Goleta Bay Sand-Dwelling *Macrocystis* Kelp

Restoration Project

Proposal

Robert Kiel

November 12, 2013

Contents

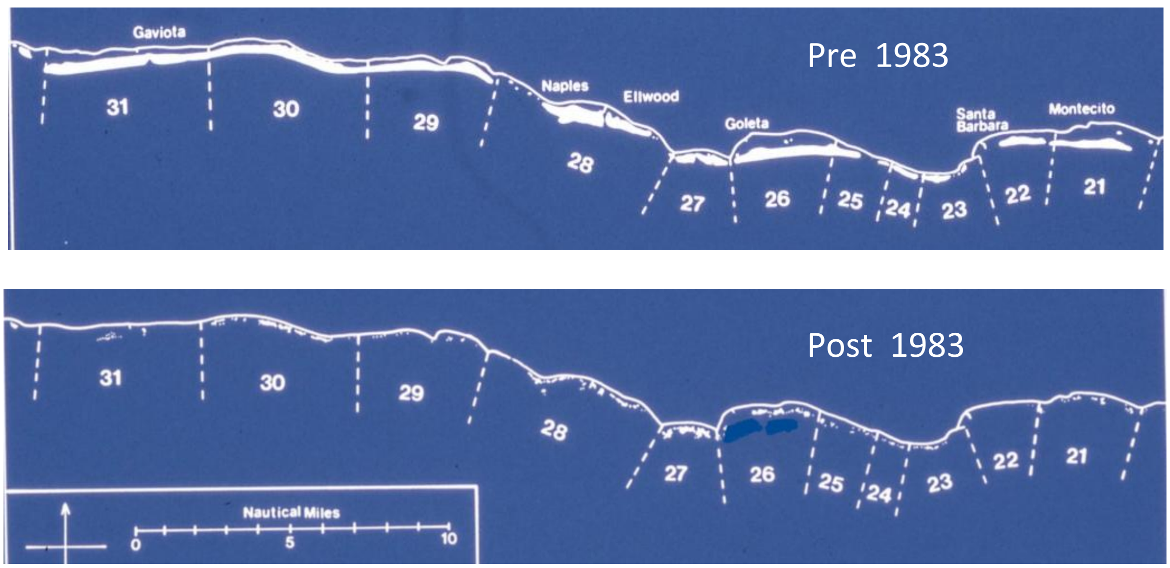
"The number of living creatures of all orders whose existence intimately depends on the kelp is wonderful. A great volume might be written describing the inhabitants of one of these beds of seaweed … I can only compare these great aquatic forests … with terrestrial ones in the intertropical regions. Yet, if in any country a forest was destroyed, I do not believe nearly so many species of animals would perish as would here, from the destruction of kelp."

Charles Darwin, 1834

Cover Photo: Juvenile *Macrocystis* kelp growing on a worm tube (*Diopatra ornata)* on sand bottom.

Introduction

A unique phenomenon to the Santa Barbara Channel, giant kelp (*Macrocystis)* successfully established itself on soft substrate producing an almost continuous band of sand-dwelling kelp along this portion of the mainland coast. To my knowledge, how and when the beds became established is unknown. Having grown up in Goleta, California, these kelp beds were a familiar sight to me. During a trip back to the area in April 1983, I was astonished to discover the once common band of kelp was gone. I soon realized it was conditions associated with the 1982-83 El Niño event which resulted in the disappearance of the beds. To date, natural recovery of the sand-dwelling kelp beds has not occurred.



Kelp Beds between Montecito and Gaviota, California, Pre and Post 1983

The numbered kelp bed zones were assigned by the California Department of Fish & Game (CDFG). The large kelp beds shown in the upper image were primarily sand-dwelling.

Images by Kelco, 1991

Oceanic conditions are favorable for the growth of kelp along the Southern California coast a majority of the time. Periodic conditions resulting in low nutrients and high water temperature are generally short-lived, and the physical condition of the kelp tends to recover in a relatively short period of time once conditions return to normal.

The weak link in the process by which giant kelp becomes established on sand bottom lies in the worm tubes upon which it recruits and grows. Getting through the early stages of development without becoming dislodged is essential to the formation of suitable holdfasts, referred to as “growth-centers” (Kelco, 1991). Considering the tenuous anchoring system of sub-adult kelp growing on sand bottom, one can only speculate that conditions must have been ideal for several consecutive years for sand-dwelling kelp beds to become established.

The geography of the region plays a significant role in the ability of sand-dwelling kelp beds to become established. The east-west orientation of the coast and the presence of the Channel Islands offshore provide protection from swells approaching from most directions.

A very large sand-dwelling kelp bed existed east of Goleta Point (offshore of Goleta Beach County Park) prior to the early 1980's. This kelp bed provided ecological benefit for a myriad of species, recreational benefit for fishing and diving enthusiasts, and economic benefit for commercial kelp harvesters. Finding a cost-effective, maintenance-free and environmentally-benign means of restoring the sand-dwelling kelp bed in Goleta Bay is the challenge and purpose of this study.

Historical Observations of Goleta Bay

Goleta Bay, December 7, 1972
This aerial photo shows Goleta Beach County Park and kelp bed offshore. The visible tracks through the kelp bed were created by kelp cutters harvesting the surface canopy.

Photo by Pacific Western Aerial Surveys

Google Earth Images of Goleta Bay, July 2004
Note the absence of the sand-dwelling kelp bed which once extended across the bay. The relatively small kelp bed near the point is growing on siltstone.

Elevated water temperatures from a developing El Niño in 1982 compromised the health of kelp in Southern California. Severe storm activity associated with this event during the winter months resulted in the dislodgement of most of the kelp along the Santa Barbara Channel mainland coast. I personally observed this on a trip to the area in spring of 1983. Recovery of some kelp beds occurred over the following years, but only in areas where rocky substrate exists.

UCSB beach, January 26, 1983
High-tide during the morning of an El Niño storm.
Photo by Arthur G. Sylvester

Sand-Dwelling *Macrocystis* Kelp

The process by which kelp anchors to sand bottom has a weak link in the early stages of development. In the offshore soft sediment regions once occupied by sand-dwelling kelp beds, worm tubes (primarily *Diopatra ornata*) are principally the only surfaces present for kelp to recruit and grow on. The fragile nature of this recruitment source and the sand substrate upon which to grow prevents sub-adult kelp from growing to maturity.

Diopatra ornata Worm Tubes

It is common to see algae pieces and other fragments (such as shells) adhered to the worm tubes for camouflage and as a means of armoring the exposed portion of tube. Gatherings of *Diopatra* are common where kelp is abundant, such as in the above photo (right) taken at Anacapa Island.

Featherduster Worm Tubes

Although less abundant than *Diopatra ornata* in sandy regions, *Eudastylia polymorpha* worm tubes also provide recruitment surfaces for *Macrocystis* kelp. These worm tubes are more durable than *Diopatra* and are therefore less inclined to break. The holdfast below was found on Campus Beach (UCSB), February 2012, and contains a remnant of the *Eudastylia* worm tube upon which it grew.

Sandcastle Worms Colonizing Holdfast

The adjacent photo shows *Phragmatopoma californica* colonizing a holdfast growing on sand. These marine polychaetes form honeycomb-like structures by adhering sand grains together. They may also contribute to growth-center formation. Note the purple tentacles of the worms protruding from the structure.

Juvenile *Macrocystis* Kelp Growing on Sand Bottom

Recruiting and growing on *Diopatra* worm tubes, young *Macrocystis* kelp sends out haptera (root-like projections) in an attempt to find solid substrate to attach to. Concurrently, the fronds must continue to grow toward the surface to acquire sunlight needed for photosynthesis, which is necessary for optimal growth and holdfast development.

The inherent buoyancy and drag of kelp increases as the fronds grow, eventually exceeding the holding capability of the holdfast on soft sediment. In time, the worm tubes break and the algae is sent adrift.

Sub-adult *Macrocystis* kelp can be found in abundance on local area beaches during the summer months. The substrate upon which they grew can be determined by examining the underside of the holdfasts. A remnant of worm tube at the center of these holdfasts indicates it was growing on sand bottom. Close inspection of these worm tubes often reveals fragments of shell and other particles adhered to the worm tube casing, a characteristic common to *Diopatra ornata*. A means of armoring the exposed portion of the worm tube, these fragments also provide surfaces for kelp spores to settle on. The close proximity of the male and female gametophytes settling on each of the worm tubes increases the odds for fertilization to occur and the eventual growth of a sporophyte (adult form of kelp).

Holdfasts Revealing Remnants of *Diopatra* Worm Tubes
Young sand-dwelling kelp is commonly found on local area beaches.

While performing investigative dives over the past few years in areas once occupied by sand-dwelling *Macrocystis* kelp beds (including Goleta Bay), I observed *Diopatra* worm tubes to be relatively scarce in some areas. This is most-likely due to a lack of food (kelp). Kelp growing on other structures in the sand usually has *Diopatra* congregating at the perimeter of the holdfasts (visible in photo at right).

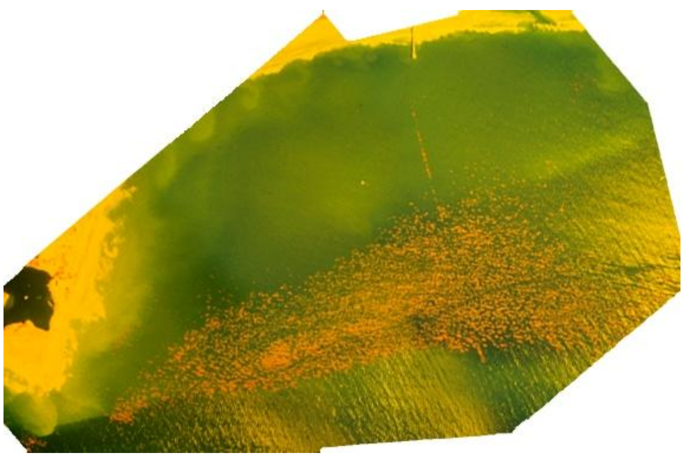
A symbiotic relationship between the *Diopatra* and kelp appears to exist. The presence of these colonizing *Diopatra* may contribute to growth-center development, while the presence of the kelp likely aids in survival of the worms.

Optimal Zone of Sand-Dwelling Kelp Beds

The optimal zone for the natural recruitment and growth of kelp within each area is evident by observing the well-defined inner and outer boundaries of the surface canopy. With often no obvious change in bottom morphology, the establishment of these boundaries appears to be influenced by other factors.

The inner boundary of sand-dwelling kelp beds is likely established at a depth and proximity to shore beyond where seasonal and episodic fluctuations in sediment overburden occur. This inner boundary tends to lie in about 30 feet water depth (below MLLW) in Goleta Bay.

The outer boundary of the sand-dwelling kelp beds is likely established by one or more of the following: the number and size of fronds relative to holdfast size and growth rate; nominal water clarity and the resulting sunlight penetration; composition of the seafloor sediment (percentage of fines increases offshore); overall reduction of surge at greater depths, which is the means by which seafloor sediment is transported into the interstitial voids of the holdfasts; and the presence of current, which drawdown the high-drag fronds. Kelp grows to depths of 70 feet or more in areas along the mainland coast where solid substrate exists, while sand-dwelling kelp grows to a maximum depth range of about 55 feet (below MLLW).



Aerial Photo of Goleta Bay, 1975

The sand-dwelling kelp beds had well-defined inner and outer boundaries with no obvious change in bottom morphology.
Note the kelp growing on the sewer pipe riprap inside and outside the kelp bed.
This image was made by splicing together pictures taken by Kelco (Kelp Company), who routinely harvested this bed (CDFG bed #26). Note the kelp harvesting track visible in the picture.

Image by Greg Christman

Investigative Dives in Goleta Bay

I have performed numerous dives in Goleta Bay since 2003 with my research partner (Greg Christman) and others, primarily within the zone once occupied by the historic sand-dwelling kelp bed. With the sewer pipe rip-rap being the exception, we observed benthic marine life to be relatively scarce, even among the eelgrass (*Zostera marina*). The highest concentrations of eelgrass in Goleta Bay lie in water depths shallower than the inner boundary of the historical kelp bed (personal observation).

Restoring a sand-dwelling kelp bed within the bay would likely benefit its ecology, primarily through the establishment of giant kelp habitat. Additionally, reestablishment of the kelp bed could possibly improve conditions inshore for the growth of eelgrass. Eelgrass tends to be most abundant in water depths less than 35 feet, with a gradual decrease in density to ~ 45 feet within Goleta Bay. I observed fluctuations in the concentration of eelgrass in many locations throughout the bay over the years.

On some of the dives we encountered golf balls on the seafloor, which were likely transported there by current from the Sandpiper golf course (~ 5.5 miles to the west).

In April 2007, we performed survey dives within the zone once occupied by a sand-dwelling kelp bed in Goleta Bay. Using SCUBA with "Dive-Link" voice communication and dive sleds, divers were towed by a boat following lines of longitude between the outer and inner boundaries of the historical kelp bed.

