KELP FOREST MONITORING HANDBOOK
VOLUME 1: SAMPLING PROTOCOL

CHANNEL ISLANDS NATIONAL PARK

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The design of this ecological monitoring program wa supported by the National Park Service in cooperation with the California Department of Fish and Game and the U.S. Department of Commerce, National Oceanographic and Atmospheric Administration, Marine Sanctuary Program. More than **150** scientists and resource managers from many academic institutions and resource management agencies participated in this endeavor. Of particular note were the sustained efforts of J. M. Engle, M. D. Conlin, T. J. Herrlinger, T. W. Anderson, J. D. Lewis, D. C. Canestro, S. L. Kim, D. Forcucci, J. W. Trone. Their broad experience greatly strengthened the experimental design and resulting monitoring protocols.

INTRODUCTION

Kelp forests constitute one of the largest most complex, and most threatened ecosystems in Channel Islands National Park. Lying across the boundary of two major biogeographical provinces and near unusually persistent upwelling features, the park is endowed with marine ecosystems of exceptional diversity; the five park islands are surrounded by extensive kelp forest habitat and the high productivity supports large, diverse seabird and pinniped rookeries on the islands. As a result of these conditions and the relative isolation from mainland activities, kelp forests in the park are among the best examples of this important ecosystem in southern California.

The park boundary extends one nautical mile around each of the five islands, including the waters and submerged lands. The living marine resources in the park are managed by the State of California. The National Park Service, in cooperation with the State of California and the U. S. Department of Commerce, are charged with the responsibility of monitoring the health of park ecosystems and recommending actions to better protect those systems (16 USC 41Off Sec. 203).

The waters in Channel Islands Natioanl Park constitute less than 3% of California's coastal zone, yet produce about 15% of the State's coastal fishery harvests. In spite of closed seasons, individual size and bag limits, and restricted uses in some areas, there are virtually no limits on total harvest of fish, lobster, algae, and other marine organisms from park waters. With this direct harvest impact and the threat of chronic and acute pollution from mainland waste disposal and from adjacent offshore petroleum development, the potential for major anthropogenic disturbance of these ecosystems is great. Natural disturbance also appears to play an important role in this ecosystem, yet very little information on the long-term dynamics of the system are available. The cost of providing the information required to make wise decision regarding these resources is high, but the cost of losing them through ignorance is higher. Managing and conserving kelp forest requires innovative approaches and more ecological knowledge about them than currently exists.

In the 1990's, the state of California began using data collected by this program to assist California's abalone resource management strategies. Much of the data collected by this program aided in the States decision to close the pink, green and white abalone fisheries in 1996, and the red abalone fishery in southern California in 1997. Fisheries were closed to prevent brood stock extinction from harvest.

This handbook describes design considerations for a long-term population dynamics approach to monitoring kelp forest ecosystems and documents the protocol for monitoring kelp forests in the park. This is the second edition of the Kelp Forest Monitoring Handbook. Changes have been made following 15 years of operation and a formal review of the program in 1995 (Davis et. al., 1996). We discuss selection of index species and monitoring sites and present detailed instructions for data collection. Historical data collection techniques and changes in protocol are also described. Data management and daa entry proceedures are described in Volume 2 of this handbook.

MONITORING DESIGN CONSIDERATIONS

Species Selection

Specific kelp forest plants and animals were selected for monitoring from a list of nearly 1,000 species. The list was complied by Dr. John M. Engle of the Tatman Foundation. The list was derived from scientific literature and data collected during a series of Tatman Foundation supported cruises in the Channel Islands while Dr. Engle was working for the University of Southern California Catalina Marine Science Center. The primary objective in selecting taxa for monitoring was to provide a representative cross section of the ecological roles found in park kelp forests so that these taxa could serve as ecological "vital signs" of system health. To fulfill this objective, selected species needed to include representatives of all trophic levels, a variety of reproductive strategies, both sessile and mobile organisms, and variety of feeding stratigies.

Six criteria were used to select species from the list. Species were selected that were:

- specifically mentioned in the park's enabling legislation or protected by law (e.g. endangered)
- legally harvested
- exceptionally common or characteristic of entire communities
- alien to the park
- endemic to the park, or extremely limited in disitribution
- well known or "charismatic"

Using these criteria, 15 plant, 38 invertebrate, and 15 fish taxa were origianlly selected for long-term monitoring. Since its conception, the list of taxa has been modified through the process of statisitcal and peer review (Davis et. al, 1996). Some taxa have been removed from the list while others have been added. Changes to the original list of taxa have been minor to maintain consistancy of year to year data comparisons. There are currently 14 plant, 36 invertebrates, and 16 fish taxa monitored (Appendix A). The changes to the original list of taxa are discussed in Volume 3 of this handbook.

The monitored species are characteristic of kelp forests throughout the park and represent both boreal and temperate biogeographical provinces and species whose centers of abundance fall within the transition zone. Some species, such as giant kelp, *Macorcystis pyrifera*, and red sea urchins, *Strongylocentrotus franciscanus*, are ubiquitous in the park. Other species such as the California hydrocoral, *Stylaster (Allopora) californicus*, are found only at a few isolated sites. Some are extremly abundant like the purple sea urchin, *S. purpuratus*, whereas others like the giant-spined sea star, *Pisaster giganteus*, are wide spread in distribution but occur in low densities. Many of the selected species are long-lived, with life spans of 10 to more that 50 years, thus their abundance provides a stable measure of conditions in kelp forests that is relatively insulated from annual fluctuations. At the same time, annual recruitment and reproductive efforts of some populations provide measures of year-to-year fluctuations in conditiions that augment observations of short-lived species. For example, the abundance of the blue-banded goby, *Lythrypnus dalli*, depends heavily on local environmental conditions. The combination of organisms provides mechanisms for detecting both

short and long-term variations in kelp forests.

The monitored species also represent a wide array of trophic levels, from primary producers and obligate herbivores to high level predators and detritivores. In addition the organisms demonstrate feeding techniques ranging from sessile filter feeders and sedentary grazers to highly mobile planktivorous fishes and wide ranging benthic foragers. Reproductive strategies of these species run the gamut from live births seen in surf perches to precarious release of gametes into the sea by abalone and urchins, to the long-lived pelagic larvae of spiny lobsters, *Panulirus interruptus*. The selected array of species provides many opportunities to monitor the health of kelp forests and detect many facets of human impact, ranging from pollution to habitat disturbance and direct removal.

Site Selection

The waters of Channel Islands National Park harbor an ecologically diverse array of species assemblages. The park is located at the boundary of two major biogeographical provinces: the Oregonian province to the north and the Californian to the south. The western park islands, San Miguel and Santa Rosa, are bathed by northern waters carried south by the California current and therefore reflect the biological assemblages of the Oregonian province. Waters around the eastern park islands, Anacapa and Santa Barbara come from the south along the mainland coast and support the warm temperate biota characteristic of the Californian province. Around Santa Cruz Island, at the boundary of these two provinces, there is a broad transition zone where plants and animals from both provinces mingle and create a special assemblage of species that are capable of adapting to the unique and variable conditions of the transition zone.

Prevailing winds and the bathymetry of adjacent basins also greatly influence marine communities in the park. Strong north winds buffet the north sides of the islands, while the biota of the southern coasts reflect their more sheltered position. Upwelling nutrients from 2,000 meter-deep basins to the south and west of the park produce exceptionally productive food webs and temperature regimes that differ significantly from the shallow northern sides of the islands.

Sixteen sites (Figure 1) representing the north and south sides of each of the islands and the east-west transition from Californian to Oregonian provinces were selected for long term population monitoring. The sites reflect the broad range of conditions and biological assemblages in the park. Description of each of the 16 sites and their specific locations are found in Table 1.

Sampling Technique Selection

The array of organisms and physical settings associated with kelp forests in the park required equally diverse sampling approaches to monitor their population dynamics. Accuracy (the closeness of a measure value to its true value) an important attribute of a sampling technique, but precision (the closeness of repeated measurements of the same quantity) and ability to sample several target species at once must also be great to make a technique efficient for use underwater in a kelp forest. Accuracy and precision of sampling techniques used in long-term monitoring programs must also be

transmitted through many generations of observers without degradation. Finally, sampling techniques for this monitoring program must provide values relatively free of variation amoung observers and must not significantly reduce populations of organisms being monitored or allter their environment.

At this time, the technology for remote sensing or sampling of kelp forest organisms from the sea surface is neither accurate nor precise enough to monitor population dynamics of key species. Development of diving equipment has spawned an array of *in situ* sampling techniques that have potential for providing accurate and precise measures of population abundance, distribution, age structure, reproduction, recruitment, growth rate, mortality rate, sex composition, phenology of kelp forest organisms, and photgraphic equipment that yeilds permanent records.

In January, 1982, a workshop to review potential sampling techniques was held at the Marine Science Institute, University of California at Santa Barbara. Thirty-seven scientists participated in the two-day workshop. Sampling techniques for kelp forest organisms were evaluated using the following criteria:

- ability to sample target species accurately and precisely
- impacts on target and other species
- efficiency (cost effectiveness)
- ability to create permanent records of samples for confirmation and future analysis
- requirements for highly trained observers or extremely complex procedures or equipment

Permanent 100-meter transects were established at the 16 locations. Permanent transects were used to reduce within site variability and provide precise measurements of population dynamics where the major variable is time. Each transect of 12-mm diameter lead-filled woven nylon line was permanently affixed to the seabed with 11 stainless steel eyebolts, a detailed description on transect installation is found in Appendix B. Transects are relocated with Loran-C ,GPS, and Radar distance references. The transects provide a reference for divers and for sample plot orientation which facilitiates data collection during the limited bottom time available to divers.

Revisions of the original sampling techniques have been implemented prior to and following a review workshop held in 1995 (Davis et.al., 1996). The most current sampling techniques used are described this volume. Protocols that have changed or have been replaced are discussed in Volume 3 of this handbook.

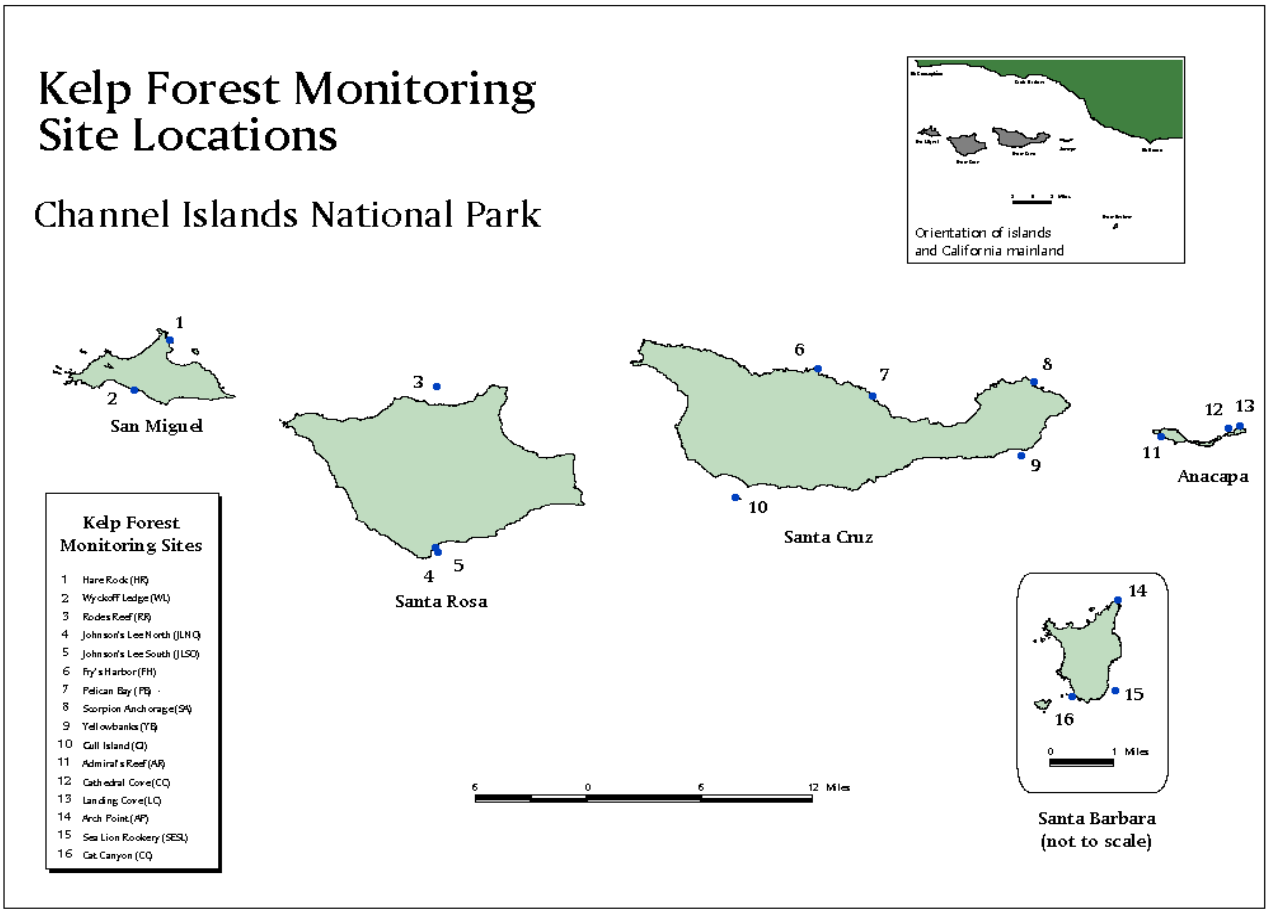


Figure 1. Channel Islands National Park Kelp Forest Monitoring Sites.

Table 1. Description of Kelp Forest Monitoring Sites

ISLAND	LOCATION	CODE NAME	SITE No.	DATE ESTAB.	LATITUDE/ LONGITUDE	LORAN C (TD1/TD2)	DEPTH (m)
San Miguel	Wyckoff Ledge	SM-WL	1	1981	34°00.91' N 120°23.31' W	27866.0 416440.0	14 - 16
San Miguel	Hare Rock	SM-HR	2	1981	34°02.84' N 120°21.45' W	27871.9 41643.5	6 - 10
Santa Rosa	Johnson's Lee North	SR-JLN	3	1981	33°53.61' N 120°06.36' W	27911.4 41543.7	8 - 12
Santa Rosa	Johnson's Lee South	SR-JLS	4	1981	33°53.35' N 120°06.22' W	27911.7 41542.3	15 - 18
Santa Rosa	Rodes Reef	SR-RR	5	1983	34°01.38' N 120°06.66' W	27913.3 41576.9	15 - 18
Santa Cruz	Gull Island South	SC-GI	6	1981	33°56.66' N 119°49.57' W	25957.6 41488.5	15 - 18
Santa Cruz	Fry's Harbor	SC-FH	7	1981	34°03.09' N 119°45.14' W	27972.9 41496.5	13 - 14
Santa Cruz	Pelican Bay	SC-PB	8	1981	34°01.67' N 119°42.24' W	27980.9 41477.8	6 - 9
Santa Cruz	Scorpion Anchorage	SC-SA	9	1981	34°02.77' N 119°32.81' W	28006.8 41442.3	4 - 8
Santa Cruz	Yellow Banks	SC-YB	10	1986	33°59.00' N 119°33.81' W	28002.8 41431.0	15 - 16
Anacapa	Admiral's Reef	AN-AR	11	1981	34°00.33' N 119°25.86' W	28024.4 41402.2	14 - 16
Anacapa	Cathedral Cove	AN-CC	12	1981	34°00.71' N 119°22.29' W	28035.0 41387.5	6 - 11
Anacapa	Landing Cove	AN-LC	13	1981	34°00.70' N 119°21.71' W	28036.8 41383.9	5 - 13
Santa Barbara	SE Sea Lion Rookery	SB-SESL	14	1981	33°27.45' N 119°01.52' W	28066.1 41177.2	13 - 15
Santa Barbara	Arch Point	SB-AP	15	1981	33°28.65' N 119°01.73' W	28067.2 41181.3	7 - 9
Santa Barbara	Cat Canyon	SB-CAT	16	1986	33°27.24' N 119°02.47' W	28064.4 41180.2	7 - 9

TRANSECT BEARING	ARTIFICIAL RECRUITMENT MODULE LOCATION	HYDROTHERMOGRAPH LOCATION
(SM-WL) 090-270°	none	0 m mark on east end; depth 14 m
(SM-HR) 090-270°	none	from 10 m mark, 8.4 m 315°, and from from 20 m mark, 7.8 m 345°; depth 5m
(SR-JLNO) 030-210°	13 ARMs; all ARMs ~5m north of transect line: 4 at 10 m mark, 4 at 40m mark, and 4 at 90m mark	0 m mark on northeast end; depth 11m
(SR-JLSO) 020-200°	7 ARMs; 4 ARMs ~12 m east of transect line at 60m mark, 3 ARMs ~12 m east at 70m	100 m mark on northeast end; depth 16m
(SR-RR) 090-270°	none	100 m mark on nest end; depth 13m
(SC-GI) 000-180°	15 ARMs; 5 ARMs ~10m E of transect @ 20m mark; 5 ARMs ~10m W of transect @ 60m mark, 5 ARMs ~5m W of transect @ 80m mark	20m from N end, 4m west of transect; depth 16m
(SC-FH) 020-200°	7 ARMs; all ARMs ~3-10m west of transect line at 70m mark	0 m mark at north end; depth 13m
(SC-PB) 020-200°	6 ARMs; all ARMs ~10 m northwest of the 0/north end of the transect	~5 m west of the 5 m mark; depth 8m
(SC-SA) 090-270°	7 ARMs; all ARMs ~ 10-15 m north of transect line at the 100 m mark	0 m mark at east end; depth 7m
(SC-YB) 090-270°	20 ARMs; 5 ARMs ~5m north of 0 m mark, 5 ARMs ~8 mnorth of 45m mark, 5 ARMs at the 100 m mark, and 5 ARMs ~25m east of 0m mark	0 m mark at east end; depth 15m
(AN-AR) 150-330°	7 ARMs; all ARMs ~20m southwest of the 30m mark	0 m mark at southeast end; depth 14m
(AN-CC) 120-300°	7 ARMs; all ARMs 5-8m northeast of 0 m mark	100m mark at southeast end; depth 6m
(AN-LC) 040- 220°	7 ARMs, all ARMs ~8m north of 45m mark	2 m west from 0 m mark; depth 5m
(SB-SESL) 000-180°	none	0 m mark on north end; depth 12m
(SB-AP) 010-190°	none	~15 m from south/100 m end, ~4m east of transect; depth 7 m
(SB-CAT) 090-270°	none	0 m mark at east end; depth 7 m

SAMPLING METHOD PROTOCOL

General Information

Twelve sampling techniques (Table 2) are used to gather information on population dynamics of selected kelp forest monitoring organisms. Information is gathered annually during the summer, between June and October, at fixed transects (Table 1). The monitored species and their species codes are found in Appendix A. The species list for all Chanel Islands National Park stations is found in Appendix C. Logistic considerations for the monitoring cruises, as well as suggestions for scheduling and acquisition of necessary supplies are discussed in Appendix D.

Table 2. Summary of sampling techniques used to monitor population dynamics of selected kelp forest organisms.

TECHNIQUE	AREA or TIME SAMPLED	NO. of REPLICATES
1m Quadrat	1 x 2 m	12 per site
5m Quadrat	1 x 5 m	40 per site
Band transect	3 x 20 m	12 per site
Random point contact	40 points (0.5 x 3 m)	15 per site
Visual fish transect	2(w) x 3(h) x 50(l) m; 2.5 minutes	8 per site
Roving Diver Fish Count	30 minutes	4 - 8 per site
Video transects	100 m; 5 minutes	2 per site
Video photogrammetric plots	360^0 pan of bottom 360^0 pan of water column	3 per site (0m, 50m, 100m marks along transect)
Size frequency	individual	30 to 200 per species
Artificial Recruitment Modules	module	7 - 20 per site
Species checklist	30 - 90 minutes	1 per site
Temperature	hourly	all sites

1m Quadrats

Purpose

To determine the abundance (density) of selected sedentary indicator species.

Materials

2 underwater clipboards
2 underwater quadrat data sheets (Appendix E)
4 3-sided PVC meter square quadrats

Personnel

2 SCUBA equipped observers

Methods

Each diver will sample twelve points along the transect line. Each year different points are sampled along the transect line, therefore, new sampling points must be selected. Prior to entering the water, the initial sampling point (a number between 0-8) is randomly selected using a computer or another random method. The subsequent sampling points are at 8m intervals. Sampling is therefore systematic with a randomized starting point. The sampling points are recorded on the top of the data sheets.

Each diver is equipped with two three-sided meter square quadrats. The divers should work on opposite sides (A and B) of the transect line using the line as the fourth side to the quadrat. Position the quadrat so that one leg is on the predetermined sampling point and place the other leg on the next greater meter number (Figure 2). The divers should place one quadrat down on the first meter mark (meter #5 in the figure below) listed on the data sheet and then proceed down the transect line to the next meter number (meter #9 in the figure below) on the data sheet and position the other quadrat in a similar manner. The divers then return to the first pair (A_1 and B_1) of quadrats placed along the transect line. Divers may cause island kelp fish and gobies to retreat into crevices, therefore approach the quadrats slowly to minimize disturbance. Count fish first within the quadrat. Once they are counted, do not count additional fish that swim into the quadrat. Be sure to search under ledges and in cracks for organisms. Sometimes it is necessary to clean off the pebbles and shells that hide

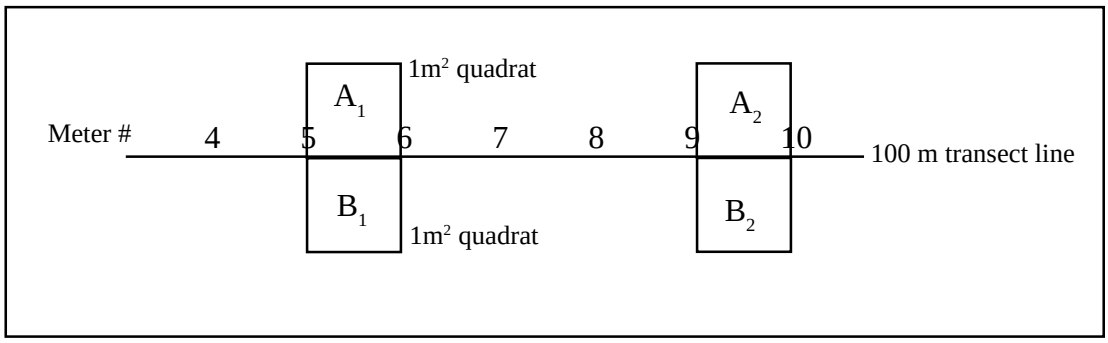


Figure 2. Placement of two 1 m^2 quadrats on transect line at meter mark 5 and 9.

organisms in order to identify them, however, do not conduct any invasive sampling (i.e. do not turn over rocks and do not remove organisms). Combine adults and juveniles for all species, except the algae. Record juveniles and adult algae separately. See the "Organisms sampled" section below for the definitions of adult/juvenile algae.

After the first set of quadrat counts are completed, move the PVC quadrat to the third meter number listed on the data sheet. Swim carefully around the other set of quadrats, keeping at least one meter to the outside of the quadrats. After positioning the third set of quadrats, return to the second set (A_2 and B_2 in the figure above) and begin by counting the fishes. Repeat this cycle until each diver has sampled all twelve 1m x 1m quadrats.

