

Under **Section IV – Commercial General Liability Conditions**, the following is added to Condition **6. Representations:**

Your failure to disclose all hazards or prior "occurrences" existing as of the inception date of the policy shall not prejudice the coverage afforded by this policy provided such failure to disclose all hazards or prior "occurrences" is not intentional.

M. KNOWLEDGE OF OCCURRENCE, OFFENSE, CLAIM OR SUIT

Under **Section IV – Commercial General Liability Conditions,** the following is added to Condition **2. Duties In The Event of Occurrence, Offense, Claim Or Suit:**

Knowledge of an "occurrence", offense, claim or "suit" by an agent, servant or "employee" of any insured shall not in itself constitute knowledge of the insured unless an insured listed under Paragraph **1.** of **Section II – Who Is An Insured** or a person who has been designated by them to receive reports of "occurrences", offenses, claims or "suits" shall have received such notice from the agent, servant or "employee".

N. LIBERALIZATION CLAUSE

If we revise this Commercial General Liability Extension Endorsement to provide more coverage without additional premium charge, your policy will automatically provide the coverage as of the day the revision is effective in your state.

O. BODILY INJURY REDEFINED

Under **Section V – Definitions,** Definition **3.** is replaced by the following:

3. "Bodily Injury" means physical injury, sickness or disease sustained by a person. This includes mental anguish, mental injury, shock, fright or death that results from such physical injury, sickness or disease.

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P. **EXTENDED PROPERTY DAMAGE**

Exclusion a. of **COVERAGE A. BODILY INJURY AND PROPERTY DAMAGE LIABILITY** is replaced by the following:

a. Expected Or Intended Injury

"Bodily injury" or "property damage" expected or intended from the standpoint of the insured. This exclusion does not apply to "bodily injury" or "property damage" resulting from the use of reasonable force to protect persons or property.

Q. **WAIVER OF TRANSFER OF RIGHTS OF RECOVERY AGAINST OTHERS TO US – WHEN REQUIRED IN A CONTRACT OR AGREEMENT WITH YOU**

Under **Section IV – Commercial General Liability Conditions,** the following is added to Condition **8. Transfer Of Rights Of Recovery Against Others To Us:**

We waive any right of recovery we may have against a person or organization because of payments we make for injury or damage arising out of your ongoing operations or "your work" done under a contract with that person or organization and included in the "products-completed operations hazard" provided:

1. You and that person or organization have agreed in writing in a contract or agreement that you waive such rights against that person or organization; and

2. The injury or damage occurs subsequent to the execution of the written contract or written agreement.

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OP ID: MB

CERTIFICATE OF LIABILITY INSURANCE

DATE (MM/DD/YYYY): 08/26/2016

THIS CERTIFICATE IS ISSUED AS A MATTER OF INFORMATION ONLY AND CONFERS NO RIGHTS UPON THE CERTIFICATE HOLDER. THIS CERTIFICATE DOES NOT AFFIRMATIVELY OR NEGATIVELY AMEND, EXTEND OR ALTER THE COVERAGE AFFORDED BY THE POLICIES BELOW. THIS CERTIFICATE OF INSURANCE DOES NOT CONSTITUTE A CONTRACT BETWEEN THE ISSUING INSURER(S), AUTHORIZED REPRESENTATIVE OR PRODUCER, AND THE CERTIFICATE HOLDER.

IMPORTANT: If the certificate holder is an ADDITIONAL INSURED, the policy(ies) must be endorsed. If SUBROGATION IS WAIVED, subject to the terms and conditions of the policy, certain policies may require an endorsement. A statement on this certificate does not confer rights to the certificate holder in lieu of such endorsement(s).

PRODUCER Metro Insurance Services Lic. #0B95215 17421 Irvine Blvd. Tustin,, CA 92780	CONTACT NAME: PHONE (A/C, No, Ext): FAX (A/C, No): E-MAIL ADDRESS: PRODUCER CUSTOMER ID #: REEFC-1
INSURED REEF Check Foundation 13723 Fiji Way Ste. B2 Marina Del Rey, CA 90292	INSURER(S) AFFORDING COVERAGE — NAIC # INSURER A : State Compensation Ins. Fund INSURER B : INSURER C : INSURER D : INSURER E : INSURER F :

COVERAGES **CERTIFICATE NUMBER:** **REVISION NUMBER:**

THIS IS TO CERTIFY THAT THE POLICIES OF INSURANCE LISTED BELOW HAVE BEEN ISSUED TO THE INSURED NAMED ABOVE FOR THE POLICY PERIOD INDICATED. NOTWITHSTANDING ANY REQUIREMENT, TERM OR CONDITION OF ANY CONTRACT OR OTHER DOCUMENT WITH RESPECT TO WHICH THIS CERTIFICATE MAY BE ISSUED OR MAY PERTAIN, THE INSURANCE AFFORDED BY THE POLICIES DESCRIBED HEREIN IS SUBJECT TO ALL THE TERMS, EXCLUSIONS AND CONDITIONS OF SUCH POLICIES. LIMITS SHOWN MAY HAVE BEEN REDUCED BY PAID CLAIMS.

INSR LTR	TYPE OF INSURANCE	ADDL INSR	SUBR WVD	POLICY NUMBER	POLICY EFF (MM/DD/YYYY)	POLICY EXP (MM/DD/YYYY)	LIMITS	
	GENERAL LIABILITY						EACH OCCURRENCE	$
	COMMERCIAL GENERAL LIABILITY						DAMAGE TO RENTED PREMISES (Ea occurrence)	$
	CLAIMS-MADE OCCUR						MED EXP (Any one person)	$
							PERSONAL & ADV INJURY	$
							GENERAL AGGREGATE	$
	GEN'L AGGREGATE LIMIT APPLIES PER:						PRODUCTS - COMP/OP AGG	$
	POLICY PRO-JECT LOC							$
	AUTOMOBILE LIABILITY						COMBINED SINGLE LIMIT (Ea accident)	$
	ANY AUTO						BODILY INJURY (Per person)	$
	ALL OWNED AUTOS						BODILY INJURY (Per accident)	$
	SCHEDULED AUTOS						PROPERTY DAMAGE (PER ACCIDENT)	$
	HIRED AUTOS							$
	NON-OWNED AUTOS							$
	UMBRELLA LIAB OCCUR						EACH OCCURRENCE	$
	EXCESS LIAB CLAIMS-MADE						AGGREGATE	$
	DEDUCTIBLE							$
	RETENTION $							$
A	WORKERS COMPENSATION AND EMPLOYERS' LIABILITY Y / N						X WC STATU-TORY LIMITS OTH-ER	
A	ANY PROPRIETOR/PARTNER/EXECUTIVE OFFICER/MEMBER EXCLUDED? (Mandatory in NH)	N / A		L&H904539--16	06/01/2016	06/01/2017	E.L. EACH ACCIDENT	$ 1,000,000
A	If yes, describe under DESCRIPTION OF OPERATIONS below			0804539-16	06/01/2016	06/01/2017	E.L. DISEASE - EA EMPLOYEE	$ 1,000,000
							E.L. DISEASE - POLICY LIMIT	$ 1,000,000

DESCRIPTION OF OPERATIONS / LOCATIONS / VEHICLES (Attach ACORD 101, Additional Remarks Schedule, if more space is required)

CERTIFICATE HOLDER

PROOF-1

"Proof of Coverage Only"

CANCELLATION

SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELLED BEFORE THE EXPIRATION DATE THEREOF, NOTICE WILL BE DELIVERED IN ACCORDANCE WITH THE POLICY PROVISIONS.

AUTHORIZED REPRESENTATIVE

Tom Smith

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Citizen-scientist Monitoring of Rocky Reefs and Kelp Forests

Principle Investigator: Jan Freiwald, Director Reef Check California
Long Marine Laboratory, 100 Shaffer Rd, Santa Cruz, CA 95060
jfreiwald@reefcheck.org
(831) 345-8167

Dr. Freiwald will oversee all aspects of the proposed work. Specifically, he will analyze the monitoring results as well as the historical data Reef Check California has collected over the past ten years. Freiwald will also liaison with the collaborators in our MPa monitoring effort and insure that the data will be reported and available for researchers, resource managers, decision makers. Freiwald has much experience in rocky reef ecology and monitoring as his research at UC Santa Cruz, prior to joining Reef Check California in 2010 as RCCA Program Director, focused on this system (Freiwald 2012).

Abstract

Reef Check California has been collecting monitoring data on California's rocky reefs and kelp forest at over seventy sites along the coast since 2006. Sixteen of these sites require access to California State Parks. Data is collected by volunteer scuba divers who have been trained to collect scientifically sound data on over seventy species of fish, invertebrates and algae. All data that Reef Check California collects is accessible online via the Global Reef Tracker (data.reefcheck.us) for scientists, marine managers, and the general public to use.

Introduction

California has over 1100 miles of coastline that, as a result of the passage of the Marine Life Protection Act (MLPA) in 1999, the state is required to protect by reevaluating and redesigning California's system of marine protected areas (MPAs). As of the end of 2012 a network of MPAs along the entire open coast of California has been completed and now about 16% of the state waters are protected in a network of 124 MPAs. The Ocean Protection Council's (OPC) 5-year Plan and the OPC/CDFG Joint Work Plan emphasize the fundamental importance of baseline data for the implementation of both the MLPA and the Marine Life Management Act (MLMA)— passed in 1998 (OPC 2006). Motivations to evaluate the effectiveness of MPAs in meeting their management objectives are numerous (Syms and Carr 2001, Willis et al. 2003, Gaines et al. 2010), and determining reserve effectiveness is necessary to avoid a false sense of security, which can also be exacerbated if other regulations are relaxed because of the presumed conservation role that MPAs are intended to achieve. Failure of any management approach, due either to poor design or evaluation, can potentially endanger the resources it was designed to protect. Now, more than ever in the history of California's management of marine resources, agencies are compelled to provide both clear statements of MPA objectives and the means by which their effectiveness will be measured (CDFG 2007).

The MLMA Master Plan specifically recognizes volunteer divers as an important asset for conducting habitat, invertebrate and fish abundance surveys to support the development of sustainable Fishery Management Plans (CDFG 2001). Currently Reef Check California (RCCA) is a collaborator in the baseline monitoring of the MLPA MPAs in the North Central Coast Study Region (NCCSR) and in the state-wide long-term monitoring of MPAs in the other regions. Further, RCCA has contributed to the first 5-year review of MPAs under the MLPA initiative in the central coast and presented its findings and approaches at the Status of the California Central Coast Symposium in Monterey in February, 2013 (OST and CDFW 2013). Since its initiation in 2006, RCCA has therefore significantly contributed to the baseline, and now

long-term, monitoring of MPAs in all MLPA study regions, and now has about 90 monitoring sites inside and out of MPAs along the entire California coast. Its monitoring protocols have been adapted over the years to increase their usefulness for informing MPA evaluation and management (e.g., higher resolution fish size data), and have been tested and shown to be compatible with the rocky reef monitoring efforts of other large, academic monitoring programs in California (Gillett et al. 2012).

The rocky reefs and kelp forests along the California coast are an iconic and highly valued (e.g., commercially fisheries, recreational fishing, diving, kayaking, wildlife viewing) but also highly impacted (commercial and recreational use) ecosystem feature in state waters. Therefore, understanding the baseline and future effects, or the lack thereof, of MPAs on this key ecosystem feature is particularly critical to the successful management of exploited species and impacted ecosystems. If we cannot demonstrate successful management of this key marine habitat by MPAs, then public support for this management tool may decline even if they show benefits in other ecosystem features. The baseline monitoring of the newly established networks of MPAs in California needs to provide the information necessary to evaluate if and how the MPA network can serve conservation and fisheries management purposes (Willis et al. 2003, Gaines et al. 2010). It also needs to establish a comprehensive understanding of the current state of the system to prevent the effects of a 'sliding baseline' that will prevent detection of future MPA effects (Dayton et al. 1998).

Reef Check's goal is to use citizen-science, community-based monitoring and data-collection to improve marine management and educate the public about the marine environment off the California coast. This is achieved through the engagement of local community partners and research institutions in order to integrate the marine user community and research networks. Through its partnerships, RCCA creates a link between citizen scientists and the academic research community, thus integrating community action and citizen science into the wider MPA baseline monitoring effort. This allows the statewide program to develop a local presence in the areas where our volunteers live and work, and generates an avenue for integrating local knowledge into the statewide reef-monitoring program. This local integration of the program lets us address local concerns when formulating research question based on our monitoring data. At the same time local teams of citizen scientists are integrated into statewide reef monitoring, thus building a network of local reef knowledge that spans across the state. RCCA's integrative approach provides local community members access to marine science expertise (i.e. trainings, interactions with staff), creates a constituency supportive of science-based management, and fosters a sense of ocean stewardship.

Reef Check Organizational and Program Background

The Reef Check Foundation has proven the strength and agility of the 'public-involvement' approach over the last 20 years, and Reef Check California is engaging citizen volunteers in ways that have not been achieved by any other group or institution in California. By partnering with state agencies, community volunteers, nonprofit groups, and institutional programs, Reef Check California provides the needed infrastructure and support to get community members involved in the state's resource management through their contribution to scientific data collection as citizen scientists. RCCA has established, and will continue to build, a comprehensive citizen science scuba monitoring program to inform marine policy and management practices on a sustainable and long-term basis.

The Reef Check California (RCCA) program, established in 2005, continues the organization's global reef monitoring approach in California's shallow rocky reefs and kelp forest ecosystems. Modeled after Reef Check's successful tropical program, RCCA educates, trains, and engages coastal communities and ocean users in the collection of scientifically sound data to help inform California marine management decisions.

Specifically, RCCA's goal is to use citizen-science, community-based monitoring and data-collection to improve marine management and educate the public about the marine environment off the California coast. RCCA's membership and institutional partners include recreational divers, community members, commercial and recreational fishermen, scientists, academic institutions, state agencies, and business groups, all of whom work together to monitor California's most diverse nearshore ecosystems, the rocky reefs. RCCA has trained over 1000 scuba divers in our survey method and has an active pool of about 250 volunteers that is annually certified before conducting surveys. Over the 10 years of its existence RCCA has built a statewide network of rocky reef monitoring sites ranging from San Diego, in the south, to Humboldt County, in the north, and is the only organization maintaining a statewide community-based subtidal rocky reef monitoring network. RCCA has been involved in the MLPA initiative's MPA design and implementation process right from its inception. Through our online Nearshore Ecological Database (NED), where we make all data publically available and which has been linked to Global Reef Tracker (data.reefcheck.us), we have contributed our data to the MPA implementation process in the north-central, southern and northern study regions.

Methods

A. Study Area

Sixteen of our roughly 90 survey sites require our surveyor to enter a California State Park to Survey. Six of our survey sites are located within the boundary of a State Park. The remaining ten survey sites are not located within the boundaries of a State Park but require us to enter the park to reach our off shore survey sites. Of these ten, for seven of them we use park facilities such as parking lots and bathrooms, while the remaining three we park outside of the State Park and walk through it to reach our survey site. Current sites are listed in Table XX. In the future additional survey sites might be added that might require access though additional state parks

Surveys began in 2006 and will continue indefinitely. Most sites are surveyed once per year though some sites are surveyed twice per year. Surveys generally take 1-2 days per site to complete.

Reef Check Site	California State Park	County	Lat	Long
Sites located within State Park Boundaries				
Grestle Cove	Salt Point State Park	Sonoma	38.56646	-123.329964
Fort Ross	Fort Ross State Historic Park	Sonoma	38.510601	-123.245064
Middle Reef	Point Lobos State Natural Reserve	Monterey	36.522484	-121.938614
Weston	Point Lobos State Natural Reserve	Monterey	36.5112	-121.946297
Refugio	Refugio State Beach	Santa Barbara	34.461056	-120.066872
Crystal Cove	Crystal Cove State Park	Orange	33.57135	-117.841103
Sites located outside of State Park Boundaries in which Park facilities are used				
Mendocino Headlands	Mendocino Headlands State Park	Mendocino	39.305283	-123.811218
Glass Beach	MacKerricher State Park	Mendocino	39.451645	-123.814728
Caspar South	Caspar Headlands State Beach	Mendocino	39.361729	-123.822449
Caspar North	Caspar Headlands State Beach	Mendocino	39.364429	-123.821327
Russian Gulch	Russian Gulch State Park	Mendocino	39.327984	-123.8088
Van Damme	Van Damme State Park	Mendocino	39.271915	-123.795914
Limekiln	Limkiln State Park	Monterey	36.008499	-121.523354
Sites located outside of State Park boundaries in which Park facilities are not used				
Portuguese Beach	Mendocino Headlands State Park	Mendocino	39.3032	-123.8034
Frolic Cove	Point Cabrillo Lighthouse Station	Mendocino	39.355026	-123.823868
North Monastery	Carmel River State Beach	Monterey	36.526806	-121.926544

B. **Procedures**

At each selected site we will conduct surveys according to the RCCA protocol (Freiwald et al. 2013b). RCCA surveys consist of eighteen 30m transects to monitor key species of fishes (35 species), invertebrates (32 species), and algae (5 native, 4 invasive species) (Appendix 1). Because the distribution and abundance of fish, invertebrate and algae species are known to vary with depth and cross-shore location within the kelp forest (i.e. offshore to onshore), samples are stratified across these gradients. This is achieved by distributing total of 18 fish and 6 invertebrate, algae and UPC transects in equal numbers of transects (n= 9 for fish, n=3 for invertebrates & algae) for sampling in two strata: an inshore (3 -12m) and an offshore (12-20m) area of the rocky reef (Figure 4).

Transects are divided into core transects (3 in each depth zone) and fish 'only' transects (6 in each zone) that are placed haphazardly but parallel to the depth contours in each strata. Along the core transects the fish, invertebrate and algae communities, as well as the physical habitat, are sampled. Response variables in this sampling design are density and size structure of the 35 fish species, density of key invertebrates (abalone are sizes to nearest cm), and algae species (Appendix 1). For giant kelp (*Macrocystis pyrifera*) the number of plants and the number of stipes on individual plants are counted. Further, the reef substrate is characterized in four categories of reef (>1m), boulder (<1m), cobble (<0.1m) and sand as well as by a categorical estimate of the relief (4 categories: 0 – 10 cm, 11 cm – 1m, 1 – 2 m, and > 2). Fish are counted and sized to the nearest centimeter from within a two by two meter volume above the seafloor along the transect (2m wide by 2m tall by 30m long). Key invertebrate and algae species are counted within a two-meter band (2m by 30m swath) along the rocky reef seafloor. The physical substrate and proportional cover of species for which individuals are not readily distinguishable (e.g., colonial species, small macroalgae) is characterized using uniform point contact (UPC) survey methods. Taxonomic resolution (i.e. species, genus, family, and higher) of data collected on UPC transects varies among taxa. To increase the sampling of fish they are sampled

in the same way along six additional transects (fish only transects) in each zone (Figure 4). At no point during the surveys are organisms moved or taken from the environment.

Diver training and data quality assurance

RCCA's immersion learning training and ecosystem monitoring form the core of the program and effectively engage hundreds of California's citizen scientists in the marine management process. The program was designed with oversight from state resource managers and leading marine scientists, and is formally recognized by the CDFW in a Memorandum of Understanding as a valuable tool for marine management and public engagement. RCCA's training course consists of a four-day immersion-learning curriculum. It includes: rigorous classroom work focused on reef ecology, conservation and MPA science, and identification of 73 selected indicator species (both native and invasive); swimming pool sessions for learning underwater scientific data collection techniques; and field days for practice, testing, and certification in RCCA's survey protocols. Through this training, volunteers acquire a thorough understanding of the value of a healthy native marine environment, an appreciation for the importance of monitoring, and the tools to conduct scientific surveys. Divers who complete the course and pass certification levels sufficient to conduct surveys continue to increase their knowledge by actively participating in underwater surveys. Only divers who completed the required training and testing in each transect type and have demonstrated proficiency in data collection activities are allowed to contribute data for the transect types they are certified for. This tiered approach allows volunteers to collect data for certain taxa once they complete testing for those transect types and enables volunteers with differing abilities to participate in the program without adversely affecting data quality. Strict quality assurance and control procedures ensure that the collected data are of high quality and scientifically useful. These procedures include a one-day annual recertification (including written and field tests) of each diver by RCCA staff each year after initial certification. Further, divers discuss the data they collected with each other and RCCA staff after each dive, and datasheets are proofread by fellow volunteers to insure accuracy of the data. This procedure has proven to be a very effective way of catching mistakes or unusual data early on when it can still be addressed. At this quality assurance step transects are redone if mistakes or data omissions (e.g., species misidentified or not counted) are noted. RCCA's online data entry system (NED) provides another layer of quality control. Automated data error checks (e.g., species size ranges, regional distributions) are programmed into the database so that unusual data is flagged for examination by RCCA staff. Additionally, all data are reviewed by RCCA staff marine scientists and erroneous data are removed before data are submitted into the final database. Over the last three years we have maintained a volunteer base of about 250 active divers statewide (Figure 1). Every year we have increased our diver retention and now have a body of experienced citizen scientists who have surveyed many of RCCA's sites for several years. This long-term retention of volunteers guaranties consistency in data collection and quality and the years of service of many volunteers are comparable to those by undergraduate student or technicians in academic monitoring programs.

C. Collections

No specimens will be collected.

D. Other State or Federal Permits

Reef Check California has a Memorandum of Understanding with the California Department of Fish and Wildlife (Appendix X). As per the CDFW, a collecting permit is not required for the work RCCA is conducting in state waters.

E. **Soil Disturbance**

No soil-disturbing activities will be conducted.

Literature Cited

Budget

Products

Reef Check California (RCCA) has surveyed rocky reefs and kelp forests in California since 2006 and has over seventy sites along the California coast. The goal of this project is to quantify key attributes of species, populations, communities and habitat variables that constitute representative kelp forest ecosystems within and outside of the MPAs, in order to characterize this important ecosystem feature. The proposed sampling design, selected response variables (i.e. key species), and analytical approaches are intended to provide scientists, managers, stakeholders and policy makers with a baseline for future assessment of the effectiveness of the MPAs, as well as to detect initial changes in the ecosystem should they occur. Further, the outcomes from this study will also provide recommendations for long-term monitoring metrics and build capacity for cost-effective long-term monitoring. Products will include technical reports and scientific publications as well as outreach and educational materials.

Specific objectives of RCCA long-term monitoring are:

1. **Assess the condition of the rocky reef and kelp forest ecosystem feature by analyzing RCCA's dataset and auxiliary data in the context of the MPAs.** Analysis of the ecosystem conditions at MPA implementation can provide valuable information for understanding future MPA performance and setting goals/targets for evaluating MPAs effectiveness.
2. **Build capacity for cost-effective long-term MPA monitoring through the continued involvement of community members in the monitoring of MPAs.** This effort will be part of our goal to further develop and strengthen a statewide citizen scientist-based monitoring network to provide data and analysis for regional and statewide evaluation of individual MPAs and network performance.
3. **Expand existing public online data dissemination and illustration tool through the Global Reef Tracker to inform managers, stakeholders, policymakers and the public about the status of the marine environment.**

Reef Check Site	Park	County	Lat	Long
Sites located within State Park Boundaries				
Grestle Cove	Salt Point State Park	Sonoma	38.56646	-123.329964
Fort Ross	Fort Ross State Historic Park	Sonoma	38.510601	-123.245064
Middle Reef	Point Lobos State Natural Reserve	Monterey	36.522484	-121.938614
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Crystal Cove	Crystal Cove State Park	Orange	33.57135	-117.841103
Sites located outside of State Park Boundaries in which Park facilities are used				
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Caspar North	Caspar Headlands State Beach	Mendocino	39.364429	-123.821327
Russian Gulch	Russian Gulch State Park	Mendocino	39.327984	-123.8088
Van Damme	Van Damme State Park	Mendocino	39.271915	-123.795914
Limekiln	Limkiln State Park	Monterey	36.008499	-121.523354
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Frolic Cove	Point Cabrillo Lighthouse Station	Mendocino	39.355026	-123.823868
North Monastery	Carmel River State Beach	Monterey	36.526806	-121.926544

Jan Freiwald, PhD

Curriculum Vitae
August 2016

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University of California
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Telephone: +1 831 345-8167
Email: freiwald@ucsc.edu

Education:

PhD Ecology and Evolutionary Biology: UC Santa Cruz, USA "Causes and Consequences of the Movement of Temperate Reef Fishes". Advisor: Dr Mark Carr Committee members: Dr Pete Raimondi, Dr Rick Starr	2009
B.Sc. Marine Biology: University of California Santa Cruz, USA	2002
Vordiplom Biology: Christian-Albrechts-University Kiel, Germany	1998

Current position:

Director, Reef Check California

Academic appointments:

2011-16 Research Associate, Institute of Marine Sciences, UC Santa Cruz
2011 Visiting Assistant Professor in Ecology and Evolutionary Biology, UC Santa Cruz

Research interests:

Population ecology of marine fishes; effect of movement of individuals on population and community dynamics. Applied community ecology; marine conservation and fisheries management, specifically marine protected area (MPA) design and evaluation.

Publications:

Freiwald, J., C. J. Wisniewski, D. Abbott. In print. Northward range extension of the crowned sea urchin (*Centrostephanus coronatus*) to Monterey Bay, California. California Fish and Game.

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floor sonar surveys: Spatial patterns and impacts to species' richness and diversity. Continental Shelf Research 55:40-51.

Freiwald, J. 2012. Movement of adult temperate reef fishes off the west coast of North America. Canadian Journal of Fisheries and Aquatic Sciences 69:1362-1374.

Gillett, D. Pondella, II, J. Freiwald, K. Schiff, J. Caselle, C. Shuman, and S. Weisberg. 2012. Comparing volunteer and professionally collected monitoring data from the rocky subtidal reefs of Southern California, USA. Environmental Monitoring and Assessment 184:3239-3257.

Freiwald, J., N. L. Stewart, D. C. Yates, and G. Bernardi. 2009. Isolation and characterization of nine polymorphic microsatellite loci of the kelp greenling, *Hexagrammos decagrammus*, a temperate reef fish. Molecular Ecology Resources 9:563-565.

Technical reports:

Sandoval E., J. Freiwald. 2016. Santa Cruz Port District – Evaluation of Dredging Impacts on Giant Kelp.

Freiwald, J., C. Wisniewski. 2015. 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.

Sandoval E., J. Freiwald. 2014. Santa Cruz Port District Three Year Baseline Monitoring of Giant Kelp.

Freiwald, J., M. Wehrenberg, G. Hodgson. 2013. Reef Check California: North Central Coast Baseline Surveys of Shallow Rocky Reef Ecosystems. Final Report: North Central Coast MPA Baseline Monitoring.

Freiwald J., Megan Wehrenberg, Colleen Wisniewski, Gregor Hodgson. 2013 Status of Rocky Reef Ecosystems in California 2006 – 2011. Reef Check Foundation, Pacific Palisades, CA, USA.

Freiwald J., C. Wisniewski, M. Wehrenberg, C. Shuman, & C. Dawson. 2015. Reef Check California Instruction Manual: A Guide to Rocky Reef Monitoring, 8th Edition. Reef Check Foundation, Pacific Palisades, CA, USA.

Presentations:

2015 Western Society of Naturalists: Freiwald J., Caselle, J., Meyer, R., Blanchette, C., Hovel, K., Neilson, D., Dugan, J., Altstatt, J., Nielsen, K., Bursek, J.. Challenges and opportunities for citizen science monitoring of MPAs in California: case studies and recommendations. Sacramento, California.

2015 Western Society of Naturalists: Freiwald J., Abbott, D, Neumann, A.T. Long-term MPA monitoring reveals community changes: a north central California coast case study. Sacramento, California

2015 Western Society of Naturalists: Claisse, J.T., Blanchette, C, Dugan, J, Caselle, J.E., Williams, J.P., Freiwald, J., Pondella, D.J., Schooler, N., Davis, K., Zahn, L.A., Williams, C.M.. MPA baseline data integration: biogeographic patterns of communities across multiple marine ecosystems in southern California. Sacramento, California.

2015 MBNMS Currents Symposium. Tapping into the public's skills – how citizen scientists become experts. Jan Freiwald. Seaside, CA. Invited talk.

2015 Reef Check California: Citizen Scientist Divers Monitor California's MPAs and Inform Marine Management. Jan Freiwald. SoCal SETAC annual meeting. San Pedro, CA April. Invited talk.

2015 Involving the public in marine research: citizen scientist divers Monitor California's marine protected areas. Jan Freiwald. Citizen Science Conference 2015. San Jose, CA. Poster.

2014 Western Society of Naturalists: Diversity drives dynamics: variable regulation of black surfperch populations. Johnson, D.W., Bernardi, G., Freiwald, J. Tacoma, Washington. Talk

2014 Involving fishing communities in Baja California, Mexico, in the monitoring of their resources to achieve sustainable fisheries and livelihoods. Jan Freiwald, Amanda Leijbowicz, Fiorenza Micheli. 2nd World Small-Scale Fisheries Congress. Merida, Mexico.

2014 Citizen scientist divers monitor California's MPAs and inform marine conservation. Jan Freiwald. 3rd IMCC, Glasgow, Scotland.

2014 Science of Marine Protected Areas. Webinar organized by Monterey Bay Sanctuary Foundation. With Mark Carr and Rikki Dunsmore. (May 29).

2013 Annual Conference of Society for Conservation GIS. Jan Freiwald. Marine Spatial Session. Invited panel speaker.

2013 Ecosystem-Based Management tools Network. Effective Citizen Science for Coastal and Marine Environments: Reef Check California, COASST, and MPA Watch. Open Channel webinar. Invited speaker. http://openchannels.org/webinars/ecosystem- based-management-ebm/citizen-science-coastal-and-marine-environments-reef-check

2013 Humboldt State University. Citizen scientist kelp forest surveys: Statewide MPA monitoring. Jan Freiwald. Invited Seminar.

2013 Status of the California Central Coast Symposium: Jan Freiwald. Citizen Scientist kelp forest monitoring: Results from Marine Protected Area (MPA) baseline surveys along California's Central Coast. Monterey. Invited speaker

2013 Status of the California Central Coast Symposium: Jan Freiwald. Engaging Communities in support of Effective MPA Management. Invited panel speaker.

2012 Western Society of Naturalist: Jan Freiwald, Megan Wehrenberg, Colleen Wisniewski. Rocky Reefs since the 1970's: Comparison of Historic Data to Reef Check California Surveys. Talk.

2012 AAUS Symposium: Chelsea Prindle, James Lindholm, and Jan Freiwald. Seasonal variability of kelp forest fishes and the implications for sampling frequency in a citizen science monitoring program. Talk

2012 AAUS Symposium: Megan L. Wehrenberg, Jan Freiwald. Reef Check California: applied ecosystem monitoring as a training tool for AAUS programs. Talk

2012 Monterey Bay National Marine Sanctuary symposium: Jared Figurski, Jan Freiwald, Steve Lonhart, & Curt Storlazzi. Effects of Burial and Exhumation on Temperate Rocky Reef Benthos. Monterey, California. Poster.

2011 Western Society of Naturalists: Fejtek, S.M.*, Waltz, G.T., Reynaga, A.P., Macleod, A., Malone, D.P., Freiwald, J., Carr, M.H. Massive die-off of red abalone, *H. rufescens*, quantified in marine protected areas along the coast of sonoma county, California. Vancouver, WA. Talk

2011 Western Society of Naturalists: Lonhart, S., Figurski, J., Freiwald, J., Storlazzi, C. Biological responses to burial and exhumation of bedrock reefs in central California.

2011 Public lecture at Monterey Bay Aquarium. Movement and its Implications temperate reef fishes and MPAs. Monterey California. Vancouver, WA. Talk

2010 California State University Monterey Bay, Division of Science and Environmental Policy: Causes and consequences of the movement of temperate reef fishes. Monterey, California. Invited Seminar.

2010 California and the World Ocean 2010. Informing marine management through citizen-science. San Francisco, California. Concurrent session (organized).

2010 California and the World Ocean 2010. Reef Check California: A citizen-science program to inform marine management. San Francisco, California. Talk.

2010 Monterey Bay National Marine Sanctuary symposium: The effect of habitat variability on the home range size of two temperate reef fishes, kelp greenling and kelp rockfish. Monterey, California. Poster.

2010 Monterey Bay Aquarium: Causes and consequences of the movement of temperate reef fishes, Monterey, California. Invited Seminar.

2009 University of California Santa Cruz, Applied Mathematics Department: Causes and consequences of the movement of temperate reef fishes, Santa Cruz, California. Seminar.

2009 Western Society of Naturalists: Density-dependent home range size in a temperate reef fish, the kelp greenling (*Hexagrammos decagrammus*). Monterey, California. Talk

2009 University of California Davis, Bodega Marine Laboratory: Causes and consequences of the movement of temperate reef fishes, Bodega Bay, California. Invited Seminar.

2009 Monterey Bay National Marine Sanctuary symposium: Density-dependent home range size in kelp greenling. Monterey, California. Poster.
2008 Western Ground Fish Conference: Movement of Temperate Reef Fishes: Informing the California's MLPA process. Santa Cruz, California. Talk.
2008 STEPS Central Coast Biodiversity Workshop. Acoustic tracking of Kelp Forest Fishes: Informing Marine Protected Area Design. Santa Cruz, California. Poster.
2008 Monterey Bay Aquarium: Movement of Temperate Reef Fishes: From Individual Behavior to Population Ecology and MPA Design. Monterey, California. Invited Talk.
2007 Western Society of Naturalists: Movement of Temperate Reef Fishes: Informing MPA size design. Ventura, California. Talk.
2007 European Symposium on Marine Protected Areas. Movement of Temperate Reef Fishes: From Individual Behavior to MPA Design. Murcia, Spain. Talk.
2006 Western Society of Naturalists: The Interaction of Habitat Structure and Species Characteristics Influences Movement Patterns of Temperate Reef Fishes. Seattle, Washington. Talk.
2006 Monterey Bay National Marine Sanctuary symposium: High-resolution, Long-term Study of Kelp Greenling Habitat Use and Movement Ranges. Monterey, California. Poster.
2004 Monterey Bay National Marine Sanctuary symposium: Tracking Kelp Forest Fishes Movement: An Important Parameter in Marine Protected Area Design. Monterey, California. Poster.

Honors and Fellowships:

2009 Monterey Bay National Marine Sanctuary, Currents symposium. Best Graduate Student Poster: Density-dependent home range size in kelp greenling.
2007-08 University of California Marine Counsel, CEQI Graduate Student Fellowship.
2004-07 National Science Foundation, Graduate Research Fellowship.
2007 UCSC STARS scholarship.
2002 Highest Honors in Marine Biology (GPA 3.95), UC Santa Cruz.
2002 Thimann Scholarship, University of California, Santa Cruz.
2001 Biology GRE with Honors.
2001 Bell Scholarship, University of California, Santa Cruz.

Teaching

Courses taught:

2011 Short course: Fisheries assessment at small, local scales – using a simple assessment tool FiSAT. La Paz, Mexico
2011 Research Methods in Ecology and Evolutionary Biology, upper division undergraduate course, UC Santa Cruz
2007 Ichthyology, Teaching Assistant with Giacomo Bernardi, UC Santa Cruz
2006 Marine Ecology, Teaching Assistant with Mark Carr, UC Santa Cruz
2002 Marine Conservation, Undergraduate Teaching Assistant with Mark Carr, UC Santa Cruz

Guest Lectures:

2009 Ichtyology, COSMOS summer school, UC Santa Cruz.
2007-09 Software for scientific literature searches and literature management. Scientific skills, Graduate Seminar UC Santa Cruz.
2009 The effect of habitat variability and population density on the movement of two kelp forest fishes. Kelp Forest Ecology, UC Santa Cruz.
2007 Movement of three species of temperate reef fishes. Kelp Forest Ecology, UC Santa Cruz.

2005 Movement patterns of temperate reef fishes and methods of studying them. Kelp Forest Ecology, UC Santa Cruz.

2005 Movement patterns of temperate reef fishes and methods of studying them. Ichthyology, UC Santa Cruz.

Graduate student committee member:

Ben Higgins (University of Califorina Santa Cruz, PhD)
Chelsea Parrish-Kuhn (California State University Monterey Bay, MS).

Student Mentoring:

2010-12	Caitlin Cooper	Undergraduate Research Experience – Reef Check Internship. Mentoring undergraduates in applied research UROC program California State University Monterey Bay
2007-08	Patrick Lane:	Movement and habitat associations: contrasting acoustic telemetry with mark re-sight techniques, Undergraduate independent study Using ultrasonic telemetry and SCUBA surveys to determine habitat associations of kelp rockfish: differences in habitat structure between inner and outer areas of home range, Undergraduate senior thesis
2007-08	Devona Yates	Field and laboratory techniques for paternity study of kelp greenling (*Hexagrammos decagrammus*), Undergraduate independent study
2007	Jasmine Ruvalcaba	Diving for marine ecological research, Undergraduate internship thorough Undergraduate Research Opportunities Center (UROC) at California State University Monterey Bay
2006-07	Nathan Stewart:	Acoustic telemetry and genetic laboratory work, post graduate research experience
2005	Jared Kibele:	Measuring Topological Complexity: A comparison of manual and remote sensing methods, Undergraduate independent study
2005	Terill Efird	Sex change and harem dynamics of gobies, Undergraduate independent study

Community Service / Scientific Advisor / Consultant:

Partnering for Healthy Oceans - Global Marine Protected Areas Partner Summit. Marine Conservation Institute, ESRI. Redlands, November 2-3, 2015. Invited participant.

MPA Monitoring Data & Information Management. September 14th 2015. OST workshop. Invited participant.

Planning for change: developing long-term ecosystem monitoring recommendations for marine and coastal decision-maker. Sacramento, November 5th 2015. Convened by Partnership for Interdisciplinary Studies of Coastal Oceans, the California Ocean Science Trust, Oregon Department of Fish and Wildlife, and California Department of Fish and Wildlife. Invited participant.

Open Science and Innovation: Of the People, By the People, For the People. The White House, Office of Science and Technology Policy. September 30, 2015. Invited Speaker.

Planning for long-term monitoring in the South Coast. UC Santa Barbara. August 20-21. 2015. Invited participant.

Designing long-term MPAs monitoring in central California. Hosted by Ocean Sciences Trust (OST). March 27, 2015. Invited participant.

Provided input and data for the Monterey Bay National Marine Sanctuary "Sanctuary Condition Report". 2015

Advisory board member: Citizen Sciences Initiative. Ocean Sciences Trust.2013-2014.

Northern California Public Participation in Scientific Research (PPSR) Regional Workshop. UC Davis. February 22-23, 2013. Invited participant.

West Coast MPAs Information Exchange. Monterey Bay Aquarium Division of Conservation and Science. February 26, 2013. Monterey. Invited participant.

Invited participant: Developing Principles and Good Practice for Expert Judgments workshop, sponsored by the California Monitoring Enterprise, National Center for Ecological Analysis and Synthesis (NCEAS) Santa Barbara, CA, January, 2012.

Ecological consultant: United States Geological Survey

Ecological consultant: Diver habitat surveys for Santa Cruz harbor dredging mitigation, Sandoval and Associates

National Science Foundation (NSF) proposal reviewer

Journal Reviewer:
PLOS ONE, Environmental Biology of Fishes, Genetics and Molecular Biology, ICES Journal of Marine Science, Marine Biology, Marine Environmental Research, International Journal of Molecular Sciences, Journal of Fish Biology, Marine Ecology Progress Series, Journal of the Royal Society Interface

Diving certifications:
2002 Small Boat Operator, University of California Santa Cruz
2001 Dive Master, NAUI
2000 Scientific Diver (UCSC), American Association Underwater Sciences

Professional Associations:
American Association for the Advancement of Science (AAAS)
Ecological Society of America (ESA)
Western Society of Naturalists (WSN)

Languages: English, German

Dan Abbott

6044 Wenk Ave. Richmond CA, 94804
510.684.7835 dabbott@reefcheck.org

EDUCATION

B.S. Environmental Economics and Policy, December 2003. University of California, Berkeley, College of Natural Resources

EXPERIENCE

***Central Coast Regional Manager,* Reef Check California (August 2014–Present)** Oversee operation of Reef Check California's Central Coast program.

- Instruct certified recreational divers in scientific sampling protocols to characterize substrates and identify, enumerate, and measure marine invertebrates, fishes, and algae.
- Lead surveys teams of 20 to 30 volunteer divers at sites along the California coast from San Diego to Mendocino from both shore and from vessels.
- Spearheaded multi-day survey expedition to nine sites along the Big Sur coast.
- Take part in mulit-day ship based surveys at the Channel Islands, including Santa Rosa, Santa Cruz, Anacapa, and Santa Catalina Islands.
- Train local fishermen at Isla Natividad and El Rosario, Mexico, in Reefcheck California monitoring protocols as part of an initiative by Comunidad y Biodiversidad (COBI) to work with fishing communities to set up Marine Protected Areas in Baja California
- Volunteer with outreach efforts for public education for Marine Protected Areas

***Scientist,* Tenera Environmental (October 2006–July 2015)** Lead field operations of biological monitoring team and contribute to technical reports. Coordinate with clients and internal departments to budget, plan and conduct a wide range of studies in marine and aquatic environments.

- Conducted entrainment and source water studies for proposed desalination plants to determine the effects of increased water diversions on local fish populations. Aid in investigations into new technologies designed to reduce adverse impacts.
- Oversaw several long-term environmental monitoring projects to ascertain entrainment and impingement effects to adult, juvenile, and larval fish as well as marine invertebrates resulting from water diversions from several generating stations and water district pumping facilities.
- Conducted the biological inventories and evaluations of three reservoirs.
- Conducted bathymetry mapping of a number of sloughs, reservoirs, and areas adjacent to industrial sites to determine thermal discharge plume characteristics, dredging effects assessment and/or evaluations of biological communities.
- Conducted thermal plume studies of the discharge water of several power plants and one refinery located in the San Francisco Bay-Delta, utilizing stationary long-deployment temperature monitoring and mobile vessel-based monitoring equipment.
- Installed and service Electronic Monitoring Systems on commercial fishing vessels, comprised of cameras, global positioning systems, hydrologic pressure gauges, and hard drive with corresponding software.
- Conducted extensive research and monitoring on a new state-of-the-art fish screen in the Sacramento-San Joaquin Delta including identifying and enumerating over 5,000 fish removed from the screen construction area. Install and maintain a camera system designed to investigate the collection of salmonids by the screen's rake system, conduct scuba surveys in front of the

screen to study the screen's effect on predator behavior, and offer extensive consultation on aquatic vegetation management.

