Goleta Bay Kelp Study

(Coastal Development Permit 4-11-028)

2018 Survey Reports

Robert Kiel and Greg Christman

January 19, 2019

Cover photo: Kelp plant growing on column with remnants of empty shells adjacent to holdfast, indicating an octopus is residing within.

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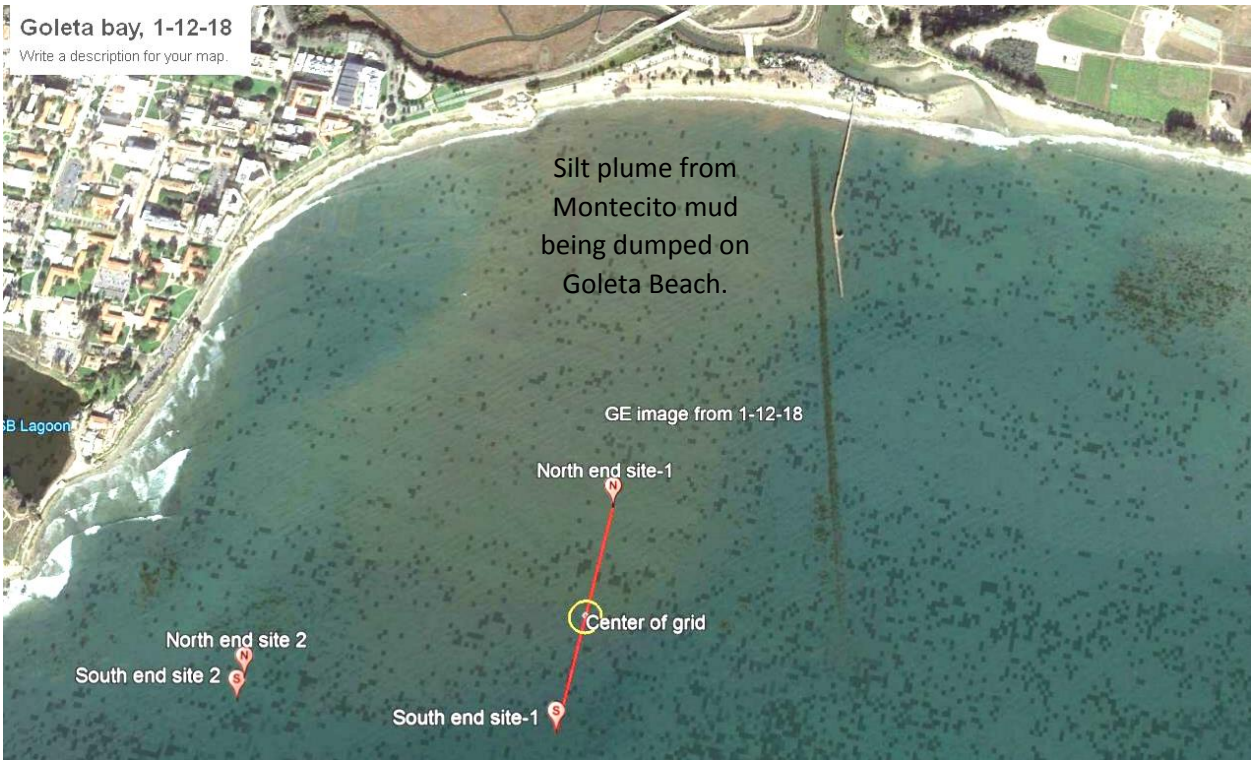
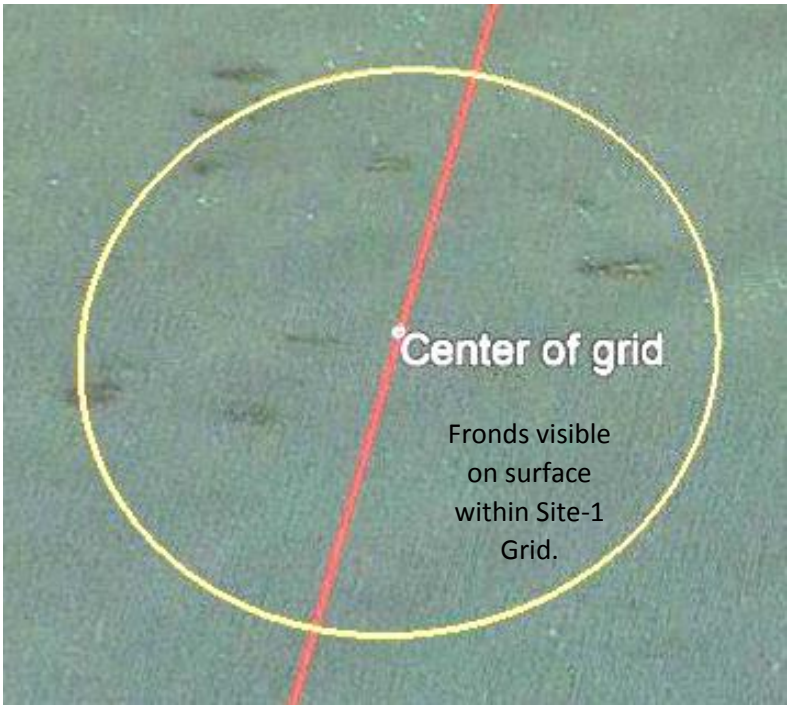
January 12, 2018 – Google Earth image

Project Background:	
Reference:	Google Earth image, Appendix I
Kelp Anchor Installation:	NA
Survey Performance Specifics:	
Date:	1-12-18
Method:	NASA/Google Earth satellite took image of Santa Barbara/Goleta area after the Montecito Flood. Another image was taken February 3, 2018, but the image quality of the water offshore is poor and highly pixelated.
Performed By:	Google Earth
Scope:	Document Montecito flood event.

Survey Results/Observations:		
1	**Weather:**	Clear. Slight SE breeze as evident from surface ripples in image.
2	**Visibility:**	NA
3	**Accounting for Installed Columns:**	NA
4	**Column Burial:**	NA
5	**Vertical or horizontal Movement of Installed Columns:**	NA
6	**Scour evident:**	NA
7	**Kelp Recruitment:**	~ 10 kelp plants observed on surface within grid.
8	**Type of kelp recruited:**	*Macrocystis pyrifora*
9	**Size and condition of Kelp:**	Fronds growing across surface.
10	**Size of "hold-fast" at columns (if present):**	NA
11	**Review of Other Features in the Navigable Water Way:**	NA
12	**Presence of Eelgrass:**	NA
11	**Presence of Invasive Species on Columns:**	NA


Goleta bay, 1-12-18
Write a description for your map.
Silt plume from Montecito mud being dumped on Goleta Beach.
GE image from 1-12-18
North end site-1
Center of grid
North end site 2
South end site 2
South end site-1


Center of grid
Fronds visible on surface within Site-1 Grid.

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February 4, 2018 – Site-1 survey by boat

Project Background:	
Reference:	Appendix I
Kelp Anchor Installation:	NA
Survey Performance Specifics:	
Date:	2-4-18
Method:	Surface survey by boat (Amanda). Greg and his daughter Hanna checked Site-1 to see if there were any kelp fronds at the surface. 12 fronds were observed at or just below the surface. Two lobster trap buoys were observed within the central grid. Three lobster trap buoys were observed within the central grid.
Performed By:	Greg Christman and his daughter Hannah
Scope:	Check for visible kelp from surface.

Survey Results/Observations:		
1	**Weather:**	Calm
2	**Visibility:**	Water visibility ~ 10’ at surface.
3	**Accounting for Installed Columns:**	NA
4	**Column Burial:**	NA
5	**Vertical or horizontal Movement of Installed Columns:**	NA
6	**Scour evident:**	NA
7	**Kelp Recruitment:**	Observed from surface on 12 columns.
8	**Type of kelp recruited:**	*Macrocystis pyrifora*
9	**Size and condition of Kelp:**	Fronds growing near or across surface.
10	**Size of “hold-fast” at columns (if present):**	NA
11	**Review of Other Features in the Navigable Water Way:**	None
12	**Presence of Eelgrass:**	NA

11	**Presence of Invasive Species on Columns:**	NA

Kelp at surface and boat (Amanda) within Site-1 grid viewed from pole-cam.

Lobster trap buoy.

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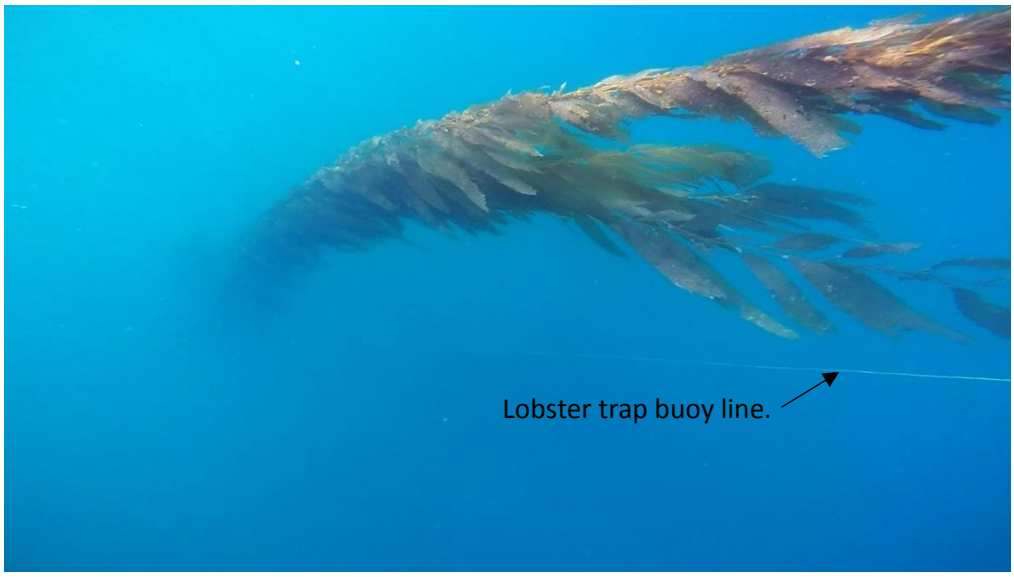
February 17, 2018 – Survey by boat

Project Background:	
Reference:	Appendix I
Kelp Anchor Installation:	NA
Survey Performance Specifics:	
Date:	2-17-18
Method:	Greg and his daughter Hannah checked for visible kelp at the surface within the test site from the surface by boat (Amanda), use of ROV (remote operated vehicle) with underwater camera, and use of camera mounted on a pole.
Performed By:	Greg.
Scope:	Checked for visible kelp from surface, videoed kelp plants using ROV with underwater camera and took pictures with camera mounted on pole.

Survey Results/Observations:		
1	**Weather:**	Slight breeze earlier in the afternoon, then the breeze subsided later in the day. Multiple kelp fronds came to the surface after the southwest breeze (and subsequent current) subsided.
2	**Visibility:**	~ 20' at surface, but dropped to zero near the seafloor. Water visibility decreased exponentially as the ROV descended. The screen went black when the ROV was ~ 25' below the surface. Suspected the low visibility was due to silt from the Montecito mud dumped on Goleta Beach being moved offshore by current. A southward-moving benthic current is often observed when prevailing southwesterly winds are blowing. The speed of the current corresponds with wind speed: the stronger the wind, the stronger the current.
3	**Accounting for Installed Columns:**	NA
4	**Column Burial:**	NA
5	**Vertical or horizontal Movement of Installed Columns:**	NA
6	**Scour evident:**	NA
7	**Kelp Recruitment:**	Observed from surface growing on 12 columns.
8	**Type of kelp recruited:**	*Macrocystis pyrifora*
9	**Size and condition of Kelp:**	Fronds growing near and across surface.

10	**Size of "hold-fast" at columns (if present):**	NA
11	**Review of Other Features in the Navigable Water Way:**	None
12	**Presence of Eelgrass:**	NA
11	**Presence of Invasive Species on Columns:**	NA



April 6, 2018 - Meeting with Dan Reed at UCSB

Attendees: Dan Reed, Bob Kiel, Greg Christman, Mike Rattray and Scott Kimura (Tenera – via phone).