After returning to the surface, check the two quadrat sheets for readability and outliers. Rinse the data sheets, allow them to air dry and store them in the completed data sheet notebook. The raw data sheets will be used for data entry.

Time Required

Approximately 120 minutes of bottom time are needed. Experienced biologists in an area of low species diversity and/or abundance will take less time.

Organisms Sampled

Fishes	
Lythrypnus dalli	bluebanded goby
Coryphopterus nicholsii	blackeye goby
Alloclinus holderi	island kelp fish
Algae	
Macrocystis pyrifera	giant kelp (juveniles)
Macrocystis pyrifera	giant kelp (adults > 1m)
Laminaria farlowii	oar weed (juveniles)
Laminaria farlowii	oar weed (adults = over 10 cm wide)
Eisenia arborea	southern sea palm (juvenile = single blade)
Eisenia arborea	southern sea palm (adult)
Pterygophora californica	California sea palm (juvenile = single blade)
Pterygophora californica	California sea palm (adult)
Invertebrates	
Lithopoma (Astraea) gibberosum	red top snail
Lithopoma (Astraea) undosum	wavy top snail
Centrostephanus coronatus	coronado urchin
Cypraea spadicea	chestnut cowrie
Lytechinus anamesus	white sea urchin
Strongylocentrotus franciscanus	red sea urchin
Strongylocentrotus purpuratus	purple sea urchin
Asterina (Patiria) miniata	bat star
Pisaster giganteus	giant spined sea star
Parastichopus parvimensis	warty sea cucumber
Styela montereyensis	stalked tunicate

5 m Quadrats

Purpose

To determine the abundance of selected rare, clumped, sedentary indicator species.

Materials

2 underwater clipboards with pencils
2 underwater 5m quadrat sheets (Appendix E)
2 1m metal meter sticks

Personnel

2 SCUBA equipped observers

Methods

The 100m transect is divided into 20 quadrats 5m in length and 1m wide. The first quadrat is 0-5m, the second quadrat is 5-10m, etc. (Figure 3). Each diver samples opposite sides of the transect resulting in 40 quadrats overall.

Set up the data sheets for each diver indicating the sequential meter intervals. Starting at the zero end of the transect line, each diver swims along opposite sides of the transect line recording the number of all species indicated on the data sheet into the corresponding quadrat. Use the metal 1m sticks to determine the width of each quadrat. The 5m length of each quadrat is marked with red electrical tape on the transect line.

Time Required

Approximately 35 minutes

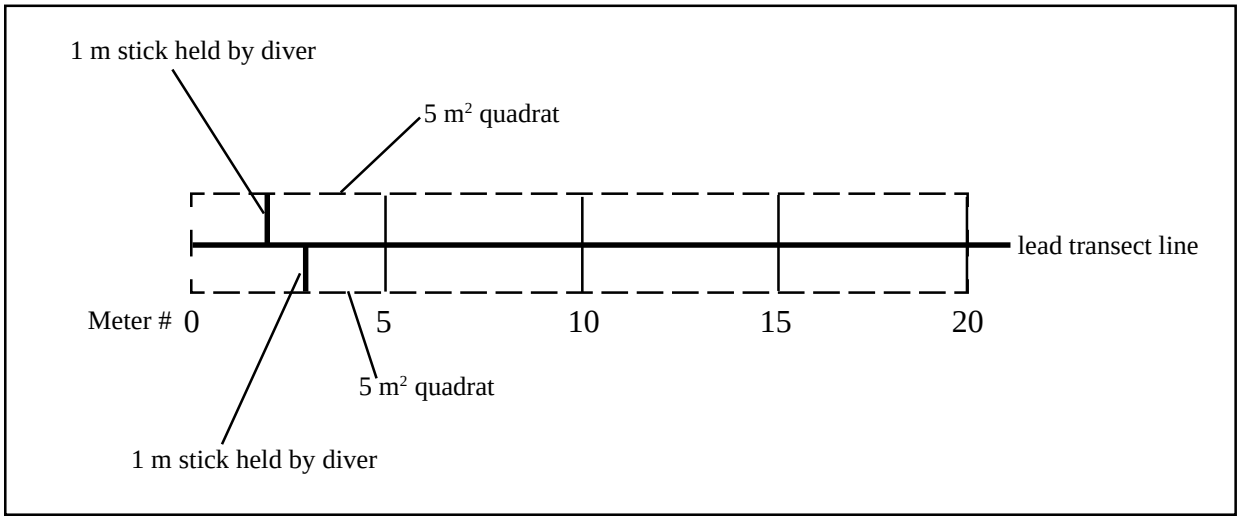


Figure 3. Layout of the 5 m^2 quadrats along the lead line.

Organisms Sampled

Algae

Macrocystis pyrifera	giant kelp
subadult	> 1m tall and no haptera above primary dichotomy (Figure 4)
adult	> 1m tall and haptera above primary dichotomy (Figure 4)

Invertebrates

Pisaster giganteus	giant spined sea star

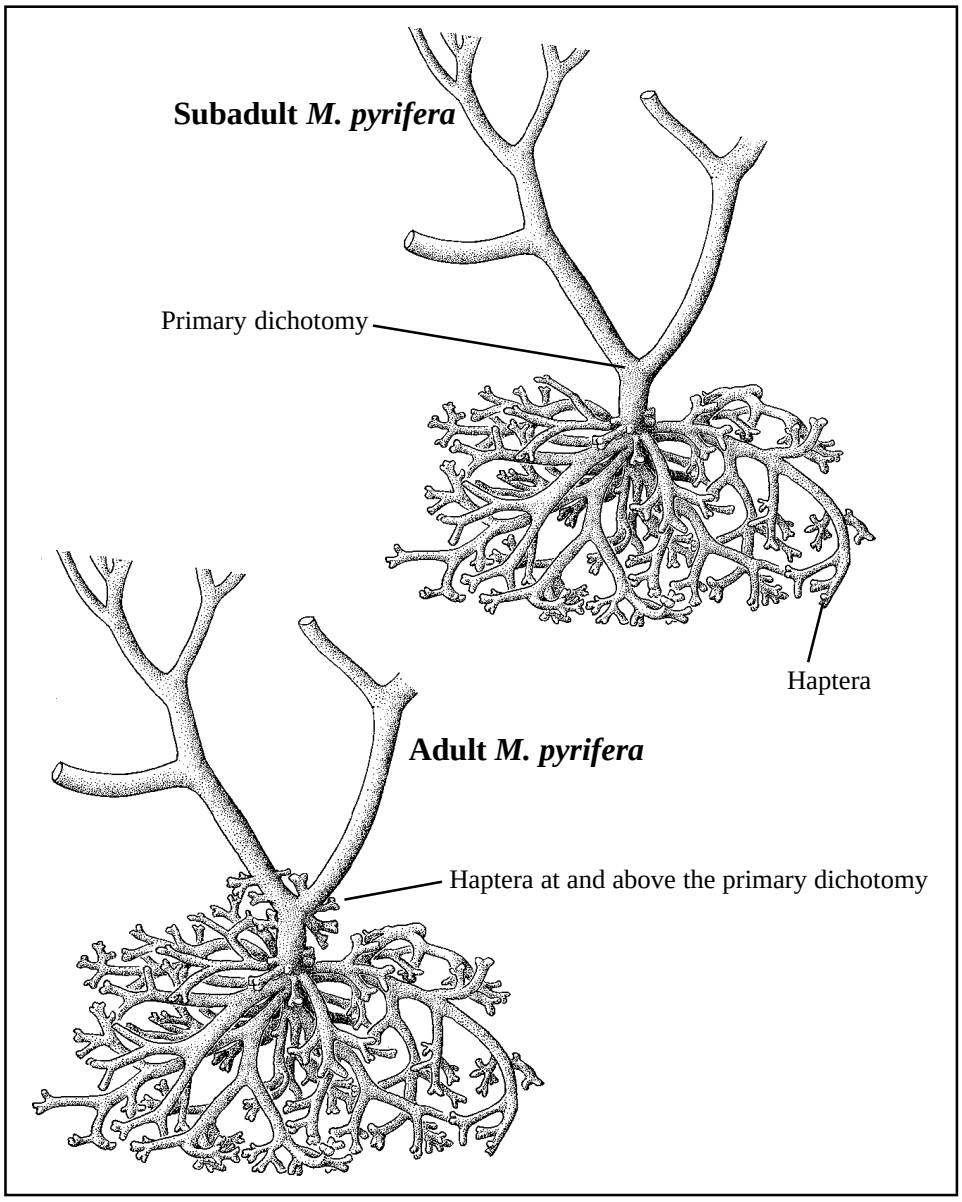


Figure 4. Subadult and adult *Macrocystis pyrifera* distinguished by haptera growth near the primary dichotomy.

Band Transects

Purpose

To determine abundance and distribution of rare and clumped organisms not adequately sampled by quadrats.

Materials

2 underwater clipboards
2 1.5-m PVC rods
2 mall meter tapes (30 m)
2 underwater band transect data sheets (Appendix E)

Personnel

2 SCUBA equipped observers

Methods

Each diver will sample twelve points along the transect line. Each year different points are sampled along the transect line, therefore, new sampling points must be selected. Prior to entering the water, the initial sampling point (a number between 0-8) is randomly selected using a computer or another random method. The subsequent sampling points are at 8m intervals. Sampling is therefore systematic with a randomized starting point. Record the sampling points on top of the data sheets.

At each sampling point along the transect line, a meter tape is attached to the transect line with a carabiner. The divers swim out 10 m in opposite directions perpendicular to the 100m transect line (Figure 5). Secure the tape reels and swim toward the 100m transect line along one side of the 10m tape. Use the 1.5m PVC stick to determine the width of the transect and count the organisms listed on the data sheet that occur within 1.5 m of the tape. Once the lead-line is reached, work back to the reel along the opposite side of the tape, again, counting target organisms within 1.5 m of the tape. Once the reel is reached, wind the tape up and move to the next randomly selected meter number along the 100 transect line.

Be sure to search the habitat thoroughly, including cracks, and crevices. However, do not conduct any invasive sampling (i.e. do not turn over rocks).

After returning to the surface, check the two quadrat sheets for readability and outliers. Rinse the data sheets, allow them to air dry and store them in the completed data sheet notebook. The raw data sheets will for data entry.

On each transect, each diver covers an area of 3 m x 10 m. Add adjacent segments (Count A and Count B) from both divers together to produce a sampled area of 3 m x 20 m at each of the 12 points.

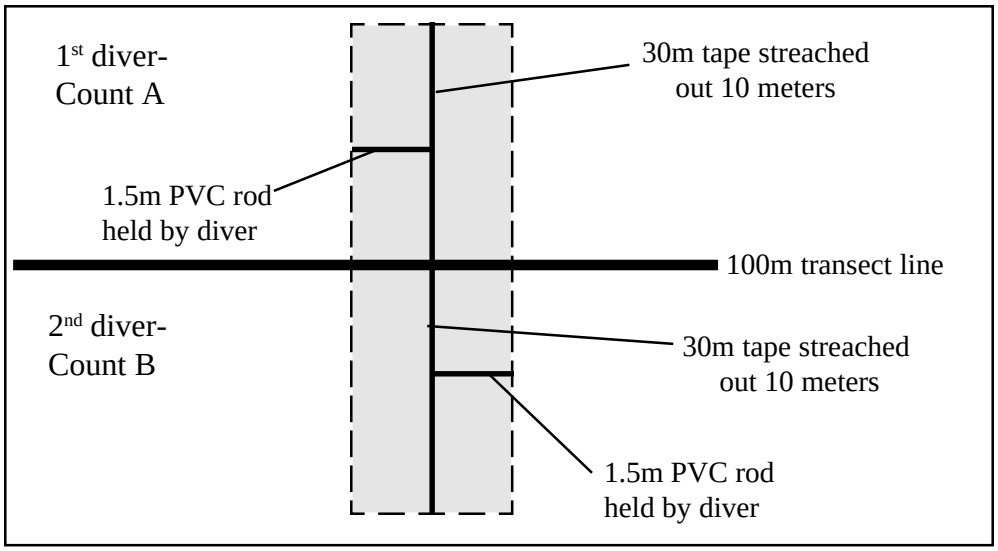


Figure 5. Band transect sampling procedure. Shaded portion is the area sampled.

Time Required

Typically 120 to 150 minutes is required for sampling, a minimum of 100 minutes for experienced biologists. Sampling time is decreased for flat, low relief habitats. Sampling time will increase at high relief, high cover areas. In addition, areas with large densities of the white sea urchin, *Lytechinus anamesus*, will significantly slow sampling, and may be best sampled using quadrats at the discretion of the chief scientist on each cruise.

Organisms Sampled

Tethya aurantia	orange puffball sponge
Stylaster (Allopora) californicus	California hydrocoral
Urticina (Tealia) lofotensis	white-spotted rose anemone
Lophogorgia chilensis	red gorgonian
Muricea fruticosa	brown gorgonian
Muricea californica	California golden gorgonian
Megathura crenulata	giant keyhole limpet
Haliotis rufescens	red abalone
Haliotis corrugata	pink abalone
Haliotis fulgens	green abalone
Kelletia kelletii	Kellet's whelk
Crassedoma (Hinnites) giganteum	rock scallop
Lytechinus anamesus	white sea urchin
Pycnopodia helianthoides	sunflower sea star
Aplysia californica	California brown sea hare
Panulirus interruptus	California spiny lobster

Random Point Contacts

Purpose

To estimate substrate composition and percent cover of selected algal and invertebrate taxa.

Materials

1 random point contact (RPC) bar: a 1.5 m PVC rod filled with rebar with two strings, each string with 5 knots. One string is 1.8 m long, the other 1.2 m long. The long string is attached to the end of the bar, the short string is attached 25 cm before each end. Knots are at least 20 cm apart.
1 set of RPC data sheets (Appendix E)
1 clipboard and pencil with eraser
1 underwater species list reference card
1 set surface supplied diving equipment: Diver Control System(DCS), Exo 26 mask, and umbilical

Personnel

1 console operator/data recorder
1 line tender and backup diver (as appropriate based on surface supplied dive regulations)
1 diver

Methods

Each year different points are sampled along the transect line, therefore, new sampling points must be selected. Prior to entering the water, the initial sampling point (a number between 0-7) is randomly selected using a computer or another random method. If the random number picked is less than 3, the subsequent sampling points are at 7 m intervals, and if the number picked is greater than 2, the subsequent sampling points are at 6 m intervals. Sampling is therefore systematic with a randomized starting point. The sampling points are recorded consecutively on the top of the data sheets for efficiency. Numbers indicate the position along the transect line that observations are made.

Console operator/recorder:

Once the diver is in the water, the console operator/recorder is responsible for telling the diver the random points along the line where observations will be made. When the diver has arrived at the designated random meter mark, measure the depth with the pneumofathometer on the Diver Control System (DCS) and record this on the data sheet.

As the diver names the organisms and substrate under each point record these on the data sheet. The number of substrate tallies can be used to double check for missed points. Each random point along the line has 4 columns on the data sheet (Appendix E). Each column corresponds to the observations taken for two strings on one side of the RPC bar (Figure 6). Therefore, each column should have ten substrate tallies, and each point along the line should have forty substrate tallies.

Monitor the diver's air pressure and change scuba cylinders when appropriate. Tanks should be changed at a PSI of 500. It is important for both the tender and the diver to be aware of the divers depth and bottom time (especially at deeper sites), so periodically ask the diver look at their com-

puter.

Line Tender:

The line tender will aid in coiling and uncoiling the umbilical so that the diver is able reach the random points. The tender will also assist in helping to change tanks and record data if need be.

Diver:

Carry the RPC bar and underwater species-list reference card. Locate the transect line, and proceed to the first random point on zero end of the line.

Place the RPC bar perpendicular to the transect line (Figure 6), hold it in place, and stretch the string taut at each knot perpendicular to the RPC bar. Visualize an imaginary line running vertically through the knot up to one meter above the substratum. Relate to the console operator/recorder the organisms that intersect this imaginary line. Try to call the organisms in the same order as they are listed on the underwater species list, this matches the way the data sheet is organized and facilitates data recording. Other attached or sessile animals providing cover are recorded as "miscellaneous invertebrates." Do not count motile invertebrates (except for brittle stars), but move them to determine what is underneath.

Proceed calling all organisms under the knots on both strings on one side of the bar; then move the string and do the same on the opposite side of the bar. Next, place the RPC bar on the opposite side of the transect line and repeat the process (Figure 6). As you move, communicate with the console operator with comments like: "other side of the bar" or "next ten" and "other side of the transect" when appropriate. These phrases will assist the console operator and ensure that the proper number of points are scored and recorded in their respective place on the data sheet.

Always name the type substrate, where: "sand" is sediment that one can push a finger into without hitting rock, "cobble" is rock easily moved by a diver, and "rock" is immovable substrate. "Bare" is used when the substrate is devoid of any apparent living organisms and can be used in combination with any substrate type.

It is important to keep track of your depth and bottom time so be sure to monitor your computer as you dive.

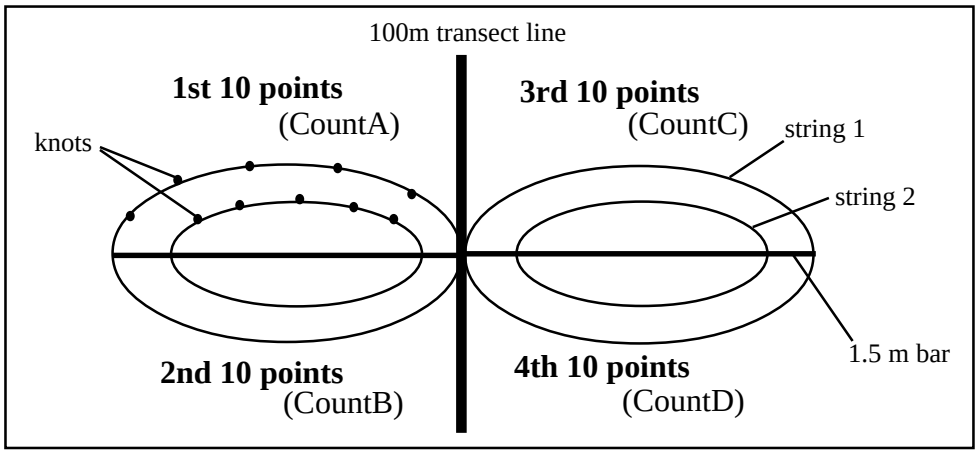


Figure 6. Orientation of the random point contact bar and strings (with knots) during sampling.

Additional information on this technique can be found in Carter et al. (1978), Goodall (1952), Johnston (1957), Kemp (1956), and Winkworth (1955).

Time Required

Five to fifteen minutes are required for each random point along the line (75-225 minutes total). Familiarity with the organism list, a console operator/recorder who is adept at scoring data sheets, and areas with few canopy species will decrease bottom time. Heavy surge, dense canopy, and deep sites increase bottom time and/or the number of dives necessary to complete a site.

Organisms Sampled

Plants	
green algae	
other brown algae	
Desmarestia spp.	acid weed
Cystoseira spp.	bladder chain kelp
Macrocystis pyrifera	giant kelp
Eisenia arborea	southern sea palm
Pterygophora californica	California sea palm
Laminaria farlowii	oar weed
other red algae	
articulated coralline algae	
encrusting coralline algae	
Gelidium spp.	agar weed
Gigartina spp.	sea tongue
miscellaneous plants	e.g. diatoms, *Phyllospadix*, etc.
Animals	
Astrangia lajollaensis	La Jolla cup coral
Balanophyllia elegans	orange cup coral
Diopatra ornata	ornate tube worm
Phragmatopoma californica	colonial sand-tube worm
Serpulorbis squamigerus	scaled tube snail
Corynactis californica	strawberry anemone
Diaporecia californica	southern staghorn bryozoan
Pachythyone rubra	
other bryozoans	
tunicates	
sponges	
miscellaneous invertebrates	
Bare	No cover; devoid of living organisms
Substrates	
rock	difficult to impossible to move
cobble	easily moved by a diver
sand	sediment that one can push their finger through without hitting rock

Visual Fish Transects

Purpose

To determine the abundance of selected fish species along the 100 m transect line.

Materials

2 underwater clipboards with watches (other timing device may be substituted)
1 or 2 (depending if the other diver is counting fish or conducting the video transects) "Fish All" underwater visual fish survey data sheet (Appendix E).
1 30-m tape with secchi disk
1 surge meter

Personnel

2 SCUBA equipped observers

Methods

Each diver swims at a uniform speed of 20 m per minute on one side of the 100-m transect line counting and recording all the indicator fish species 3 m above the meter tape/lead line and 2 m on one side of the line for half (50 m) of the transect for each of the four transects (Figure 7). Each diver will have a "Fish All" underwater data sheet unless one of the divers is conducting video transects. The divers will count fish in the same transect (same side of the line) during each of the four transects. Counts are differentiated by species and by age class (adults or juveniles, with juveniles usually defined as less than 10 cm in length). After the first transect is completed, check the time to see if you are swimming a pace of 2.5 minutes/50 meter transect. If not, adjust your swimming speed appropriately. After each two transects (100 m), the divers should swim about 5 m past the end of the line and then turn around to begin the next count. This procedure allows the fish (sometimes numerous) that follow the divers to diffuse off of the transect. Immediately following the dive, on the surface,

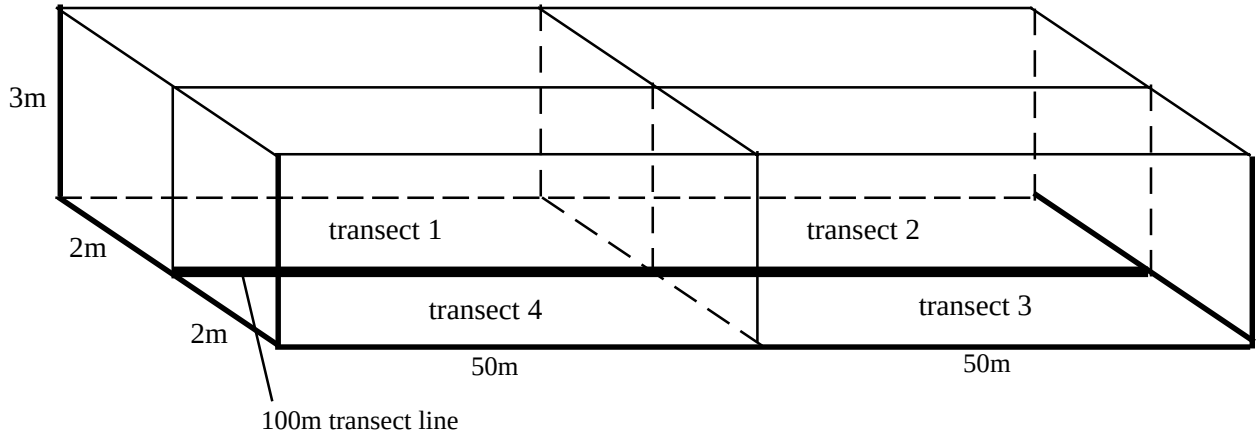


Figure 7. Area covered for visual fish counts.

observers should check data sheets to be sure all numbers are legible and totals for each species are accurate.