Diving Safety Officer, **Tenera Environmental (February 2011– July 2015)** Manage a diverse team of scientific divers in a wide range of dive projects in a variety of locations.

- Spearheaded Tenera's application into the American Association of Underwater Scientists, to which Tenera was accepted as an AAUS Organizational Member in November 2011.
- Responsible for the routine operational authority of the scientific diving program including the conducting of training and certification of divers, approval of dive plans, maintenance of diving records, and ensuring compliance AAUS regulations.
- Act as lead diver with team on numerous scientific dive operations conducted in locations varying from remote offshore islands to nearshore industrial areas. Tasks include ascertaining density of fish, invertebrates and algae, installing, servicing and retrieving a wide array of instrumentation in depths up to 120', installing and maintaining underwater camera and lights.

Fisheries Technician, **Pacific States Marine Fisheries Commission (June 2004 – June 2006)**

- Carried out fisheries research aboard commercial passenger fishing vessels. Recorded GPS data, seal interactions, fish mortality rates, indentified, enumerated, weighed and measured catch and by-catch.
- Collaborated with California Department of Fish and Game's Ocean Salmon Project to conduct salmon research, including recovering tagged salmon heads to determine population distribution. Educated fisherman on salmon identification and regulations.
- Conducted creel census as part of team of samplers responsible for fisheries data in the San Francisco Bay Area. Collected data to determine catch and effort estimates for local fisheries. Recorded demographic information by communicating effectively with diverse fishing community.

CERTIFICATIONS

NAUI Scuba Instructor #47148. NAUI scuba instructor since 2006. Teach all levels of scuba classes ranging from Open Water to Divemaster. Additionally teach NAUI First Aid, Basic Life Support (CPR), and Emergency Oxygen Administration.

Outdoor Emergency Care Technician. Hold current certification as an OEC technician. OEC is an EMT-level certification adapted for the non-urban environment overseen by the American Academy of Orthopedic Surgeons and administered by the National Ski Patrol.

PSI/PCI Inspector. Certified to conduct visual inspections of scuba tanks.

USCG Boating Skills and Seamanship. US Coast Guard certified in small boat operation.

Basic Life Support for Health Care Providers (BLS-HCP) Hold current certification in Basic Life Support for Health Care Providers from the American Heart Association.

National Ski Patrol Member of the National Ski Patrol since 2010. Provide emergency care and transportation for injuries ranging from minor to life-threatening in remote non-urban environments.

Archipelago Electronic Monitoring Technician. Certified February 2011 to install Archipelago Electronic Monitoring Systems on commercial fishing boats.

Contributing Author to Selected Technical Reports

Mallard Reservoir Aquatic Ecosystem Evaluation. Prepared for Contra Costa Water District. Tenera 2007.

Los Vaqueros Reservoir Aquatic Ecosystem and Fisheries Evaluation. Prepared for Contra Costa Water District. Tenera 2008.

Entrainment and Impingement Monitoring Plan for IEP Annual Report, November 2007 to October 2008, Contra Costa and Pittsburg Power Plants. Prepared for Mirant. Tenera 2009.

Entrainment and Impingement Monitoring for IEP Second Annual Report, November 2008 – October 2009, Contra Costa and Pittsburg Power Plants. Prepared for Mirant. Tenera 2010.

SCWD^2 Desalination Program Intake Effects Assessment Draft Report. Prepared for City of Santa Cruz Water Department & Soquel Creek Water District. Tenera 2010.

Bear Gulch Reservoir Aquatic Ecosystem Evaluation. Prepared for the California Water Service Company. Tenera 2010.

COLEEN J. WISNIEWSKI

4825 Coronado Ave #5 San Diego, CA 92107 Phone: (619)-787-8866 marinecolleen@gmail.com

SUMMARY:

Dedicated scientist and educator with over 14 years of program management experience in the environmental and conservation field. Extensive environmental leadership network including environmental NGOs, government agencies, institutions and academia. Projects a strong work ethic and thrives in both team and individual work environments. Successful management experience including creating new programs, leading team collaboration and fundraising. Working to bridge the gap between scientific findings, resource management and public education.

EDUCATION:

Bachelor of Science, Biology, Rutgers University, New Brunswick, NJ

Certificate of Performance, Geographic Information Systems (GIS), Mesa College, San Diego, CA

EXPERIENCE:

Reef Check California, Marina Del Rey, CA 4/2007-present

Southern California Regional Manager

- Manage the Southern California region of the statewide rocky reef monitoring program, from Santa Barbara to the Mexican Border with some cross-border work; recruit, train and manage over 200 active community volunteers per year.
- Organize and lead volunteer dive teams to perform over 50 survey trips annually in order to manage baseline monitoring and analysis of data for new regional California Marine Protected Areas (MPAs).
- Organize and conduct six training workshops per year (32 hours each) for community volunteers focusing on marine ecology, threats to ocean ecosystems, California marine management, species identification and scientific monitoring protocol.
- Conduct annual training of Mexican commercial fishing cooperatives to scientifically monitor Marine Protected Areas at Isla Natividad and El Rosario, remote fishing villages in Baja California Sur.
- Coordinate outreach efforts in the region and give presentations at a variety of venues including agency meetings, conferences, community forums, dive clubs and schools.
- Select, hire, train and manage employees, contract workers and paid college interns.
- Create and update monitoring protocols, curricula and educational materials for trainings.
- Initiate and maintain collaborations with various groups including university programs, state and local agencies, aquariums, other non-profit organizations and marine field institutes.
- Investigate new funding opportunities, write annual reports and assist with grant applications, reports and proposals.

San Diego Canyonlands, San Diego, CA (concurrent with above position) 1/2014 - 5/2014

Geographic Information Systems (GIS) Intern

- Documented existing conditions in a San Diego area open space canyon in support of the San Diego Canyonlands Canyon Enhancement Planning (CEP) process.
- Planned and performed field data collection of a variety of canyon features and their condition during 10 field collection days in a 140-hour internship.
- Created and managed canyon-specific geodatabase in accordance with CEP protocols and created a Geo-Topographical Viewshed map for use in stakeholder meetings for planning purposes; presented to stakeholders.

San Diego Coastkeeper, San Diego, CA 4/2002 – 6/2007

Kelp Project Director, Marine Biologist

- Directed kelp monitoring, restoration and education program for San Diego County. Coordinated efforts with four other regional organizations throughout the Southern California Bight.
- Recruited, trained and mobilized teams of over 30 volunteer community scuba divers to assist with kelp research efforts. Coordinated dive operations, collected data, maintained sites, planted lab-grown kelp, performed other restoration methods as necessary and collected biological samples.
- Managed and interpreted field data and maintained database; authored annual reports to local, state and federal permitting agencies; wrote funding proposals to support project; and tracked budget for various foundation, corporate and federal grants.
- Developed kelp forest and watershed ecology educational outreach materials, presentations and curricula, implemented program and delivered 32 presentations annually to schools, volunteer divers, community forums, agency meetings and media events throughout the region.
- Managed Project SWELL, a K-6 hands-on watershed protection, water conservation and pollution prevention curriculum serving over 50,000 elementary students annually in the San Diego Unified School District. Coordinated partner groups including the City of San Diego/Think Blue, the Unified Port of San Diego and San Diego Unified School District, among others.

Catalina Island Marine Institute, Avalon, CA

Assistant Diving Director, Divemaster 9/97-11/2001

- Coordinated staff training/evaluation and accident prevention/management protocols; updated training materials and diving policies; scheduled 24 staff members; and led weekly staff meetings.
- Guided third through twelfth grade students through island ecology and marine science curriculum; assisted in training 15 new staff members annually; and captained ocean vessels.

CERTIFICATIONS & SPECIAL SKILLS:

- Recipient of 2010-2011 Emmy award for participation as a mentor in SciGirls, a national PBS television series which emphasizes science, technology, engineering and math (STEM) education for middle-school girls. Engaging public speaker. Basic conversational Spanish.
- Accomplished in various computer programs including Microsoft Office (Excel, Word, Power Point, Outlook and Publisher), ESRI ArcGIS and internet software.
- California Department of Fish and Wildlife Scientific Diver certification; NAUI Scuba Instructor; over 2000 scuba dives. Small boat handling skills.

SELECTED PUBLICATIONS:

Jan Freiwald and Colleen Wisniewski (2015). Reef Check California: Citizen Scientist Monitoring of Rocky Reefs and Kelp Forests: Creating a baseline for California's South Coast. Reef Check Foundation, Pacific Palisades, CA, USA.

Freiwald J., C. Wisniewski, M. Wehrenberg, C. S. Shuman and C. Dawson. (2015). Reef Check California Instruction Manual: A Guide to Rocky Reef Monitoring, 8th Edition. Reef Check Foundation, Pacific Palisades, CA, USA.

Shuman, C. S., A. Sáenz-Arroyo, M. C. Luna., M. L. Wehrenberg, J. Friewald, C. Wisniewski (2013). Reef Check California Manual de Instrucción: una Guía para el Monitoreo del Bosque de Sargazo en la Península de Baja California. Reef Check Foundation, Pacific Palisades, CA, USA.

Jan Freiwald, Megan Wehrenberg, Colleen Wisniewski, Gregor Hodgson (2013). Status of Rocky Reef Ecosystems in California 2006 – 2011. Reef Check Foundation, Pacific Palisades, CA, USA.

Anna Neumann

19275 S. Harbor Dr, Fort Bragg, CA (805) 458-4902 mail4annien@gmail.com

Education

- Humboldt State University
  2010-present
  Major: Oceanography
  Graduation Date: May 2013
  GPA: 3.48
- Cuesta Community College
  2008-2010
  GPA: 3.15

Work Experience

- North Coast Regional Manager — Reef Check California
  5/2013-Present — Fort Bragg, Ca
  Responsibilities include training Reef Check California divers, organizing and conducting Reef Check California surveys, working as a co-chair of the Mendocino MPA Collaborative, as well as managing all social media platforms for the Reef Check Foundation.
- Open Water Scuba Instructor — Dressel Divers International
  7/2013-4/2014 — Playa del Carmen, Mexico
  Responsibilities included certifying PADI Discover Scuba Divers, Scuba Diver, Open Water Scuba Divers, Advanced Scuba Diver and Rescue Scuba Diver as well as selling dive tours and outfitting clients with dive gear.
- Intern — Humboldt State University Tidewater Goby Project
  6/2012-5/2013 — Arcata, CA
  Responsibilities include traveling to the marine lab to acquire algae, feeding fish, cleaning tanks, and preforming general chores associated with captive cultivation.
- Research Intern — University of Victoria Whale Lab
  7/2012-8/2012 — Flores Island, B.C.
  Intern's responsibilities included preparation of the boat, taking longitude and latitude data of whales along a predetermined transect, identifying the whales at sea, and using photos taken to identify whales in the lab.
- Research and Public Outreach Intern — Blue Ocean Society
  6/2011-8/2011 — Portsmouth, NH
  Research Intern responsibilities included taking behavioral sequencing data on whales being watched by local whale watching boats, taking longitude and latitude data on whale location and identifying whales.

Public Outreach responsibilities included going on local whale watching tours and educating passengers about whale biology and ocean process, attending and hosting local beach clean up's and working local events and touch tanks educating children about marine life.

- Lead Lifeguard/ Swim Lesson Coordinator — Cuesta Community College
  8/2009-6/2010 — San Luis Obispo, CA

  Lead Lifeguard responsibilities included scheduling staff, hiring staff, leading training days, reviewing time cards, resolving staff conflicts, and general paperwork.

  Swim Lesson Coordinator responsibilities included scheduling swim instructors, hiring swim instructors, meeting with parents, and swim lesson registration. I was also responsible for insuring that our program met the regulations set forth by the American Red Cross.

- Lifeguard/Swim Lessons Instructor — Cuesta Community College
  6/2007-8/2009 — San Luis Obispo, CA

  Lifeguard responsibilities included administering first aid, checking first aid equipment, opening and closing the pool, setting up for swim lesson as well as swimming and water polo meets.
  Swim Lesson Instructor responsibilities included teaching lessons for children ranging from 1 -13 years old, teaching water safety and interacting with parents.

Extracurricular Activities

- Marine Debris Program Founder — Humboldt State University
  8/2012-Present — Arcata, CA

  As part of an independent research project I founded the Humboldt State University Marine Debris Program. We are currently monitoring 3 sites in the local area for marine debris and are submitting the data to the NOAA Marine Debris Program. I have also created a website where information on Marine Debris can be found and am currently working on creating a database where members of the community can record debris found on local beaches. www.humboldt.edu/marinedebris

Certifications

- PADI Open Water Scuba Instructor (#334515)
- PADI Emergency First Responder Instructor
- DAN Oxygen Provider
- NAUI Dive Master
- AAUS Scientific Diver
- Fill Station Operator

Elena K. Kozma

4550 Via Marina Apt 202
Marina del Rey, California 90292

Cell: (909) 838-8120
Katiekozma@gmail.com

Employment Experience

- Southern California Training Coordinator, Reef Check Foundation (3/2016-Present)
  Assist with training citizen science divers in the California monitoring protocol and organize and conduct research surveys in the Southern California region. Assist with the development of Reef Check California's youth education program and teach 4th-12th graders state standards of marine science through classroom sessions and hands-on demonstration in the field. Assist with communication, reports, and outreach events for both statewide and international tropical programs.

- Divemaster, SD Expeditions, LLC (6/2015-7/2016)
  Provided customer service and maintained a safe environment for all guests while guiding shore dives, boat dives, and snorkel tours as a certified PADI Divemaster. Periodically acted as a safety diver for cage-less shark trips and other pelagic expeditions.

- Marine Mammal Observer (MMO), Tierra Data, Inc. (4/2015-1/2016)
  Periodically provided assistance with marine mammal monitoring during the construction of NAVY Fuel Pier Replacement Project. All monitors were positioned throughout the acoustic harassment zones of influence (ZOI) to document the species, numbers, and behavior of marine mammals during Active Construction and Non-construction phases to avoid any Level A harassment.

- Scientific Diver, Tierra Data, Inc. (4/2015-1/2016)
  Periodically performed Eelgrass habitat transect surveys in Oceanside Harbor and San Diego Bay in order to quantify and observe density, length, and condition of shoots in Eelgrass beds.

- Operations Associate Lead, SEA LIFE Aquarium (2/2015-3/2016)
  Worked as part of a team with other facilitators to interact with and inspire guests at educational areas within the aquarium. Provided ocean science education to children and families through direct communication, demonstration, and hands-on exploration. Maintained the safety and well being of all animals in touch pools and ensured that the aquarium was kept clean and organized at all times. Assisted the Displays Team with animal husbandry and tank diving to clean all displays and fed animals as a member of the Dive Team.

- Research Associate, Coastal Environments (1/2015-3/2016)
  Assisted colleagues with monitoring and conducting environmental impact assessments on major reef restoration projects by working closely with local and state government officials to summarize key findings related to project development at each site. Compiled reports and presentations for all project proposals and analyzed data collected during field observations. Periodically provided aide during field research projects.

- Marine Science Instructor, SEACAMP San Diego (1/2012-11/2014)
  Worked as part of a team of instructors to provide and teach hands on marine science education to students and teachers attending from schools in the United States and countries abroad. Conducted and supervised student field activities and provided laboratory demonstrations and instruction. Assisted with animal care as well as fresh and saltwater aquarium maintenance. Periodically acted as Group Operational Leader, providing guidance and supervision for other instructors to insure all aspects of the program ran smoothly.

Internship Experience

- Research Assistant, Coastal and Marine Institute, San Diego, CA (1/2011-9/2011)
  Lab Advisor: Dr. Kevin A. Hovel
  Ran Predator-prey relationship surveys in seagrass habitats both in field and laboratory settings. Observed data trends through statistical analysis using SYSTAT and laboratory processing. Assisted with laboratory and scientific dive protocol for the ZEN Project headed by VIMS at the San Diego, CA project location near Shelter Island.

- Research Assistant, San Diego State University (2/2011-5/2011)
  Advisor: Dr. Elizabeth Dinsdale
  Assisted with the genome sequencing of California Sea Lion, *Zalophus californianus*. Followed strict laboratory protocol preparation for 454 sequencer, ran DNA sequences and observed and interpreted data results.

- Volunteer Dive Collector, San Diego State University (5/2014-8/2014)
  Head Dive Collector: Constance Gramlich
  Periodically assisted with the collection of marine specimens, including algae and invertebrates, for laboratory use at San Diego State University.

- Volunteer AAUS Diver, San Diego State University (8/2012-1/2013)
  Preformed benthic surveys along the Southern California Coast (Carlsbad to Point Loma) with a team of Graduate and Doctoral students for personal thesis projects and for the Navy Point Loma Project. Conducted species identification for algae and invertebrates and measured Uniform Point Contact (UPC) using strict protocol along transect lines.

- Undergraduate Semester of Special Study, San Diego State University (1/2011-5/2011)
  Advisor: Dr. Kevin A. Hovel
  Assisted Graduate and Doctoral students in the Hovel Lab with their perspective thesis projects both in the lab and in the field. Conducted epifaunal seagrass sampling in San Diego Bay near Shelter Island and sorted samples microscopically for amphipods and other invertebrates. Performed predator surveys in San Diego Bay by seining along transect lines and recorded all species present at Shelter Island project site. Periodically assisted with sediment sampling by using sieves.

- Volunteer Internship, Marine Biological Laboratory, Woods Hole, MA (8/2002-9/2002)
  Collected specimens from the harbor in Woods Hole and brought them into the laboratory for use in research.

- Volunteer Internship, Sea Star Marine Biological Adventure Cruise (8/2002-9/2002)
  Observed and helped out instructors on the boat the Sea Star. Recorded and observed data and began to teach guests as I became more proficient in the subject matter

Education

San Diego State University, San Diego, CA (2005-2011)
Degree: Bachelors of Science in Biology, with an emphasis in Marine Biology
Graduated: May 20th, 2011

Beaumont Senior High School, Beaumont, CA (2002-2005)
Graduating class of 2005
Degree: High School Diploma
Graduated Suma Cum Laude (top 2% of graduating class)

Leadership Experience

- Operations Associate Lead, SEA LIFE Aquarium (7/2015-Present)
- SEACAMP San Diego Group Operational Leader (2012-2014)
- Western District President, Tau Beta Sigma (2008-2009)
- Zeta Xi Chapter President, Tau Beta Sigma (2006-2008)
- Sigma Alpha Iota, Parliamentarian (2007-2008)
- HOBY Youth Leadership Weekend Seminar, USD Campus (6/2003)

Certifications

- CPR and First-Aid for the Professional Rescuer (1/2016-Present)
- DAN Oxygen Administrator (1/2012-Present)
- American Academy of Underwater Sciences (AAUS) Certified Diver (5/2011-Present)
- PADI Open Water Certified Diver (1/2011-Present)
- PADI Advanced Open Water Certified Diver (1/2014-Present)
- PADI Rescue Diver (1/2015-Present)
- PADI Divemaster (6/2015-Present)

Organizations

- Tau Beta Sigma, National Honorary Band Service Sorority, Zeta Xi Chapter
- Kappa Kappa Psi, National Honorary Band Service Fraternity, Gamma Kappa Chapter
- Sigma Alpha Iota, International Music Fraternity, Iota Delta Chapter
- Marching Aztecs, San Diego State University Marching Band, Flute Section

Recent Awards and Recognition

- Best Student Film for "Under the Boat", 2nd Annual Beneath the Waves Film Festival, Benthic Ecology Meeting 2011
- Baton Award for Tau Beta Sigma, National Honorary Band Sorority
  Received in April of 2009 for excellence in student leadership
- Marching Aztecs Director's Award
  Received in December of 2008 for displaying leadership and overall dedication to the marching band during the 2008 season.

The Resources Agency

State of California

DEPARTMENT OF FISH AND GAME
DIRECTOR'S ACTION REQUEST

To: Ryan Broddrick, Director

Via: SONKE MASTRUP , Deputy Director

Subject: (Select one)

- [X] For Director's Signature
- [ ] Request for Meeting
- [ ] For Director's Information
- [ ] Request for Executive Team Review
- [ ] Other:
- [ ] Request for Approval
- [ ] Request for Review and Comment
- [ ] Request for Director's Participation
- [ ] Request for Leadership Team Review

Issue Statement:	This MOU memorializes a collaboration with a nonprofit foundation to generate data on nearshore reef systems to advance the adaptive management and public outreach goals of the MLPA and the MLMA.
Time Factor or Limitations:	The foundation desires to have this MOU executed by March 1, 2007, in order to expedite fundraising by demonstrating Department support of its program.
Summary of Implications:	This MOU advances Theme II, Goal 4 of the Strategic Plan (Cooperative Approaches to Resouce Stewardship and Use).
Effects on Existing Law or Regulation:	The MLPA and MLMA both contemplate adaptive management and collaborative data-gathering (FGC §§ 2852(a), 2855(b), 2856(a); §§ 90.1, 7056(g), 7059).
Estimated Costs:	Nominal. Any funds expended on this MOU will be part of those already allotted to marine resource assessment. Collaboration with the foundation enables the Department to maximize the effectiveness of these already-budgeted funds.

- [X] Legal Office Review
- [ ] Legislature Office Review

Author's Signature Joseph Milton **Typed Name:** JOSEPH MILTON	**Title:** STAFF COUNSEL III **Div/Reg/ Branch:** OGC	**Date:** 02/06/07	**Phone:** 916.654.5336
Supervisor's Signature **Typed Name:** ANN S. MALCOLM	**Title:** GENERAL COUNSEL **Div/Reg/ Branch:** OGC	**Date:** 2/9/07	**Phone:** 916.654.3815
Branch Chief's Signature **Typed Name:**	**Title:** **Div/Reg/ Branch:**	**Date:**	**Phone:**
Regional Manager's Signature Gary B. Stacey **Typed Name:** GARY B. STASEY	**Title:** REGIONAL MANAGER **Div/Reg/ Branch:** MARINE REGION	**Date:** 2/14/07	**Phone:** 562.342.7108
Deputy Director's Signature **Typed Name:** SONKE MASTRUP	**Title:** DEPUTY DIRECTOR **Div/Reg/ Branch:** RESOURCES MGMT & POLICY	**Date:** 2/16/07	

Ryan Broddrick, Director

Date: 02/22/07

MEMORANDUM OF UNDERSTANDING
Between
THE CALIFORNIA DEPARTMENT OF FISH AND GAME
And THE REEF CHECK FOUNDATION
Regarding
REEF CHECK CALIFORNIA

RECITALS

WHEREAS, the Foundation is an independent 501(c)(3) non-profit corporation registered in California, whose proposed "Reef Check California Program" would educate, train, and engage ocean users in the collection of scientifically sound data on California's nearshore rocky reefs;

WHEREAS, the Foundation's outreach activities also address the public education goals outlined in the Marine Life Management Act, the Marine Life Protection Act (MLPA) and the Ocean Protection Council Five-Year Strategic Plan;

WHEREAS, Reef Check California could fill data gaps, provide information for adaptive management of living marine resources, and generate important baselines to assist the Department's Marine Life Protection Program;

WHEREAS, the Department considers the Reef Check California Monitoring Protocol (**Exhibit A**) to be methodologically sound and compatible with its existing monitoring methods and data sets;

WHEREAS, further, the Department considers the Reef Check California Training Course and Quality Assurance and Quality Control Procedures (**Exhibit B**) to be of sufficient rigor and intensity to equip participants to provide scientifically valid and defensible data;

NOW, THEREFORE, in consideration of the foregoing recitals, the Parties agree as follows:

1.0. GENERAL PROVISIONS

1.1. Authority. This MOU is entered into by the Department, pursuant to Fish and Game Code Sections 1000 and 1801, and Government Code Section 3119, and, by the Foundation, pursuant to Board of Trustees resolution.

1.2. Parties. The Parties to this MOU are the Department and the Foundation. The term "Department" includes its officers, employees, agents and other representatives. The term "Foundation" includes its trustees, officers, employees, contractors, agents or other representatives, volunteers, and successors.

1.3. **Scope and Purpose.** The purpose of this MOU is to memorialize the broad goals and objectives that will guide the Parties in their relationship. The Parties may enter in additional agreements, as necessary, to further define and memorialize specific details of that relationship.

1.4. **Applicability.** This MOU is intended to memorialize the following goals and objectives of the Parties:

- To develop a long-term statewide community-based subtidal monitoring network.
- To design, develop, and implement a user-friendly web-based GIS application for entering and querying all data.
- To maintain a collaborative and cooperative relationship for the effective collection and dissemination of data.

2.0. THE DEPARTMENT

In furtherance of the goals and objectives identified in Section 1.4 above, the Department agrees to use best efforts to:

2.1. Provide staff support for ongoing training and protocol development.

2.2. Provide vessels for qualified Foundation divers who meet the Department requirements.

2.3. Provide staff for data collection, survey site set-up and maintenance, database support, data entry and analysis.

2.4. Provide GIS layers and staff expertise to facilitate data collection.

2.5. Develop and maintain a data dissemination web portal.

3.0. THE FOUNDATION

In furtherance of the goals and objectives identified in Section 1.4 above, the Foundation agrees to use its best efforts to:

3.1. Cooperatively establish survey sites based on Department resource management needs.

3.2. Cooperatively develop a data storage and interface system compatible with, and complimentary to, existing Department systems.

3.3. Make data accessible to the Department as soon as possible, but no later than 6 months after its collection.

3.4. Maintain existing, and develop new, education and outreach programs.

3.5. Maintain and develop monitoring sites outlined in Department marine protected area monitoring plans.

3.6. Strictly adhere to Quality Assurance/Quality Control Guidelines (**Exhibit B**).

4.0. MISCELLANEOUS PROVISIONS

4.1. The Parties agree in good faith to work to fulfill the objectives of this MOU. Nothing in this MOU shall be construed as an obligation by the Department to commit or expend funds, or for the future payment of money, in excess of appropriations authorized by law.

4.2. Neither this MOU nor any of its provisions may be waived, modified, amended, or discharged except by a written instrument signed by the Parties.

4.3. This MOU constitutes the entire understanding between the Parties with respect to the subject and supersedes any prior or contemporaneous understandings or agreements, whether oral or written.

4.4. If a court of competent jurisdiction determines that any part of this MOU is legally invalid, illegal, or unenforceable, and such decision becomes final, it shall be deemed severed and deleted and the balance of this MOU shall be reasonably interpreted to achieve the intent of the Parties. The Parties agree to replace such void or unenforceable provision with a valid and enforceable one that will achieve, to the extent possible, the purposes of the void or unenforceable provision.

4.5. Neither Party may assign any rights granted by this MOU without prior written approval of the other, which approval may be granted or withheld in that Party's reasonably discretion.

4.6. This MOU shall become effective upon the last date of either Party to execute it, and shall continue in effect from that date until terminated pursuant to Section 4.8.

4.7. Either Party may withdraw from this MOU, for cause, by written notice to the other Party, and after a good faith attempt to resolve the issue prompting the withdrawal. Upon the withdrawal of the Party, this MOU shall terminate. The only remedy to either Party for a breach of this MOU shall be termination of this MOU pursuant to this Section.

4.8. Nothing in this MOU is intended to construe benefits upon, or be subject to, enforcement by third parties, to create any agency or employment relationship between the Parties, or to supercede any applicable state or federal law, or any regulations issued thereto.

4.9. Nothing in this MOU shall be deemed to create an employment, agency, partnership or any other trust relationship between the Parties, it being expressly understood and agreed that the Parties' obligations hereunder are not fiduciary in nature.

4.10. This MOU and any amendment(s) may be executed in counterparts.

4.11. The signatories attest they are each duly authorized to execute this MOU:

FOR THE DEPARTMENT OF FISH AND GAME

L. Ryan Broddrick Feb 22, 2007

L. Ryan Broddrick Date

Director, California Department of Fish and Game

FOR THE REEF CHECK FOUNDATION

Gregor Hodgson March 1, 2007

Gregor Hodgson, PhD Date

Executive Director, Reef Check Foundation

Reef Check California Monitoring Protocol 2006

Craig S. Shuman
December 2005 - Updated June 2006

Preface

This document summarizes the newly developed Reef Check California Monitoring Protocol and the rationale for its development. This document was written as a scientific document to facilitate effective peer review. Training materials are currently being 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 at each site will include:

- Site description (1 per year)
- Substrate Uniform Point Contact (UPC) (6 fixed transects surveyed in spring and fall)
- Invertebrate band transect (6 fixed transects surveyed in spring and fall)
- Seaweed band transect (6 fixed transects surveyed in spring and fall)
- Fish survey (size and identity) (6 fixed transects surveyed in spring and fall)
    - Twelve additional non-fixed 30 x 2 x 2 m transects (6 in each habitat zone)
- Urchin size frequency survey (1 per site in spring and fall)

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.

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.

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.

Although the primary focus will be on permanent transects, random transects can be performed where permanent transects are logistically infeasible. 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.

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 25 invertebrate species, 33 fish species, 8 algal species and 1 algal genera (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. Species and rationale of Reef Check California indicator algae species

Common Name	Latin Name	Rationale
giant kelp*	*Macrocystis pyrifera*	C, E, EI
southern sea palm**	*Eisenia arborea*	EI
elkhorn kelp**	*Pterygophora californica*	EI
bull kelp**	*Nereocystis luetkeana*	C, EI
*Laminaria***	*Laminaria* spp.	EI
wireweed†	*Sargassum muticum, S. Filicinum*	EI, I
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 (trophically important species), 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
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*	EI
chestnut cowry	*Cypraea spadicea*	E
Kellet's whelk	*Kelletia kelletii*	E
rock crab	*Cancer* spp.	E
sheep crab	*Loxorhynchus grandis*	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 gorgonian**	*Lophogorgia chilensis*	C

* Size estimated to nearest centimeter

** Must be taller than 15 cm to be recorded

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

††Test diameter must be greater than 2.5 cm

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	*Damalichthys vacca*	<15, 15-30, >30	C, E
rainbow perch	*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
gopher rockfish*	*Sebastes carnatus*	<15, 15-30, >30	E
black and yellow*	*Sebastes chrysomelas*	<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 Plans (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.

Two invasive species of algae (*Undaria pinnatifida* and *Caulerpa taxifolia*) 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
- 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
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Dr. John Stephens	Vantuna Research Group
John Ugoretz	CA Dept. of Fish and Game- Nearshore Ecosystem / MLPA Coordinator

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EXHIBIT B

REEF CHECK CALIFORNIA QA/QC PROCEDURES

Cyndi Dawson and Craig Shuman
Draft November 13, 2006

This document summarizes the Quality Assurance/Quality Control procedures implemented by the Reef Check California Program (RCCA). These procedures were put in place to help ensure the quality of data collected by standardizing the training, data collection, and data entry processes.

Training

All participants are required to successfully complete the RCCA Training course under the direct supervision of a certified RCCA instructor to be eligible to submit data to the RCCA Database. Participants with extensive prior experience can opt out of the training course but must demonstrate proficiency in all components of the RCCA protocol under the supervision of a certified RCCA instructor before they can submit data to the RCCA database.

Requisite components of the RCCA training course are:

1. Completed reading of the Reef Check California Training Manual
2. Attendance and participation at all classroom sessions (10 hours)
3. Attendance and participation at the pool session (3 hours)
4. Attendance and participation at all field sessions (6 dives)
5. Successfully pass the written multiple choice test (85% passing score)
6. Successfully pass the species identification test (85% passing score)
7. Successfully complete the methods and species identification field practical exercises

Data Collection

Data collection methods have been designed to promote the safety of the surveyor as the primary goal followed by the accuracy and precision of all data collected. All surveyors must follow the methods outlined in the Reef Check California Training Manual. The following items have been included in the survey protocol to increase the precision and accuracy of all surveys by reducing sampler error and bias:

1. Standardized site selection and transect deployment procedures
2. Standardized time requirements, search image and use of flashlights for all band transects and fish surveys
3. Minimum size requirements for all invertebrate and algal species to focus on emergent animals only
4. Grouping of species with similar morphological traits (*i.e.*, canary and vermillion rockfishes) to reduce the likelihood of misidentification
5. Employment of size categories for fish surveys
6. Employment of two divers during fish surveys to complete redundant counts

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7. Employment of standardized data notation procedures on the underwater data sheets
8. High level of replication within a site (Eighteen 30 x 2 m transects)

Data Entry

The text below is provided as a guide to direct the entry of all data.

Materials Needed

- Washed and dried datasheets
- Red and blue or green pencil or pen
- Print out of QA/QC procedures
- Electronic copy of data entry forms called *DataEntryRCCA_CenCAv14.xls* or *DataEntryRCCA_SoCAv14.xls*

Prior to Data Entry

1) Confirm all datasheets are present and accounted for. The total number of sheets will vary but you will need to make sure you can find fish transects 1-18, invertebrate transects 1-6, seaweed transects 1-6, and UPC transects 1-6. You also may have urchin datasheets but not always.

2) Review each datasheet for completeness. There may be fields which were intentionally left blank. IF ANY FIELDS ARE BLANK, BE ABSOLUTELY SURE A CHANGE IS APPROPRIATE. VERIFY WITH THE DIVER THE CORRECT INFORMATION BEFORE YOU MAKE ANY CHANGES. The most common omission is start and end time. If those are left blank there is no way to get that information so it will have to be left blank in the database. This is also true for start and end depth. DO NOT MAKE UP THESE NUMBERS JUST LEAVE THEM BLANK IF THEY WERE TO BEGIN WITH.

3) ALL EDITS ARE TO BE MADE IN RED PENCIL OR RED SHARPIE ON ORIGINAL DATASHEETS. The most common questions arise from not being able to determine the total counts for a species, either due to illegible writing or unfamiliar non-standardized notation (see Data sheet notation.doc). Before you change anything on the datasheet, it may be necessary to fax or scan a copy of the datasheet in question and send it to the diver to verify the edit in question. You may also call the diver but often it requires the diver to see the original before they can interpret the correct count. If you cannot figure out what to do with an entry leave it blank and flag questionable records on the datasheet with a Post-It and circle it in red on the datasheet. Send the data manager (cadata@reefcheck.org) an email notifying them to review this survey before they import it into the database.

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Entering Data

1) Open up the correct standardized Excel data entry form either *DataEntryRCCA_CenCAv14.xls* or *DataEntryRCCA_SoCAv14.xls*. Choose "Enable macros" when the pop-up box comes up (this will not give you a virus).

2) Before you begin entering the data go to "File" and on the drop down and choose "Save as.." Save the data entry sheets as *sitename_enddate(mm-dd-yy).xls (PtLucas_11-11-06.xls)*

3) Select the "Site Description Report" tab and fill out the sheet. Be sure to include as much information as you can in the "Comments" section describing the site both from the surface and describing the habitat below. Be sure to follow the directions outlined in the Reef Check California Training Manual and use the converter in the upper right of the sheet to enter the temperatures, distances, and depths in Celsius and meters.

4) Next select the "Fish_Core" tab. Begin by entering the header information. If there are blanks in the header, leave them that way. Observer name should be entered first initial, period space and last name (*e.g.* C. Dawson or C. Shuman). IT IS IMPORTANT TO ENTER OBSERVER NAME EXACTLY AS DESCRIBED ABOVE TO AVOID ERRORS IN THE DATABASE!

5) Carefully enter the observation in the Excel spreadsheets being sure fill all fields with zeros where no species are seen. A blank in the Excel data entry form represents missing data which is very different from a zero. After each datasheet is entered successfully put your initials and "OK" in the upper right hand of the datasheet in red.

6) After you finish continue by selecting "Fish_Only" and entering the data continue in any order on to "Invert_Core", "Seaweed_Core", "UPC_Core", and "Urchin_Size" if applicable.

Data Verification

1) At this stage please do a cursory check of the data that you entered. One way to accomplish this is to randomly select a couple of datasheets and go back and make sure data entered by you matches up. Also scroll through all the tabs to make sure all the data is entered and there are no duplications especially in the header information on the "Fish_Core" transects. Having another person look over the entries to independently verify the data entry is highly recommended.

2) Make sure all datasheets are accounted for and all Post-its/data flags are readable. Paperclip or staple all the datasheets together.

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Data Submission

1) After you have completed all the above steps, save the file and email the electronic datasheet to cadata@reefcheck.org

2) Package up the datasheets and if the survey site was from San Luis Obispo County north send them to:

RCCA Data
1724 Escalona Dr.
Santa Cruz, CA 95062

If the survey site is south of San Luis Obispo county send the datasheets to:

Reef Check Foundation
Attn: California Data
PO Box 1057
Pacific Palisades, CA 90272

Database Import

1) Upon receipt of the data sheets, the data manager will perform random spot checks of the data.
2) After the data are vetted, the data manager will perform import. The data import procedure will perform field verifications to highlight missing data and outliers.
3) The data manager will review the data summary report and compare total number of species and total counts with original data sheets as well as all fields flagged by the automated validation process. If review of the original data sheet does not resolve the problem, the data manager will contact the team leader and surveyor to resolve the issue.
4) All summary reports will be archived in digital and hard copy formats.
5) Corrections are to be made in the database and notations are to be made on the original datasheet in either blue or green describing the change made. An error log binder will also be maintained describing any all errors and the steps taken to resolve them.

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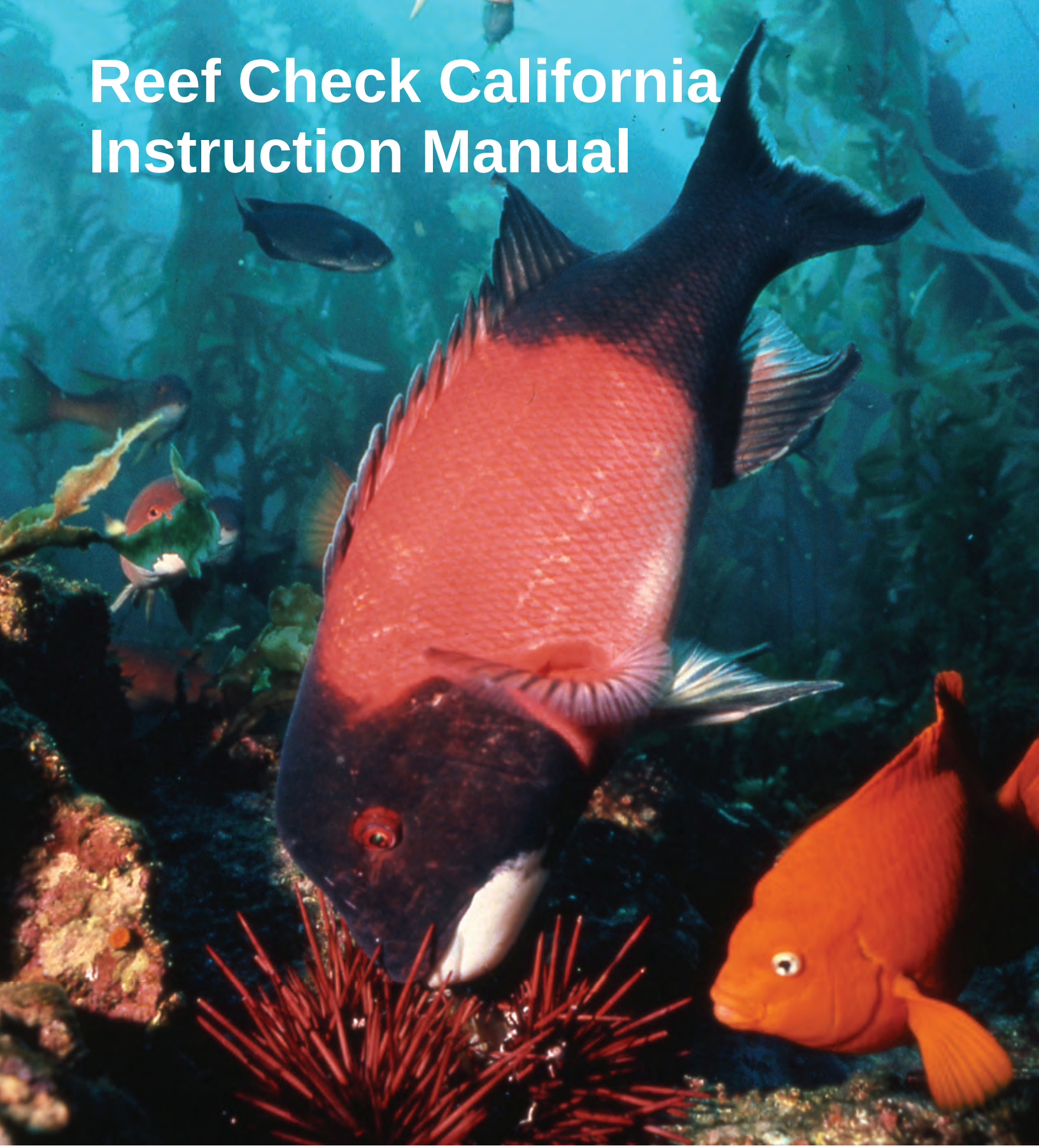
Reef Check California Instruction Manual



A Guide to Monitoring California's Rocky Reefs

8th Edition

REEF CHECK CALIFORNIA

INSTRUCTION MANUAL

A Guide to Monitoring

California's Rocky Reefs

8th Edition

This is the official instruction manual (8th Edition) for the Reef Check California Community Monitoring Program. If you have any questions about training procedures or about the Reef Check California protocol, please contact Reef Check at the contact numbers given below.

8th Edition April 2015 (1st Edition June 2006)

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Dirk Burcham	Aquarium of the Pacific - Catalina Conservancy Divers
Dr. Mark Carr	UCSC - PISCO
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Dr. Donna Schroeder	UCSB - Marine Science Institute
Dr. John Stephens	Vantuna Research Group - Retired
John Ugoretz	Habitat Conservation Program Manager, Marine Region CDFW

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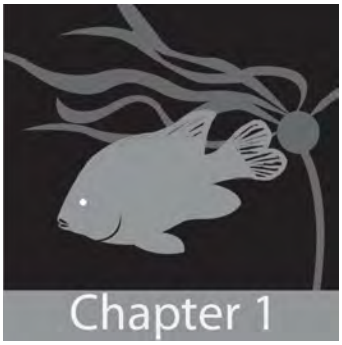


Introduction

Stretching over 1,700 miles, California's coastline is the gateway to a unique and often underappreciated wealth of life. Offshore, just below the surface, kelp forests and rocky reefs are home to a vast array of marine organisms that many Californians regularly enjoy and others depend upon for their livelihoods. Unfortunately, the rapid growth of California's population and the resulting impacts due to coastal development, pollution and overfishing have placed increasing demands on our nearshore resources. Many species that were once abundant, such as some species of rockfish and abalone in southern California, are now almost gone.