Discussed many things including details of our project, the SONGS project Dr. Reed is involved with and various topics pertaining to kelp forest ecosystems.

Both Dan and Scott were supportive of our endeavor and felt it has merit and is worth pursuing.

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Kelp Anchor Demonstration Project
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April 7, 2018 – Surveys of Site-1

Project Background:	
Reference:	Appendix I, Appendix II, Appendix V
Kelp Anchor Installation:	Bob had made cedar stakes with identification insignias carved into them (example: S1-A1 for Site-1, column A1 in grid) and brought them down from Seattle. The intent was to install an identification stake at each column to facilitate in referencing during surveys (Site-1 is too big with too many columns to keep track of – it's also easy to get disoriented during dives, especially with the normally low visibility). Greg and Bob surveyed columns within the site-1 grid while installing the cedar stakes at the columns in the west N-S row (A) of the grid. The stakes proved to be difficult and time consuming to install. Visibility was good (~ 20'). We continued surveying columns within the grid and the south leg on successive dives, while Mike Rattray operated the boat and provided surface support. Due to the large area and distance covered, we had Mike drop us off and pick us up. Many columns which had relatively healthy kelp plants growing on them in recent surveys showed signs of being heavily grazed. Eelgrass in the area looked brownish and unhealthy. Numerous kelp crabs were observed clinging to the remnants of fronds. At least 6 of the large plants with fronds at the surface in February were gone. Because there weren't any large swell events, we can only speculate that they may have been torn free by the pulling of lobster traps (lobster trap buoys were observed within the test site during the February surveys performed by Greg from his boat, Amanda). With multiple fronds on the surface, it's likely the lobster fisherman spotted them and set traps in the area. We also noted very fine sediment on the tops of the columns, which was most likely from the Montecito mud dumped on Goleta Beach. The three of us (Greg, Mike and Bob) discussed the discouraging findings on the boat after the first dive and came to the following conclusions: • The test sites were too large to track each column during the ~ quarterly surveys. The size and number of test sites needed to be reduced so all columns could be surveyed and accounted for on a single dive. • The separation of sites 1 and 2 made it difficult to survey both sites during every survey trip to Goleta Bay. We decided to remove Site-2 completely. • A critical mass of kelp per unit area of seafloor is likely needed in order to overcome the grazing pressures from kelp crabs and top snails. Clustering several columns together (within a couple feet of each other) might result in more fronds growing within the cluster. This would diffuse the grazing pressures among the

	fronds within the cluster, increasing the likelihood of some fronds making it to the surface. • Some of the holdfasts were balling up as they grew on top of the columns rather than sprawling out across the seafloor. Setting the columns deeper into the seafloor leaving < 3" protruding would likely help prevent this. • Sediment settles on top of the columns, which prevents spores from settling and developing on this area of the columns. Adding a pyramid-shaped (45 degree) taper to the tops of the columns might prevent sediment from accumulating. Taking all these issues into consideration, we contemplated pulling columns in preparation for reconfiguring the columns and how they're set. We have been observing a large canopy of kelp ~ 100 yards west of the sewer pipe along with some smaller canopies between it and the sewer pipe. Mike dropped us off and we descended at the large stand of kelp. The majority of the kelp was growing on what appears to be an old radial piston engine from a plane. Some other plants were growing on other debris nearby. We also found a couple well-established sand-dwelling kelp plants closer to the sewer pipe rip rap, and a large lobster walking across the sand. The eelgrass was brownish and looked unhealthy.
Survey Performance Specifics:	
Date:	4-7-18
Method:	SCUBA with surface vessel assistance. Used mallet with PVC cap over end of stakes to pound them into the seafloor. Took a lot of whacks to embed a stake!
Performed By:	Dives performed by Greg Christman and Bob Kiel. Mike Rattray operated the boat and provided surface support.
Scope:	Install cedar identification stakes at columns in row A of the Site-1 grid. Investigate kelp plants producing large surface canopies within ~ 100 yards west of the sewer pipe rip rap. Survey visible columns within in grid.

Survey Results/Observations:		
1	**Weather:**	Slight breeze from the SE.
2	**Visibility:**	~ 15 feet.
3	**Accounting for Installed Columns:**	~ 50.
4	**Column Burial:**	All columns were protruding ~ 6-10 inches from the seafloor. No apparent change from when they were originally installed.
5	**Vertical or horizontal Movement of Installed Columns:**	None

6	**Scour evident:**	All columns have minor scouring around the base, which results from surge eddying around the columns.
7	**Kelp Recruitment:**	Remnants of kelp were found on over half the columns, but many of the fronds were heavily grazed. Kelp crabs and top snails were observed on the fronds.
8	**Type of kelp recruited:**	*Macrocystis pyrifora*
9	**Size and condition of Kelp:**	Remnants of kelp were found on over half the columns, but many of the fronds were heavily grazed. Kelp crabs and top snails were observed on the fronds. Most of the large plants which were observed at the surface in February were gone. Suspect they may have been broken off by the pulling of lobster traps (buoys were found in the area in February). All eelgrass looked brownish and unhealthy.
10	**Size of "hold-fast" at columns (if present):**	Most holdfasts were small, as the fronds were heavily grazed by kelp crabs and top snails.
11	**Review of Other Features in the Navigable Water Way:**	This is an open bay with no harbor and very limited recreational boating activity. There is an existing recreational pier to the east. This work did not make any changes to the navigable waterway.
12	**Presence of Eelgrass:**	Sparse and random.
11	**Presence of Invasive Species on Columns:**	None.

Kelp crabs (*Pugettia producta*)

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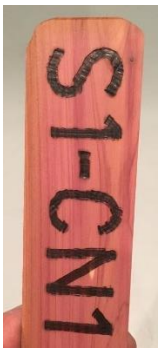
April 8, 2018 – Installing ID stakes, pulling columns, gray whale encounter, modifying column end.

Project Background:	
Reference:	Appendix I, Appendix II
Kelp Anchor Installation:	Installed cedar identification stakes at columns in the center N-S row (F) of the center grid of Site-1. We began pulling columns on the next two dives, and managed to pull all 31 columns in the south leg of site-1. Using SCUBA, each column was pulled from the seafloor and prussic hitched to a line which was later pulled up from the boat. The pulling of each column took significant effort and consisted of imparting back-and-forth and upward forces. After pulling columns, Greg and I both feel it's highly unlikely naturally-occurring forces would result in dislodgement of the columns. A gray whale paid us a visit during one of the dives. Bob was occupied testing the use of the underwater drill with auger and didn't see the whale, but Greg managed to video the whale as it swam ~ 15' behind Bob. https://www.youtube.com/watch?v=XobKy7ZN1rI The next day, Bob started cutting pyramid-shaped tapers on the tops of the columns which were pulled using a chop saw with a diamond blade and water.
Survey Performance Specifics:	
Date:	4-8-18
Method:	Installed cedar identification stakes using a mallet and PVC cap. Pulled columns by applying back-and-forth and upward forces. The majority of growth on the columns was carved off the columns after they were pulled, then they were prussic-hitched to a line which was later pulled up from the boat.
Performed By:	Bob and Greg with SCUBA along with surface support from Mike.
Scope:	

Survey Results/Observations:		
1	**Weather:**	Calm
2	**Visibility:**	15'
3	**Accounting for Installed Columns:**	~ 50 columns.
4	**Column Burial:**	None.

5	**Vertical or horizontal Movement of Installed Columns:**	None.
6	**Scour evident:**	None.
7	**Kelp Recruitment:**	Some.
8	**Type of kelp recruited:**	*Macrocystis pyrifora*
9	**Size and condition of Kelp:**	Most fronds looked heavily grazed upon.
10	**Size of "hold-fast" at columns (if present):**	< 1' in diameter. None were growing outward across the seafloor.
11	**Review of Other Features in the Navigable Water Way:**	This is an open bay with no harbor and very limited recreational boating activity. There is an existing recreational pier to the east. This work did not make any changes to the navigable waterway.
12	**Presence of Eelgrass:**	Looked brown and unhealthy.
11	**Presence of Invasive Species on Columns:**	None.

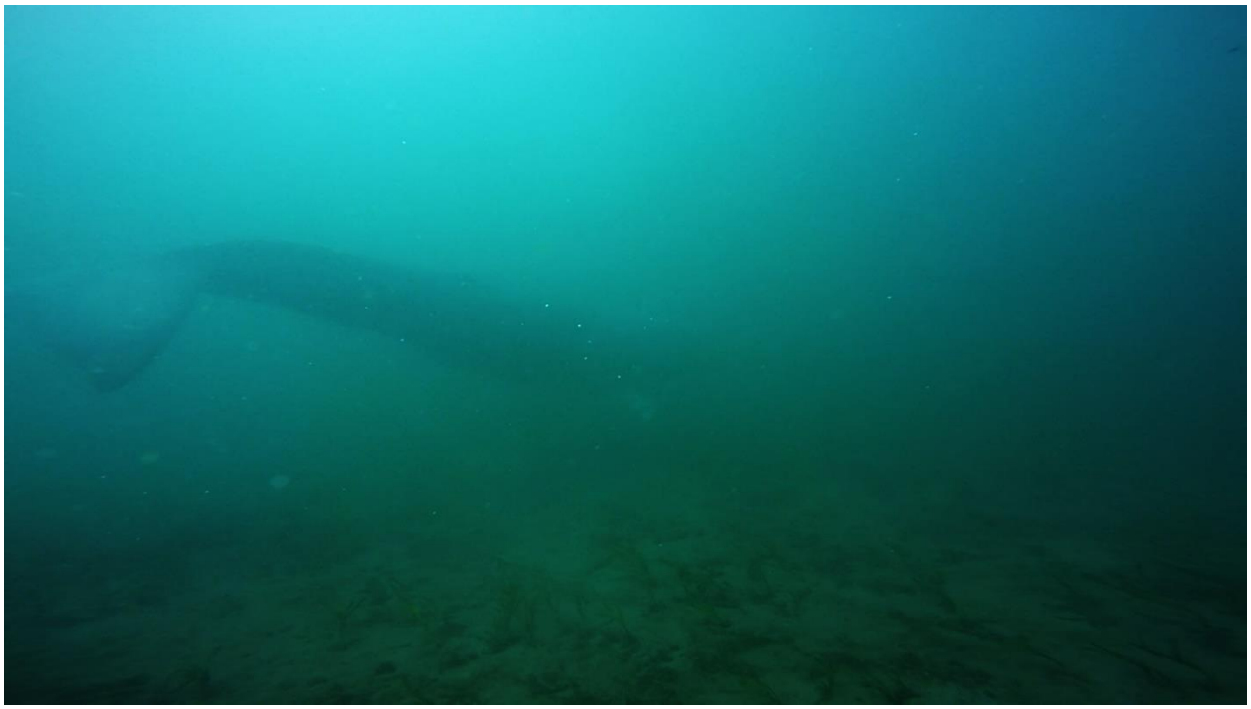


Cedar stake with column identification info carved into it.

We ended up only installing a few of the stakes, which proved to be difficult and time consuming to install into the seafloor.

Pulled columns with kelp holdfasts attached.

Columns with tapers cut on top to reduce tendency of sediment to settle on top.



Ctrl + click to view gray whale video: https://www.youtube.com/watch?v=XobKy7ZN1rI

April 9, 2018 - SONGS Public Workshop

California Coastal Commission (CCC): Technical Review Workshop for the San Onofre Nuclear Generating Station (SONGS) Wheeler North Reef Mitigation Project.

Bob attended the workshop.