After the four fish transects have been completed, visibility and surge are measured. Visibility is measured horizontally near the bottom with a 20 cm secchi disk. The secchi disk is always oriented to face the sun, i.e. to the east in the morning and to the west in the afternoon. One diver holds the secchi disk in place, while the other diver with the measuring tape swims away (towards the sun) from the secchi disk. When the secchi disk disappears, the diver with the reel stops, notes the distance and then begins to rewind the tape noting the distance the secchi disc reappears. Visibility is recorded as the mean of the two distances. Surge is measured with a diver-held surge meter (Barlotti, 1980; Foster et al., 1985) and is recorded as the maximum degrees of movement of a cork on a 30 cm-long string that is attached to a protractor and placed parallel to the surge direction.

Fish transect are conducted two times per summer at each site, with a minimun of two weeks between sampling.

Training Required

New divers conducting fish transects must be trained. Training entails conducting fish transects as described above and comparing the datasheets at the end of the dive (remember, trainer and trainee are counting fish on the same side of the transect). When the project leader is confident the new observer is counting fish as accurately as possible within the defined transects, then and only then will the new observers data be included in the database. This training may take several dives or an entire summer depending on the experience of the diver in training. It is possible that some divers may not be qualified to conduct this protocol.

Time Required

15-20 minutes are required for fish transects.

Organisms Sampled

Adults and juveniles are sampled for all species.

Species name	Common name	Juvenile characteristics
Chromis punctipinnis	blacksmith	yellow tail coloration
Oxyjulis californica	señorita	< 10 cm length
Sebastes mystinus	blue rockfish	< 10 cm length, red color
Sebastes serranoides	olive rockfish	< 10 cm length
Sebastes atrovirens	kelp rockfish	< 10 cm length
Paralabrax clathratus	kelp bass	< 10 cm length
Semicossyphus pulcher (male, female and juv.)	sheephead	< 10 cm length, white stripe
Embiotoca jacksoni	black surfperch	< 10 cm length
Embiotoca lateralis	stripped surfperch	< 10 cm length
Damalichthys vacca	pile perch	< 10 cm length
Hpsypops rubicundus	garibaldi	< 10 cm length, blue spots
Girella nigricans	opaleye	< 10 cm length
Halichoeres semicinctus (male and female)	rock wrasse	< 10 cm length

Roving Diver Fish Count (RDFC)

Purpose

To estimate species diversity and abundance of fishes within 10m of each side of the transect line.

Materials

1 underwater roving diver fish count slate and pencils for each diver
1 watch or bottom timer for each diver
1 Color fish ID card for each diver if needed
1 data sheet (Appendix E)

Personnel

4 SCUBA equipped observers (minimum)

Methods

This method produces two indices of fish abundance: one scaled from 0 to 10, and an actual estimated count expressed in categories (single = 1, few = 2-10, common = 11-100, and many = >100). During the fish count, the divers progressively move down the transect line and eventaully cover the entire transect area which encompasses 10 meter on both sides of the line (sampling area = 2000m^2 of bottom). Throughout the RDFC each observer should attempt to search in a variety of habitats (i.e. bottom, midwater, under ledges, at the surface, etc.).

Time Score:

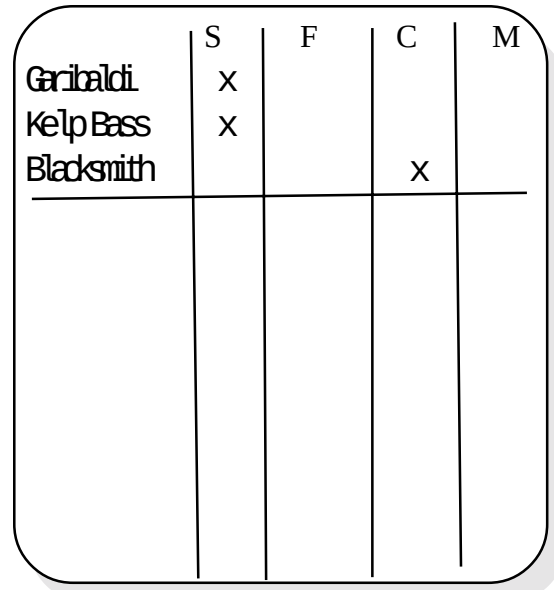
Divers enter the water above the transect, and immediately begin to list the species observed while descending to the bottom. As each species is observed the common or scientific name is written down. The sampling is divided into five minute increments and is limited to 30 minutes. After each five minutes has passed, a line is drawn horizontally across the slate under the list of species seen during that five minutes (Figure 8). If no species were observed in the 5 minutes, then a horizontal lines is drawn anyway to indicate the time.

In the next five minutes, newly observed species are listed. If more individuals of an already listed species are observed, the species is not written again. In other words, only list species once during the entire 30 minutes.

Fish observed in the first five minutes will be given a 10 point score, the second five minutes will be given a 9 point score, the third 5 minutes a 8 pont score, and so on, for 30 minutes.

Abundance estimate:

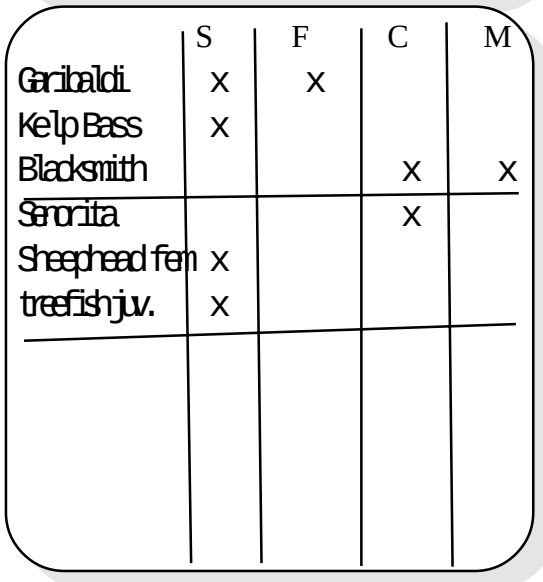
Four columns are drawn on the slate with space for the abundance categories: S(single = 1), F(few = 2-10), C(common = 11-100), and M(many = >100) (Figure 8). These categories are assigned and updated throughout the dive (see description in Figure 8) and at the end of the dive one of the four categories is assigned for each species observed. Do your best not to count the same individual fish more than once.



	S	F	C	M
Garibaldi	x			
Kelp Bass	x			
Blacksmith			x	

Time into the dive: 5 minutes

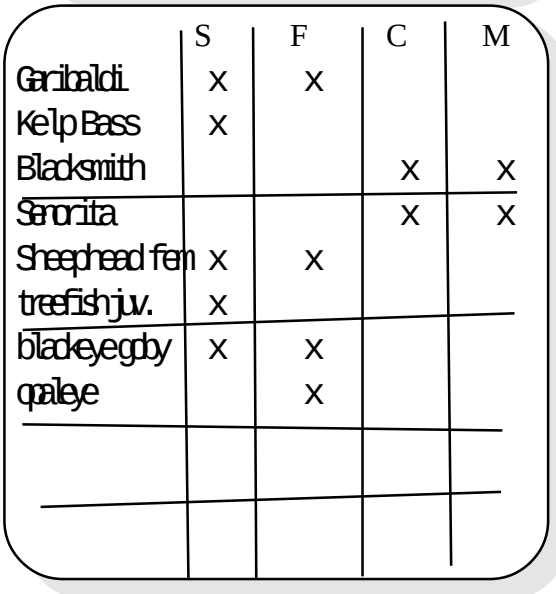
This diver sees 3 fish species in the first 5 minsutes: a single garibaldi, a single kelp bass and between 11 and 100 blacksmith. After 5 minutes, a horizontal line is drawn.



	S	F	C	M
Garibaldi	x	x		
Kelp Bass	x			
Blacksmith			x	x
Senorita			x	
Sheephead fem	x			
treefish juv.	x			

Time into the dive: 10 minutes

In the second five minutes the diver sees 3 new fish species: senoritas (between 11 and 100), a single female sheephead and a single juvenile treefish. In addition, the diver sees a school of blacksmith and another garibaldi. However, these fish are NOT listed again! Instead, the diver updates the abundance estimates to reflect seeing more fish. So, garibaldi go from S to a F, and blacksmith go from a C to a M.



	S	F	C	M
Garibaldi	x	x		
Kelp Bass	x			
Blacksmith			x	x
Senorita			x	x
Sheephead fem	x	x		
treefish juv.	x			
blackeye goby	x	x		
opaleye		x		

Time into the dive: 20 minutes

In the third 5 minute period the diver sees two new species. First a single blackeye goby is seen (S) and then a few minutes later 3 more gobies are seen, making the total abundance F. A school of between 2 and 10 opaleye are also observed (F). In addition, the diver sees a huge school senoritas and 2 more female sheephead. So the abundance estimates for these species are updated - the fish are NOT listed again.

In the fourth 5 minutes no new fish were observed but a horizontal line is still drawn.

Figure 8. An example of a Roving Diver Fish Count slate at three times during a dive.

In addition to listing and counting all identifiable fish, each diver will search for 17 indicator species (see Organisms Sampled) and note if they are absent during the fish count. These 17 species are listed on your underwater slate, and you can check them off towards the end of your dive. Make sure you can identify each of these species before your dive, and then actively search for them. The purpose of this will be to enable us to assign these species a zero (0) in the database, indicating they were absent during the fish count.

Please note that each observers data is a individual count, and observer should refrain from pointing out species to other observers. If one is unable to identify a fish species, careful notes related to size, shape, color, etc. should be taken for possible later identification. Males, females, and Juveniles should also be counted individually when applicable. Typically, the roving diver fish counts will be conducted immediately after the fish transects. During Fish transects a secchi disc reading is taken to measure visibility. If fish transects were not performed a Secchi disc reading should be taken at the time of the roving diver fish count.

After the count is completed, the divers should be debriefed and any unusual fish sited should be questioned and confirmed. All questionable fish identifications are eliminated from the survey. Be sure to ask each diver if they looked for the indicator species mentioned below. At each sites, roving diver fish count data from all observers is transcribed from the slates to one data sheet (Appendix E).

Organisms Sampled

All positively identifiable fish species are counted, but at least the following indicator species are to be actively searched for and assigned a zero (0) in the database if they are absent.

Species Name	Common Name
Chromis punctipinnis	Blacksmith
Oxyjulis californica	Señorita
Sebastes mystinus	Blue Rockfish
Sebastes serranoides	Olive Rockfish
Sebastes atrovirens	Kelp Rockfish
Sebastes serriceps adult and juv. (juv.= no pink on chin or lip)	Treefish
Paralabrax clathratus	Kelp Bass
Semicossyphus pulcher (male, female and juv.)	Sheephead
Embiotoca jacksoni	Black Surfperch
Embiotoca lateralis	Striped Surfperch
Damalichthys vacca	Pile Perch
Hypsypops rubicundus	Garibaldi
Girella nigricans	Opaleye
Lythrypnus dalli	Bluebanded Goby
Coryphopterus nicholsii	Blackeye Goby
Alloclinus holderi	Island Kelpfish
Halichoeres semicinctus (male and female)	Rock Wrasse

Video-taped Transects

Purpose

General appearance of each site is recorded along the fixed lead line transect following the similar procedures employed for the visual fish transects. A video camera is used to record conditions along the 100-m transect line, about 1 m off the bottom, during a five minute/pass period. Two passes along the transect line, one to the left and one to the right, and then three 360 degree pans of the bottom and water column at the 0 (north or east), 50, and 100 (south or west) meter marks are conducted.

Materials

Digital Sony DCR-VX700
Top Dawg U/W housing
1 digital video tape
1 dive slate labeled with N, S, E, W, and 50 m

Personnel

1 SCUBA equipped diver and a dive buddy

Methods

> ****IMPORTANT: READ THE ENTIRE INSTRUCTION MANNUALS FOR BOTH THE CAMERA AND THE VIDEO HOUSING BEFORE USING THE VIDEO EQUIPMENT!!!****

This monitoring technique uses very expensive and delicate audio-visual equipment. It is vital that you understand how the equipment works and that you follow instructions carefully or you may ruin the camera, batteries or the housing. Follow these steps to prepare, set-up, and operate the underwater video camera to video tape the transects only after reading the instruction manuals.

Before the cruise:

- Charge all batteries.
- Check the supply of digital tapes.

Camera set-up for underwater use:

- Find a DRY, CLEAN place to work.
- Insert a charged battery.
- Insert a digital tape.
- Turn camera power switch to the "**Camera"** position.
- Rotate the "Lock/Standby" switch to the "**Standby"** position.
- Be sure that **Steady state is ON**. Represented by a hand with quotes " " on the left of the view finder.
- Be sure that **Auto Focus is ON**. Switch is located on the front left of the camera.

- Adjust telephoto (switch on upper right of camera with W and T labeled on it) to **Wide angle**. Watch bar in view finder until bar reaches W.
- Remove view-finder extension, lens guard, and cap.

Camera installation:

- Open housing. Remove the back plate by rotating the latches.
- Remove housing tray by depressing the release lever, on the left, and pulling the tray out of the housing.
- Affix camera to the tray.
- Plug in black remote cord to blue-ringed jack labeled “LANC” or “REMOTE” (located on the back of the camera).
- Plug in the gray cord to the yellow-ringed video jack labeled “VIDEO OUT” (located near front right of the camera).
- Adjust cords and straps so camera slides freely into housing. Slide tray and camera into the housing. Make sure the tray locks into place.
- Remove o-rings from their grooves in the back plate. Carefully clean ANY debris out of the grooves.
- Inspect the o-rings for cracks. If they are in good condition, clean them and apply a light coat of silicone grease. NOTE: Silicone grease does not act as a sealant! Liberal amounts are NOT needed and could act as a magnet for dirt.
- Put the o-rings back into their grooves on the back plate. ****Be SURE that they are not twisted and that there is NO debris (hair, dust, etc.) on the o-ring surface!****
- Place the back plate onto housing and flip latches until they snap into place.
- Make a final inspection of the housing/back plate seal. Make sure that the seal looks tight and that no o-ring is visible.

At the surface:

- The camera will automatically turn off after one minute of non use. To turn it back on: flip the power switch back and hold on for a couple of seconds. The camera will turn on and you will be able to see through the view finder.
- Label a dry-erase board with the date, island and site.
- Focus the camera on the labeled board and record the information for at least 1 minute.
- Now point the camera at an object approximately 3 ft away and toggle the AF switch forward once. This will set the auto focus distance at about that length. Look through the camera to ensure the image is sharp and get in the water.

On the transect:

- Make sure the camera is on.
- Swim along one side of the transect starting at the 0 meter (north or east) end. Swim the transect (100 meters) with the camera about one meter off the bottom, with a slight downward angle and the transect line showing in the left or right third of the video frame depending on what side of the transect you are on.
- At the end of the transect, place the video in the Stand-By mode
- Repeat the procedure and video the other side of the transect.
- After the second video transect is completed, conduct a pan of the 0m/N or E, 50m and 100m/S or W end of the transect. Turn on the video, and be careful to label the video tape appropri-

ately (N, S, E, W, or 50 m) with the already labeled slate the operator should be carrying, and then conduct the pan. The pan consists of a 360 degree video of both the bottom and the water column. Pan the bottom holding the camera about two meters off the bottom, and at a 65-80 degree angle towards the bottom, starting with the transect line in view and slowly panning clockwise.

- Repeat the pan in the same place holding the camera horizontal to the bottom while video taping the water column.
- Repeat the procedure at the 50m and 100m end of the transect. Be sure to label each pan as N, S, E, W or 50m.
- Turn the camera off.

Back on the boat:

- Rinse the housing.
- Put the housing in safe, dry location.
- Remove the camera from the housing and recharge the batteries if they need it (recharging the batteries if it is not needed will create a memory, decreasing the battery life and reliability).
- Review the tape as soon as possible to ensure that the image is clear.

Time Required

Approximately 30 minutes of bottom time

Organisms Sampled

Kelp forest community

Size Frequency

Purpose

Size frequency distributions are used to estimate population age structure, and to identify and monitor recruitment cohorts.

Materials

6 stainless steel vernier calipers, 220 mm
6 underwater slates
2 meter sticks, non-floating
2 1 x 1 m quadrats
4 large canvass or mesh collection bags
2 small pry bars
Data sheets (Appendix E):
- 20 size frequency data sheets
- 2 underwater data sheets for each species of gorgonians
- 2 underwater data sheets for *Macrocystis pyrifera*

Personnel

6 SCUBA divers

Methods

It is very important in sampling for size frequency distributions that all individuals in the target population are represented in proportion to their abundance in the population. To reduce bias every member of the target species in the study plot must be found and measured. Divers search the area along the fixed transect line using a band transect type search method to limit their search to a specific area. During this method a diver swims transects that are approximately 5-10m by 2 arms-length and are perpendicular to the main transect. These transects are spaced approximately 5-10m apart along the main transect, the spacing will depend on the abundance of the target species. Essentially, this is the same type of search methodology that is conducted during band transects, except the divers arms-length replaces the band transect bar, no meter tape is used, and the size and number of band transects varies with the target species abundance.

In cases where there is relatively high densities (greater than $0.20/m^2$) of the target species, the divers can conduct one long band transect along the main transect line using their arms or a 1.5 m band transect bar for reference. In cases where densities are very high one can use 0.5 or 1.0 m^2 quadrats to focus their search effort. The chief scientist will instruct divers what seach method to use. Pairs of divers are assigned one to three species to maximize diver efficiency.

Sea cucumbers, Parastichopus parvimensis, size frequencies are conducted by collecting 30-60 individuals along the transect, bringing them to the surface in mesh bags and measuring their length while contracted to the nearest cm.. Only emergent animals are collected (no turning over rocks). The P. parvimensis are induced to contract their longitudinal muscles by “jostling” them in ones

hand for 10-15 seconds. "Jostling" can be described as placing the cucumber in ones hand, while shaking and squeezing lightly until the animal is contracted and hard. Once hard, promptly measure the animal to the nearest cm using a meter stick or similar measuring device. Be careful not to squeeze so hard that the animal is induced to eviscerate. After measurement the animals are to be returned to the area of collection as soon as possible. In the meantime, the animals should be suspended in the water over the side of the boat.

Giant kelp, *Macrocystis pyrifera*, plants are always measured along the entire length of the main transect. The sampled distance away from the line may vary from 1 to 5 m depending on kelp density. Greatest holdfast diameter and the number of stipes one meter above the bottom are enumerated. This data is recorded on the underwater data sheets for *M. pyrifera* (Appendix E).

For certain species that are cryptic, and have relatively low densities at some sites such as pink abalone, *Haliotis corrugata*, several pairs of divers can be deployed. If this is done, divers will carry wood chalk to mark abalone that are measured. This will prevent the same animals from being measured by more than one diver.

What ever the method employed, divers should gather a representative sample from the entire transect. Don't measure all of the sea urchins at the zero end of the transect, even if densities are high. One should measure about one third at each third of the transect. The number of individuals of a particular species to be measured are indicated below (see Organisims Sampled).

Height and width for gorgonians and California hydrocoral, and holdfast diameters for giant kelp are measured to the nearest cm, all other measurements are made to the nearest mm. Measurements are made *in situ* with minimal disturbance to the organisms, except for sea urchins which are removed (if possible) to check under the spine canopy of adults for juveniles. If time is limited and densities are high, sea urchins can be collected, measured on board the research vessel, and returned to the point of collection. The minimum sample sizes and types of measurements for each species are

indicated in the section on organisms sampled.

Except for gorgonians, California hydrocoral, and giant kelp (which have separate underwater data sheets) measurements taken underwater are written on a slate, and then transcribed to a natural habitat size frequency data sheet (Appendix E). One data sheet is used for each diver at each site, and multiple species may be placed on the same data sheet using the letter listed for each species at the top of the sheet.

Time Required

Depending on distribution and abundance, sampling may take between 30-100 minutes for each species.

Organisms Sampled

Species	Sample Size	Measurement
Macrocystis pyrifera	100	Stipe count (1 m above bottom), max. holdfast diameter, cm
Tethya aurantia	60	Max. diameter, mm
Stylaster (Allopora) californica	60	Max. height and width, cm
Lophogorgia chilensis	60	Max. height and width, cm
Muricea fruticosa	60	Max. height and width, cm
Muricea californica	60	Max. height and width, cm
Megathura crenulata	60	Max. shell length, mm
Haliotis corrugata	60	Max. shell length, mm
Haliotis fulgens	60	Max. shell length, mm
Haliotis rufescens	60	Max. shell length, mm
Lithopoma (Astraea) undosum	60	Max. shell diameter, mm
Lithopoma (Astraea) gibberosum	60	Max. shell diameter, mm
Kelletia kelletii	60	Max. shell length, mm
Crassedoma (Hinnites) giganteus	60	Max. shell length, mm
Strongylocentrotus purpuratus	200	Max. test diameter, mm
Strongylocentrotus franciscanus	200	Max. test diameter, mm
Lytechinus anamesus	200	Max. test diameter, mm
Pycnopodia helianthoides	60	Length of the longest ray, mm
Astrina (Patiria) miniata	60	Length of the longest ray, mm
Pisaster giganteus	60	Length of the longest ray, mm

Artificial Recruitment Modules

Purpose

To conduct standardized invasive size frequency sampling for selected indicator species. The size frequency distributions are used to identify and monitor recruitment cohorts.

Materials

6 stainless steel vernier calipers, 220 mm
7-15 large regular mesh collection bags (7mm mesh size)
7-15 fine mesh collection bags for small animals (1 X 2 mm mesh size)
7-15 underwater slates and pencils
7-15 size frequency data sheets (Appendix E)
6 dive knives
21-45 cable ties

Personnel

6 SCUBA divers

Description of ARMs

The ARMs are constructed as described in Davis (1995). Each module consists of a wire cage made of 2" X 4" plastic coated mesh wire (Figure 9). Each cage is filled with 20 bricks. The bricks are made by cutting a concrete cinder block in half longitudinally which produces 2 bricks each with a cross section shaped like a lower case "m" (Figure 9).

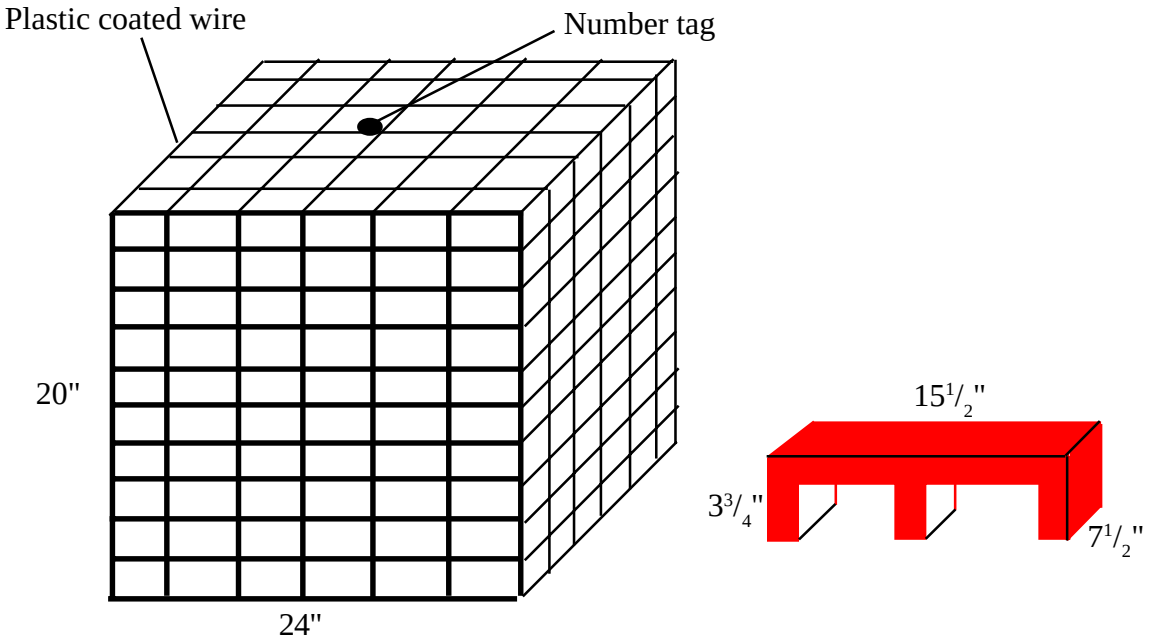


Figure 9. An artificail recruitment module and one of the 20 bricks that are placed into the module.