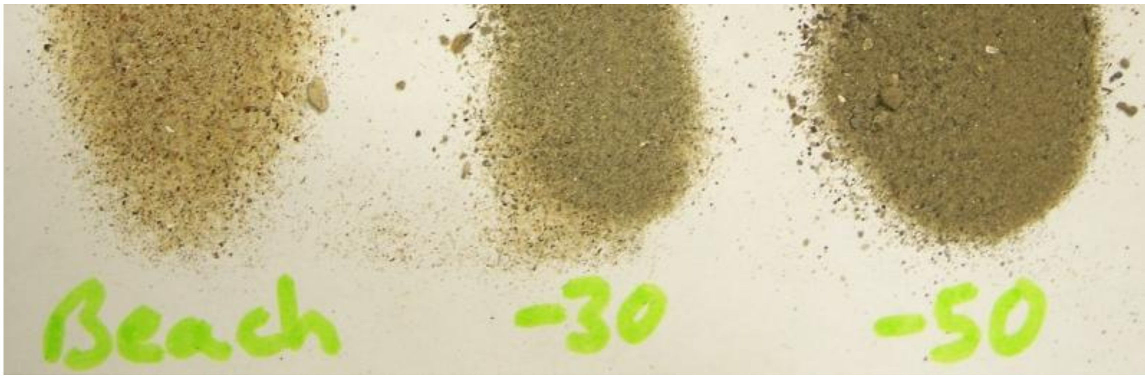
Link to 2007 Video Survey

A typical video survey along longitude 119° 49.836'W, between the outer boundary (latitude 34° 24.278'N) and inner boundary (latitude 34° 24.540'N) can be viewed by going to the following link (use ctrl + left click):
http://www.youtube.com/watch?v=b35vQQfs9A0

Seafloor Sediment

The seafloor in Goleta Bay slopes gradually away from the shoreline without any obvious change in slope inshore or offshore of the historical kelp bed boundaries (30 to 55 feet below MLLW). There is no apparent change in bottom morphology within the zone once occupied by the historical kelp bed. The historic kelp bed abuts exposed siltstone along the west edge, paralleling the shore near Goleta Point. Natural gas bubbles were observed coming from the seafloor in this area, which is ~ 30 feet water depth.

A noticeable difference in the amount of fines in sediment samples taken from different water depths can be observed. Sediment samples I gathered from the zone once occupied by a kelp bed in Goleta Bay contained fine silt particles not found in beach sand samples taken from the intertidal zone. Samples from 50 feet water depth contained more fines than in samples taken from 30 feet water depth. This indicates sediments are deposited at distances offshore with respect to grain sizes, and sediment overburden is likely to be relatively stable within the zone suitable for sand-dwelling kelp beds.



Sediment Samples
The greater the water depth and distance offshore, the greater the percentage of fine particles comprising the sediment.

Water-Jet Testing in Goleta Bay, April 2010

The following link shows video of water-jet testing performed in Goleta Bay in April 2010 *(use ctrl + left click)*: http://www.youtube.com/watch?v=CNKWzkYbQws
A ¾" diameter hose and 30" wand was used to check sediment depth and experiment with setting a granite column (the column was removed after each test). Later testing was performed with a 1.25" diameter hose and wand, which proved to be ideal for setting the columns. We are able to water-jet a hole in the seafloor to the desired depth and set a granite column in less than 30 seconds.

Shell Layer

A shell layer was observed ~ 15" beneath the seafloor during water-jet tests and through the taking of core samples. It was slightly more difficult to water-jet through this layer than the sediment above and below. How and when this layer was deposited is unknown, but may have to do with historic changes in sea level. This layer is likely a common feature of the sediment at this water depth along the Santa Barbara Channel mainland coast, as we encountered the layer at Tajiguas (~ 16 miles west of Goleta Bay) as well.

Core Sample

This (typical) core sample was taken from ~ 45 feet water depth in Goleta Bay in October 2011. Note the shell layer at ~ 15" sediment depth. This shell layer is evident in all areas probed in Goleta Bay within the historical kelp bed zone. Thirty-inch pieces of class-200 PVC pipe were used to take the core samples. Each pipe was driven into the seafloor to the desired depth (24"), then capped and removed. A cap was placed on the remaining open end of the pipe for transport.

In October 2011 we performed multiple dives within the proposed test sites (#'s 1, 2, and 3) and near the east side of Goleta Point. The purpose of these dives was to locate various endpoints and corners of the test sites using GPS, mark the points with temporary weights and buoys, install wooden stakes at each point, measure the distances and video survey the seafloor between the points, take core samples, test and measure the descent rate of "whirligig" descenders (intended to be used as a deployment method), and locate the area offshore of the east side of Goleta Point to determine where the sediment overburden was greater than 24".

The various GPS coordinates were obtained from Google Earth. By adjusting the transparency of historical kelp bed photos, I was able to superimpose them over the Google Earth image of Goleta Bay by aligning objects common to both images. Using additional features available in Google Earth, I was able to take measurements and determine desired GPS coordinates. These coordinates were located in Goleta Bay by boat using a hand-held GPS (Magellan Sport Track Pro), and were temporarily marked with anchors and buoys. We observed the last digit of each coordinate on the hand-held GPS to change in value at ~ 5 feet of distance change when using degrees, decimal-minutes. The actual measurements on the seafloor between all the various points we marked were within 5-10 feet of the distances obtained from Google Earth. This exercise confirmed the suitability of this method for accurately mapping the test sites.

Test Sites 2 & 3 with Suitable Sediment Overburden Boundary (Google Earth with Overlays)

A survey dive was performed on 10-19-2011 to determine where the sediment overburden was suitable for placement of granite columns. From the north end of Site 3, I swam NE until I encountered the single main seawater intake for UCSB, further on this same heading I encountered the dual main seawater intake pipes for UCSB. The dual pipes were laying on siltstone, so I followed the pipes heading offshore (SE heading) until adequate sediment overburden was encountered. From there I again headed in a NE direction to determine where suitable sediment overburden for granite column placement exists. I marked various locations by deploying surface markers (balloons) tied to pieces of rebar I drove into the seafloor. We later measured the GPS coordinates of these markers at the surface, then pulled them free from the seafloor. It appears the dual pipes are lying over an exposed ridge of siltstone at the west edge of the historical kelp bed. A rebar probing rod was used to measure for a minimum sediment overburden of 24".

2011 La Niña

I was informed by friends and family living in Goleta and Santa Barbara that it was unseasonably foggy throughout the summer months of 2011. During a visit to the area in October 2011, I noticed a significant reduction in the presence of kelp canopies further offshore along the Santa Barbara Channel mainland coast. I also noticed a decrease in the density of eelgrass within Goleta Bay from what we observed in the past. Urchin divers I talked to mentioned that *Macrocystis* kelp was also lacking in deeper water at the Channel Islands as well. This decrease in deep-water kelp and eelgrass is likely temporary and possibly linked to the reduction of sunlight associated with the La Niña weather conditions.

Reestablishing Sand-Dwelling Kelp Beds

The presences of worm tubes combined with years of mild swell activity are likely to be key factors influencing the past establishment of sand-dwelling kelp beds. Unless conditions are optimal for several consecutive years, regeneration of these beds (to pre-1982 conditions) through natural processes is unlikely to occur anytime soon. Even if reestablishment of the kelp beds were to occur, there would be no assurances they would recover in a timely manner if/when they disappear again during future episodic events. Providing supplemental structures within the optimal zone for sand-dwelling kelp beds could provide a means for aiding in the restoration of the kelp beds and help ensure their long-term existence.

Past Attempts to Aid in Recovery of Sand-Dwelling Kelp Beds

Kelco tested the following methods in attempts to establish growth-centers on sand bottom from 1983 through 1987 (Kelco, 1991):

1. Mushroom anchors (made from concrete);
2. Nylon-mesh bags filled with gravel;
3. Combination concrete and chain-link fence;
4. Double chain-link fence, with and without rug adhesive and sand;
5. Transplanting juvenile kelp plants to rebar driven into the sand;
6. Transplanting juvenile kelp plants to sections of chain-link fence deployed from the surface;
7. Stapling pleated polyethylene mesh (“Vexar”) sheets to the seafloor with rebar;
8. Stapling naturally occurring plants to the bottom with staples made from rebar;
9. Sea urchin control to protect existing kelp plants.

Although the restoration work was initially claimed to be successful, severe storms in 1987-88 and grazing by urchins destroyed ~ 90% of the restored areas (Kelco, 1991).

An analysis of the above alternatives reveals inherent problems with respect to materials used, subsidence, maintenance, longevity, cost, environmental hazards, and suitability for large-scale projects.

Proposed Strategy to Aid in Recovery of Sand-Dwelling Kelp Beds

To maximize the likelihood for long-term success, I used the following criteria to develop a method for aiding in the establishment of *Macrocystis* kelp on soft substrate:

- Cost: Economical, one-time investment.
- Deployment: Inconsequential impact to existing marine life.
- Dislodgement: Will not become dislodged by natural forces once set in place.
- Durability: Withstands handling and the forces acting upon them once set in place.
- Economics: Ability to reliably grow kelp for commercially viable uses.
- Environment: Environmentally benign.
- Fabrication: Devices must be capable of being mass-produced in a timely and cost-effective manner.
- Feasibility: Doable on a large-scale from fabrication to deployment.
- Fisheries: Ecologically enriching with no negative impacts.
- Handling: Manageable for transporting and deployment.
- Hazards: Non-hazardous to marine life or the environment.
- Invasiveness: Non-invasive from deployment phase throughout the anchors' existence.
- Location: Placed within the zone best suited for the establishment of sand-dwelling kelp beds.
- Longevity: Lasts indefinitely (possibly thousands of years) with no chance of creating a problem for future generations to contend with.
- Maintenance: No future maintenance of any kind required.
- Materials: 100% natural (stone).
- Mitigation: Suitable for mitigation projects to restore sand-dwelling kelp beds.
- Profile: Minimal profile and exposure above the seafloor.
- Recruitment: Utilizes natural recruitment of *Macrocystis* kelp.
- Scale: Suitable for large-scale projects.
- Scouring: Withstands the effects of scouring from surge.
- Stability: Stays-put under all conditions once set in place.
- Spacing: Accounts for the natural spacing and formation of growth-centers within a sand-dwelling kelp bed.
- Subsidence: Will not subside over time.
- Surge: Not prone to subsidence or dislodgement from the effects of surge.
- Volume: Uses the least amount of material possible.

The anchoring system I am proposing meets or exceeds <u>all</u> the above criteria.

The delicate nature of the worm tubes appears to be the primary factor in preventing the natural recovery of sand-dwelling kelp beds offshore of the Santa Barbara Channel mainland coast. Supplementing the worm tubes with more substantial structures would likely increase the chances for recovery of the beds. However, due to the depth of sediment within the optimal zone for establishing growth-centers on sand bottom and the effects of scouring, objects placed on the seafloor would eventually subside and disappear. Large boulders and piles of rocks placed on the seafloor would generally not fully-subside, but the amount of material and cost would be prohibitive on a large scale (See Appendix I, page 40: Edison's, "Wheeler North Reef" Article).

Granite Columns

Water-jetting granite columns (measuring 30"x 2"x 2") into the seafloor, leaving ~ 4-6 inches of column exposed above the seafloor, meets all the criteria previously mentioned. The presence of the granite columns simply augments a natural phenomena already taking place along the mainland coast of the Santa Barbara Channel. Unlike the worm tubes, the exposed portion of the granite columns provides greater assurance juvenile kelp will grow to the surface without becoming dislodged. This in turn optimizes photosynthesis and the subsequent production of sugars necessary for the holdfasts to compound in size, producing growth-centers capable of anchoring the kelp to the seafloor.

The seafloor sediment within the specified test site water depths is comprised of a large percentage of fines. The tight compaction and friction of this sediment results in a high shear force required to dislodge the columns. Crude experiments indicate the pullout force of a column set in compacted sand submerged in water to be greater than 110 lbs. - much higher than any naturally occurring physical forces which could potentially act on the columns. Five additional columns are added to test site 1 for use in performing in-situ testing to determine the pullout force required to dislodge the columns. These tests will be performed after one year of deployment to allow time for complete settling of the surrounding sediment.

Since it is highly unlikely the columns will dislodge from natural forces, there is no contingency plan for such an occurrence. If they were to dislodge, then it indicates this method won't work. Being comprised of 100% natural stone, the columns (or fragments of columns should they break) will not pose any hazard to the ecosystem.

Due to the small profile of each column presented to the water column, the effects of surge will produce only minimal scouring. The 24 inch embedment of the columns far exceeds any scouring effects likely to occur within the proposed water depths.

