Orange County Giant Kelp Restoration Project:

**Data Summary
for the Stakeholders of the
Marine Life Protection Act
April 2009**

Prepared by:
Nancy Caruso- Marine Biologist/ Project Director
Dirk Burcham- Biologist/ Research Associate

100 Aquarium Way
Long Beach, CA 90802

Table of Contents

Orange County Giant Kelp Restoration Project 2002-2007

Introduction
The purpose of this report is to provide a brief overview, for the MLPA process, of select species groups that have been monitored for the last seven years in Orange County as part of the *Orange County Giant Kelp Restoration Project*. These data are taken from the manuscripts being prepared for publication on a wider subject. The urgency of the MLPA process prompted the creation of the report to be used by citizen stakeholders. This report provides no analysis or discussions, simply the observations in graphical formats.

Project Description
The Orange County Giant Kelp Restoration Project began in 2002 with an aim to restore historical giant kelp (*Macrocystis pyrifera)* forests along the Orange County Coastline through outreach and education. This Project has employed the help of hundreds of volunteers to grow, plant, and monitor giant kelp in north Orange County and has seen much success. Through the education of junior high and high school students who grew kelp in their classrooms and training of the volunteers, giant kelp forests were restored in North Orange County.

Volunteer divers were an integral part of the Project's success. Volunteers planted kelp and conducted monitoring under the direction of the Project Biologist. These volunteers were recruited and trained continuously during the Project. Volunteer divers who participated in collecting monitoring data were trained both in classroom sessions and in the field. Volunteers were given assignments commensurate with their skill level. All data were quality checked by the Project Biologist in the field with those individuals who collected the data. Fish surveys were conducted by Project Biologists and by three select volunteers who had extensive experience in conducting fish surveys.

Restoration sites, control sites, and a reference site were chosen in Crystal Cove State Park (Newport Beach, CA), Heisler Park (Laguna Beach, CA), and Salt Creek (Dana Point, CA) (Table 1, Figure 1). All sites are in Orange County, California. Throughout the report the sites will be referred to as Crystal Cove, Laguna Beach, and Salt Creek. Restoration sites refer to areas where restoration treatments were implemented. Control sites refer to areas that were chosen to monitor, adjacent to restoration sites, where no treatments were implemented. The reference site refers to a natural kelp bed that was monitored where no treatments were implemented.

Table 1. The area of monitoring sites in Crystal Cove, Laguna Beach, and Salt Creek. Total area of all the sites combined is 24,000m^2. 2002-2007.

	Control Sites m^2	Restoration Sites m^2	Reference Site m^2
Crystal Cove	3000	9000	x
Laguna Beach	1500	9000	x
Salt Creek	x	x	1500
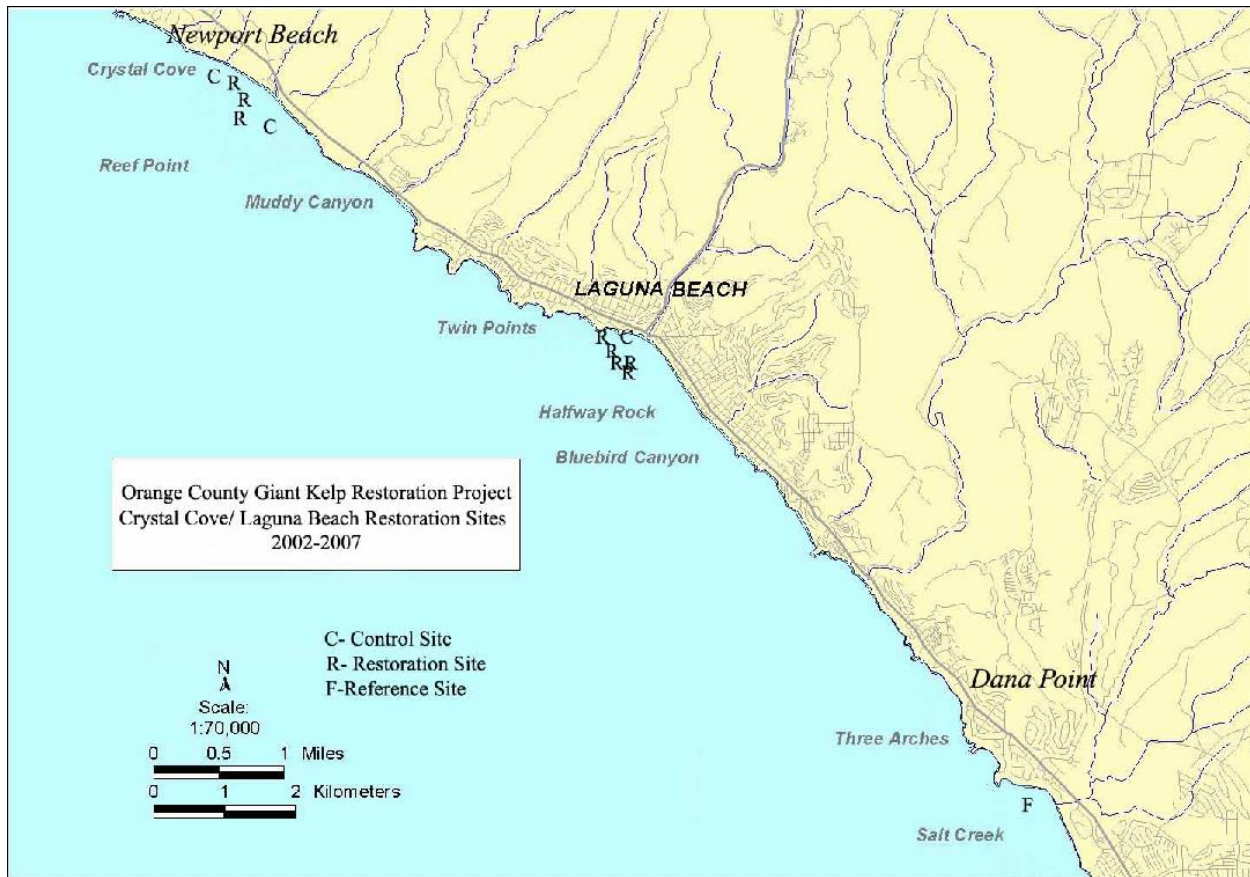
Figure 1. Locations of restoration, control, and reference sites. 2002-2007.