Methods

The number and location of artificial recruitment modules (ARMs) varies at each site (Table 1), but typically there are 7 or 15. If there are seven, they are usually grouped together, however if there are 15, they are in groups of 5, one group at each end of the line and one group at the middle.

To monitor each ARM, the divers should have a slate, pencil, vernier caliper, large mesh bag, and a fine mesh bag (make sure there are no tears in the mesh bag). Once at a ARM, locate the small stainless steel number tag on the top of the ARM (Figure 9) and write the ARM number on a slate (a separate slate should be available for each ARM sampled). Next cut the plastic cable ties that hold the lid shut and open it. Slowly remove any of the indicator species that are on top of the bricks and place them in a mesh bag (animals on and outside of the cage are not sampled). If there are any animals less than 7mm place them in the small mesh bag. All other animals go in the large mesh bag. Carefully, and slowly begin removing the bricks while watching for any animals that are dislodged or begin to swim away (juvenile rock scallops swim rapidly!). Place all of the animals in their appropriate mesh bags, but measure any *Haliotis* spp. (abalone) and *Megathura crenulata* (keyhole limpets) and place them back on the bricks that have already been sampled. These species are easily killed when placed in a mesh bag full of sea urchins. Enumerate the *Parastichipus parvimensis* (warty sea cucumbers) that are less than 10 cm and greater then 10 cm, and record this on the slate (estimate the sizes when they are in a relaxed state). After sampling the bricks, stack them next to the ARM, so they can be easily replaced.

IT IS VERY IMPORTANT TO WORK SLOWLY, AND MAKE SURE YOU CAREFULLY SEARCH EACH BRICK FOR SMALL INDIVIDUALS OF ALL THE INDICATOR SPECIES.

If *Strongylocentrotus purpuratus* (purple sea urchins) or *S. franciscanus* (red sea urchins) are very abundant, not all of the ARMs need to be sampled for these two species. If there are 200+ per ARM of one of these species, only sample *S. purpuratus* and/or *S. franciscanus* in 3-4 ARMs at a site that has seven ARMs. If a site has 15 ARMs, attempt to sample sea urchins from two of the five ARMs in each group. Make sure to indicate at the top of the slate that **ALL** or **PART** of the list of indicator species were monitored in the ARMs. This will then be transferred to the appropriate space on the data form (Appendix E). This step is very important, without this information it will not be possible to calculate the number of a particular species found per ARM for analysis. Also write down any interesting notes about the ARM, such as octopus present or all the bricks were covered with a species of sponge etc.

After sampling all of the bricks, place the slate labeled with the ARM number into the bag, and close the mesh bags so the animals do not escape. Next, replace all of the bricks into the ARM in the same alternating stacks, so that the arrangement of bricks is the same as when they were removed. Leave the top open, as the animals will be placed back in their appropriate ARM after they have been measured on the surface. Go on to the next ARM if you have enough bottom time and air to complete it; do not start a new ARM, unless you have enough bottom time and air to complete the ARM. Return to the surface with the mesh bags. If there are not many animals in the ARMs and you have sufficient bottom time, you may measure the animals on the bottom recording their sizes

on the slate. The animals can then be returned to the ARM, and the top can be closed with cable ties.

Once the animals are brought to the surface, it is best to keep them in the water, as it may take several hours before they are returned to the ARMs. Measuring the animals brought up typically takes three people on the surface, two measurers and one recorder. On a ARMs size frequency sheet (Appendix E), fill in all of the blanks at the top and the number of cucumbers at the bottom. If no ARM # was present or some other anomaly occurred make a note of this in the comment section on the bottom of the data sheet. Other notes such as an octopus being present in the ARMs can also be mentioned here. The two people that are measuring should measure the same specie and make sure the recorder is a aware of what species they are recording. The recorder will place the correct letter code (see top of data sheet) by size on the data sheet. The recorder must make **sure** she/he is using the correct letter code.

Once the animals are measured, place them back into the mesh bag and hang them in the water, until they can be returned to the ARM from which they came. Be sure to place the appropriate slate in the mesh bag so the animals can be returned to the ARM from which they came.

Time Required

Depending on the depth, number of modules, and abundance of species to be measured, the amount of time and number of divers required to sample the ARMs varies greatly. At any given site, a pair of divers will work on one ARM at a time, however depending on the site and the experience of the divers, they may be able to work on separate ARMs if they are next to each other. It may take up to 30 minutes to sample one ARM.

Organisms Sampled

Species	Measurement
Tethya aurantia	Max. diameter, mm
Haliotis rufescens	Max. shell length, mm
Haliotis corrugata	Max. shell length, mm
Haliotis fulgens	Max. shell length, mm
Cypraea spadicea	Max. shell length, mm
Kelletia kelletii	Max. shell length, mm
Lithopoma (Astraea) undosum	Max. shell diameter, mm
Lithopoma (Astraea) gibberosum	Max. shell diameter, mm
Megathura crenulata	Max. shell length, mm
Crassedoma (Hinnites) giganteum	Max. shell length, mm
Aterina (Patiria) miniata	Length of the longest ray, mm
Pisaster giganteus	Length of the longest ray, mm
Pycnopodia helianthoides	Length of the longest ray, mm
Lytechinus anamesus	Max. test diameter, mm
Strongylocentrotus franciscanus	Max. test diameter, mm
Strongylocentrotus purpuratus	Max. test diameter, mm
Parastichopus parvimensis	Estimated size, < or > 10cm
Centrostephanus coronatus	Max. test diameter, mm

Species Checklist

Purpose

To make a yearly estimate of the relative abundance of all species observed at each site.

Materials

1 underwater slate

Personnel

2 SCUBA Divers

Methods

The relative abundance of all species observed at each site is estimated every year. During the quantitative and size frequency sampling, notes are kept by all observers on the occurrence and abundance of all species encountered. Near the end of each site visit, one or more observer pairs search the entire monitoring site for rare or obscure species and make specific notes on the relative abundance of all species. Relative abundance for the species observed is recorded on a scale of X, 0, 1, 2, 3, 4, where:

X = present, but with no reliable estimate of abundance
0 = absent, expected but unfound upon directed search
1 = rare
2 = present
3 = common
4 = abundant

The value recorded for each species is a consensus, determined by the cruise's chief scientist in conference with all observers using the check list of known species in Appendix C. The value reflects the potential abundance of that species. For example, sightings of four giant black sea bass, *Stereolepis gigas*, at a site would be recorded as abundant (4), whereas 100 purple sea urchins, would probably rate only present (2) or common (3).

Time Required

Minimum of 30 minutes.

Organisms Sampled

Kelp forest community.

Oceanographic Conditions

Purpose

To record temperature fluctuations at all of the 16 kelp forest monitoring sites.

Materials

1 STOWAWAY™ temperature logger with probe
1 underwater housing with good 0-ring
1 tube of silicon greese
2 9/16 inch open end wrench
2 3/4 inch open end wrench
1 computer with appropriate software

Methods

The STOWAWAY temperature loggers are placed in a underwater housings that are bolted to a thread rod epoxied to the bottom at each site**.** The location of the unit at each site is listed in Table 1. The loggers are programmed to record one temperature reading per hour. The loggers are serviced once per year during the summer sampling.

Remove the temperature unit from the site using two wrenches. While doing this check to see that the thread rod to which the unit is attached is still well epoxied to the bottom. Note if it needs repair or replacement. Also, before removing the unit, make sure that the lead weight attached to the housing is still attached. If it is not, beware that the unit will be positively buoyant and if you let go, it will rapidly float to the surface!

Bring the temperature unit to the surface, and note the time and date that it was retrieved, later when you are dry make sure this information is copied into the *Hobotemp* notebook.

> ****Note: it is very important to record the correct time as the temperature logger is still recording data and the erroneous data points will need to be deleted later.****

Procedures on how to download the temperature data and prepare the unit for redeployment are described in Volume 2 of this handbook.

When you are ready to place the unit underwater, use two wrenches to tighten the nuts. Make sure that the nuts are tight enough to ensure that the unit cannot move on the thread rod, however, be careful not to crack the PVC housing. Record the time the unit was launched and deployed and write this information in the *Hobotemp* notebook.

DATA MANAGEMENT AND DATA HISTORY

After sampling is completed, data are stored and summarized using Microsoft Access. Detailed instructions for data entry are described in Volume 2 of this handbook.

This section explains what changes have been made in sampling methods and database management since the program was started in 1982. For the most part, few changes have been made, and the changes that were made still enable the data to be comparable between years. However, A CLEAR UNDERSTANDING OF BOTH THE CHANGES IN SAMPLING METHODS AND DATABASE MANAGEMENT ARE NECESSARY FOR ACCURATE ANALYSIS AND INTERPRETATION OF THE DATA.

General Information

Establishing Transects

In August and September, 1981 a total of 45 SCUBA divers conducted 643 dives to locate and establish 13 100-m transects (Table 1). The divers used the National Park Service's 17 m-long vessel (the *Pacific Ranger*) as a base of operation. Six week-long cruises were conducted, with eight to ten divers on each cruise. Five diving biologists from the California Department of Fish and Game assisted the National Park Service in selecting and marking the transects. During the remaining cruises, 33 divers from the National Park Service Western Region dive team and seven scientists from local universities and the National Marine Fisheries Service established the permanent transect lines on the sea floor. Establishment of each transect line consisted of a sequence of operations involving specialized equipment and skills developed specifically for this project (Appendix B). One additional transect was added in 1983 and two in 1986 (Table 1).

The first five years 1982-1986 of this program was considered its design phase. During this period there were several changes to the protocols with regards to the number of samples and species sampled. Although the data are comparable, it will be essential for the person analyzing the data to understand the changes that were made, and to adjust the analysis accordingly.

Database Management

Since the beginning of this project in 1982, advancements in computer technology and the volume and complexity of the data collected has stimulated this project to change database programs several times. In 1982 database management was conducted in Dbmaster. In 1985 the data was reentered into Dbase. The most recent change was in 1995 when the data was transferred from DbaseIII to Microsoft Access. Access was chosen because of the need for Channel Islands National Park to use a relational database to link all of Resources Management's data. Database management has been a important issue for this program and much time and effort has gone into keeping the data accessible and accurate.

General notes regarding the transition from Dbase to Access

Prior to using Access, the data per quadrat (for the 1m quadrat and random point contact data) or

1 m Quadrats

Access table design structure for -1mQuadrat:

Field Name	Data Type
ProgramCode	Text
EventNumber	Text
IslandCode	Text
SiteCode	Text
Species	Number
Quadrat	Number
CountA	Number
CountB	Number

Sample size and database anomalies

The number of quadrats sampled per year has changed several times with 30 sampled in 1982, 40 sampled in 1983 and 1984, 20 sampled from 1985-1995, and 12 sampled from 1996 to present. Each quadrat for 1982, 1983, and 1984 represents $1m^2$. From 1985 to present each quadrat represents $2m^2$ (**Tablexxx).**

CountA and CountB

From 1982-1984 each $1m^2$ quadrat was entered into the data base under CountA, and CountB is null (see below).

From 1985-present $2m^2$ quadrats were sampled. However, from 1985-1994 the two divers (sampling adjacent $1m^2$ quadrats) added their Counts together before entering the data. Hence, from 1985-1994 data entered under CountA represents $2m^2$, and CountB is null (see below).

From 1995-present, the data for each diver is entered under CountA and CountB, so that the addition of CountA and CountB represents $2m^2$ (see below).

Number and size of 1m Quadrats:

Year	# of quadrats sampled	Quadrat size	CountA	CountB
1982	30	$1m^2$	yes	null
1983-1984	40	$1m^2$	yes	null
1985-1994	20	$2m^2$	yes	null
1995	20	$2m^2$	yes	yes
1996-present	12	$2m^2$	yes	yes

transect (for the band transect data) were summarized and entered in one count field labeled “count”. With the creation of Access, CountA, CountB, CountC, CountD were created for adjacent quadrats or transects, so that summarization of the data could be conducted by computer, and not by hand. Further explanation of how the data is collected and entered is described in the Sampling Method

Protocol and Data Entry sections of this handbook.

Quadrat Placement

Prior to 1996 random points selected for placement of the quadrats were stratified random. After 1996, the random points are systematic with a random starting point.

Organisms Sampled Information

Sampling of adult and juvenile *Macrocystis pyrifera* began in 1983.

Prior to 1996, adult and juvenile *Laminaria farlowii*, *Pterygophora californica,* and *Eisenia arborea* were not distinguished and were grouped into *L. farlowii* all, *P. californica* all, and *E. arborea* all categories. Starting in 1996, adult and juvenile categories for each of these species were added.

In 1996, the categories for *M. pyrifera* all, *L. farlowii* all, *P. californica* all, and *e. arborea* all were discontinued. However, this information can still be calculated by combining the adult and juvenile categories.

Cypraea spadicea were added to quadrats in 1983, except at Admiral's Reef, Anacapa Island, and Rodes Reef, Santa Rosa Island where they were added in 1982.

The fish, *Lythrypnus dalli*, *Coryphopterus nicholsii,* and *Alloclinus holderi* were added to quadrats in 1985.

Coronado sea urchins, *Centrostephanus coronatus*, were added to quadrats in 1996.

Organisms sampled with 1m quadrats.

Species Name	Species	Comments
Macrocystis pyrifera Adult (>1m)	2002.00	Sampling began in 1983
Macrocystis pyrifera Juvenile (<1m)	2002.50	Sampling began in 1983
Macrocystis pyrifera All	2010.00	Discontinued in 1996 (can be calculated by adding Ad.+Juv.)
Eisenia arborea adult	2004.00	Sampling began in 1996
Eisenia arborea juvenile	2004.50	Sampling began in 1996
Eisenia arborea All	2012.00	Discontinued in 1996 (can be calculated by adding Ad.+Juv.)
Pterygophora californica adult	2005.00	Sampling began in 1996
Pterygophora californica juvenile	2005.50	Sampling began in 1996
Pterygophora californica All	2013.00	Discontinued in 1996 (can be calculated by adding Ad.+Juv.)
Laminaria farlowii adult	2006.00	Sampling began in 1996
Laminaria farlowii juvenile	2006.50	Sampling began in 1996
Laminaria farlowii All	2014.00	Discontinued in 1996 (can be calculated by adding Ad.+Juv.)
Cypraea spadicea	9005.00	Sampling began in 1983 (Except AR,RR began in 1982)
Kelletia kelletii	9006.00	Sampling conducted sporadically
Lithopoma (Astraea) undosa	9007.00	Continuously sampled
Lithopoma (Astraea) gibberosa	9008.00	Began sampling 1985, sporadic sampling at select sites
Crassedoma (Hinnites) giganteus	9010.00	Sporadically sampled when densities are high
Asterina (Patiria) miniata	11001.00	Continuously sampled
Pisaster giganteus	11002.00	Continuously sampled
Lytechinus anamesus	11004.00	Sporadically sampled when densities are high
Strongylocentrotus franciscanus	11005.00	Continuously sampled

Strongylocentrotus purpuratus	11006.00	Continuously sampled
Parastichopus parvimensis	11007.00	Continuously sampled
Centrostephanus coronatus	11009.00	Sampling began in 1996
Styela montereyensis	12002.00	Continuously sampled
Lythrypnus dalli	14025.00	Sampling began in 1985
Coryphopterus nicholsii	14026.00	Sampling began in 1985
Alloclinus holderi	14027.00	Sampling began in 1985

Sites Sampled

Quadrat data are available for 13 kelp forest monitoring sites from 1982-present, one site from 1983-present, and two sites from 1986-present (see below).

The years 1m quadrat data is available for the kelp forest monitoring sites.

Island Name	Site Name	Quadrat data available
Anacapa	Admiral's Reef	1982 - present
Anacapa	Cathedral Cove	1982 - present
Anacapa	Landing Cove	1982 - present
Santa Barbara	Arch Point	1982 - present
Santa Barbara	Cat Canyon	1986 - present
Santa Barbara	SE Sea Lion Rookery	1982 - present
Santa Cruz	Fry's Harbor	1982 - present
Santa Cruz	Gull Island South	1982 - present
Santa Cruz	Pelican Bay	1982 - present
Santa Cruz	Scorpion Anchorage	1982 - present
Santa Cruz	Yellow Banks	1986 - present
San Miguel	Hare Rock	1982 - present
San Miguel	Wyckoff Ledge	1982 - present
Santa Rosa	Johnson's Lee North	1982 - present
Santa Rosa	Johnson's Lee South	1982 - present
Santa Rosa	Rodes Reef	1983 - present

5 m Quadrats

Access table design structure for -5mQuadrat:

Field Name	Data Type
ProgramCode	Text
EventNumber	Text
IslandCode	Text
SiteCode	Text
Species	Number
Quadrat	Number
Count	Number

Sample size and database anomalies:

This protocol was implemented in 1996, and there have been no changes or anomalies incurred.

Quadrat Placement:

The quadrats are "placed" continuosly and adjacent along the transect. See the protocol section for a complete discription of this sampling technique.

Organisms Sampled Information:

Species Name	Species	Comments
Macrocystis pyrifera Adult (>1m and haptera above the primary dicotomy)	2002.25	Sampling began in 1996
Macrocystis pyrifera Subadult (>1m and no haptera above the primary dichotomy)	2002.75	Sampling began in 1996
Pisaster giganteus	11002	Sampling began in 1996

Sites Sampled:

5 meter quadrat data is available for all 16 kelp forest monitoring sites from 1996-present.

Band Transects

Access table design structure for -BandTransect:

Field Name	Data Type
ProgramCode	Text
EventNumber	Text
IslandCode	Text
SiteCode	Text
Species	Number
Transect	Number
CountA	Number
CountB	Number

Sample size and database anomalies

The number of band transects and their size has changed only once since 1983, when data collection began using this method. In 1983 and 1984 10 band transects at each site were taken. Each of these transects represented 2X20m or 40 m^2. From 1985 to the present, 12 band transect were conducted at each site. These transect measure 3X20m or 60m^2.

CountA and CountB

Divers sample adjacent transects (CountA and CountB) that are half the size of the entire transect (see sampling method protocol). From 1983-1994 counts A and B were added by hand before entering into the computer. This combined data was then entered as CountA with CountB as null.

From 1995-present the data for each diver (Counts A and B) are entered directly into the computer as CountA and CountB.

Number and size of band transects:

Year	# of band transects sampled	band transect size	CountA	CountB
1983-1984	10	40m2	yes	null
1985-present	12	60m2	yes	yes

Band Transect Placement

Prior to 1996 random points selected for placement of the band transects were stratified random. After 1996 the random points are systematic with a random starting point.

Organisms Sampled Information

Only two anomalies exist in the Band Transect dataset:

Muricea californica was sporadically sampled from 1988-1990, and was formally added to this protocol in 1991.

Lytechinus anamesus is counted on band transects, however when their densities are extremely high, we count them on quadrats for efficiency. There are some years where they are counted on both quadrats and bandtransects.

Organisms sampled with band transects.

Species Name	Species	Comments
Tethya aurantia	5002	Sampling began in 1983
Stylaster (Allopora) californica	6001	Sampling began in 1983
Telia lofotensis	6002	Sampling began in 1983
Lophogorgia chilensis	6006	Sampling began in 1983
Muricea friticosa	6007	Sampling began in 1983
Muricea californica	6008	Sampling began at the sites from 1988-1990
Panulirus interruptus	8001	Sampling began in 1983
Haliotis rufescens	9002	Sampling began in 1983
Haliotis corrugata	9003	Sampling began in 1983
Haliotis fulgens	9004	Sampling began in 1983
Kelletia kelletii	9006	Sampling began in 1983
Megathura crenulata	9009	Sampling began in 1983
Crssedoma (*Hinnites*) *giganteus*	9010	Sampling began in 1983
Aplysia californica	9011	Sampling began in 1983
Pycnopodia helianthoides	11003	Sampling began in 1983
Lytechinus anamesus	11004	Sampling began in 1983, absent some years when counted on quadrats (see above notes).

Sites Sampled

Band transect data are available for 14 kelp forest monitoring sites from 1983-present, and two sites from 1986-present (see below).

The years band transect data is available for the kelp forest monitoring sites.

Island Name	Site Name	Band transect data available
Anacapa	Admiral's Reef	1983 - present
Anacapa	Cathedral Cove	1983- present
Anacapa	Landing Cove	1983 - present
Santa Barbara	Arch Point	1983 - present
Santa Barbara	Cat Canyon	1986 - present
Santa Barbara	SE Sea Lion Rookery	1983 - present
Santa Cruz	Fry's Harbor	1983 - present
Santa Cruz	Gull Island South	1983 - present
Santa Cruz	Pelican Bay	1983 - present
Santa Cruz	Scorpion Anchorage	1983 - present
Santa Cruz	Yellow Banks	1986 - present
San Miguel	Hare Rock	1983 - present
San Miguel	Wyckoff Ledge	1983 - present
Santa Rosa	Johnson's Lee North	1983 - present
Santa Rosa	Johnson's Lee South	1983 - present
Santa Rosa	Rodes Reef	1983 - present

Random Point Contacts

Access table design structure for -RandomPointContact:

Field Name	Data Type
ProgramCode	Text
EventNumber	Text
IslandCode	Text
SiteCode	Text
Quadrat	Number
Species	Number
CountA	Number
CountB	Number
CountC	Number
CountD	Number

Sample size and database anomalies:

The number of Random Point Contact quadrats and points within each quadrat have changed several times since this protocol was emplo yed. For analysis, it will be essential to know the total number of points collected each year when calculting percent coverage.

For each site sampled in:

1982 there were 25 quadrats with 20 points each, totaling 500 points.
1983 there were 40 quadrats with 10 points each, totaling 400 points.
1984 there were 10 quadrats with 50 points each, totaling 500 points.
1985-1995 there were 25 quadrats with 40 points each, totaling 1000 points.
1996-present there were 15 quadrats with 40 points each, totaling 600 points.