Source

Cold Spring Granite Company
17482 Granite West Road
Cold Spring, MN 56320-4578
1-800-328-5040

Granite Type

Sierra White

Quarry Location

Raymond, CA

Testing

Bulk Density	ASTM C97
Avg. Bulk Density	164.9 pcf
Absorption	ASTM C97
Avg. Absorption	0.32%
Compressive Strength	ASTM C170
Avg. Compressive Strength	17,180 psi
Modulus of Rupture	ASTM C99
Avg. Modulus of Rupture	2,130 psi

Size

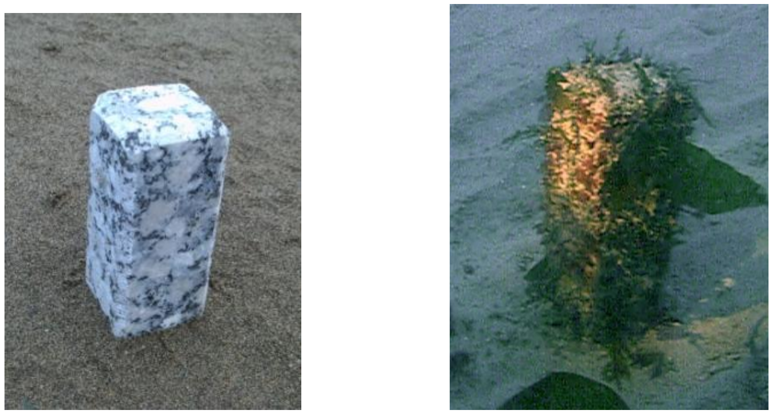
2” x 2” x 30” per column
Slabs are cut to length (30”) and thickness (2”), then cut to final width (2”)

Volume

0.0694 cu-ft per column
212 columns (total proposed number) = 14.375 cu-ft = 0.54 cu-yds

Weight

11.4 lbs/column (theoretical)
11.9 lbs/column (actual)
212 columns (total proposed number) = 2,523 lbs (using actual weight per column)



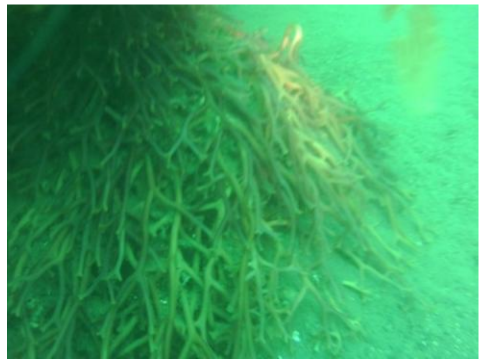
Granite Columns Fully Set into the Seafloor

Macrocystis Kelp Naturally Recruited and Growing on Granite Columns

How Columns Aid in Growth-Center Development

The columns allow kelp to grow to the surface where exposure to sunlight is optimized without becoming dislodged. Sugars produced through the process of photosynthesis are utilized to grow holdfasts of suitable size. As the holdfasts compound in size, sediment collects within the interstitial voids anchoring the growth-centers to the seafloor.

Turbulence around the holdfasts is produced by surge from swells. Depressions form in the seafloor around the perimeter of the holdfasts as sediment is scoured away. The actively growing haptera sprawling across the seafloor can be observed bending downward into these depressions. These haptera become buried beneath the seafloor when the depressions fill in as the surge subsides. This periodic occurrence results in a portion of the holdfasts becoming buried beneath the normal plane of the seafloor, conceivably increasing the anchoring potential. The holdfasts eventually become large enough they can endure periods of larger swell activity, which was evident in the decades prior to 1983. The developing growth-centers become the foundations for succeeding generations of kelp to grow on. Large numbers of growth-centers within close proximity to one another will eventually form a sand-dwelling kelp bed.



Growth-Centers Established on Sand Bottom

Placing the proposed granite columns on ~ 20 foot centers will likely provide an adequate spacing for maximizing kelp canopy coverage within an area. The density of kelp is a function of surface canopy coverage and light penetration to the seafloor. Kelp growing on rock substrate is generally spaced closer together and contains fewer fronds than kelp growing on soft bottom (Kelco, 1991; and personal observation).

As *Diopatra* are drawn to the area by the presence of kelp, additional growth-centers are likely to develop on worm tubes as well. Kelp growing in close proximity to one another will create localized conditions favorable to their continued growth and survival.

The performance of this method as a means for establishing sand-dwelling kelp beds can be demonstrated and examined further by performing a pilot study.

Proposed Pilot Study

Purpose

1. Demonstrate the ability to recruit and grow *Macrocystis* kelp on sand bottom.
2. Assess if the proposed method is suitable for a future large-scale project.
3. Determine if seafloor sediment depth changes seasonally within the near shore area east of Goleta Point, within the zone once occupied by a sand-dwelling *Macrocystis* kelp bed.

Scope

Set a total of 212 granite columns (measuring 2" x 2" x 30") ~ 24 inches into the seafloor in three different sites within the zone once occupied by a sand-dwelling *Macrocystis* kelp bed east of Goleta Point. All three sites lie east of a naturally occurring siltstone reef east of Goleta Point. Kelp growing on these stone outcroppings and off Isla Vista (west of Goleta Point) can be used to assess the growing conditions for kelp within the region at any given time. The total volume of (fill) material would equal 0.54 cubic yards and would consist of 100% granite. My preference is to leave the columns in place indefinitely to continue monitoring their performance over time. In the event the columns are ordered to be removed, I will do so by using a water-jetting wand to free the columns. The columns would then be recycled for landscaping or road fill.

Site 1 (Primary): Consists of 188 columns. A line of columns will be set 20 feet apart along longitude 119° 49.925'W, between latitudes 34° 24.497'N and 34° 24.259'N (the inner and outer boundaries of the historical kelp bed). A 200 foot x 200 foot (40,000 sq-ft) plot consisting of columns set 20 feet apart will be included in the middle of the line. Two columns will be set about five feet apart at each end of the test site, in the middle of the main line and where each edge of the plot intersects the main line. These five additional columns will be used to aid in locating these points during future surveys and can be used to perform pullout tests on (within ~ a year after deployment - after the surrounding sediment has had time to fully settle around the columns).

Site 2: Consists of 12 columns set 20 feet apart along longitude 119° 50.363'W, between latitudes 34° 24.297'N and 34° 24.263'N.

Site 3: Consists of 12 columns set 20 feet apart along longitude 119° 50.482'W, between latitudes 34° 24.226'N and 34° 24.191'N.

See Appendix II, pages 42-47: Legal Descriptions of Test Sites.

Table of Test Site Specifics

Site	Number of Columns	Area (includes 5' buffer)	Location Description	Coordinates	Nominal Water Depth (feet)	Comments
1	188	1.68 acres 73,200 sq-ft	North End	34° 24.497'N 119° 49.925'W	30-35	Additional column added 5 feet towards west
			South End	34° 24.259'N 119° 49.925'W	50-55	Additional column added 5 feet towards west
			Center	34° 24.376'N 119° 49.925'W	40-45	Additional column added 5 feet towards west
			Center North Side of Plot	34° 24.393'N 119° 49.925'W	40-45	Additional column added 5 feet towards west
			Center South Side of Plot	34° 24.360'N 119° 49.925'W	40-45	Additional column added 5 feet towards west
			NW Corner of Plot	34° 24.393'N 119° 49.945'W	40-45	
			SW Corner of Plot	34° 24.360'N 119° 49.945'W	40-45	
			NE Corner of Plot	34° 24.393'N 119° 49.905'W	40-45	
			SE Corner of Plot	34° 24.360'N 119° 49.905'W	40-45	
2	12	< 0.06 acres 2,300 sq-ft	North End	34° 24.297'N 119° 50.363'W	35-40	Revised from original plan
			South End	34° 24.263'N 119° 50.363'W	35-40	Revised from original plan
3	12	< 0.06 acres 2,300 sq-ft	North End	34° 24.226'N 119° 50.482'W	35-40	
			South End	34° 24.191'N 119° 50.482'W	35-40	

Plan

Plan photo: 1972 photo from Pacific Western Aerial Photos

The columns set at sites 2 and 3 will be used to check for seasonal changes in sediment depth, and kelp recruitment and growth within the nearshore area east of Goleta Point. I anticipate little change in sediment depth within the area of Site 1.

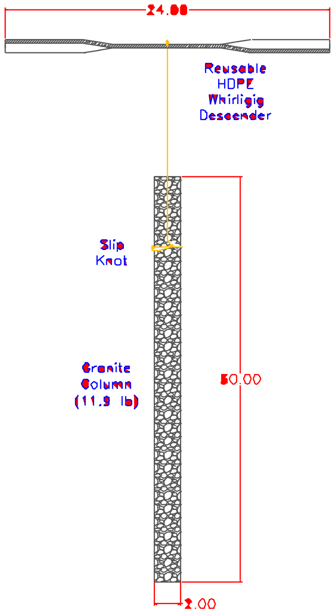
Due to the relatively small area of the test sites and the subsequent exposure of the kelp, I anticipate only limited growth-center formation of the holdfasts. The larger the kelp bed, the larger the individual growth-centers are likely to be.

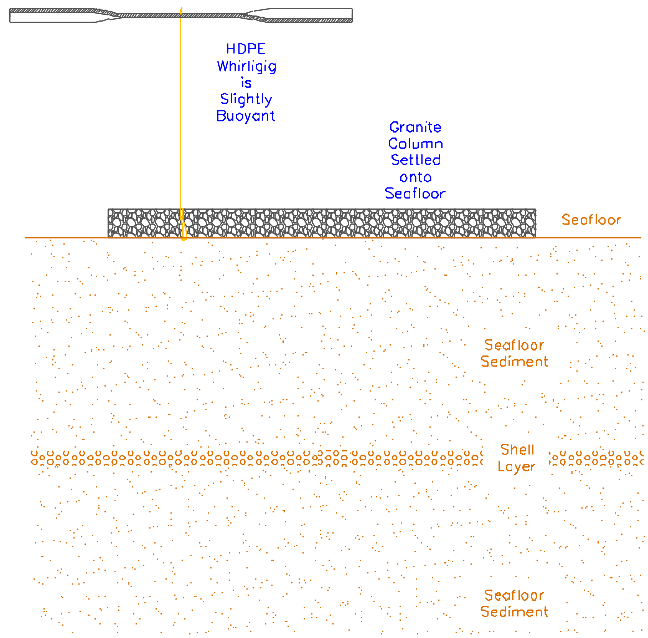
Methods of Deployment

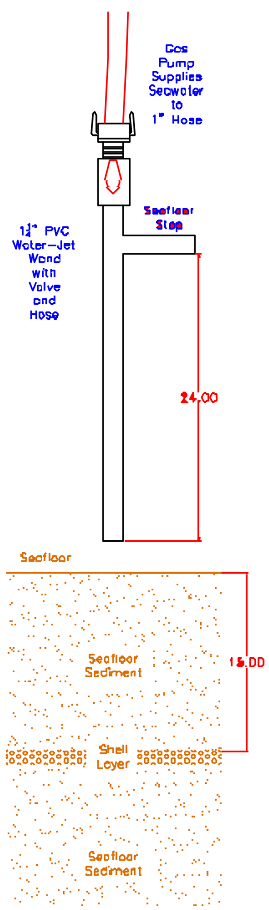
Getting the columns to the seafloor in an orderly and minimally-invasive manner is the goal. There are two methods of deploying the columns worth considering. One method consists of using a boat configured with a spool of rope and winch. The free end of the rope would be attached to an anchor and lowered to the seafloor. The rope would be payed-out from a boat moving along a specific heading. Granite columns would be attached to the rope at the desired interval with longline clips, which are attached to each column with a length of line and a slip knot. The rope lying on the seafloor (still connected to the columns) could be used by the diver to locate the columns when water-jetting them into the seafloor if visibility is low. Because this method requires specialized equipment, it may not be feasible for deploying the 212 columns used in the proposed pilot study. This method may however be worth considering for a future large-scale project.

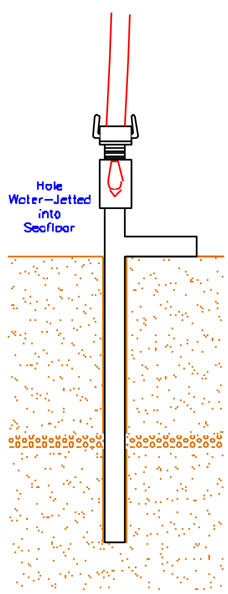
The deployment method I would like to use in the proposed pilot study involves the use of "whirligig" descenders. These consist of high-density polyethylene (HDPE) plates, two feet long by three inches wide, shaped into propeller blades. A line with a slip knot is used to attach each descender to a column. These devices slow the descent rate to less than two feet per second, and ensure the columns fall straight and set gently onto the seafloor. The columns would then be water-jetted into the seafloor by a diver. The HDPE descenders have a specific gravity of 0.97 and are therefore slightly buoyant. The descenders are retrieved from each column prior to setting and are stored either on the water-jetting hose (using the slip knot) or in a bag carried by the diver.

Note: The following CAD illustrations suffered some glitches when converting from MS Word to a pdf file.







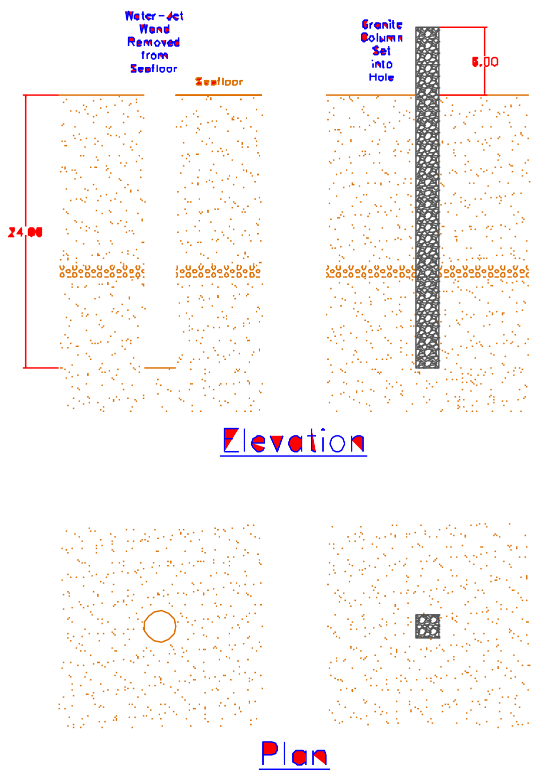


A pump on a boat supplies seawater through a 1.25" diameter hose to a water-jetting wand used by a diver. The wand is used to bore a hole into the seafloor to the proper depth, determined by a stop protruding from the side of the wand.