Monitoring

Monitoring was a major component of the Orange County Kelp Restoration Project. The purpose of the monitoring work was to determine an estimated abundance of algae, invertebrates and fish at restoration, control, and reference sites over time. Additionally, monitoring was a requirement of certain permits, which were necessary in order to conduct restoration work.

The restoration and monitoring methods used in the Project are described in detail by Reed et al. (2002). They included random quadrats, band transects, substrate surveys, and roving diver fish counts. The monitoring protocol manual is available on request.

Surveys were conducted throughout the year along permanent 30 meter long transects. Sampling occurred during all seasons in a range of conditions. The results presented in this report were taken from a total of 369 surveys (Table 2), which produced 11,161 individual species records.

Table 2. The time period in which monitoring surveys were conducted and the number of each survey type at Crystal Cove, Laguna Beach and Salt Creek.

Location	All Surveys Time Period	Survey Total	Fish	Band Transect	Quadrat	Urchin Random Quadrat	Substrate
Crystal Cove	2002 – 2007	238	60	69	71	32	6
Laguna Beach	2003 – 2007	114	30	31	32	14	7
Salt Creek	2003 - 2007	17	2	6	6	2	1
TOTAL		369	92	106	109	48	14

Selected species of algae and invertebrates were counted using quadrat and band transect methods. The invertebrate species chosen for monitoring represented a cross section of taxonomic groups, trophic levels, reproductive strategies, and motility.

Sea urchins feed on giant kelp and for this reason, they were of particular concern for the Project. Four species of urchins are found in the areas of restoration they include: red (*Strongylocentrotus franciscanis*), purple (*Strongylocentrotus purpuratus*), black crowned (*Centrostephanus coronatus*), and a rare urchin, *Arbacia stellata*. *Arbacia stellata* is found predominantly further south in the Gulf of California to Peru and Galapagos but Southern California is part of the most northern range for this species (Morris et al. 1980). Although white urchins (*Lytechinus anamesus*) are present in Orange County, they were not encountered in any of the study sites. It should be noted that the urchin densities were altered over time on the restoration sites and this is presented in the data. With a permit from the California Department of Fish and Game, sea urchins were removed and relocated to decrease densities and allow for kelp restoration. The control sites had no urchin removal. The reference site is commercially fished for red sea urchin.

Sea urchin densities and size frequencies were assessed on each site prior to any restoration treatments. Sea urchin relocation then followed and sea urchin populations were continuously monitored to observe recruitment events and other changes in populations. Averages of all the surveys were graphed to illustrate the differences in sea urchin densities on sites that were being manipulated by restoration (treated) and those in their natural state (untreated).

Fish were surveyed using the Roving Diver Technique (Schmitt and Sullivan 1996). Divers would swim adjacent to a transect, actively looking for fish counting all species of fish seen. Surveys were conducted when horizontal visibility was equal to or greater than 5 meters.

Substrate surveys were conducted once at each of the restoration, control, and reference sites. The surveys covered the entire site. Restoration sites were chosen that had significant low lying rocky substrata suitable for kelp growth. All contained areas of sand as well. The substrate was sampled every 2 meters along a transect (point of contact) and categorized into one of five substrate types: bedrock, large boulder (≥ 1 m), small boulder (.3 m – 1 m), cobble/pebble (5 mm – .3 m), sand/silt/clay (< 5 mm). Bedrock and large boulders were subcategorized into height classes: < 1 m, 1 – 3 m, > 3 m.

Monitoring Sites

### Crystal Cove Restoration and Control Sites
The Crystal Cove sites all lie between the west end of the Historic District and Reef Point. The area spans approximately 1.6 kilometers, with all sites in 7-12 meters of water, ranging from 100 to 400 meters from shore.

Table 3. The coordinates in decimal degrees of restoration and control sites at Crystal Cove.

Site Identification	Latitude	Longitude
1A&1B	N 33.57135	W 117.84115
1D& 2A	N 33.56848	W 117.83805
2B&2D	N 33.56568	W 117.83801
1C (control)	N 33.57383	W 117.84442
2C (control)	N 33.56415	W 117.83478