Reef Check California is an exciting program that is building a network of informed and involved citizens who support the sustainable use and conservation of the Golden State's nearshore marine resources. To accomplish this, volunteers are trained to survey nearshore reefs and generate data on the status of key indicator species.

Reef Check California's survey methodology has been specifically designed for you – the volunteer. Once you are trained in the California methodology, you will be able to make a significant contribution to the science behind the conservation and management of California's precious marine resources by becoming a citizen-scientist. Your regular surveying efforts will not only fill gaps in the state's existing marine monitoring network, but will allow you to contribute your valuable ocean knowledge to the management process.

This instruction manual provides all the information necessary for Reef Check California teams to carry out rocky reef monitoring using the standard Reef Check California protocol. In addition to this manual, there are a variety of training materials available including PowerPoint presentations, flashcards and identification tests that you will be exposed to during your course. Upon successful completion of the Reef Check California Training course, participants will be eligible to contribute data to the Reef Check California Nearshore Ecosystem Database (NED) and can elect to receive a specialty certification card (NAUI). While anyone may participate in Reef Check California, data will only be accepted from individuals who have successfully completed the full training course taught by a Reef Check California accredited instructor or have demonstrated proficiency in Reef Check California methods by completing the requisite examinations.

About The Reef Check Foundation

Reef Check data (and projects) are managed by the Reef Check Foundation, which is an international award-winning conservation organization based in Los Angeles, California. Reef Check began in 1997 as the volunteer network of the United Nation's Global Coral Reef Monitoring Network. In 2000, the 501(c)(3) non-profit Reef Check Foundation was established to manage the coral reef data collected from over 90 countries and territories worldwide and to create more opportunities for direct coral reef conservation. Reef Check has many partners, but places special attention on establishing long-term partnerships with businesses such as the tourism, diving, surfing and marine aquarium industries.

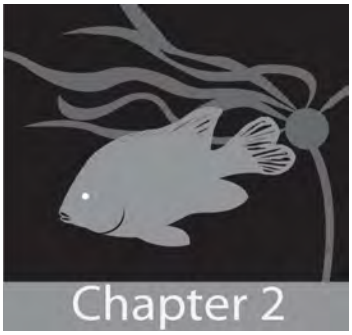
Reef Check has developed scientific methods to monitor and manage coral reef fisheries for fishes and invertebrates to determine what level of catch could be sustainable. Reef Check has successfully used a coastal management process in the Philippines and Indonesia to leverage local governments and village fishermen to agree to set up Marine Protected Areas so that they could better manage their aquarium fisheries. Initial results indicate that a sustainable fishery may be possible with proper attention to management, but it is not yet clear if this can be cost-effective in the long-term.

For more information about Reef Check activities, including how you can participate in our tropical work, please visit our website **www.reefcheck.org** or write to **info@reefcheck.org**.

Reef Check California's Mission

Reef Check California (RCCA) educates, trains and engages ocean users in the collection of data describing California's nearshore rocky reefs using a community-based approach that informs marine management and creates a constituency supportive of science based management.

By becoming part of RCCA you are taking direct action to improve marine management!



Reef Check California

California's nearshore waters are considered to be one of the most productive ocean areas in the world (CDFG, 2001). This productivity, coupled with over 1,100 miles of one of the most stunning natural habitats on earth, drives an ocean economy of approximately $43 billion, the largest in the United States (Kildow and Colgan, 2005). Sadly, rapid population growth coupled with the most consumption-oriented culture in the history of the earth has led to an unprecedented level of human stress on California's ecosystems.

The primary aim of the Reef Check California program is to improve our knowledge of California's rocky reefs by involving local community members in generating data from careful observation of these ecosystems over time. We will then provide the data you collect to fellow citizens, resource managers and policymakers so that informed choices can be made concerning the management of California's precious living resources.

Our goal is to collect unbiased data --- not perform advocacy.

The Program in Context

Reef Check California has been designed in consultation with some of the foremost marine monitoring experts in California. The initiative aims to specifically address two problems that have plagued past programs.

First, Reef Check California recognizes the problematic nature of maintaining funding for long-term efforts. There is a long history of aquatic 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; US EPA, 1997; Wells, 1995; www.reef.org). For example, in the case of water quality monitoring, community-based programs have already proven effective in informing management and regulatory processes (Abrahamson et al., 2000; US EPA, 1997). In the marine realm, the largest and most comprehensive scientific sampling effort in California's nearshore waters was conducted in 2004 by the Cooperative Research and Assessment of Nearshore Ecosystems (CRANE) in association with the Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO, www.piscoweb.org) and other partners. This sampling effort surveyed 88 sites between Monterey Bay 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.). Fortunately, the State of California has recognized the shortage of funding and manpower for such government-driven efforts and supports community monitoring as a necessary component to meet monitoring objectives (CDFG, 2005 a & b).

Second, there is currently no standardized statewide monitoring program specifically designed to investigate human impacts on California's nearshore ecosystems. Most groups use different methods, focus on different target species and have different data reporting formats. These factors make it extremely difficult to perform statewide analyses. As such, science's picture of the status of California's rocky reef ecosystems is incomplete. This dearth of knowledge leaves decision makers without the data required to make informed management decisions (Baird et al., 2005).

Reef Check California addresses both of these problems by engaging you, the motivated volunteer, to regularly conduct monitoring with Reef Check California's statewide standardized protocol. Including stakeholders in training and implementing marine monitoring confers significant benefits. Perhaps the two most important are: 1) the formation of a new and informed constituency that will support science-based ocean management and 2) a channel for key stakeholders (e.g., recreational divers, fishermen, ocean lovers) to leverage their intimate knowledge of local habitats to contribute valuable scientific data to the regulatory process.

Your research efforts will focus on key indicator species. In lieu of performing a detailed ecological survey of every reef we encounter, we will be focusing on the abundance and size distribution of indicator species and whether or not they change over time. The technique you are soon to learn is extremely valuable because it can be mastered in a relatively short period of time and be employed by divers like yourself up and down California's coast. This means that you will play a key role in providing data to government agencies such as the Department of Fish and Wildlife, help fill data gaps within existing broad-scale monitoring networks (e.g., PISCO) and expand data collection efforts by geographically-focused programs such as the Kelp Forest Monitoring program in the Channel Islands National Park (Davis et al., 1997).

In terms of more concrete applications, the data you generate with the techniques learned in this course will have a host of uses. In fact, your participation in the Reef Check California program will put you on the cutting edge of California's scientific understanding of the changes happening along our coastline. For example, the data you collect will allow for early diagnosis of abnormal change within the range of different species. Will the changes you observe be best explained by a recent El Niño year, serious pollution concentrated in your area, long-lasting shifts in global climate change or natural variation? By engaging a large network of divers to collect data throughout the state, we will be able to develop a much clearer picture of what factors are responsible for changes in California's rocky reef ecosystems. This knowledge will allow for the development of more informed management measures, and perhaps more importantly, for the evaluation of the effectiveness of different management regimes.

One immediate application of the data you collect will be to aid the implementation and evaluate the effectiveness of two of California's most important management measures, the Marine Life Management Act (MLMA) and the Marine Life Protection Act (MLPA). Passed in 1998, 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 (Fish and Game Code § 7050 et seq; CDFG, 2001; Geever and Dart, 2003). Passed in 1999, 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). The long-term data you collect will help evaluate the effectiveness of the MLPA implementation process and allow managers to adapt their efforts according to changes in the marine resources they are working to conserve.

By regularly carrying out Reef Check California surveys **you can make a difference in the fate of California's marine resources**. After all, they are our ocean resources and if we don't take action to protect them who else will?

Your Involvement Matters!

Involving the community in monitoring builds public support for management initiatives. The Reef Check California program is carried out by volunteers from the community and is a useful tool in building public support for state and non-governmental organization (NGO) marine conservation efforts. The publicity generated from your survey activities can also be particularly useful in raising public awareness and rewarding government agencies, companies and NGOs for their support.

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.**

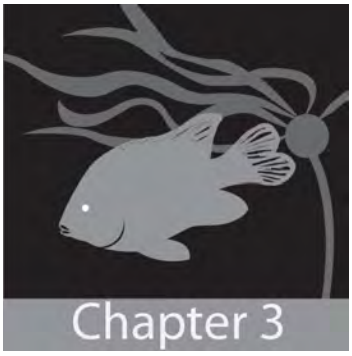
Liability

Participants in Reef Check are considered to be fully independent individuals who have chosen to follow the Reef Check California survey methodology of their own free will and are entirely responsible for their own safety. All participants must sign the liability waiver (found in Appendix A) before taking part in this volunteer activity.

Reef Check California has been designed to minimize safety risks by limiting dives to a maximum depth of 60 feet (18 m). However, accidents can occur at any depth. Each participant is independently responsible for their personal safety and their decision to participate in any Reef Check activities.

A Note on Safety and Liability!

Diving, boating and related activities present inherent substantial risks to participants, **including risk of severe injury and death**. Reef Check surveys may take place at a substantial distance from facilities providing medical treatment or rescue services. Every volunteer participant in Reef Check activities is expected to take full personal responsibility for their physical and mental health, insurance coverage, compliance with standard safety rules and every personal decision relating to said activities in which they engage. **Only you can decide when and where you dive.**



California's Marine Environment

Marine Ecology Crash Course

Ways of appreciating nature are as diverse as human beings. California's native cultures, for example, had an extensive system of classifying and understanding their natural resources. However, to make a powerful case for the conservation of California's marine resources, we must monitor California's rocky reefs with scientific methodology.

Although science and the heavy jargon associated with it can seem a bit daunting at first, it can actually be a lot of fun. In fact, what you will be doing when employing the Reef Check California protocol, **studying the interrelationship of living things and their environment**, is arguably the most fun branch of the natural sciences. It is called **ecology**.

To study ecology, of course, we need an ecosystem to study. **An ecosystem is the complex of living things and their environment functioning as a unit**. Our ecosystem of interest is the temperate rocky reef. Stop for a second to imagine all of the inhabitants in a rocky reef ecosystem. Sea lions, California sheephead, rockfishes, urchins, sea otters and kelp may immediately come to mind. As you are already aware, there are a lot of additional species in the rocky reef ecosystem and all of them are interconnected.

To better illustrate the importance of understanding the interrelationship of different organisms in California's underwater forests, let's stop to focus on three groups or taxa in particular: sea urchins, sea otters and kelp. Prior to the arrival of European fur trappers in California, the range of sea otters extended as far south as Baja California. Historical records tell us that the kelp forests in Baja, Southern and Central California were much more abundant, as well. Interestingly, in areas where otters were eliminated, the area of the kelp forests rapidly receded. What do you imagine caused this change? Was there suddenly a wave of warm water or series of giant storms that destroyed the kelp? Was there a specific disease that hit different species of kelp particularly hard?

A quick look at the dietary preferences of otters and urchins may prove revealing: otters feed heavily on urchins and urchins feed on kelp. You can now probably generate a hypothesis that could explain the depletion of California's kelp during that time period. Of course it is not quite that simple. Along with the removal of otters, intensive fishing of other urchin predators such as sheephead and spiny lobster and for sea urchin competitors such as abalone disrupted the

natural population dynamics in the kelp forests. This allowed urchin populations to grow exponentially in some areas and overgraze the kelp creating urchin barrens (CDFG, 2001). Understanding the complex relationships illustrated in the above example require large amounts of data on many species over long periods of time, which do not exist for most ecosystems and species in California. These types of data are the type you will be collecting as a citizen-scientist for Reef Check California.

"When one tugs at a single thing in nature, he finds it attached to the rest of the world."

-- John Muir

California's Currents

Unlike coral reefs, which generally only occur in warmer waters, kelp forests are only found in areas with colder, nutrient-rich seas. California's cold water comes primarily from the Gulf of Alaska as a surface current (Figure 1). Known as the **California Current**, its flow is generally southern throughout the year and its intensity varies with the season. As Northern California divers are quite aware, it hugs the coastline of northern and central California during winter and spring. As we all know, however, there are also days when California's nearshore waters flow northerly. If it is occurring between November and February and accompanied by southwest winds and warmer waters, chances are you are observing the **Davidson Current**. Another northerly current known as the **Southern California Counter Current** occurs in the **Southern California Bight** (the area between the Mexican Border and Point Conception) and may be thought of as a very large scale eddy in the California Current (Hickey, 1994).

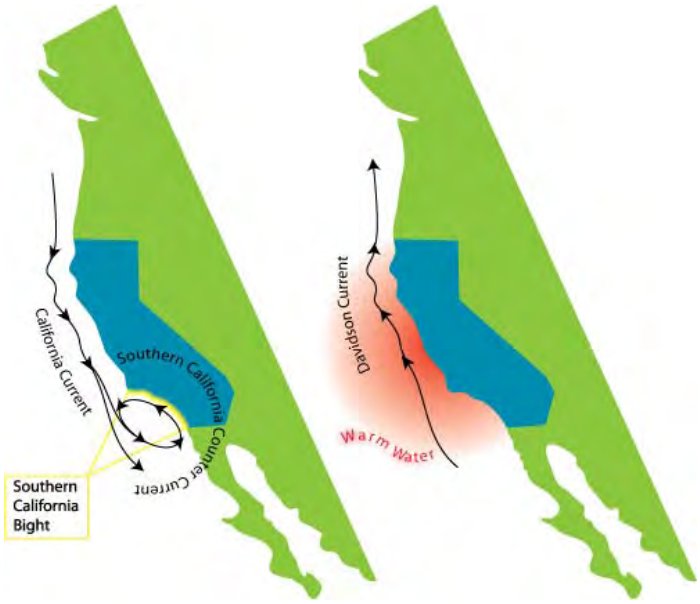


Figure 1. The currents along California's coast help explain the distribution of kelp forests throughout the state (Dave Makena Illustrations).

Upwelling

As you have probably noticed in your dives along California's coastline, some areas are much colder than surrounding stretches of coastline. It also happens that in most of these colder areas we see the highest concentration of kelp forests. This pattern of kelp forest zonation is usually best explained by an oceanographic process known as upwelling. **Upwelling occurs when surface waters are pushed away from the coast and are replaced by nutrient-rich water from deeper levels.** In California, upwelling usually occurs as a result of prevailing northwesterly winds and the influence of the earth's rotation pulling surface waters offshore (California Coastal Commission, 1987). The water is replaced by deeper waters that rise to the surface (Figure 2). The deeper the immediate waters, such as the waters inshore of giant canyons or at points that jut out into deep waters, the more upwelling will occur. The strongest upwelling and coldest waters off the coast of California usually occur during the spring.

The reason we generally see kelp forests in areas with strong upwelling is because the waters that rise from the depths are loaded with nutrients, most of which come from decaying organic matter on the ocean floor. These nutrients, in turn, serve as the base of the food web that allows kelp forests to thrive (Snyderman, 1998).

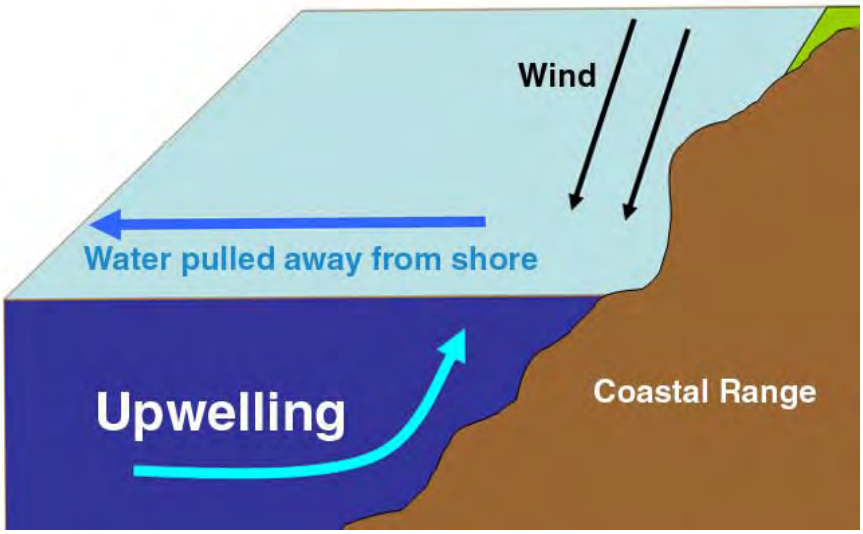


Figure 2. The currents along California's coast help explain the distribution of kelp forests throughout the state (Dave Makena Illustrations).

California's Rocky Reefs

The stunning natural beauty of California's rocky reef ecosystems is likely to have played no small role in motivating you to take this course. The 800 plus species that kelp forests support are a thrill to experience, and many feel that this biological wealth is reason enough to conserve these habitats. There are also compelling economic reasons to protect these habitats. Rocky reefs, like virtually all large ecosystems, provide us with a host of **ecosystem services**. First and foremost, they are an important habitat for many food fish that supply both commercial and recreational fishermen with a source of income and food. Kelp alone provides several

ecosystem services. For example, giant kelp was historically harvested to produce alginates used as thickeners in ice cream and other dairy products such as chocolate milk and yogurt, as well as being an important emulsifier in beer, toothpaste and cosmetics (Druehl, 2003; Mondragon and Mondragon, 2003). More recently, harvested giant kelp has been used in high-end pharmaceutical products and for consumption by humans and aquacultured abalones.

Ecosystem Services: The conditions and processes through which natural ecosystems, and the species that comprise them, sustain and fulfill human life. They maintain biodiversity and the production of ecosystem goods such as seafood, forage, timber, biomass fuels, natural fiber, pharmaceuticals, industrial products and their precursors (From Daily et al., 1997).

Human Pressures and Long-term Monitoring

Despite the aesthetic and economic value of rocky reef habitats, they continue to be stressed by human pressures. The most immediate human pressures rocky reefs face are point and non-point source pollution, sedimentation and overfishing. Combined, these impacts have severely degraded habitats up and down the coast. Changes in abalone numbers provide us with a poignant example. The endemic California Black Abalone (*Haliotis cracherodii*), was formerly so abundant that they could be found stacked on top of each other in intertidal areas with as many as 100 individuals per square meter (CDFG, 2004a; G. Davis, personal comm.). The commercial fishery for black abalone began in the late 1960s, peaked in the 1970s and witnessed a slow decline thereafter and was closed in 1993 (CDFG, 2001). The abalone fishery for pink, green, and white abalone was closed in 1996. A disease known as Withering Syndrome (WS) contributed to the continued decline of abalone populations along California's coastline, especially that of the black abalone. As a result, the black abalone population has collapsed (Figure 3). The species is currently on the World Conservation Union (IUCN) Red List of Threatened Species (Smith et al., 2003) and was listed under the U.S Endangered Species Act January 14, 2009 (CDFG, 2004a).

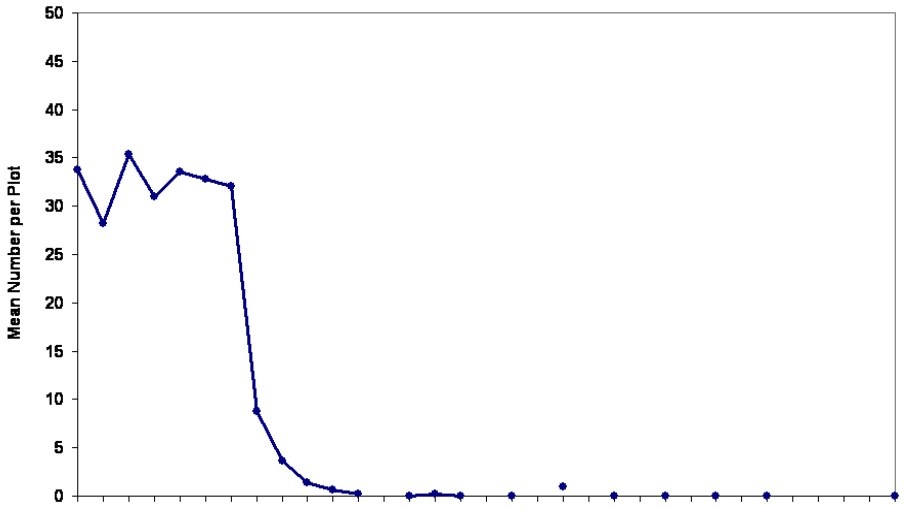


Figure 3. Black abalone density measured in spring and fall between 1985 and 2001 on Santa Barbara Island (Graph courtesy of Multi-Agency Rocky Intertidal Network).

Black abalone is just one of a long list of species that have been hit hard by human and environmental impacts. The status of rockfish populations in California offers another example of the depletion of California's marine resources. Love et al. (1998) describe the decline:

> "From at least the 1950s through the late 1970s, black-and-yellow, blue, gopher and olive rockfishes, as well as young bocaccio, were important components of the inshore rocky reef community of the southern California Bight. In particular, blue rockfish and olive rockfish were among the dominant species over many reefs. However, since the early 1980s, most species of rockfishes have nearly disappeared from the near-shore waters of the Southern California Bight. On many of the reefs that once held substantial numbers of these species, very few rockfish remain."

As the stories of California's abalones and rockfishes illustrate, California, like most areas of our planet, is losing its species at an alarming rate. It is important to mention, however, that we have yet to identify to what extent the changes in species diversity and abundance are directly caused by humans and to what extent they are attributable to patterns of natural disturbance.

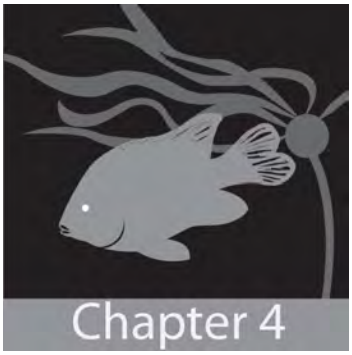
Since the origins of life on earth over 3.8 billion years ago there have been continuous shifts in species distributions, population numbers and composition. In fact, the wonderful diversity of life is a direct result of past species interactions with non-living elements and each other over the millennia. While this course is inevitable, sound management decisions will aim to try and minimize the degree of human impact on this process.

With respect to rocky reefs, we can observe fairly regular natural disturbance and recovery patterns. For example, in many areas along California's coastline winter storms oftentimes uproot the giant kelp forests. Soon thereafter, new juveniles (known to biologists as "recruits") settle those areas. Since giant kelp can grow up to 30 centimeters a day it doesn't take long for these forests to regenerate. Hence when we speak of the health of an ecosystem we aren't necessarily focusing on the number of fish or the number of kelp stipes. Instead, **"ecosystem health"** is directly related to the ability of an ecosystem to bounce back after disturbance.

In short, **long-term monitoring is required to get an accurate picture of the state of California's rocky reef ecosystems**. Long-term data will help tease out human impacts from natural fluctuations of marine resources. The data generated from your Reef Check California surveys will help paint a clearer picture of the possible human stressors that may be causing observed trends. This information will help determine what management actions should be taken and help evaluate the success, or failure, of management actions down the road.

"Death is one thing. The end of birth is something else."

--Michael Soule



Scientific Survey Methods

As anyone who has ever jumped out of a plane, surfed a thirty-foot wave or swam alongside a whale will tell you, no description will ever do justice to experiencing the real thing. For better or worse, we are oftentimes required to describe our experience in order to communicate with others. While science is not immune to this problem, it does its best to minimize the error that is inherent in characterizing phenomena.

Intricacies with Data Collection

Scientific surveys are used to characterize the natural environment by making estimates of reality. In a perfect world, we would count every fish in the ocean to know the population size of that species. Unfortunately, such a task is impossible and we must make controlled observations or take samples to estimate the true nature of a population. The more observations we make, of course, the more confident we are in our estimate. By making repeated observations you can tackle one of the greatest problems that all ecological monitoring programs face -- **variability**.

Variability

Imagine if your Reef Check team went out and counted the number of kelp bass observed along a 30 x 2 m area of reef inside a Marine Protected Area (MPA) and another Reef Check team surveyed the same area outside the MPA. Would you expect the difference in the number of fish counted inside and outside of the MPA to be sufficient to determine whether the MPA had an effect on kelp bass abundance? Consider all the factors: What if there were more fish inside the reserve to begin with? What if you happened to sample one of the sites just after a group of divers came through the area and scared away the fish or perhaps attracted fish with food?

Before diving into the intricacies of the Reef Check California methodology, it is worth considering the potential causes of error in our sampling. Consider the kelp bass counting example once more, but let's just concentrate on the data collected within the MPA.

One factor we need to account for is **temporal variability**. That is just a fancy way of saying that sampling the exact same site at different times is likely to yield different counts (estimates of reality). We can't expect the fish to remain still throughout the day; perhaps the kelp bass are more likely to be seen in the evenings than the mornings. Another factor would be **spatial**

variability. Just as the timing of your survey can influence your results, the location of the survey can also have an influence. Your survey might be located so that you happen to swim through a large school of fish, or, alternately you positioned yourself so that the same school swam right behind you.

Perhaps the most obvious cause in difference between each kelp bass count would be human error. Maybe one individual tends to count really high or one buddy team tends to underestimate and end up with an especially low count. In other words, each sampler and group of samplers is going to introduce different **biases** in the overall data set.

Our goal in providing you with a rigorous training in Reef Check California methodology is to standardize the data collection procedure as much as possible so that we can minimize the human bias to reduce the variation between each survey. **One of the most obvious ways to overcome variability is to regularly sample the same exact transects at the same time of day during the same period of the year.** Furthermore, as you go through the standardized Reef Check California training your data collecting technique will be calibrated. You will be taking an underwater species counting test and your error will be quantified. This is an integral part of your training and will allow you to correct for your biases.

Monitoring Diversity

There are a host of monitoring programs and significant differences between them. When a hypothesis is being tested, for example, the monitoring effort is generally referred to as **scientific monitoring**. This form of monitoring is characterized by its strong consistency, high data quality and strong scientific rigor. **Regulatory monitoring**, on the other hand, describes monitoring imposed by a regulatory agency (e.g., regular monitoring as a component of a discharge permit). Finally, and arguably one of the most important forms of monitoring to achieve conservation goals is **community monitoring**. Monitoring programs that involve local citizens are beneficial because they utilize vast manpower and generally have a built-in educational component.

Replication

At this point you may be asking, even if we do end up doing our best to account for the differences in spatial variability, temporal variability and sampler bias, isn't there still going to be too much variability in our data to say anything meaningful? In a word, the answer is **replication**. In statistics, replication means having replicate observations in the same or similar conditions. Replication is essential because biological systems are inherently variable and it adds information about the reliability of the conclusions or estimates to be drawn from the data (Quinn and Keough, 2002). As you begin to learn the Reef Check California survey methodology, you will see that we have incorporated numerous replicates to try to minimize the error in our estimates associated with spatial and temporal variability.

Precision vs. Accuracy

The goal of any sampling program is to be both precise and accurate. Although used synonymously in everyday speech, the two terms are technically quite different. **Accuracy** is

the closeness of an estimated value to its true value; **precision** is the closeness of different replicates to each other (Sokal and Rohlf, 2001) (Figure 4). For example, assume that the true number of kelp bass on a reef is 25. Your first day of training you perform 3 replicate surveys yielding counts of 10, 25, and 40, giving you a mean number (average) of 25 kelp bass. This would be a highly accurate number, but one that is not precise. Now imagine that you go out one hour later, repeat the same surveys, and tally 39, 40, and 41 kelp bass, giving you a mean of 40. This number would be precise, but not accurate. Finally, imagine that you perform the same three surveys after your Reef Check California training and count 23, 25 and 27 kelp bass, yielding an average of 25. This estimate would be both accurate and precise.

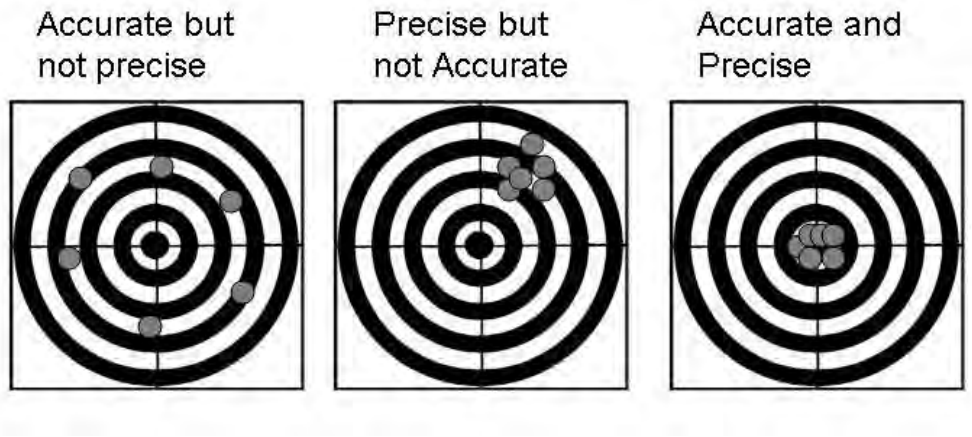


Figure 4. Examples of precision and accuracy

Unless a bias is present, precision will generally lead to accuracy. Hence, we must focus our training on removing all biases to ensure observations are consistent among different observers as well as by the same individual over time.

General Sampling Methods

Science knows no physical boundaries. Whether we are performing investigations ashore, at sea, or on the moon, the scientific method can be employed. Every study will be conducted with metrics. **Metrics are systems or standards of measurement**. If you are studying a population of Douglas fir in the Eastern Sierra, for example, you could do a **census** of each individual tree you saw in a particular area (i.e., you could count all the trees). Another system of measurement is the quadrat. **A quadrat is a predefined area (usually a square) inside of which samples are taken**. Most of the time quadrats are randomly placed in a particular habitat in order to get a representative picture of the habitat without measuring every square centimeter. Another way to study a habitat is to use a transect.

A transect is a line or strip across a surface along which a survey is conducted. There are several techniques you could use. If for example, you wanted to estimate the amount of clutter on your desk, you could run a tape measure across the length of your desk and use the line intercept method to measure the distance occupied by clutter and the distance of bare desk under the tape. Alternatively, you could use the point contact method and take a point at

uniformly spaced intervals **(Uniform Point Contact-UPC)** or randomly spaced intervals **(Random Point Contact – RPC)** along the tape to get an estimate of number of points of clutter and number of points of desk. Both methods give you an estimate of the percentage of your desk occupied by clutter (of course more lines or replicates will give you a better estimate). A final type of transect is a **band transect**, which has a specified width and will be referred to here as either a fish transect, invertebrate transect or seaweed transect.

Sampling Rocky Reefs

Sampling rocky reefs presents numerous challenges as traditional survey equipment, such as trawls and seines, cannot be used on rocky reefs and kelp forests due to entanglement issues (Stephens et al., 2006). Stationary gear such as gill nets, traps and hook and line are often used. However, these techniques are invasive and can damage the substrate and remove organisms from the environment. These techniques can also be biased toward more mobile fishes, such as those that are attracted to the bait or are of a particular size that is most effectively captured by the sampling device (Stephens et al., 2006). Surveys conducted by divers on scuba are the most widely used method for surveying rocky reefs (Stephens et al., 2006) because they have proved to be the least damaging and most reliable survey method for **non-cryptic species**.

Reef Check California surveys will employ the UPC and the various transects described above applied to the underwater environment by divers on scuba. Specifics of these transects will be discussed later in this manual.

Transects

The Reef Check California methodology is transect-based. There are two principal kinds of transects - random and fixed. You will perform primarily random transects during your surveys. The text below discusses their relative strengths and weaknesses.

Random transects

Random transects are laid haphazardly (i.e., as close to random as possible), placing the starting point of your transect at various locations in your target zone. Random transects help to minimize bias by randomly distributing transects over the sampling area. Another advantage is that the data from a number of randomly placed transects may provide a more representative picture of the whole reef area than fixed transects. This only holds true when a sufficient number of transects are conducted to account for spatial variation on the reef so that these can be differentiated from the temporal differences that are of interest to you. A key element to successfully implementing random transects is non-biased transect placement. Predefined compass headings and starting points can be used to help minimize bias of random transects. A disadvantage of using random transects is that the site selection process (i.e., finding suitable rocky reefs in your target zone) must be done each year.

Fixed transects

Fixed transects have permanently marked beginning and end points, ensuring you lay the transect tape in approximately the same position each year. The primary advantage of fixed

transects is that each survey will be directly comparable to surveys conducted in previous years. Due to their non-random nature, fixed transects do not provide an estimate of population size at the site but are useful for tracking changes over time in a small area. Because they minimize spatial variability, any observed changes can be attributed directly to changes over time (assuming sampler bias is not an issue). Another significant advantage is that the site selection process only has to be done once. A significant disadvantage is that the one site may not be representative of an entire ecosystem, requiring that a number of sites in the area be monitored. Another disadvantage of fixed transects is that they can be time consuming and expensive to set up and maintain and are often difficult to relocate each year.

Fixed transects can be marked with eyebolts or stakes cemented into holes drilled into rocks. The idea is to be able to wrap your tape measure around the markers to ensure you are surveying the same stretch of reef each time. **It is critical that you obtain permission from the relevant resource management agency before setting up permanent transects**. It is helpful to draw a map with the compass bearing to follow to find the next marker. We further recommend using a marker every 10 m along the transect. Using sub-surface marker-buoys can be useful for finding the start point of the transect. Be aware that surface marker buoys can get lost and can require different permits from various agencies. Hill and Wilkinson (2004) provide a more detailed discussion.

Calibration

One of the most important aspects of any methodology is being certain that all data recorders make similar observations. This is an especially large concern in the marine environment. Unlike terrestrial sampling, which is generally more straightforward, there are a host of difficulties inherent in marine environment sampling. In the case of collecting Reef Check California data, special gear is required, your sampling times are extremely dependent on the sea conditions and estimating animal size is much more difficult underwater. **In general, sampling underwater is much more difficult than on land.**

For this reason, during the course of your training, all course members and the instructor will successively record data on a fixed transect. This will be done to determine your relative weaknesses and strengths. If your data are too far off the mean, you will be required to continue your training before you will be certified as a Reef Check California diver. Your team should calibrate as often as possible including throughout the survey season. This could be done by setting up a non-permanent fixed transect as done during your training and comparing counts among team members. These data would not be submitted to the database but ensures you keep your survey skills sharp throughout the year. This is especially important if it has been sometime since your training or your last survey.

To maintain data submission eligibility, all divers must complete yearly recertification dive training as well as complete the online testing course.

Scientific Integrity & Ethical Concerns

As mentioned earlier, the data you collect is playing an integral part in implementing key legislative measures in California. It is imperative that it is collected in the most unbiased way

possible. While it may be tempting to "fudge" the data in order to serve a personal agenda, no matter how noble, in the long run it will only distort the decision making process. If you are only interested in pursuing an agenda, please put your scientific aspirations aside and join an advocacy group.

Be forewarned - marine sampling involves quite a lot of zeros. Even among experienced scientists there is a temptation to record a species observed just outside the transect boundaries. As a Reef Check California diver, you must exercise restraint when confronted with such a situation. Remember, our goal is to minimize variability between individual samplers. Therefore we must ensure everybody is using the exact same methodology. Zeros in your data are not a bad thing, but representative of the variable ocean environment. The long-term average is much more important than a single survey. Organisms not falling within transect boundaries can be recorded in the comments section, but must not be recorded in the data reporting fields.

Disturbance

Despite good intentions, the number of people visiting a habitat, coupled with lack of education, can lead to environmental degradation. Two obvious examples that you may have experienced in California are smog and gridlock in Yosemite and trampled tidepools in Southern California. People love to visit the Sierras and the tidepools, but even if they don't take anything, their trampling can have a major impact. One of the goals of your training is to teach responsible diving in order to minimize disturbances to the rocky reef habitats we are studying.

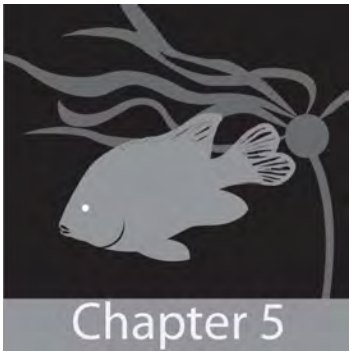
The divers that cause the least disturbance are those that are the most familiar with their gear. They minimize loose or dangling equipment and have excellent **buoyancy control**. We strongly recommend that you attach extra clips and buckles for holding your research gear.

Safety

Safety is the number one priority of Reef Check California. One of the most common errors divers make when completing specific tasks underwater is to be too liberal with their dive plan. It is much easier to lose track of time, your surroundings and your buddy when concentrating on data collection than when diving without a specific purpose. Carrying out any tasks underwater can increase susceptibility to decompression sickness. Hence, it is imperative that you **plan dives more conservatively when collecting data and remain aware of air and bottom time**. A good rule of thumb for research diving is to use the next deeper depth level when calculating your dive tables and maximum allowable bottom time.

Although you may have heard it a thousand times, it doesn't make it any less essential to maintain the buddy system. **At no point in any dive is it acceptable to lose sight of your buddy.** As with all dives, you and your buddy should agree on lost buddy procedures prior to entering the water and follow them accordingly.

Please remember, the data are not worth getting injured or risking your life! You can always come back another day to complete a survey. Under no circumstance should you conduct a survey if you are not completely confident in your ability to safely complete the dive.



Conducting Reef Check California Surveys

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, then 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 5).

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.

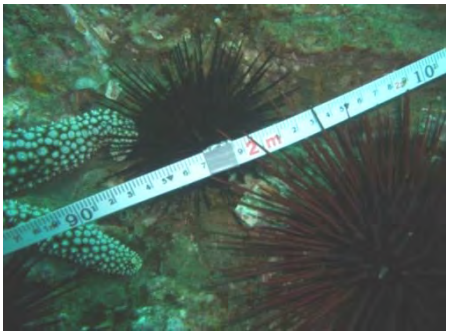


Figure 5 One-meter intervals marked with tape on transect line. This practice is especially important when the transect tape does not have meters marked on both sides (Photo: G. Hodgson).

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 6).

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).

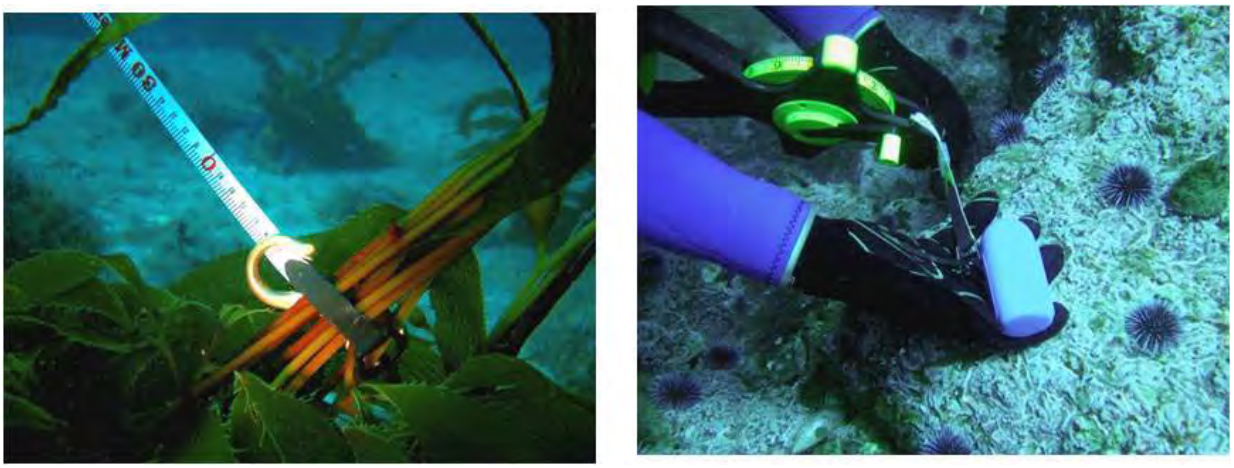
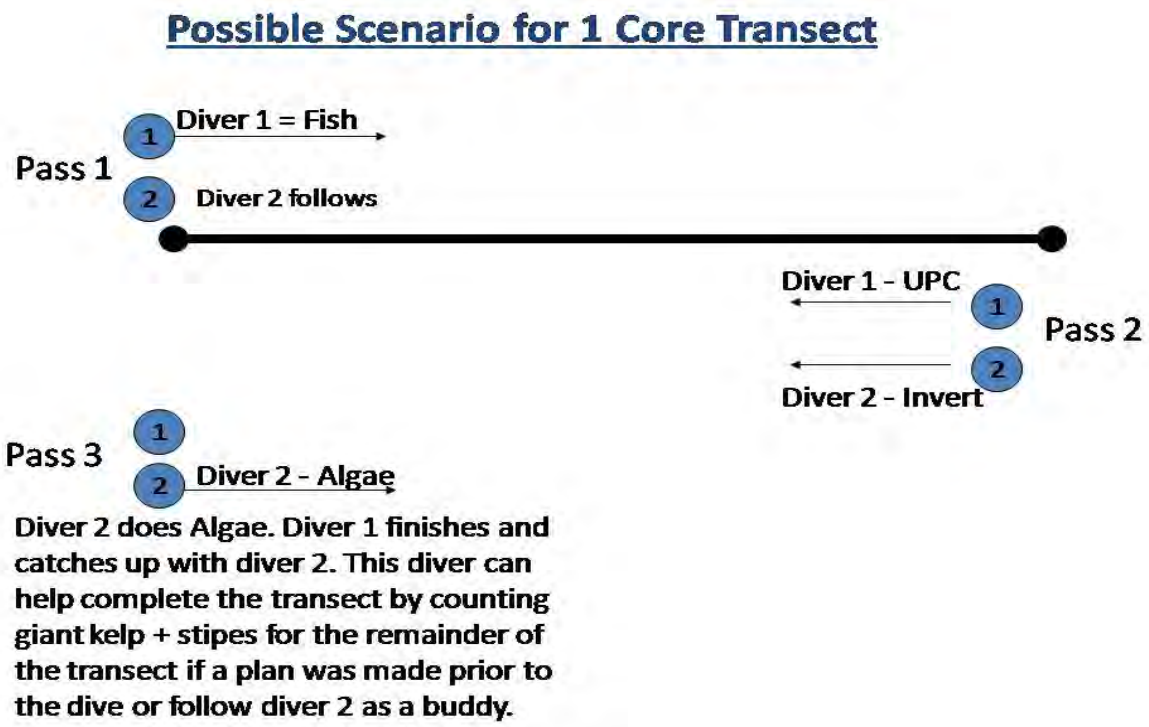


Figure 6. Two ways of anchoring core transect: either with a clip or with a two pound weight (Photos: N. Flash, www.flashpics.com).