Agenda

- Introduction to SONGS reef mitigation – Dan Reed, UCSB
- Results from the 2017 Performance monitoring of the Wheeler North Reef – Steve Schroeter, UCSB
- Assessing the current and future performance of giant kelp at Wheeler North Reef – Dan Reed, UCSB
- Update on Wheeler North Reef Remediation – Kate Huckelbridge, CCC
- General Discussion

http://marinemitigation.msi.ucsb.edu/documents/annual_review_workshops/artificial_reef/index.html

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April 11, 2018 – Site-2 survey, Site-1 grid survey and silt

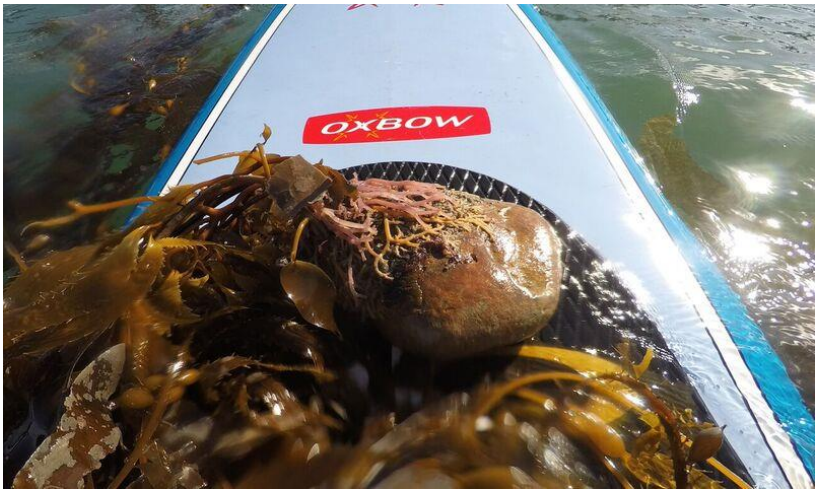
Project Background:	
Reference:	Appendix I
Kelp Anchor Installation:	Greg and Bob dove test Site-2 in the morning while Mike provided topside support. Kelp was growing on 12 of the 14 columns, but the fronds showed signs of being grazed upon and kelp crabs were observed clinging to many of them. A SW wind was picking up (and had been blowing strong the previous 3 afternoons as well). We decided to dive the west edge of Site-1 again to take pictures of the remaining large kelp plants in that area. Visibility at the surface within the Site-1 grid was ~ 20', but the water looked dark in appearance below. A slight NE current was running at the surface, which is commonly observed when SW winds are blowing. As we descended the visibility began to drop exponentially. By ~ 25' below the surface the visibility was down to nearly zero. Visibility soon dropped to zero and it was dark within the bottom ~ 10-15' – we ran into the seafloor without ever seeing it! The southward moving benthic current produced by the SW winds had moved the silty water from shore (from the Montecito mud dumped on Goleta Beach) offshore. We speculate the frequent presence of this dirty water over the past months contributed to the unhealthy appearance of kelp and eelgrass offshore. The wind continued to increase so we decided to call it a day and went back to the harbor.
Survey Performance Specifics:	
Date:	4-11-15
Method:	Used SCUBA to perform surveys.
Performed By:	Bob and Greg with surface support from Mike.
Scope:	Survey Site-2. Survey west side of Site-1.

Survey Results/Observations:		
1	**Weather:**	Breezy in the morning with SW winds picking up in the afternoon (which was also the case the previous 3 days).
2	**Visibility:**	Visibility at Site-2 was ~ 15'. Visibility at the surface of Site-1 was ~ 20', but reduced to zero within the bottom 10-15'.
3	**Accounting for Installed Columns:**	All 14 columns in Site-2 were present and looked normal.
4	**Column Burial:**	None.

5	**Vertical or horizontal Movement of Installed Columns:**	None.
6	**Scour evident:**	None.
7	**Kelp Recruitment:**	12 of 14 columns had kelp growing on them.
8	**Type of kelp recruited:**	*Macrocystis pyrifora*
9	**Size and condition of Kelp:**	All kelp plants had fronds < 20' long and showed signs of being grazed upon. Noticed kelp crabs clinging to some of the fronds.
10	**Size of "hold-fast" at columns (if present):**	All holdfasts were < 1' in diameter. Only a few were starting to sprawl across the seafloor. Most of the columns could have (and should have) been set deeper.
11	**Review of Other Features in the Navigable Water Way:**	This is an open bay with no harbor and very limited recreational boating activity. There is an existing recreational pier to the east. This work did not make any changes to the navigable waterway.
12	**Presence of Eelgrass:**	Seemed to be normal for the area.
11	**Presence of Invasive Species on Columns:**	None.

April 14, 2018 – Boat engine troubles and visit to Goleta Beach

We attempted to go out to perform more dives but had issues with the boat engine fuel solenoid valve. Went to Goleta Beach to check it out instead.



Kelp plants presently growing around pier are growing on cobble from geo-textile bags (used for erosion control along the shore) which broke apart. Plants are easily pulled up from the surface.

As the plants grow, their inherent buoyancy and drag continues to transport the stones.

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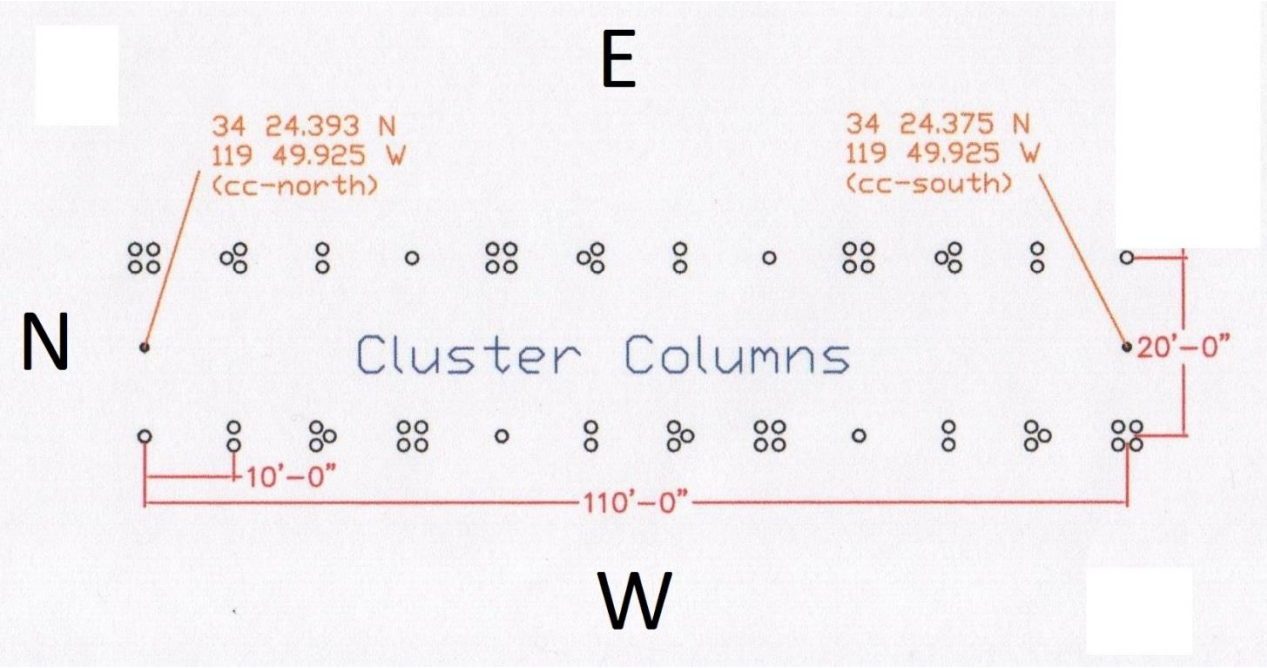
June 1 & 2, 2018 – Pulling columns from Site-1, installing cluster column site

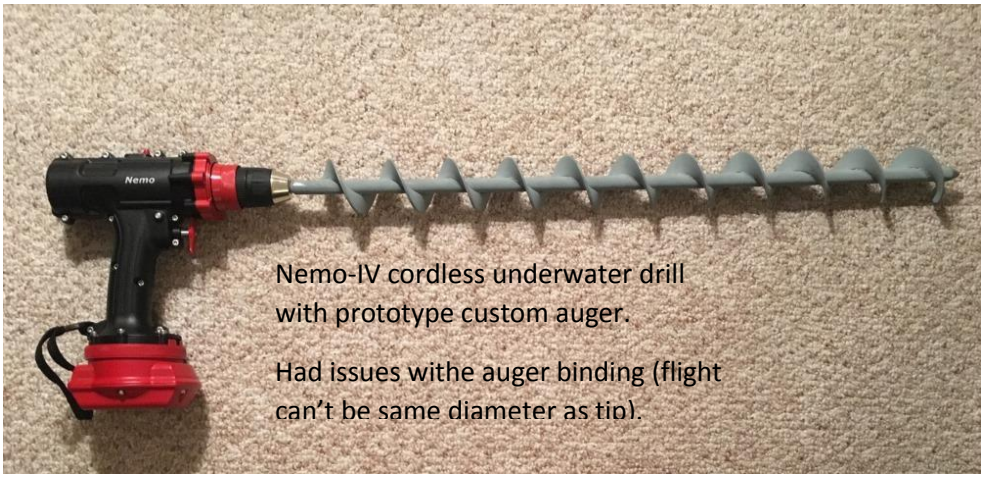
Project Background:	
Reference:	Appendix I, Appendix II
Kelp Anchor Installation:	Greg and Bob performed 6 dives over 2 days (3 dives per day) while Mike Rattray operated the boat (Amanda) and provided topside support. We pulled 31 columns from the north leg of Site-1, 12 columns from the center portion of the grid, and 11 columns from row A (west side). low-laying red alga was growing on all columns up to the 37th column from the north end. The blades from the algae swaying in the surge acted to build sand up around each of the columns, leaving ~ 2" protruding from the sediment. Large congregations of snails and kelp crabs were observed seeking refuge under the algae. Note: kelp crabs take on the pigments of the algae they eat. Many of the kelp crabs observed under the red algae were red in color (the kelp crabs we find on *Macrocystis* are amber in color). A few short bare stipes of *Macrocystis* were observed on 3 of the columns which were covered with the red algae. We took the columns back and cut tapers on them using the chop saw, diamond blade and water. On June 2nd we laid out a test site for testing clusters of columns. The site consists of two parallel 110' long lines spaced 20' apart. Clusters of columns were set on 10' centers along each line in a repeating pattern of 1 column, 2 columns, 3 columns, and 4 columns. The columns within each of the clusters were set 2' apart and the columns were embedded to a depth leaving < 3" protruding. A NEMO-IV underwater cordless drill and custom auger was used to bore each hole into the seafloor. This proved to be far less cumbersome and faster than using a water jetting system. Numerous juvenile kelp plants were observed growing on worm tubes within the area we were installing the modified test site. We have never observed such a high concentration of kelp plants growing on worm tubes. It's possible these plants were a byproduct of spores from the large kelp plants which we observed growing on our columns late 2017 – early 2018. We decided to speed up the testing of the cluster columns by harvesting some of the plants and attaching them to the columns using rubber bands. Plants were attached to 50 of the 60 columns. We purposely left one set of columns (single, double, triple, quadruple) at the SW corner of the site bare for a control to test for natural recruitment.

Survey Performance Specifics:	
Date:	6-1&2-18
Method:	Greg and Bob pulled columns using SCUBA while Mike provided surface support. Cut tapers on tops of columns with chop saw. GPS and buoys were used to layout the test site. Deployed modified columns from boat using descenders attached to each column. Used transect tape and 10' long PVC pipe to layout columns on seafloor. Used a NEMO-IV underwater cordless drill and custom auger to bore holes in seafloor to set columns (to depth leaving < 3" protruding above seafloor plane). Used ¼" wide rubber bands to attach juvenile kelp plants (found growing on worm tubes within the area) to 50 of the 60 columns.
Performed By:	Diving operations performed by Greg Christman and Bob Kiel. Mike Rattray assisted topside and operated the boat.
Scope:	Pull columns from north leg of Site-1 grid and from central region of grid. Install cluster column site using columns with tapers cut at the top, setting them to a depth leaving < 3" above the seafloor, and clustering them in groups of 1, 2, 3, & 4 columns. This pattern was repeated along each of the two 110' lines of the test site. Collect nearby juvenile kelp plants growing on worm tubes and attach to columns with rubber bands to speed up process.