Test holes made in Goleta Bay (April 2010) revealed a shell layer ~ 15 inches below the seafloor. This layer is slightly more difficult to bore through, but the entire hole still only takes less than 20 seconds to make.

Removal of columns previously set into the seafloor can be accomplished by reintroducing a water-jetting wand adjacent to each column. Fluidization of the sediment allows for easy removal of the columns.

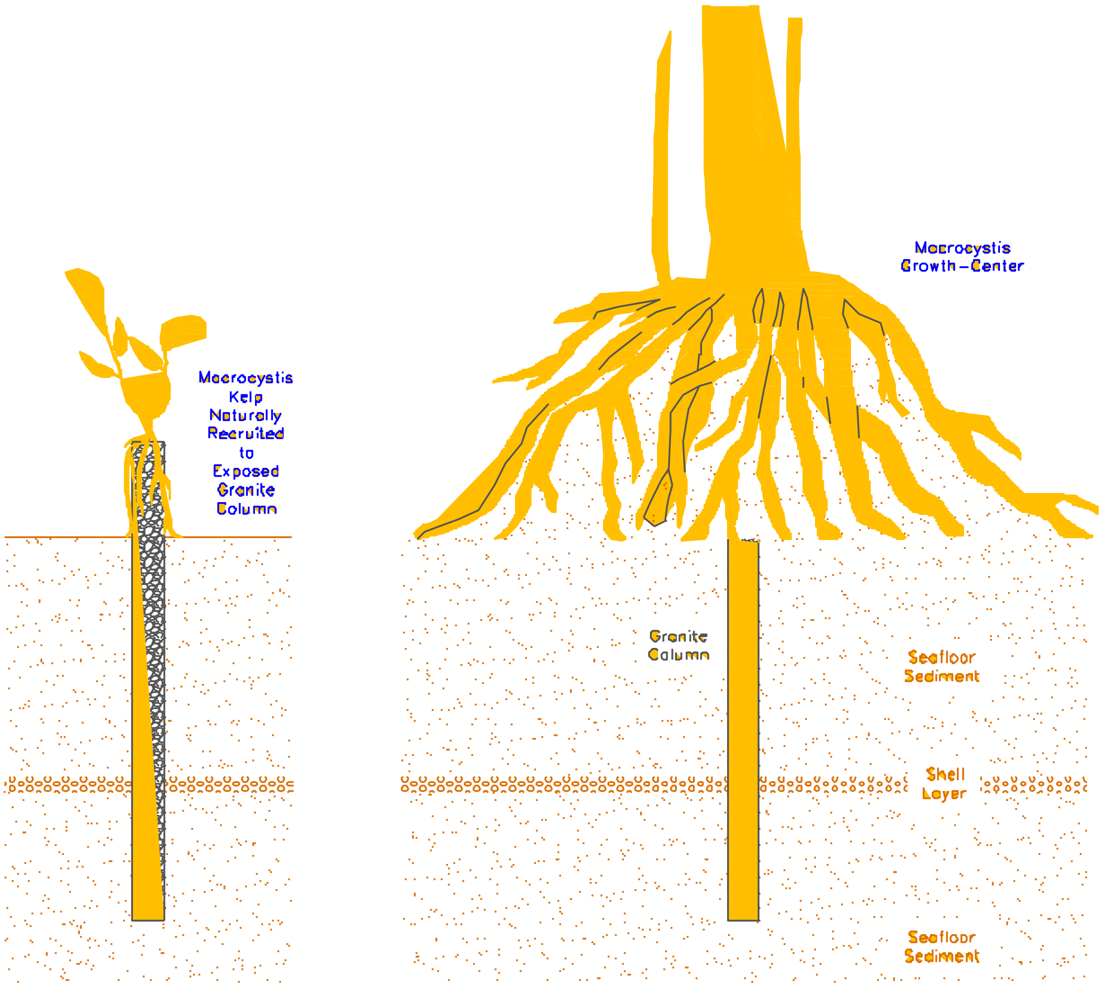
Due to the density of the seafloor offshore, a newly water-jetted hole does not readily fill in (unlike holes made in less compacted sediments closer to shore). This allows time to place a column in a hole immediately after the water-jetting wand is removed.



A 30 inch granite column is set into the 24 inch deep hole by a diver, leaving 4-6 inches of the column protruding from the seafloor. The wand can be used to flush additional sediment into the remaining voids alongside the column. The column becomes locked into the seafloor as the surrounding sediment settles.

Note: L3 Communications MariPro (located adjacent to the airport in Goleta) has expressed interest in helping with and contributing resources in the deployment phase of this study.

> *L-3 MariPro, a leading provider of undersea cabled sensor systems and reliable through-water communications for undersea defense, hydroacoustic monitoring and ocean science applications. Since the early 1960s, L-3 MariPro has designed, manufactured and installed highly reliable, long-life underwater acoustic and electromagnetic sensor systems used by the world's navies for submarine training, tracking exercises and surveillance. L-3 MariPro also provides cabled seafloor observatories to support the ocean research community. We have recently introduced proprietary through water communications technology for use by the US Navy.*
>
> *L-3 MariPro has been in the Goleta community for nearly five decades and employs approximately 90 people.*



Kelp spores settle naturally onto the exposed portion of the granite columns. The haptera of developing juvenile kelp attaches to the columns. The holding capacity of the holdfasts on the columns and the structural integrity of the columns allow the fronds to grow to the surface where photosynthesis is optimized. Rapid growth of the kelp ensues with the increased exposure to sunlight and the holdfasts soon envelop the columns. Sand begins to fill the interstitial voids of the developing holdfasts, which becomes the means by which they anchor themselves to the seafloor.

When the eventual dislodgement of the holdfasts occurs, the exposed portion of the granite columns become available once again for kelp spores to settle on.

Performance Criteria to be Tested

1. A diver (with SCUBA or hookah) using the water-jetting method described can set a 30 inch granite column into the seafloor to the desired depth in less than 30 seconds.
2. The columns will remain indefinitely as originally placed.
3. *Macrocystis* Kelp spores will settle and develop naturally on the exposed portion of the granite columns protruding from the seafloor.
4. The granite columns will support the growth of *Macrocystis* kelp when placed within the ideal depth zone.
5. Kelp growing on the granite columns will reach the surface within one year under normal oceanic and weather conditions.
6. Growth-centers will develop at each granite column as the holdfasts grow onto and over the seafloor. Voids within the holdfasts will fill with sediment, which becomes the means by which each growth-center anchors itself to the seafloor.
7. This method for growing kelp on sand bottom will prove to enrich the marine ecosystem without any adverse effects.
8. Due to the benign nature of this strategy and the myriad of criteria it meets, conditions requiring adaptive management measures are highly-unlikely to occur, and are therefore not being considered in this study. Either the columns work as described or they don't.

The idea of setting granite columns into the seafloor of Goleta Bay for the purpose of providing substrate for giant kelp (*Macrocystis pyrifora*) recruitment is supported by reputable biologists. Structure placed within the optimal depth zone for giant kelp growth is highly-likely, at one time or another, to support the recruitment and growth of kelp. The variability of kelp establishment and growth from year to year, as well as the number of variables affecting its establishment and growth is well known. During periods when the columns are not covered by giant kelp holdfasts, they still provide benefit for other types of marine life such as other algae species and invertebrates.

Installing granite columns throughout an area known to support sand-dwelling kelp beds can be considered an artificial reef. Although unconventional, this reef concept is designed to aid in the establishment of a unique type of kelp forest habitat. It addresses numerous criteria and could prove to be a viable, maintenance-free and cost-effective means of establishing giant kelp over large areas of sand bottom. Like any other artificial reef, the substrate used is not intended to be removed unless it proves to be detrimental in some manner.

Lacking the protection offered within a kelp bed of optimal size and density, kelp growing on the test site columns is not anticipated to grow beyond a certain size. Like terrestrial forests, kelp beds alter localized conditions to favor the growth and survival of individuals within the stand. For this reason, the establishment of large kelp holdfasts (growth-centers) is not anticipated to occur within the (small) proposed test sites. If *Macrocystis* begins to grow on any number of the columns within the test sites, it's reasonable to expect it will grow on others over time. Since kelp recruitment on worm tubes tends to result in dislodgement well before the fronds make it to the surface, a measure of success of the columns would be in their ability to support the growth of fronds to the surface.

Kelp growing on worm tubes within the vicinity of the columns and on siltstone east and west of Goleta Point will be used as the control to assess if conditions are favorable for recruitment and growth.

Considering the benign nature of the granite columns proposed in this study, and the benefits they provide aside from aiding in the targeted establishment of *Macrocystis* growth-centers, the intent is to leave the columns in place indefinitely unless they show signs of becoming dislodged or some other unanticipated environmental hazard is identified.

Summary of Specific Criteria to be Evaluated:

Occurrence	Action required	Successful	Unsuccessful	Criteria for removal?
Recruitment of *Macrocystis* kelp.	None	Occurs on any number of columns.	Does not occur on any columns.	No
Growth of Macrocystis kelp.	None	Kelp grows to the surface.	Kelp does not reach the surface.	No
Establishment of growth-centers.	None	Holdfasts grow large and fill with sediment.	Holdfasts don't extend beyond the columns.	No
Recruitment of other species of algae.	None	Occurs on any number of columns.	Does not occur on any columns.	No
Recruitment of sessile invertebrates.	None	Occurs on any number of columns.	Does not occur on any columns.	No
Utilization by non-sessile invertebrates.	None	Occurs on any number of columns.	Does not occur on any columns.	No
Colonization of tube worms around columns	None	Occurs around any number of columns.	Does not occur around any columns	No
Colonization by urchins.	None	Does not occur on any columns.	Occurs on any number of columns.	No
Sediment burial.	None, but indicates area of placement is prone to seasonal or episodic changes in sediment overburden.	Does not occur at any columns.	Occurs at any number of columns.	No
Subsidence.	None, but indicates method is not likely to last long term.	Does not occur on any columns.	Occurs on any number of columns.	No
Disintegration of columns.	None	Granite remains intact.	Granite chips, breaks, or erodes	No
Snagging fishing gear.	Identify what type of fishing and consider banning or discouraging specific practice within selected areas.	Does not occur.	Occurs.	No
Dislodgement.	Warrants removal of all columns. Method proved to be unacceptable.	Does not occur on any columns.	Occurs on any number of columns.	Yes
Any environmental hazard.	Warrants removal of all columns.	None observed.	Observed.	Yes

Surveys and Monitoring

Preliminary video surveys of the test sites were performed using SCUBA in October 2011. Post-deployment underwater video surveys of each site will also be performed. Additional post-deployment surveys will be conducted at specified intervals, preferably immediately after deployment and at ~ 4 month intervals for at least another 2 years. The surveys will be performed using SCUBA, and will include video surveys of the test sites and nearby areas. The recruitment and growth of kelp on the columns can be compared against kelp growing on worm tubes (used as the control) along respective water depth contours within Goleta Bay. A report will be submitted within one month after each survey and will include images along with written documentation. Professional marine biologists will be contracted to review and comment on the surveys, and possibly dive the test sites for themselves.

Considering the distances and areas to be covered underwater, any help with the procurement of two dive scooters would be greatly appreciated!

An environmental study of Goleta Bay was performed in 2007 by the Chambers Group as part of an Environmental Impact Report (EIR) for the Goleta Beach Master Plan. A letter by Noel Davis (PhD, Marine Biologist for Chambers Group) commenting on this study is included in Appendix III, pages 48-49.