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.



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 7). 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.

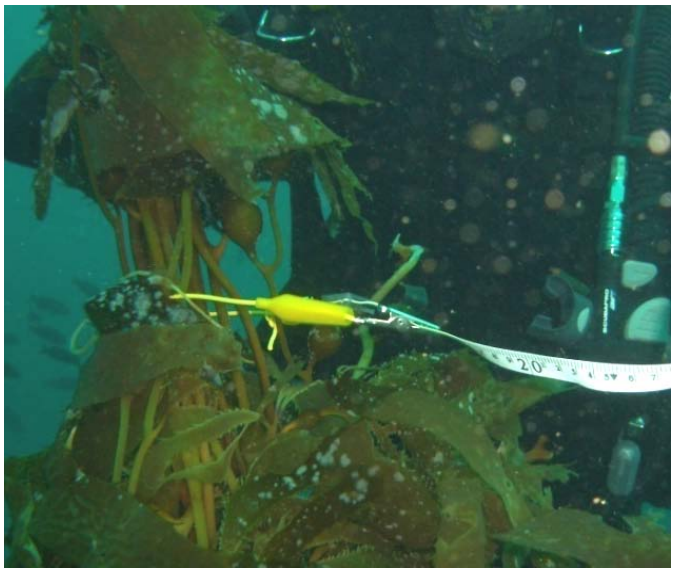


Figure 7. Twelve gauge wire and alligator clip anchoring Fish Only Transects (Photos: N. Fash, www.fashpics.com and G. Hodgson).

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 8). 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 8. 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 be recorded in a legible fashion so that others 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.

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 transects as discussed in the scientific survey methods section. 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 Conducting The Survey & Data Collection section).

- **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 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.

- **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.

- **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 5.

Visibility must be at least 3 meters to conduct fish surveys. More details on checking visibility will be given in the Fish Transect section of this chapter.

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 9).

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.

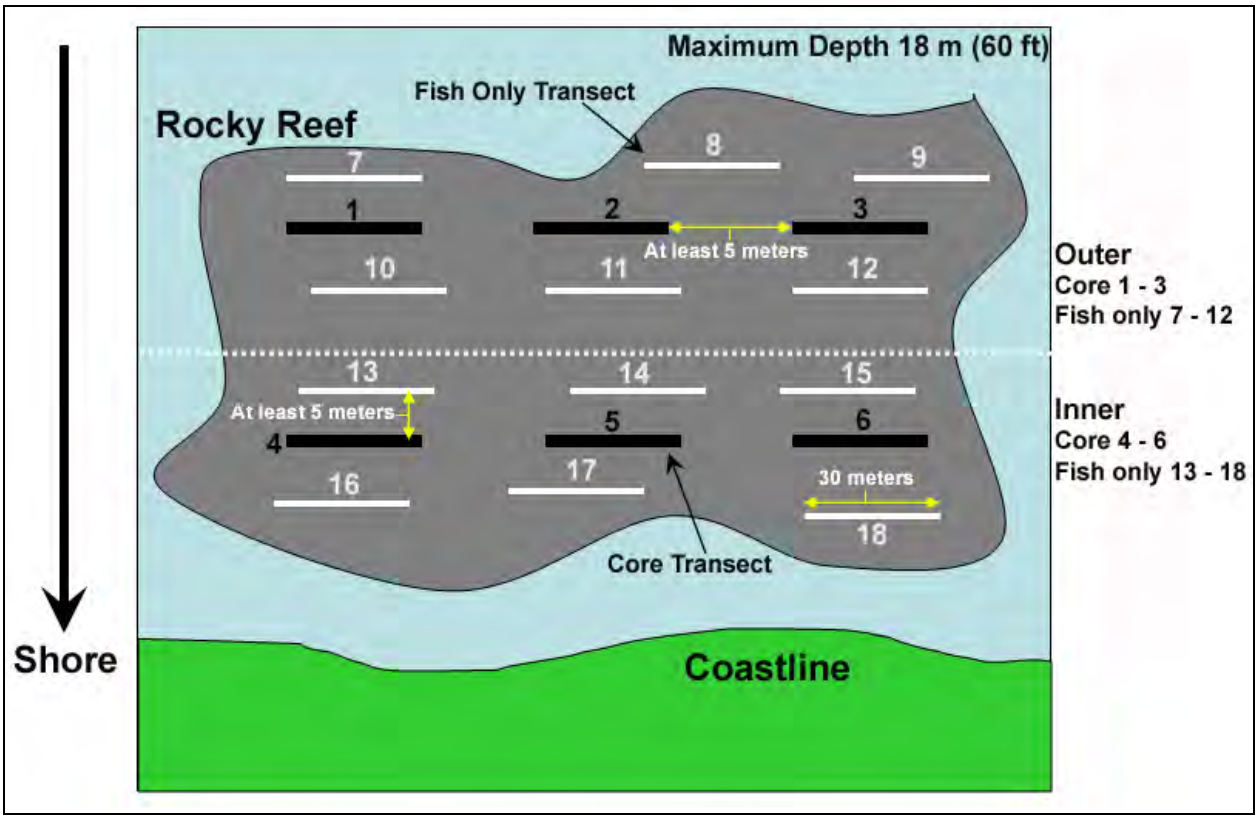


Figure 9. Diagram of transects over a rocky reef. All teams should aim to complete six core transects, which are marked in bold (3 in each zone), plus an additional twelve random fish only transects, which are marked in white (6 in each zone). All transects are 30 meters in length.

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	*Megastraea undosa*, *Lithopoma 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 16). 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 minute 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 11 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 horneri* and *S. muticum*). These species should be recorded as present if they are seen anywhere during a survey. In addition to being recorded as present at a site (Yes/No field on datasheet), *Sargassum horneri* will be survey in the same way as other types of seaweed. Its holdfasts will be counted along the seaweed transect. If you detect either *Undaria pinnatifida or 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 horneri*	I. EI
Sargassum†	*Sargassum muticum*	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. For giant kelp, the number of stipes ("stems") 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 10). 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 minute goal in mind. See Figure 11 for an example on how to record data on the seaweed datasheet.

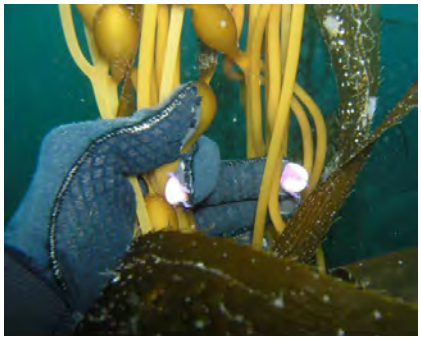
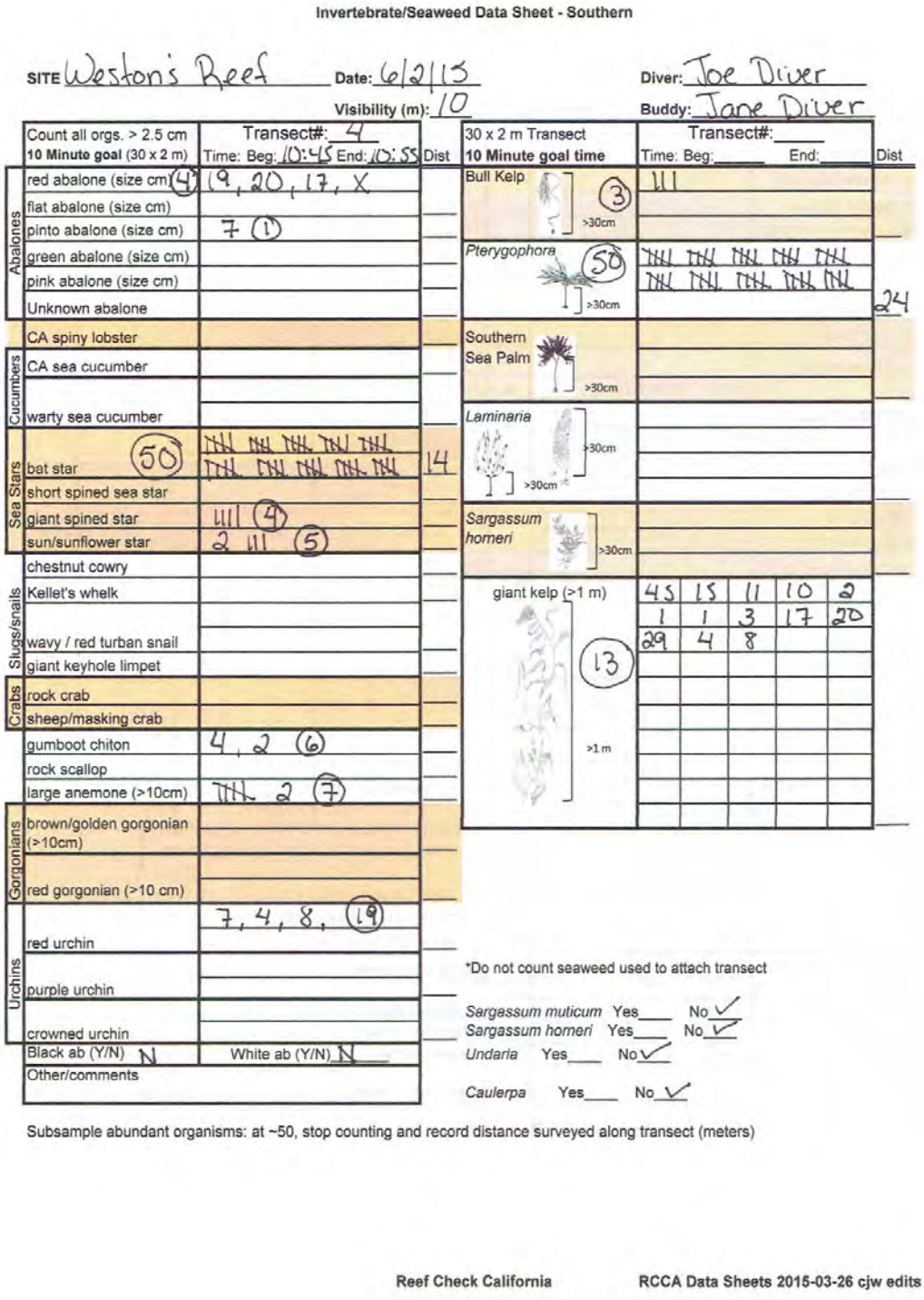


Figure 10. Using fingers to count kelp stipes at 1m off



Invertebrate/Seaweed Data Sheet - Southern

SITE Weston's Reef Date: 6/2/13 Visibility (m): 10

Diver: Joe Diver Buddy: Jane Diver

Count all orgs. > 2.5 cm **10 Minute goal** (30 x 2 m)	Transect#: 4 Time: Beg: 10:45 End: 10:55	Dist
Abalones: red abalone (size cm) (4)	19, 20, 17, X	
Abalones: flat abalone (size cm)		
Abalones: pinto abalone (size cm)	7 (1)	
Abalones: green abalone (size cm)		
Abalones: pink abalone (size cm)		
Abalones: Unknown abalone		
CA spiny lobster		
Cucumbers: CA sea cucumber		
Cucumbers: warty sea cucumber		
Sea Stars: bat star (50)	𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸	14
Sea Stars: short spined sea star		
Sea Stars: giant spined star	𝍸 (4)	
Sea Stars: sun/sunflower star	2 𝍸 (5)	
Slugs/snails: chestnut cowry		
Slugs/snails: Kellet's whelk		
Slugs/snails: wavy / red turban snail		
Slugs/snails: giant keyhole limpet		
Crabs: rock crab		
Crabs: sheep/masking crab		
gumboot chiton	4, 2 (6)	
rock scallop		
large anemone (>10cm)	𝍸 2 (7)	
Gorgonians: brown/golden gorgonian (>10cm)		
Gorgonians: red gorgonian (>10 cm)		
Urchins: red urchin	7, 4, 8, (19)	
Urchins: purple urchin		
Urchins: crowned urchin		
Black ab (Y/N) N	White ab (Y/N) N	
Other/comments		

30 x 2 m Transect **10 Minute goal time**	Transect#: Time: Beg: End:	Dist
Bull Kelp (3) >30cm	𝍸	
Pterygophora (50) >30cm	𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸	24
Southern Sea Palm >30cm		
Laminaria >30cm >30cm		
Sargassum homeri >30cm		
giant kelp (>1 m) (13) >1 m	45 15 11 10 2 1 1 3 17 20 29 4 8	

*Do not count seaweed used to attach transect

Sargassum muticum Yes___ No ✓
Sargassum homeri 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 2015-03-26 cjw edits

Figure 11. 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 12).

OB – Other Brown Seaweed. Any other type of brown seaweed including *Sargassum* spp., *Undaria pinnatifida* and *Cystoseira* (Figure 13).

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 14).

SI - Sessile Invertebrates. Includes sponges, anemones, bryozoans, gorgonians, sand castle worms, barnacles, etc. (Figure 15).

MI- Mobile Invertebrates. Includes sea stars, urchins, sea cucumbers, crabs, limpets, etc (Figure 16, Figure 17).

SG- Seagrasses. Includes surfgrass and eelgrass.

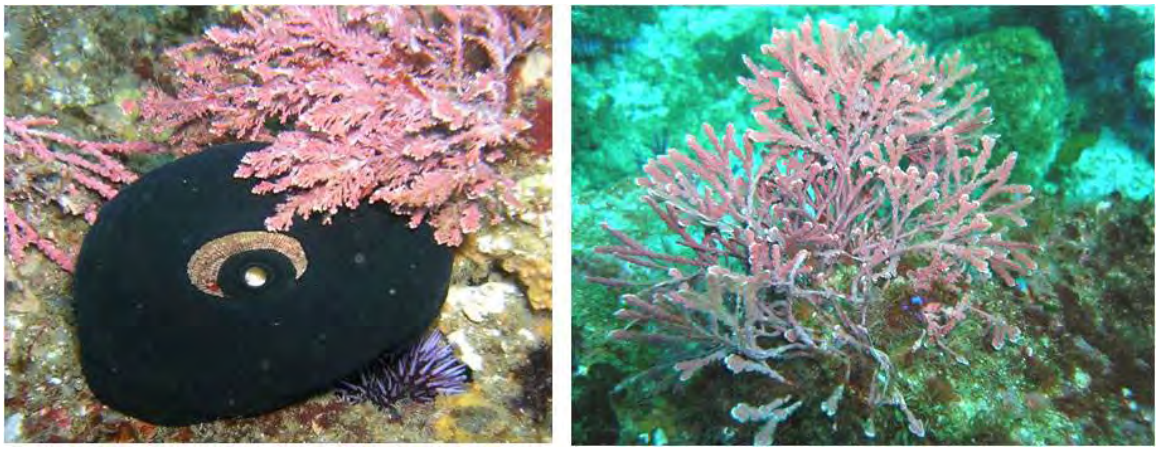


Figure 12. Different types of articulated coralline algae. The keyhole limpet and purple urchin burrowed in the rock would be recorded as mobile invertebrates (Photos: C. Shuman).

Figure 13. Examples of Other Brown algae (OB) (Photos: D. Richards, M. Schwalbach, and K. A. Miller).

Figure 14. Crustose coralline algae
(Photo: C.Wisniewski)

Figure 15. 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 16. 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)

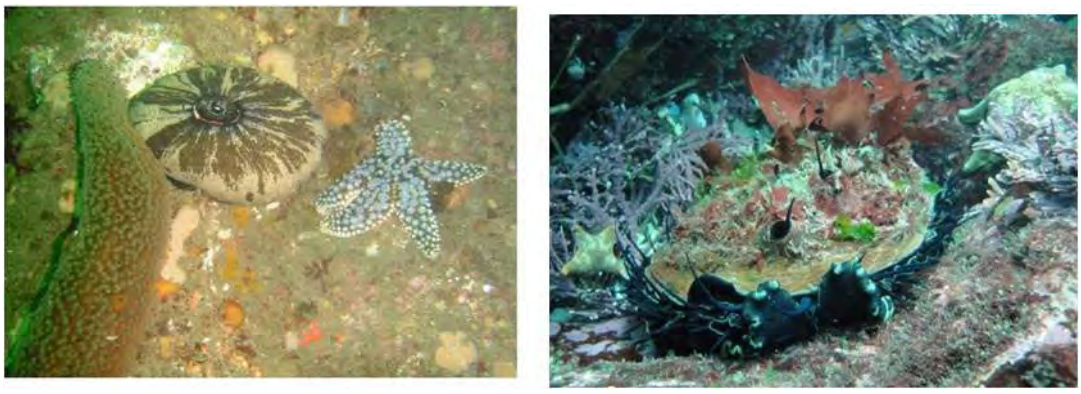


Figure 17. The sea cucumber, keyhole limpet, sea star (left photo) and red abalone (right picture) are examples of mobile invertebrates (Photos: L. Fink and M. Wehrenberg).

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 18. 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

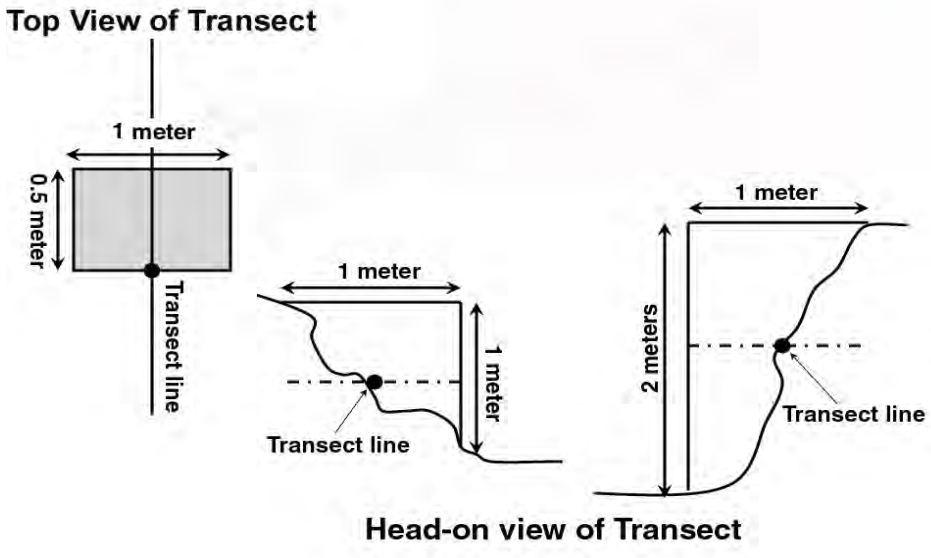


Figure 18. Physical relief is measured as the greatest vertical relief within a 1-meter wide section across the tape and .5-meter section in front of each point

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	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 (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 19). 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 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 19 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 and displays their other hand (preferably wearing a black glove) 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 20).

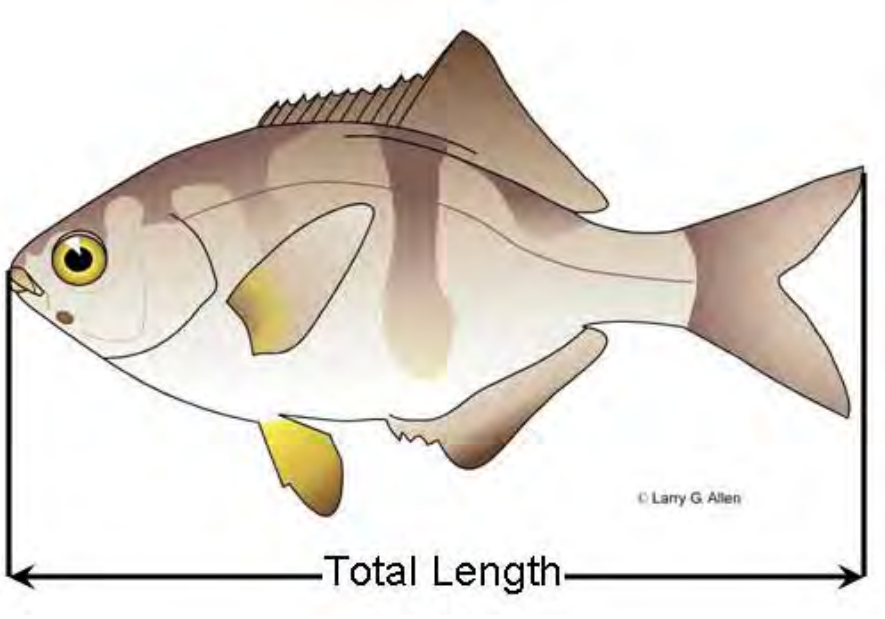


Figure 20. Total length of fish, in this case a pile perch, is measured from mouth to tip of tail (Illustration © Larry G. Allen).

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.

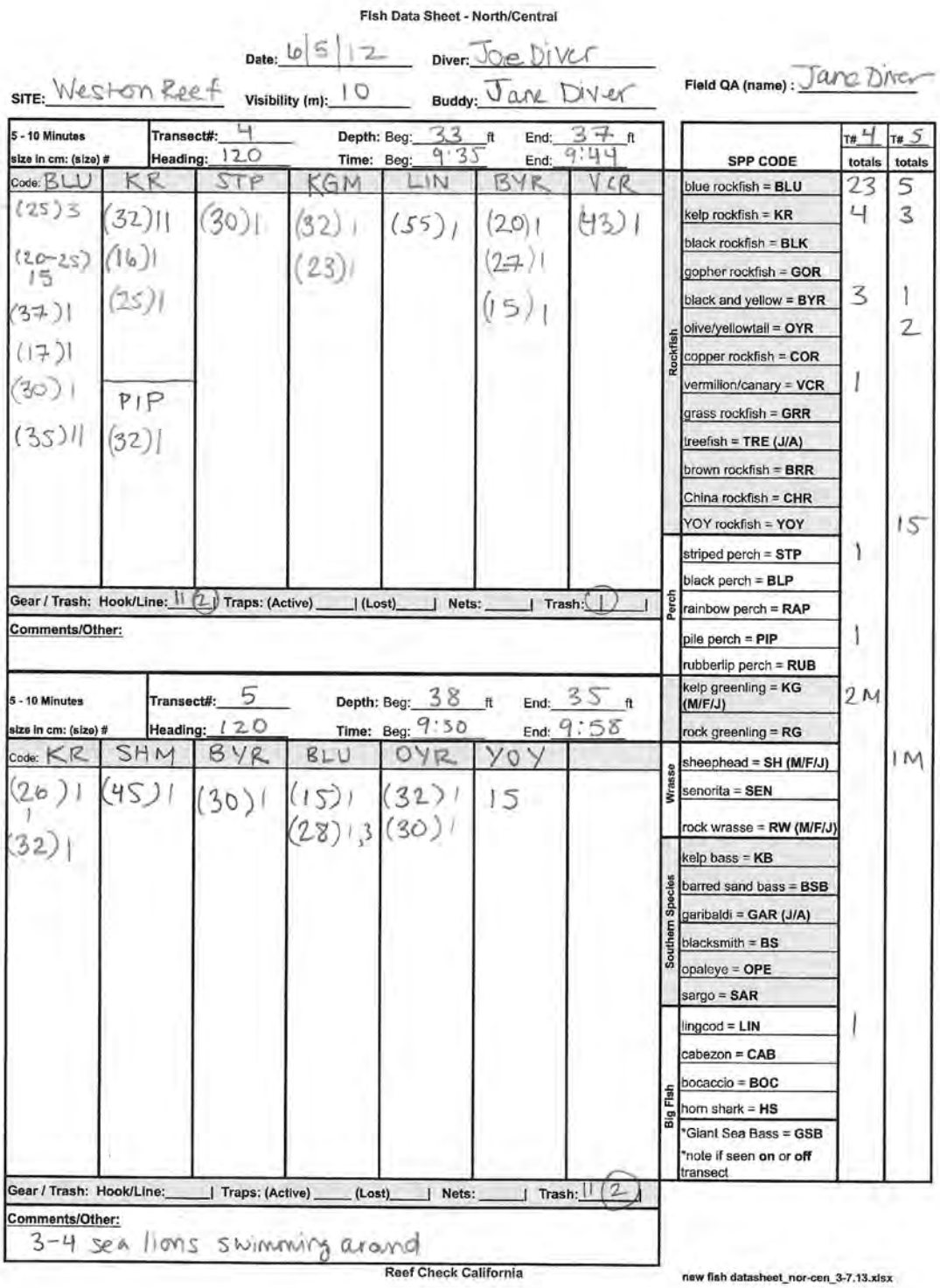
Another helpful practice is to estimate the size of non-moving objects or organisms (e.g., sea stars, sea cucumbers) then approach them and measure their size with your slate. After you measure, note if your estimate was below or above the measured size and adjust your estimation before you repeat this 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 21 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

5 - 10 Minutes
size in cm: (size) #

Transect#: 4 Depth: Beg: 33 ft End: 37 ft
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:

5 - 10 Minutes
size in cm: (size) #

Transect#: 5 Depth: Beg: 38 ft End: 35 ft
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	
1 (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	T# 4 totals	T# 5 totals
Rockfish: blue rockfish = BLU	23	5
Rockfish: kelp rockfish = KR	4	3
Rockfish: black rockfish = BLK		
Rockfish: gopher rockfish = GOR		
Rockfish: black and yellow = BYR	3	1
Rockfish: olive/yellowtail = OYR		2
Rockfish: copper rockfish = COR		
Rockfish: vermilion/canary = VCR	1	
Rockfish: grass rockfish = GRR		
Rockfish: treefish = TRE (J/A)		
Rockfish: brown rockfish = BRR		
Rockfish: China rockfish = CHR		
Rockfish: YOY rockfish = YOY		15
Perch: striped perch = STP	1	
Perch: black perch = BLP		
Perch: rainbow perch = RAP		
Perch: pile perch = PIP	1	
Perch: rubberlip perch = RUB		
Perch: kelp greenling = KG (M/F/J)	2M	
Perch: rock greenling = RG		
Wrasse: sheephead = SH (M/F/J)		1M
Wrasse: senorita = SEN		
Wrasse: rock wrasse = RW (M/F/J)		
Southern Species: kelp bass = KB		
Southern Species: barred sand bass = BSB		
Southern Species: garibaldi = GAR (J/A)		
Southern Species: blacksmith = BS		
Southern Species: opaleye = OPE		
Southern Species: sargo = SAR		
Big Fish: lingcod = LIN	1	
Big Fish: cabezon = CAB		
Big Fish: bocaccio = BOC		
Big Fish: horn shark = HS		
*Giant Sea Bass = GSB		
*note if seen on or off transect		

Reef Check California

new fish datasheet_nor-cen_3-7.13.xlsx

Figure 21. 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 21). 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 22). **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 22. Urchin sizing with calipers (Photo: N. Fash, www.fashpics.com).

Data Entry & Data Reporting

Accurate data entry is one of the most critical components of the monitoring process. As discussed in the previous chapter, it is critical that consistency be maintained within and among individuals. The Data Captain is responsible for data checking, data entry and submission of data. All team members should assist with this activity.

The first level of data checking is performed at the site immediately following the dive either on the boat or on the beach. The Data Captain must collect **and review** all data to ensure the datasheets are legible and ask any questions while the data are fresh in everyone's minds. This is a crucial step!

Within 72 hours of returning ashore all data must be entered into the Reef Check California online Nearshore Ecosystem Database (NED). Using your web browser, navigate to the diver portal at http://ned.reefcheck.org (Figure 23). All RCCA data captains will be issued a username and password that will allow them to:

- Add a new survey
- Continue an incomplete survey
- Review a completed survey

Accurate Data Entry is Critically Important!
The data entry system contains two automated validations to check your entries. Despite this, you must be very careful to accurately enter your data.

Once data are entered and final data checks are completed by Reef Check staff all data are made publically available in Reef Check's Global Reef Tracker at: http://data.reefcheck.org. The interested public, resource managers and scientists can view, explore and download Reef Check California's data from this site through an interactive and intuitive map-based interface.

Sending the Datasheets to Reef Check

Original datasheets should be mailed to your Regional Manager for final review and archiving after you have completed entering the data into NED. Data should be sent no later than ten days after completing your survey. We will send you new blank datasheets for your next survey upon receipt of your completed datasheets.

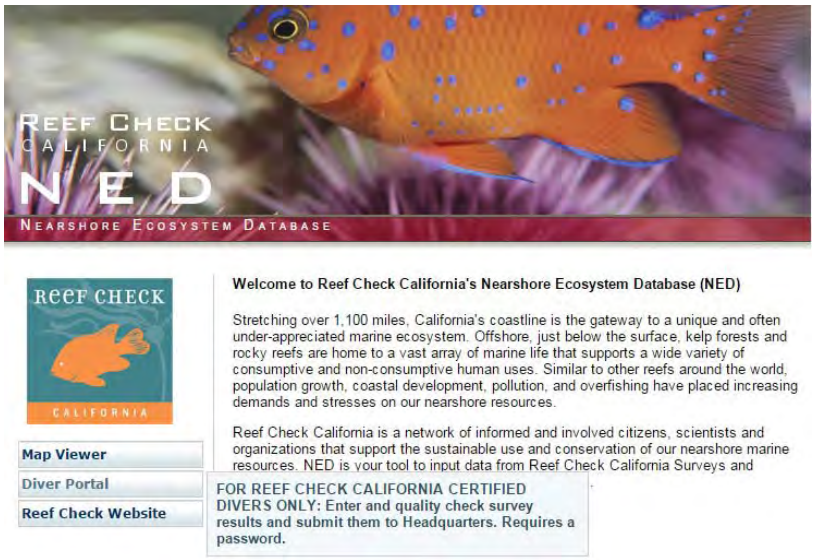


Figure 23. NED home page with Diver Portal selected.

What More Can You Do?

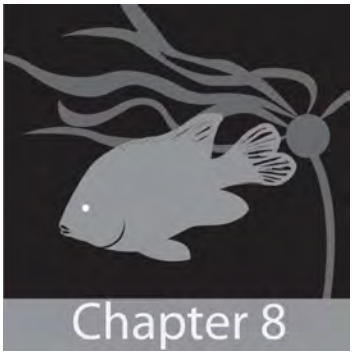
- Take part in our planned surveys up and down the coast. Use Reef Check's statewide program as a means of diving in new locations with divers who know the areas well.

- Survey additional sites. The more sites that are surveyed as part of Reef Check California the more complete our picture will be of the status of California's reefs.

- Record additional information. For long-term monitoring, it is recommended that a full set of still photos and a video be obtained along the transect and surrounding area. Such photographs and video can be very useful in answering unexpected questions that crop up long after the survey is completed. We also recommend taking several above water photos in several directions showing the locations of the transects lined up against whatever landmarks may be available for future reference. It is generally not advisable to rely completely on video or photo monitoring for two reasons: 1) the ability to identify organisms in videos and photos is limited, and 2) analysis requires a great deal of time, even when aided by semi-automated procedures.

- Document your efforts. We strongly encourage all teams to record their travel, survey, analysis, post-dive party and any PR/media events with still photos or video. Photos and videos can be uploaded to the Reef Check Foundation's Facebook page or to our regional Facebook groups:

  https://www.facebook.com/reefcheckfoundation
  https://www.facebook.com/groups/NorCalReefCheck
  https://www.facebook.com/groups/SoCalReefCheck



Quality Assurance Procedures

Quality assurance (QA) is a system for ensuring that data collection, entry and reporting follow a defined written plan and that if a mistake is made, it can be promptly detected, traced to a responsible person and corrected. This chapter defines the procedures for ensuring that data collected for a Reef Check California survey are correctly logged and submitted to the Reef Check database for analysis. Data quality insurance and quality control steps are build into the program beginning with the training all the way through to the final data submission to the public database. Key steps are:

1. RCCA's four-day training course
2. Annual recertification of volunteers
3. Standardized data collection methods and datasheets
4. Field data verification
5. Data entry interface that minimizes user error
6. Automated data checks programmed into database
7. Data verification after data entry
8. Final data review by RCCA staff

Training

All participants are required to successfully complete the RCCA training course under the direct supervision of a certified RCCA instructor to be eligible to submit data to the RCCA Nearshore Ecosystem Database (NED). Divers who complete the course and pass certification levels sufficient to conduct surveys continue to increase their knowledge by actively participating in underwater surveys. Only divers who completed the required training and testing in each transect type and have demonstrated proficiency in data collection activities are allowed to contribute data for the transect types they are certified for. This tiered approach allows volunteers to collect data for certain taxa once they complete testing for those transect types and enables volunteers with differing abilities to participate in the program without adversely affecting data quality. Participants with extensive prior monitoring experience can opt out of the training course but must demonstrate proficiency in all components of the RCCA protocol under the supervision of a certified RCCA instructor before they can submit data to the RCCA database.

Requisite components of the RCCA training course are:

1. Completed reading of the Reef Check California Training Manual
2. Attendance and participation at all classroom sessions (10 hours)
3. Attendance and participation at the pool session (3 hours)
4. Attendance and participation at all field sessions (6 dives)
5. Successfully pass the written multiple choice test (85% passing score)
6. Successfully pass the species identification tests (85% passing scores)
7. Successfully complete the methods and species identification field practical exercises

After the initial training, all volunteers are required to complete a one-day recertification in each subsequent year before being allowed to collect data in that survey season. This recertification includes written species identifications test and a field day during which volunteers are tested in all transect types before being certified for data collection.

Data Collection

Data collection methods have been designed to promote the safety of the surveyor as the primary goal followed by the accuracy and precision of all data collected. All surveyors must follow the methods outlined in the Reef Check California Training Manual. The following items have been included in the survey protocol to increase the precision and accuracy of all surveys by reducing sampler error and bias:

1. Standardized site selection and transect deployment procedures
2. Standardized time requirements, search image and use of flashlights for all invertebrate and fish surveys
3. Minimum size requirements for all invertebrate and algal species to focus on emergent organisms only
4. Grouping of species with similar morphological traits (i.e., canary and vermilion rockfishes) to reduce the likelihood of misidentification
5. Employment of standardized data notation procedures on the underwater datasheets
6. High level of replication within a site (eighteen 30 x 2 x 2 m transects)

Field Data Verification

Immediately following each dive, each team member must review their datasheet for completeness and legibility. The Data Captain verifies this prior to collection of each sheet and discusses any potential outliers with the team member. If a consensus on any data cannot be reached, the team leader will flag the datasheet for further review by the data manager.

Data Entry

The text below is provided as a guide to direct the entry of all data. Materials Needed

- Washed and dried datasheets
- Red and blue or green pencil or pen

- Print out of RCCA NED Instructions document which includes detailed quality assurance procedures

Prior to Data Entry

1. Confirm all datasheets are present and accounted for. The total number of sheets will vary but you will need to make sure you can find fish transects 1-18, invertebrate transects 1-6, seaweed transects 1-6, and UPC transects 1-6. You also may have urchin size-frequency datasheets, but not always.

2. Review each datasheet for completeness. There may be fields which were intentionally left blank. IF ANY FIELDS ARE BLANK, BE ABSOLUTELY SURE A CHANGE IS APPROPRIATE. VERIFY WITH THE DIVER THE CORRECT INFORMATION BEFORE YOU MAKE ANY CHANGES. The most common omission is start and end time. If those are left blank there is no way to get that information so it will have to be left blank in the database. This is also true for start and end depth. DO NOT MAKE UP THESE NUMBERS. JUST LEAVE THEM BLANK IF THEY WERE NOT ENTERED.

3. ALL EDITS ARE TO BE MADE IN RED PENCIL OR RED SHARPIE ON ORIGINAL DATASHEETS. The most common questions arise from not being able to determine the total counts for a species, either due to illegible writing or unfamiliar non-standardized notation (see Recording Data and Ensuring Quality section). Before you change anything on the datasheet, it may be necessary to fax or scan a copy of the datasheet in question and send it to the diver to verify the edit in question. You may also call the diver but often it requires the diver to see the original before they can interpret the correct count. If you cannot figure out what to do with an entry, leave it blank and flag questionable records on the datasheet with a Post-It and circle it in red on the datasheet.

Entering Data

Visit http://ned.reefcheck.org/instructions for detailed data entry procedures

Data Verification

At this stage please do check of the data that you entered. One way to accomplish this is to randomly select a couple of datasheets and go back and make sure data entered by you matches up. Having another person look over the entries to independently verify the data entry is highly recommended.

Make sure all datasheets are accounted for and all Post-its/data flags are readable. Paperclip or staple all the datasheets together.

Datasheet Submission

After you have completed all the above steps, perform one more check to ensure you have all the datasheets for the site.

Package the datasheets and mail them to the Regional Manager.

Finalizing Data

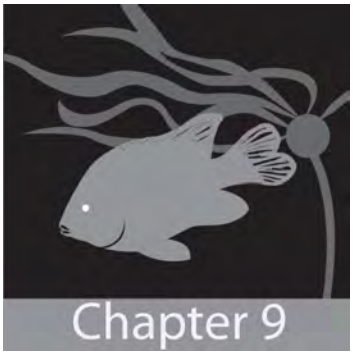
Upon receipt of the datasheets, all data will be reviewed by the Regional Manager and erroneous data are removed before data are submitted into the final database

After the data are vetted, the Regional Manager will scan the datasheets and pass those files onto the database manager. The finalized data will be displayed via Reef Check's Global Reef Tracker on the web at http://data.reefcheck.org.

All datasheets will be archived in digital and hard copy formats.

Note!

Chapters 5 – 8 provided you with the theory necessary to conduct surveys with Reef Check California methodology. **YOUR UNDERSTANDING OF THESE SECTIONS IS CRITICAL FOR THE SUCCESS OF REEF CHECK CALIFORNIA**. If you have any questions while reading through these materials or during the lectures, please ask your instructor. We are constantly working to improve our materials and value your interest and input.



Sustainable Long-Term Monitoring

Reef Check's Role in California

A major goal of marine monitoring programs is to provide the data required for sound and sustainable management practices. In 2012, the state of California completed a historic and unprecedented 12-year process of establishing its first network of marine protected areas. This has resulted in approximately 16% of state waters being protected from many human activities including commercial and recreational fishing. With the full implementation of this statewide network of MPAs, the long-term monitoring of these MPAs has become a major focus of Reef Check California.

Despite strong support for volunteer-collected data (Harding et al., 2002; Abramson et al., 2000) there are still skeptics that do not believe in the effectiveness of citizen science for environmental monitoring. Therefore, it is very important that you take your training and subsequent surveys very seriously to ensure you produce high quality data. As resources for monitoring are limited, volunteer monitoring becomes increasingly valuable to provide critically needed information (Levrel et al. 2010). The usefulness of RCCA data for marine management in California has been demonstrated in a study comparing RCCA data to data collected by academic monitoring programs in southern California. Gillett et. al. (2012) concludes that the data collected by RCCA's citizen scientists can be used in conjunction with other monitoring data to inform marine management in California.

Without objective scientific monitoring, changes in California's marine ecosystem in response to changing climate, human and management and conservation actions such as MPAs, cannot be tracked. Therefore, the establishment of Reef Check's volunteer monitoring program in 2006, just as the first MPAs were being implemented, was timely. Over the first six years, Reef Check California has grown into a statewide citizen-science monitoring network focused on rocky reef and kelp forest ecosystems. The program is now monitoring over 80 sites along the entire length of California's coast. This rapid growth was accomplished through the training of over 1000 volunteer citizen scientists and collaboration with academic, state and private institutions and organizations. The program is now well established and sustains a dedicated body of about 250 active volunteers annually, many of whom have been with Reef Check since its early years. Reef Check California partners with many universities, research programs, private organizations, state agencies and private businesses to conduct volunteer training and reef monitoring. RCCA's community based approach not only provides timely information to marine managers, it also builds up public support for marine monitoring and science-based

management. Without such support, even well-funded, government-led management efforts can fail. Moreover, by participating in Reef Check training, fundraising and surveys, community members can develop a sense of stewardship toward the ecosystem they are monitoring.

Sustainable Financing

As state funding for marine monitoring is extremely limited, finding new and sustainable financing for the Reef Check's public service of monitoring the status of California's marine environment is tremendously important. Several funding streams have been established and the involvement of RCCA's volunteers in this ongoing effort of sustaining and growing the program's funding, partnerships and sponsors is a major part of the program's funding success.

Grants

Grants are available from a wide range of funding sources, from hundreds of private philanthropic foundations focused on marine education, monitoring and management, to State and Federal agencies interested in supporting marine monitoring and conservation programs. A major role of Reef Check's development staff is to work with our teams across the state to help find grant support to start up and maintain Reef Check programs until such time that they can be locally self-supporting. Please let us know if you would like to work with us to search for and develop new grants or if you know of a funder that you would like to connect us to.

Corporate Sponsors

Corporate sponsorships are often the easiest type of funding for our volunteers to obtain by connecting us to their employers or other businesses in their network. These partnerships often lead to sustainable financing as corporations become long-term partners. Corporations actively seek out ways to maintain a "good" public image as well as sell their products through advertising. Reef Check California offers excellent opportunities for both to corporations. There is a wide range of media opportunities for corporate sponsors and many of our new corporate sponsorships focus on funding for our Annual Gala, whereby the company may "buy tables", ad space in the Gala brochure and event signage. It is worth remembering that these same companies may spend tens of thousands of dollars, if not more, for print, radio and television advertising. A single print ad in a major US newspaper or magazine can cost between $50,000 and $100,000. Please consider helping us by connecting us to businesses and corporations within your network. We find that the highest success rate for new corporate sponsors comes from companies whose friends or employees are Reef Check volunteers.

Many companies, such as dive boats or shops may also provide "in-kind" donations such as use of facilities, boats, dive equipment and staff time.

Adopt-A-Reef

The Adopt-A-Reef program partners with California's corporate brands to sponsor and support the community-based monitoring and conservation of California's reefs. Through these partnerships with coastal communities and companies, the Adopt-A-Reef program leverages the support and resources of local businesses to directly sponsor local volunteer dive teams to annually monitor the health of their local marine ecosystems. By replicating this model on a

statewide basis, the Adopt-A-Reef program engages California's business community to take direct action, and a very proactive and forward-thinking stance, in moving beyond business-specific environmentally friendly practices towards actions that positively impact their local, and our global, community and environment.