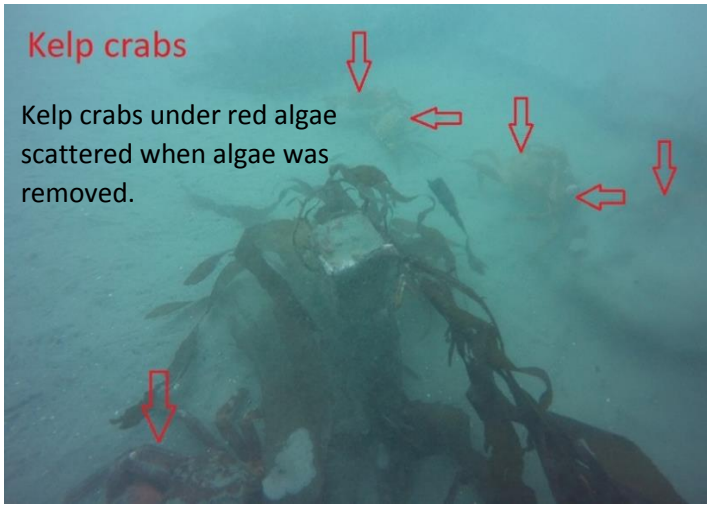
Survey Results/Observations:		
1	**Weather:**	Winds were light from the SW.
2	**Visibility:**	~ 15 feet.
3	**Accounting for Installed Columns:**	Removed 43 columns and installed 60 modified columns.
4	**Column Burial:**	No burial below seafloor plane, but the columns with the red low-lying algae growing on them had sediment built up around the columns. The columns were protruding ~ 2" above the sediment, which was built up by the algae blades moving sediment as they swayed in the surge.
5	**Vertical or horizontal Movement of Installed Columns:**	No.
6	**Scour evident:**	No.
7	**Kelp Recruitment:**	Some.
8	**Type of kelp recruited:**	*Macrocystis* on columns below ~ 40' water depth. Low-lying red algae on columns at depths within ~ 30-40. Numerous juvenile kelp plants growing on worm tubes within test Site-1. Possibly result of spores produced by large kelp plants which were observed growing on ~ 12 columns late 2017 and early 2018.

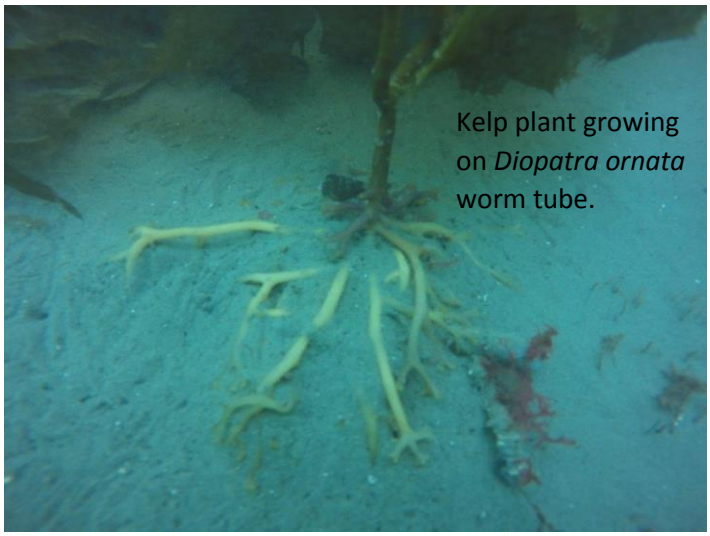
9	**Size and condition of Kelp:**	Most older plants showed signs of senescing and being heavily grazed. Minimal grazing on the juvenile plants growing on worm tubes in the area.
10	**Size of "hold-fast" at columns (if present):**	Varied. None were larger than ~ 16" in diameter.
11	**Review of Other Features in the Navigable Water Way:**	This is an open bay with no harbor and very limited recreational boating activity. There is an existing recreational pier to the east. This work did not make any changes to the navigable waterway.
12	**Presence of Eelgrass:**	Varied.
11	**Presence of Invasive Species on Columns:**	None.





Columns on north leg of Site-1 with low-lying red algae.


Kelp crabs
Kelp crabs under red algae scattered when algae was removed.


Kelp plant growing on *Diopatra ornata* worm tube.


Kelp plant growing on worm tube attached to newly-installed cluster column with rubber bands.

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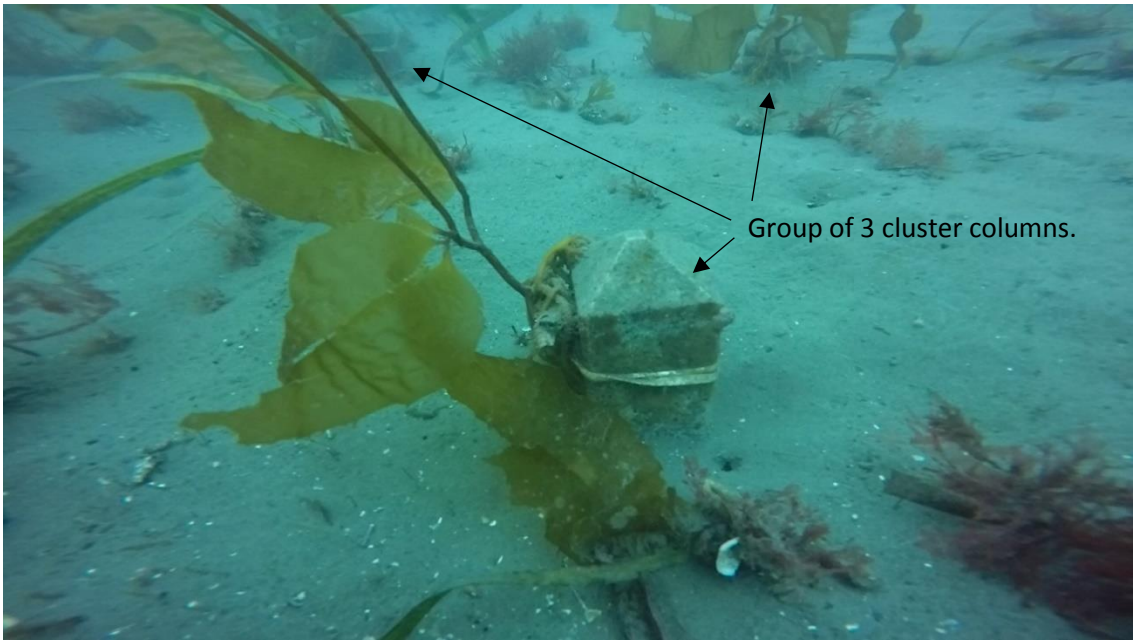
Kelp Anchor Demonstration Project
Monitoring Report

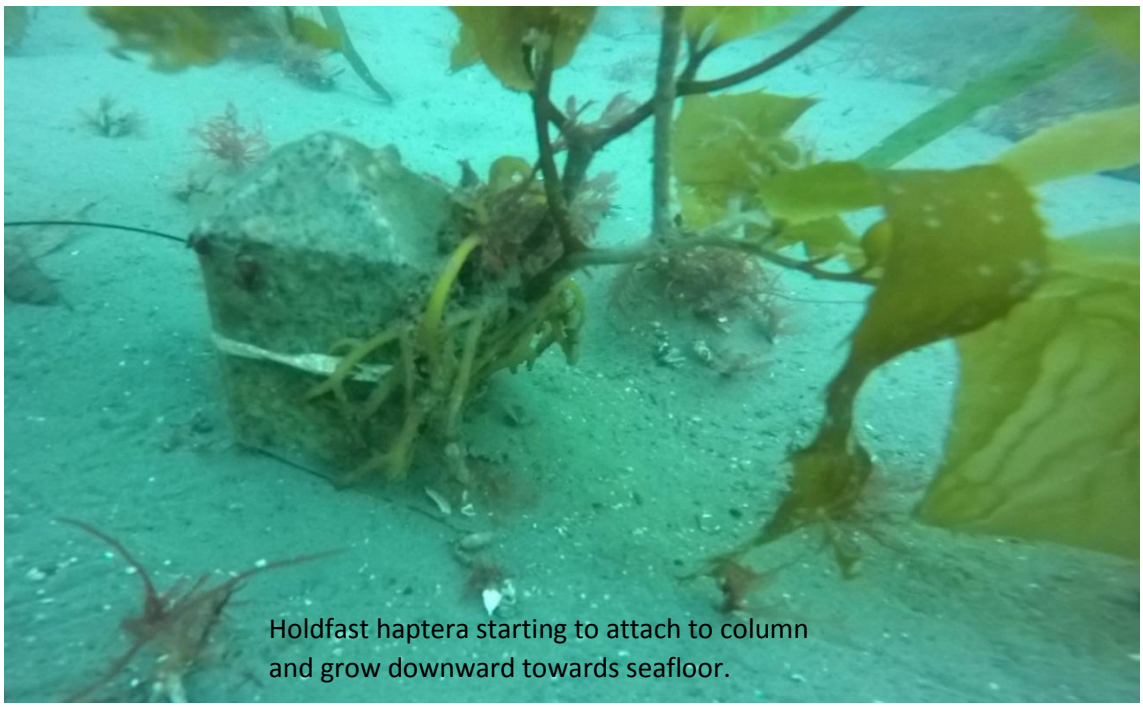
July 2,3,7, 2018 – Pulling columns in Site-2, surveying cluster column site

Project Background:	
Reference:	Appendix I, Appendix II
Kelp Anchor Installation:	Greg and Bob performed 6 dives over 3 days (2 dives per day) while Mike Rattray operated the boat (Amanda) and provided surface support. Bob's daughter Jessie made one dive on the cluster column site on the 7th and managed to lose her snorkel. All 14 columns were pulled from Site-2 (abandoned site). We took the columns back and cut tapers on them using the chop saw, diamond blade and water. Numerous juvenile kelp plants were observed still growing on worm tubes within the area we were installing the new test site. A few of the kelp plants we attached in July were missing, so we attached new plants to them. A slight algae fuzz was noticed on the 10 columns left bare within the cluster column site.
Survey Performance Specifics:	
Date:	7-2,3,7-18
Method:	Pulled columns by applying sideways and upward forces, scraped off algae, and prussic-hitched them to a line which was later pulled up from the boat. Later, cut tapers on tops of columns with chop saw. Used ¼" wide rubber bands to attach juvenile kelp plants (found growing on worm tubes within the area) to 50 of the 60 columns.
Performed By:	Diving operations performed by Greg Christman, Bob Kiel and Jessie Kiel. Mike Rattray assisted topside and operated the boat.
Scope:	Survey columns in new cluster column site and within Site-1 grid. Remove all 14 columns from Site-2. Attached juvenile kelp plants to ~ 4 columns in cluster column site which were missing plants attached with rubber bands in June.

Survey Results/Observations:		
1	**Weather:**	Winds were light from the SW.
2	**Visibility:**	~ 10 feet.
3	**Accounting for Installed Columns:**	No missing columns were observed.

4	**Column Burial:**	None.
5	**Vertical or horizontal Movement of Installed Columns:**	No.
6	**Scour evident:**	No.
7	**Kelp Recruitment:**	Some *Macrocystis* on older columns worm tubes within the area. None on the newly-installed columns in the cluster column site (too soon).
8	**Type of kelp recruited:**	*Macrocystis* on columns within test site-1. Numerous juvenile kelp plants growing on worm tubes within test site-1. Possibly result of spores produced by large kelp plants which were observed growing on ~ 12 columns late 2017 and early 2018.
9	**Size and condition of Kelp:**	No noticeable change in size/condition of kelp plants installed in June. Haptera were growing onto the columns in the cluster column site. Some kelp crabs were observed on the plants.
10	**Size of "hold-fast" at columns (if present):**	Varied. None of the older holdfasts were larger than ~ 16" in diameter. The holdfasts of the plants attached to the cluster columns were small, but some haptera were attaching onto the columns.
11	**Review of Other Features in the Navigable Water Way:**	This is an open bay with no harbor and very limited recreational boating activity. There is an existing recreational pier to the east. This work did not make any changes to the navigable waterway.
12	**Presence of Eelgrass:**	Varied.
11	**Presence of Invasive Species on Columns:**	None.





Holdfast haptera starting to attach to column and grow downward towards seafloor.