Preliminary Survey Dives, October 2011

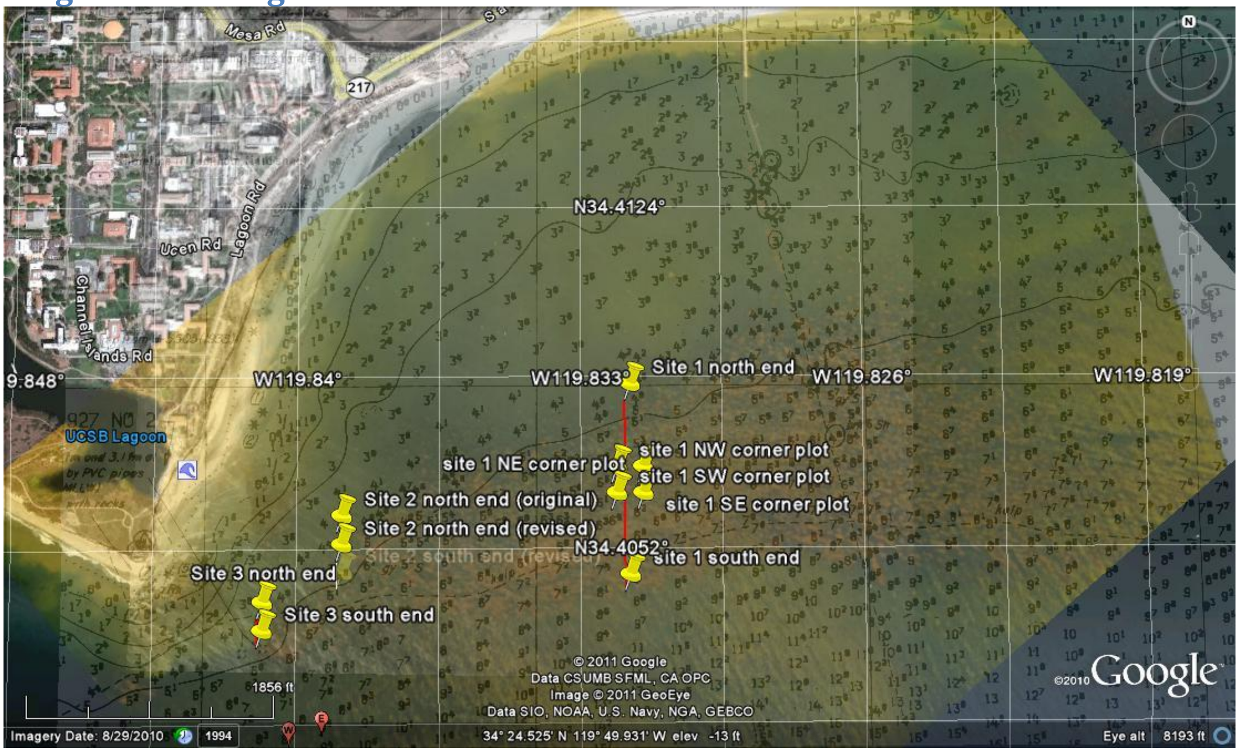
Test Site 1 - south end 10-15-2011 - late afternoon Beach-launched (12-foot Achilles) boat; located south end of site 1 using hand-held GPS; set mushroom anchor with buoy at desired coordinates; set boat anchor; used SCUBA to perform the following: set wooden stake into seafloor at mushroom anchor at 52-foot water depth; took core sample, emptied core sample to examine contents, noted shell layer section; observed Speckled Sanddabs (*Citharichthys stigmaeus*) congregating to investigate our activity; took final core sample; surveyed seafloor of proposed site 1 by swimming north of marker until our SCUBA air was at ~ 1,000 psi, then doubled-back to return to marker; seafloor was mostly barren soft sediment; found one unhealthy juvenile *Macrocystis* kelp growing on *Diopatra* worm tube, a White Sea Pen (*Stylatula elonga*te), and a Longspine Combfish (*Zaniolepis latipinnis*); ascended; observed sunset; pulled anchor and marker buoy; returned to shore; wave swamped boat (major hassle!). Note: visibility was poor and light levels were low. Video shows core sliced open. Use ctrl + left click on the following link to see edited video clip of dive: http://youtu.be/Ti2NfwGKmVQ
Test Site 3 10-16-2011 Launched 12-foot Achilles boat from Goleta pier (thanks to Dave – SB County Parks staff!); located south end of site 3 using hand-held GPS; set mushroom anchor with buoy at desired coordinates; located north end of site 3 using hand-held GPS; set mushroom anchor with buoy at desired coordinates; set boat anchor; used SCUBA to perform the following: set wooden stake into seafloor at mushroom anchor (32 foot water depth); took core sample; set transect line to south end; staked south end (38 foot water depth); video surveyed transect line; noted prevalent clumps of algae (species not known at this time) on sand bottom; found a buried stone I couldn't remove; took core sample adjacent to stone (36-foot water depth - verified sediment overburden depth was adequate); observed juvenile *Macrocystis* kelp growing on a *Diopatra* worm tube, and another on a *Eudastylia* (Featherduster) worm tube; removed transect line; pulled anchor and marker buoys; returned to shore. Note: visibility was poor and we found managing a transect line to be difficult. Use ctrl + left click on the following link to see edited video clip of dive: http://youtu.be/O3quKRsBCN4
Test Site 1 - center of south side of plot to north end of site 1 10-17-2011 - afternoon Used Goleta pier boat launch to launch 12-foot Achilles boat (thanks to SBCP's Paul Voyen, Brian Switzer, and Dave!); located north end of site 1 using hand-held GPS; set mushroom anchor with buoy at desired coordinates; located north end of south side of plot using hand-held GPS; set mushroom anchor with buoy at desired coordinates; set boat anchor; used SCUBA to perform the following: set wooden stake into seafloor at mushroom anchor (40 foot water depth); took core sample; used compass to navigate to north end of site 1 – video surveyed seafloor; observed Yellow Crab (*Cancer anthonyi*), Speckled Sanddabs (*Citharichthys stigmaeus*), Short Spined Sea Star (*Pisaster brevispinus*), Spiny Sea Star (*Astropecten armatus*), juvenile *Macrocystis* kelp growing on *Diopatra* worm tubes (~ 6 total), algae (*Desmarestia ligulata*), Eelgrass (*Zostera marina*) – from ~ 36 foot water depth and increasing in abundance shoreward with decreasing water depth; staked north end of test site and took core sample at mushroom anchor (34 foot water depth); ascended; swam back to boat on surface; pulled anchor and marker buoys; returned to shore. Note: the seafloor sloped gradually and was exclusively soft sediment. Shell layer was present in core samples. Use ctrl + left click on the following link to see edited video clip of dive: http://youtu.be/Upu-ynBEaBg

Test Site 2
10-18-2011 - afternoon
Used Goleta Pier boat launch to launch 12-foot Achilles boat; located south end of site 2 using hand-held GPS; set mushroom anchor with buoy at desired coordinates; located north end of site 2 using hand-held GPS; set mushroom anchor with buoy at desired coordinates; set boat anchor; used SCUBA to perform the following: attempted to set wooden stake into seafloor at mushroom anchor (32-foot water depth), found low sediment overburden and exposed siltstone; used compass to navigate south – seafloor was mixture of soft sediment and stones – observed natural gas bubbles coming from seafloor and an abundance of various species of algae; set wood stake at south end of proposed test site, which then became the **new north end** (38-foot water depth); took core sample and confirmed adequate depth of sediment overburden, used compass to navigate to **new south end** (measured to 220 feet); observed algae clumps abundant throughout sand bottom (species not identified at this time); took core sample at **new south end** (41-foot water depth) – stake floated away!; ascended; surface swam to boat; retrieved marker buoys and stake; returned to shore. Use ctrl + left click on the following link to see edited video clip of dive: http://youtu.be/soiiY2t7uLw

Test Site 1 – Plot north side center to NW to SW corners
10-21-2011 – afternoon
Used Goleta Pier boat launch to launch 12-foot Achilles boat; located site points using hand-held GPS; set mushroom anchors with buoys at desired coordinates (plot north side center, NW and SW corners); set boat anchor; video of surface buoys and Bob Kiel preparing to dive; used SCUBA to perform the following: staking desired coordinates, measuring distances and surveying seafloor between them; north side center to NW corner of plot (41-foot water depth, 104 feet measurement); Yellow Crab (*Cancer anthonyi*); Speckled Sanddab (*Citharichthys stigmaeus*); NW corner to SW corner of plot (41-foot water depth, measured 195 feet); dead *Macrocystis* kelp growing on *Diopatra* worm tube; ascended; surface swam to boat; retrieved marker buoys. Seafloor was sand bottom. Use ctrl + left click on the following link to see edited video clip of dive: http://youtu.be/X-r7h5wTdkI

Test Site 1 – Plot SE to NE corners to north side center
10-21-2011 – afternoon
Continued with surveying the plot perimeter in site 1. Located site points using hand-held GPS; set mushroom anchors with buoys at desired coordinates (plot SE to NE corners to north side center). Used SCUBA to perform the following: performed drop test on column with “whirligig” descender (the descent rate is less than two feet per second, and the column falls straight and rests gently on the seafloor - the HDPE descender is buoyant and floats above the column); staking desired coordinates, measuring distances and surveying seafloor between them; SE corner of plot (42-foot water depth) to NE corner marker (40-foot water depth, 210-foot distance); NE corner of plot to north side of plot (99-foot distance); ascended; surface swam to boat; retrieved marker buoys; returned to shore. Seafloor was sand bottom. Use ctrl + left click on the following link to see edited video clip of dive: http://youtu.be/VuAJTtMzIQs

Google Earth Image



Google Earth Image with Overlays

The historical kelp bed and proposed pilot study test site markers are shown. The transparency of the overlays (1972 and 1979 photos, and hydrographic chart) has been adjusted to reveal the present day image as well. The following can be performed when viewed in Google Earth:

- Zooming in on the image reveals all the center (40,000 sq-ft) plot markers.
- GPS coordinates of any spot can be obtained by moving the curser to the desired location and reading the displayed latitude and longitude values.
- Measurements can be taken.
- The three overlays and test site markers can be switched ON and OFF independently.
- Historical images can be obtained dating back to 1994.

If Google Earth is loaded on your computer and this report is viewed as a Word document (not PDF), click on the link below once, and then double-click on the KMZ file icon to open this image on Google Earth. Click on the boxes and menu items to the left of the image in 'Places' to switch the various images (1972 aerial photo overlay, Kelco 1975 photo overlay, hydrographic chart overlay and test site markers) on and off. All the features of Google Earth found in the tool bar at the top (historical images, measuring, zooming in/out) can be used on this image. The GPS coordinates of any point can be obtained by moving the curser over the point and reading the latitude and longitude values at the bottom.
This link will not open in pdf format and will therefore have to be sent as a separate file.

Google Earth Link

KMZ

Temporary Places 11-2011.kmz

Future Large-Scale Project

If the pilot study performs favorably, the method could be used in a future large-scale project to reestablish a kelp bed of historical proportions in Goleta Bay. A kelp bed extending ~ 1.25 miles (6,600 feet) eastward from the west end of the historical bed, with an average width of ~ 0.27 miles (1,426 feet), would cover an area of ~ 216 acres (9,408,960 sq-ft). Covering this area with a kelp bed of optimal density would require 23,832 columns if placed on 20 foot centers. At a cost of $25.00 per column, the total cost of columns needed would be ~ $600,000. The total volume of columns (fill material) = 61 cubic yards (~ 142 tons).

Assuming a diver could set 50 columns per hour (once the columns are lowered onto the seafloor); it would take ~ 500 single-diver hours to set all 23,832 columns. With a diver actively setting columns for six hours per day (shared between any number of divers), it would take ~ 80 diving days (at six man-hours per day) to set all the columns. Using multiple boats and divers would reduce the amount of days proportionately.

More precise cost and time estimates could be determined after setting a few lines of columns, but it appears this project could be completed within a reasonable timeframe and for a reasonable cost. Considering the potential longevity of the columns and the resulting benefits to the ecosystem, the return on this investment over time could prove to be substantial.

Assuming the pilot study is initiated in spring of 2014 and the study yields acceptable results over a 2 year period, it should become apparent by summer 2016 whether a large-scale project is worth pursuing. If the large-scale project were completed by mid-summer 2018, it's conceivable a kelp bed canopy could be visible offshore of Goleta Bay by the middle of 2020.

Justifications

Species of giant *Macrocystis* kelp are vital to healthy ecosystems in the temperate coastal waters throughout the world. *Macrocystis* is also considered a valuable resource to humans and is harvested globally for a variety of uses. Each of the following could stand alone as justifications for reestablishing a sand-dwelling kelp bed in Goleta Bay and elsewhere:

1. Environmentally Enriching:

Creating kelp forest habitat in relatively barren soft sediment areas would benefit a myriad of biota. The proposed method allows for rapid recovery of the kelp bed if it were to be dislodged again during future episodic events. Because well-established sand-dwelling kelp holdfasts are capable of withstanding periodic large swell events, the proposed method might also work to grow kelp in locations outside the more sheltered Santa Barbara Channel.

2. Test feasibility of cultivating kelp for commercial uses:

Investments in the commercial uses of kelp could be a viable means of funding future large-scale restoration projects. Kelp can be harvested and processed to extract alginates used in a variety of applications in the food, industrial and pharmaceutical industries.

Presently, kelp is only harvested in California to acquire feedstock for abalone farms. *Commercial cultivation of abalone could help supply the global demand for abalone. Large-scale commercial cultivation of abalone could conceivably reduce fishing and poaching pressures of wild stocks by lowering the market value.*

Developing large-scale cultivation methods for kelp is a key challenge in the advancement of macro-algae biofuels. The carbohydrate-rich and lignin-free tissues of *Macrocystis* make it an ideal feedstock for the production of biofuels (use ctrl + left click to view the following links):
http://news.discovery.com/autos/seaweed-kelp-fuel-cars-crops-110711.html
http://biofuelsdigest.com/bdigest/2010/10/04/seaweed-a-new-wave-of-investment-in-macro-algae/

3. Scientific study:

The close proximity of the UCSB campus to Goleta Bay offers a unique opportunity for research and assessing the ecological benefits of this endeavor.

4. Mitigation:

An example of a recent mitigation project is the Wheeler North reef project in San Clemente, California. This ($40-million) project is intended to mitigate for kelp losses at a reef offshore of the San Onofre Nuclear Power Generating Station (SONGS). See Appendix I, page 40, Edison's "Wheeler North Reef" Article.

Conclusion

There are many justifications for restoring sand-dwelling *Macrocystis* kelp beds. The method used to do so however must meet numerous criteria for there to be any reasonable chance of success and to reduce the possibility of unintended consequences. Performing a pilot study to examine the proposed method described in this proposal is essential for determining the feasibility and likelihood for success.