Volunteers play a big part of helping Reef Check to connect with potential Adopt-A-Reef partners through networking and, once a reef is adopted, by working with the corporate partner to take full advantage of the sponsorship. Please let us know if you would like to help expand this program.

Donations and sustaining membership

An important funding source for the California program is the donations made by volunteers and Reef Check members. By becoming a Reef Check member you can help sustain the program with an annual contribution or you can choose to become a sustaining RCCA All-Star by signing up for Reef Check's monthly donation program at:

http://admin.reefcheck.org/crm/rcca/rcca-allstar_subscribe.php

Concluding Remarks

Reef Check California's data are contributing to our understanding of California's nearshore ocean. Our collaborative work with the California Department of Fish and Wildlife (DFW) and the MPA Monitoring Enterprise is providing a public service to the people of California by insuring that our shared marine resources are managed and conserved based on available science as mandated by the state. As such, RCCA's data have been used to inform marine management and conservation on an ongoing basis. The data were used for the siting of the new MPAs under the Marine Life Protection Act Initiative and RCCA's data and analyses have been part of the ongoing baseline monitoring in all regions where MPAs are in place. Going forward, RCCA will be focusing on the long-term monitoring of these new MPAs throughout the state.

Having trained over 1000 citizen scientists and educated many more about marine resource management and conservation issues, Reef Check has created a body of well-informed citizens who have taken action to improve marine management in California. As management and conservation issues are likely to remain controversial, this will help to build an educated and active constituency that can demand sound science-based management and conservation. This will serve California well as issues, such as the effects of climate change, come to the forefront of the state's resource management and conservation policies.

Remember, we are relying on you to produce high quality data that can be used to help make informed management decisions. To achieve this, you must constantly update your skills and calibrate your sampling with other members of your team. It is imperative that all Reef Check California surveys are standardized or else we will not be able to identify ecological trends in the data. Thank you for choosing Reef Check as a vehicle for making a difference, and above all, thank you for being concerned enough to take action!

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Appendix A: Reef Check California Protocol Updates

In the following we list the updates and changes that have been made to the Reef Check California protocol over the years since the program started in 2006. All of these changes are reflected in this current version of the manual. This section should serve as a reference when analyzing RCCA data so that these updates can be accounted for. All updates were made in a way that they are backwards compatible with the data collected before the respective protocol change. Therefore, they should not cause any problems in data analyses but is some cases they have to be considered and accounted for before results are interpreted (e.g., if a species was added or a certain category of taxa was split into two).

2015 Protocol Updates

Adding invasive algae *Sargassum horneri* to algae transect

Over the last survey seasons we have noticed a qualitative increase in the abundance of the invasive algae *Sargassum horneri* (formerly *S. filicinum*) at several of our monitoring sites in southern California. In response to this, and to an increased interest by scientists and mangers in the spread of this invasive species, we will update Reef Check California's monitoring protocol to be able to better track the extent and spread of this species. To date, we have been recording the presence or absence of *S. horneri* at each of our monitoring sites. Starting in 2015, we will add *S. horneri* to the species that we count along our algae transects.

On each algae transect, we will count the number of holdfasts of *S. horneri* within the 30X2meter transect area. This is done in the same way as we count the other species of algae along the transect. *S. horneri* holdfasts are small but easy to identify once the algae have grown to their adult stage. Therefore, we will only count individuals over 30 centimeters in height. Height is measured from the substrate to the top of the alga. Consistent with the other species of algae, *S. horneri* is subsampled at 50 individual holdfasts and the distance along the transect is recorded to the nearest meter.

We will continue to record the presence or absence of both invasive Sargassum species, *S. horneri* and *S. muticum*, at monitoring sites as we have done in the past by checking 'yes' or 'no' on the algae datasheet. We are continuing to do this despite recording *S. horneri* on transects to maintain consistency in our data and monitor the presence of this species even if it is not found on one of our algae transects. Often *S. horneri* is found as small recruits (i.e. juvenile stage) during our main survey season in the summer. These recruits can be very abundant at times but if they are less than 30cm in height they will not be recorded during the algae transect but *S. horneri* will be recorded as present at the site in the Yes/No checkbox on the datasheet.

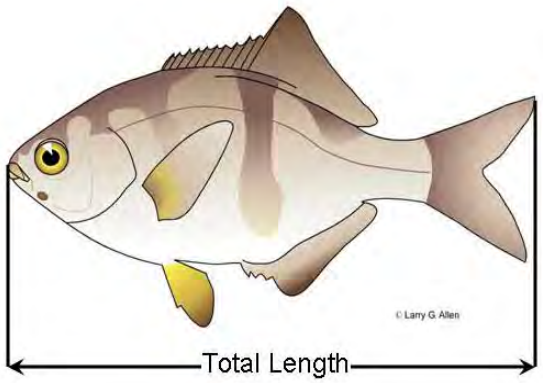
During the UPC transect we will continue to record *S. horneri* as "Other Brown" (OB) algae. Therefore, nothing has changed in the UPC protocol and we are still recording all invasive species as "Other Brown". This keeps the UPC data compatible with what we have done in the past because we are not modifying the existing UPC categories.

2013 Protocol Updates

This year we have implemented some updates to our fish transect protocol and datasheets. Please take the time to review these. The updates are as follows:

Fish Sizing

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 20).



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 9-15cm (for details on how to record this on the datasheet, see section: Recording Data and Ensuring Quality). 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
- Dull body color
- Poor visibility
- Objects in background
- 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
- Bright body color
- Good visibility
- Objects in foreground
- 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.

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 (i.e. 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 (i.e. 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 spear fishing gear, including spears, tips and guns (spear fishing gear seems to be uncommon and it should be noted in the comments if spear fishing gear is found to differentiate it from other gear).
- 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, anchors, ropes, etc.

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. The 2013 fish data sheet will have these categories listed at the bottom of each transect section.

2011 Protocol Updates

This year we have implemented some updates to our protocol and datasheets which include both changes and clarifications. Please take the time to review these prior to coming out to your Re-certification. We will discuss and clarify any questions about the changes when we meet for the Re-cert. The updates are as follows:

All Transects

1. 10 meters or more of sand

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. As we have done in the past, 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 recently covered rocky reef habitat and you should continue your transect according to your heading.

2. Time guidelines

Fish transects are to be completed in 5-10min. Invertebrate and seaweed transects should be done with a 10 minute goal in mind, but there is no cut-off time. Due to the differences in complexity of the reef habitat and abundance of certain organisms transects might deviate from this goal. UPC has no time limit, but remember to write down start and end time.

3. Counting organisms in cracks

If your transect passes over a crack/crevice that is too small to swim into, count organisms in the entire area of the crevice within the 2 meter width of the swath. If the transect is placed under a ledge that creates a ceiling above the diver do not count invertebrates on the ceiling.

Fish Transect

1. “Unknown Rockfish” and “YOY Rockfish” categories

In addition to all the species of rockfishes on our indicator organism list, RCCA also counts “young-of- the-year” (YOY) rockfishes, which are juveniles that are less than a year old. It is very difficult to identify YOY rockfishes to species when they are < 10 cm. As an RCCA certified diver you will count 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 in the “YOY Rockfish” category on your datasheet. Even if you have been trained to identify YOYs to species do not record them under the respective species but record them in the “YOY Rockfish” category on the datasheet. There is only one size category since YOYs are < 10 cm. It is not uncommon to see 100 or more YOYs on one transect during certain times of year (mainly the northern part of the state). It is important therefore to do your best to count ALL YOYs seen on transect (we DO NOT subsample any fishes) by coming up with a helpful technique, such as counting in groups of 5 or 10. We have removed the “unknown rockfish” category from the datasheet. If you encounter an individual (other than YOYs) that you cannot identify to species take notes on your datasheet and discuss these with the team after the dive.

*Note: In the past we have recorded juvenile blue rockfish separately from the others. We will not be doing that anymore and group all YOYs together.

2. Kelp greenling

We have added a juvenile category for kelp greenling to the datasheet. Individuals that are less than 20cm and cannot be clearly identified either as female or male (non-descript markings) should be recorded in this category.

Invertebrate Transect

1. Black abalones now treated like white abalones

Due to their endangered statuses, white and black abalones should be recorded if they are observed anywhere during the survey (on or off transect). As such, note that black abalone has now been moved to the bottom of the datasheet, where you can mark yes if you see one. If you believe you see a black or white abalone, do as much of the following as possible: confirm with your buddy; record whether or not it is on transect; take a photo including the respiratory holes, shell and mantel; and mark the location with a float so GPS coordinates can be taken from the surface.

2. Abalone sizing

As usual, divers will attempt to measure all abalone to the nearest cm. However, if a measurement is impossible, mark an "X" on your datasheet. This replaces the "-999" entry we've done in the past.

UPC Transect

1. SUBSTRATE: Bedrock is now Reef

We are now calling our old “Bedrock” category “Reef” to eliminate the confusion between marking “B” or “R”.

B - Boulder (> 15 cm – 1m diameter)

R - Reef (> 1m diameter)

2. COVER: How to record algae

There are two categories for brown seaweed, Brown Seaweed (B) and Other Brown Seaweed (OB) on the UPC datasheet. 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 your UPC point falls upon ANY PART (blade, stipe, holdfast) of any color alga it should be recorded. This rule applies to all algae categories except Brown Seaweed (B), 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 gentile tug). If they are they will be recorded and if they are not they will not be recorded.

3. COVER: New categories

Mobile Invert (MI)- Invertebrates that can change location including urchins, sea cucumbers, sea stars, abalone, limpets, etc.

Sessile Invert (SI) - Invertebrates that cannot change location including sponges, tunicates, scallops, barnacles, sandcastle worms, anemones, etc.

Seagrass (SG) - Seagrasses, including surfgrass and eelgrass.

4. How to record sandcastle worms

Sandcastle worms are recorded in the cover category as sessile invertebrate (SI) no matter if they is growing in sand or on rock, or even if there is anything growing on the colony (e.g., algae).

2007 Protocol Updates

Fish Transects

There are no changes to the survey method; however, 2 new species of fish have been added.

The first species is the brown rockfish.

The Department of Fish and Game's "California's Living Marine Resources: A Status Report (2001) had this to say about this fish:

"Brown rockfish, (*Sebastes auriculatus*), commonly referred to as bolina by fishermen and markets, have long been an important component of the marine recreational fishery and a relatively minor but important component of the nearshore commercial fishery in California, especially north of Point Conception. While there have been studies of local abundance in certain coastal areas and within bays, the population size and structure of this species has not been comprehensively assessed. Evidence of stress on brown rockfish stocks in California exists, however, and some relative changes in the population have been identified. Commercial

and recreational catches have steadily increased during the last 40 years, while the average length and weight of brown rockfish in landings have declined."

"The distinguishing characteristics of the brown rockfish are orange-brown or dark brown mottling, especially on the back, and a prominent dark brown blotch on the gill cover. Brown rockfish are typically found associated with sand-rock interfaces and rocky bottoms of artificial and natural reefs. In shallow waters, they may be found in small aggregations associated with rocky areas and kelp beds, whereas they stay near the rocky bottom when in deeper waters."

The brown rockfish was added to the Reef Check California species list because it is commonly targeted by both recreational and commercial fisherman as well as being a species of special concern due to the signs of stress evident in the population. This species can be confused with the grass rockfish, but can be distinguished by having a much lighter crème colored background and darker blotches as well as a clear dark brown blotch on the gill cover.

The second species is the China rockfish. The Department of Fish and Game's "California's Living Marine Resources: A Status Report (2001)" had this to say about this fish:

"China rockfish (*Sebastes nebulosus*), have been a minor component of recreational and commercial fisheries. The China rockfish is abundant into Washington, British Columbia, and southeastern Alaska, declining in abundance south into California. It is quite rare
south of Point Conception, and seems to inhabit progressively deeper water in the southern part of its range."

The distinguishing characteristics of China rockfish include a dark to black body color covered completely with white to yellow speckles. The key identifying characteristic is a yellow stripe beginning on the front of the dorsal fin continuing down on to the body and extending back to the tail fin along the lateral line. This fish was added because it is commonly observed as you move northward and easily identifiable.

<u>Invertebrate transects</u>

There are no substantive changes to the general survey method. However, we have added a few species to ensure we are getting a representative sample of the invertebrate community on California's rocky reefs and have changed the minimum size requirement for all gorgonians (sea fans).

We have added two new abalone species. All abalone are species of interest and it was important to include more species as the program expanded north to include the more northerly distributed species.

Flat abalone - *Haliotis walallensis*

I. Sayer

The flat abalone is characterized by a more oval shaped oblong shell when compared to other species and is significantly flatter or lower in profile. The holes range from 4-8 and are raised off the shell. The color of the body is yellowish green mottled and the tentacles are yellowish green and light in color.

Pinto abalone – *Haliotis kamtschatkana*

C. Borowski

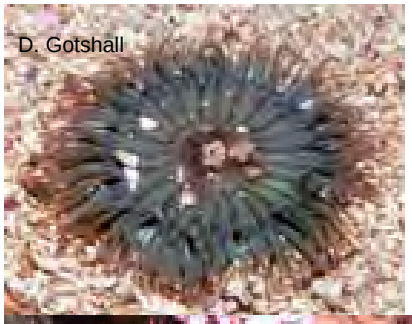
The pinto abalone shell color is reddish with white and blue markings. They tend to be rather small and squat looking when compared to other species. The body color is mottled greenish tan or brown and the tentacles are greenish brown and can be rather bright in color.

Masking carb – *Loxorhynchus crispatus*

M. Wehrenberg

We have added the masking crab to avoid surveyors having to spend time trying to differentiate it from the sheep crab. The body shape is the same as the sheep crab but generally will be smaller. The key characteristic is the shell will be covered with various growths of seaweed or other invertebrates that the masking crab uses for camouflage unlike the sheep crab whose shell is relatively growth free. Please note that the masking crab is combined with the sheep crab on your datasheet.

The last addition to the invertebrate species is the grouping “Large anemone”. This group includes a group of anemones that are all members of the Order Actanaria. We added this group because we did not have any truly sessile (non-mobile) species on our list and we thought that a sessile organism was important to include for long-term monitoring. You should count any anemone you see that is > 10 cm in diameter in this category. You should not count small < 10 cm colonial anemones in this category. Here are some examples of anemones that should be included:


D. Gotshall


J. Gross & K. Clements


D. Gotshall

We have made one additional change to the survey method for all gorgonians and switched the minimum size to count from 15 cm to 10 cm. This makes the minimum size to count consistent with the “Large anemone” group and should simplify things a bit.

Appendix B: Liability Release

All participants must sign a copy of this form before taking part in any Reef Check activities.

I, _____, being over the age of eighteen (18) years, acknowledge that I have voluntarily applied to be a part of Reef Check's California Program. I acknowledge that Reef Check is a volunteer program. I recognize that I do not have to participate. I acknowledge that I have chosen to follow the Reef Check California survey methodology because it provides one suitable way of collecting scientific information, and not because it minimizes any of the risks of scuba diving.

I RECOGNIZE THAT SCUBA DIVING IS AN INHERENTLY RISKY ACTIVITY, AND I EXPRESSLY ASSUME ANY AND ALL RISK OF PROPERTY DAMAGE, INJURY OR DEATH ASSOCIATED WITH SCUBA DIVING IN ANY WAY AFFILIATED WITH REEF CHECK.

_____

(Initials)

I hereby voluntarily release, discharge, waive and relinquish any and all actions or causes of action for personal injuries, known or unknown, and injuries to property, real or personal, and wrongful death OCCURRING to me arising as a result of engaging or receiving instructions pertaining to Reef check against Gregor Hodgson, the Reef Check Foundation and all affiliates in any country, territory, or state, and any personnel associated with any of the above, including but not limited to employees, agents, independent contractors, team leaders and other volunteers. I absolve THE AFOREMENTIONED PARTIES OF any responsibility for my safety or any injuries or damages, which I may suffer during a reef check activity or in the process of following the Reef Check survey methodology or any deviation from it. where permitted to do so by applicable law, I further hold the aforementioned parties harmless for any and all negligent acts in any way related to Reef Check activities.

_____

(Initials)

I verify that I have been made aware of the risks inherent in scuba diving through participation in a diver certification course endorsed by _____ (agency). I further verify that am a qualified and certified scuba diver from the following training agencies _____ (agency), and that I hold training and certification to the level of _____ (state level), certification card number _____, certified date _____. I recognize that the ocean can be dangerous and that conditions may become more hazardous and dangerous during the time that I am participating in a diving excursion with the purpose of gathering data for Reef Check. I voluntarily assume any risks associated with diving in conditions or depths that exceed my training and/or skills.

_____

(Initials)

I release Reef Check from any liability for injuries resulting from risks and dangers inherent in the sport of scuba diving, whether foreseen or unforeseen. I further release Reef Check from any liability for injuries resulting from activities conducted in immediate preparation of scuba diving.

I agree that I, and only I, shall be responsible for my safety, and any injuries I may sustain.

_____

(Initials)

If any term, condition or portion of this agreement is held by a court of competent jurisdiction to be invalid, void or unenforceable, the remaining provisions of this agreement shall nevertheless remain valid and binding on signor.

I HAVE CAREFULLY READ THIS RELEASE AND FULLY UNDERSTAND ITS CONTENTS. I AM AWARE THAT THIS IS A RELEASE OF LIABILITY AND A CONTRACT BETWEEN ME AND REEF CHECK AND SIGN IT OF MY OWN FREE WILL.

Executed on _____, 20__ at _____[city, state/country]

_____[signature of obligee]

_____[printed name]

Appendix C: Datasheets

Site Description Form

Site Description Report

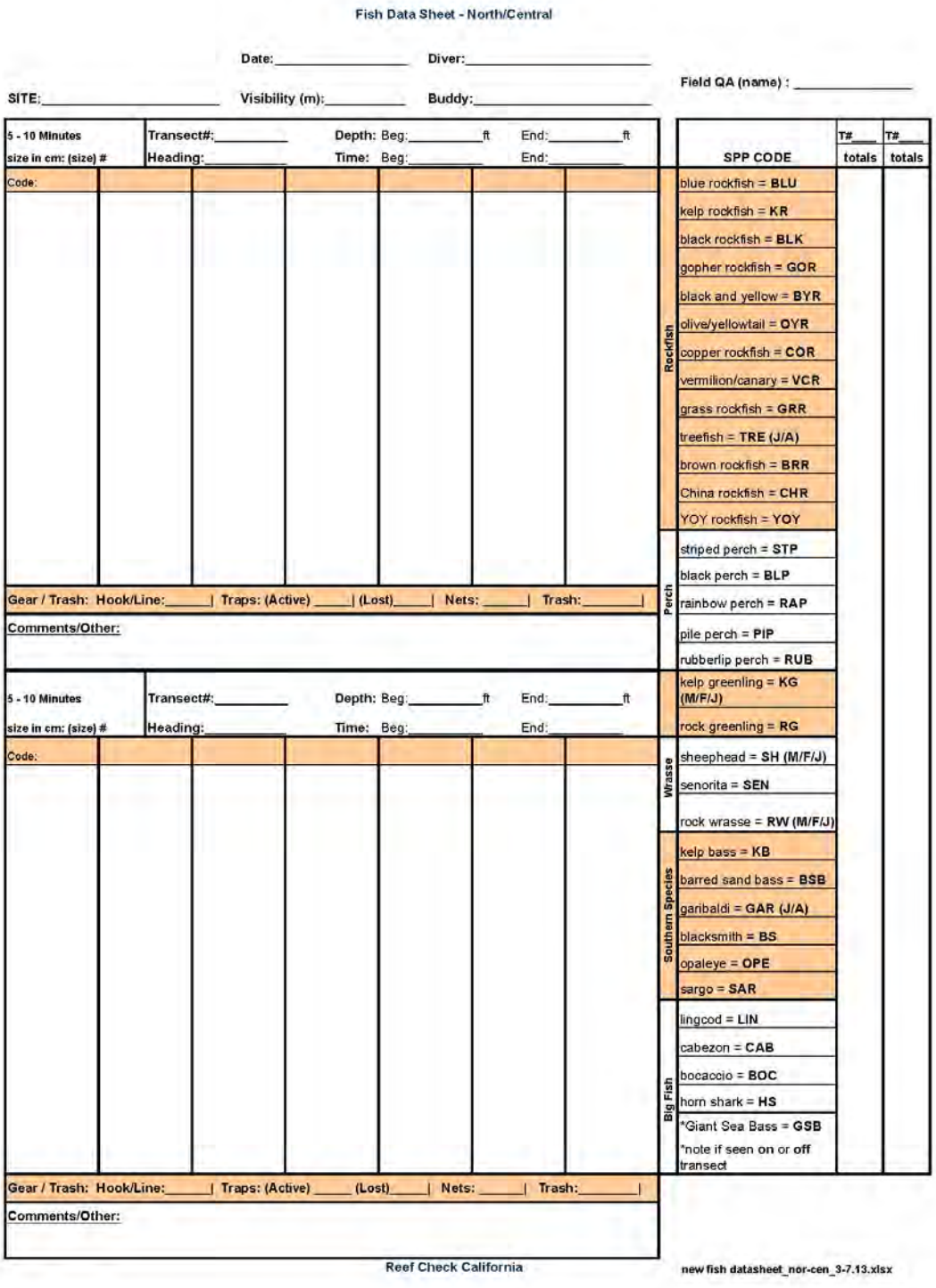
Site Information		Temperature in Celsius	
Site Name		Air	
City / Island		Surface	
County		5 Meters	
State	California	10 Meters	
Latitude (deg min.min)	North	**Distance in Meters**	
Longitude (deg min.min)	West	Distance from shore	
Dates format (mm/dd/yyyy)		Average Depth of Site	
Start Date		**Permanent, Random**	
End Date		Transect Type	
		Always Sheltered, Sometimes Sheltered, Exposed	
Sunny, Cloudy, Raining		Site Exposure	
Weather		Recent Storms	Yes / No

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-Central



Fish Data Sheet - North/Central

Date:_____ Diver:_____

SITE:_____ Visibility (m):_____ Buddy:_____ Field QA (name) : _____

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

Code:

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

Comments/Other:

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

Code:

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

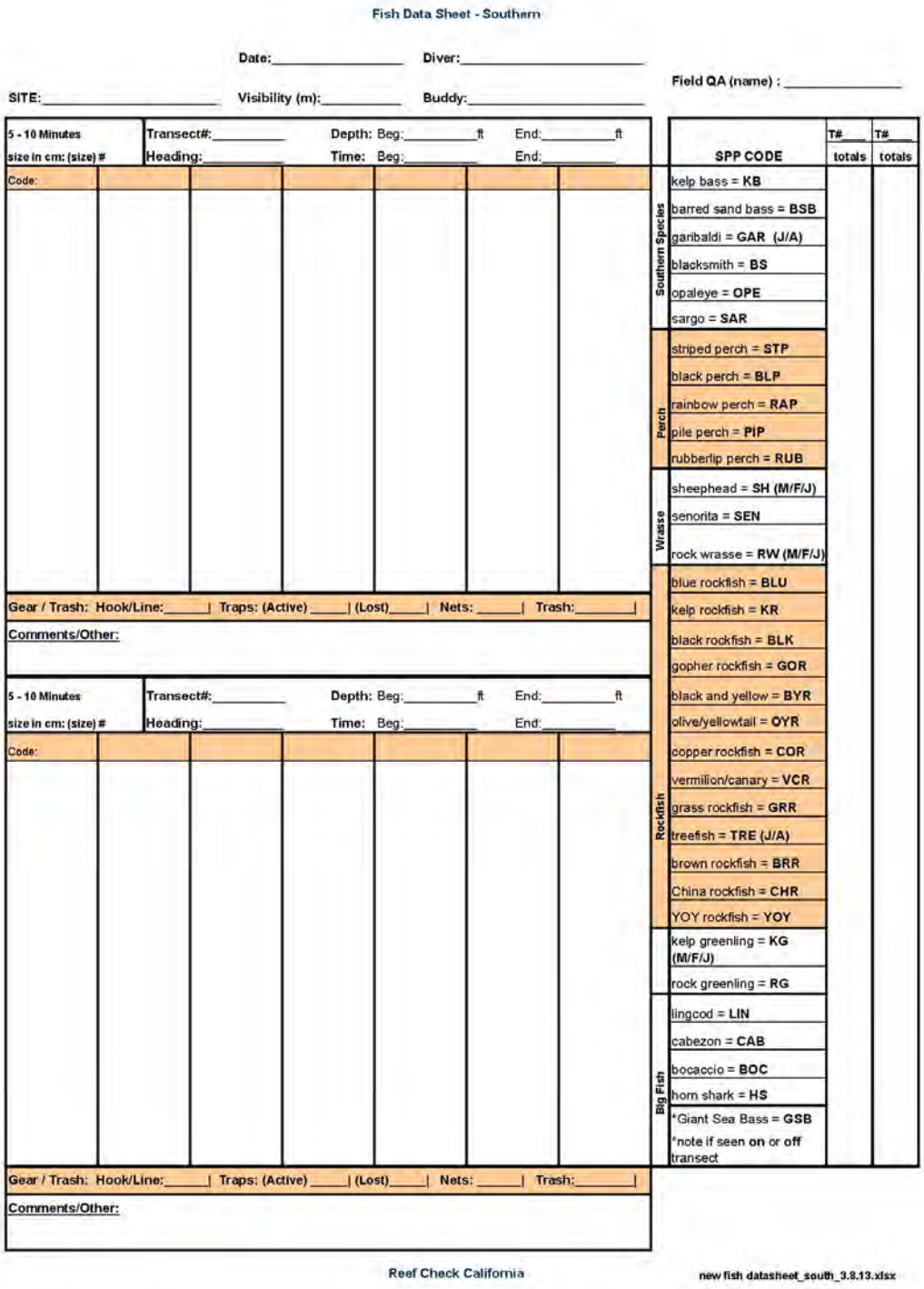
Comments/Other:

	SPP CODE	T#___ totals	T#___ totals
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**		
Perch	striped perch = **STP**		
	black perch = **BLP**		
	rainbow perch = **RAP**		
	pile perch = **PIP**		
	rubberlip perch = **RUB**		
	kelp greenling = **KG (M/F/J)**		
	rock greenling = **RG**		
Wrasse	sheephead = **SH (M/F/J)**		
	senorita = **SEN**		
	rock wrasse = **RW (M/F/J)**		
Southern Species	kelp bass = **KB**		
	barred sand bass = **BSB**		
	garibaldi = **GAR (J/A)**		
	blacksmith = **BS**		
	opaleye = **OPE**		
	sargo = **SAR**		
Big Fish	lingcod = **LIN**		
	cabezon = **CAB**		
	bocaccio = **BOC**		
	horn shark = **HS**		
	*Giant Sea Bass = **GSB**		
	*note if seen on or off transect		

Reef Check California

new fish datasheet_nor-cen_3-7.13.xlsx

Fish Datasheet-Southern



Fish Data Sheet - Southern

Date:_____ Diver:_____

SITE:_____ Visibility (m):_____ Buddy:_____ Field QA (name) : _____

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

Code:						

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

Comments/Other:

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

Code:						

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

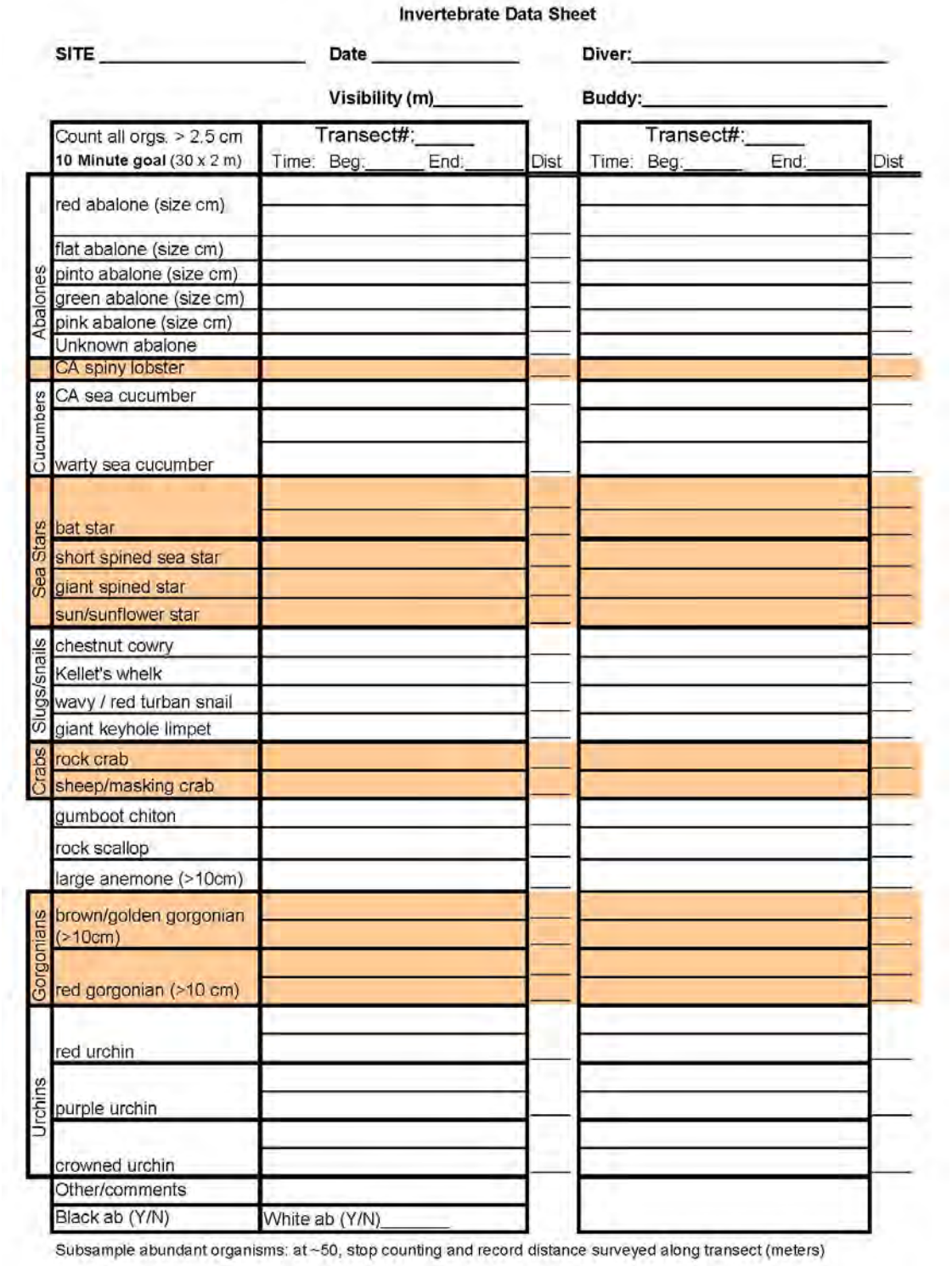
Comments/Other:

	SPP CODE	T#___ totals	T#___ totals
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		

Reef Check California

new fish datasheet_south_3.8.13.xlsx

Invertebrate Datasheet



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 Datasheet

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 horneri 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				
Sargassum horneri  >30cm				
giant kelp (>1 m)  >1 m				

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

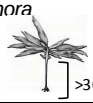
Comments:_____

Invertebrate/Seaweed Combo Datasheet

SITE _____ **Date:**_____ **Diver:**_____

Visibility (m):_____ **Buddy:**_____

	Count all orgs. > 2.5 cm **10 Minute goal** (30 x 2 m)	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		
	Black ab (Y/N)	White ab (Y/N)_____	
	Other/comments		

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

*Do not count seaweed used to attach transect

Sargassum muticum Yes____ No____

Sargassum horneri Yes____ No____

Undaria Yes____ No____

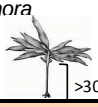
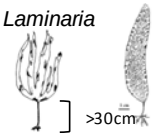
Caulerpa Yes____ No____

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

Site: _____ **Date:** _____ **Diver:**_____

Visibility:_____**m** **Buddy:**_____

Count all orgs. > 2.5 cm	Transect#:					
10 Minute goal (30 x 2 m	Time:	Beg:		End:		Dist
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						___
CA sea cucumber						___
warty sea cucumber						___
bat star						___
short spined sea star						___
giant spined star						___
sun/sunflower star						___
chestnut cowry						___
Kellet's whelk						___
wavy / red turban snail						___
giant keyhole limpet						___
rock crab						___
sheep/masking crab						___
gumboot chiton						___
rock scallop						___
large anemone (>10cm)						___
brown/golden (>10cm)						___
red gorgonian (>10 cm)						___
red urchin						___
						___
purple urchin						___
						___
crowned urchin						___
Black ab (Y/N):	White ab (Y/N):					

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

*Do not count seaweed used to attach transect

Sargassum muticum Yes____ No____

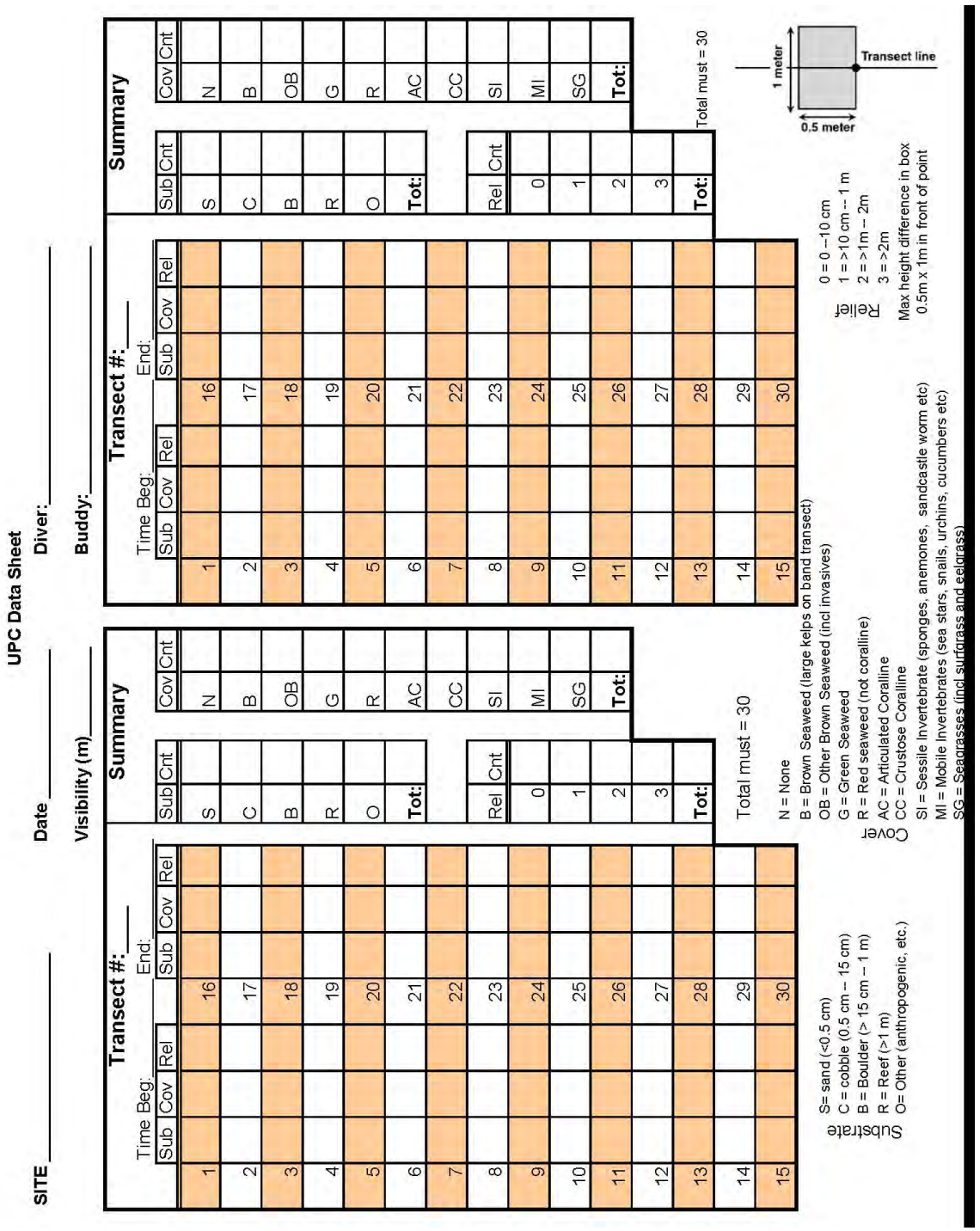
Sargassum horneri Yes____ No____

Undaria Yes____ No____

Caulerpa Yes____ No____

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

UPC Datasheet



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: _____

_____

_____

_____

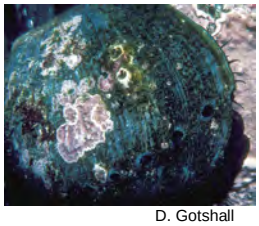
Appendix D: Species

Invertebrates

Snails and Slugs – Class Gastropoda

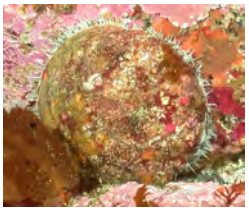
Howard Hall Productions

Red abalone
Haliotis rufescens



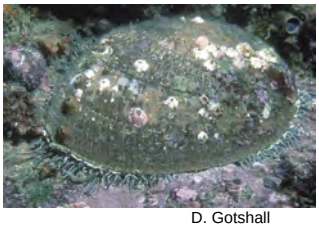
D. Gotshall

Black abalone
Haliotis cracherodii



J. Butler

White abalone
Haliotis sorenseni

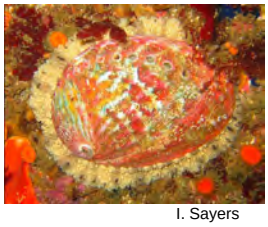


D. Gotshall

Green abalone
Haliotis fulgens

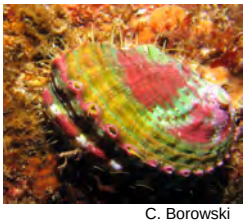
Howard Hall Productions

Pink abalone
Haliotis corrugata



I. Sayers

Flat abalone
Haliotis wallensis



C. Borowski

Pinto abalone
Haliotis kantschatkana

C. Shuman

Giant keyhole limpet
Megathura crenulata

Phillip Colla / oceanlight.com

Chestnut cowry
Cypraea spadicea

Steve Lonhart / MBNMS

Kellet's whelk
Kelletia kelletii

Santa Barbara Coastal LTER

Wavy turban snail
Megastraea undosum

Chitons - Class Polyplacophora

D. Gotshall

Gumboot chiton
Cryptochiton stelleri

Scallops/Clams-Class Bivalvia

Howard Hall Productions

Rock scallop
Crassedoma giganteum

Sea Cucumbers – Class Holothuroidea

Howard Hall Productions

CA sea cucumber
Parastichopus californicus

Howard Hall Productions

Warty sea cucumber
Parastichopus parvimensis

Sea Stars – Class Asteroidea

Howard Hall Productions

Bat star
Patiria miniata

Santa Barbara Coastal LTER

Short spined star
Pisaster brevispinus

C. Shuman

Giant spined star
Pisaster giganteus

Steve Lonhart / MBNMS

Sunflower star
Pycnopodia helianthoides

J. Gross & K. Clements

Sun star
Solaster stimpsoni.

J. Gross & K. Clements

Sun star
Solaster dawsoni

Lobster and Crabs – Class Crustacea

Howard Hall Productions

CA spiny lobster
Panulirus interruptus

Chad King

Rock crab
Cancer spp.