CountA , CountB, CountC, and CountD

From 1982-1994 all of the points for each quadrat were added together and entered into the data base as CountA, with data fields CountB, CountC, and CountD remaining null. With the database conversion to Access in 1995 we began entering the four sides of each quadrat as CountA, CountB, CountC and CountD. The computer now needs to be instructed to add the four sides (CountA-D). By allowing the computer to conduct the additions, we decrease the chance of human error and improve data entry efficiency. For a summary of the number of quadrats and entry format by year see below:

Year	# of quadrats sampled	Points per Quadrat	CountA	CountB	CountC	CountD
1982	25	20	yes	null	null	null
1983	40	10	yes	null	null	null
1984	10	50	yes	null	null	null
1985-1994	25	40	yes	null	null	null
1995	25	40	yes	yes	yes	yes
1996-present	15	40	yes	yes	yes	yes

Quadrat Placement

Prior to 1996, random points selected for placement of the quadrats were stratified random. After 1996, the random points are systematic with a random starting point.

Organisms Sampled Information

From 1982-1993, the group of algae (species #2008) *Macrocystis pyrifera*, *Pterygophora californica*, and *Eisenia arborea* was sampled. In 1993, this category of algae was separated into its three species, and hence can be calculated by adding the three species together for the years it wasn't sampled. To calculate species #2008 for years after 1993, add species 2010, 2012, and 2013 together. Note, that species #2008 CAN have greater than 100% cover. When sampling was conducted for species #2008 prior to 1993, each species in the group was counted. For example, it would be possible in any given quadrat to have a layering affect where all three species of algae (*M. pyrifera*, *P. californica*, and *E. arborea*) intercepted each point. This would create a 300% cover of this category.

As mentioned above, sampling for *Macrocystis pyrifera*, *Pterygophora californica,* and *Eisenia arborea* as separate species began in 1993.

Sampling for *Sargassum spp.*, *Leucetta losangelensis,* and *Polymastia pachymastia* were conducted only from 1982 - 1984.

The categories Hydroids (6009), *Spirobrancus spinosus (7003), and Balanus spp*. (8002) were only sampled in 1985, and in some cases only at one or few sites.

Sampling for miscellaneous bryozoans and sponges began in 1985 and have continued since then.

Species Name	Species	Comments
Green Algae	1001	Sampling began in 1982
Miscellaneous Brown Algae	2001	Sampling began in 1982
Desmarestia Spp.	2003	Sampling began in 1982
Cystoseira Spp.	2007	Sampling began in 1982
Macrocystis,*Pterygophora*,and *Eisenia* combined	2008	Began in 1982, discontinued in 1993, but can be calculated.
Macrocystis pyrifera All	2010	Sampling began in 1993
Sargassum spp.	2011	Sampling began in 1982 and was discontinued in 1984.
Eisenia arborea All	2012	Sampling began in 1993
Pterygophora californica All	2013	Sampling began in 1993
Laminaria farlowii All	2014	Sampling began in 1982
Miscellaneous Red Algae	3001	Sampling began in 1982
Articulated Coralline Algae	3002	Sampling began in 1982
Encrusting Coralline Algae	3003	Sampling began in 1982
Gelidium Spp.	3004	Sampling began in 1982
Gigartina Spp.	3005	Sampling began in 1982
Miscellaneous Plants (ie: Diatoms)	4001	Sampling began in 1982
Sponges	5001	Sampling began in 1985

Leucetta losangelensis	5003	Sampling began in 1982 and was discontinued in 1984.
Polymastia pachymastia	5004	Sampling began in 1982 and was discontinued in 1984.
Corynactis californica	6003	Sampling began in 1982
Balanophyllia elegans	6004	Sampling began in 1982
Astrangia lajollaensis	6005	Sampling began in 1982
Hydroids	6009	Sampled in 1985 for only a few sites.
Diopatra ornata	7001	Sampling began in 1982
Phragmatopoma californica	7002	Sampling began in 1982
Spirobrancus spinosus	7003	Sampled in 1985 for only one site.
Balanus spp.	8002	Sampled in 1985 for only one site.
Serpulorbis squamigerus	9001	Sampling began in 1982
Miscellaneous Bryozoans	10001	Sampling began in 1985
Diaperoecia californica	10002	Sampling began in 1982
Pachythyone rubra	11008	Sampling began in 1982
Tunicates	12001	Sampling began in 1982
Miscellaneous Invertebrates	13001	Sampling began in 1983
Bare Substrate	15001	Sampling began in 1982
Rock	15002	Sampling began in 1982
Cobble	15003	Sampling began in 1982
Sand	15004	Sampling began in 1982

Sites Sampled

Random Point Contact data are available for 13 kelp forest monitoring sites from 1982-present, one site from 1983-present, and two sites from 1986-present (see below).

The years Random point contact data is available for the kelp forest monitoring sites.

Island Name	Site Name	Random Point Contact data available
Anacapa	Admiral's Reef	1982 - present
Anacapa	Cathedral Cove	1982 - present
Anacapa	Landing Cove	1982 - present
Santa Barbara	Arch Point	1982 - present
Santa Barbara	Cat Canyon	1986 - present
Santa Barbara	SE Sea Lion Rookery	1982 - present
Santa Cruz	Fry's Harbor	1982 - present
Santa Cruz	Gull Island South	1982 - present
Santa Cruz	Pelican Bay	1982 - present
Santa Cruz	Scorpion Anchorage	1982 - present
Santa Cruz	Yellow Banks	1986 - present
San Miguel	Hare Rock	1982 - present
San Miguel	Wyckoff Ledge	1982 - present
Santa Rosa	Johnson's Lee North	1982 - present
Santa Rosa	Johnson's Lee South	1982 - present
Santa Rosa	Rodes Reef	1983 - present

Visual fish Transects

Access table design structure for -Visual Fish Transects:

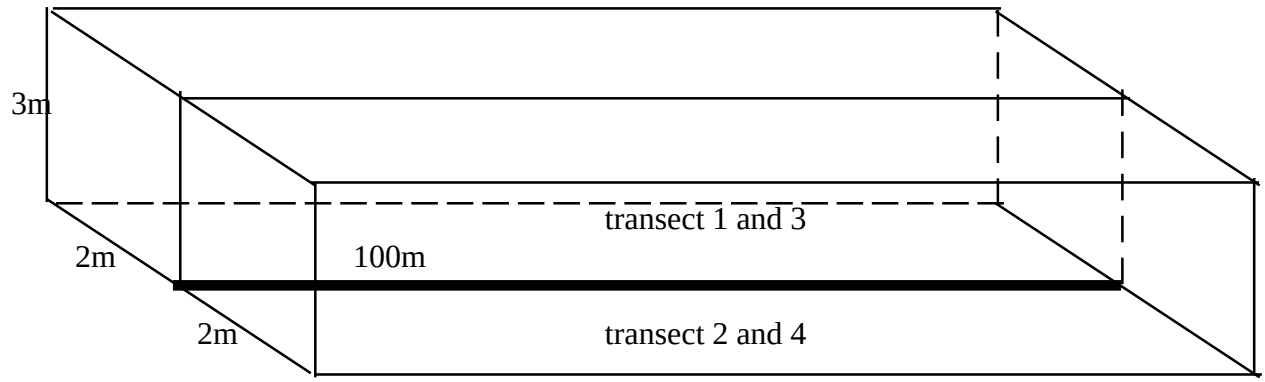
Field Name	Data Type
ProgramCode	Text
EventNumber	Text
IslandCode	Text
SiteCode	Text
Date	Date/Time
Species	Number
Transect	Number
ObserverA	Text
CountA	Number
ObserverB	Text
CountB	Number

Sample size and database anomalies:

Visual fish transect size has changed once since the protocol was implemented in 1985. From 1985-1995 fish transect size was 3m x2m x 100m. From 1996-present, transect size is 3m x 2m x 50m. Although the size of the transects has changed, four transects have always been conducted during each sampling. Note: if fish transects are to be compared between years, the transects can be normalized so that comparisons for all years can be made. This can be conducted by adding transects 1 and 2 for the years >=1996, these will then be equal to transect 1 for years <=1995, and transects 3 and 4 for the years >=1996 can be added together to equal transect 2 for years <=1995. Comparisons of transects 3 and 4 prior to 1996 with years after 1996 can not be conducted.

Below is a diagram of how fish transects were conducted prior to 1996. For a diagram for the 1996-present fish transects, please see the section on visual fish transects presented in the protocol section.

1985-1995:



1996-Present:

See diagram and description of proceedures on page 18.

1996-1997:

In 1996 and 1997, fish species were split into midwater and benthic fish with two separate data sheets. This was conducted as a recomendation of the 1995 Kelp Forest Monitoring Design Review (Davis et al, 1996). Two trained observers conducted fish transect, one counting the midwater fish and the other counting benthic fish. New staff were hired in 1998, and it was not possible to continue counting midwater and benthic fish with trained divers (see Training required on page 19 of this handbook). In 1998, the midwater and benthic data sheets were combined into a "fishall" sheet, similar to what had been used prior to 1996. We believe there has been little to no effect of splitting up the fish into midwater and benthic categories for the 1996 and 1997 sampling years.

In 1995 we added the Observer field into the database. The observers were not entered into the database prior to this year.

CountA , and CountB

Prior to 1996, there were sometimes two observers counting fish along the same transect. When this occured the data were entered as CountB. From 1996 - 1997 observers counted separate sets of fish ("midwater" and "benthic", see 1996-1997 above) and these counts were enterered under CountA, but the ObserverA number changed.

Year	# of transects sampled	Size of transect	CountA	CountB
1985-1995	4	3mx2mx100m	yes	yes, when second observer is present.
1996-1997	4	3mx2mx50m	yes	null
1997- present	4	3mx2mx50m	yes	yes, when second observer is present

Transect Placement

The transects run directly along the entire transect line at the site. Prior to 1996, transects 1 and 3 covered the same substrate, as did transects 2 and 4. From 1996-present, each transect covers different substrate. See digrams mentioned earlier.

Organisms Sampled Information

Sampling began for adult and juvenile *Halichoeres semicinctus* in 1993, and for juvenile *Semicossyphus pulcher* in 1996.

All other species have been continuosly sampled since 1985.

Species	Species Name	Adult/Juvenile/sex	Comments
14001	Chromis punctipinnis	Adult	Sampling began in 1985
14002	Chromis punctipinnis	Juvenile	Sampling began in 1985
14003	Oxyjulis californica	Adult	Sampling began in 1985
14004	Oxyjulis californica	Juvenile	Sampling began in 1985
14005	Sebastes mystinus	Adult	Sampling began in 1985
14006	Sebastes mystinus	Juvenile	Sampling began in 1985
14007	Sebastes serranoides	Adult	Sampling began in 1985
14008	Sebastes serranoides	Juvenile	Sampling began in 1985
14009	Sebastes atrovirens	Adult	Sampling began in 1985
14010	Sebastes atrovirens	Juvenile	Sampling began in 1985
14011	Paralabrax clathratus	Adult	Sampling began in 1985
14012	Paralabrax clathratus	Juvenile	Sampling began in 1985
14013	Semicossyphus pulcher	Male	Sampling began in 1985
14014	Semicossyphus pulcher	Female	Sampling began in 1985
14015	Semicossyphus pulcher	Juvenile	Sampling began in 1996
14015	Embiotoca jacksoni	Adult	Sampling began in 1985
14016	Embiotoca jacksoni	Juvenile	Sampling began in 1985
14017	Embiotoca lateralis	Adult	Sampling began in 1985
14018	Embiotoca lateralis	Juvenile	Sampling began in 1985
14019	Damalichthys vacca	Adult	Sampling began in 1985
14020	Damalichthys vacca	Juvenile	Sampling began in 1985
14021	Hypsypops rubicundus	Adult	Sampling began in 1985
14022	Hypsypops rubicundus	Juvenile	Sampling began in 1985
14023	Girella nigricans	Adult	Sampling began in 1985
14024	Girella nigricans	Juvenile	Sampling began in 1985
14028	Halichoeres semicinctus	Male	Sampling began in 1993
14029	Halichoeres semicinctus	Female	Sampling began in 1993

Sites Sampled

Fish transect data are available for 14 kelp forest monitoring sites from 1985-present, and two sites e from 1986-present.

Island Name	Site Name	fish transect data available
Anacapa	Admiral's Reef	1985 - present
Anacapa	Cathedral Cove	1985- present
Anacapa	Landing Cove	1985 - present
Santa Barbara	Arch Point	1985 - present
Santa Barbara	Cat Canyon	1986 - present
Santa Barbara	SE Sea Lion Rookery	1985 - present
Santa Cruz	Fry's Harbor	1985 - present
Santa Cruz	Gull Island South	1985 - present
Santa Cruz	Pelican Bay	1985 - present
Santa Cruz	Scorpion Anchorage	1985 - present
Santa Cruz	Yellow Banks	1986 - present
San Miguel	Hare Rock	1985 - present
San Miguel	Wyckoff Ledge	1985 - present
Santa Rosa	Johnson's Lee North	1985 - present
Santa Rosa	Johnson's Lee South	1985 - present
Santa Rosa	Rodes Reef	1985 - present

Roving Diver Fish Count

Access table design structure for -Roving Diver Fish Count:

Field Name	Data Type
ProgramCode	Text
EventNumber	Text
IslandCode	Text
SiteCode	Text
Date	Date/Time
Observer	Number
CommonName	Text
Score	Number
Abundance	Text

Sample size and database anomalies:

This protocol was implemented in 1996 to assess fish populations at the kelp forest monitoring sites. During the first year of sampling, 1996, if a species of fish was not observed it was simply not entered into the database. From 1997-present, a list of specific species was created so that these species would be actively serched for during the fish count, and if they were not present a zero would be entered into the database indicating their absence.

Organisms Sampled Information

All fish species are sampled. In 1997 a list of specific species was created so that they were actively serched for (see above or in the protocol section of this handbook) and be given the abundance of zero if they were not observed. For this list of species, please see the protocol section of this handbook.

Sites Sampled

Data exists from all 16 kelp forest monitoring sites since this protocol was implemented in 1996.

Video-taped Transects and Video Plots

No Access database exists for the Video-taped Transects and Video Plots:

The video tapes are all in there original form on VHS, Hi8 or didgital format.

Sample size and database anomalies:

Two video-taped transects, one on either side of the transect for each site have been taken since 1985.

Three video plots have been taken at each site since, 1993.

Video Format:

Years:	Format:
1985-1989	VHS
1990-1997	Hi8
1997-present	Digital

Sites Sampled

Video transects exists from 14 kelp forest monitoring sites since 1985, and from the two sites that were established in 1986, Cat Canyon, and Yellow Banks since 1986.

Video plots exist from all 16 kelp forest monitoring sites since 1993.

Size Frequency

Access table design structure for --SizeFreqNatHab:

Field Name	Data Type
ProgramCode	Text
EventNumber	Text
IslandCode	Text
SiteCode	Text
Observer	Text
Technique	Text
Species	Number
Size	Number
Count	Number

Sample size and database anomalies:

This protocol was implemented in 1985. Although there is a target sample size for each species that data is to be acquired at each site, the sample size varies for each species, site and year depending on the their abundance and amount of search time that was available for sampling.

Begining in 1993 the data fields Observer and Technique were added to the database. Although no data is entered prior to 1993, one can assume that the general search method was the technique used to locate the organisms to be measured. After 1993, the technique used is listed, and was most often the band transect method of search. For a detailed description of the different search methods please refer to the protocol section of this handbook.

Size and Count fields:

The Size field is the size of the animal measured, and the Count is the number of that of that species that were measured at that size. For example, if for *Strongylocentrotus purpuratus* the size field reads 22mm, and the count field reads 11, this means that for this site and sampling event there were 11 *S. purpuratus* that were measured at 22mm.

Organisms Sampled Information

See the protocol section for the list of species sampled. Size frequencies for Cypraea spadicea and Parastichopus parvimensis were discontinued in 1990.

Sites Sampled

Size frequency data is available from 14 kelp forest monitoring sites since 1985, and from the two sites that were established in 1986, Cat Canyon, and Yellow Banks since 1986.

Artificial Recruitment Modules

Access table design structure for -SizeFreqArms:

Field Name	Data Type
ProgramCode	Text
EventNumber	Text
IslandCode	Text
SiteCode	Text
ArmNo	Number
Species	Number
Size	Number
Count	Number

Sample size and database anomalies:

This protocol was implemented in 1992. Not all of the sites have artificial recruitment modules (ARMs), and the number of ARMs at these sites varies. In addition, the number of ARMs that are sampled at a given site for each year varies. If comparisons of abundance are made between years or sites be careful not to use total numbers, but to use the number/ARM.

Due to problems with numbering the ARMs, any particular ARM may have had more than one number assigned to it. In some cases it is possible to track a specific ARM although the numbers have changed. All of the information available as to what ARM was what number for a particular year is contained in the Access table, PickListArms.

Size and Count fields:

The Size field is the size of the animal measured, and the Count is the number of that species that were measured at that size. For example, if for *Strongylocentrotus purpuratus* the size field reads 22mm, and the count field reads 11, this means that for this site and sampling event there were 11 *S. purpuratus* that were measured at 22mm.

Organisms Sampled Information

See the protocol section for the list of species sampled.

l**Sites Sampled**

ARMs data are available for 10 kelp forest monitoring sites; six from 1992-present, three from 1993-present, and one from 1994-present.

Island Name	Site Name	ARMs data available
Anacapa	Admiral's Reef	1992 - present
Anacapa	Cathedral Cove	1992 - present
Anacapa	Landing Cove	1992 - present
Santa Cruz	Fry's Harbor	1993 - present
Santa Cruz	Gull Island South	1992 - present
Santa Cruz	Pelican Bay	1994 - present
Santa Cruz	Scorpion Anchorage	1993 - present
Santa Cruz	Yellow Banks	1992 - present
Santa Rosa	Johnson's Lee North	1992 - present
Santa Rosa	Johnson's Lee South	1993 - present

Species Checklist

Access table design structure for -SpeciesChecklist:

Field Name	Data Type
ProgramCode	Text
Year	Number
IslandCode	Text
SiteCode	Text
Division/Phylum	Text
Class	Text
Order	Text
Family	Text
Species	Text
AbundanceRating	Text

Sample size and database anomalies:

This table is not completed

Organisms Sampled Information

All identifiable species are listed.

Sites Sampled

Oceanographic Conditions

Access table design structure for -OceanTemp:

Field Name	Data Type
ProgramCode	Text
IslandCode	Text
SiteCode	Text
Date	Date/Time
Time	Date/Time
TemperatureC	Number
Unit	Text

Sample size and database anomalies:

Prior to 1993 , temperature was recorded only at a few of the kelp forest monitoiring sites using a temperature-depth recorder (TDR). Many problems were experienced with the TDRs, and only sporadic data exist from the sites where they were deployed. The data from the TDRs can be found in the Access table -OceanTempTDR

In 1993, small remote temperature loggers were deployed at each of the 16 kelp forest monitoring sites. This data is in the Access table -OceanTemp. If data is missing for a particular site, one can assume that the temperature logger failed and the data is unavailble.

Sites Sampled:

All 16 kelp forest monitoring sites have had temperature recording devices from 1993-present.

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APPENDIX A. List of Kelp forest species monitored annually at 16 locations in Channel Islands National Park.

SPECIES		SPECIES CODE	SAMPLING TECHNIQUE	YEARS SAMPLED	LOCATIONS	ABUNDANCE	SIZE/AGE STUCTURE
ALGAE							
Green algae		1000					
Misc. green algae		1001	R	annual	16	% cover	no
Brown algae		2000					
Misc. brown algae *		2001	R	annual	16	% cover	no
Giant Kelp	adult	2002	Q,S,M	annual	16	% cover &	yes &
Macrocystis pyrifera	juv	2002.5	Q	annual	16	density	size-freq
	sub	2002.75	Q,S,M	annual	16		
Acid weed *Desmarestia* sp.		2003	R	annual	16	% cover	no
Southern sea palm	adult	2004	Q	annual	16	density	yes
Eisenia arborea	juv.	2004.5	Q	annual	16	density	
California sea palm	adult	2005	Q	annual	16	% cover &	yes
Pterygophora californica	juv.	2005.5	Q	annual	16	density	
Oar weed	adult	2006	Q	annual	16	% cover &	yes
Laminaria farlowii	juv.	2006.5	Q	annual	16	density	
Bladder chain kelp *Cystoseira* sp.		2007	R	annual	16	% cover	no
Giant kelp, California sea palm, and Southern sea palm * *Macrocystis*, *Pterygophora*, and *Eisenia*		2008	R	annual	16	% cover	no

SPECIES	SPECIES CODE	SAMPLING TECHNIQUES	YEARS SAMPLED	LOCATIONS	ABUNDANCE	SIZE/AGE STUCTURE
ALGAE (con't)						
Giant kelp All *Macrocystis pyrifera*	2010	R	annual	16	% cover	no
Sargassum weed * *Sargassum muticum*	2011	R	annual	16	% cover	no
Southern sea palm All *Eisenia arborea*	2012	R	annual	16	% cover	no
California sea palm All *Pterygophora californica*	2013	R	annual	16	% cover	no
Oar weed All *Laminaria farlowii*	2014	R	annual	16	% cover	no
Red algae	3000					
Misc. red algae	3001	R	annual	16	% cover	no
Articulated Coralline algae	3002	R	annual	16	% cover	no
Encrusting Coralline algae	3003	R	annual	16	% cover	no
Agar weed *Gelidium Spp.*	3004	R	annual	16	% cover	no
Sea tongue *Gigartina Spp.*	3005	R	annual	16	% cover	no
Misc. Plants (i.e. Diatoms)	4001	R	annual	16	% cover	no

SPECIES	SPECIES CODE	SAMPLING TECHNIQUES	YEARS SAMPLED	LOCATIONS	ABUNDANCE	SIZE/AGE STUCTURE
INVERTEBRATES						
Porifera	5000					
Misc. sponges	5001	R	annual	16	%cover	no
Orange puffball sponge *Tethya aurantia*	5002	B,S,A	annual	16	density	size-freq
Convoluted sponge * *Leucetta losangelensis*	5003	R	annual	16	%cover	no
Aggregated nipple sponge * *Polymastia pacifica*	5004	R	annual	16	%cover	no
Cnidaria	6000					
California hydrocoral *Stylaster (Allopora) californica*	6001	B,S	annual	16	density	size-freq
White-spotted rose anemone *Urticina (Tealia) lofotensis*	6002	B	annual	16	density	no
Club-tipped anemone *Corynactis californica*	6003	R	annual	16	%cover	no
Orange cup coral *Balanophyllia elegans*	6004	R	annual	16	%cover	no
La Jolla cup coral *Astrangia lajollaensis*	6005	R	annual	16	%cover	no
Red gorgonian *Lophogorgia chilensis*	6006	B,S	annual	16	density	size-freq

SPECIES	SPECIES CODE	SAMPLING TECHNIQUES	YEARS SAMPLED	LOCATIONS	ABUNDANCE	SIZE/AGE STUCTURE
INVERTEBRATES (con't)						
Brown gorgonian *Muricea fruticosa*	6007	B,S	annual	16	density	size-freq
Californian golden gorgonian ** *Muricea californica*	6008	B,S	annual	16	density	size-freq
Annelida, Polychaeta	7000					
Ornate tube worm *Diopatra ornata*	7001	R	annual	16	%cover	no
Colonial sand-tube worm *Phragmatopoma californica*	7002	R	annual	16	%cover	no
Arthropoda, Crustacea	8000					
California spiny lobster *Panulirus interruptus*	8001	B	annual	16	density	no
Mollusca	9000					
Scaled wormsnail *Serpulorbis squamigerus*	9001	R	annual	16	%cover	no
Red abalone *Haliotis rufescens*	9002	B,S,A	annual	16	density	size-freq
Pink abalone *Haliotis corrugata*	9003	B,S,A	annual	16	density	size-freq
Green abalone *Haliotis fulgens*	9004	B,S,A	annual	16	density	size-freq