Acknowledgements

I extend my sincerest appreciation to the following individuals and agencies: my wife Kelley, and my children Justin and Jessie for putting up with me and my endeavor to research and develop this proposal; my partner Greg Christman for making architectural plans, dive support, photography and picture editings; Dr. Arthur Gibbs Sylvester for permitting me to use some of his pictures; Jeff Phillips for volunteering the use of his boat and assisting with survey dives; Fred Hepp for contributing his time and boat for research dives in Goleta Bay; Craig Barilotti, Dale Glantz, Dan Reed, Bruce Harger, Noel Davis, and Hany Elwany for taking time to consult with me and provide pertinent information; my colleagues at work for their support and contributions; John Anderson for editing; B.E.A.C.O.N. and Santa Barbara County Parks for supporting me in my pursuit of this project; the support and contributions from the many businesses I contacted; and everyone who takes the time to read this proposal and help with its implementation.

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- www.ispcorp.com/products/alginates/overview.html
- "Kelp Forest Ecology Species List." www.biology.ucsc.edu/classes/biol61/KFE%2001%species%201ist.htm
- "Kelp Forest Facts." Monterey Bay National Marine Sanctuary Office. www.birdingbyboat.org/kelp.htm

- "Modern and Paleo Climate Records." www.ualr.edu/~erse/oceanography/enso/page5.htm.
- NOAA National Marine Sanctuaries – Science and Education. "Kelp Habitat."
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- Rourke, Mary. 2002. "Wheeler North, 80: Helped Save Kelp Beds." "Kelp Reforestation Project." www.coastkeeper.org/kelp.html
- "The Pacific Decadal Oscillation." 2000. http://tao.atm05.washington.edu/pdo/

Appendix I
Edison's, Wheeler North Reef Article

SC Times San Clemente
LOCAL NEWS YOU CAN USE
Sunday, April 10, 2011

Edison's Wheeler North Reef Alive and Well

by David Zimmerle

Aug 26, 2010 | 1560 views | 0 | 7 | |

view slideshow (5 images)

<< >> The 174-acre Wheeler North Reef off San Clemente, an artificial kelp reef built by Southern California Edison during the summer of 2008, produced its first full kelp forest canopy during the past several weeks.

Edison provided reporters helicopter rides over the ocean last week for a chance at photos and some question and answer time with officials to explain the reef's success.

Initial underwater inspections have shown that the new man-made reef is biologically very productive, already meeting nine of 14 performance standards set by the California Coastal Commission in just the first full year of the kelp forest's existence.

The reef is one of three environmental mitigation projects the California Coastal Commission has required to offset the impact of the San Onofre Nuclear Generating Station on coastal marine life.

It is a successful creation of one of the nation's largest and most complex ecosystems of its kind.

Named after Caltech environmental scientist Wheeler J. North, one of the nation's first kelp-restoration experts, Southern California Edison's $46 million project is approximately one-mile off the coast of San Clemente, and is creating a new habitat for local marine life.

"This whole project was part of an agreement with the California Coastal Commission to do a long-term study on the marine environment, particularly on the fish, the water quality and the water temperature and if any of those elements are impacted by the plant," said Patrick Tennant, a marine biologist with SCE.

To cool the plant at San Onofre, water from the ocean passes through the plant's system and is then discharged through a larger diffuser pipe back into the ocean. Some experts wanted to know if the cloudy water actually inhibited the growth of the kelp, which is why the California Coastal Commission ordered the study.

Some of the benefits of the reef include adding a significant amount of new marine habitat to the Southern California coast that both protects and nourishes as many as 50 different varieties of fish and invertebrates. The reef will increase recreational opportunities including fishing and diving.

"We're happy about the reef's growth," said David Kay, SCE'S manager for environmental projects. "However, we're cautious because it has to outlast the life of the plant. So I'd say we're cautiously optimistic that it's a long-term success, but it's definitely a short-term success."

Read more: San Clemente Times - Edison's Wheeler North Reef Alive and Well

Appendix II
Legal Description of Test Sites

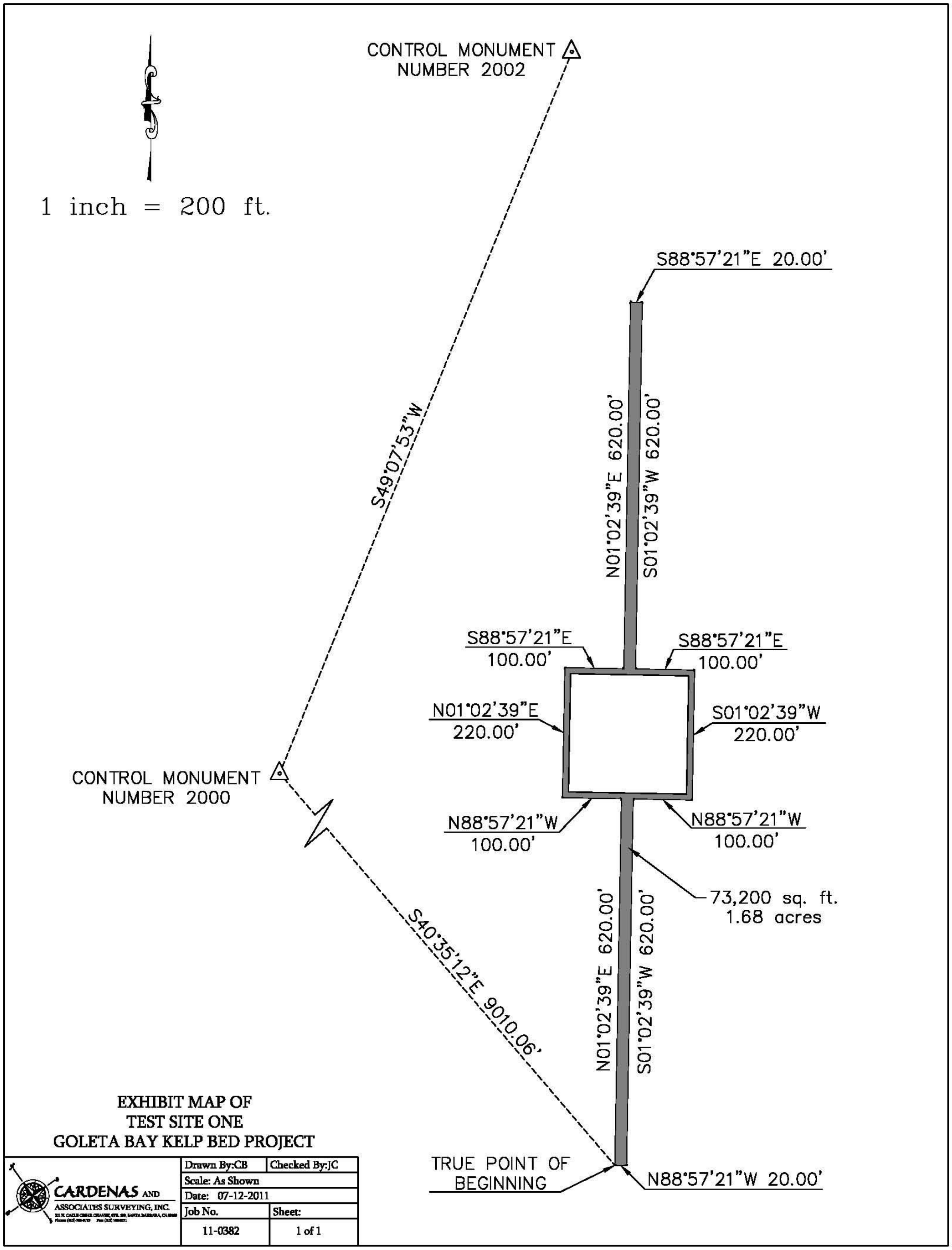
(by Cardenas & Associates Surveying, Inc.)

Test Site One
Exhibit A

A strip of land in the Pacific Ocean between the westerly side of the Goleta Pier and Goleta Point, said Goleta Point shown in the Recorded Map of the Kelp Beds in Miscellaneous Maps Book 41, Page 85 in the Office of the County Surveyor, County of Santa Barbara, State of California, more particularly described as follows;
Beginning at Control Monument Number 2000, as shown in Record of Survey Book 170, Pages 47-49
Recorded in the Office of the County Surveyor of said County, said monument bears S49º07'53"W from Control Monument Number 2002 as shown on said Record of Survey;
Thence S 40º35'12" E 9,010.06 feet to the southerly westerly corner of said strip and the True Point of Beginning;
Thence N 01º02'39" E 620.00 feet to an angle point;
Thence N 88º57'21" W 100.00 feet to an angle point;
Thence N 01º02'39" E 220.00 feet to an angle point;
Thence S 88º57'21" E 100.00 feet to an angle point;
Thence N 01º02'39" E 620.00 feet to an angle point;
Thence S 88º57'21" E 20.00 feet to an angle point;
Thence S 01º02'39" W 620.00 feet to an angle point;
Thence S 88º57'21" E 100.00 feet to an angle point;
Thence S 01º02'39" E 220.00 feet to an angle point;
Thence N 88º57'21" W 100.00 feet to an angle point;
Thence S 01º02'39" W 620.00 feet to an angle point;
Thence N 88º57'21" W 20.00 feet to the True Point of Beginning.
Said Described parcel containing 1.68 acres more or less.

Bearings are based on the California Coordinate System Zone 5, distances are grid and the combined scale factor is 0.99994349 at control monument Number 2000 per said Record of Survey.

End of Description



CONTROL MONUMENT
NUMBER 2002
1 inch = 200 ft.
S88°57'21"E 20.00'
S49°07'53"W
N01°02'39"E 620.00'
S01°02'39"W 620.00'
S88°57'21"E
100.00'
S88°57'21"E
100.00'
N01°02'39"E
220.00'
S01°02'39"W
220.00'
CONTROL MONUMENT
NUMBER 2000
N88°57'21"W
100.00'
N88°57'21"W
100.00'
73,200 sq. ft.
1.68 acres
S40°35'12"E 9010.06'
N01°02'39"E 620.00'
S01°02'39"W 620.00'
EXHIBIT MAP OF
TEST SITE ONE
GOLETA BAY KELP BED PROJECT
TRUE POINT OF
BEGINNING
N88°57'21"W 20.00'
CARDENAS AND
ASSOCIATES SURVEYING, INC.
Drawn By:CB
Checked By:JC
Scale: As Shown
Date: 07-12-2011
Job No.
11-0382
Sheet:
1 of 1

Test Site Two

Exhibit A

A 10 foot wide strip of land in the Pacific Ocean between the westerly side of the Goleta Pier and Goleta Point, said Goleta Point shown in the Recorded Map of the Kelp Beds in Miscellaneous Maps Book 41, Page 85 in the Office of the County Surveyor, County of Santa Barbara, State of California, the center line of said strip more particularly described as follows;

Beginning at control monument Number 2000, as shown in Record of Survey Book 170, Pages 47-49
Recorded in the Office of the County Surveyor of said County, said monument bears S49º07'53"W from control monument Number 2002 as shown on said Record of Survey;

Thence S28º28'29"E 7699.60 feet to the southerly end and beginning said 10 wide strip in the Pacific Ocean;

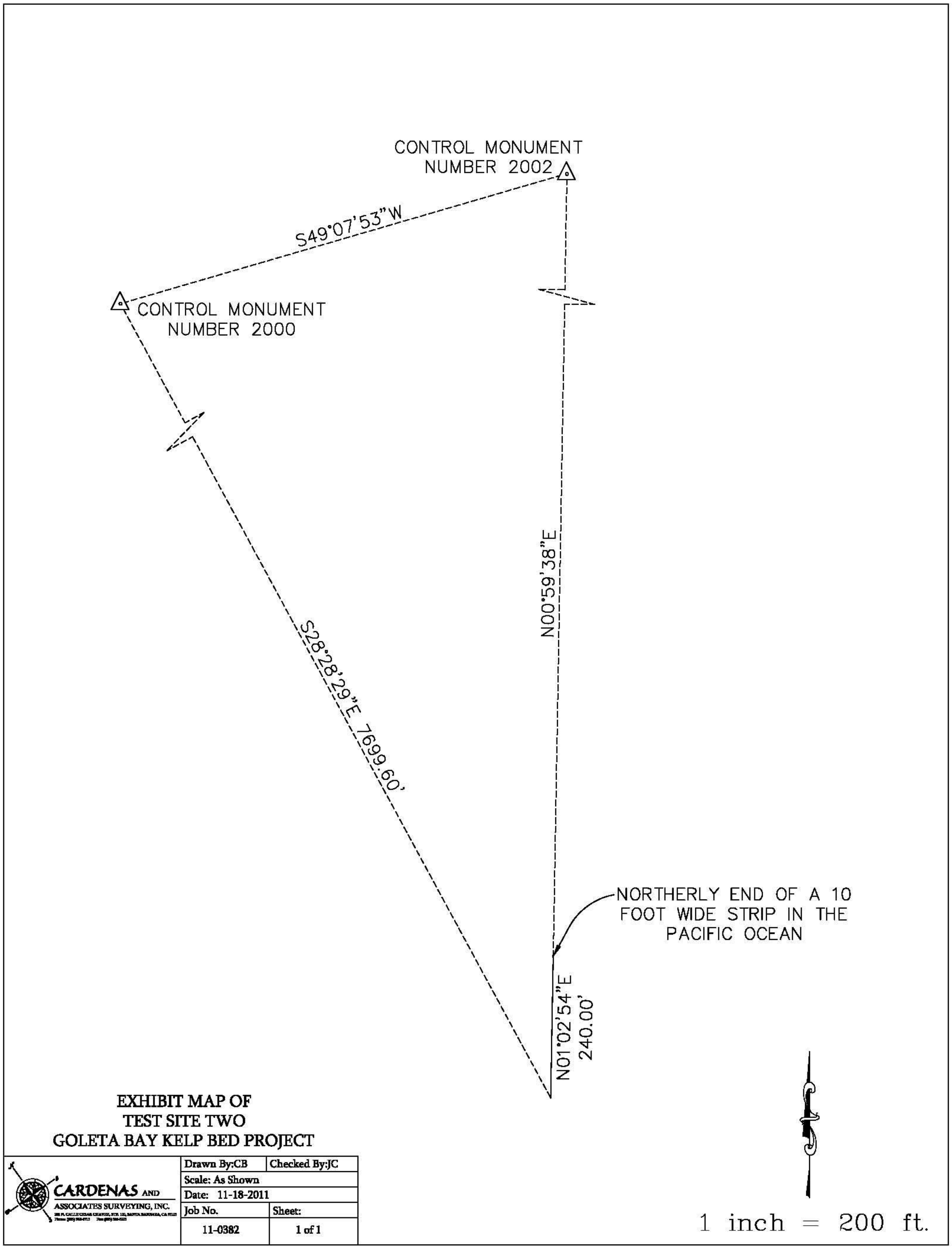
Thence N 01º02'54"E 240.00 feet to the northerly end and end of said 10 wide strip in the Pacific Ocean from which control monument Number 2002 bears N00º59'38"E;

The side lines of said 10 foot wide strip of land (five feet on either side of described center line) shall be prolonged or shortened to terminate at right angles to the southerly and northerly ends of the described center line;

Said Described parcel containing 0.06 acres more or less.