Substrate Characteristics
Bedrock composed 57% of the Crystal Cove sites, with 43% composed of sand, cobble and small boulders (Figure 2).
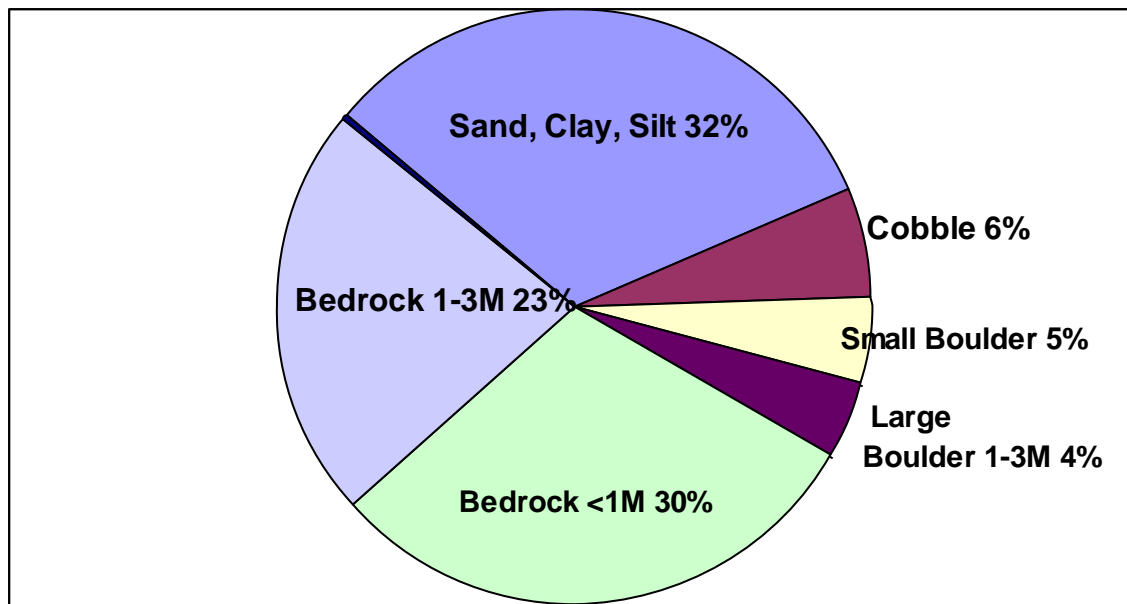
Figure 2. Composition of substrate in Crystal Cove as measured on six different sites totaling 12,000m^2. These sites are found from the west end of the Historic District east to Reef Point. 1060 points sampled.

Fish Populations
Sixty fish surveys were conducted in Crystal Cove with 1800 minutes of total survey time . A total of 37 species of fish were recorded at Crystal Cove (Table 4). Garibaldi, female sheephead, and blacksmith were observed in 100% of the surveys. Blacksmith were the most abundant fish followed by senorita.

4

Table 4. Frequency of sightings and relative abundance of all fish species recorded in Crystal Cove during 60 roving diver fish counts. 2002-2007.

| Species	Per Cent Sighting Frequency	Abundance Score
Blacksmith	100	3.55
Garibaldi	100	2.93
Sheephead Female	100	2.82
Senorita	98	3.20
Kelp Bass	98	2.73
Rock Wrasse Male	98	2.48
Rock Wrasse Female	97	2.55
Barred Sand Bass	97	2.30
Garibaldi Juvenile	97	2.15
Sheephead Male	97	1.92
Black Surfperch	85	1.88
Blackeye Goby	77	1.83
Halfmoon	75	1.53
Painted Greenling	68	1.28
Opaleye	57	1.07
Sargo	53	1.13
Senorita Juvenile (< 7 cm total length)	37	1.25
Blacksmith Juvenile	33	1.17
Sheephead Juvenile	30	0.60
Pile Surfperch	30	0.42
California Scorpionfish	30	0.32
White Surfperch	23	0.40
Rainbow Surfperch	22	0.38
Topsmelt	13	0.45
Kelp Surfperch	13	0.23
Giant Kelpfish	13	0.17
Rock Wrasse Juvenile	12	0.32
Treefish	12	0.15
Spotted Sand Bass	10	0.13
California Barracuda	8	0.23
Rubberlip Surfperch	7	0.08
Jacksmelt	5	0.13
Black Croaker	5	0.08
Cabezon	5	0.07
Moray Eel	5	0.05
Giant Kelpfish Juvenile (< 7 cm total length)	3	0.08
Black Surfperch Juvenile (< 7 cm total length)	3	0.07
Shovelnose Guitarfish	3	0.03
Kelp Bass Juvenile (< 7 cm total length)	2	0.03
Shinner Surfperch	2	0.03
Bat Ray	2	0.02
California Halibut	2	0.02
Island Kelpfish	2	0.02
Ocean Whitefish	2	0.02
Rockfish Species Unknown	2	0.02
Plain Midshipman	2	0.02
Spotted Kelpfish	2	0.02

Invertebrate Populations
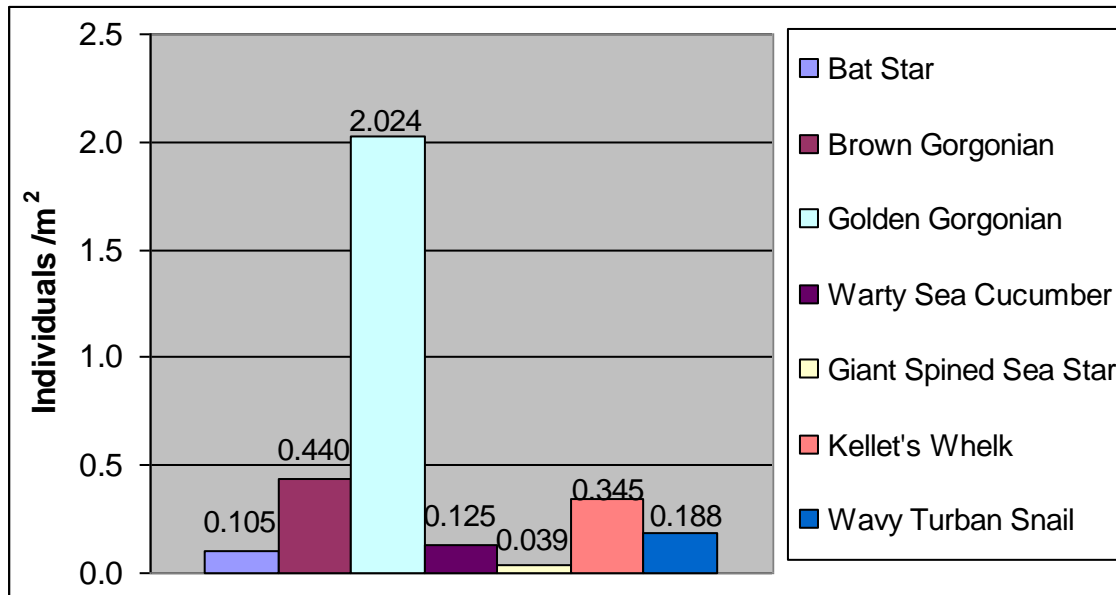
Figure 3. Invertebrate density estimates for Crystal Cove sites from 140 surveys. 2002-2007.