SPECIES	SPECIES CODE	SAMPLING TECHNIQUES	YEARS SAMPLED	LOCATIONS	ABUNDANCE	SIZE/AGE STUCTURE
INVERTEBRATES (con't)						
Chestnut cowrie *Cypraea spadicea*	9005	Q,A	annual	16	density	no
Kellets whelk *Kelletia kelletii*	9006	B,S,A	annual	16	density	size-freq
Wavy turban snail *Lithopoma (Astraea) undosum*	9007	Q,S,A	annual	16	density	size-freq
Red turban snail ** *Lithopoma (Astraea) gibberosum*	9008	Q,S,A	annual	16	density	size-freq
Giant keyhole limpet *Megathura crenulata*	9009	B,S,A	annual	16	density	size-freq
Rock scallop *Crassedoma (Hinnites) giganteum*	9010	B,S,A	annual	16	density	size-freq
California brown sea hare *Aplysia californica*	9011	B	annual	16	density	no
Bryozoa	10000					
Misc. bryozoans	10001	R	annual	16	%cover	no
Southern staghorn bryozoan *Diaperoecia californica*	10002	R	annual	16	%cover	no
Echinodermata	11000					
Bat Star *Asterina (Patiria) miniata*	11001	Q,S,A	annual	16	density	size-freq

SPECIES	SPECIES CODE	SAMPLING TECHNIQUES	YEARS SAMPLED	LOCATIONS	ABUNDANCE	SIZE/AGE STUCTURE
INVERTEBRATES (con't)						
Giant-spined sea star *Pisaster giganteus*	11002	Q,S,M,A	annual	16	density	size-freq
Sunflower star *Pycnopodia helianthoides*	11003	B,S,A	annual	16	density	size-freq
White sea urchin *Lytechinus anamesus*	11004	B,S,A	annual	16	density	size-freq
Red sea urchin *Strongylocentrotus franciscanus*	11005	Q,S,A	annual	16	density	size-freq
Purple sea urchin *Strongylocentrotus purpuratus*	11006	Q,S,A	annual	16	density	size-freq
Warty sea cucumber *Parastichopus parvimensis*	11007	Q,A	annual	16	density	size-freq
Aggregated red cucumber *Pachythyone rubra*	11008	R	annual	16	%cover	no
Crowned sea urchin ** *Centrostephanus coronatus*	11009	Q,S,A	annual	16	density	size-freq
Tunicates *	12000					
Misc. tunicates	12001	R	annual	16	%cover	no
Stalked tunicate *Styela montereyensis*	12002	Q	annual	16	density	no
Misc. marine invertebrates	13001	R	annual	16	%cover	no

SPECIES		SPECIES CODE	SAMPLING TECHNIQUES	YEARS SAMPLED	LOCATIONS	ABUNDANCE	SIZE/AGE STUCTURE
FISHES			14000				
Blacksmith	adult	14001	F,G	biannual	16	relative	yes
Chromis Punctipinnis	juv.	14002	F,G	biannual	16	relative	
Señorita	adult	14003	F,G	biannual	16	relative	yes
Oxyjulis californica	juv.	14004	F	biannual	16	relative	
Blue rockfish	adult	14005	F,G	biannual	16	relative	yes
Sebastes mystinus	juv.	14006	F	biannual	16	relative	
Olive rockfish	adult	14007	F,G	biannual	16	relative	yes
Sebastes serranoides	juv.	14008	F	biannual	16	relative	
Kelp rockfish	adult	14009	F,G	biannual	16	relative	yes
Sebastes atrovirens	juv.	14010	F	biannual	16	relative	
Kelp bass	adult	14011	F,G	biannual	16	relative	yes
Paralabrax clathratus	juv.	14012	F	biannual	16	relative	
California sheephead	male	14013	F,G	biannual	16	relative	yes
Semicossyphus pulcher	female	14014	F,G	biannual	16	relative	
	juv.	14014.5	F,G	biannual	16	relative	
Black surfperch	adult	14015	F,G	biannual	16	relative	yes
Embiotoca jacksoni	juv.	14016	F	biannual	16	relative	
Striped surfperch	adult	14017	F,G	biannual	16	relative	yes
Embiotoca lateralis	juv.	14018	F	biannual	16	relative	
Pile perch	adult	14019	F,G	biannual	16	relative	yes
Damalichthys vacca	juv.	14020	F	biannual	16	relative	

SPECIES		SPECIES CODE	SAMPLING TECHNIQUES	YEARS SAMPLED	LOCATIONS	ABUNDANCE	SIZE/AGE STUCTURE
FISHES (con't)							
Garibaldi	adult	14021	F,G	biannual	16	relative	yes
Hypsypops rubicundus	juv.	14022	F,G	biannual	16	relative	
Opaleye	adult	14023	F,G	biannual	16	relative	yes
Girella nigricans	juv.	14024	F	biannual	16	relative	
Bluebanded goby		14025	Q,G	annual/	16	density	no
Lythrypnus dalli				biannual	16	relative	
Blackeye goby		14026	Q,G	annual/	16	density	no
Coryphopterus nicholsii				biannual	16	relative	
Island kelp fish		14027	Q,G	annual/	16	density	no
Alloclinus holderi				biannual	16	relative	
Rock wrasse	male	14028	F,G	biannual	16	relative	yes
Halichoeres semicinctus	female	14029	F,G	biannual	16	relative	
SUBSTATES		15000					
Bare		15001	R	annual	16	% cover	no
Rock		15002	R	annual	16	% cover	no
Cobble		15003	R	annual	16	% cover	no
Sand		15004	R	annual	16	% cover	no

APPENDIX B. Establishing underwater tansects

Emplacement procedures were designed to be conducted in stages by a series of divers because the time an individual diver can spend underwater without risk of decompression sickness is limited.

The first pair of divers laid out a 100-m fiberglass measuring tape on a section of relatively continuous rocky bottom with a conspicuous kelp canopy or cover. The tape was anchored at both ends by cement filled automobile tires weighing about 60-100 kg on the surface. Using the tape measure as a guide, the second pair of divers drilled 11 holes into the bedrock at 10 m intervals. Each hole was 2.5 cm in diameter and 20-25 cm deep. The holes were drilled with a hydraulic hammer drill (Stanley HD-45) modified for underwater use, and a carbide-tipped fluted drill (Skill #736). The holes were drilled in basalt and other volcanic rocks at the rate of 1-2 cm per minute, and 3-5 cm per minute in sandstone. The hammer drill requires a flow of 25-35 liters per minute at 105 bar and was driven with a hydraulic pump mounted on the boat. The drill was connected to the boat by 150 m of 2.5 cm diameter synflex hydraulic hose. The drilling team also placed a 30 x 1 cm stainless steel eyebolt in each hole.

The next team consisted of three divers who measured the precise distance between the eyebolts, cut 1.2 cm diameter leadcore nylon sampson line to appropriate lengths, draped the line over the sea floor between the eyebolts, and secured the line at both ends using opposing figure eight knots at each eyebolt. The leadcore line for each transect weighted 30-40 kg depending on the amount of vertical relief traversed, and required considerable skill and ingenuity to deploy underwater in kelp forests and strong wave surge.

The last dive team injected each hole with a two-part epoxy bonding adhesive (Celtite 42-45 hi bond) that was mixed underwater in cartridges designed for this use by Semco Inc., of Glendale, CA. The adhesive was applied with a pneumatic caulking gun (Semco Model 550) modified to operate with a SCUBA tank and a modified regulator. The last dive team also retrieved the measuring tape and inspected the transect line. The adhesive was reported to harden in 40-60 minutes, but apparently cool (14-20^{O} C) temperatures and extreme humidity slowed the curing process of an order of magnitude to 10-12 hours.

Each finished transect line consists of 11 stainless steel eyebolts anchored in bedrock in ten meter intervals connected by ten lengths of leadcore nylon line. The advantages of this design are that the 11 eyebolts provide precise locations to which various biological sampling schemes may be referenced. In addition, loss of an entire transect line to storm or a boat anchor drug across the line is greatly reduced.

The sites are visited at least once a year and inspected for line breaks and eyebolt damage. If parts of the lead line are missing or broken, the transects is repaired by tying new line to the existing transect. Damage or missing eyboldts are replaced by drilling new holes and adding a new eyeboldt with epoxy.

APPENDIX C.
Species list for all Channel Islands National Park stations

CHLOROPHYTA
Bryopsis
Bryopsis corticulans
Bryopsis hypnoides
Chaetomorpha
Chaetomorpha linum
Chaetomorpha spiralis
Cladophora columbiana
Cladophora graminea
Cladophora microcladioides
Cladophora
Codium cuneatum
Codium fragile
Codium hubbsii
Codium hubbsii/setchellii
Codium johnstonei
Codium setchellii
Derbesia marina
Enteromorpha
Enteromorpha compressa
Enteromorpha intestinalis
Enteromorpha linza
Green mat on sand
Halicystis ovalis
Ulva
Ulva californica
Ulva lactuca
Ulva lobata
Ulva rigida
Ulva taeniata

PHAEOPHYTA
Acinetospora nicholsoniae
Agarum fimbriatum
Coilodesme
Coilodesme californica
Coilodesme corrugata
Coilodesme rigida
Colpomenia
Colpomenia peregrina
Colpomenia sinuosa
Colpomenia/Hydroclathrus
Costaria costata
Cutleria cylindrica
Cylindrocarpus rugosus
Cystoseira
Cystoseira neglecta
Cystoseira osmundacea
Cystoseira setchellii
Desmarestia
Desmarestia latifrons
Desmarestia ligulata
Desmarestia ligulata var. *firma*
Desmarestia munda
Desmarestia viridis
Dictyoneuropsis reticulata
Dictyopteris new species
Dictyopteris undulata
Dictyota
Dictyota binghamiae
Dictyota flabellata
Dictyota/Pachydictyon
Ectocarpoid fuzz
Egregia menziesii
Eisenia arborea
Endarachne binghamiae
Giffordia
Giffordia/Ectocarpus
Giffordia granulosa
Giffordia mitchelliae
Halidrys dioica
Hapterophycus canaliculatus
Hesperophycus harveyanus
Hydroclathrus clathratus
Laminaria
Laminaria farlowii
Laminaria setchellii
Leathesia difformis
Macrocystis pyrifera
Pachydictyon coriaceum
Pelagophycus porra
Pelvetia fastigiata
Petalonia fascia
Pseudolithoderma nigra
Pterygophora californica
Punctaria hespera
Punctaria occidentalis
Ralfsia
Rosenvingea floridana
Sargassum
Sargassum agardhianum
Sargassum muticum
Sargassum palmeri
Scytosiphon
Scytosiphon dotyi
Scytosiphon lomentaria
Soranthera ulvoidea
Sphacelaria
Sphacelaria californica
Sphacelaria furcigera
Sporochnus pedunculatus
Taonia lennebackeriae
Tinocladia crassa
Zonaria farlowii

RHODOPHYTA
Acrochaetium desmarestiae
Acrosorium uncinatum
Ahnfeltia
Ahnfeltia plicata
Amphiroa zonata
Amplisiphonia pacifica
Anisocladella
Anisocladella pacifica
Antithamnion
Antithamnion defectum
Antithamnion dendroideum
Antithamnionella breviramosa
Antithamnionella
Asparagopsis taxiformis
Asterocolax gardneri
Bangia
Bangia vermicularis
Binghamia
Binghamia californica
Bonnemaisonia hamifera
Bossiella
Bossiella californica
Bossiella californica var. *schmitti*
Bossiella orbigniana
Bossiella orbigniana ssp. *dichotoma*
Bossiella plumosa
Bossiella/Calliarthron
Botryocladia
Botryocladia neushulii
Botryocladia pseudodichotoma
Botryoglossum farlowianum
Botryoglossum ruprechtianum
Branchioglossum
Branchioglossum woodii
Calliarthron
Calliarthron cheilosporioides
Callithamnion
Calliarthron tuberculosum
Callithamnion biseriatum
Callithamnion pikeanum
Callithamnion rupicolum
Callocolax fungiformis
Callophyllis
Callophyllis firma
Callophyllis flabellulata
Callophyllis heanophylla

Callophyllis obtusifolia
Callophyllis pinnata
Callophyllis violacea
Carpopeltis
Carpopeltis bushiae
Centroceras
Centroceras clavulatum
FAMILY CERAMIACEAE
Ceramium
Ceramium californicum
Ceramium caudatum
Ceramium clarionense
Ceramium codicola
Ceramium eatonianum
Ceramium pacificum
Ceramium procumbens
Ceramium sinicola
Chondria
Chondria californica
Chondria decipiens
Chondria nidifica
Coeloseira
Coeloseira compressa
Corallina
Corallina officinalis
Corallina pinnatifolia
Corallina vancouveriensis
Corallines-Encrusting
Corallines-Erect
Cryptonemia
Cryptonemia obovata
Cryptopleura
Cryptopleura corallinara
Cryptopleura crispa
Cryptopleura lobulifera
Cryptopleura ruprechtiana
Cryptopleura violacea
Cumagloia andersonii
Dasya sinicola var. *californica*
Dasya sinicola var. *abyssicola*
Dasya sinicola
Dermocorynus occidentalis
FAMILY DELISSERIACEAE
Endocladia muricata
Erythrocystis saccata
Erythrophyllum delisserioides
Erythrotrichia carnea
Erythrotrichia tetraseriata
Farlowia compressa
Farlowia conferta
Farlowia pink/white rosette
Fauchea
Fauchea laciniata
Fauchea n.sp.
Fryeella gardneri
Gastroclonium
Gastroclonium coulteri
Gastroclonium subarticulatum
Gelidium
Gelidium coulteri
Gelidium nudifrons
Gelidium purpurascens
Gelidium pusillum
Gelidium robustum
Gelidium/Pterocladia
Gigartina
Gigartina canaliculata
Gigartina corymbifera
Gigartina exasperata
Gigartina harveyana
Gigartina leptorhynchos
Gigartina spinosa
Gigartina volans
Goniotrichopsis sublittoralis
Goniotrichun alsidii
Gracilaria
Gracilaria andersonii
Gracilaria robusta
Gracilaria sjoestedtii
Gracilaria textorii
Gracilaria verrucosa
Gracilariophila oryzoides
Grateloupia
Grateloupia doryphora
Grateloupia filicina
Grateloupia prolongata
Griffithsia pacifica
Gymnogongrus
Gymnogongrus leptophyllus
Gymnogongrus platyphyllus
Haliptylon gracile
Halymenia
Halymenia californica
Halymenia coccinea
Halymenia/Schizymenia
Helminthocladia australis
Herposiphonia
Herposiphonia plumula
Herposiphonia verticillata
Herposiphonia plumula
Heterosiphonia erecta
Heterosiphonia japonica
Hildenbrandia
Hymenena flabilligera
Hypnea
Hypnea cervicornis
Hypnea johnstonii
Hypnea valentiae
Hypnea variabilis
Iridaea
Iridaea cordata
Iridaea linearis
Iridaea/Rhodoglossum
Janczewskia gardneri
Janczewskia lappacea
Jania
Jania crassa
Jantinella verrucaeformis
Kalymenia pacifica
Laurencia
Laurencia crispa
Laurencia masonii
Laurencia pacifica
Laurencia sinicola
Laurencia snyderiae
Laurencia spectabilis
Laurencia spectabilis var. *diegoensis*
Laurencia splendens
Laurencia subdistica
Laurencia subopposita
Leptocladia binghamiae
Liagora californica
Lithophyllum proboscideum
Lithothamnium
Lithothamnium australe
Lithothamnium californicum
Lithothamnium crassiusculum
Lithothamnium giganteum
Lithothamnium pacificum
Lithothrix aspergillum
Maripelta rotata
Mastocarpus papillatus
Melobesia
Melobesia marginata
Melobesia mediocris
Mesophyllum lamellatum
Mesophyllum
Microcladia
Microcladia coulteri
Nemalion helminthoides
Neoagardhiella
Neoptilota densa
Neorhodomella larix
Nienburgia andersoniana
Odonthalia floccosa
Opuntiella californica
Ozophora clevelandii
Ozophora latifolia
Petrocelis franciscana
Petrocelis
Peyssonellia
Phycodrys
Phycodrys isabelliae
Phycodrys setchellii
Pikea
Pikea robusta
Platoma n.sp.
Platythamnion villosum
Pleonosporium
Pleonosporium squarrulosum
Pleonosporium vancouverianum

Plocamium
Plocamium cartilagineum
Plocamium violaceum
Pogonophorella californica
Polysiphonia
Polyneura latissima
Polysiphonia hendryi
Polysiphonia hendryi var. *gerdneri*
Polysiphonia pacifica
Polysiphonia pacifica var. *delicatula*
Polysiphonia paniculata
Polysiphonia savatieri
Polysiphonia scopulorum
Porphyra
Porphyra lanceolata
Porphyra occidentalis
Porphyra perforata
Predaea masonii
Prionitis
Prionitis angusta
Prionitis australis
Prionitis cornea
Prionitis lanceolata
Prionitis lyallii
Priopeltis
Pseudolithophyllum muricatum
Pseudogloiophloea confusa
Pseudoscinaia snyderiae
Pterochondria woodii
Pterochondria dendroiodea
Pterocladia
Pterocladia capillacea
Pterosiphonia
Pterosiphonia baileyi
Pterosiphonia dendroidea
Pterosiphonia pennata
Ptilothamniopsis lejolisea
Pugetia fragilissima
Rhodochorton purpureum
Rhodoglossum
Rhodoglossum affine
Rhodoglossum californicum
Rhodoglossum roseum
Rhodoptilum plumosum
Rhodymenia
Rhodymenia arborescens
Rhodymenia californica
Rhodymenia callophyllidoides
Rhodymenia pacifica
Rhodymeniocolax botryoides
Sarcodiotheca furcata
Sarcodiotheca gaudichaudii
Schimmelmania plumosa
Schizymenia
Schizymenia epiphytica
Schizymenia/Halymenia
Schizymenia pacifica
Sciadophycus stellatus
Scinaia
Scinaia articulata
Scinaia confusa
Scinaia johnstoniae
Smithora naiadum
Sorella
Sorella delicatula
Stenogramme interrupta
Tenarea
Tenarea dispar
Tiffaniella snyderiae
Weeksia reticulata

ANGIOSPERMA

Phyllospadix
Phyllospadix scouleri
Phyllospadix torreyi
Zostera marina

BACTERIA

white bacterial filaments
Cyanobacterial film
Cyanobacterial filaments

DIATOMS

Diatom film
Schizymenia colonial diatoms
Dendritis jelly

PROTOZOA

Homotrema rubrum
Gromia oviformis
Radiolarians
Suctorians (Ephelota?)

PORIFERA

Clathrina
Clathrina blanca
Leucandra
Clathrina coriacea
Leucandra healthi
Leucandra/Scypha
Leucetta losangelensis
Leucilla nuttingi
Leucosolenia eleanor
Scypha ciliata
yello sponge with tall pores
Acarnus
Acarnus erithacus
Adocia
Anaata spongigartina
Antho lithiphoenix
Aplysilla glacialis
Artemisina archegona
Astylinifer arndti
Axinella mexicana
Axocielita originalis
Clathriopsamma pseudonapya
Cliona
Cliona celata
Cliona celata var. *californiana*
Cyamon neon
Dysidea amblia
Eurypon asodes
Geodia mesotriaena
Halichondria
Haliclona
Haliclona permollis
Haliclona orange or green/whit form
Halisarca sacre
Hemectyon hyale
Higginsia higginsina
Hymedesmia brepha
Hymenamphiastra cyanocrypta
Hymeniacidon sinapium
Hymeniacidon
Iophon chelifer
Lissodendoryx firma
Lissodendoryx topsenti
Microciona parthena
Microciona microjoanna
Mycale macginitiei
Myxilla
Ophalitaspongia pennata
Penares cortius
Plocamia karykina
Plocamissa igzo
Polymastia pachymastia
red sponges - encrusting
Spheciospongia confoederata
Steletta estrella
Suberites
Tethya aurantia
Tetilla
Tetilla arb
Tetilla flamingo
Toxodocia zumi
Verongia aurea
Aplysina fistularis
Xestospongia trindinaea
Xestospongia vanilla

CNIDARIA

CLASS HYDROZOA

Abietinaria
Aglaophenia
Aglaophenia latirostris
Aglaophenia struthionoides
Allopora californica
Allopora porphyra
Antenella avalonia
Apolemia uvaria

Apolemia siphonophore
Bougainvilla
Campanularia
Clytia
Corymorpha palma
Corymorpha
Corynes/Syncoryne
Eucopella everta
Eudendrium
Eudendrium californicum
Garveia annulata
Hydractinia
Lytocarpus nuttingi
Obelia
Physophora hydrostatica
Plumularia
Sertularella
Sertularia
Tubularia
Clavularia
Pachycerianthus fimbriatus
Chrysaura melanaster
Pelagia colorata
Stauromedusae
Thaumatoscyphus atlanticus
Cubo-mediusea
Siphonophores
Velella velella

CLASS ANTHOZOA

Adelogorgia phyllosclera
Eugorgia rubens
Lophogorgia chilensis
Muricea californica
Muricea fruticosa
Acanthoptilum
Ptilosarcus gurneyi
Renilla kollikeri
Stylatula elongata
Epizoanthus induratum
Epizoanthus leptoderma
Epizoanthus
Parazoanthus lucificum
Corynactis californica
Anthopleura artemisia
Anthopleura elegantissima
Anthopleura xanthogrammica
Cactosoma arenaria
Diadumene
Epiactis prolifera
Halcampa decemtentaculata
Harenactis attenuata
Isanthus
Metridium exilis
Metridium senile
Phylactis
Phyllactis bradleyi
Sagartia catalinensis
Tealia
Tealia columbiana
Tealia coriacea
Tealia n.sp.
Tealia crassicornis
Tealia lofotensis
Tealia piscivora
Zaolutus actius

Order madreporaria

Astrangia lajollensis
Balanophyllia elegans
Coenocyathus bowersi
Paracyathus stearnsi
Nomlandia californica
Desmophyllum dianthus
Labyrinthocyathus quaylei
Lophelia pertusa
Madrepora oculata
Polymyces montereyensis

CTENOPHORA

Beroe
Leucothea
Pleurobrachia
Cestum/Vellum

PLATYHELMINTHES

Enchiridium punctatum
Eurylepta aurantiaca
Eurylepta californica
Kaburakia
Leptoplana/Notoplana
Phylloplana viridis
Prostheceraeus bellostriatus
Psuedoceros luteus
Pseudoceros montereyensis
Pseudoceros perviolaceus
Stylochus insolitus
Stylochus tripartitus
Thysanozoon californicum

NEMERTEA

Baseodiscus punnetti
Cerebratulus californiensis
Cerebratulus
Emplectonema gracile
Lineus pictifrons
Micrura pardalis
Paranemertes californica
Paranemertes peregrina
Paranemertes
Tubulanus frenatus
Tubulanus pellucidus
Tubulanus sexlineatus
Tubulanus polymorphous
Tubulanus