Phillip Colla / oceanlight.com

Sheep crab
Loxorhynchus grandis

M. Wehrenberg

Masking crab
Loxorhynchus crispatus

Anemones - Order *Actiniaria*

D. Gotshall

Large anemone
Anthopleura sola

J. Gross & K. Clements

Large anemone
Metridium farcimen

D. Gotshall

Large anemone
Urticina lofotensis

Gorgonians – Class Anthozoa

Phillip Colla / oceanlight.com

Brown gorgonian
Muricea fruticosa

Phillip Colla / oceanlight.com

Golden gorgonian
Muricea californica

Phillip Colla / oceanlight.com

Red gorgonian
Leophogorgia chilensis

Sea Urchins – Class Echinoidea

Howard Hall Productions

Red urchin
Strongylocentrotus franciscanus

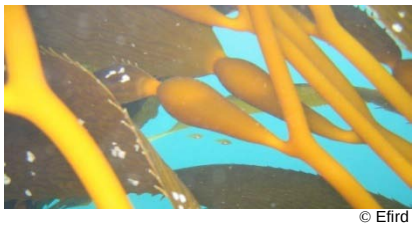
Howard Hall Productions

Purple urchin
Strongylocentrotus purpuratus

Phillip Colla/oceanlight.com

Crowned urchin
Centrostephanus coronatus

Native seaweed Species



© Efird

Giant kelp
Macrocystis pyrifera

Steve Lonhart / MBNMS

Southern sea palm
Eisenia arborea

C. Wisniewski

Pterygophora
Pterygophora californica

Steve Lonhart / MBNMS

Bull kelp
Nereocystis luetkeana

R. Herrmann

Laminaria (south)
Laminaria farlowii

Laminaria (north)
Laminaria setchelii

Invasive seaweed species

Kathy Ann Miller

Sargassum
Sargassum filicinum

Kathy Ann Miller

Sargassum
Sargassum muticum

Rachel Woodfield

Caulerpa
Caulerpa taxifolia

Kathy Ann Miller

Undaria
Undaria pinnatifida

Sea Basses and Groupers – Family Serranidae

Phillip Colla/oceanlight.com

Giant sea bass
Stereolepis gigas

Howard Hall Productions

Kelp bass
Paralabrax clathratus

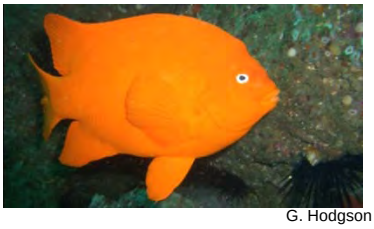
D. Gotshall

Barred sand bass
Paralabrax nebulifer

Damselfishes – Family Pomacentridae

Phillip Colla / oceanlight.com

Juvenile garibaldi
Hypsypops rubicundus



G. Hodgson

Adult Garibaldi
Hypsypops rubicundus

Phillip Colla / oceanlight.com

Blacksmith
Chromis punctipinnis

Sea Chubs – Family Kyphosidae

N. Fash. Courtesy FASHPIX.COM

Opaleye
Girella nigricans

Grunts – Family Haemulidae

N. Fash. Courtesy FASHPIX.COM

Sargo
Anisotremus davidsoni

Surfperches - Family Embiotocidae

Phillip Colla/oceanlight.com

Black perch
Embiotoca jacksoni

J. Freiwald

Striped perch
Embiotoca lateralis

D. Gotshall

Rubberlip perch
Rhacochilus toxotes

Santa Barbara Coastal

Pile perch
Rhacochilus vacca

Chad King

Rainbow perch
Hypsurus caryi

Wrasses – Family Labridae

Phillip Colla/oceanlight.com

Juvenile sheephead
Semicossyphus pulcher

Howard Hall Productions

Male sheephead
Semicossyphus pulcher

Howard Hall Productions

Female sheephead
Semicossyphus pulcher

Phillip Colla/oceanlight.com

Señorita
Oxyjulis californica

Phillip Colla/oceanlight.com

Male Rock wrasse
Halichoeres semicinctus

D. Gotshall

Female Rock wrasse
Halichoeres semicinctus

D. Gotshall

Juvenile Rock wrasse
Halichoeres semicinctus

Rockfishes – Family Scorpaenidae

Steve Lonhart / MBNMS

Black rockfish
Sebastes melanops

Phillip Colla/oceanlight.com

Blue rockfish
Sebastes mystinus

D. Gotshall

Yellowtail rockfish
Sebastes flavidus

J. Freiwald

Olive rockfish
Sebastes serranoides

Howard Hall Productions

Kelp rockfish
Sebastes atrovirens

D. Gotshall

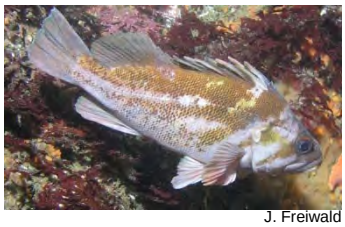
Grass rockfish
Sebastes rastrelliger

Phillip Colla/oceanlight.com

Gopher rockfish
Sebastes carnatus

Howard Hall Productions

Black & yellow rockfish
Sebastes chrysomelas



J. Freiwald

Copper rockfish
Sebastes caurinus

D. Gotshall

Treefish
Sebastes serriceps

Phillip Colla/oceanlight.com

Vermilion rockfish
Sebastes miniatus

D. Gotshall

Canary rockfish
Sebastes pinniger

J. Freiwald

Brown rockfish
Sebastes auriculatus

©Jon Gross & Keith Clements

China rockfish
Sebastes nebulosus

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Bocaccio
Sebastes paucispinis

Young-of-the-Year (YOY) Rockfishes

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Lingcod and Greenlings – Family Hexagrammidae

D. Gotshall

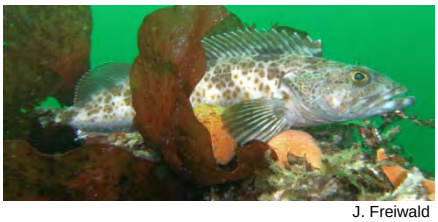
Male kelp greenling
Hexagrammos decagrammus

D. Gotshall

Female kelp greenling
Hexagrammos decagrammus

D. Gotshall

Rock greenling
Hexagrammos lagocephalus



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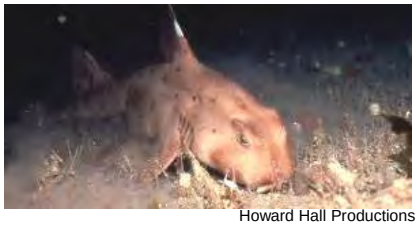
Lingcod
Ophiodon elongatus

Bullhead Sharks – Family Heterodontidae



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Horn shark
Heterodontus francisci

Sculpins - Family Cottidae

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Cabezon
Scorpaenichthys marmoratus

NOTES

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Western Snowy Plover

Sharing the Beach

Our Mission

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WHAT IS A SNOWY PLOVER?

The western snowy plover (*Charadrius alexandrinus nivosus*) is a sparrow-sized, light colored shorebird with dark patches on either side of the neck, behind the eye, and on the forehead. The Pacific coast population of the snowy plover is a threatened species.

WHERE ARE THESE PLOVERS?

Plovers can be found on flat, open coastal beaches, in dunes, and near stream mouths. They are well-camouflaged and extremely hard to see, often crouching in small depressions taking shelter from the wind. California State Parks beaches provide much of the suitable habitat remaining in California for this small shorebird.

During the winter months, snowy plovers eat and rest, building up fat reserves. In the spring and summer, plovers nest in loose colonies, often

Adult and chicks

coming back to the same beaches every year. The breeding season lasts from early spring to mid-fall, and during that time the female may hatch more than one brood with different males. The nests are simple scrapes in the sand with 1-3 eggs that the male warms at night, while the female does day duty. Eggs hatch in about 27 days, and within hours the chicks are searching for their food of insects and other beach invertebrates. The chicks are on their own in 30 days. But surviving those two months is the trick.

HOW ARE THEY THREATENED?

Snowy plovers are threatened due to disturbance, predation and habitat loss. Because the birds and eggs are camouflaged, beach visitors can disturb resting birds or wander right through a nesting area, never knowing the damage they have caused. Visitor use of the beach close to nests causes adult birds to stay off the nest, exposing eggs to predators and the elements. Beach fires and fireworks disturb the nesting birds, and kites flown above look like predators. During the winter, continual disturbance uses up their stored reserves and may lower their breeding success.

Predators on the beach are also threats. Dogs chase and may catch birds or destroy nests, cats prey on birds and chicks, and even leashed dogs may appear as a danger. Native predators such as skunks, crows, ravens, and shrikes are joined by exotic predators such as the non-native red fox to further pressure the birds.

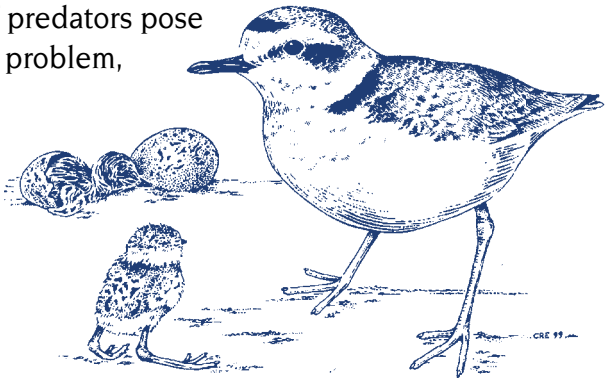
WHY SHOULD WE CARE?

The snowy plover is an important part of the interconnected web of life on the shore. Plovers have lived on California and other Pacific coast beaches for thousands of years, but today human use of their remaining beach habitat seriously threatens their survival. Once numbered in the thousands, fewer than 1,500 breeding plovers remain in California. Prior to 1970 they nested at 53 locations in the state, while today they nest in only half as many sites. Since snowy plovers are listed as a threatened species and protected by the federal Endangered Species Act, beach visitors who harm or disturb plovers or their habitat may be cited and fined. Plovers need our help if they are to survive alongside human beach recreation.

Plover habitat at Montaña de Oro State Park

WHAT IS CALIFORNIA STATE PARKS DOING TO PROTECT PLOVERS?

California State Parks is doing a wide variety of things to help this bird in need. Plovers are monitored to determine the number of birds using parklands and the success of their breeding attempts, sometimes banding the chicks' tiny legs so that they can be identified throughout their lives. Individual nests or larger nesting areas may be fenced or delineated by signs to keep visitors away. Exotic plants that affect plover nesting habitat are removed, and if predators pose a problem,



Plover eggs in nest, often called a "scrape"

control programs are initiated. Some recreational activities are restricted, and some portions of beaches are closed to dogs to protect important nesting areas. California State Parks is working closely with the U.S. Fish and Wildlife Service and other coastal land managers to cooperatively manage the plover on California beaches.

Temporary closure of a portion of the beach during the nesting season

WHAT CAN I DO TO HELP?

Since snowy plover nesting coincides with the busy beach season, there are many things park visitors can do to avoid or minimize impacts on the birds.

- Do not approach birds or nests. Avoid prolonged picnicking or sunbathing near plover nesting habitat.
- Stay out of fenced or posted habitat areas, and do not approach fencing.
- Dogs are prohibited on California State Parks coastal beaches unless specifically authorized. Where dogs are allowed, they must be on a leash.
- Do not light fires or camp on the beach except in designated areas.
- Dispose of garbage properly to avoid attracting gulls, ravens and other plover predators. Do not feed any wildlife.
- Equestrians must stay out of nesting areas. Observe posted restrictions and stay on wet sand in plover habitat.
- Leave kelp and driftwood on the beach; it provides nesting and feeding habitat for snowy plovers.
- Do not fly kites, hang glide or toss Frisbees or balls near snowy plover nesting habitat. Fireworks are prohibited. Other activities causing disturbance may also be restricted.
- Please report to park staff any nests, threats or disturbances to plovers.

With California State Parks' efforts and your active cooperation, we can make a difference in the survival of the western snowy plover on California's beaches.

Plovers are protected by law, and safeguarding their nesting habitat requires the cooperation of beach visitors.

Our Mission

The mission of the California Department of Parks and Recreation is to provide for the health, inspiration and education of the people of California by helping to preserve the state's extraordinary biological diversity, protecting its most valued natural and cultural resources, and creating opportunities for high-quality outdoor recreation.

ARNOLD SCHWARZENEGGER
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Cover drawing by Carleton Eyster. Photography by Peter Knapp (plover) and Dave Dixon (plover nest).

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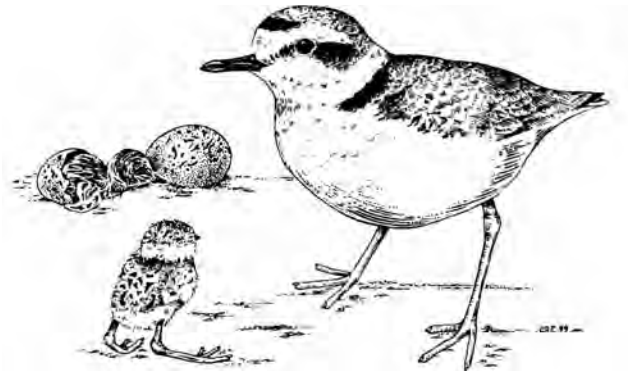
Rules & Guidelines for Protecting the Snowy Plover



You have a role in the survival of the western snowy plover on California beaches.

Rules Visitors Must Follow

Since snowy plover nesting coincides with the busy beach season, there are rules that visitors must follow to avoid or minimize impacts on the birds.

1. Dogs are prohibited on all California State Parks coastal beaches unless specifically authorized. Where authorized, dogs must be leashed.
2. Do not light fires or camp on the beach except in designated areas.
3. Stay out of fenced or posted habitat areas.
4. Fireworks are prohibited.
5. Do not feed any wildlife.

Failure to follow these rules may result in citations and fines.

Guidelines Visitors Should Follow

- Do not approach birds, nests or fencing. Avoid picnicking or sunbathing near plover nesting habitat.
- Equestrians must stay out of nesting areas. Observe posted restrictions and keep to wet sand in plover habitat.
- Do not fly kites, hang glide, or toss Frisbees or balls near snowy plover nesting habitat. Other activities causing disturbance may also be restricted.
- Dispose of garbage properly to avoid attracting plover predators.
- Do not collect kelp or driftwood from the beach; it provides nesting and feeding habitat for snowy plovers.

THE CHALLENGE TO SURVIVE

The Pacific coast population of the western snowy plover is listed as a threatened species and is protected by the federal Endangered Species Act. California State Parks has a legal obligation to protect snowy plovers. **Please report to park staff any plover nests, threats or disturbances to plovers.**

Snowy plovers have lived on California beaches for thousands of years, but today human use of their remaining beach habitat seriously threatens their survival. Once numbering in the thousands, less than 1500 breeding plovers remain. Prior to 1970 they nested at 53 locations in California, while today they nest in only half as many sites. California State Parks beaches provide much of the suitable habitat remaining in California for this small shorebird.

The western snowy plover is a sparrow-sized, light-colored shorebird with dark patches on either side of the neck, behind the eye, and on the forehead. Plovers blend in with their surroundings so well that they are extremely hard to see, making it easy for unsuspecting visitors to disturb the birds or even crush the eggs and chicks, never realizing the damage they've caused.

Plovers can be found on flat, open, coastal beaches, in dunes, and near stream mouths. In the spring and summer, loose colonies of plovers lay 1-3 eggs in nests that are simple scrapes in the sand. Eggs hatch in about 27 days, and within hours the tiny chicks are on the beach searching for food. Chicks are on their own in 30 days. The breeding season lasts from early spring to mid-fall, coinciding with the time of greatest human use on California beaches.

THREATS AND PROTECTIONS

Besides the presence of humans, domestic animals on the beach also pose a problem. Dogs chase and may catch birds or destroy nests, cats prey on birds and chicks, and even leashed dogs may frighten plovers off their nests. Native predators such as skunks, crows, ravens and shrikes join exotic predators such as the non-native red fox to prey upon plovers and their chicks, and kites flown above look like predators. Other threats include beach fires and fireworks. During the winter, when the plovers are resting and feeding, continual disturbances use up their stored reserves and may lower their breeding success the following year.

To protect the plover, California State Parks monitors plover numbers and the success of their breeding efforts, fences individual nests or larger nesting areas to keep visitors away, removes exotic plants that affect plover nesting habitat, and initiates control programs if predators threaten chick survival. Some recreational activities are restricted, and some portions of beaches are closed to dogs to protect important nesting areas. California State Parks is working closely with the U.S. Fish and Wildlife Service and others to ensure the survival of the plover on California public beaches.

REEF CHECK CALIFORNIA

INSTRUCTION MANUAL

A Guide to Monitoring

California's Rocky Reefs

8th Edition

This is the official instruction manual (8th Edition) for the Reef Check California Community Monitoring Program. If you have any questions about training procedures or about the Reef Check California protocol, please contact Reef Check at the contact numbers given below.

8th Edition April 2015 (1st Edition June 2006)

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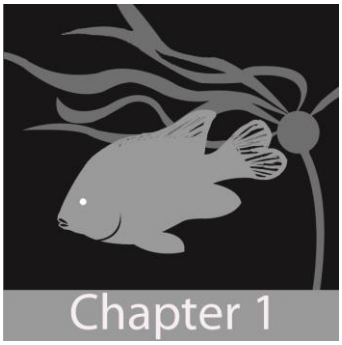


Introduction

Stretching over 1,700 miles, California's coastline is the gateway to a unique and often underappreciated wealth of life. Offshore, just below the surface, kelp forests and rocky reefs are home to a vast array of marine organisms that many Californians regularly enjoy and others depend upon for their livelihoods. Unfortunately, the rapid growth of California's population and the resulting impacts due to coastal development, pollution and overfishing have placed increasing demands on our nearshore resources. Many species that were once abundant, such as some species of rockfish and abalone in southern California, are now almost gone.

Reef Check California is an exciting program that is building a network of informed and involved citizens who support the sustainable use and conservation of the Golden State's nearshore marine resources. To accomplish this, volunteers are trained to survey nearshore reefs and generate data on the status of key indicator species.

Reef Check California's survey methodology has been specifically designed for you – the volunteer. Once you are trained in the California methodology, you will be able to make a significant contribution to the science behind the conservation and management of California's precious marine resources by becoming a citizen-scientist. Your regular surveying efforts will not only fill gaps in the state's existing marine monitoring network, but will allow you to contribute your valuable ocean knowledge to the management process.

This instruction manual provides all the information necessary for Reef Check California teams to carry out rocky reef monitoring using the standard Reef Check California protocol. In addition to this manual, there are a variety of training materials available including PowerPoint presentations, flashcards and identification tests that you will be exposed to during your course. Upon successful completion of the Reef Check California Training course, participants will be eligible to contribute data to the Reef Check California Nearshore Ecosystem Database (NED) and can elect to receive a specialty certification card (NAUI). While anyone may participate in Reef Check California, data will only be accepted from individuals who have successfully completed the full training course taught by a Reef Check California accredited instructor or have demonstrated proficiency in Reef Check California methods by completing the requisite examinations.

About The Reef Check Foundation

Reef Check data (and projects) are managed by the Reef Check Foundation, which is an international award-winning conservation organization based in Los Angeles, California. Reef Check began in 1997 as the volunteer network of the United Nation's Global Coral Reef Monitoring Network. In 2000, the 501(c)(3) non-profit Reef Check Foundation was established to manage the coral reef data collected from over 90 countries and territories worldwide and to create more opportunities for direct coral reef conservation. Reef Check has many partners, but places special attention on establishing long-term partnerships with businesses such as the tourism, diving, surfing and marine aquarium industries.

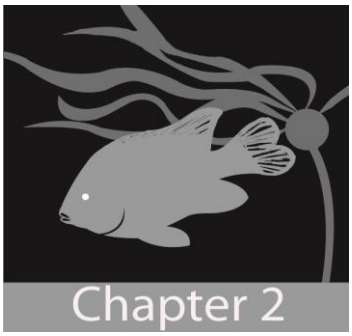
Reef Check has developed scientific methods to monitor and manage coral reef fisheries for fishes and invertebrates to determine what level of catch could be sustainable. Reef Check has successfully used a coastal management process in the Philippines and Indonesia to leverage local governments and village fishermen to agree to set up Marine Protected Areas so that they could better manage their aquarium fisheries. Initial results indicate that a sustainable fishery may be possible with proper attention to management, but it is not yet clear if this can be cost-effective in the long-term.

For more information about Reef Check activities, including how you can participate in our tropical work, please visit our website **www.reefcheck.org** or write to **info@reefcheck.org**.

Reef Check California's Mission

Reef Check California (RCCA) educates, trains and engages ocean users in the collection of data describing California's nearshore rocky reefs using a community-based approach that informs marine management and creates a constituency supportive of science based management.

By becoming part of RCCA you are taking direct action to improve marine management!



Reef Check California

California's nearshore waters are considered to be one of the most productive ocean areas in the world (CDFG, 2001). This productivity, coupled with over 1,100 miles of one of the most stunning natural habitats on earth, drives an ocean economy of approximately $43 billion, the largest in the United States (Kildow and Colgan, 2005). Sadly, rapid population growth coupled with the most consumption-oriented culture in the history of the earth has led to an unprecedented level of human stress on California's ecosystems.

The primary aim of the Reef Check California program is to improve our knowledge of California's rocky reefs by involving local community members in generating data from careful observation of these ecosystems over time. We will then provide the data you collect to fellow citizens, resource managers and policymakers so that informed choices can be made concerning the management of California's precious living resources.

Our goal is to collect unbiased data --- not perform advocacy.

The Program in Context

Reef Check California has been designed in consultation with some of the foremost marine monitoring experts in California. The initiative aims to specifically address two problems that have plagued past programs.

First, Reef Check California recognizes the problematic nature of maintaining funding for long-term efforts. There is a long history of aquatic 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; US EPA, 1997; Wells, 1995; www.reef.org). For example, in the case of water quality monitoring, community-based programs have already proven effective in informing management and regulatory processes (Abrahamson et al., 2000; US EPA, 1997). In the marine realm, the largest and most comprehensive scientific sampling effort in California's nearshore waters was conducted in 2004 by the Cooperative Research and Assessment of Nearshore Ecosystems (CRANE) in association with the Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO, www.piscoweb.org) and other partners. This sampling effort surveyed 88 sites between Monterey Bay 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.). Fortunately, the State of California has recognized the shortage of funding and manpower for such government-driven efforts and supports community monitoring as a necessary component to meet monitoring objectives (CDFG, 2005 a & b).

Second, there is currently no standardized statewide monitoring program specifically designed to investigate human impacts on California's nearshore ecosystems. Most groups use different methods, focus on different target species and have different data reporting formats. These factors make it extremely difficult to perform statewide analyses. As such, science's picture of the status of California's rocky reef ecosystems is incomplete. This dearth of knowledge leaves decision makers without the data required to make informed management decisions (Baird et al., 2005).

Reef Check California addresses both of these problems by engaging you, the motivated volunteer, to regularly conduct monitoring with Reef Check California's statewide standardized protocol. Including stakeholders in training and implementing marine monitoring confers significant benefits. Perhaps the two most important are: 1) the formation of a new and informed constituency that will support science-based ocean management and 2) a channel for key stakeholders (e.g., recreational divers, fishermen, ocean lovers) to leverage their intimate knowledge of local habitats to contribute valuable scientific data to the regulatory process.

Your research efforts will focus on key indicator species. In lieu of performing a detailed ecological survey of every reef we encounter, we will be focusing on the abundance and size distribution of indicator species and whether or not they change over time. The technique you are soon to learn is extremely valuable because it can be mastered in a relatively short period of time and be employed by divers like yourself up and down California's coast. This means that you will play a key role in providing data to government agencies such as the Department of Fish and Wildlife, help fill data gaps within existing broad-scale monitoring networks (e.g., PISCO) and expand data collection efforts by geographically-focused programs such as the Kelp Forest Monitoring program in the Channel Islands National Park (Davis et al., 1997).

In terms of more concrete applications, the data you generate with the techniques learned in this course will have a host of uses. In fact, your participation in the Reef Check California program will put you on the cutting edge of California's scientific understanding of the changes happening along our coastline. For example, the data you collect will allow for early diagnosis of abnormal change within the range of different species. Will the changes you observe be best explained by a recent El Niño year, serious pollution concentrated in your area, long-lasting shifts in global climate change or natural variation? By engaging a large network of divers to collect data throughout the state, we will be able to develop a much clearer picture of what factors are responsible for changes in California's rocky reef ecosystems. This knowledge will allow for the development of more informed management measures, and perhaps more importantly, for the evaluation of the effectiveness of different management regimes.

One immediate application of the data you collect will be to aid the implementation and evaluate the effectiveness of two of California's most important management measures, the Marine Life Management Act (MLMA) and the Marine Life Protection Act (MLPA). Passed in 1998, 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 (Fish and Game Code § 7050 et seq; CDFG, 2001; Geever and Dart, 2003). Passed in 1999, 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). The long-term data you collect will help evaluate the effectiveness of the MLPA implementation process and allow managers to adapt their efforts according to changes in the marine resources they are working to conserve.

By regularly carrying out Reef Check California surveys **you can make a difference in the fate of California's marine resources**. After all, they are our ocean resources and if we don't take action to protect them who else will?

Your Involvement Matters!

Involving the community in monitoring builds public support for management initiatives. The Reef Check California program is carried out by volunteers from the community and is a useful tool in building public support for state and non-governmental organization (NGO) marine conservation efforts. The publicity generated from your survey activities can also be particularly useful in raising public awareness and rewarding government agencies, companies and NGOs for their support.

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.**

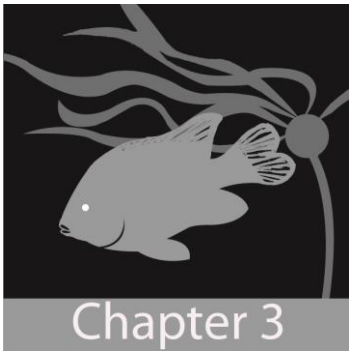
Liability

Participants in Reef Check are considered to be fully independent individuals who have chosen to follow the Reef Check California survey methodology of their own free will and are entirely responsible for their own safety. All participants must sign the liability waiver (found in Appendix A) before taking part in this volunteer activity.

Reef Check California has been designed to minimize safety risks by limiting dives to a maximum depth of 60 feet (18 m). However, accidents can occur at any depth. Each participant is independently responsible for their personal safety and their decision to participate in any Reef Check activities.

A Note on Safety and Liability!

Diving, boating and related activities present inherent substantial risks to participants, **including risk of severe injury and death**. Reef Check surveys may take place at a substantial distance from facilities providing medical treatment or rescue services. Every volunteer participant in Reef Check activities is expected to take full personal responsibility for their physical and mental health, insurance coverage, compliance with standard safety rules and every personal decision relating to said activities in which they engage. **Only you can decide when and where you dive.**



California's Marine Environment

Marine Ecology Crash Course

Ways of appreciating nature are as diverse as human beings. California's native cultures, for example, had an extensive system of classifying and understanding their natural resources. However, to make a powerful case for the conservation of California's marine resources, we must monitor California's rocky reefs with scientific methodology.

Although science and the heavy jargon associated with it can seem a bit daunting at first, it can actually be a lot of fun. In fact, what you will be doing when employing the Reef Check California protocol, **studying the interrelationship of living things and their environment**, is arguably the most fun branch of the natural sciences. It is called **ecology**.

To study ecology, of course, we need an ecosystem to study. **An ecosystem is the complex of living things and their environment functioning as a unit**. Our ecosystem of interest is the temperate rocky reef. Stop for a second to imagine all of the inhabitants in a rocky reef ecosystem. Sea lions, California sheephead, rockfishes, urchins, sea otters and kelp may immediately come to mind. As you are already aware, there are a lot of additional species in the rocky reef ecosystem and all of them are interconnected.

To better illustrate the importance of understanding the interrelationship of different organisms in California's underwater forests, let's stop to focus on three groups or taxa in particular: sea urchins, sea otters and kelp. Prior to the arrival of European fur trappers in California, the range of sea otters extended as far south as Baja California. Historical records tell us that the kelp forests in Baja, Southern and Central California were much more abundant, as well. Interestingly, in areas where otters were eliminated, the area of the kelp forests rapidly receded. What do you imagine caused this change? Was there suddenly a wave of warm water or series of giant storms that destroyed the kelp? Was there a specific disease that hit different species of kelp particularly hard?

A quick look at the dietary preferences of otters and urchins may prove revealing: otters feed heavily on urchins and urchins feed on kelp. You can now probably generate a hypothesis that could explain the depletion of California's kelp during that time period. Of course it is not quite that simple. Along with the removal of otters, intensive fishing of other urchin predators such as sheephead and spiny lobster and for sea urchin competitors such as abalone disrupted the

natural population dynamics in the kelp forests. This allowed urchin populations to grow exponentially in some areas and overgraze the kelp creating urchin barrens (CDFG, 2001). Understanding the complex relationships illustrated in the above example require large amounts of data on many species over long periods of time, which do not exist for most ecosystems and species in California. These types of data are the type you will be collecting as a citizen-scientist for Reef Check California.

"When one tugs at a single thing in nature, he finds it attached to the rest of the world."

-- John Muir

California's Currents

Unlike coral reefs, which generally only occur in warmer waters, kelp forests are only found in areas with colder, nutrient-rich seas. California's cold water comes primarily from the Gulf of Alaska as a surface current (Figure 1). Known as the **California Current**, its flow is generally southern throughout the year and its intensity varies with the season. As Northern California divers are quite aware, it hugs the coastline of northern and central California during winter and spring. As we all know, however, there are also days when California's nearshore waters flow northerly. If it is occurring between November and February and accompanied by southwest winds and warmer waters, chances are you are observing the **Davidson Current**. Another northerly current known as the **Southern California Counter Current** occurs in the **Southern California Bight** (the area between the Mexican Border and Point Conception) and may be thought of as a very large scale eddy in the California Current (Hickey, 1994).

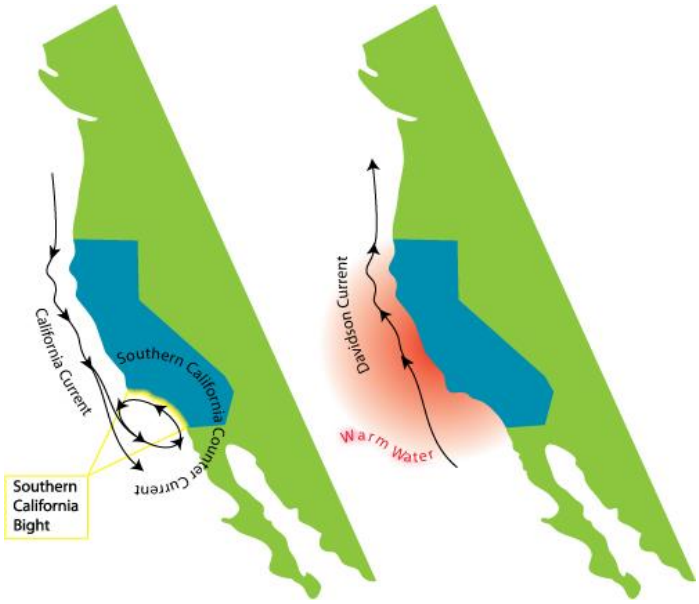


Figure 1. The currents along California's coast help explain the distribution of kelp forests throughout the state (Dave Makena Illustrations).

Upwelling

As you have probably noticed in your dives along California's coastline, some areas are much colder than surrounding stretches of coastline. It also happens that in most of these colder areas we see the highest concentration of kelp forests. This pattern of kelp forest zonation is usually best explained by an oceanographic process known as upwelling. **Upwelling occurs when surface waters are pushed away from the coast and are replaced by nutrient-rich water from deeper levels.** In California, upwelling usually occurs as a result of prevailing northwesterly winds and the influence of the earth's rotation pulling surface waters offshore (California Coastal Commission, 1987). The water is replaced by deeper waters that rise to the surface (Figure 2). The deeper the immediate waters, such as the waters inshore of giant canyons or at points that jut out into deep waters, the more upwelling will occur. The strongest upwelling and coldest waters off the coast of California usually occur during the spring.

The reason we generally see kelp forests in areas with strong upwelling is because the waters that rise from the depths are loaded with nutrients, most of which come from decaying organic matter on the ocean floor. These nutrients, in turn, serve as the base of the food web that allows kelp forests to thrive (Snyderman, 1998).

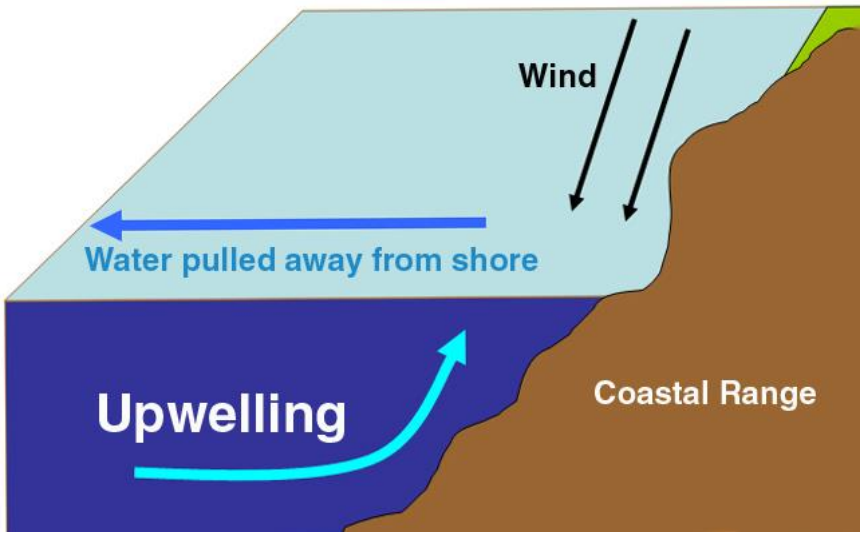


Figure 2. The currents along California's coast help explain the distribution of kelp forests throughout the state (Dave Makena Illustrations).

California's Rocky Reefs

The stunning natural beauty of California's rocky reef ecosystems is likely to have played no small role in motivating you to take this course. The 800 plus species that kelp forests support are a thrill to experience, and many feel that this biological wealth is reason enough to conserve these habitats. There are also compelling economic reasons to protect these habitats. Rocky reefs, like virtually all large ecosystems, provide us with a host of **ecosystem services**. First and foremost, they are an important habitat for many food fish that supply both commercial and recreational fishermen with a source of income and food. Kelp alone provides several

ecosystem services. For example, giant kelp was historically harvested to produce alginates used as thickeners in ice cream and other dairy products such as chocolate milk and yogurt, as well as being an important emulsifier in beer, toothpaste and cosmetics (Druehl, 2003; Mondragon and Mondragon, 2003). More recently, harvested giant kelp has been used in high-end pharmaceutical products and for consumption by humans and aquacultured abalones.

Ecosystem Services: The conditions and processes through which natural ecosystems, and the species that comprise them, sustain and fulfill human life. They maintain biodiversity and the production of ecosystem goods such as seafood, forage, timber, biomass fuels, natural fiber, pharmaceuticals, industrial products and their precursors (From Daily et al., 1997).

Human Pressures and Long-term Monitoring

Despite the aesthetic and economic value of rocky reef habitats, they continue to be stressed by human pressures. The most immediate human pressures rocky reefs face are point and non-point source pollution, sedimentation and overfishing. Combined, these impacts have severely degraded habitats up and down the coast. Changes in abalone numbers provide us with a poignant example. The endemic California Black Abalone (*Haliotis cracherodii*), was formerly so abundant that they could be found stacked on top of each other in intertidal areas with as many as 100 individuals per square meter (CDFG, 2004a; G. Davis, personal comm.). The commercial fishery for black abalone began in the late 1960s, peaked in the 1970s and witnessed a slow decline thereafter and was closed in 1993 (CDFG, 2001). The abalone fishery for pink, green, and white abalone was closed in 1996. A disease known as Withering Syndrome (WS) contributed to the continued decline of abalone populations along California's coastline, especially that of the black abalone. As a result, the black abalone population has collapsed (Figure 3). The species is currently on the World Conservation Union (IUCN) Red List of Threatened Species (Smith et al., 2003) and was listed under the U.S Endangered Species Act January 14, 2009 (CDFG, 2004a).

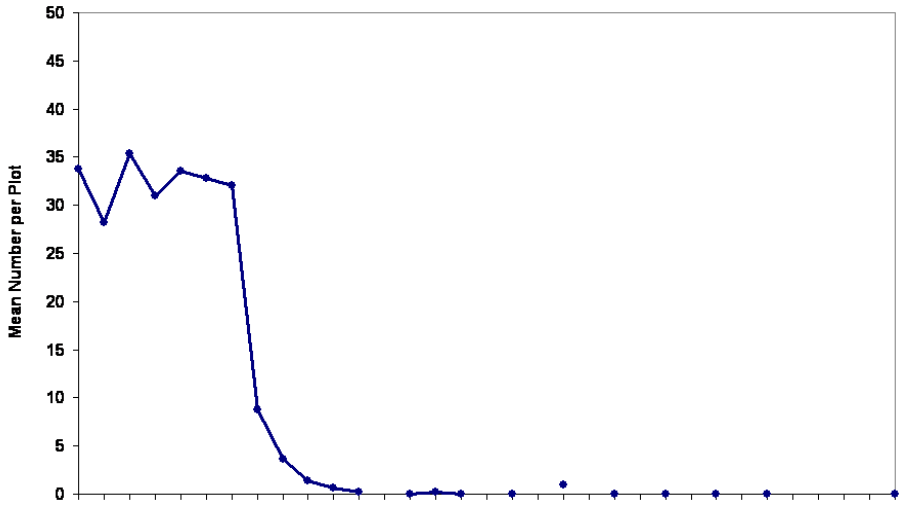


Figure 3. Black abalone density measured in spring and fall between 1985 and 2001 on Santa Barbara Island (Graph courtesy of Multi-Agency Rocky Intertidal Network).

Black abalone is just one of a long list of species that have been hit hard by human and environmental impacts. The status of rockfish populations in California offers another example of the depletion of California's marine resources. Love et al. (1998) describe the decline:

> "From at least the 1950s through the late 1970s, black-and-yellow, blue, gopher and olive rockfishes, as well as young bocaccio, were important components of the inshore rocky reef community of the southern California Bight. In particular, blue rockfish and olive rockfish were among the dominant species over many reefs. However, since the early 1980s, most species of rockfishes have nearly disappeared from the near-shore waters of the Southern California Bight. On many of the reefs that once held substantial numbers of these species, very few rockfish remain."

As the stories of California's abalones and rockfishes illustrate, California, like most areas of our planet, is losing its species at an alarming rate. It is important to mention, however, that we have yet to identify to what extent the changes in species diversity and abundance are directly caused by humans and to what extent they are attributable to patterns of natural disturbance.

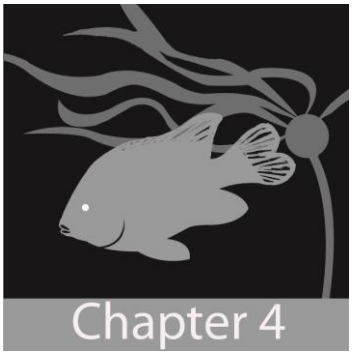
Since the origins of life on earth over 3.8 billion years ago there have been continuous shifts in species distributions, population numbers and composition. In fact, the wonderful diversity of life is a direct result of past species interactions with non-living elements and each other over the millennia. While this course is inevitable, sound management decisions will aim to try and minimize the degree of human impact on this process.

With respect to rocky reefs, we can observe fairly regular natural disturbance and recovery patterns. For example, in many areas along California's coastline winter storms oftentimes uproot the giant kelp forests. Soon thereafter, new juveniles (known to biologists as "recruits") settle those areas. Since giant kelp can grow up to 30 centimeters a day it doesn't take long for these forests to regenerate. Hence when we speak of the health of an ecosystem we aren't necessarily focusing on the number of fish or the number of kelp stipes. Instead, **"ecosystem health"** is directly related to the ability of an ecosystem to bounce back after disturbance.

In short, **long-term monitoring is required to get an accurate picture of the state of California's rocky reef ecosystems**. Long-term data will help tease out human impacts from natural fluctuations of marine resources. The data generated from your Reef Check California surveys will help paint a clearer picture of the possible human stressors that may be causing observed trends. This information will help determine what management actions should be taken and help evaluate the success, or failure, of management actions down the road.

"Death is one thing. The end of birth is something else."

--Michael Soule



Scientific Survey Methods

As anyone who has ever jumped out of a plane, surfed a thirty-foot wave or swam alongside a whale will tell you, no description will ever do justice to experiencing the real thing. For better or worse, we are oftentimes required to describe our experience in order to communicate with others. While science is not immune to this problem, it does its best to minimize the error that is inherent in characterizing phenomena.

Intricacies with Data Collection

Scientific surveys are used to characterize the natural environment by making estimates of reality. In a perfect world, we would count every fish in the ocean to know the population size of that species. Unfortunately, such a task is impossible and we must make controlled observations or take samples to estimate the true nature of a population. The more observations we make, of course, the more confident we are in our estimate. By making repeated observations you can tackle one of the greatest problems that all ecological monitoring programs face -- **variability**.

Variability

Imagine if your Reef Check team went out and counted the number of kelp bass observed along a 30 x 2 m area of reef inside a Marine Protected Area (MPA) and another Reef Check team surveyed the same area outside the MPA. Would you expect the difference in the number of fish counted inside and outside of the MPA to be sufficient to determine whether the MPA had an effect on kelp bass abundance? Consider all the factors: What if there were more fish inside the reserve to begin with? What if you happened to sample one of the sites just after a group of divers came through the area and scared away the fish or perhaps attracted fish with food?

Before diving into the intricacies of the Reef Check California methodology, it is worth considering the potential causes of error in our sampling. Consider the kelp bass counting example once more, but let's just concentrate on the data collected within the MPA.

One factor we need to account for is **temporal variability**. That is just a fancy way of saying that sampling the exact same site at different times is likely to yield different counts (estimates of reality). We can't expect the fish to remain still throughout the day; perhaps the kelp bass are more likely to be seen in the evenings than the mornings. Another factor would be **spatial**

variability. Just as the timing of your survey can influence your results, the location of the survey can also have an influence. Your survey might be located so that you happen to swim through a large school of fish, or, alternately you positioned yourself so that the same school swam right behind you.

Perhaps the most obvious cause in difference between each kelp bass count would be human error. Maybe one individual tends to count really high or one buddy team tends to underestimate and end up with an especially low count. In other words, each sampler and group of samplers is going to introduce different **biases** in the overall data set.

Our goal in providing you with a rigorous training in Reef Check California methodology is to standardize the data collection procedure as much as possible so that we can minimize the human bias to reduce the variation between each survey. **One of the most obvious ways to overcome variability is to regularly sample the same exact transects at the same time of day during the same period of the year.** Furthermore, as you go through the standardized Reef Check California training your data collecting technique will be calibrated. You will be taking an underwater species counting test and your error will be quantified. This is an integral part of your training and will allow you to correct for your biases.

Monitoring Diversity

There are a host of monitoring programs and significant differences between them. When a hypothesis is being tested, for example, the monitoring effort is generally referred to as **scientific monitoring**. This form of monitoring is characterized by its strong consistency, high data quality and strong scientific rigor. **Regulatory monitoring**, on the other hand, describes monitoring imposed by a regulatory agency (e.g., regular monitoring as a component of a discharge permit). Finally, and arguably one of the most important forms of monitoring to achieve conservation goals is **community monitoring**. Monitoring programs that involve local citizens are beneficial because they utilize vast manpower and generally have a built-in educational component.

Replication

At this point you may be asking, even if we do end up doing our best to account for the differences in spatial variability, temporal variability and sampler bias, isn't there still going to be too much variability in our data to say anything meaningful? In a word, the answer is **replication**. In statistics, replication means having replicate observations in the same or similar conditions. Replication is essential because biological systems are inherently variable and it adds information about the reliability of the conclusions or estimates to be drawn from the data (Quinn and Keough, 2002). As you begin to learn the Reef Check California survey methodology, you will see that we have incorporated numerous replicates to try to minimize the error in our estimates associated with spatial and temporal variability.

Precision vs. Accuracy

The goal of any sampling program is to be both precise and accurate. Although used synonymously in everyday speech, the two terms are technically quite different. **Accuracy** is

the closeness of an estimated value to its true value; **precision** is the closeness of different replicates to each other (Sokal and Rohlf, 2001) (Figure 4). For example, assume that the true number of kelp bass on a reef is 25. Your first day of training you perform 3 replicate surveys yielding counts of 10, 25, and 40, giving you a mean number (average) of 25 kelp bass. This would be a highly accurate number, but one that is not precise. Now imagine that you go out one hour later, repeat the same surveys, and tally 39, 40, and 41 kelp bass, giving you a mean of 40. This number would be precise, but not accurate. Finally, imagine that you perform the same three surveys after your Reef Check California training and count 23, 25 and 27 kelp bass, yielding an average of 25. This estimate would be both accurate and precise.