Sea Urchins

The average red sea urchin density in Crystal Cove was as high as 2.5/m^2 (Figure 4). After initial monitoring, 3,855 sea urchins were removed from Crystal Cove restoration sites and relocated to deeper water. Nine *Arbacia stellata* and 24 black urchins were found from 2002-2007. Both numbers were so low that they were not included in Figure 4. Results from urchin sizing concluded that 86% of the purple urchins measured 35-65mm and 77% of the red urchins measured 75-105mm (Figure 5).
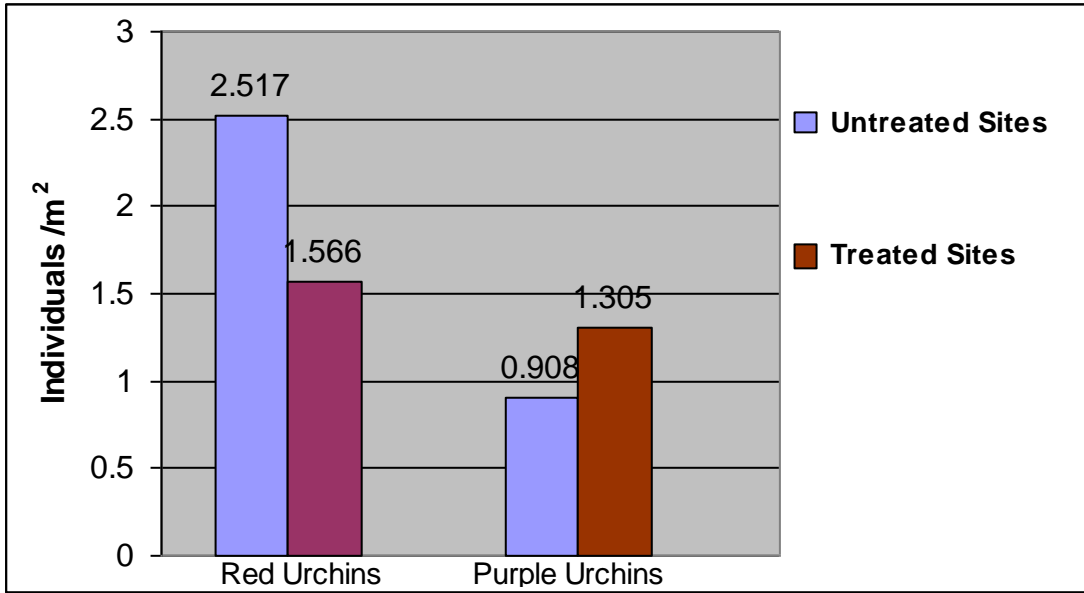
Figure 4. Mean sea urchin density/m2 on treated (restoration) and untreated (control) sites in Crystal Cove from 32 surveys. 2002-2007.
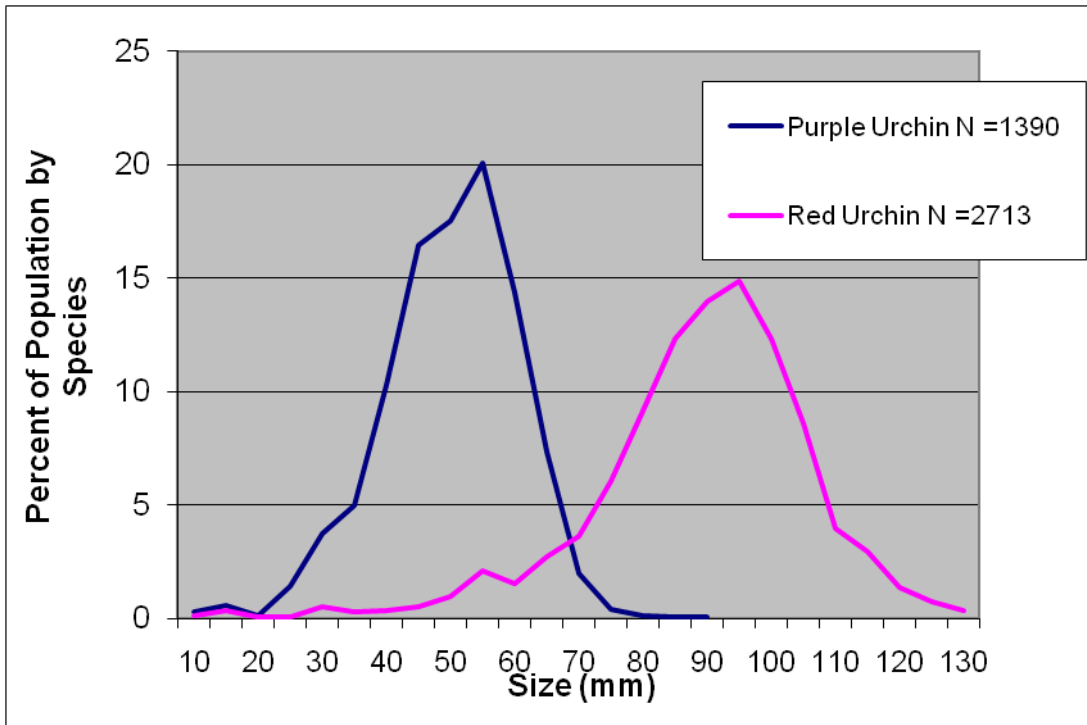
Figure 5. Size distribution of sea urchins surveyed in Crystal Cove. 2002-2007.