SIPUNCULA

Phascolosoma
Phascolosoma agassizii
Sipunculus nudus
Themiste pyroides

ECHIURA

Urechis caupo

ANNALIDA

CLASS POLYCHAETA

Anaitides
Anaitides groenlandica
Arctonoe
Arctonoe pulchra
Arctonoe vittata
Arctonoe on *Desmarestia*
Bispira turneri
Chaetopterus variopedatus
Cirriformia luxuriosa
Cirriformia spirabrancha
Dispio uncinata
Diopatra ornata
Dodecaceria fewkesi
Eudistylia
Eudistylia polymorpha
Euphrosine
Euzonus dillonensis
Euzonus mucronata
Glycera americanus
Halosydna brevisetosa
Halosydna johnsoni
Halosydna
Harmothoe lunulata
Harmothoe
Flabelligera commensalis
Flabelligera essenberge
Lumberneris zonata
Mesochaetopterus
Myxicola infundibulum
Nephtys californiensis
Nerid
Ophiodromus pugettensis
Paraonella platybrachia
Pectinaria californiensis
Phragmatopoma californica
Phyllochaetopterus prolifica
Phyllodoce hartmanae
Phyllodocid
Pista elongata
Polydoris alloporis
Polychete eggs
Polynoid
Potamilla occelata
Bispira crassicornis
Sabellaria cementum

Sabellid
Sand sabellid
Sabellid with eyestalk
Salmacina tribranchiata
Scololepis squamata
Scololepis nr. armiger
Serpulid
Serpula vermicularis
Soda straw tubes in sand
Spiochaetopterus costarum
Spirobranchus spinosus
Spirobranchus spionid
Spirorbid
Sthenelais berkeleyi
Terebellid
Thelepus
Thelepus crispus
Thelepus setosus
Polychaete 'balloons'

ARTHROPODA

SUBPHYLUM CRUSTACEA

SUBCLASS CIRRIPEDIA

Armatobalanus nefrens
Balanus
Balanus amphitrite
Balanus aquila
Balanus aquila/nubilus
Balanus glandula
Balanus nubilus
Balanus pacificus
Balanus trigonus
Chthamalus dalli/fissus
Conopea galeata
Megabalanus californicus
Membranobalanus orcutti
Pollicipes polymerus
Tetraclita elegans
Tetraclita rubescens

CLASS MALOCOSTRACA

Mysids
Mysids brown canopy dwellers
Mysids clear bottom dwellers
Archeomysis grebnitzkii
Acanthomysis sculpta
Zeuxo paranormani

Order Isopoda

Alloniscus perconvexus
Cirolana
Cirolana harfordi
Excirolana chiltoni
Exsphaeroma inorata
Colidotea
Idotea
Idotea resecata
Idotea stenops
Ligia occidentalis
Lironeca vulgaris
Tylos

Order Amphipoda

Amphipod tube masses
Ampithoe humeralis
brown and yellow Pleustes
Eohaustorius washingtonianus
Mandibulophoxus gilesi
Hyale frequens
Perampithoe
Synchelidium shoemakeri
Paraphoxus milleri
Pleustes platypa
Rhepoxynius abronius
Corophium
Megalorchestia californiana
Megalorchestia corniculata
Megalorchestia minor
Caprellidea

Order Euphausiacea

Copepods
Copepods on *Megathura*
Copepods on fish
Tigriopus californicus

Order Decapoda

Alpheus
Alpheus clamator
Betaeus
Betaeus harfordi
Betaeus longidactylus
Betaeus macginitieae
Crangon
Crangon alaskensis
Crangon nigricauda
Heptacarpus
Heptacarpus pictus
Hippolyte
Hippolyte californiensis
Hippolyte clarki
Lysmata californica
Neocrangon
Neocrangon resima
Neocrangon zacae
Pandalus
Pandalus danae
Spirontocaris
Spirontocaris prionata
Synalpheus lockingtoni
Panulirus interruptus
Blepharipoda occidentalis
Lepidopa californica
Callianassa
Cryptolithodes sitchensis
Emerita analoga
Fabia
Hapalogaster cavicauda
Isocheles pilosus
Pachycheles rudis
Orthopagurus
Orthopagurus minimus
Pachycheles
Paguristes
Paguristes bakeri
Paguristes parvus
Paguristes turgidus
Pagurus
Pagurus armatus
Pagurus granosimanus
Pagurus hemphilli
Pagurus hirsutiusculus
Pagurus samuelis
Petrolisthes
Petrolisthes cabrilloi
Pimochirus californiensis
Pleuroncodes planipes
Polyonyx quadriungulatus
Pylopagurus sp.(=pimochirus)
Cancer
Cancer antennarius
Cancer anthonyi
Cancer branneri
Cancer gracilis
Cancer jordani
Cancer productus
Cycloxanthops novemdentatus
Epialtoides hiltoni
Erileptus spinosus
Hemigrapsus nudus
Herbstia parvifrons
Heterocrypta occidentalis
Lophopanopeus
Loxorhynchus crispatus
Loxorhynchus grandis
Mimulus foliatus
Oregonia gracilis
Mursia gaudichaudii
Pachygrapsus crassipes
Paraxanthias taylori
Pelia tumida
Pilumnus spinohirsutus
Pinnixa
Pinnotherid
Podochela hemphilli
Portunus xantusii
Pugettia
Pugettia dalli
Pugettia producta
Pugettia richii
Pyromaia tuberculata
Randallia ornata
Scyra acutifrons
Taliepus nuttalli
Hemisquilla ensigera

SUBCLASS ARACHNIDA
Gammaridacarus brevisternalis
CLASS INSECTA
Coelopa vanduzei
Family Staphylinidae
Bledius fenyesi
Cafius canescens
Cafius seminitens
Carpelimus
Empenota arenaria
Hadrotes crassus
Pontomalota opaca
Thinopinus pictus
Family Carabidae
Dyschirius marinus
Phalaria rotundata
Family Hydraenidae
Neochthobius vandykei
Family Curculionidae
Emphyastes fucicola
Family Histeridae
Neopachylopus sulcifrons
Family Hydrophilidae
Cercyon luniger
Family Hemiptera
Trichocorixa reticulata

MOLLUSCA

CLASS GASTROPODA
Acanthina
Acanthina punctulata
Acanthina spirata
Acmaea mitra
Alia carinata
Amphissa versicolor
Lithopoma gibberosum
Lithopoma undosum
Balcis
Balcis rutila
Bittium
Bittium attenuatum
Bursa californica
Caecum
Caecum crebricinctum
Calliostoma
Calliostoma annulatum
Calliostoma canaliculatum
Calliostoma gemmulatum
Calliostoma gloriosum
Calliostoma ligatum
Calliostoma supragranosum
Cancellaria cooperi
Ceratostoma foliatum
Ceratostoma nuttalli
Cerithiopsis
Collisella
Collisella asmi
Collisella conus
Collisella digitalis
Collisella limatula
Collisella ochracea
Collisella pelta
Collisella scabra
Collisella strigatella
Conus californicus
Crassispira semiinflata
Crepipatella lingulata
Crepidula
Crepidula adunca
Crepidula dorsata
Crepidula norrisarum
Crepidula onyx
Crepidula perforans
Crucibulum spinosum
Cypraea spadicea
Dendropoma
Dendropoma lituella
Diodora
Diodora arnoldi
Diodora aspera
Epitonium
Epitonium tinctum
Erato
Erato columbella
Erato vitellina
Fissurella volcano
Fusinus kobelti
Fusinus luteopictus
Haliotis corrugata
Haliotis cracherodii
Haliotis fulgens
Haliotis rufescens
Haliotis sorenseni
Haliotis walallensis
Haliotis assimilis
Hipponix
Hipponix tumens
Homalopoma
Homalopoma baculum
Homalopoma luridum
Kelletia kelletii
Lacuna
Lacuna unifasciata
Lamellaria
Latiaxis oldroydi
Liotia fenestrata
Littorina keenae
Littorina scutulata
Lottia gigantea
Macron lividus
Maxwellia gemma
Maxwellia santarosana
Megasurcula carpenteriana
Megasurcula stearnsiana
Megathura crenulata
Megatebennus bimaculatus
Mitra idae
Mitrella
Mitrella tuberosa
Mitromorpha carpenteri
Nassarina penicillata
Nassarius fossatus
Nassarius insculptus
Nassarius mendicus
Nassarius perpinguis
Nassarius
Neverita recluziana
Norrisia norrisi
Notoacmaea insessa
Notoacmaea paleacea
Notoacmaea depicta
Nucella
Nucella emarginata
Ocenebra
Ocenebra circumtexta
Ocenebra foveolata
Ocenebra lurida
Ocenebra interfossa
Olivella
Olivella baetica
Olivella biplicata
Opalia funiculata
Ophiodermella ophioderma
Parviturbo acuticostatus
Pedicularia californica
Petaloconchus
Petaloconchus montereyensis
Polinices
Polinices altus
Polinices reclusianus
Polinices lewisii
Pseudomelatoma
Pseudomelatoma torosa
Pteropurpura
Pteropurpura festiva
Pteropurpura trialata
Roperia poulsoni
Seila montereyensis
Serpulorbis squamigerus
Simnia vidleri
Tegula
Tegula aureotincta
Tegula brunnea
Tegula eiseni
Tegula funebralis
Tegula gallina
Tegula pulligo
Tegula regina
Tegula montereyi
Terebra pedroana
Tricolia

Tricolia pulloides
Triphora
Triphora pedroana
Trivia
Trivia californiana
Trivia solandri
Vitrinella
Vitrinella oldroydi
Volvarina taeniolata
Acteocina
Acteocina harpa
Acteocina inculta
Subclass Opisthobranchia
Aplysia
Aplysia californica
Aplysia vaccaria
Aplysiopsis smithi
Berthella californica
Berthellina engeli
Bulla
Bulla gouldiana
Bulla/Haminoea
Navanax inermis
Cylichna
Cylichna diegensis
Elysia hedgepethii
Haminoea
Haminoea vesicula
Haminoea virescens
Haminoea virescens eggs
Iselica ovoidea
Odostomia
Odostomia navisa
Phyllaplysia taylori
Pleurobranchus
Pleurobranchaea californica
Rictaxis
Rictaxis punctocaelatus
Rictaxis 'DNA' egg spirals
Tylodina fungina
Volvulella
Volvulella panamica
Nudibranchia
Acanthodoris
Acanthodoris brunnea
Acanthodoris lutea
Acanthodoris rhodoceras
Acanthodoris hudsoni
Aegires albopunctatus
Aeolidia papillosa
Aldisa sanguinea
Ancula pacifica
Anisodoris nobilis
Antiopella barbarensis
Archidoris montereyensis
Archidoris odhneri
Armina californica
Atagema quadrimaculata
Cadlina
Cadlina flavomaculata
Cadlina limbaughi
Cadlina luteomarginata
Cerberilla
Chromodoris macfarlandi
Chromodoris porterae
Conualevia alba
Corambe pacifica
Coryphella
Coryphella trilineata
Cuthona lagunae
Dendrodoris n.sp.
Dendronotus albus/diversicolor
Dendronotus frondosus
Dendronotus iris
Dendronotus subramosus
Diaulula sandiegensis
Dirona albolineata
Dirona picta
Discodoris heathi
Doriopsilla albopunctata
Doto amyra
Facelina stearnsi
Fiona pinnata
Flabellinopsis iodinea
Hermissenda crassicornis
Hopkinsia rosacea
Hypselodoris californiensis
Jorunna pardus
Laila cockerelli
Melibe leonina
Mexichromis porterae
Peltodoris n.sp.
Phidiana pugnax
Polycera atra
Polycera tricolor
Precuthona divae
Rostanga pulchra
Spurilla chromosoma
Spurilla olivae
Thordisa bimaculata
Triopha catalinae
Triopha maculata
Tritonia diomedea
Tritonia festiva
Subclass Pulmonata
Trimusculus reticulatus
Onchidella borealis
CLASS POLYPLACOPHORA
Callistochiton crassicostatus
Callistochiton
Chaetopleura gemma
Cryptochiton stelleri
Lepidochitona dentiens
Lepidochitona hartwegii
Lepidochitona hartwegii
Lepidozona
Lepidozona mertensii
Lepidozona pectinulata
Mopalia
Mopalia muscosa
Nuttalina
Nuttalina californica
Placiphorella velata
Stenoplax
Stenoplax conspicua
Tonicella lineata
CLASS BIVALVIA
Adula diegensis
Adula falcata
Americardia biangulata
Brachidonties adamsianus
Chaceia ovoidea
Chama arcana
Chione
Chione californiensis
Chione undatella
Chlamydoconcha orcutti
Clinocardium nuttallii
Diplodonta orbellus
Donax
Ensis
Epilucina californica
Leporimetis obesa
Gari californica
Glans carpenteri
Gregariella chenui
Hiatella artica
Crassadoma giganteum
Irusella lamellifera
Kellia laperousii
Laevicardium substriatum
Leptopecten latiauratus
Lima hemphilli
Lithophaga plumula
Lithophaga subula
Lyonsia californica
Macoma
Macoma nasuta
Macoma secta
Mactra californica
Modiolus capax
Modiolus rectus
Mysella pedroana
Mytilimeria nuttalli
Mytilus californianus
Mytilus edulis
Mytilus galloprovencialis
Panopea generosa
Parapholus californicus
Parvilucina
Parvilucina tenuisculpta

Pecten diegensis
Penitella conradi
Penitella penita
Pholad
Pitar newcombianus
Platydon cancellatus
Pododesmus cepio
Protothaca laciniata
Protothaca
Protothaca staminea
Pseudochama exogyra
Saxidomus nuttalli
Semele
Semele decisa
Semele rupicola
Septifer bifurcatus
Siliqua
Siliqua lucida
Solen rosaceus
Solemya reidi
Tagelus
Tagelus californianus
Tagelus subteres
Tellina
Tellina bodegensis
Tellina carpenteri
Tellina modesta
Thracia curta
Tivela stultorum
Trachycardium quadragenarium
Tresus nuttallii
Ventricolaria fordii
Zirfaea pilsbryi

CLASS CEPHALAPODA

Argonata pacifica
Loligo opalescens
Rossia pacifica
Octopus
Octopus bimaculatus
Octopus bimaculoides
Octopus bimaculatus/bimaculoides
Octopus dofleini
Octopus micropyrsus
Octopus rubescens

ECTOPROCTA

Aetea
Antropora tincta
Bicrisia edwardsiana
Bowerbankia
Bugula
Bugula californica
Bugula neritina
Callopora
Cauloramphus
Cellaria
Cellaria mandibulata
Celleporaria brunnea
Celleporella hyalina
Coleopora gigantea
Costazia robertsoniae
Crisia
Crisulipora
Crisulipora occidentalis
Diaperoecia californica
Disporella
Eurystomella bilabiata
Eurystomella
Fenestrulina malusi
Filicrisia
Filicrisia geniculata
Flustrellidra
Heteropora magna
Hippodiplosia insculpta
Hippothoa distans
Lagenipora
Lagenipora punctata
Lichenopora novae-zelandiae
Lyrula hippocrepis
Membranipora
Membranipora membranacea
Membranipora tuberculata
Microporella
Pherusella brevituba
Phidolopora labiata
Phidolopora pacifica
Rhynchozoon
Schizoporella
Scrupocellaria
Thalamoporella californica
Tricellaria occidentalis
Tricellaria
Tubulipora

ENTOPROCTA

Barentsia

PHORONIDA

Phoronis
Phoronis vancouverensis
Phoronopsis californica

BRACHIOPODA

Glottidia albida
Terebratalia

ECHINODERMATA

CLASS ASTEROIDEA

Astrometis sertulifera
Astropecten
Astropecten armatus
Astropecten verrilli
Dermasterias imbricata
Henricia
Henricia leviuscula
Henricia n.sp.
Leptasterias
Linckia columbiae
Luidia foliolata
Mediaster aequalis
Orthasterias koehleri
Asterina miniata
Pisaster brevispinus
Pisaster giganteus
Pisaster ochraceus
Pycnopodia helianthoides

CLASS ECHINOIDEA

Centrostephanus coronatus
Dendraster excentricus
Lovenia cordiformis
Lytechinus anamesus
Strongylocentrotus franciscanus
Strongylocentrotus purpuratus
Amphiodia occidentalis
Amphipholis squamata
Ophiactis simplex
Ophioderma panamense
Ophionereis annulata
Ophionereis
Ophiopholis
Ophioplocus esmarki
Ophiopsilla californica
Ophiopteris papillosa
Ophiothrix spiculata
Chirodota

CLASS HOLOTHUROIDEA

Caudina chilensis
Cucumaria
Cucumaria
Cucumaria curata/pseudocurata
Cucumaria lubrica
Cucumaria miniata
Cucumaria piperata
Cucumaria salma
Eupentacta quinquesemita
Leptosynapta albicans
Lissothuria nutriens
Molpadia
Molpadia arenicola
Pachythyone rubra
Parastichopus californicus
Parastichopus parvimensis

CHORDATA

SUBPHYLUM UROCHORDATA

Aplidium
Aplidium californicum

Aplidium propinquum
Aplidium solidum
Archidistoma
Archidistoma diaphanes
Archidistoma molle
Archidistoma psammion
Archidistoma ritteri
Ascidia ceratodes
Ascidia vermiformis
Boltenia villosa
Botrylloides diegensis
Botryllus
Botryllus tuberatus
Ciona intestinalis
Clavelina huntsmani
Cnemidocarpa finmarkiensis
Cystodytes lobatus
Didemnum
Didemnum carnulentum
Diplosoma macdonaldi
Distaplia occidentalis
Euherdmania claviformis
Halocynthia hilgendorfi
Laraceans
Metandrocarpa dura
Metandrocarpa taylori
Molgula
Molgula pugetiensis
Molgula regularis
Perophora annectens
Polyclinum planum
Pycnoclavella stanleyi
Pyura haustor
Pyura mirabilis
Ritterella
salps
Styela
Styela clava
Styela coriacea
Styela gibbsii/truncata
Styela montereyensis
Styela plicata
Synoicum parfustis
Thetis vagina
Tridemnum opacum

SUBPHYLUM VERTEBRATA
CLASS ELASMOBRANCHI
Cephaloscyllium ventriosum
Cetorhinus maximus
Heterodontus francisci
Squalus acanthias
Alopias supercilosus
Alopias vulpius
Carcharodon carcharias
Isurus oxyrinchus
Mustelus
Mustelus californicus
Mustelus henlei
Myliobatis californica
Platyrhinoidis triseriata
Prionace glauca
Raja binoculata
Raja inornata
Raja stellulata
Rhinobatos productus
Squatina californica
Torpedo californica
Triakis semifasciata
Urolophus halleri
Eptatretus stoutii
Hydrolagus colliei
CLASS OSTEICHTHYES
Gymnothorax mordax
Porichthys
Porichthys myriaster
Porichthys notatus
Gobiesox
Gobiesox eugrammus
Gobiesox maeandricus
Gobiesox rhessodon
Rimicola muscarum
Chilara taylori
Sardinops sagax
Engraulis mordax
Cololabis saira
Atherinops affinis
Atherinops californiensis
Leuresthes tenuis
Synodus lucioceps
Cypselurus californicus
Aulorhynchus flavidus
Syngnathus
Sygnathus auliscus
Sygnathus arctus
Syngnathus californiensis
Syngnathus leptorhynchus
Rathbunella hypoplecta
Kathetostoma averruncus
Anarrhichthys ocellatus
Hypsoblennius
Hypsoblennius gilberti
Hypsoblennius jenkinsi
Liparis mucosus
Seriola lalandei
Trachurus symmetricus
Alloclinus holderi
Cryptotrema corallinum
Chaenopsis alepidota
Gibbonsia
Gibbonsia elegans
Gibbonsia metzi
Gibbonsia montereyensis
Gibbonsia erythra
Heterostichus rostratus
Neoclinus
Neoclinus blanchardi
Neoclinus stephansae
Neoclinus uninotatus
Paraclinus integripinnis
Artedius
Artedius corallinus
Artedius creaseri
Artedius notospilotus
Chitonotus pugetensis
Clinocottus
Clinocottus analis
Icelinus tenius
Leiocottus hirundo
Oligocottus snyderi
Orthonopias triacis
Scorpaenichthys marmoratus
Amphistichus argenteus
Amphistichus koelzi
Brachyistius frenatus
Cymatogaster
Cymatogaster aggregata
Rhacochilus vacca
Embiotoca jacksoni
Embiotoca lateralis
Hyperprosopon
Hyperprosopon argenteum
Hyperprosopon ellipticum
Hypsurus caryi
Micrometrus auroa
Micrometrus minimus
Phanerodon
Phanerodon atripes
Phanerodon furcatus
Rhacochilus toxotes
Coryphopterus nicholsi
Lythrypnus dalli
Lythrypnus zebra
Typhlogobius californiensis
Lethops connectens
Eucyclogobius newberryi
Clevelandia ios
Lepidogobius lepidus
Anisotremus davidsonii
Xenistius californiensis
Hexagrammos decagrammus
Ophiodon elongatus
Oxylebius pictus
Girella nigricans
Hermosilla azurea
Medialuna californiensis
Medialuna (juveniles)
Chaetodon falcifer
Halichoeres semicinctus
Oxyjulis californica
Semicossyphus pulcher

Caulolatilus princeps
Stereolepis gigas
Pholis
Ulvicola sanctaerosae
Xerepes fucorum
Chromis punctipinnis
Hypsypops rubicundus
Atractoscion nobilis
Cheilotrema saturnum
Roncador stearnsi
Seriphus politus
Umbrina roncador
Sarda chiliensis
Scomber japonicus
Scorpaena guttata
Sebastes
Sebastes auriculatus
Sebastes atrovirens
Sebastes carnatus
Sebastes caurinus
Sebastes chlorostictus
Sebastes chrysomelas
Sebastes constellatus
Sebastes dalli
Sebastes diploproa
Sebastes entomelas
Sebastes flavidus
Sebastes goodei
Sebastes hopkinsi
Sebastes jordani
Sebastes levis
Sebastes melanops
Sebastes miniatus
Sebastes mystinus
Sebastes nebulosus
Sebastes paucispinis
Sebastes pinniger
Sebastes rastrelliger
Sebastes rosaceus
Sebastes rubrivinctus
Sebastes semicinctus
Sebastes serranoides
Sebastes serriceps
Paralabrax clathratus
Paralabrax maculatofasciatus
Paralabrax nebulifer
Chirolophis nugator
Sphyraena argentea
Cebidichthys violaceus
Stichaeid
Xiphister atropupureus
Anoplarchus purpurescens
Xiphias gladius
Tetrapturus audax
Citharichthys
Citharichthys sordidus
Citharichthys stigmaeus
Citharichthys xanthostigma
Hippoglossina stomata
Hypsopsetla guttulata
Paralichthys californicus
Xystreurys liolepis
Symphurus atricauda
Platichthys stellatus
Pleuronichthys
Pleuronichthys coenosus
Pleuronichthys decurrens
Pleuronichthys ritteri
Pleuronichthys verticalis
Parophrys ventulus
Glyptocephalus zachirus
Eopsetta jordani
Microstomus pacificus
Symphurus atricauda
Diodon hystrix
Ostracion diaphanum
Balistes polylepis
Icichthys lockingtoni
Mola mola

CLASS MAMMALIA

Pinnipedia

Mirounga angustirostris
Phoca vitulina
Zalophus californianus
Eumetopias jubata
Arctocephalus townsendi
Callorhinus ursinus

Carnivora

Enhydra lutris

Cetecea

Balaena glacialis
Eschrichtius gibbosus
Balaenoptera musculus
Balaenoptera physalus
Balaenoptera borealis
Balaenoptera acutorostrata
Megaptera novaengliae

CLASS REPTILIA

Dermochelys coriacea
Chelonia mydas

APPENDIX D. Logistical Considerations

Cruise Preparation

Introduction

These instructions are designed to help prepare for the seven, five-day, research cruises. The objective is to increase efficiency, minimize stress, and hopefully keep from forgetting anything. Included are several suggestions related to equipment maintenance, food ordering, and raw data organization. During the field season, from June to October, cruises typically run in two week cycles. The starting point for this discussion is prior to the first cruise.