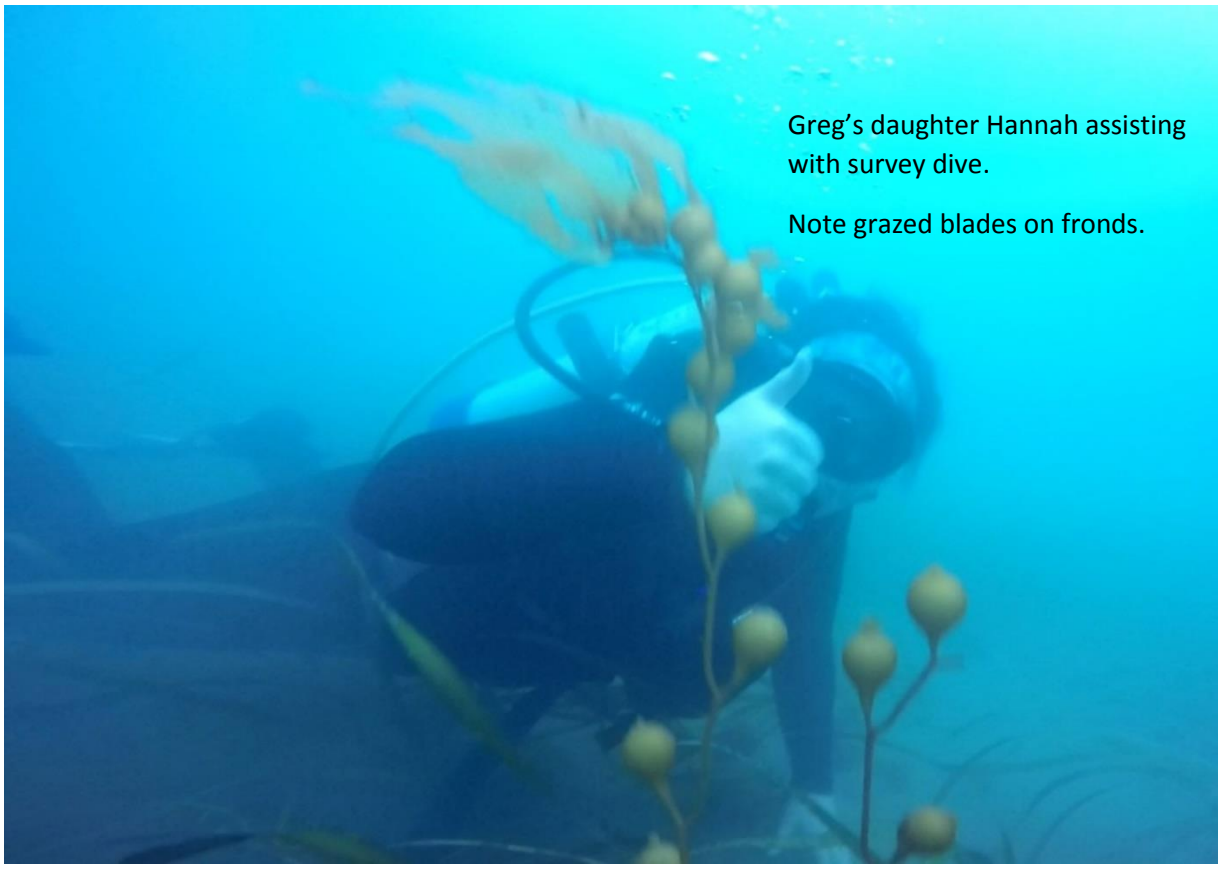
BEACON
Kelp Anchor Demonstration Project
Monitoring Report

August 26, 2018 – Surveying cluster column site

Project Background:	
Reference:	Appendix I, Appendix II
Kelp Anchor Installation:	Greg and his daughter Hannah performed one survey dive while Mike Rattray provided surface support on the Amanda. Little change was observed in the growth of kelp on the columns and multiple kelp crabs were observed clinging to the fronds. A slight algae fuzz was noticed on the 10 columns left bare within the cluster column site. Note: Nutrient levels in the water are generally low this time of year, so kelp plants near the seafloor (where light levels are low) don't tend to grow very fast. Most of the older fronds start to show signs of senescence.
Survey Performance Specifics:	
Date:	8-26-18
Method:	Used SCUBA to survey site and took pictures with Go-Pro underwater camera.
Performed By:	Greg Christman and his daughter Hannah performed dive, while Mike provided surface support.
Scope:	Surveyed columns in new cluster column site.

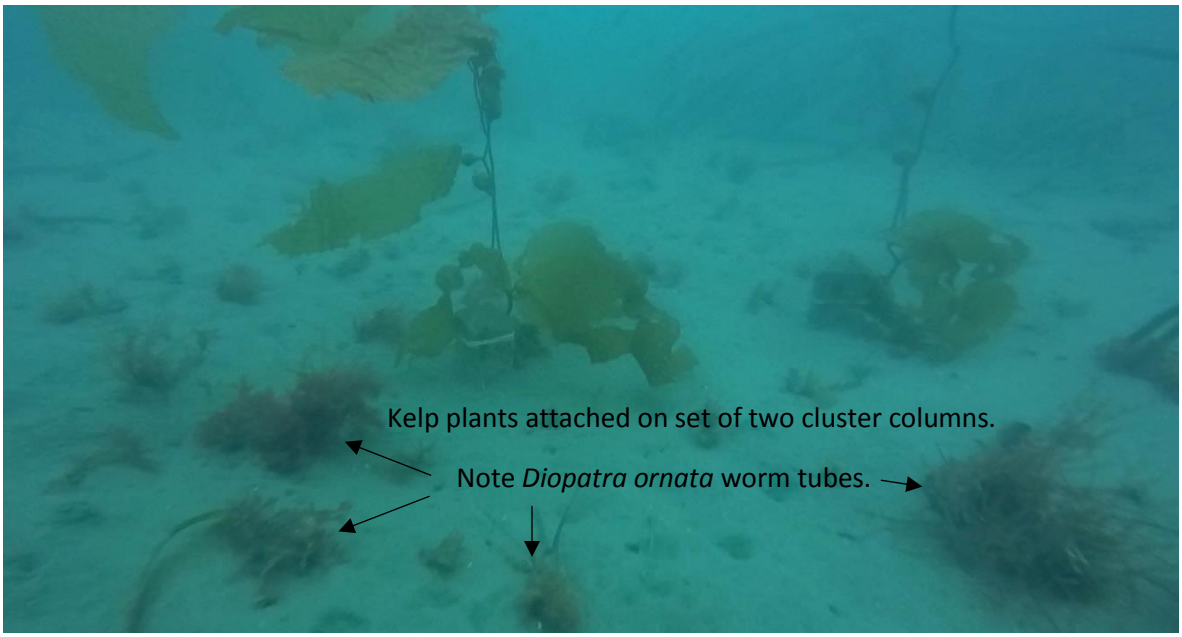
Survey Results/Observations:		
1	**Weather:**	Winds were light from the SW.
2	**Visibility:**	~ 15 feet.
3	**Accounting for Installed Columns:**	No missing columns were observed.
4	**Column Burial:**	None.
5	**Vertical or horizontal Movement of Installed Columns:**	No.
6	**Scour evident:**	No.
7	**Kelp Recruitment:**	None – only the kelp plants transplanted to columns and attached with rubber bands.
8	**Type of kelp recruited:**	NA

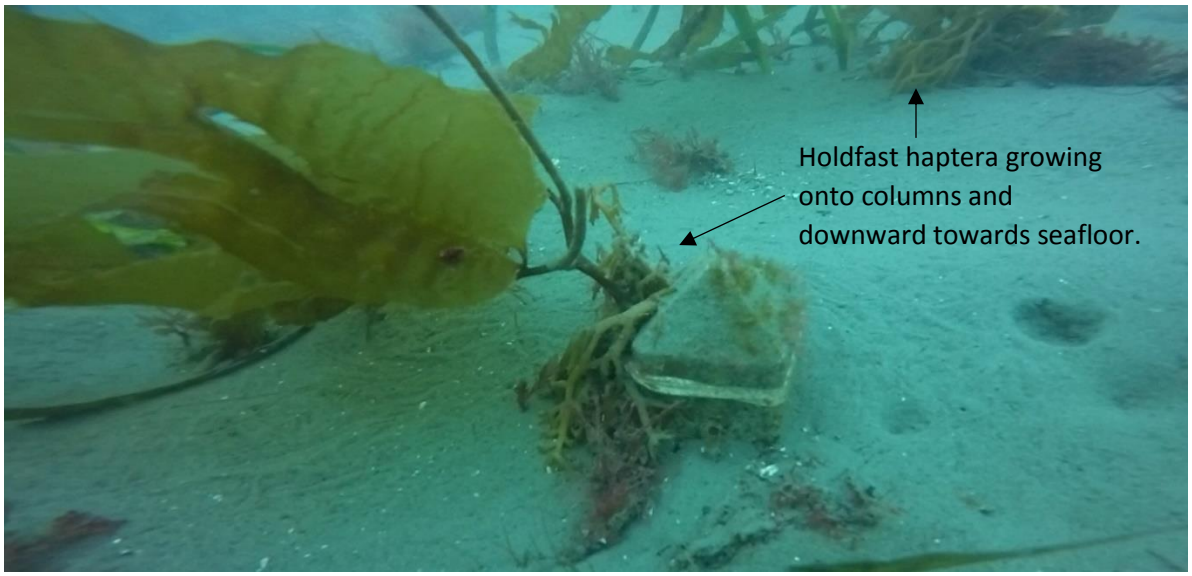
9	**Size and condition of Kelp:**	No noticeable change in size of kelp plants installed in June, but fronds appeared to be more grazed upon and multiple kelp crabs were observed clinging to the fronds. Haptera were growing onto the columns.
10	**Size of "hold-fast" at columns (if present):**	Small – just starting to grow onto the columns.
11	**Review of Other Features in the Navigable Water Way:**	This is an open bay with no harbor and very limited recreational boating activity. There is an existing recreational pier to the east. This work did not make any changes to the navigable waterway.
12	**Presence of Eelgrass:**	Varied – normal.
11	**Presence of Invasive Species on Columns:**	None.



Greg's daughter Hannah assisting with survey dive.

Note grazed blades on fronds.


Kelp plants attached on set of two cluster columns.
Note *Diopatra ornata* worm tubes.


Holdfast haptera growing onto columns and downward towards seafloor.

BEACON
Kelp Anchor Demonstration Project
Monitoring Report

November 13-17, 2018 – Fabrication and installation of octo columns, survey of cluster column site, use of "new" boat (Amanda II)