Laguna Beach Control and Restoration Sites

Six of the Laguna Beach sites are located on the expansive Heisler Park reef system just west of Main Beach. The seventh site (3D) lies in front of the Surf and Sand Hotel at Bluebird Canyon Drive. All sites are in 7-12 meters of water, ranging from 300 to 800 meters from shore.

Table 5. The coordinates in decimal degrees of restoration and control sites at Laguna Beach.

Site Identification	Latitude	Longitude
3A&3B	N 33.54225	W 117.79503
3D	N 33.52808	W 117.7768
4A & 4D	N 33.5407	W 117.7935
4B	N 33.5402	W 117.7920
3C (control)	N 33.54267	W 117.7949

Substrate Characteristics

Bedrock composed 60% of the Laguna Beach sites, with only 9% of the sites composed of sand, silt or clay (Figure 6).
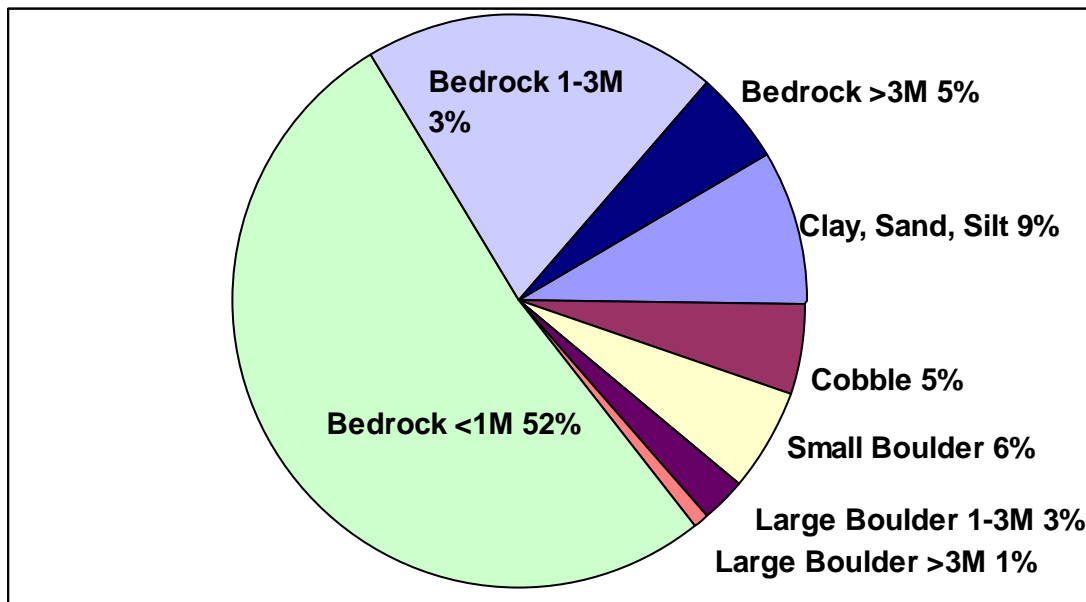
Figure 6. Composition of substrate in Laguna Beach as measured on (5) different sites totaling 10,500m^2. These sites are found from Heisler Park to Bluebird Canyon Drive. 1482 points sampled.

Fish Populations

Thirty fish surveys were conducted on Laguna Beach sites with 900 minutes of total survey time. A total of 30 fish species were recorded at Laguna Beach (Table 6). Blacksmith, garibaldi, female sheephead, female rock wrasse, and kelp bass were observed in 100% of the surveys. Both adult blacksmith juvenile blacksmith were the most abundant on the sites.

Table 6. Frequency of sightings and relative abundance of all fish species recorded in Laguna Beach during 30 roving diver fish counts. 2003-2007.

| Species	Per Cent Sighting Frequency	Abundance Score
Blacksmith	100	3.67
Garibaldi	100	3.07
Kelp Bass	100	2.77
Sheephead Female	100	2.77
Rock Wrasse Female	100	2.40
Barred Sand Bass	97	2.67
Black Surfperch	97	2.33
Blackeye Goby	97	2.17
Garibaldi Juvenile	97	2.17
Blacksmith Juvenile	93	3.37
Senorita	93	2.93
Rock Wrasse Male	87	2.00
Painted Greenling	87	1.87
Sheephead Male	83	1.73
Senorita Juvenile (< 7 cm total length)	73	2.30
Sargo	67	1.37
Rock Wrasse Juvenile	60	1.83
Halfmoon	53	0.93
Sheephead Juvenile	50	1.10
California Scorpionfish	47	0.83
Black Croaker	43	0.93
Pile Surfperch	40	0.70
Rubberlip Surfperch	30	0.50
Opaleye	23	0.47
Treefish	10	0.13
Zebraperch	10	0.10
Rainbow Surfperch	7	0.13
Lingcod	4	0.25
Jacksmelt	3	0.10
Topsmelt	3	0.10
Grass Rockfish	3	0.07
White Surfperch	3	0.07
Cabezon	3	0.03
Copper Rockfish	3	0.03
Moray Eel	3	0.03
Spotted Sand Bass	3	0.03