Bearings are based on the California Coordinate System Zone 5, distances are grid and the combined scale factor is 0.99994349 at control monument Number 2000 per said Record of Survey.

End of Description


CONTROL MONUMENT
NUMBER 2002
S49°07'53"W
CONTROL MONUMENT
NUMBER 2000
N00°59'38"E
S28°28'29"E 7699.60'
NORTHERLY END OF A 10
FOOT WIDE STRIP IN THE
PACIFIC OCEAN
N01°02'54"E
240.00'
EXHIBIT MAP OF
TEST SITE TWO
GOLETA BAY KELP BED PROJECT
CARDENAS AND
ASSOCIATES SURVEYING, INC.
Drawn By:CB
Checked By:JC
Scale: As Shown
Date: 11-18-2011
Job No.
Sheet:
11-0382
1 of 1
1 inch = 200 ft.

Test Site Three

Exhibit A

A 10 foot wide strip of land in the Pacific Ocean between the westerly side of the Goleta Pier and Goleta Point, said Goleta Point shown in the Recorded Map of the Kelp Beds in Miscellaneous Maps Book 41, Page 85 in the Office of the County Surveyor, County of Santa Barbara, State of California, the center line of said strip more particularly described as follows;

Beginning at control monument Number 2000, as shown in Record of Survey Book 170, Pages 47-49
Recorded in the Office of the County Surveyor of said County, said monument bears S49º07'53"W from control monument Number 2002 as shown on said Record of Survey;

Thence S23º01'21"E 7835.66 feet to the southerly end and beginning said 10 wide strip in the Pacific Ocean;

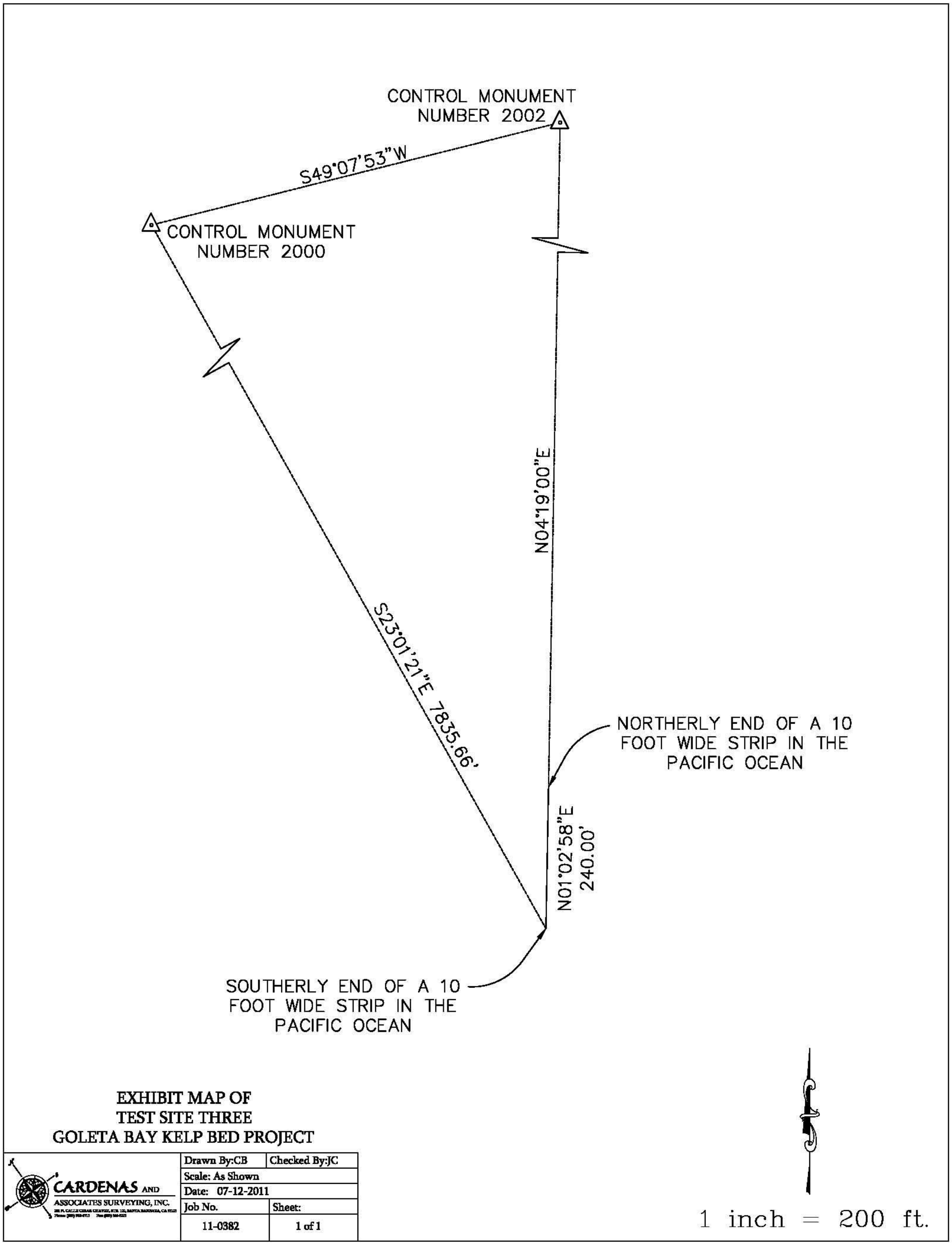
Thence N 01º02'58"E 240.00 feet to the northerly end and end of said 10 wide strip in the Pacific Ocean from which control monument Number 2002 bears N04º19'00"E;

The side lines of said 10 foot wide strip of land (five feet on either side of described center line) shall be prolonged or shortened to terminate at right angles to the southerly and northerly ends of the described center line;

Said Described parcel containing 0.06 acres more or less.

Bearings are based on the California Coordinate System Zone 5, distances are grid and the combined scale factor is 0.99994349 at control monument Number 2000 per said Record of Survey.

End of Description


CONTROL MONUMENT
NUMBER 2002
S49°07'53"W
CONTROL MONUMENT
NUMBER 2000
N04°19'00"E
S23°01'21"E 7835.66'
NORTHERLY END OF A 10
FOOT WIDE STRIP IN THE
PACIFIC OCEAN
N01°02'58"E
240.00'
SOUTHERLY END OF A 10
FOOT WIDE STRIP IN THE
PACIFIC OCEAN
EXHIBIT MAP OF
TEST SITE THREE
GOLETA BAY KELP BED PROJECT
CARDENAS AND
ASSOCIATES SURVEYING, INC.
Drawn By:CB
Checked By:JC
Scale: As Shown
Date: 07-12-2011
Job No.
Sheet:
11-0382
1 of 1
1 inch = 200 ft.

Appendix III
Letter by Noel Davis

PhD, Marine Biologist – Chambers Group

February 24, 2012

Gerald Comati, P.E.
Program Manager, BEACON
206 East Victoria Street
Santa Barbara, CA 93101

Dear Mr. Comati
This letter is in support of Robert Kiel's proposal to test an experimental method of restoring sand-based giant kelp to the Santa Barbara County southern coast mainland by installing granite columns in Goleta Bay. I have over 40 years of experience as a marine biologist in Southern California and over 20 years of experience with the Santa Barbara County mainland coast. I monitored the sand-based kelp bed off El Capitan during installation of a gas pipeline prior to the decimation of the kelp beds by the 1982/83 El Nino. I have been performing studies in Goleta Bay beginning in 1991 and have been monitoring the kelp and eelgrass there since 2003. Therefore, I am thoroughly familiar with the marine environment where the project would be performed as well as with the sand-based kelp that is the subject of the proposed restoration.

As discussed in the proposal, restoration of sand-based kelp would have many benefits for the southern Santa Barbara County mainland coastline. Sand-based kelp beds add vertical structure to what would otherwise be monotonous soft bottom, and provide food, shelter and attachment sites for many species of algae, invertebrates, and fish. When the kelp dies, it forms the basis of a detritus-based food web that continues to support marine food chains both in the ocean and on the shore where it washes up as wrack on the beaches. In addition, the sand-based kelp beds functioned to calm the nearshore environment by buffering wave action and may have helped to reduce erosion of beach sand. Since the sand-based kelp beds disappeared in the 1982/83 El Nino, scientists have been attempting to find a method to restore kelp to this area. I believe Robert Kiel's proposal is a promising method that should be implemented.

As discussed in the proposal, kelp has been unable to re-establish on the nearshore sand bottom because the worm tubes to which it attaches are not strong enough to withstand the drag of the growing kelp during larger wave events, and the kelp and the worm tube to which it is attached become dislodged. The proposed installation of 4 square inch granite columns would provide a stable attachment site for kelp to become established on the sand bottom. Once kelp becomes established, its holdfasts grow and become growth centers that support more kelp recruitment. I believe the proposed methodology of restoring kelp by providing small granite columns as attachment sites is extremely promising.

The proposed kelp restoration methodology of jetting 2 inch by 2 inch granite columns into the sea floor in Goleta Bay will have essentially no discernible adverse impact on the environment. I have used rebar, screw anchors and other structures, similar to narrow granite columns, as markers of subtidal research sites and have observed no scour or other adverse effects. I have collected sand bottom invertebrate samples near such small structures and have not recorded an infaunal invertebrate community atypical of sand bottom communities at these depths. The disturbance of the jet that would be used to install the columns would be similar to the disturbance of sand by wave surge. The amount of seafloor the columns would occupy and the jetting would disturb is minimal. Most of the columns would be installed beyond the eelgrass zone which is mostly shallower than 35 feet in Goleta Bay. The minimal amount of disturbance associated with column installation would not be expected to have a significant adverse effect on any eelgrass that may occur in the shallower installation sites.

In summary, I believe that the proposed experimental kelp restoration would be beneficial and would not harm the environment. Even if the methodology fails, useful information will be gained to guide future attempts to restore sand-based kelp. I believe, however, that the proposed methodology has a good chance of success.

Sincerely,

CHAMBERS GROUP, INC.

Noel Davis, Ph.D.
Marine Biologist

Appendix IV
Coastal Commission Staff Comments

File No. 4-11-028, Goleta Bay Kelp Study

Note “References to Responses to Coastal Commission Staff Comments” section in this proposal (page 63).

RNIA COASTAL COMMISSION
AL COAST AREA
IFORNIA ST., SUITE 200
93001

4-11-028
(File No.)

BEACON
(Applicant)

Gerald Comati, Program Manager
(Agent)

Offshore Goleta Beach, Goleta
(Project Street and City)

Dear Applicant:

Your Coastal Development Permit (CDP) application has been reviewed and is incomplete pursuant to California Code of Regulations, Title 14, Sections 13053.5 through 13056. In order to process the permit application in accordance with the provisions of the Coastal Act and with Administrative Code, we are unable to file and schedule the application for a Commission hearing until we receive additional information as described below. Information submitted in response to this letter may raise additional issues and/or necessitate further clarification or information requirements.

ADMINISTRATIVE

☐ 1. Filing fee is $________ . Payable by check or money order to the California Coastal Commission. Amount due $______

☒ 2. Stamped, addressed envelopes (no metered postage) and a list of names and addresses of all other parties known to the applicant to be interested in the proposed development (such as persons expressing interest at a local government hearing, etc.). **Please provide a stamped addressed envelope for the University of California, an adjacent property owner.**

☒ 3. 2 set(s) of project drawings. Drawing must be to scale with dimensions shown. Trees to be removed must be marked on the site plan. Plans must be approved by the City or County Planning Department and stamped “Approval-in-Concept.” **See Staff Comments below.**

☒ 4. A legible set of project plans reduced to 8½ x 11” in size.

GOVERNMENTAL APPROVALS

☐ 5. “Approval-in-Concept” form completed by the City or County Planning department or other responsible department.

☐ 6. City or County Environmental Review Board Approval, or evidence that such approval is not required.

☐ 7. All projects in or adjacent to a Stream, Wetland, or possible Wetland - California Department of Fish and Game and U.S. Fish and Wildlife Service approvals, or evidence that such approval is not required.