Project Background:	
Reference:	Appendix III, Appendix IV, Appendix I
Kelp Anchor Installation:	Bob flew down (on a jet!) from Seattle and brought molds he made for casting concrete chambers (suitable for octopus habitation) on the tops of columns. High-strength, fast setting concrete (with no fibers) was used to cast the chambers, which consisted of a monolithic (seamless) pour. A sand/bentonite mixture was used to mold the chambers and access portals. A total of 28 columns were made and 25 were installed in a test site adjacent to (40' to the east of) the cluster column site. The site consists of two parallel rows 220' long spaced 20' apart, with columns set on 20' centers. Each row contains 12 columns, with the east row having one additional column set at position east 170' (between east 160' and 180'). The octo columns were installed into the seafloor using the NEMO-IV underwater drill and a new custom auger which had a modified cutting head. Visibility was ~ 10' and we were unable to locate one of the columns, which we later found after we had installed another spare column. Since we had the drill with us when we found the column, we decided to install it between two of the other columns. The purpose of the octo columns is to test the hypothesis that octopus (primarily the local Two Spot octopus, *Octopus bimaculoides*) play a key role in controlling populations of kelp-eating invertebrates, such as kelp crabs and top snails (sea urchins have not been observed on the sand barrens). We seldom see kelp crabs or top snails on kelp plants growing on rock substrate (natural reefs or rip-rap covering the sewer outfall pipe in Goleta Bay) where suitable octopus habitat is found. We have observed octopus residing at the base of almost all of the larger kelp plants growing on the columns. Once the plants become large with well-established holdfasts and multiple fronds, they become one of the only suitable refuges for octopus on the sand barrens. We also noted a lack of kelp crabs and top snails on these larger established plants as well, similar to what we observe on kelp growing on rock substrate. Remnants of snail shells and crabs are seen on the sediment around the holdfasts. We loaded the octo columns onto our "new" boat (the Amanda-II – 24' Sea Ray built in 1974) on November 15th and docked the boat in a rental slip at Santa Barbara Harbor. During the first dive on the 16th, while measuring from the center of the north side of the cluster column site, we noticed a very large halibut (~ 4' long) positioned with its head between a group of 4 columns. We didn't

	have a camera with us at the time, as we were focusing on performing work associated with laying out the new octo column site. We managed to get within ~ 5' of it before it swam away. We performed two dives on the 16th. The sea was calm with only a slight breeze, but the surface (NE) current was as strong as we've ever encountered in the past. This made it difficult to set mushroom anchors and surface buoys, and get accurate GPS readings (the GPS coordinates are used for locating the site during future surveys). It's a mystery why the current was so strong. There must have been a far-ranging influence outside the Southern California bight which created this current, as there was no obvious localized influence (such as strong wind) within the Santa Barbara Channel. We deployed the columns with descenders attached from the boat, then positioned them on the seafloor using a transect tape and 10' long PVC pipe (to set distance from the transect tape). The following day (17th) the sea was calm with only a slight breeze and the surface current was minimal. All 24 columns were embedded during the first dive. We located another column we couldn't find the previous day, so we opted to install it at E-170 (east row, at position 170' from the north end on the transect tape), making a total of 25 columns within the octo column site. We surveyed the adjacent cluster column site upon completion of the octo column site. There was minimal change in the size of the kelp plants from previous surveys, which is likely due to the low nutrient levels of the water (common during late summer and fall). Many fronds were grazed upon and kelp crabs were observed clinging to the fronds. However, the holdfasts looked healthy with haptera continuing to grow downward towards the seafloor. We found the snorkel Jesse had lost during July and brought it back onto the boat. While taking a break between dives, we noticed a small octopus (which came out of the snorkel) crawling on the deck. We put the octopus in a baggie with seawater and took it down with us on the following dive, then released and coaxed it to the opening in column E-0 (east row 0' from north end of test site), where it promptly went inside. We had our first tenant! Another observation worth noting was the lack of kelp fronds at the surface on rock reefs (natural and sewer pipe rip rap) compared to what had existed earlier in the year and through summer. Any remaining fronds were senescing. High water temperatures and low nutrient levels is the likely explanation for the large dieback of the fronds.
Survey Performance Specifics:	
Date:	11-16,17-18

Method:	Polyethylene molds were made in which high-strength, fast-setting concrete (with no fibers) was used to cast the chambers which consist of a monolithic (seamless) pour. A sand/bentonite/water mixture was used to mold the chambers and access portals, and was removed after the concrete was set. Notches were cut near the tops of the columns to lock the chambers onto the columns. Used our "new" boat (the Amanda-II) for the first time! Used GPS to locate and mark test site from surface. Used descenders attached to columns and deployed them from the boat. Used transect tape and 10' long PVC pipe to layout columns in test site. Used NEMO-IV underwater drill with custom auger to bore holes in seafloor. Greg used a Go-Pro camera to take underwater pictures.
Performed By:	Greg Christman and Bob Kiel performed in-water work, while Mike Rattray provided surface support.
Scope:	Mark octo column test site using surface buoys with mushroom anchors. Deploy columns from boat using descenders. Layout columns on seafloor using transect tape and 10' long PVC pipe. Bore holes in seafloor in which to set columns using a NEMO-IV underwater drill motor and custom auger. Survey adjacent cluster column site. Take pictures.

Survey Results/Observations:		
1	**Weather:**	Calm with only a slight breeze.
2	**Visibility:**	~ 15'
3	**Accounting for Installed Columns:**	Performed final survey of all 60 columns in cluster column site and all 25 columns in octo column site.
4	**Column Burial:**	None.
5	**Vertical or horizontal Movement of Installed Columns:**	None.
6	**Scour evident:**	None.
7	**Kelp Recruitment:**	None.
8	**Type of kelp recruited:**	NA
9	**Size and condition of Kelp:**	Little change in kelp growth on the cluster columns. Some kelp crabs were seen clinging to the fronds.
10	**Size of "hold-fast" at columns (if present):**	Small, but growing downward toward the seafloor.
11	**Review of Other Features in the Navigable Water Way:**	This is an open bay with no harbor and very limited recreational boating activity. There is an existing recreational pier to the east. This work did not make any changes to the navigable waterway.

12	**Presence of Eelgrass:**	Varied – normal.
11	**Presence of Invasive Species on Columns:**	None.

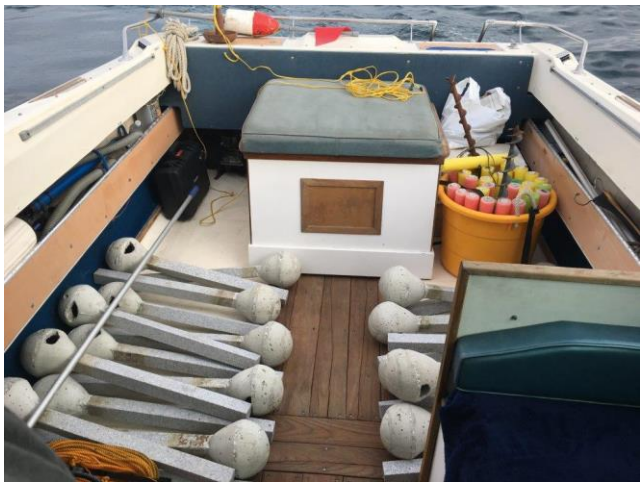
Columns with notched ends set upright inside PVC pipes, with bottom portion of molds set in place.

The other mold pieces are made ready. Note piece of formed casting sand for entrance portal sitting on top of half-spheres with casting sand packed inside.

Once a batch of concrete is mixed, each column chamber is made consecutively with no cold joints.

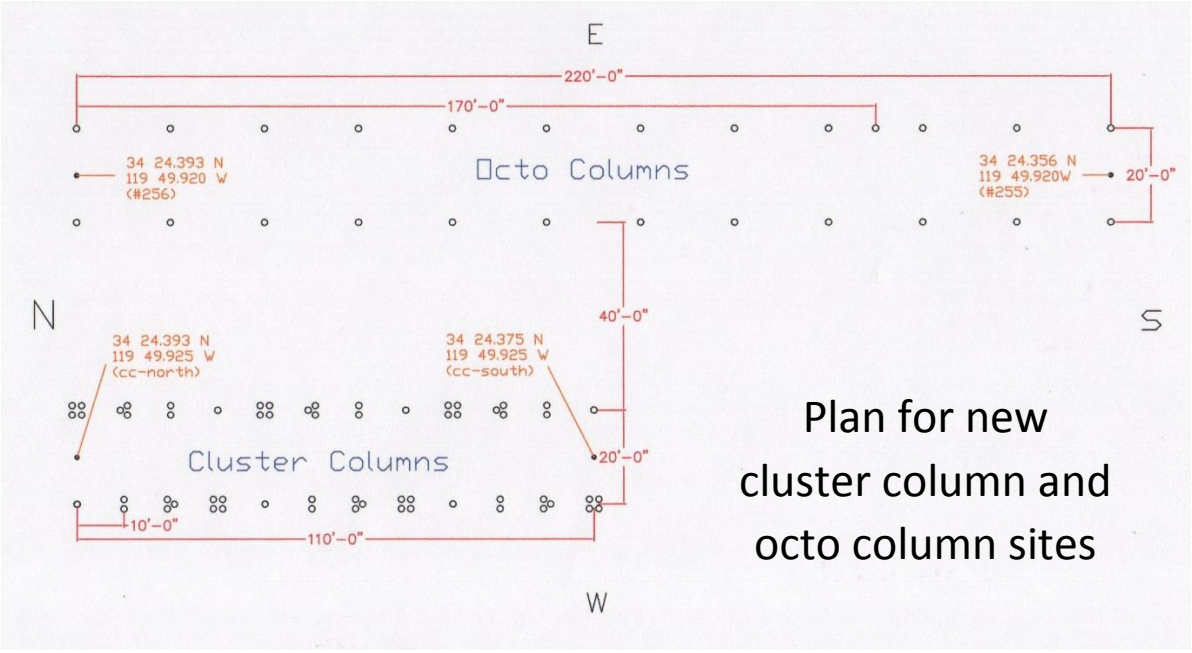
Each chamber consists of a monolithic casting of high-strength, fast-setting concrete. The visible seams on the exterior are where the mold sections meet.

The sand/bentonite/water mixture used for casting the interior chamber and access portal is dug and flushed out of the chamber afterwards.



The Amanda II loaded with octo columns, descenders, augers, mushroom anchors and buoys.

Justin Kiel assisting with a day of dive operations on the Amanda II.



Plan for new cluster column and octo column sites

BEACON
Kelp Anchor Demonstration Project
Monitoring Report

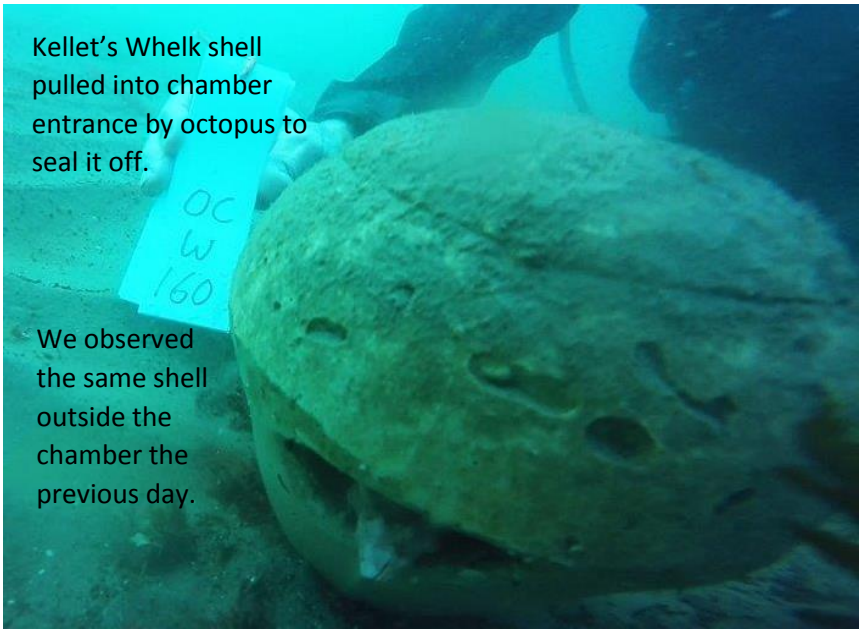
December 28-29, 2015 – Surveys of octo column site and cluster column site

Project Background:	
Reference:	Appendix IV
Kelp Anchor Installation:	Performed a single dive on each day, surveying the two sites in one dive. Bob used his drysuit for the first time! Kelp plants on the cluster columns showed significant growth since November and no kelp crabs were observed on the fronds. Some fronds were ~ 30' tall and new fronds were observed growing from the base of all the plants. A single small spade-shaped blade (possibly *Macrocystis*) was observed on one of the 10 columns in the control section of the cluster column site. Offshore winds and the resulting up-welling of cool, nutrient-rich water is the likely explanation for the noticeable increase in growth of the plants. Even though most of the large fronds observed on the surface on rock substrate (natural reefs and sewer pipe rip rap) early in the year were gone, we observed multiple new fronds just below the surface from the boat. 22 of the 25 octo columns had octopus inside the chambers! During the survey performed on the second day, two of the columns had Kellett's Whelk shells pulled into the chamber opening to close it off. These same two empty shells were observed the previous day sitting at the base of the columns. Another octo column had algae pulled into the opening to seal it off. We're wondering if the presence of these octopus have anything to do with the lack of kelp crabs and top snails within the adjacent cluster column site.
Survey Performance Specifics:	
Date:	12-28,29-18
Method:	SCUBA with drysuits! Underwater Go-Pro camera.
Performed By:	Greg Christman and Bob Kiel. Jessie Kiel provided topside support.
Scope:	Survey both sites (cluster columns and octo columns) in one dive. Take pictures with Go-Pro camera.