Invertebrate Populations
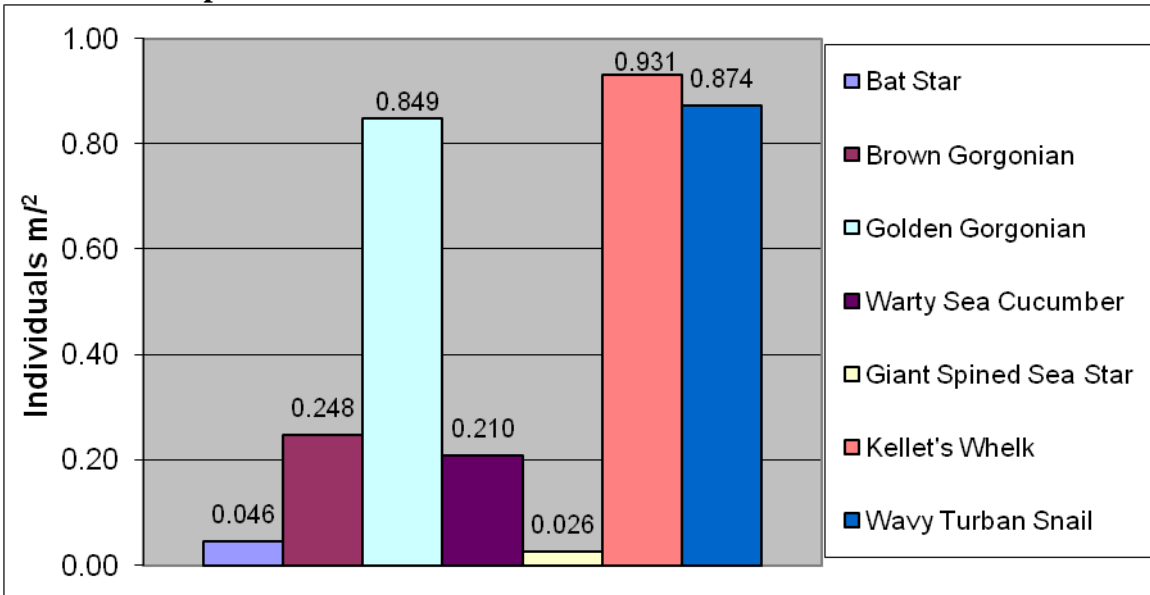
Figure 7. Invertebrate density estimates for Laguna Beach sites from 63 surveys. 2003-2007.

Sea Urchins

Sea urchin densities in Laguna Beach were as a high as 5.9 purple urchins/m^2 (Figure 8). After initial monitoring, 14,675 sea urchins were removed from Laguna Beach restoration sites and relocated to deeper water. Red urchin densities were reduced by nearly 30% through urchin relocation. Only 12 *Arbacia stellata* and 105 black urchins were found during the monitoring period. Both numbers were so low that they were not included in Figure 8. Results from urchin sizing concluded that 96% of the purple urchins measured 30-55mm and 84% of the red urchins measured 55-90mm (Figure 9).
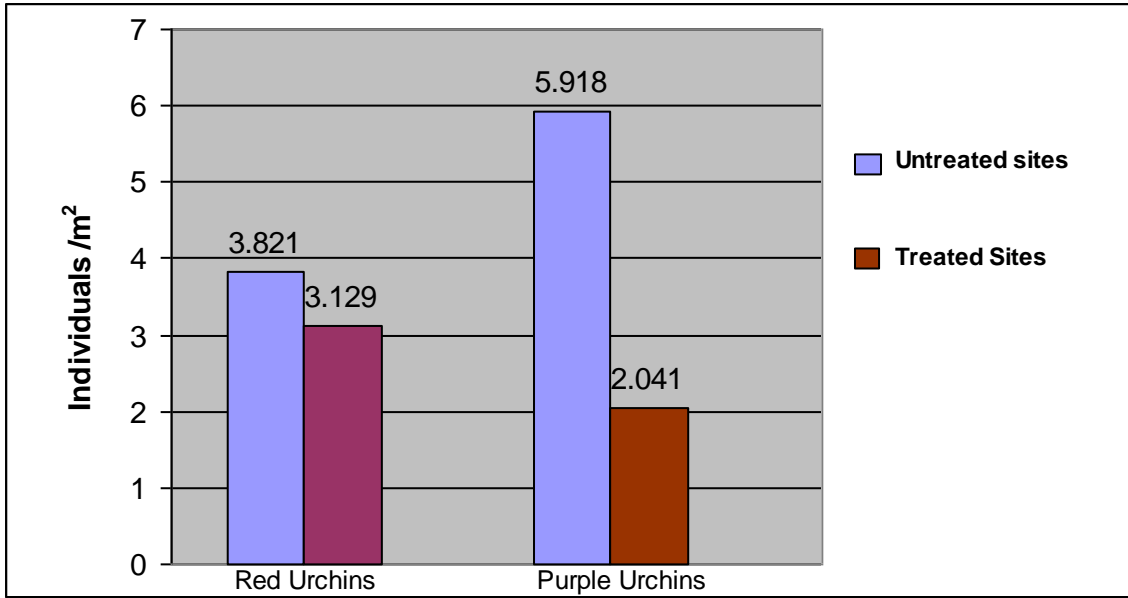
Figure 8. Mean sea urchin density/m² on treated (restoration) and untreated (control) sites in Laguna Beach from 14 surveys. 2003-2007.
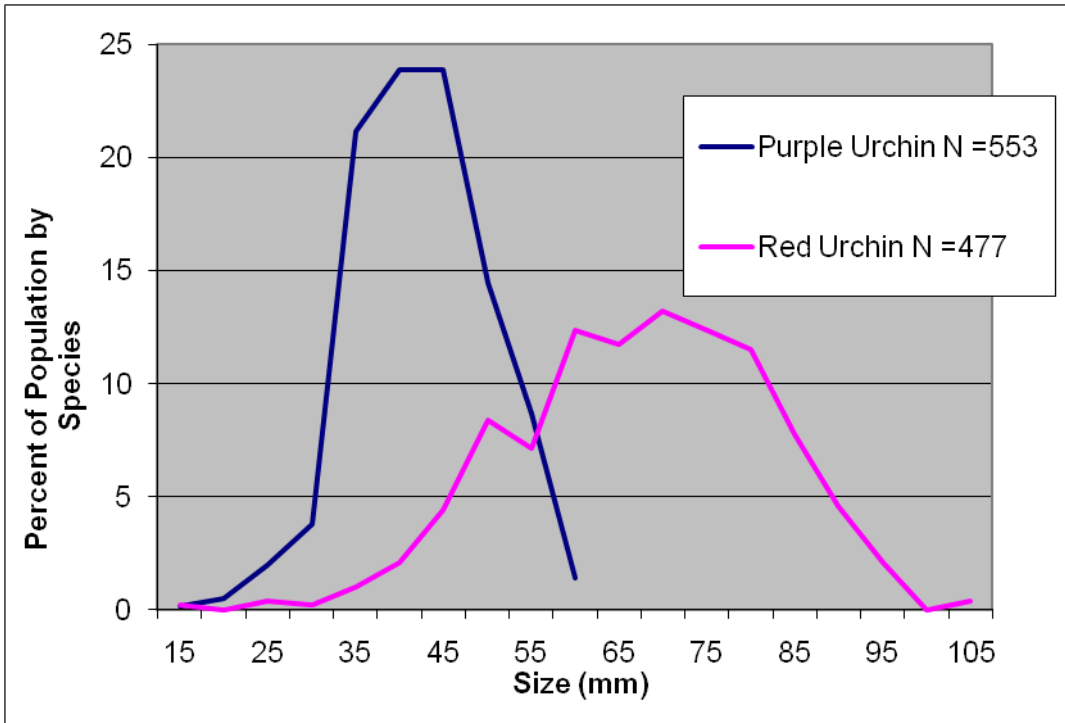
Figure 9. Size distribution of sea urchins surveyed in Laguna Beach. 2003-2007.