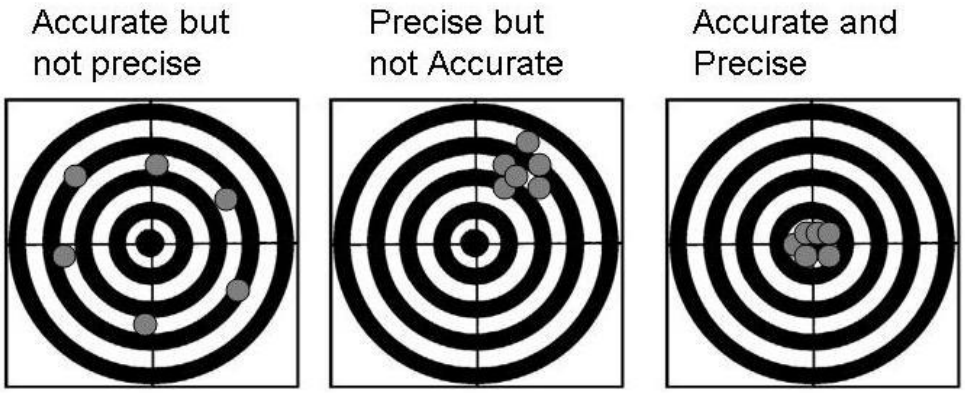


Figure 4. Examples of precision and accuracy

Unless a bias is present, precision will generally lead to accuracy. Hence, we must focus our training on removing all biases to ensure observations are consistent among different observers as well as by the same individual over time.

General Sampling Methods

Science knows no physical boundaries. Whether we are performing investigations ashore, at sea, or on the moon, the scientific method can be employed. Every study will be conducted with metrics. **Metrics are systems or standards of measurement**. If you are studying a population of Douglas fir in the Eastern Sierra, for example, you could do a **census** of each individual tree you saw in a particular area (i.e., you could count all the trees). Another system of measurement is the quadrat. **A quadrat is a predefined area (usually a square) inside of which samples are taken**. Most of the time quadrats are randomly placed in a particular habitat in order to get a representative picture of the habitat without measuring every square centimeter. Another way to study a habitat is to use a transect.

A transect is a line or strip across a surface along which a survey is conducted. There are several techniques you could use. If for example, you wanted to estimate the amount of clutter on your desk, you could run a tape measure across the length of your desk and use the line intercept method to measure the distance occupied by clutter and the distance of bare desk under the tape. Alternatively, you could use the point contact method and take a point at

uniformly spaced intervals **(Uniform Point Contact-UPC)** or randomly spaced intervals **(Random Point Contact – RPC)** along the tape to get an estimate of number of points of clutter and number of points of desk. Both methods give you an estimate of the percentage of your desk occupied by clutter (of course more lines or replicates will give you a better estimate). A final type of transect is a **band transect**, which has a specified width and will be referred to here as either a fish transect, invertebrate transect or seaweed transect.

Sampling Rocky Reefs

Sampling rocky reefs presents numerous challenges as traditional survey equipment, such as trawls and seines, cannot be used on rocky reefs and kelp forests due to entanglement issues (Stephens et al., 2006). Stationary gear such as gill nets, traps and hook and line are often used. However, these techniques are invasive and can damage the substrate and remove organisms from the environment. These techniques can also be biased toward more mobile fishes, such as those that are attracted to the bait or are of a particular size that is most effectively captured by the sampling device (Stephens et al., 2006). Surveys conducted by divers on scuba are the most widely used method for surveying rocky reefs (Stephens et al., 2006) because they have proved to be the least damaging and most reliable survey method for **non-cryptic species**.

Reef Check California surveys will employ the UPC and the various transects described above applied to the underwater environment by divers on scuba. Specifics of these transects will be discussed later in this manual.

Transects

The Reef Check California methodology is transect-based. There are two principal kinds of transects - random and fixed. You will perform primarily random transects during your surveys. The text below discusses their relative strengths and weaknesses.

Random transects

Random transects are laid haphazardly (i.e., as close to random as possible), placing the starting point of your transect at various locations in your target zone. Random transects help to minimize bias by randomly distributing transects over the sampling area. Another advantage is that the data from a number of randomly placed transects may provide a more representative picture of the whole reef area than fixed transects. This only holds true when a sufficient number of transects are conducted to account for spatial variation on the reef so that these can be differentiated from the temporal differences that are of interest to you. A key element to successfully implementing random transects is non-biased transect placement. Predefined compass headings and starting points can be used to help minimize bias of random transects. A disadvantage of using random transects is that the site selection process (i.e., finding suitable rocky reefs in your target zone) must be done each year.

Fixed transects

Fixed transects have permanently marked beginning and end points, ensuring you lay the transect tape in approximately the same position each year. The primary advantage of fixed

transects is that each survey will be directly comparable to surveys conducted in previous years. Due to their non-random nature, fixed transects do not provide an estimate of population size at the site but are useful for tracking changes over time in a small area. Because they minimize spatial variability, any observed changes can be attributed directly to changes over time (assuming sampler bias is not an issue). Another significant advantage is that the site selection process only has to be done once. A significant disadvantage is that the one site may not be representative of an entire ecosystem, requiring that a number of sites in the area be monitored. Another disadvantage of fixed transects is that they can be time consuming and expensive to set up and maintain and are often difficult to relocate each year.

Fixed transects can be marked with eyebolts or stakes cemented into holes drilled into rocks. The idea is to be able to wrap your tape measure around the markers to ensure you are surveying the same stretch of reef each time. **It is critical that you obtain permission from the relevant resource management agency before setting up permanent transects**. It is helpful to draw a map with the compass bearing to follow to find the next marker. We further recommend using a marker every 10 m along the transect. Using sub-surface marker-buoys can be useful for finding the start point of the transect. Be aware that surface marker buoys can get lost and can require different permits from various agencies. Hill and Wilkinson (2004) provide a more detailed discussion.

Calibration

One of the most important aspects of any methodology is being certain that all data recorders make similar observations. This is an especially large concern in the marine environment. Unlike terrestrial sampling, which is generally more straightforward, there are a host of difficulties inherent in marine environment sampling. In the case of collecting Reef Check California data, special gear is required, your sampling times are extremely dependent on the sea conditions and estimating animal size is much more difficult underwater. **In general, sampling underwater is much more difficult than on land.**

For this reason, during the course of your training, all course members and the instructor will successively record data on a fixed transect. This will be done to determine your relative weaknesses and strengths. If your data are too far off the mean, you will be required to continue your training before you will be certified as a Reef Check California diver. Your team should calibrate as often as possible including throughout the survey season. This could be done by setting up a non-permanent fixed transect as done during your training and comparing counts among team members. These data would not be submitted to the database but ensures you keep your survey skills sharp throughout the year. This is especially important if it has been sometime since your training or your last survey.

To maintain data submission eligibility, all divers must complete yearly recertification dive training as well as complete the online testing course.

Scientific Integrity & Ethical Concerns

As mentioned earlier, the data you collect is playing an integral part in implementing key legislative measures in California. It is imperative that it is collected in the most unbiased way

possible. While it may be tempting to "fudge" the data in order to serve a personal agenda, no matter how noble, in the long run it will only distort the decision making process. If you are only interested in pursuing an agenda, please put your scientific aspirations aside and join an advocacy group.

Be forewarned - marine sampling involves quite a lot of zeros. Even among experienced scientists there is a temptation to record a species observed just outside the transect boundaries. As a Reef Check California diver, you must exercise restraint when confronted with such a situation. Remember, our goal is to minimize variability between individual samplers. Therefore we must ensure everybody is using the exact same methodology. Zeros in your data are not a bad thing, but representative of the variable ocean environment. The long-term average is much more important than a single survey. Organisms not falling within transect boundaries can be recorded in the comments section, but must not be recorded in the data reporting fields.

Disturbance

Despite good intentions, the number of people visiting a habitat, coupled with lack of education, can lead to environmental degradation. Two obvious examples that you may have experienced in California are smog and gridlock in Yosemite and trampled tidepools in Southern California. People love to visit the Sierras and the tidepools, but even if they don't take anything, their trampling can have a major impact. One of the goals of your training is to teach responsible diving in order to minimize disturbances to the rocky reef habitats we are studying.

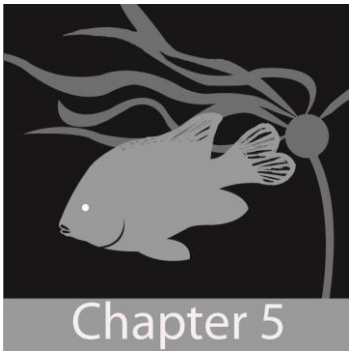
The divers that cause the least disturbance are those that are the most familiar with their gear. They minimize loose or dangling equipment and have excellent **buoyancy control**. We strongly recommend that you attach extra clips and buckles for holding your research gear.

Safety

Safety is the number one priority of Reef Check California. One of the most common errors divers make when completing specific tasks underwater is to be too liberal with their dive plan. It is much easier to lose track of time, your surroundings and your buddy when concentrating on data collection than when diving without a specific purpose. Carrying out any tasks underwater can increase susceptibility to decompression sickness. Hence, it is imperative that you **plan dives more conservatively when collecting data and remain aware of air and bottom time**. A good rule of thumb for research diving is to use the next deeper depth level when calculating your dive tables and maximum allowable bottom time.

Although you may have heard it a thousand times, it doesn't make it any less essential to maintain the buddy system. **At no point in any dive is it acceptable to lose sight of your buddy.** As with all dives, you and your buddy should agree on lost buddy procedures prior to entering the water and follow them accordingly.

Please remember, the data are not worth getting injured or risking your life! You can always come back another day to complete a survey. Under no circumstance should you conduct a survey if you are not completely confident in your ability to safely complete the dive.



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, then 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 5).

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.

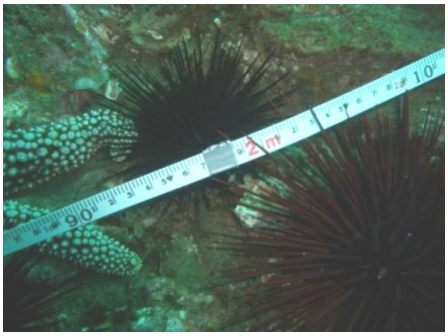


Figure 5 One-meter intervals marked with tape on transect line. This practice is especially important when the transect tape does not have meters marked on both sides (Photo: G. Hodgson).

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 6).

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).

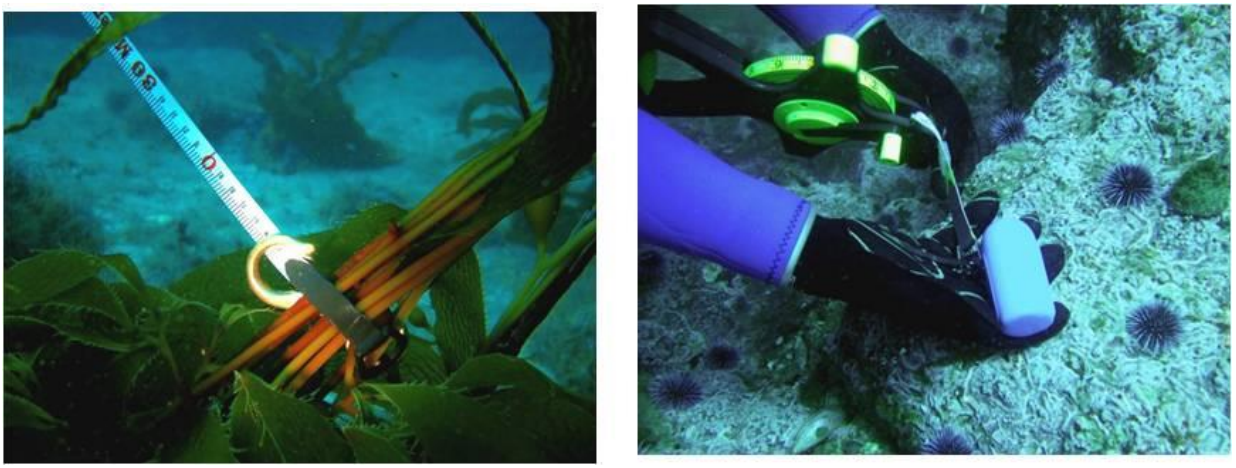
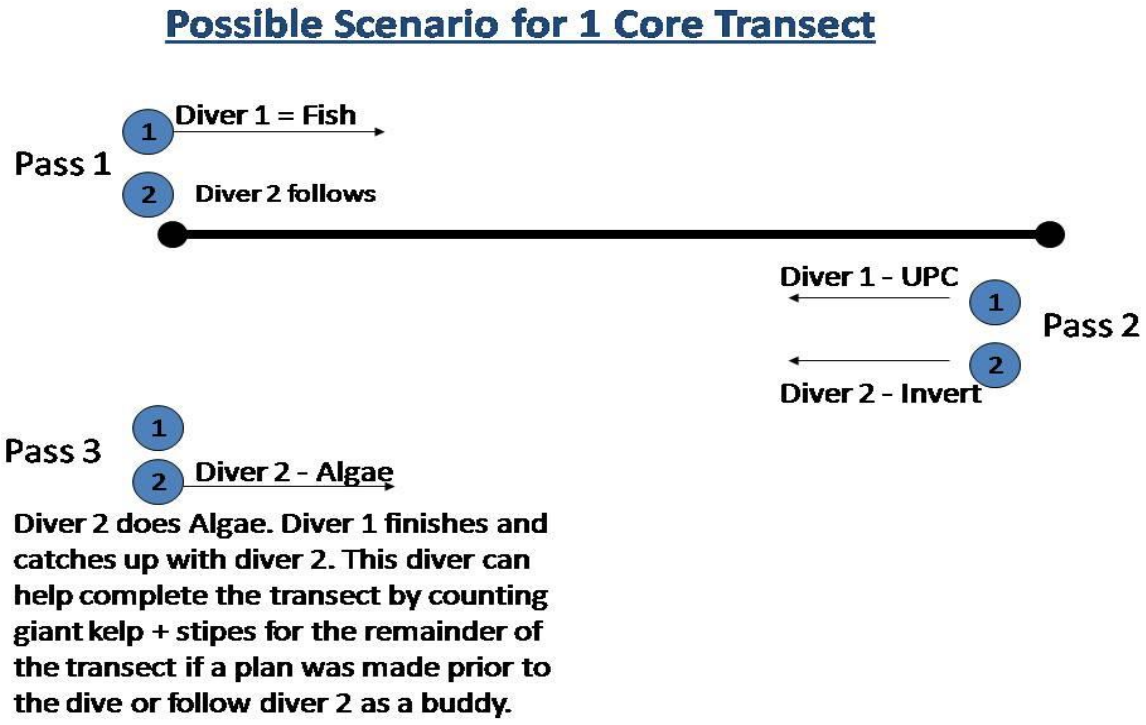


Figure 6. Two ways of anchoring core transect: either with a clip or with a two pound weight (Photos: N. Flash, www.flashpics.com).

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.



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 7). 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.

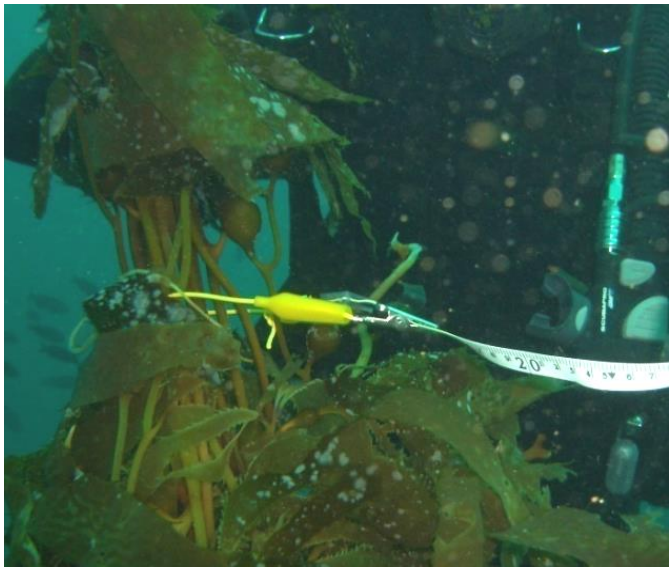


Figure 7. Twelve gauge wire and alligator clip anchoring Fish Only Transects (Photos: N. Fash, www.fashpics.com and G. Hodgson).

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 8). 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 8. 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).

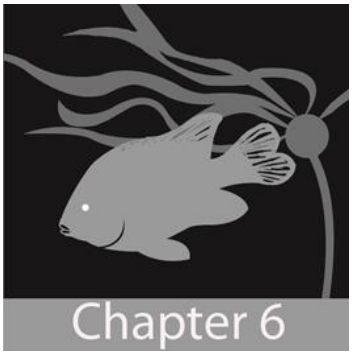
For the seaweed transects only, teams can elect to split up the species being counted – one buddy would count giant kelp plants and stipes while the other buddy would count all the other seaweed species. After the dive, the buddy team would reconcile their data sheets so all the seaweed data is on one 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 be recorded in a legible fashion so that others 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.



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 transects discussed in the scientific survey methods section. 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 Conducting The Survey & Data Collection section).

- **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 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.

- **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.

- **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 5.

Visibility must be at least 3 meters to conduct fish surveys. More details on checking visibility will be given in the Fish Transect section of this chapter .

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 9).

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.

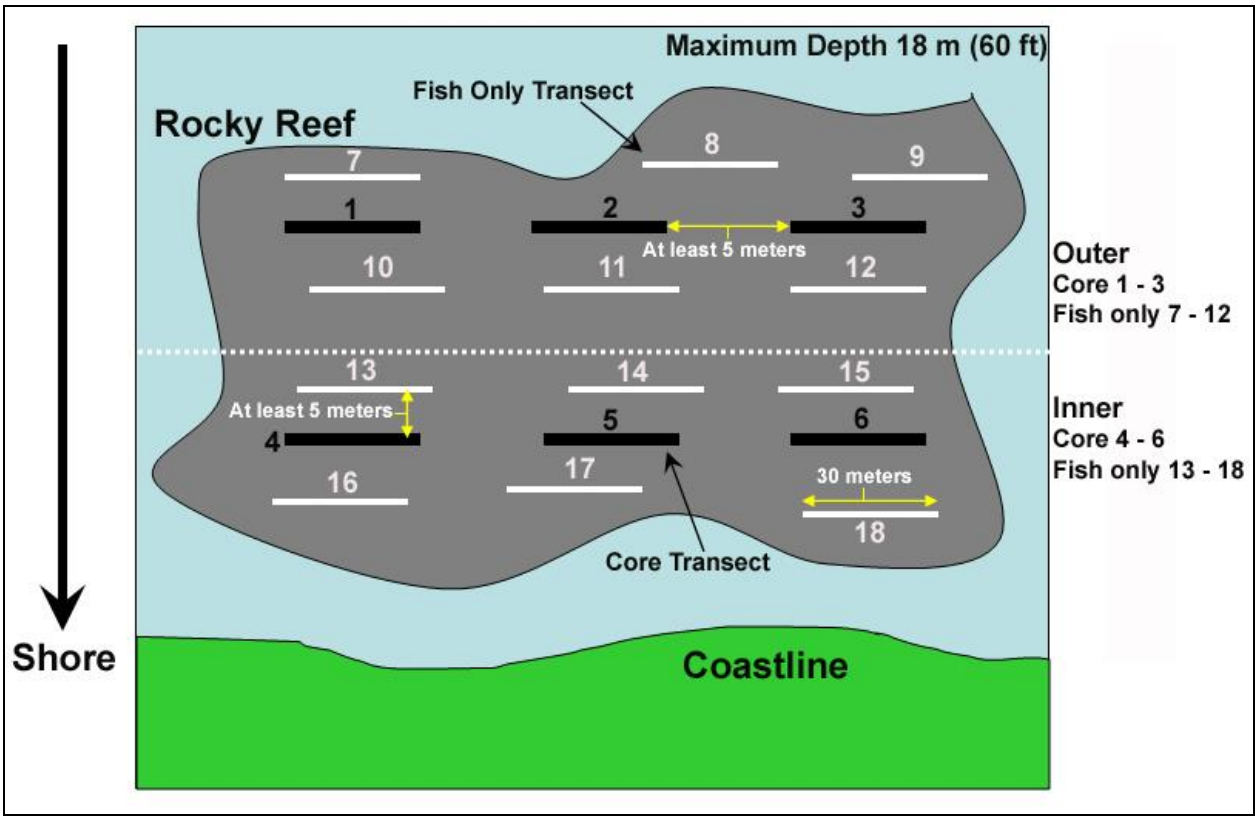


Figure 9. Diagram of transects over a rocky reef. All teams should aim to complete six core transects, which are marked in bold (3 in each zone), plus an additional twelve random fish only transects, which are marked in white (6 in each zone). All transects are 30 meters in length.

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	*Megastraea undosa*, *Lithopoma 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 16). 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 minute 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 11 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 horneri* and *S. muticum*). These species should be recorded as present if they are seen anywhere during a survey, with the exception of *Sargassum horneri*. *S. horneri* will be treated the same as other types of seaweed and holdfasts will be counted in addition to noting if *S. horneri* is seen on the site. If you detect either *Undaria pinnatifida or 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 horneri*	I. EI
Sargassum†	*Sargassum muticum*	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 10). 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 minute goal in mind. See Figure 11 for an example on how to record data on the seaweed datasheet.

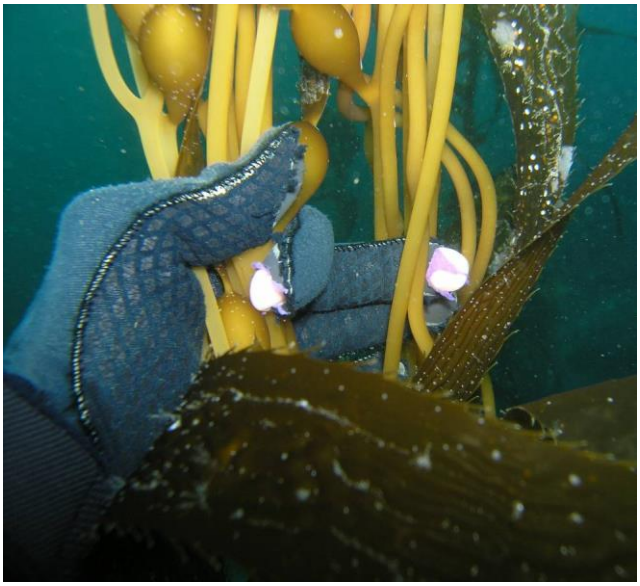


Figure 10. Using fingers to count kelp stipes at 1m off the bottom (Photo: C. Shuman).

Invertebrate/Seaweed Data Sheet - Southern

SITE Weston's Reef Date: 6/2/15 Visibility (m): 10

Diver: Joe Diver Buddy: Jane Diver

	Count all orgs. > 2.5 cm **10 Minute goal** (30 x 2 m)	Transect#: 4 Time: Beg: 10:45 End: 10:55	Dist
Abalones	red abalone (size cm) (4)	19, 20, 17, X	
	flat abalone (size cm)		
	pinto abalone (size cm)	7 (1)	
	green abalone (size cm)		
	pink abalone (size cm)		
	Unknown abalone		
	CA spiny lobster		
Cucumbers	CA sea cucumber		
	warty sea cucumber		
Sea Stars	bat star (50)	14	
	short spined sea star		
	giant spined star	4 (4)	
	sun/sunflower star	2 4 (5)	
Slugs/snails	chestnut cowry		
	Kellet's whelk		
	wavy / red turban snail		
	giant keyhole limpet		
Crabs	rock crab		
	sheep/masking crab		
	gumboot chiton	4, 2 (6)	
	rock scallop		
	large anemone (>10cm)	2 (7)	
Gorgonians	brown/golden gorgonian (>10cm)		
	red gorgonian (>10 cm)		
Urchins	red urchin	7, 4, 8, (19)	
	purple urchin		
	crowned urchin		
	Black ab (Y/N) N	White ab (Y/N) N	
	Other/comments		

30 x 2 m Transect **10 Minute goal time**	Transect#: Time: Beg: End:	Dist
Bull Kelp (3) >30cm	4	
Pterygophora (50) >30cm	24	
Southern Sea Palm >30cm		
Laminaria >30cm		
Sargassum horneri >30cm		
giant kelp (>1 m) (13) >1 m	45 15 11 10 2 1 1 3 17 20 29 4 8	

*Do not count seaweed used to attach transect

Sargassum muticum Yes___ No✓
Sargassum horneri Yes___ No✓
Undaria Yes___ No✓
Caulerpa Yes___ No✓

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

Figure 11. 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 12).

OB – Other Brown Seaweed. Any other type of brown seaweed including *Sargassum* spp., *Undaria pinnatifida* and *Cystoseira* (Figure 13).

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 14).

SI - Sessile Invertebrates. Includes sponges, anemones, bryozoans, gorgonians, sand castle worms, barnacles, etc. (Figure 15).

MI- Mobile Invertebrates. Includes sea stars, urchins, sea cucumbers, crabs, limpets, etc (Figure 16, Figure 17).

SG- Seagrasses. Includes surfgrass and eelgrass.

Figure 12. 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 13. Examples of Other Brown algae (OB) (Photos: D. Richards, M. Schwalbach, and K. A. Miller).

Figure 14. Crustose coralline algae
(Photo: C.Wisniewski)

Figure 15. 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 16. 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 17. 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 18. 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

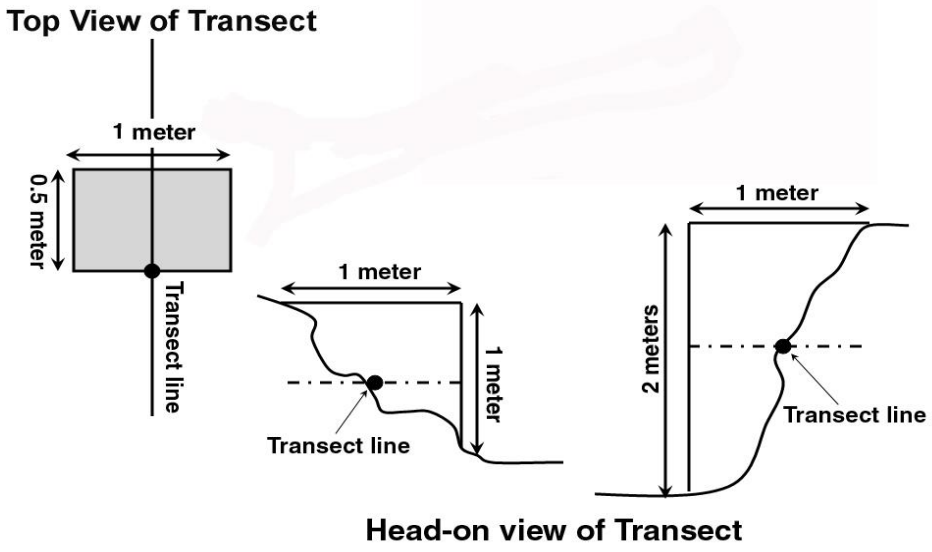


Figure 18. Physical relief is measured as the greatest vertical relief within a 1-meter wide section across the tape and .5-meter section in front of each point

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	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 (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 19). 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 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 19 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 and displays their other hand (preferably wearing a black glove) 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 20).

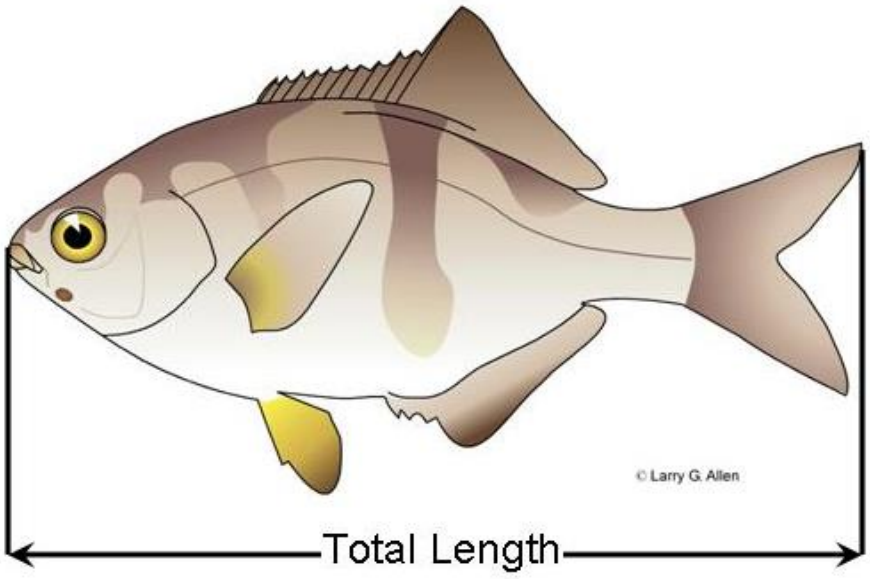


Figure 20. Total length of fish, in this case a pile perch, is measured from mouth to tip of tail (Illustration © Larry G. Allen).

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.

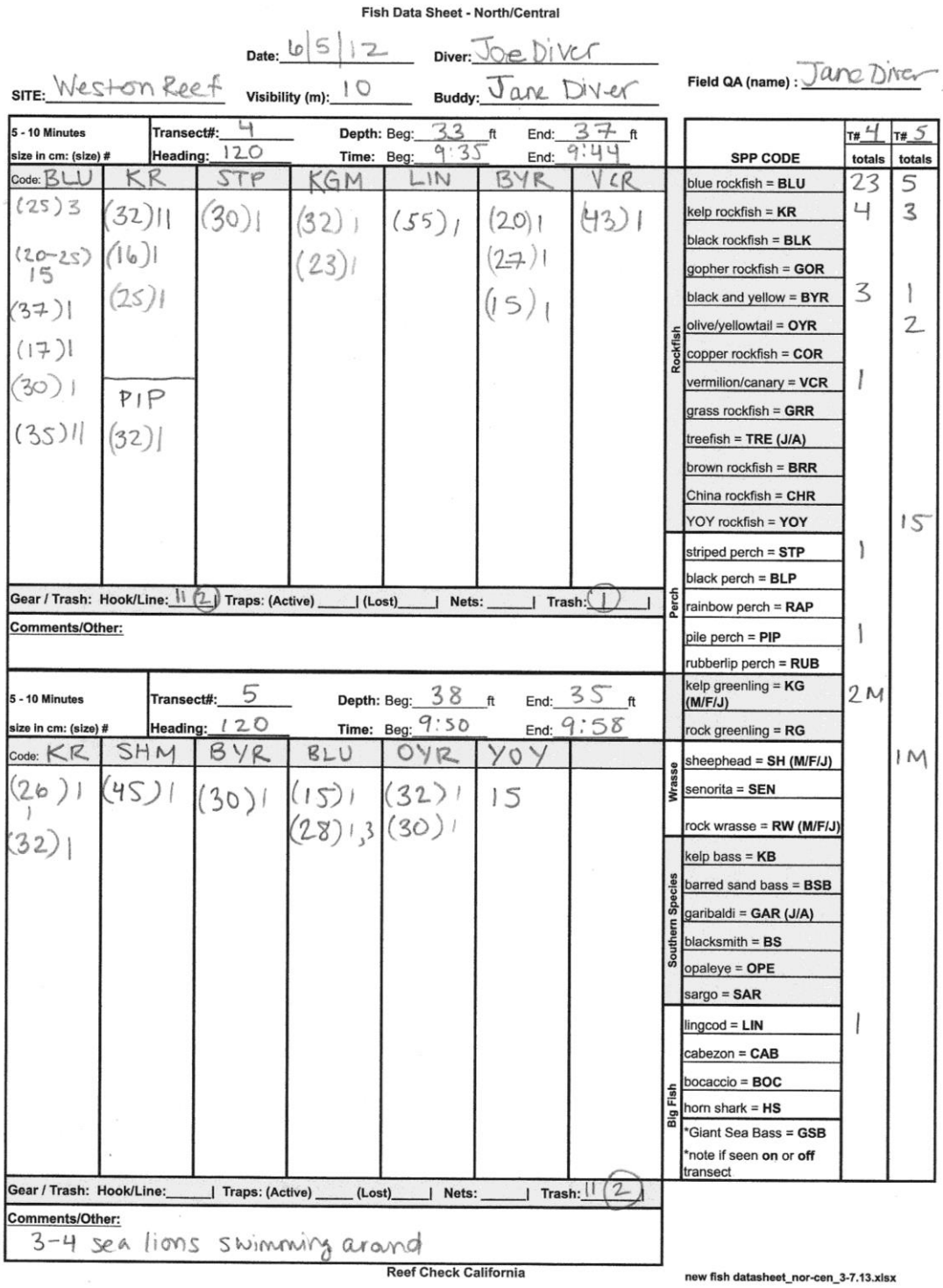
Another helpful practice is to estimate the size of non-moving objects or organisms (e.g., sea stars, sea cucumbers) then approach them and measure their size with your slate. After you measure, note if your estimate was below or above the measured size and adjust your estimation before you repeat this 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 21 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

5 - 10 Minutes
size in cm: (size) #

Transect#: 4 Depth: Beg: 33 ft End: 37 ft
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:

5 - 10 Minutes
size in cm: (size) #

Transect#: 5 Depth: Beg: 38 ft End: 35 ft
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	T# 4 totals	T# 5 totals
Rockfish	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
Perch	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		
Wrasse	sheephead = SH (M/F/J)		1M
	senorita = SEN		
	rock wrasse = RW (M/F/J)		
Southern Species	kelp bass = KB		
	barred sand bass = BSB		
	garibaldi = GAR (J/A)		
	blacksmith = BS		
	opaleye = OPE		
	sargo = SAR		
Big Fish	lingcod = LIN	1	
	cabezon = CAB		
	bocaccio = BOC		
	horn shark = HS		
	*Giant Sea Bass = GSB		
	*note if seen on or off transect		

Reef Check California

new fish datasheet_nor-cen_3-7.13.xlsx

Figure 21. 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.

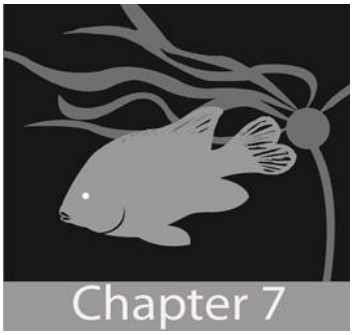
Trash - includes anything manmade that was lost or tossed into the ocean and that doesn't fall into one of the fishing gear categories such as plastics, bottles, cans, metal, ropes, etc. (if trash is recorded it should be noted in the comments section what was found).

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 21). 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 22). **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 22. Urchin sizing with calipers (Photo: N. Fash, www.fashpics.com).



Data Entry & Data Reporting

Accurate data entry is one of the most critical components of the sampling process. As discussed in the previous chapter, it is critical that consistency be maintained within and among individuals. The Data Captain is responsible for data checking, data entry and submission of data. All team members should assist with this activity.

The first level of data checking is performed at the site immediately following the dive either on the boat or on the beach. The Data Captain must collect **and review** all data to ensure the datasheets are legible and ask any questions while the data are fresh in everyone's minds. This is a crucial step!

Within 72 hours of returning ashore all data must be entered into the Reef Check California online Nearshore Ecosystem Database (NED). Using your web browser, navigate to the diver portal at http://ned.reefcheck.org (Figure 23). All RCCA data captains will be issued a username and password that will allow them to:

- Add a new survey
- Continue an incomplete survey
- Review a completed survey

Accurate Data Entry is Critically Important!

The data entry system contains two automated validations to check your entries. Despite this, you must be very careful to accurately enter your data.

Sending the Datasheets to Reef Check

Original datasheets should be mailed to your Regional Manager for final review and archiving after you have completed entering the data into NED. Data should be sent no later than ten days after completing your survey. We will send you new blank datasheets for your next survey upon receipt of your completed datasheets.

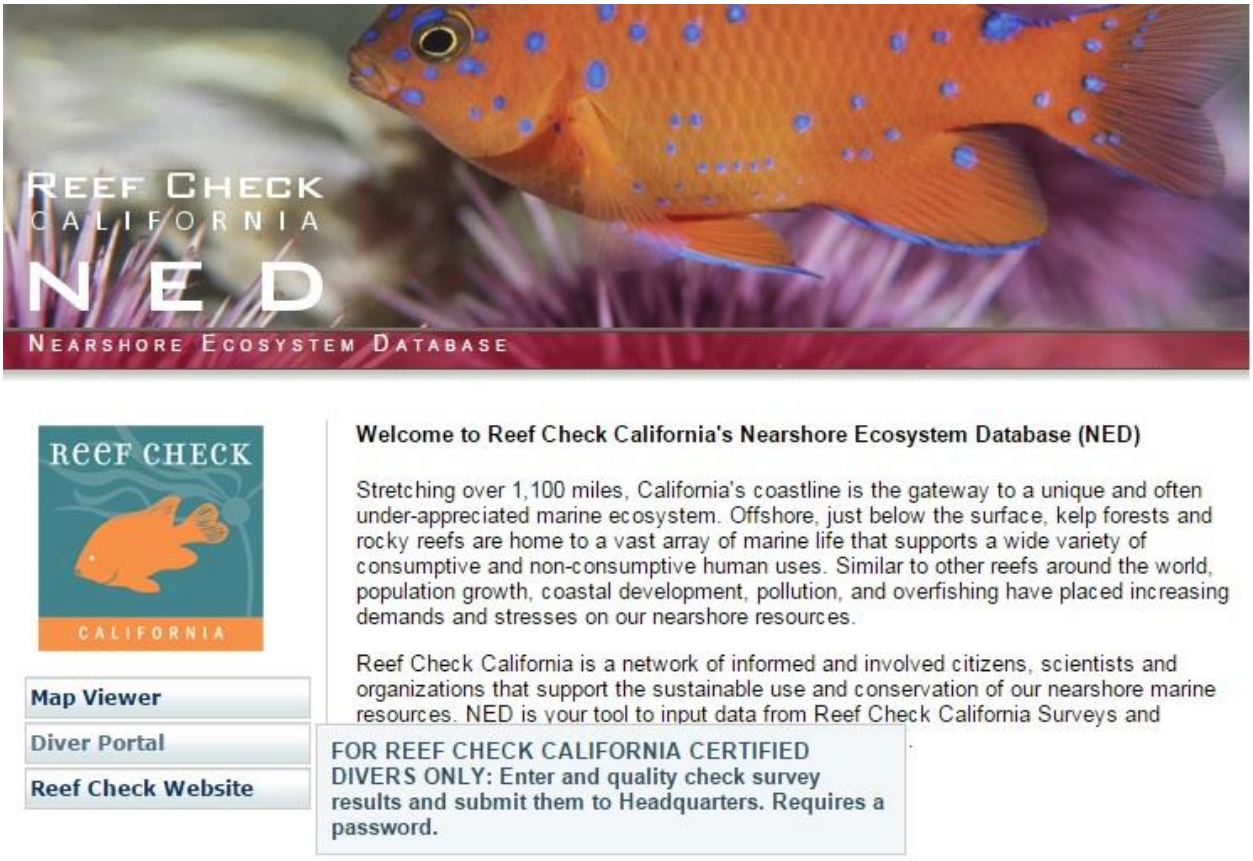


Figure 23 NED home page with Diver Portal selected.

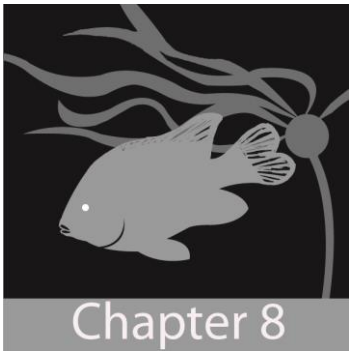
What More Can You Do?

- Take part in our planned surveys up and down the coast. Use Reef Check's statewide program as a means of diving in new locations with divers who know the areas well.

- Survey additional sites. The more sites that are surveyed as part of Reef Check California the more complete our picture will be of the status of California's reefs.

- Record additional information. For long-term monitoring, it is recommended that a full set of still photos and a video be obtained along the transect and surrounding area. Such photographs and video can be very useful in answering unexpected questions that crop up long after the survey is completed. We also recommend taking several above water photos in several directions showing the locations of the transects lined up against whatever landmarks may be available for future reference. It is generally not advisable to rely completely on video or photo monitoring for two reasons: 1) the ability to identify organisms in videos and photos is limited, and 2) analysis requires a great deal of time, even when aided by semi-automated procedures.

- Document your efforts. We strongly encourage all teams to record their travel, survey, analysis, post-dive party and any PR/media events with still photos or video. Photos and videos can be uploaded to the Reef Check Foundation's Facebook (https://www.facebook.com/reefcheckfoundation) page or the regional specific group Facebook pages (www.facebook.com/groups/NorCalReefCheck, https://www.facebook.com/groups/SoCalReefCheck). A general video of the Reef Check survey and the site environment would be extremely useful to us for media presentations and to HQ for our annual Press Conference. We will feature these in our newsletters, reports and publications in order to bring attention to the problems facing California's rocky reefs and how Reef Check is part of the solution.



Quality Assurance Procedures

Quality assurance (QA) is a system for ensuring that data collection, entry and reporting follow a defined written plan and that if a mistake is made, it can be promptly detected, traced to a responsible person and corrected. This chapter defines the procedures for ensuring that data collected for a Reef Check California survey are correctly logged and submitted to the Reef Check database for analysis.

Training

All participants are required to successfully complete the RCCA training course under the direct supervision of a certified RCCA instructor to be eligible to submit data to the RCCA Nearshore Ecosystem Database (NED). Participants with extensive prior monitoring experience can opt out of the training course but must demonstrate proficiency in all components of the RCCA protocol under the supervision of a certified RCCA instructor before they can submit data to the RCCA database.