Survey Results/Observations:		
1	**Weather:**	Great! Calm seas and very little breeze.
2	**Visibility:**	~ 10' on the 28th, and 15' on the 29th.

3	**Accounting for Installed Columns:**	All 60 in cluster column site. All 25 in octo column site.
4	**Column Burial:**	None.
5	**Vertical or horizontal Movement of Installed Columns:**	None.
6	**Scour evident:**	None.
7	**Kelp Recruitment:**	None.
8	**Type of kelp recruited:**	Possibly *Macrocystis pyrifora* on the single control column in the cluster column site (too early in the growth phase to tell for sure).
9	**Size and condition of Kelp:**	Looking much better. Some fronds ~ 30' long, with multiple new fronds growing from the bases of virtually all the plants.
10	**Size of "hold-fast" at columns (if present):**	Haptera were growing onto the columns and downward toward the seafloor.
11	**Review of Other Features in the Navigable Water Way:**	This is an open bay with no harbor and very limited recreational boating activity. There is an existing recreational pier to the east. This work did not make any changes to the navigable waterway.
12	**Presence of Eelgrass:**	Varied – normal.
11	**Presence of Invasive Species on Columns:**	None.

Octo column with resident Two Spot octopus keeping watch.


Kellet's Whelk shell pulled into chamber entrance by octopus to seal it off.
OC
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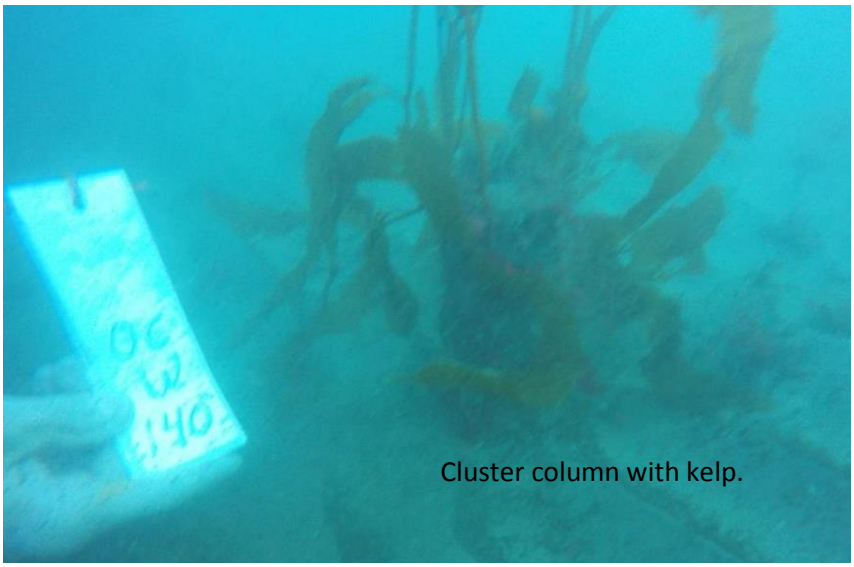
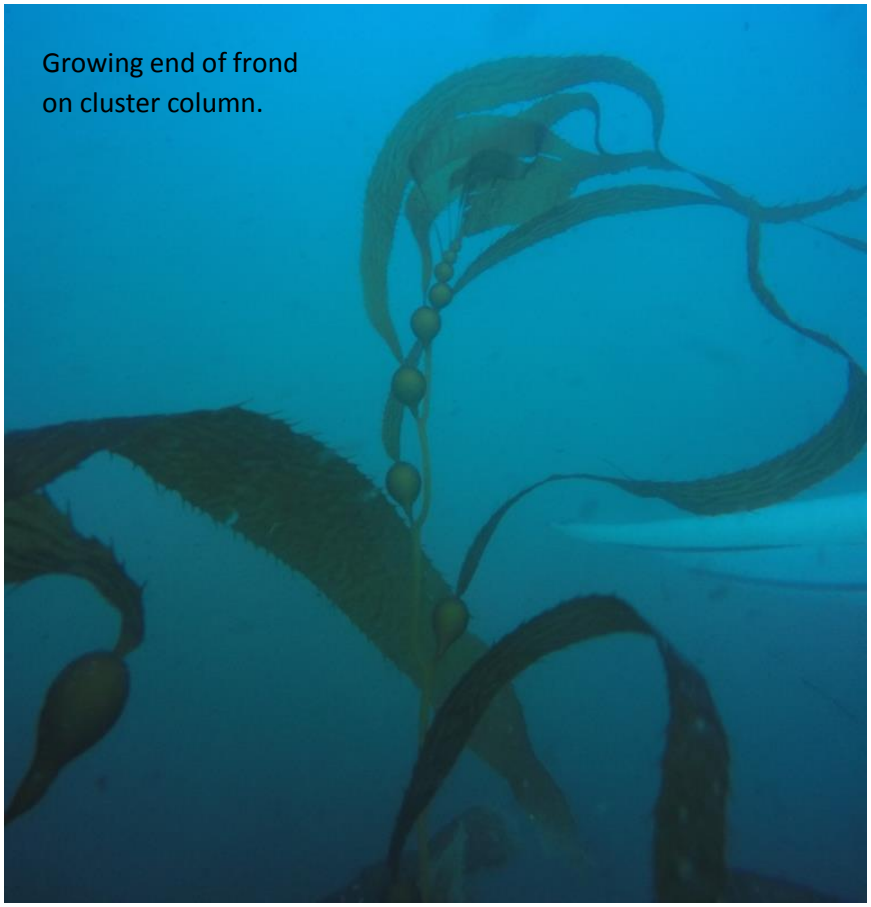
160
We observed the same shell outside the chamber the previous day.

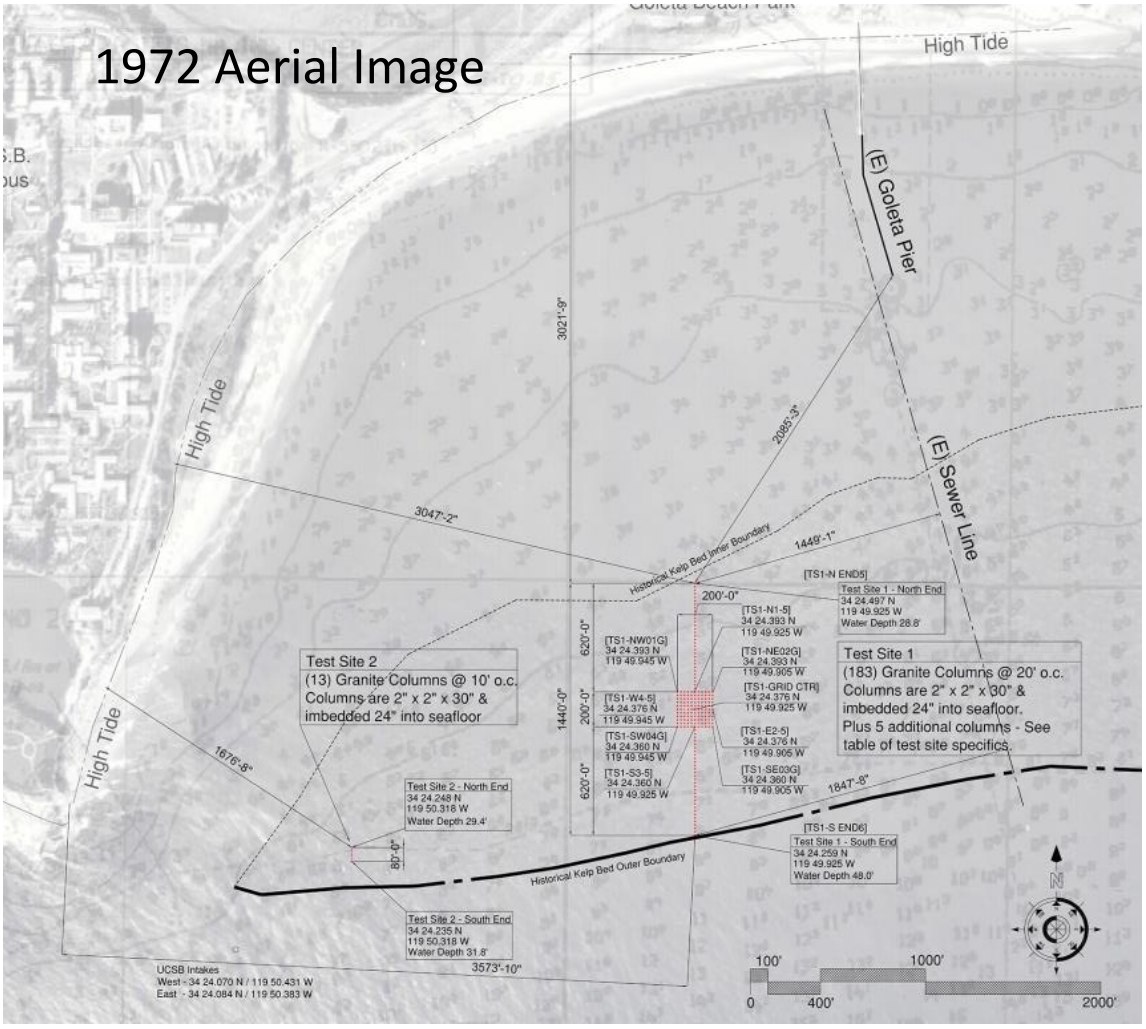

Cluster column with kelp.

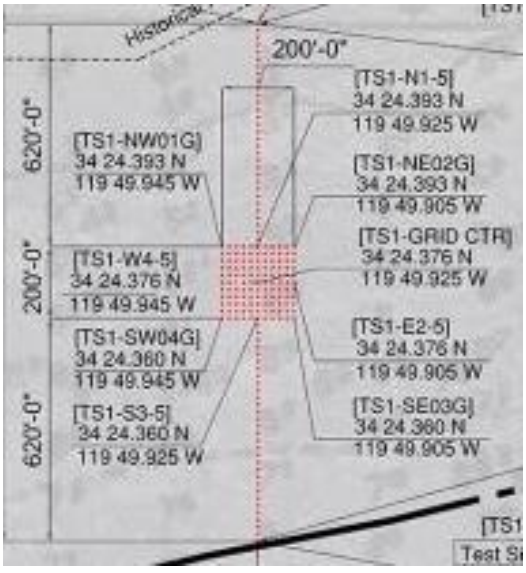
Fronds on cluster column.



Growing end of frond
on cluster column.