Salt Creek is a large bay that lies just north of Dana Point in Orange County. Only a small area
of this expansive reef system was monitored. The surveyed area is on the west side of Salt
Creek, in front of the snack bar/restroom facilities approximately 600 m from shore in 6-11m of
water with the coordinates below in decimal degrees.

Table 7. The coordinates in decimal degrees of reference site at Salt Creek.

Site Identification	Latitude	Longitude
Salt Creek R	N 33.47932	W 117.84598

Substrate Characteristics
Bedrock composed 67% of the Salt Creek site with only 16% made up of sand, silt, or clay
(Figure 10).
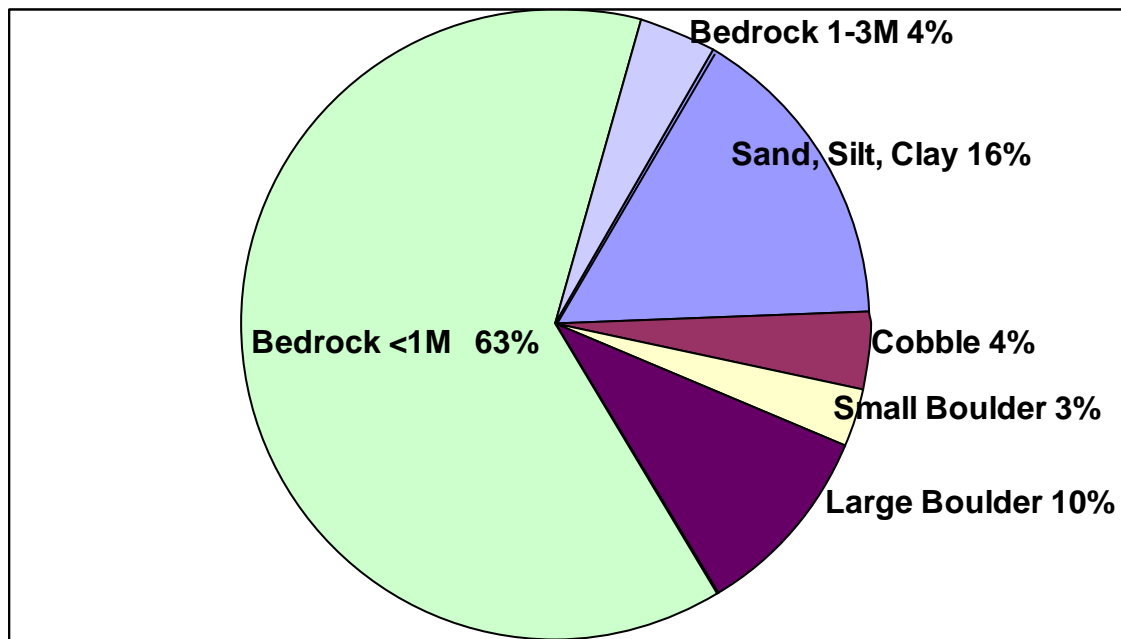
Figure 10. **Composition of substrate in Salt Creek as measured on one site totaling 1500m^2.
This site is on the west side of the bay in front of the snack bar/restrooms**. **144 points
sampled.**

Fish Populations
Two fish surveys were conducted on the Salt Creek sites with 60 minutes of total survey time. A
total of 17 species were recorded at Salt Creek (Table 8). Blacksmith, jacksmelt, and juvenile
senorita were the most abundant species on this site.

Table 8.   Frequency of sightings and relative abundance of all fish species recorded in Salt Creek during 2 roving diver fish counts. 2002-2007.