Procedure

Prior to the first cruise all equipment should be completely overhauled and accounted for. Specifically, all SCUBA equipment and surface supply diving equipment should be annually serviced, SCUBA tanks visually inspected, and underwater cameras and housings cleaned and tested. Sampling equipment including calipers, measuring tapes, pelican buoys, and lift bags should be inspected and repaired as needed. Inventory lists of tools, spare parts, and accessories should be thoroughly reviewed and updated. Any purchasing or replacement should be done at this time.

Data sheets for underwater sampling should be copied on waterproof paper. Sufficient quantities of data sheets for site summaries, volunteer forms, and data summaries need to copied as well. Draft a letter to the food supplier stating that another field season is about to begin and will be accompanied with a associated purchase order number.

Week, before the cruise:

- Order food from supplier and arrange for pick up on Friday (see food ordering protocol)
- Charge video batteries and lubricate O-rings.
- Assemble sampling gear in central location for easy loading Monday morning.

Monday of the cruise:

- Load gear and food. Check and recheck list. Be sure everything is out of the refrigerator, freezer, and storage area.
- Secure gear on deck and set up Surface supply unit
- Post menu for the Cruise in the galley
- Make sure all volunteers fill out release forms and cruise manifest

During the cruise:

- Keep gear organized and clean! Remove data sheets, rinse with fresh water, dry, check clarity of numbers, and file accordingly.
- Notify head biologist of observations of Marine mammals, unusual occurrences, and problems immediately!
- Write down needed items on the wish list, located on posted cruise menu.

Friday of the cruise:

- Upon return unload all gear, food, and trash. Wash all sampling and personnel gear thoroughly!

• Hang sampling equipment in storage area to dry.
• Remove wish list from galley and place in data storage file box
• Help boat captain clean up galley, sleeping, and deck areas

Monday, after the cruise:

• Begin entry of data, following data entry procedures.
• Put away dry sampling gear and review wish list for next cruise
• Review video footage for quality
• Review the wish list and order any items that are needed, fix gear that broke etc.

Food Ordering Protocol

Introduction:

Seven menus and corresponding food orders for 5 days for 10 people must be planned for the kelp forest monitoring cruises. Examples from previous years can be used, however there is no set format and creativity is encouraged. Considerations should be taken with respect to varying dietary constraints of some cruise members. Previous menus and food orders are in: F:/IM/KELP/DOCS/FOOD. The files are named by year and numbered one through seven (e.g. 1996fud2). Please note that some of the food orders listed in the computer may have items missing that you will need for that menu; this occurs when food is left over from a previous trip and thus is not ordered again. **Be sure to read the previous years orders carefully and make sure you have everything you will need.**

Typically the first cruise order is exceptionally large because it will include items that must be kept in stock (i.e. paper towels, paper plates, Tabasco sauce etc.). If these items run low during the season be sure to order them again.

Estimated food costs are:

Cruise one:	$750
Cruises 2 through 7:	$675

Procedure:

These procedures use Isla Vista Food Coop and Trader Joes as the food venders, but it is not necessary to use these venders. Isla Vista Food Coop has boxed the food for us and has had it ready for pick up. We have traditionally gotten some items at Trader Joes and a good place to buy meat is Norens Meat Market (located at 5171 Telegraph Rd.). Do not feel limited to these vendors, if you want to set up a relationship with another vendor then do so.

Before the cruises begin:

- Send a letter to Isla Vista Food Coop introducing yourself and explaining about the cruises and food orders. For an example of this letter see: IM/KELP/DOCS/FOOD: foodcoop

Friday, one week before the cruise:

- Make a hard copy of the food order.
- For each vendor you are going to use fill out a DI-1, using the estimated cost, put one copy in the DI-1 book, send 2 copies to the Procurement Officer (if you are going to use your Impact credit card to buy the food, then it is not necessary to fill out DI-1's).
- Mail or fax the food order to Isla Vista Food Coop. Include a cover letter explaining when you will pick up the order and how payment will work (for an example of this letter see: IM/KELP/DOCS/FOOD: foodltr)
- Print a copy of the menu to post on the boat
- Make sure that four 2.5 gallon water containers and ice savers are in the freezer.

Friday, before the cruise:

- Clean the four large ice chests (one for drinks, one for bread, and for fruit and one for vegetables)
- Go pick up the food at Isla Vista Food Coop
- Go buy food at Trader Joes (and whatever other stores you are using). Use your Impact visa card if possible. Be sure to get itemized receipts!
- Put a copy of each receipt in the DI-1 book, fill out the correct amount in the front of the book, send another copy of the receipt to the Procurement Officer (if you are using your Impact card, then make 2 copies of the receipt, put one in the DI-1 book and save the copy and the original for your monthly credit card statement).
- Store perishable items in the refrigerators.
- Store nonperishable items on the boat. Canned goods go under the front port bench in the main salon, dry goods under the back port bench, paper products under the front starboard bench, spices and condiments in the galley and drinks in the forward bilge.

Monday of the cruise:

- Load fruit and vegetables from the refrigerators into their respective ice chests. Line the lids of the coolers with ice savers and place a 2.5 gallon ice block into each cooler. Be sure to line the ice block with a piece of cardboard (to prevent the food from freezing).
- Load two 2.5 ice blocks into the drink cooler and stock the cooler with drinks.
- Put all the bread products into the smallest of the coolers, do NOT put any ice in this cooler.
- Load all dairy products, meat and frozen food into the refrigerator on the boat. Try to pack the freezer in an organized fashion to prevent melting and avoid digging later.
- Post the menu.

During the cruise:

- Keep snacks available for people between dives. If it is cold, heat water in the morning and keep it available in the pump thermos for tea and hot chocolate.
- Keep the drink cooler stocked.
- Make sure to start defrosting the evening meal by noon.
- Get everyone to participate in cooking and cleanup.

Friday when you get back from the cruise:

- Unload and clean the refrigerator on the boat.
- Clean the galley on the boat.
- Return any drinks to the forward bilge.
- Put all left-over food in the RM refrigerator.
- Clean out the coolers and let them dry.
- If there is time, complete the next trip’s food order and fax it to Isla Vista Food Coop.

Equipment Checklist

LOCATION	ITEM	QUANTITY
Red Cooler	Scuba Pro Depth Gauges	2
	Bottom timer	1
	Console w/ Pressure and Depth Gauge	1
	U.S. Divers Gloves (new)	3
	Weight Belts	3
	Weight belt buckle	1
	AIR II's (2178118 and 16391018)	2
	Knife straps (bag)	1
	Mask and Fin straps (bag)	1
	BC hose Scuba Pro	1
	Stiletto Knifes	1
	Regulator mouth pieces	4
	Seal cement (tube)	1
	Nylon line (50 ft+)	1
	X-small zip ties	approx 100
	Carabiners	2
	Screws for slates	approx 20
	Lumber crayons (yellow)	4
	Regulator Parts (Box)	1
	Wire (Red and Black)	2
	Scuba Tuba	1
	Compass w/strap	2
	Velcro straps	4
	Spare neoprene	1
	Dental Floss	1
	Intermediate pressure hose 25"	1
	BC straps	2
	Knifes	2
	Nylon cord spool	
Blue Cooler	Silicon Mask	1
	SP Jet Fins (3prs: 1med, 1xl)	2
	Hood	1
	Booties	1
	Gloves	2
	Snorkels	2
	Regulators and Consoles	2
	Zeagle BC with Air II	2
Blue Tool Box	Lumber crayons	8
	Flagging rolls (orange and yellow)	3
	Stainless washers 2"	8
	Stainless bolts 4"and nuts	4
	Magnifying lens	1
	Nylon line	2
	Hole punch	1

LOCATION	ITEM	QUANTITY
Blue Tool Box (cont.)	Whistles	5
	Numbered stainless washers	150
	Electrical tape	10
	Spanner wrench for Dacor Regs.	1
	Low Pressure Plugs for Dacor regs.	6
	ohm meter	1
	First stage replacement for Dacor Reg.	1
	Calipers	5
	Stainless wire (roll)	1
	Collection vials and bags (bag)	1
	WD40 (can)	1
Book Cooler	6V Batteries (for Dive Lights)	8
	9 V Batteries (for Edges)	15
	Abbott & Hollenberg, Marine Algae of CA	1
	Alcohol Bottle	1
	Behrens, Nudibranchs (1st & 2nd edition)	2
	California Abalone	2
	Carpenter Crayons	1
	CHIS KFM 1982-1989	1
	Dawson & Foster, Plants	1
	Decompression	1
	Electrical Tape	1
	Eschmeyer, Fishes	1
	Fitch & Lavenberg, Tidepool & Nearshore Fishes	1
	Gotshall & Laurent, Fishwatchers Guide	1
	Gotshall & Laurent, Pacific Coast Subtidal Marine Invertebrates	1
	Gotshall, Pacific Coast Inshore Fishes	1
	Hand Lens	1
	Hauser, Book of Fishes	1
	Hedgepeth & Hinton, Common Seashore Life	1
	Hole Punch	1
	Keen & Koan, Molluscs	1
	Kelp Forest Dynamics, CHIS 1982-1985	1
	KFM Handbook	4
	KFM Project Report	1
	Lights Manual	1
	Mcdonald & Nybakken, Nudibranchs	1
	McLean, Marine Shells of S. Cal	1
	Miller & Lea, Fishes	1
	Morris, Abbott, & Haderlie, Intertidal Invertebrates of California	1
	NAUI Dive Tables	1
	Pencils/Erasers/Leads	15/5/5

LOCATION	ITEM	QUANTITY
	Peterson, Birds	1
	Sample Bottles	4
Book Cooler (cont.)	Sand Beach & Lagoon Handbook	1
	Scalpel/Blades/Tweezers	1/2/1
	Sharpies (red)	2
	Specimen Bags	1bag
	Specimen Samples	1 folder
	Surge Meter	2
	Thermometer	1
	USC Invertebrate List	1
	Venier Calipers	8
	Video Tapes	8
	Voltmeter	1
	Waaland, Seaweed	2
	Wilson & Wilson, Fishes	1

APPENDIX E. Sample data sheets

QUADRAT Data Sheet: Channel Islands National Park Kelp Forest Monitoring Project

Date:_____ Location:_____ Time in:____ Time out:____ Number of dives:____

Observer:_____ Partner:_____ Event #_____

Quadrat # (Dimension: 1m^2)		1	2	3	4	5	6	7	8	9	10	11	12
Random Meter number													
Alloclinus holderi **Island Kelpfish**	14027												
Coryphopterus nicholsii **Blackeyed Goby**	14026												
Lythrypnus dalli **Bluebanded Goby**	14025												
Styela montereyensis **Stalked Tunicate**	12002												
Centrostephanus coronatus **Coronado Urchin**	11009												
Parastichopus parvimensis **Warty Sea Cucumber**	11007												
S. purpuratus **Purple Sea Urchin**	11006												
S. franciscanus **Red Sea Urchin**	11005												
Pisaster giganteus **Giant-spined Sea Star**	11002												
Asterina (Patiria) miniata **Bat Star**	11001												
Lithopoma (Astraea) undosa **Wavy Turban Snail**	9007												
Cypraea spadicea **Chestnut Cowrie**	9005												
Laminaria farlowii **juvenile Oar Weed** (less than 10 cm wide)	2006.5												
Laminaria farlowii **adult Oar Weed** (over 10 cm wide)	2006												
Pterygophora **juv. CA Sea Palm** (single blade)	2005.5												
Pterygophora **adult CA Sea Palm** (multiple blade)	2005												
Eisenia arborea **juvenile S. Sea Palm** (single blade)	2004.5												
Eisenia arborea **adult S. Sea Palm** (multiple blade)	2004												
Macrocystis pyrifera **juv. Giant Kelp** (under 1m tall)	2002.5												
Macrocystis pyrifera **adult Giant Kelp** (over 1m tall)	2002												
To measure *Laminaria* blade:		**0 cm**				**5 cm**					**10 cm**		

BAND TRANSECT

Data Sheet: Channel Islands National Park Kelp Forest Monitoring Project

Date:_____ Location:_____ Event:_____ Total Time:_____

Observer:_____ Partner:_____ Vis:____m Surge (ft):_____

Transect # (Dimension: 10 x 3 m)	1	2	3	4	5	6	7	8	9	10	11	12
Random Meter Number												
Tethya aurantia **Orange puffball sponge** 5002												
Allopora californica **California hydrocoral** 6001												
Tealia lofotensis **White spotted rose anemone** 6002												
Lophogorgia chilensis **Red Gorgonian** 6006												
Muricea fruticosa **Brown Gorgonian** 6007												
Muricea californica **California Golden Gorgonian** 6008												
Panulirus interruptus **California Spiny Lobster** 8001												
Haliotis rufescens **Red Abalone** 9002												
H. corrugata **Pink Abalone** 9003												
H. fulgens **Green Abalone** 9004												
Kelletia kelletii **Kellets Whelk** 9006												
Megathura crenulata **Giant Keyhole Limpet** 9009												
Hinnites giganteus **Rock Scallop** 9010												
Aplysia californica **California Brown Sea Hare** 9011												
Pycnopodia helianthoides **Sunflower Star** 11003												

"ALL FISH"

Visual Fish Transects — Channel Islands National Park

Location:_____ **Date**:_____
Observer:_____# **Event #**:_____ **Partner**:_____
Visibility:_____ **Video Operator**:_____
Surge: **Temperature (°C)**: **Time In**: **Time Out**:

		CODE	1	2	3	4
Chromis punctipinnis **BLACKSMITH**	ADULT	14001				
	JUVENILE	14002				
Oxyjulis californica **SENORITA**	ADULT	14003				
	JUVENILE	14004				
Sebastes mystinus **BLUE ROCKFISH**	ADULT	14005				
	JUVENILE	14006				
Sebastes serranoides **OLIVE ROCKFISH**	ADULT	14007				
	JUVENILE	14008				
Sebastes atrovirens **KELP ROCKFISH**	ADULT	14009				
	JUVENILE	14010				
Paralabrax clathratus **KELP BASS**	ADULT	14011				
	JUVENILE	14012				
Semicossyphus pulcher **SHEEPHEAD**	MALE	14013				
	FEMALE	14014				
	JUVENILE	14014.5				
Embiotoca jacksoni **BLACK SURFPERCH**	ADULT	14015				
	JUVENILE	14016				
Embiotoca lateralis **STRIPED SURFPERCH**	ADULT	14017				
	JUVENILE	14018				
Damalichthys vacca **PILE PERCH**	ADULT	14019				
	JUVENILE	14020				
Hypsypops rubicundus **GARIBALDI**	ADULT	14021				
	JUVENILE	14022				
Girella nigricans **OPALEYE**	ADULT	14023				
	JUVENILE	14024				
Halichoeres semicinctus **ROCK WRASSE**	MALE	14028				
	FEMALE	14029				

Roving Diver Fish Count

Channel Islands National Park Kelp Forest Monitoring

Location:_____ Date:_____ Time:_____ Event #:_____

ABUNDANCE KEY: S= single (1) F= few (2-10) C= common (11-100) M= many (over 100) - = not observed

* = monitoring species (**must have a count or a zero!**)

Observer:																
	obsr #		obsr #		obsr #		obsr #		obsr #		obsr #		obsr #		obsr #	
Common Name	**Score**	**Abun.**	**Score**	**Abun.**	**Score**	**Abun.**	**Score**	**Abun.**	**Score**	**Abun.**	**Score**	**Abun.**	**Score**	**Abun.**	**Score**	**Abun**
bat ray																
black surfperch*																
blackeye goby*																
blacksmith*																
blue rockfish*																
blue-banded goby*																
CA sheephead fem*																
CA sheephead juv*																
CA sheephead male*																
garibaldi*																
garibaldi, juvenile*																
gopher rockfish																
half moon																
horn shark																
island kelp fish*																
kelp bass*																
kelp rockfish*																
ocean whitefish																
olive rockfish*																
opaleye*																
painted greenling																
pile perch*																
rock wrasse, fem*																
rock wrasse, male*																
rockfish sp. juvenile																
rubberlip surfperch																
sculpin sp.																
señorita*																
striped surfperch*																
treefish																
treefish, juvenile																
zebra goby																

N.H.

Natural Habitat Size Frequency Distributions

DATE:		**LOCATION:**		
OBSERVER:	#	**SPECIES CODE:**		
MEASUREMENT:		**AREA SAMPLED:**		
METHOD		**SEARCH TIME:**		**# DIVES:**
Tethya aurantia 5002 **(A)**		Megathura crenulata 9009 **(L)**		
Haliotis rufescens 9002		Crassedoma (Hinnites) giganteum 9010 **(H)**		
Haliotis corrugata 9003		Asterina (Patiria) miniata 11001 **(M)**		
Haliotis fulgens 9004		Pisaster giganteus 11002 **(P)**		
Cypraea spadicea 9005 **(C)**		Pycnopodia helianthoides 11003 **(S)**		
Kelletia kelletii 9006 **(K)**		Lytechinus anamesus 11004 **(W)**		
Lithopoma (Astraea) undosum 9007 **(U)**		Strongylocentrotus franciscanus 11005 **(F)**		
Lithopoma (Astraea) gibberosum 9008 **(G)**		Strongylocentrotus purpuratus 11006 **(tick)**		
1		46	91	136
2		47	92	137
3		48	93	138
4		49	94	139
5		50	95	140
6		51	96	141
7		52	97	142
8		53	98	143
9		54	99	144
10		55	100	145
11		56	101	146
12		57	102	147
13		58	103	148
14		59	104	149
15		60	105	150
16		61	106	151
17		62	107	152
18		63	108	153
19		64	109	154
20		65	110	155
21		66	111	156
22		67	112	157
23		68	113	158
24		69	114	159
25		70	115	160
26		71	116	161
27		72	117	162

A.R.M.

Artifical Recruitment Module Size Frequency Distributions

DATE:		**ARM #:**	
OBSERVERS:	**#**	**LOCATION:**	
MEASUREMENT:		**ORGANISMS MEASURED: ALL:**	**PART:**

Tethya aurantia 5002 **(A)**		Megathura crenulata 9009 **(L)**	
Haliotis rufescens 9002		Crassedoma (Hinnites) giganteum 9010 **(H)**	
Haliotis corrugata 9003		Asterina (Patiria) miniata 11001 **(M)**	
Haliotis fulgens 9004		Pisaster giganteus 11002 **(P)**	
Cypraea spadicea 9005 **(C)**		Pycnopodia helianthoides 11003 **(S)**	
Kelletia kelletii 9006 **(K)**		Lytechinus anamesus 11004 **(W)**	
Lithopoma (Astraea) undosum 9007 **(U)**		Strongylocentrotus franciscanus 11005 **(F)**	
Lithopoma (Astraea) gibberosum 9008 **(G)**		Strongylocentrotus purpuratus 11006 **(tick)**	

1	46	91	136	181
2	47	92	137	182
3	48	93	138	183
4	49	94	139	184
5	50	95	140	185
6	51	96	141	186
7	52	97	142	187
8	53	98	143	188
9	54	99	144	189
10	55	100	145	190
11	56	101	146	191
12	57	102	147	192
13	58	103	148	193
14	59	104	149	194
15	60	105	150	195
16	61	106	151	196
17	62	107	152	197
18	63	108	153	198
19	64	109	154	199
20	65	110	155	200
21	66	111	156	201
22	67	112	157	202
23	68	113	158	203
24	69	114	159	204
25	70	115	160	205
26	71	116	161	206
27	72	117	162	207
28	73	118	163	208
29	74	119	164	209
30	75	120	165	210
31	76	121	166	211
32	77	122	167	212
33	78	123	168	213
34	79	124	169	214
35	80	125	170	215
36	81	126	171	216
37	82	127	172	217
38	83	128	173	218
39	84	129	174	219
40	85	130	175	220
41	86	131	176	221
42	87	132	177	222
43	88	133	178	223
44	89	134	179	224
45	90	135	180	225

COMMENTS:

# of Parastichopus parvimensis GREATER than 10cm ___.

# of Parastichopus parvimensis LESS than 10cm _____.

CHANNEL ISLANDS NATIONAL PARK
KELP FOREST MONITORING PROJECT
SIZE FREQUENCY DISTRIBUTIONS FOR **GORGONIANS**

PROCEDURE: For each gorgonian measure the greatest height and width in cm.

DATE:_____ LOCATION:_____SPECIES: _____
EVENT#:_____

Obs. NAME:_____ Obs. #_____ AREA SAMPLED:_____

	HEIGHT (cm)	WIDTH (cm)		HEIGHT (cm)	WIDTH (cm)		HEIGHT (cm)	WIDTH (cm)
1			**26**			**51**		
2			**27**			**52**		
3			**28**			**53**		
4			**29**			**54**		
5			**30**			**55**		
6			**31**			**56**		
7			**32**			**57**		
8			**33**			**58**		
9			**34**			**59**		
10			**35**			**60**		
11			**36**			**61**		
12			**37**			**62**		
13			**38**			**63**		
14			**39**			**64**		
15			**40**			**65**		
16			**41**			**66**		
17			**42**			**67**		
18			**43**			**68**		
19			**44**			**69**		
20			**45**			**70**		
21			**46**			**71**		
22			**47**			**72**		
23			**48**			**73**		
24			**49**			**74**		
25			**50**			**75**		

CHANNEL ISLANDS NATIONAL PARK
KELP FOREST MONITORING PROJECT
SIZE FREQUENCY DISTRIBUTIONS FOR ***Macrocystis pyrifera***

PROCEDURE: For each plant over 1 meter tall count the number of stipes 1 m above the substrate and measure the greatest diameter of the holdfast in cm.

DATE:_____ LOCATION:_____
EVENT#:_____

OBSERVER NAME:_____ #_____ AREA SAMPLED:_____

	STIPES #	DIAMETER (cm)		STIPES #	DIAMETER (cm)		STIPES #	DIAMETER (cm)
1			**26**			**51**		
2			**27**			**52**		
3			**28**			**53**		
4			**29**			**54**		
5			**30**			**55**		
6			**31**			**56**		
7			**32**			**57**		
8			**33**			**58**		
9			**34**			**59**		
10			**35**			**60**		
11			**36**			**61**		
12			**37**			**62**		
13			**38**			**63**		
14			**39**			**64**		
15			**40**			**65**		
16			**41**			**66**		
17			**42**			**67**		
18			**43**			**68**		
19			**44**			**69**		
20			**45**			**70**		
21			**46**			**71**		
22			**47**			**72**		
23			**48**			**73**		
24			**49**			**74**		
25			**50**			**75**		