Requisite components of the RCCA training course are:

1. Completed reading of the Reef Check California Training Manual
2. Attendance and participation at all classroom sessions (10 hours)
3. Attendance and participation at the pool session (3 hours)
4. Attendance and participation at all field sessions (6 dives)
5. Successfully pass the written multiple choice test (85% passing score)
6. Successfully pass the species identification tests (85% passing scores)
7. Successfully complete the methods and species identification field practical exercises

Data Collection

Data collection methods have been designed to promote the safety of the surveyor as the primary goal followed by the accuracy and precision of all data collected. All surveyors must follow the methods outlined in the Reef Check California Training Manual. The following items have been included in the survey protocol to increase the precision and accuracy of all surveys by reducing sampler error and bias:

1. Standardized site selection and transect deployment procedures

2. Standardized time requirements, search image and use of flashlights for all invertebrate and fish surveys
3. Minimum size requirements for all invertebrate and algal species to focus on emergent organisms only
4. Grouping of species with similar morphological traits (i.e., canary and vermilion rockfishes) to reduce the likelihood of misidentification
5. Employment of size bins for fish surveys
6. Employment of standardized data notation procedures on the underwater datasheets
7. High level of replication within a site (eighteen 30 x 2 x 2 m transects)

Field Data Verification

Immediately following each dive, each team member must review their datasheet for completeness and legibility. The Data Captain verifies this prior to collection of each sheet and discusses any potential outliers with the team member. If a consensus on any data cannot be reached, the team leader will flag the datasheet for further review by the data manager.

Data Entry

The text below is provided as a guide to direct the entry of all data.

Materials Needed

- Washed and dried datasheets
- Red and blue or green pencil or pen
- Print out of RCCA NED Instructions document which includes detailed quality assurance procedures

Prior to Data Entry

1. Confirm all datasheets are present and accounted for. The total number of sheets will vary but you will need to make sure you can find fish transects 1-18, invertebrate transects 1-6, seaweed transects 1-6, and UPC transects 1-6. You also may have urchin size-frequency datasheets, but not always.

2. Review each datasheet for completeness. There may be fields which were intentionally left blank. IF ANY FIELDS ARE BLANK, BE ABSOLUTELY SURE A CHANGE IS APPROPRIATE. VERIFY WITH THE DIVER THE CORRECT INFORMATION BEFORE YOU MAKE ANY CHANGES. The most common omission is start and end time. If those are left blank there is no way to get that information so it will have to be left blank in the database. This is also true for start and end depth. DO NOT MAKE UP THESE NUMBERS. JUST LEAVE THEM BLANK IF THEY WERE NOT ENTERED.

3. ALL EDITS ARE TO BE MADE IN RED PENCIL OR RED SHARPIE ON ORIGINAL DATASHEETS. The most common questions arise from not being able to determine the total counts for a species, either due to illegible writing or unfamiliar non-standardized notation (see Recording Data and Ensuring Quality section). Before you change anything on the datasheet, it may be necessary to fax or scan a copy of the datasheet in

question and send it to the diver to verify the edit in question. You may also call the diver but often it requires the diver to see the original before they can interpret the correct count. If you cannot figure out what to do with an entry, leave it blank and flag questionable records on the datasheet with a Post-It and circle it in red on the datasheet.

Entering Data

Visit http://ned.reefcheck.org/instructions for detailed data entry procedures

Data Verification

At this stage please do a cursory check of the data that you entered. One way to accomplish this is to randomly select a couple of datasheets and go back and make sure data entered by you matches up. Having another person look over the entries to independently verify the data entry is highly recommended.

Make sure all datasheets are accounted for and all Post-its/data flags are readable. Paperclip or staple all the datasheets together.

Datasheet Submission

After you have completed all the above steps, perform one more check to ensure you have all the datasheets for the site.

Package the datasheets and mail them to the Regional Manager.

Finalizing Data

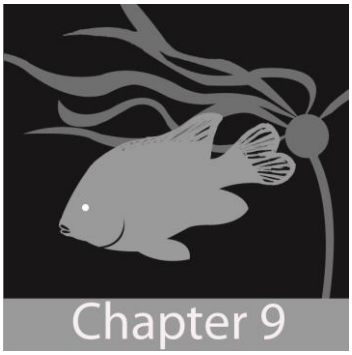
Upon receipt of the datasheets, the Regional Manager will perform random spot checks of the data.

After the data are vetted, the Regional Manager will scan the datasheets and pass those files onto the database manager. The finalized data will be displayed via the NED Map Viewer on the web.

All datasheets will be archived in digital and hard copy formats.

Note!

Chapters 5 – 8 provided you with the theory necessary to conduct surveys with Reef Check California methodology. **YOUR UNDERSTANDING OF THESE SECTIONS IS CRITICAL FOR THE SUCCESS OF REEF CHECK CALIFORNIA**. If you have any questions while reading through these materials or during the lectures, please ask your instructor. We are constantly working to improve our materials and value your interest and input.



Sustainable Long-Term Monitoring

Reef Check's Role in California

A major goal of marine monitoring programs is to provide the data required for sound and sustainable management practices. In 2012, the state of California completed a historic and unprecedented 12-year process of establishing its first network of marine protected areas. This has resulted in approximately 16% of state waters being protected from many human activities including commercial and recreational fishing. With the full implementation of this statewide network of MPAs, the long-term monitoring of these MPAs has become a major focus of Reef Check California.

Despite strong support for volunteer-collected data (Harding et al., 2002; Abramson et al., 2000) there are still skeptics that do not believe in the effectiveness of citizen science for environmental monitoring. Therefore, it is very important that you take your training and subsequent surveys very seriously to ensure you produce high quality data. As resources for monitoring are limited, volunteer monitoring becomes increasingly valuable to provide critically needed information (Levrel et al. 2010). The usefulness of RCCA data for marine management in California has been demonstrated in a study comparing RCCA data to data collected by academic monitoring programs in southern California. Gillett et. al. (2012) concludes that the data collected by RCCA's citizen scientists can be used in conjunction with other monitoring data to inform marine management in California.

Without objective scientific monitoring, changes in California's marine ecosystem in response to changing climate, human and management and conservation actions such as MPAs, cannot be tracked. Therefore, the establishment of Reef Check's volunteer monitoring program in 2006, just as the first MPAs were being implemented, was timely. Over the first six years, Reef Check California has grown into a statewide citizen-science monitoring network focused on rocky reef and kelp forest ecosystems. The program is now monitoring over 80 sites along the entire length of California's coast. This rapid growth was accomplished through the training of over 1000 volunteer citizen scientists and collaboration with academic, state and private institutions and organizations. The program is now well established and sustains a dedicated body of about 250 active volunteers annually, many of whom have been with Reef Check since its early years. Reef Check California partners with many universities, research programs, private organizations, state agencies and private businesses to conduct volunteer training and reef monitoring. RCCA's community based approach not only provides timely information to marine managers, it also builds up public support for marine monitoring and science-based

management. Without such support, even well-funded, government-led management efforts can fail. Moreover, by participating in Reef Check training, fundraising and surveys, community members can develop a sense of stewardship toward the ecosystem they are monitoring.

Sustainable Financing

As state funding for marine monitoring is extremely limited, finding new and sustainable financing for the Reef Check's public service of monitoring the status of California's marine environment is tremendously important. Several funding streams have been established and the involvement of RCCA's volunteers in this ongoing effort of sustaining and growing the program's funding, partnerships and sponsors is a major part of the program's funding success.

Grants

Grants are available from a wide range of funding sources, from hundreds of private philanthropic foundations focused on marine education, monitoring and management, to State and Federal agencies interested in supporting marine monitoring and conservation programs. A major role of Reef Check's development staff is to work with our teams across the state to help find grant support to start up and maintain Reef Check programs until such time that they can be locally self-supporting. Please let us know if you would like to work with us to search for and develop new grants or if you know of a funder that you would like to connect us to.

Corporate Sponsors

Corporate sponsorships are often the easiest type of funding for our volunteers to obtain by connecting us to their employers or other businesses in their network. These partnerships often lead to sustainable financing as corporations become long-term partners. Corporations actively seek out ways to maintain a "good" public image as well as sell their products through advertising. Reef Check California offers excellent opportunities for both to corporations. There is a wide range of media opportunities for corporate sponsors and many of our new corporate sponsorships focus on funding for our Annual Gala, whereby the company may "buy tables", ad space in the Gala brochure and event signage. It is worth remembering that these same companies may spend tens of thousands of dollars, if not more, for print, radio and television advertising. A single print ad in a major US newspaper or magazine can cost between $50,000 and $100,000. Please consider helping us by connecting us to businesses and corporations within your network. We find that the highest success rate for new corporate sponsors comes from companies whose friends or employees are Reef Check volunteers.

Many companies, such as dive boats or shops may also provide "in-kind" donations such as use of facilities, boats, dive equipment and staff time.

Adopt-A-Reef

The Adopt-A-Reef program partners with California's corporate brands to sponsor and support the community-based monitoring and conservation of California's reefs. Through these partnerships with coastal communities and companies, the Adopt-A-Reef program leverages the support and resources of local businesses to directly sponsor local volunteer dive teams to annually monitor the health of their local marine ecosystems. By replicating this model on a

statewide basis, the Adopt-A-Reef program engages California's business community to take direct action, and a very proactive and forward-thinking stance, in moving beyond business-specific environmentally friendly practices towards actions that positively impact their local, and our global, community and environment.

Volunteers play a big part of helping Reef Check to connect with potential Adopt-A-Reef partners through networking and, once a reef is adopted, by working with the corporate partner to take full advantage of the sponsorship. Please let us know if you would like to help expand this program.

Donations and sustaining membership

An important funding source for the California program is the donations made by volunteers and Reef Check members. By becoming a Reef Check member you can help sustain the program with an annual contribution or you can choose to become a sustaining RCCA All-Star by signing up for Reef Check's monthly donation program at:

http://admin.reefcheck.org/crm/rcca/rcca-allstar_subscribe.php

Concluding Remarks

Reef Check California's data are contributing to our understanding of California's nearshore ocean. Our collaborative work with the California Department of Fish and Wildlife (DFW) and the MPA Monitoring Enterprise is providing a public service to the people of California by insuring that our shared marine resources are managed and conserved based on available science as mandated by the state. As such, RCCA's data have been used to inform marine management and conservation on an ongoing basis. The data were used for the siting of the new MPAs under the Marine Life Protection Act Initiative and RCCA's data and analyses have been part of the ongoing baseline monitoring in all regions where MPAs are in place. Going forward, RCCA will be focusing on the long-term monitoring of these new MPAs throughout the state.

Having trained over 1000 citizen scientists and educated many more about marine resource management and conservation issues, Reef Check has created a body of well-informed citizens who have taken action to improve marine management in California. As management and conservation issues are likely to remain controversial, this will help to build an educated and active constituency that can demand sound science-based management and conservation. This will serve California well as issues, such as the effects of climate change, come to the forefront of the state's resource management and conservation policies.

Remember, we are relying on you to produce high quality data that can be used to help make informed management decisions. To achieve this, you must constantly update your skills and calibrate your sampling with other members of your team. It is imperative that all Reef Check California surveys are standardized or else we will not be able to identify ecological trends in the data. Thank you for choosing Reef Check as a vehicle for making a difference, and above all, thank you for being concerned enough to take action!

Reef Check California Protocol Updates

2015 Protocol Updates

Adding invasive algae *Sargassum horneri* to algae transect

Over the last survey seasons we have noticed a qualitative increase in the abundance of the invasive algae *Sargassum horneri* (formerly *S. filicinum*) at several of our monitoring sites in southern California. In response to this, and to an increased interest by scientists and mangers in the spread of this invasive species, we will update Reef Check California's monitoring protocol to be able to better track the extent and spread of this species. To date, we have been recording the presence or absence of *S. horneri* at each of our monitoring sites. Starting in 2015, we will add *S. horneri* to the species that we count along our algae transects.

On each algae transect, we will count the number of holdfasts of *S. horneri* within the 30X2meter transect area. This is done in the same way as we count the other species of algae along the transect. *S. horneri* holdfasts are small but easy to identify once the algae have grown to their adult stage. Therefore, we will only count individuals over 30 centimeters in height. Height is measured from the substrate to the top of the alga. Consistent with the other species of algae, *S. horneri* is subsampled at 50 individual holdfasts and the distance along the transect is recorded to the nearest meter.

We will continue to record the presence or absence of both invasive Sargassum species, *S. horneri* and *S. muticum*, at monitoring sites as we have done in the past by checking 'yes' or 'no' on the algae datasheet. We are continuing to do this despite recording *S. horneri* on transects to maintain consistency in our data and monitor the presence of this species even if it is not found on one of our algae transects. Often *S. horneri* is found as small recruits (i.e. juvenile stage) during our main survey season in the summer. These recruits can be very abundant at times but if they are less than 30cm in height they will not be recorded during the algae transect but *S. horneri* will be recorded as present at the site in the Yes/No checkbox on the datasheet.

During the UPC transect we will continue to record *S. horneri* as "Other Brown" (OB) algae. Therefore, nothing has changed in the UPC protocol and we are still recording all invasive species as "Other Brown". This keeps the UPC data compatible with what we have done in the past because we are not modifying the existing UPC categories.

2013 Protocol Updates

This year we have implemented some updates to our fish transect protocol and datasheets. Please take the time to review these. The updates are as follows:

Fish Sizing

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 20).

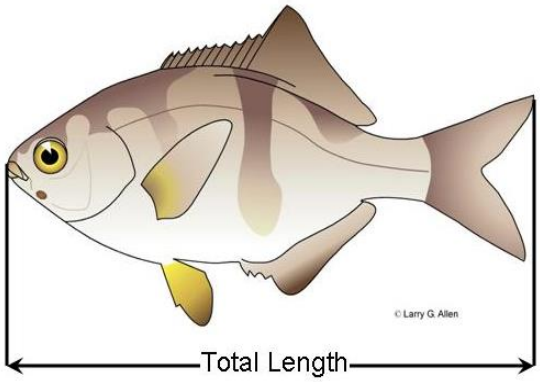


Figure 20. Total length of fish, in this case a pile perch, is measured from mouth to tip of tail (Illustration © Larry G. Allen).

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 9-15cm (for details on how to record this on the datasheet, see section: Recording Data and Ensuring Quality). 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
- Dull body color
- Poor visibility
- Objects in background
- 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
- Bright body color
- Good visibility
- Objects in foreground
- 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.

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 (i.e. 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 (i.e. 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 spear fishing gear, including spears, tips and guns (spear fishing gear seems to be uncommon and it should be noted in the comments if spear fishing gear is found to differentiate it from other gear).
- 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, anchors, ropes, etc.

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. The 2013 fish data sheet will have these categories listed at the bottom of each transect section.

2011 Protocol Updates

This year we have implemented some updates to our protocol and datasheets which include both changes and clarifications. Please take the time to review these prior to coming out to your Re-certification. We will discuss and clarify any questions about the changes when we meet for the Re-cert. The updates are as follows:

All Transects

1. 10 meters or more of sand

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. As we have done in the past, 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 recently covered rocky reef habitat and you should continue your transect according to your heading.

2. Time guidelines

Fish transects are to be completed in 5-10min. Invertebrate and seaweed transects should be done with a 10 minute goal in mind, but there is no cut-off time. Due to the differences in complexity of the reef habitat and abundance of certain organisms transects might deviate from this goal. UPC has no time limit, but remember to write down start and end time.

3. Counting organisms in cracks

If your transect passes over a crack/crevice that is too small to swim into, count organisms in

the entire area of the crevice within the 2 meter width of the swath. If the transect is placed under a ledge that creates a ceiling above the diver do not count invertebrates on the ceiling.

Fish Transect

1. "Unknown Rockfish" and "YOY Rockfish" categories

In addition to all the species of rockfishes on our indicator organism list, RCCA also counts "young-of- the-year" (YOY) rockfishes, which are juveniles that are less than a year old. It is very difficult to identify YOY rockfishes to species when they are < 10 cm. As an RCCA certified diver you will count 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 in the "YOY Rockfish" category on your datasheet. Even if you have been trained to identify YOYs to species do not record them under the respective species but record them in the "YOY Rockfish" category on the datasheet. There is only one size category since YOYs are < 10 cm. It is not uncommon to see 100 or more YOYs on one transect during certain times of year (mainly the northern part of the state). It is important therefore to do your best to count ALL YOYs seen on transect (we DO NOT subsample any fishes) by coming up with a helpful technique, such as counting in groups of 5 or 10. We have removed the "unknown rockfish" category from the datasheet. If you encounter an individual (other than YOYs) that you cannot identify to species take notes on your datasheet and discuss these with the team after the dive.

*Note: In the past we have recorded juvenile blue rockfish separately from the others. We will not be doing that anymore and group all YOYs together.

2. Kelp greenling

We have added a juvenile category for kelp greenling to the datasheet. Individuals that are less than 20cm and cannot be clearly identified either as female or male (non-descript markings) should be recorded in this category.

Invertebrate Transect

1. Black abalones now treated like white abalones

Due to their endangered statuses, white and black abalones should be recorded if they are observed anywhere during the survey (on or off transect). As such, note that black abalone has now been moved to the bottom of the datasheet, where you can mark yes if you see one. If you believe you see a black or white abalone, do as much of the following as possible: confirm with your buddy; record whether or not it is on transect; take a photo including the respiratory holes, shell and mantel; and mark the location with a float so GPS coordinates can be taken from the surface.

2. Abalone sizing

As usual, divers will attempt to measure all abalone to the nearest cm. However, if a measurement is impossible, mark an "X" on your datasheet. This replaces the "-999" entry

we've done in the past.

UPC Transect

1. SUBSTRATE: Bedrock is now Reef

We are now calling our old “Bedrock” category “Reef” to eliminate the confusion between marking “B” or “R”.

B - Boulder (> 15 cm – 1m diameter)

R - Reef (> 1m diameter)

2. COVER: How to record algae

There are two categories for brown seaweed, Brown Seaweed (B) and Other Brown Seaweed (OB) on the UPC datasheet. 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 your UPC point falls upon ANY PART (blade, stipe, holdfast) of any color alga it should be recorded. This rule applies to all algae categories except Brown Seaweed (B), 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 gentile tug). If they are they will be recorded and if they are not they will not be recorded.

3. COVER: New categories

Mobile Invert (MI)- Invertebrates that can change location including urchins, sea cucumbers, sea stars, abalone, limpets, etc.

Sessile Invert (SI) - Invertebrates that cannot change location including sponges, tunicates, scallops, barnacles, sandcastle worms, anemones, etc.

Seagrass (SG) - Seagrasses, including surfgrass and eelgrass.

4. How to record sandcastle worms

Sandcastle worms are recorded in the cover category as sessile invertebrate (SI) no matter if they is growing in sand or on rock, or even if there is anything growing on the colony (e.g., algae).

2007 Protocol Updates

Fish Transects

There are no changes to the survey method; however, 2 new species of fish have been added.

The first species is the brown rockfish.

The Department of Fish and Game's "California's Living Marine Resources: A Status Report (2001) had this to say about this fish:

"Brown rockfish, (*Sebastes auriculatus*), commonly referred to as bolina by fishermen and markets, have long been an important component of the marine recreational fishery and a relatively minor but important component of the nearshore commercial fishery in California, especially north of Point Conception. While there have been studies of local abundance in certain coastal areas and within bays, the population size and structure of this species has not been comprehensively assessed. Evidence of stress on brown rockfish stocks in California exists, however, and some relative changes in the population have been identified. Commercial and recreational catches have steadily increased during the last 40 years, while the average length and weight of brown rockfish in landings have declined."

"The distinguishing characteristics of the brown rockfish are orange-brown or dark brown mottling, especially on the back, and a prominent dark brown blotch on the gill cover. Brown rockfish are typically found associated with sand-rock interfaces and rocky bottoms of artificial and natural reefs. In shallow waters, they may be found in small aggregations associated with rocky areas and kelp beds, whereas they stay near the rocky bottom when in deeper waters."

The brown rockfish was added to the Reef Check California species list because it is commonly targeted by both recreational and commercial fisherman as well as being a species of special concern due to the signs of stress evident in the population. This species can be confused with the grass rockfish, but can be distinguished by having a much lighter crème colored background and darker blotches as well as a clear dark brown blotch on the gill cover.

The second species is the China rockfish. The Department of Fish and Game's "California's Living Marine Resources: A Status Report (2001)" had this to say about this fish:

"China rockfish (*Sebastes nebulosus*), have been a minor component of recreational and commercial fisheries. The China rockfish is abundant into Washington, British Columbia, and southeastern Alaska, declining in abundance south into California. It is quite rare south of Point Conception, and seems to inhabit progressively deeper water in the southern part of its range."

©Jon Gross & Keith

The distinguishing characteristics of China rockfish include a dark to black body color covered completely with white to yellow speckles. The key identifying characteristic is a yellow stripe beginning on the front of the dorsal fin continuing down on to the body and extending back to the tail fin along the lateral line.

This fish was added because it is commonly observed as you move northward and easily identifiable.

Invertebrate transects

There are no substantive changes to the general survey method. However, we have added a few species to ensure we are getting a representative sample of the invertebrate community on California's rocky reefs and have changed the minimum size requirement for all gorgonians (sea fans).

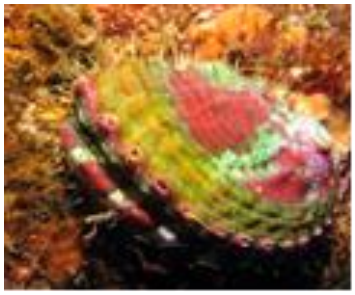
We have added two new abalone species. All abalone are species of interest and it was important to include more species as the program expanded north to include the more northerly distributed species.

Flat abalone - *Haliotis walallensis*

I. Sayer

The flat abalone is characterized by a more oval shaped oblong shell when compared to other species and is significantly flatter or lower in profile. The holes range from 4-8 and are raised off the shell. The color of the body is yellowish green mottled and the tentacles are yellowish green and light in color.

Pinto abalone – *Haliotis kamtschatkana*



The pinto abalone shell color is reddish with white and blue markings. They tend to be rather small and squat looking when compared to other species. The body color is mottled greenish tan or brown and the tentacles are greenish brown and can be rather bright in color.

C. Borowski

Masking carb – *Loxorhynchus crispatus*

M. Wehrenberg

We have added the masking crab to avoid surveyors having to spend time trying to differentiate it from the sheep crab. The body shape is the same as the sheep crab but generally will be smaller. The key characteristic is the shell will be covered with various growths of seaweed or other invertebrates that the masking crab uses for camouflage unlike the sheep crab whose shell is relatively growth free. Please note that the masking crab is combined with the sheep crab on your datasheet.

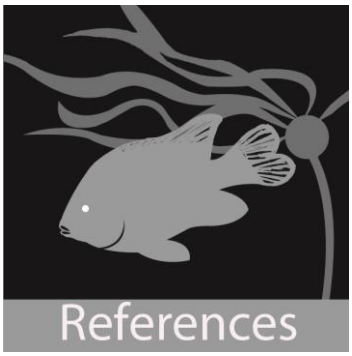
The last addition to the invertebrate species is the grouping “Large anemone”. This group includes a group of anemones that are all members of the Order Actanaria. We added this group because we did not have any truly sessile (non-mobile) species on our list and we thought that a sessile organism was important to include for long-term monitoring. You should count any anemone you see that is > 10 cm in diameter in this category. You should not count small < 10 cm colonial anemones in this category. Here are some examples of anemones that should be included:

D. Gotshall

J. Gross & K. Clements

D. Gotshall

We have made one additional change to the survey method for all gorgonians and switched the minimum size to count from 15 cm to 10 cm. This makes the minimum size to count consistent with the “Large anemone” group and should simplify things a bit.



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Appendix A. Liability Release

All participants must sign a copy of this form before taking part in any Reef Check activities.

I, _____, being over the age of eighteen (18) years, acknowledge that I have voluntarily applied to be a part of Reef Check's California Program. I acknowledge that Reef Check is a volunteer program. I recognize that I do not have to participate. I acknowledge that I have chosen to follow the Reef Check California survey methodology because it provides one suitable way of collecting scientific information, and not because it minimizes any of the risks of scuba diving.

I RECOGNIZE THAT SCUBA DIVING IS AN INHERENTLY RISKY ACTIVITY, AND I EXPRESSLY ASSUME ANY AND ALL RISK OF PROPERTY DAMAGE, INJURY OR DEATH ASSOCIATED WITH SCUBA DIVING IN ANY WAY AFFILIATED WITH REEF CHECK.

_____

(Initials)

I hereby voluntarily release, discharge, waive and relinquish any and all actions or causes of action for personal injuries, known or unknown, and injuries to property, real or personal, and wrongful death OCCURRING to me arising as a result of engaging or receiving instructions pertaining to Reef check against Gregor Hodgson, the Reef Check Foundation and all affiliates in any country, territory, or state, and any personnel associated with any of the above, including but not limited to employees, agents, independent contractors, team leaders and other volunteers. I absolve THE AFOREMENTIONED PARTIES OF any responsibility for my safety or any injuries or damages, which I may suffer during a reef check activity or in the process of following the Reef Check survey methodology or any deviation from it. where permitted to do so by applicable law, I further hold the aforementioned parties harmless for any and all negligent acts in any way related to Reef Check activities.

_____

(Initials)

I verify that I have been made aware of the risks inherent in scuba diving through participation in a diver certification course endorsed by _____ (agency). I further verify that am a qualified and certified scuba diver from the following training agencies _____ (agency), and that I hold training and certification to the level of _____ (state level), certification card number _____, certified date _____. I recognize that the ocean can be dangerous and that conditions may become more hazardous and dangerous during the time that I am participating in a diving excursion with the purpose of gathering data for Reef Check. I voluntarily assume any risks associated with diving in conditions or depths that exceed my training and/or skills.

_____

(Initials)

I release Reef Check from any liability for injuries resulting from risks and dangers inherent in the sport of scuba diving, whether foreseen or unforeseen. I further release Reef Check from any liability for injuries resulting from activities conducted in immediate preparation of scuba diving.

I agree that I, and only I, shall be responsible for my safety, and any injuries I may sustain.

_____

(Initials)

If any term, condition or portion of this agreement is held by a court of competent jurisdiction to be invalid, void or unenforceable, the remaining provisions of this agreement shall nevertheless remain valid and binding on signor.

I HAVE CAREFULLY READ THIS RELEASE AND FULLY UNDERSTAND ITS CONTENTS. I AM AWARE THAT THIS IS A RELEASE OF LIABILITY AND A CONTRACT BETWEEN ME AND REEF CHECK AND SIGN IT OF MY OWN FREE WILL.

Executed on _____, 20__ at _____[city, state/country]

_____[signature of obligee]

_____[printed name]

Appendix B. Datasheets

Site Description Form

Site Description Report

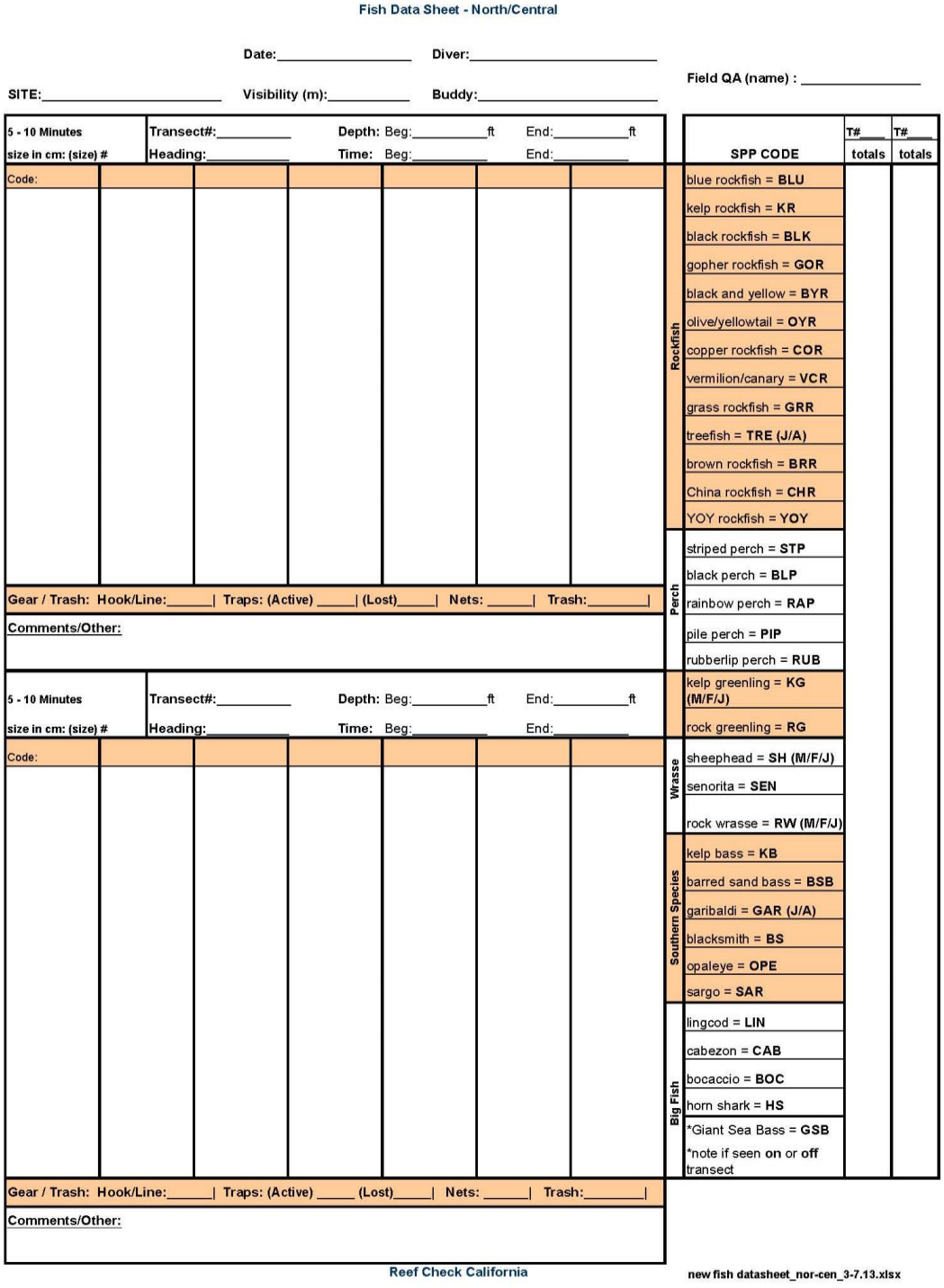
Site Information		Temperature in Celsius	
Site Name		Air	
City / Island		Surface	
County		5 Meters	
State	California	10 Meters	
Latitude (deg min.min)	North	Distance in Meters	
Longitude (deg min.min)	West	Distance from shore	
Dates format (mm/dd/yyyy)		Average Depth of Site	
Start Date		Permanent, Random	
End Date		Transect Type	
Sunny, Cloudy, Raining		Always Sheltered, Sometimes Sheltered, Exposed	
Weather		Site Exposure	
		Recent Storms	Yes / No

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-Central



Fish Data Sheet - North/Central

Date:_____ Diver:_____

SITE:_____ Visibility (m):_____ Buddy:_____ Field QA (name) : _____

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:

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:_____|

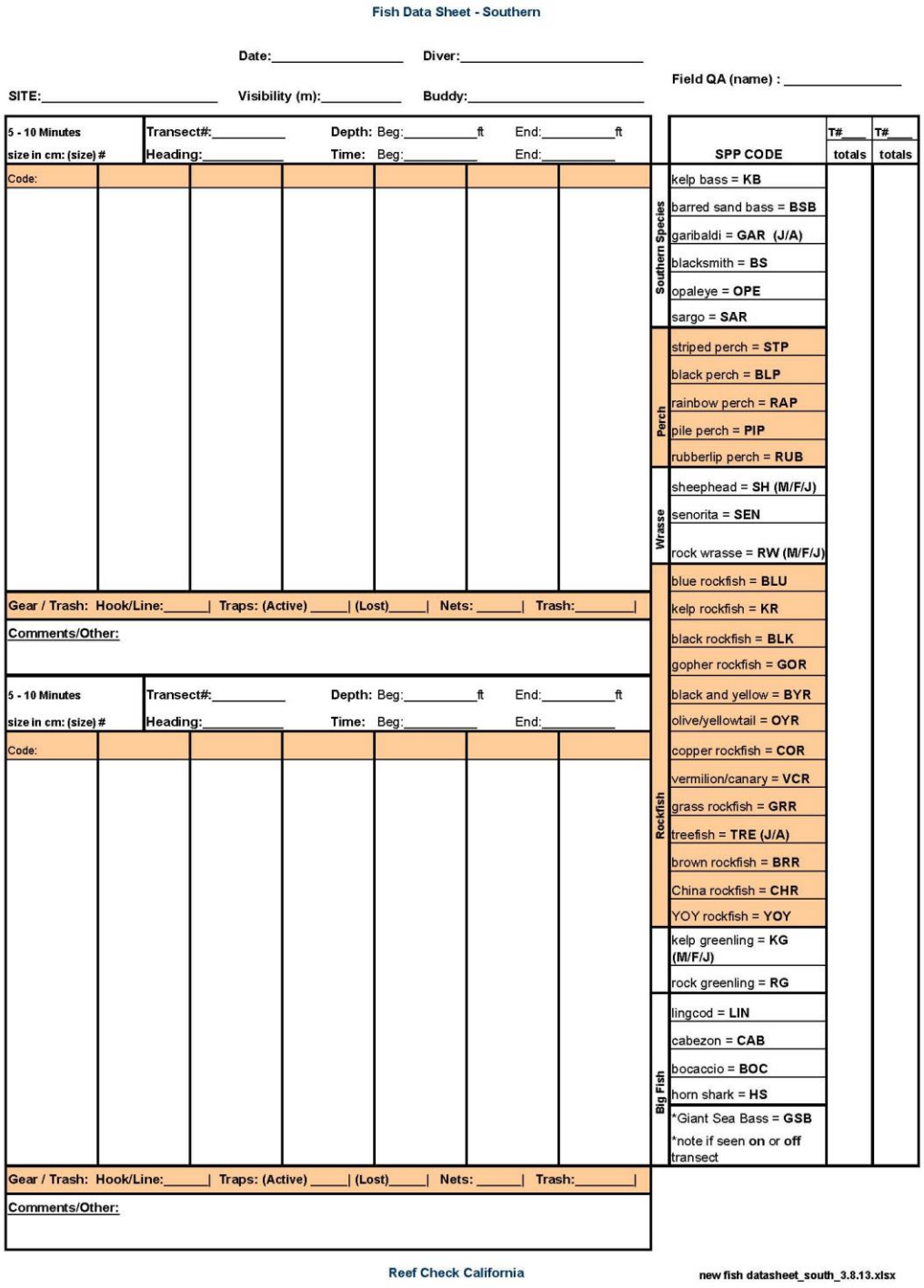
Comments/Other:

	SPP CODE	T#___ totals	T#___ totals
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**		
Perch	striped perch = **STP**		
	black perch = **BLP**		
	rainbow perch = **RAP**		
	pile perch = **PIP**		
	rubberlip perch = **RUB**		
Wrasse	kelp greenling = **KG (M/F/J)**		
	rock greenling = **RG**		
	sheephead = **SH (M/F/J)**		
	senorita = **SEN**		
	rock wrasse = **RW (M/F/J)**		
Southern Species	kelp bass = **KB**		
	barred sand bass = **BSB**		
	garibaldi = **GAR (J/A)**		
	blacksmith = **BS**		
	opaleye = **OPE**		
	sargo = **SAR**		
Big Fish	lingcod = **LIN**		
	cabezon = **CAB**		
	bocaccio = **BOC**		
	horn shark = **HS**		
	*Giant Sea Bass = **GSB**		
	*note if seen **on** or **off** transect		

Reef Check California

new fish datasheet_nor-cen_3-7.13.xlsx

Fish Datasheet-Southern



Fish Data Sheet - Southern

Date:_____ Diver:_____

SITE:_____ Visibility (m):_____ Buddy:_____ Field QA (name) : _____

5 - 10 Minutes size in cm: (size) #	Transect#:_____ Heading:_____	Depth: Beg:_____ft Time: Beg:_____	End:_____ft End:_____	SPP CODE	T#___ totals	T#___ totals
Code:				kelp bass = **KB**		
				barred sand bass = **BSB**		
				garibaldi = **GAR (J/A)**		
				blacksmith = **BS**		
				opaleye = **OPE**		
				sargo = **SAR**		
				striped perch = **STP**		
				black perch = **BLP**		
				rainbow perch = **RAP**		
				pile perch = **PIP**		
				rubberlip perch = **RUB**		
				sheephead = **SH (M/F/J)**		
				senorita = **SEN**		
				rock wrasse = **RW (M/F/J)**		
				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**		
				lingcod = **LIN**		
				cabezon = **CAB**		
				bocaccio = **BOC**		
				horn shark = **HS**		
				*Giant Sea Bass = **GSB** *note if seen **on** or **off** transect		

Southern Species | Perch | Wrasse | Rockfish | Big Fish

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

Comments/Other:

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

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 Datasheet

SITE _____ **Date** _____ **Diver:**_____

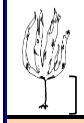
Visibility (m)_____ **Buddy:**_____

*Do not count seaweed used to attach transect

Invasives seen anywhere at site?

Sargassum muticum Yes____ No____ *Undaria* Yes____ No ____

Sargassum horneri 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				
Sargassum horneri  >30cm				
giant kelp (>1 m)  >1 m				

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

Comments:_____

Invertebrate/Seaweed Combo Datasheet

SITE _____ **Date:**_____ **Diver:**_____

Visibility (m):_____ **Buddy:**_____

	Count all orgs. > 2.5 cm **10 Minute goal** (30 x 2 m)	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		
	Black ab (Y/N)	White ab (Y/N)_____	
	Other/comments		

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

*Do not count seaweed used to attach transect

Sargassum muticum Yes____ No____

Sargassum horneri Yes____ No____

Undaria Yes____ No____

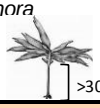
Caulerpa Yes____ No____

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

Site: _____ **Date:** _____ **Diver:**_____

Visibility:_____**m** **Buddy:**_____

Count all orgs. > 2.5 cm	Transect#:					
10 Minute goal (30 x 2 m	Time:	Beg:		End:		Dist
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						____
CA sea cucumber						____
warty sea cucumber						____
bat star						____
short spined sea star						____
giant spined star						____
sun/sunflower star						____
chestnut cowry						____
Kellet's whelk						____
wavy / red turban snail						____
giant keyhole limpet						____
rock crab						____
sheep/masking crab						____
gumboot chiton						____
rock scallop						____
large anemone (>10cm)						____
brown/golden (>10cm)						____
red gorgonian (>10 cm)						____
red urchin						
						____
purple urchin						
						____
crowned urchin						____
Black ab (Y/N):	White ab (Y/N):					

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

*Do not count seaweed used to attach transect

Sargassum muticum Yes____ No____

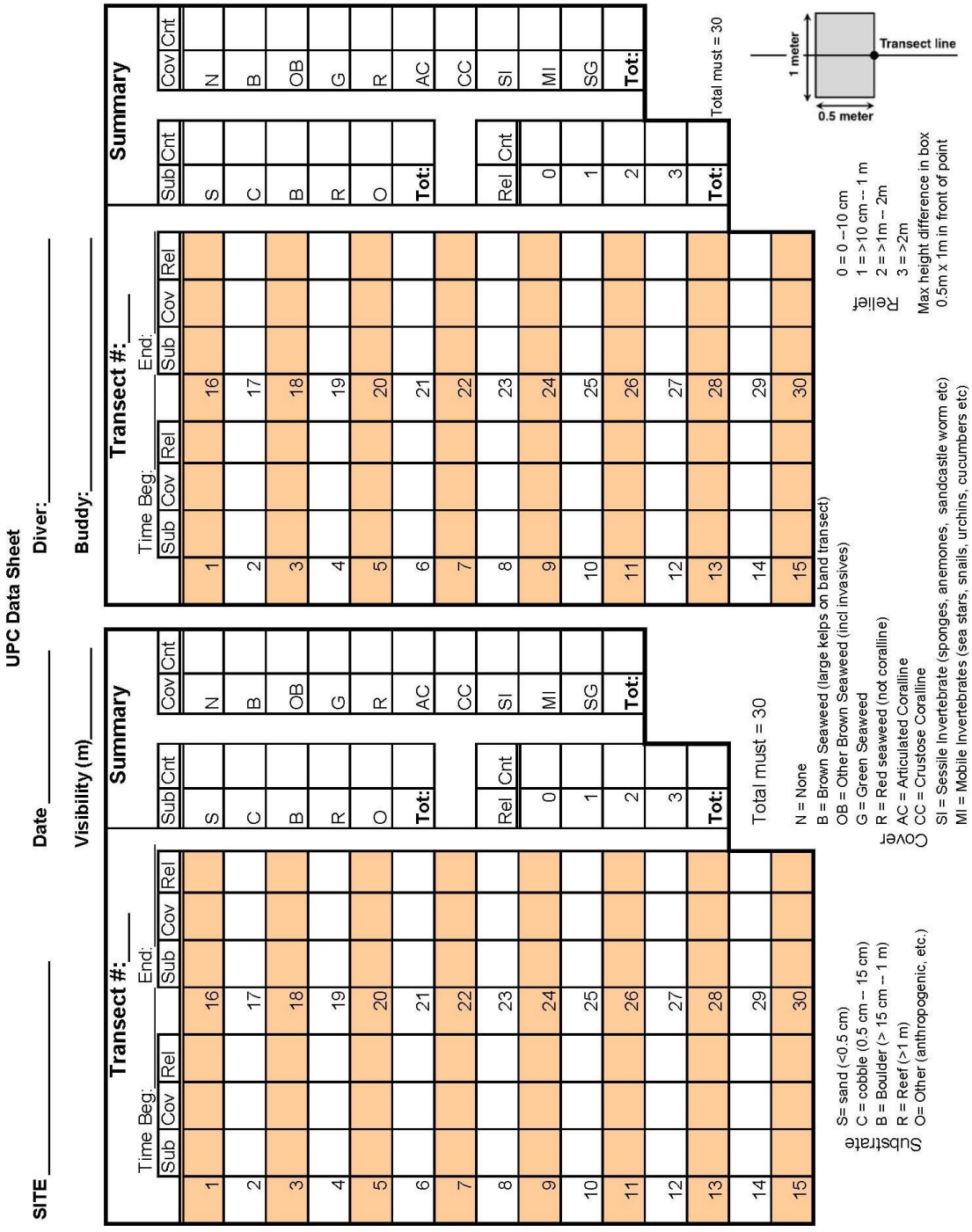
Sargassum horneri Yes____ No____

Undaria Yes____ No____

Caulerpa Yes____ No____

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

UPC Datasheet



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. Species

Invertebrates

Algae

Fish

NOTES