☒ 8. Verification of all other permits, permissions or approvals applied for or granted by public agencies (e.g., Dept. of Fish and Game, State Lands Commission, U.S. Army Corps of

Engineers, U.S. Coast Guard). ***Please provide evidence of a lease from the State Lands Commisson for the proposed project.**

☐ 9. A copy of any Negative Declaration or Mitigated Negative Declaration, Draft or Final Environmental Impact Report (DEIR or FEIR) or Final Environmental Impact Statement (FEIS) prepared or adopted, for the project. Comments of all reviewing agencies and responses to comments must be included.

STAFF COMMENTS

The following additional materials are required for the completion of this application.

10. **Project Proposal/Project Description.** Please provide an additional copy of the "Sand-Dwelling Macrocystis Kelp Resotration Project Proposal" dated March 24, 2011 prepared by Robert Kiel. Please clarify whether that document contains all of the project components and is intended to serve as the project description. The March 24, 2011 document was not provided with the application, rather only portions of it were provided with the application submittal. Additionally, please clarify the following:

    a.) What are the proposed depths for each site and what is the square footage of area for each site?

    b.) What is the proposed time of year for project implementation and/or project schedule?

    c.) Please indicate the estimated life of the proposed granite columns and describe any anticipated maintenance and repairs in the future. What are the likely impacts that will result if the structures are removed?

    d.) Please clarify whether the project includes placing juvenile kelp plants on the columns and, if so, how that process will take place.

11. **Anchor System/Stability.** Please provide evidence that the columns will be able to withstand storm surge, currents, and wave energy typically associated with the proposed location. This should include a description of the holding capacity (weight and force) of the columns and how that compares with the conditions that will be present at site. Please provide an analysis of potential anchor systems for the columns. Please provide a contingency plan if the columns become dislodged and need to be put back in place (i.e., timing, method).

12. **Dive Survey Results:** Please provide all reports and data from all preliminary dive surveys of the project area.

13. **Project Plans:** Provide two full size sets of project drawings (and one reduced size set). Drawings must be to scale with dimensions shown. The drawings must be prepared by qualified engineers and biology professionals, and must include:

a.) A site plan of the project area that includes the exact location and coordinates for the proposed kelp bed footprint for each site, a bottom profile of the project area, and the location of any rocky substrate, kelp beds, eelgrass habitat, or other sensitive resources in and around the project area; and

b.) Plans depicting the exact locations of columns on the sea floor and water surface elevations in the project area for each bed location, including cross sections.

c.) A site plan showing the project in relation to the historic inner and outer boundaries of the Goleta Bay kelp bed and the boundaries of any present kelp beds.

14. **Biological Resources:** Please provide an analysis of the biological resources present and potentially present in the project area prepared by a qualified biologist or resource specialist. The analysis must include the extent, location, and character of biological habitat present in the project area, including all hard-bottom substrate, all marine vegetation, kelp forests, eel grass, and any other habitat that has the the potential to be impacted by the project. This baseline analysis must identify any rare, threatened, or endangered species that are present or expected at the project site and provide a map depicting the location of biological resources and physical site features. The analysis must also address any potential impacts of the proposed project on identified habitat or species, project alternatives designed to avoid and minimize any potential impacts to sensitive resources, and mitigation measures that would minimize or mitigate any residual impacts.

15. **Alternatives Analysis:** Please explain what alternatives were considered for this project, including alternatives for the anchor system materials, and alternatives for kelp bed locations. Page 8 of the project proposal states that "various methods for growing kelp on artifical anchors have been tried in the past, but they all have undesirable side effects associated with them." Please provide all previous studies/methods regarding growing kelp that were referenced.

16. **Project Monitoring, Performance Criteria, Adaptive Management:** Please provide a plan that includes specific details about how the kelp beds will be monitored (this should include information regarding what will be utilized as baseline data); (2) establish clear, explicit performance criteria and standards for the goals of the project; (3) identify specific conditions that would trigger the need for immediate adaptive management measures and the timing by which these measures should be initiated; and (4) describe any associated adaptive management measures in detail.

Depending on the additional information in response to this letter, it may be necessary for us to request further clarification and/or information prior to scheduling the proposed project for Commission action. We recognize that providing this application information is time consuming and sincerely appreciate your cooperation.

By: A. Amber Tysor, Coastal Program Analyst

Date: June 16, 2011

References to Responses to Coastal Commission Staff Comments

File No. 4-11-028

10. Project Proposal/Project Description:

See "Sand-Dwelling *Macrocystis* Kelp Restoration Project Proposal," revised 11-1-2013, by Robert Kiel. This document contains all of the project components, serves as the project description and will be updated as needed.

a. Depths and square-footage of area for each site: See "Table of Test Site Specifics" section in proposal (page 22).

b. Proposed time of year for project implementation and/or schedule: Set granite columns early spring, 2014. Perform video surveys of test sites and submit report on findings ~ every 4 months.

c. Estimated lifespan of granite columns is indefinite. It is conceivable the columns could last for many centuries, perhaps even thousands of years in this application. No future maintenance or repairs are anticipated to be needed or performed. Incidentally, installation or removal of the columns would not create any adverse environmental impacts to the ecosystem. See proposal for details pertaining to the granite columns (page 17), method of installation (page 24), and options for removal (page 25).

d. The proposed system relies only on natural recruitment and growth of giant *Macrocystis* kelp on sand bottom. See "How Columns Aid in Growth-Center Development" section in proposal (page 19). *Kelp growing on worm tubes within Goleta Bay would act as the control for comparing against kelp growing on the columns at respective depth contours.*

11. Anchor System/Stability:

See "Granite Columns" section in proposal (page 17) for details pertaining to the granite columns.

12. Dive Survey Results:

See "Preliminary Survey Dives, October 2011" section in proposal (pages 31-32). Note links to edited video clips of each dive on Youtube (use ctrl + left click on each link to open).

13. Project Plans:

a. See "site plan" in proposal (page 23). Full-size plans are available upon request. See proposal for description of footprint of each site, bottom profiles and location of rocky substrate, kelp beds, eelgrass habitat and other sensitive resources in and around the project area.

b. See "Table of Test Site Specifics" section in proposal for column locations and water depths (page 22).

c. See "site plan" in proposal (page 23), Kelco image in proposal (page 10, and Google Earth overlay in proposal (page 33) for images of historical sand-dwelling kelp bed and kelp growing on rock substrate near the point and on the sewer outflow pipe riprap. Click on Google Earth link to access the Kmz file. Shows transparency overlays of historical kelp bed (1972 and 1975) and hydrographic survey (depth) chart. Also shows proposed test site endpoints and various coordinates. See proposal (page 14) for description of survey dive to map the suitable sediment overburden boundary near Goleta Point by test sites 2 and 3.

14. Biological Resources:

See Appendix III ("Goleta Bay Environmental Study" by Noel Davis, PhD, Marine Biologist, Chambers Group) in proposal, page (48). Note: Noel Davis and Dan Reed (PhD, Marine Biologist, UCSB) have agreed to comment as needed on the subject matter of this proposal.

15. Alternatives Analysis:

See "Past Attempts to Aid in Recovery of Sand-Dwelling Kelp Beds" section in proposal (page 15), and "Proposed Strategy to Aid in Recovery of Sand-Dwelling Kelp Beds" section in proposal (page 16).

16. Project Monitoring, Performance Criteria, Adaptive Management:

a) Monitoring Plan:
   See "Surveys and Monitoring" section in proposal (page 30).
b) Performance criteria and standards for the project goals:
   See "Performance Criteria to be Tested" section in proposal (page 28), and "Summary of Specific Criteria to be Evaluated" section in proposal (page 29).
c) Conditions requiring adaptive management measures + timing:
   None anticipated. See "Performance Criteria to be Tested" section in proposal, #8, (page 28)
d) Adaptive management measures details:
   Not applicable.

Contacts

Agencies Contacted

Army Corps of Engineers:

- Coastal Engineering Research Center (CERC) 601-634-3044. Thomas Richardson, Nicholas Kraus, Joan Pope (Research and Development Center, 601-634-3034)
- Seattle: Eric Nelson, 206-764-3557
- Ventura (Regulatory Office): David Castanon, 805-585-2141
- John (Jack) Malone, 805-585-2146
- Los Angeles (Civil Works Office): Tony Risco, 213-452-3789
- Theresa Stevens, Project Manager, Regulatory Division, Ventura, 808-585-2146, 805-585-2154, Theresa.Stevens@usace.army.mil

B.E.A.C.O.N:

- Kevin Ready, 805-662-6890 (past)
- Karl Treiberg, (SB Flood Control) 805-568-3443 (past)
- Gerald Comati, 805-962-0488, cell-805-895-0255, Comati@Beacon.ca.gov (recent)

California Coastal Commission:

- Headquarters office: Shana Gray, 805-585-1800 (past)
- South Central District Office, Ventura: Melanie Hale, 805-585-1800 (past)
  Steven Hudson, District Manager, 805-585-1800, shudson@coastal.ca.gov
  John (Jack) Ainsworth, Deputy Director, 805-585-1800, 562-590-5071, jainsworth@coastal.ca.gov
- San Francisco: Nancy Cave and Sharone Assa, 415-904-5298
- Alison Dettmer (415-904-5205), Marina Cazorla and Tom Luster (415-904-5249)

City of Goleta:

- Ken Curtis, 805-961-7540 (7500)
- Michael Bennett, Councilmember, 805-961-7535

Coastal Conservancy, 510-286-1015

California Department of Boating and Waterways:

- Kim Sterrett, 916-263-8157

California Department of Fish and Game:

- Marine Region: Marilyn Fluharty, 858-467-4231
- Offshore Ecosystems: Marija Voikovich, 805-568-1246
- Commercial Fisheries: Dave Thomas, 510-581-7358
- Recreational Fisheries: Steve Crooke, 562-342-7195
- John O'Brian, 562-342-7173
- Dennis Bedford, 562-342-7172

- Santa Barbara office: Ken Willson and David Ono, 805-568-1221

California State Lands Commission (Sacramento):

- Jane Smith, 916-574-1892
- Dwight Sanders, 916-574-1880
- Barbara Dugal, 916-574-1833
- Mary Hays, 916-574-1812

Santa Barbara County Board of Supervisors: 805-568-2191

- Susan Rose
- Rachel Couch
- Lisa Hummer

Santa Barbara County Parks:

- Terri Maus-Nisich 805-568-2461 (Past)
- Coleen Lund, 805-568-2470 (Past)
- Erik Axelson, 805-681-5651 (Recent)
- Juan Beletrana, 805-568-2470 (Recent)

State Regional Water Quality Control Board:

- Lisa McCann, 805-549-3132

US Coast Guard:

- Jerry Johnson, 510-437-2982 (2968)

US Department of Fish and Wildlife:

- Dan Buford, 916-414-6625

US National Marine Fisheries:

- Rodney McInnis, 562-980-4000

Businesses Contacted

- Allied Hole Hogs: 216-373-0244
- American Rope: 800-227-7673
- California Coastkeeper Alliance: 310-548-0983. Chantal Collier
- Cardenas and Associates: 805-966-3713. Jose Cardenas
- Coastal Environments: 858-459-0008. Hany Elwany
- Coastal Resources: 760-603-0612
- Cold Springs Granite: 800-328-5040
- Earth Consultants Inc.: 425-643-3780
- Environmental Defense Council: 805-963-1622. Brian Trautwine
- Globe Machine Manufacturing: 253-383-2584. Vic Croston
- Goleta Building Materials: 805-967-5413. Ken Hall and John
- Goleta Sanitary District: 805-967-4519

- Improved Construction Methods: 800-877-4571. Jimmy Buzby
- Industrial Vibration Products: 401-539-2392
- International Specialty Products (ISP) Alginates: Dale Glantz (Biologist) 619-557-3194
- InterNet Inc.: 800-328-8456. John Krause
- Kelp Forest Society: 949-721-9006. Rudolphe Streichenberger
- Laird Plastics: 206-623-4900. Jeff Dallen
- L3 Communications MariPro: 805-683-3881. Lloyd Sorenson
- Neushul Mariculture: 805-964-5844. "Sunnyside Sea farms." Bruce Harger
- NSWW Aquaculture Products: 800-368-3610. Hunt Ozmer
- Pacific Western Aerials Surveys: 805-963-0382. Michael Kambitsch
- Poly-Hi (UHMW plastic manufacturer): 360-885-1141. Dan
- Rockwell Automation: 425-746-2840. Ken Roche
- Sacramento Bag: 800-287-BAGS. Chris Marr
- Samson Rope Technologies: 800-227-7673
- Santa Barbara Channelkeeper: 805-563-3377. Michael Sheehy
- Seattle Marine and Fishing Supply: 206-285-5010
- Surfrider Foundation: 805-899-2583. Brian Keats
- TerraSystems Inc. (Wick Drains): 540-882-4130. John Jones and Dave Panich
- The Chandlery (West Marine): 800-262-8464
- The Cultured Abalone: 805-685-1956. Dick Creig
- Wacker – High Frequency Internal Vibrators: 510-222-9790
- Williams Form Engineering Corporation (Manta Ray mechanical soil anchors): 800-344-6728

Personal Contacts

Available upon request.

My Personal Contact Information

Robert Kiel – Author and Principal Investigator

kiels@comcast.net

206-244-5154 (home)
206-954-7258 (cell)

Address:
3306 SW 112th Place
Seattle, WA 98146