Appendix I – Original site plan





Appendix II – Site-1 grid

Goleta Bay Kelp Restoration Project
Installation Log

Test Site 1
Center Grid Area

	A	B	C	D	E	F	G	H	I	J	K
1	TS1-NW 01 G 34° 24+B2:D12.393' N	34 24.393 N 119.49.941 W	34 24.393 N 119 49.937 W	34 24.393 N 119 49.933 W	34 24.393 N 119 49.929 W	TS1-N 1.5 34° 24.393' N 119° 49.925' W	34 24.393 N 119.49.921 W	34 24.393 N 119 49.917 W	34 24.393 N 119 49.913 W	34 24.393 N 119 49.909 W	TS1-NE 02 G 34° 24.393' N 119° 49.905' W
2	34° 24.389' N 119° 49.945' W	34 24.389 N 119.49.941 W	34 24.389 N 119 49.937 W	34 24.389 N 119 49.933 W	34 24.389 N 119 49.929 W	34° 24.389' N 119° 49.925' W	34 24.389 N 119.49.921 W	34 24.389 N 119 49.917 W	34 24.389 N 119 49.913 W	34 24.389 N 119 49.909 W	34° 24.389' N 119° 49.905' W
3	34° 24.385' N 119° 49.945' W	34 24.385 N 119.49.941 W	34 24.385 N 119 49.937 W	34 24.385 N 119 49.933 W	34 24.385 N 119 49.929 W	34° 24.385' N 119° 49.925' W	34 24.385 N 119.49.921 W	34 24.385 N 119 49.917 W	34 24.385 N 119 49.913 W	34 24.385 N 119 49.909 W	34° 24.385' N 119° 49.905' W
4	34° 24.382' N 119° 49.945' W	34 24.382 N 119.49.941 W	34 24.382 N 119 49.937 W	34 24.382 N 119 49.933 W	34 24.382 N 119 49.929 W	34° 24.382' N 119° 49.925' W	34 24.382 N 119.49.921 W	34 24.382 N 119 49.917 W	34 24.382 N 119 49.913 W	34 24.382 N 119 49.909 W	34° 24.382' N 119° 49.905' W
5	34° 24.378' N 119° 49.945' W	34 24.379 N 119.49.941 W	34 24.379 N 119 49.937 W	34 24.379 N 119 49.933 W	34 24.379 N 119 49.929 W	34° 24.378' N 119° 49.925' W	34 24.379 N 119.49.921 W	34 24.379 N 119 49.917 W	34 24.379 N 119 49.913 W	34 24.379 N 119 49.909 W	34° 24.378' N 119° 49.905' W
6	TS1-W 4.5 34° 24.376' N 119° 49.945' W	34 24.376 119.49.941	34 24.376 119 49.937	34 24.376 119 49.933	34 24.376 119 49.929	TS1-GRID CTR 34° 24.376' N 119° 49.925' W	34 24.376 119.49.921	34 24.376 119 49.917	34 24.376 119 49.913	34 24.376 119 49.909	TS1-E 2.5 34° 24.376' N 119° 49.905' W
7	34° 24.373' N 119° 49.945' W	34 24.373 N 119.49.941 W	34 24.373 N 119 49.937 W	34 24.373 N 119 49.933 W	34 24.373 N 119 49.929 W	34° 24.373' N 119° 49.925' W	34 24.373 N 119.49.921 W	34 24.373 N 119 49.917 W	34 24.373 119 49.913	34 24.373 119 49.909	34° 24.373' N 119° 49.905' W
8	34° 24.370' N 119° 49.945' W	34 24.370 N 119.49.941 W	34 24.370 N 119 49.937 W	34 24.370 N 119 49.933 W	34 24.370 N 119 49.929 W	34° 24.370' N 119° 49.925' W	34 24.370 N 119.49.921 W	34 24.370 N 119 49.917 W	34 24.370 119 49.913	34 24.370 119 49.909	34° 24.3870 N 119° 49.905' W
9	34° 24.367' N 119° 49.945' W	34 24.367 N 119.49.941 W	34 24.367 N 119 49.937 W	34 24.367 N 119 49.933 W	34 24.367 N 119 49.929 W	34° 24.367' N 119° 49.925' W	34 24.367 N 119.49.921 W	34 24.367 N 119 49.917 W	34 24.367 119 49.913	34 24.367 119 49.909	34° 24.367' N 119° 49.905' W
10	34° 24.364' N 119° 49.945' W	34 24.364 N 119.49.941 W	34 24.364 N 119 49.937 W	34 24.364 N 119 49.933 W	34 24.364 N 119 49.929 W	34° 24.364' N 119° 49.925' W	34 24.364 N 119.49.921 W	34 24.364 N 119 49.917 W	34 24.364 119 49.913	34 24.364 119 49.909	34° 24.364' N 119° 49.905' W
11	TS1-SW 04 G 34° 24.360' N 119° 49.945' W	34 24.360 119.49.941	34 24.360 119.49.937	34 24.360 119.49.933	34 24.360 119.49.929	TS1-S 3.5 34° 24.360' N 119° 49.925' W	34 24.360 119.49.921	34 24.360 119.49.917	34 24.360 119.49.913	34 24.360 119.49.909	TS1-SE 03 G 34° 24.360' N 119° 49.905' W

Column Installation Log Legend

- Oak stakes installed Nov. 15, 2015 — G. Christman / H. Christman
- Oak stakes and Granite column installed Dec. 15-16, 2015 — R. Kiel / G. Christman
- Granite Column installed Dec 15-16, 2015 — R. Kiel / G. Christman
- Oak stakes installed Dec 15-16, 2015 — R. Kiel / G. Christman
- Granite Column installed June 4, 2016 — R. Kiel / G. Christman
- Granite Column installed May, 30 2016 — R. Kiel / G. Christman
- Granite Column installed May, 29 2016 — R. Kiel / G. Christman
- Granite Column installed May, 28 2016 — R. Kiel / G. Christman

Appendix III – Hypothesis

A puzzling question is why have the sand-dwelling kelp beds failed to recover since they disappeared in the early 1980's, in spite of the fact that kelp has been relatively healthy and abundant on rock reefs within the Santa Barbara channel in recent decades?

Something within the ecosystem is preventing the sand-dwelling kelp beds from recovering naturally.

Sea otters forage on kelp-eating invertebrates and are considered a keystone species within healthy kelp forest ecosystems. Since their disappearance in Southern California by the early 1900's (from being hunted for their pelts), some stands of kelp growing on rock substrate have suffered from being over grazed by periodic urchin blooms and yet the sand-dwelling kelp beds continued to thrive until the early 1980's. The fact they were already well-established by the time sea otters disappeared was likely part of the reason. Their size, density and overall critical mass altered localized oceanic conditions within the beds in ways which contributed to their continued growth and survival. The enormous number of spores produced by the plants within these beds would have also been distributed throughout the Southern California bight, contributing to the health and vitality of kelp stands throughout the region.

The inability of these kelp beds to recover since they disappeared in the early 1980's (beginning with the 1982/'83 El Niño event) may be due in part to the absence of predators such as sea otters foraging within the sand barrens. Once the numbers of plants comprising the beds dropped below a certain critical mass and spacing, the few remaining plants were no longer capable of altering the localized conditions in ways needed to ensure their continued survival and they too finally disappeared. With only occasional isolated plants growing on worm tubes within the sand barrens where they once thrived, they become susceptible to a number of different physical influences within the environment, which prevents their ability to survive and multiply effectively. Without large plants within some critical spacing of each other to seed surrounding worm tubes, natural recovery of the beds appears to be unlikely.

A very interesting observation we've made over the years is the presence of octopus (Two Spot – *Octopus bimaculoides*) seeking refuge at the base of the larger plants growing on the columns. We also don't see the kelp crabs (*Pugettia producta*) and top snails (Norris' – *Norrisia norrisii*, Black Turbine – *Tegula funebralis*) which tend to plague the smaller plants, which are too small to provide suitable octopus habitat.

The once large and (already) well-established sand-dwelling kelp beds, with an abundance of large plants, would have provided ideal habitat for octopus. This may partly explain how these beds managed to persist after sea otters became extinct in Southern California.

Sea otters would have also foraged on octopus, so the populations of octopus residing within the sand-dwelling kelp beds likely increased as well after the disappearance of sea otters.

The Two Spot octopus is frequently observed in locations where rocky substrate exists. Kelp is also generally healthy and abundant in these areas, with little or no indication of being grazed upon. Within

these rocky areas we simply don't see the concentrations of kelp crabs and top snails that we do on the small isolated plants growing within the sand-barrens.

The primary goal of the Goleta Bay kelp anchor study is to determine if it's feasible to aid in recovery of the sand-dwelling kelp beds. There's a good chance the presence of octopus may be a key factor in controlling the populations of kelp-eating invertebrates, which presently prevent most juvenile plants from growing to adult size within the sand barrens.

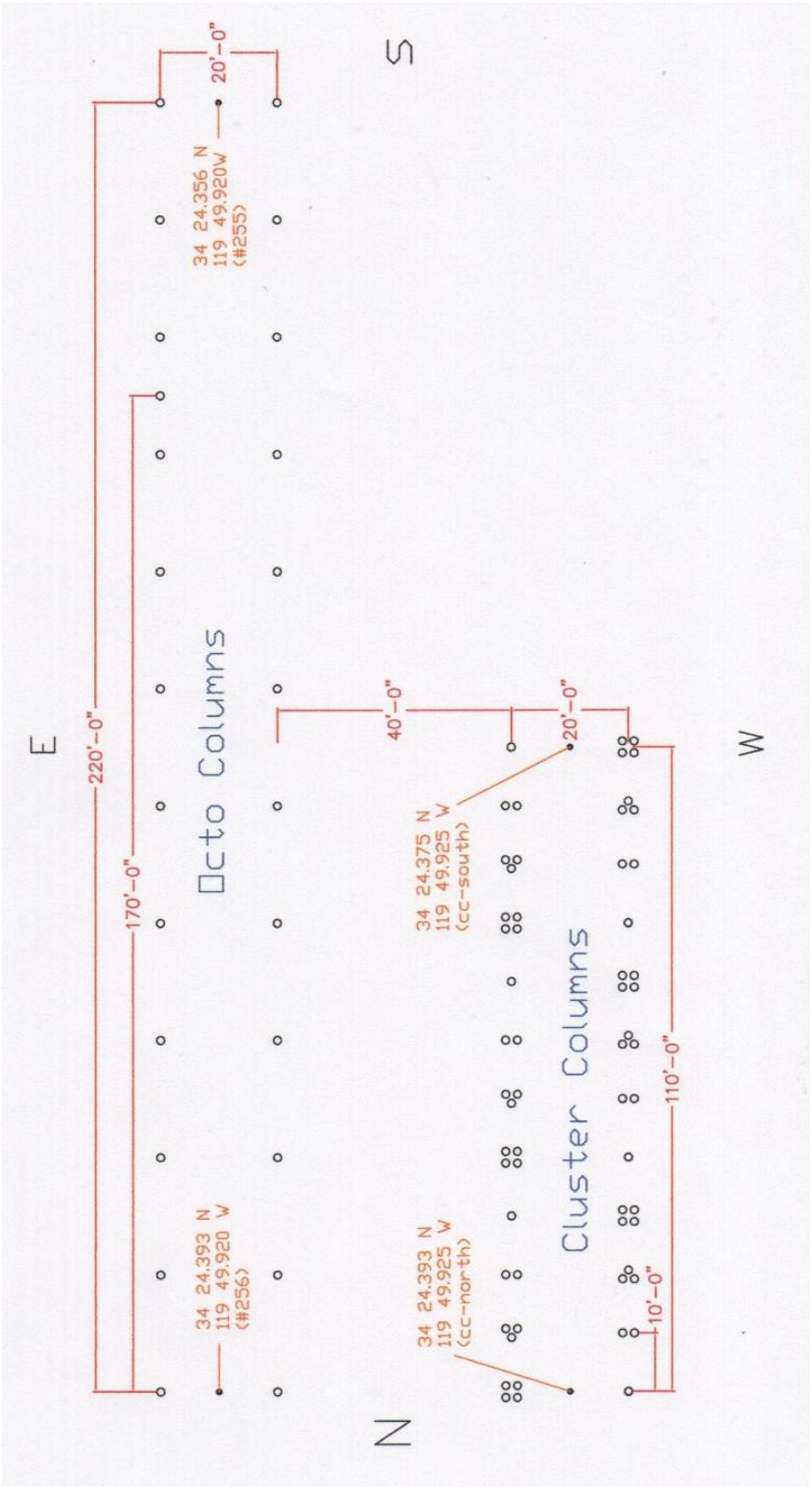
FIGURE 7. A young kelp plant with all the blades removed by some pelagic grazer, probably fish. Isolated transplants and individuals located near the edges of beds often suffer this type of damage.

The above image is from California Department of Fish and Game Fish Bulletin 139, published in 1968: "Utilization of kelp-bed resources in southern California" (Authored by Wheeler North and Carl Hubbs).
http://content.cdlib.org/view?docId=kt2489n586&brand=calisphere&doc.view=entire_text

Mike Neushel and Wheeler North experimented with transplanting kelp at the edge of La Jolla canyon between 1959-1961. They too observed grazing of kelp fronds on the isolated plants.

Kelp plants grow best when they're surrounded by other kelp plants comprising a kelp bed of optimal size and density within a specified area.

Appendix IV – Plan for cluster column and octo column sites



Appendix V – The team

Appendix VI – 1972 aerial image of Goleta Bay

Note the size and density of the kelp bed, and correspondingly wide beach.

The lines running through the canopy are from kelp cutting operations.

The purpose of this kelp study is to determine if it's feasible to aid in the restoration of a sand-dwelling kelp bed of historical proportions at this location.