Species	Per Cent Sighting Frequency	Abundance Score
Blacksmith Juvenile	100	3.50
Jacksmelt	100	3.50
Senorita Juvenile (< 7 cm total length)	100	3.50
Black Surfperch	100	3.00
Blacksmith	100	3.00
Kelp Bass	100	3.00
Kelp Bass Juvenile (< 7 cm total length)	100	3.00
Senorita	100	3.00
Sheephead Male	100	3.00
Sheephead Female	100	2.50
Garibaldi	100	2.00
Opaleye	100	2.00
Rock Wrasse Male	100	2.00
Barred Sand Bass	100	1.50
Blackeye Goby	100	1.50
Halfmoon	100	1.50
Rock Wrasse Female	100	1.50
Rubberlip Surfperch	50	1.00
Giant Kelpfish	50	0.50
Kelp Surfperch	50	0.50
Sargo	50	0.50
Kelp Rockfish	50	0.05

Invertebrate Populations
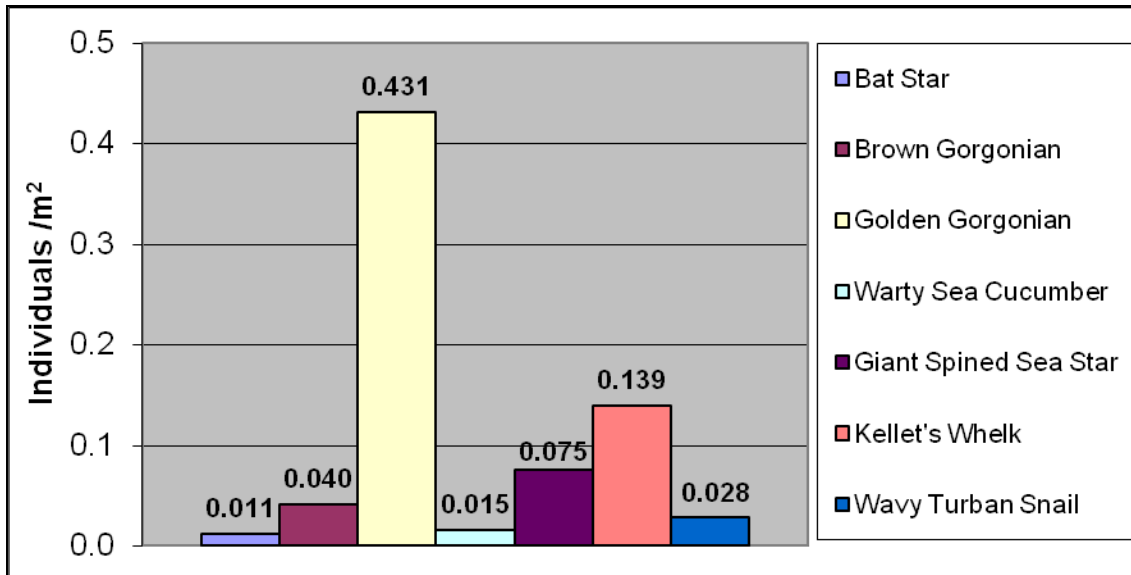
Figure 11. Invertebrate density estimates for Salt Creek from 12 surveys. 2003-2007.

Sea Urchins

Sea urchins densities in Salt Creek were as high as 2.97 purple urchins/m^2 (Figure 12). Reds are commercially fished in Salt Creek leaving only 1.714/m^2 during the monitoring period. Black urchin densities were 0.09/m^2.
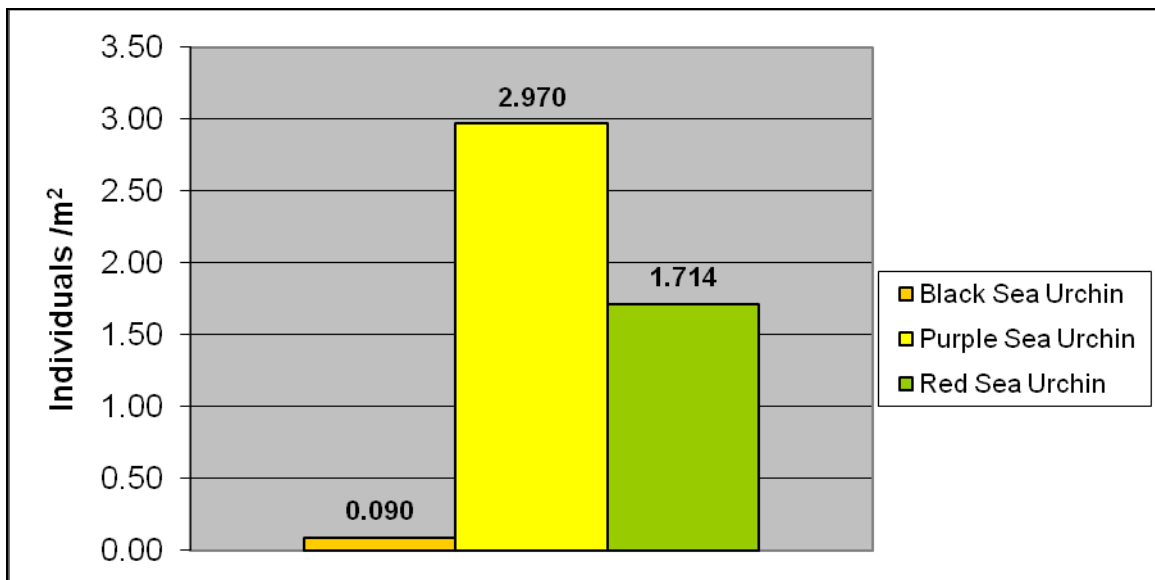

Figure 12. Mean sea urchin density/m^2 from 2 surveys. 2003-2007.

Continuation of the Project

As of the publication of this report, the Orange County Kelp Restoration Project is presently still underway. New monitoring data are being collected and will be synthesized into future reports. These reports will be available to the public through the Aquarium of the Pacific, Long Beach, California.

Literature cited

Morris, R. H., D. P. Abbot, and E. C. Haderlie, 1980. Intertidal invertebrates of California. Stanford University Press, Stanford, CA.

Reed, B., C. Collier, J. Altstatt, N. Caruso, and K. Lewand. 2002. Regional Kelp Restoration Project Restoration and Monitoring Protocol. California Coastkeeper Alliance.

Schmitt, E.F. and K.M. Sullivan. 1996. Analysis of a volunteer method for collecting fish presence and abundance data in the Florida Keys. Bull. Mar. Sci. 41 (2): 404-416.

Acknowledgements