

UCSC Baseline Rocky Intertidal Survey (CDFW Agreement # P1575003)

Final Report (2016 - 2018)

Project Description

The Cosco Busan Oil Spill occurred in the San Francisco (SF) Bay in 2007 and the Dubai Star Oil Spill happened nearby in 2009. During post spill assessment, it was discovered that there is a paucity of intertidal baseline data in the SF Bay for pre and post spill comparisons. The SF Bay is an area of high boat traffic and human use which makes it especially susceptible to anthropogenic disturbances (such as oil spills). Thus, the need for baseline data is essential.

Under this three-year agreement with the California Department of Fish and Wildlife (CDFW), the University of California, Santa Cruz (UCSC) conducted rocky intertidal surveys in the SF Bay to bolster the amount of baseline information in the event of more such anthropogenic disturbances. Each year under this agreement, two survey sites were selected in coordination with the CDFW-Office of Spill Prevention Response (OSPR) Natural Resource Damage Assessment (NRDA) staff, the surveys were conducted, access to the data was provided, and data analysis was conducted. UCSC also digitally analyzed photos from one site previously surveyed by CDFW-OSPR NRDA staff for comparison with data collected by UCSC at the same site (during different years). This report is the final summary of these activities.

Data Archiving

UCSC's intertidal website has been updated to include new SF Bay sites and survey data have been provided to CDFW-OSPR on Egnyte.com (at MARINe Internal Resources/Oil Spill/Oil Spill OSPR NRDA/SF Baseline). Data include (also see summary of deliverables):

- GPS tracks of surveys at each site
- Survey data (i.e., photo plot photographs, field data sheets, and data analysis)

In the event of an oil spill or other anthropogenic events, these photographs and field data may be further analyzed to support an understanding of baseline information (e.g., pre-spill conditions) for intertidal habitats in the SF Bay.

Methods and Results

Between 2016 and 2018, UCSC identified six sites (two per year; Table 1) to be surveyed in coordination with CDFW-OSPR NRDA staff.

Site	Coordinates	Sample Date
Yerba Buena Island	37.81855, -122.36512	4/26/16
Treasure Island	37.82071, -122.37511	4/26/16
Point Isabel	37.89756, -122.32455	2/23/17
Point Potrero	37.90762, -122.37456	2/23/17
Emeryville Marina	37.84162, -122.31491	2/26/18
San Leandro Marina	37.69823, -122.19410	2/27/18

Table 1: Sites, coordinates (decimal, degrees), and sampling dates for the six sites surveyed within SF Bay.

At each site, transect lines were laid out in different intertidal zones and quadrats were placed along each line. Photos were taken of the quadrat contents and percent cover of sessile intertidal species within each quad was estimated in the field by taking data at 100 evenly spaced points. Mobile invertebrate species were also counted within quadrats along the same lines. Size structure of the intertidal rockweed, *Fucus distichus*, was measured (where present) and panoramic photos were taken; at some sites, crab searches were conducted. The only new site (that had not been previously sampled by CDFW or UCSC) that was setup and sampled during this three year period was Emeryville Marina. A webpage has been created for this site on the UCSC website: <https://www.eeb.ucsc.edu/pacificrockyintertidal/sitepages/emeryvillemarina.html>.

Methods are further described in past Cosco Busan and Dubai Star Oil Spill reports (Raimondi et al., 2009; Raimondi et al., 2011).

Comparison of Photo Plot and Mobile Invertebrate Survey Data Collected by CDFW-OSPR versus UCSC

Point Isabel is a site that CDFW sampled (on January 8th, 2013) and UCSC revisited (in Feb, 2017). It was selected to compare percent cover data from photos taken by CDFW (in 2013) with field data collected by UCSC (in 2017). UCSC digitally analyzed the

CDFW photos to get species information over 100 points on each photograph (enabling the generation of percent cover data). Since it is harder to see and determine specific species in photographs, UCSC's field data (with higher species resolution) was lumped down into broader categories (that are used while scoring photographs) before undergoing comparison.

Percent cover data were significantly different between 2013 and 2017 ($p < 0.001$; figures 1, 2, 3). Specifically, Figure 1 shows greater rock cover in 2017 (when UCSC sampled) than 2013 (when CDFW sampled). These statistical differences could be attributed to the surveys being done during different years (and months), the transect lines and quadrats not being placed in the same zone(s) between years, and/or zones actually shifting over time (among other possible factors).

Percent Cover of Species (by year) at Pt. Isabel

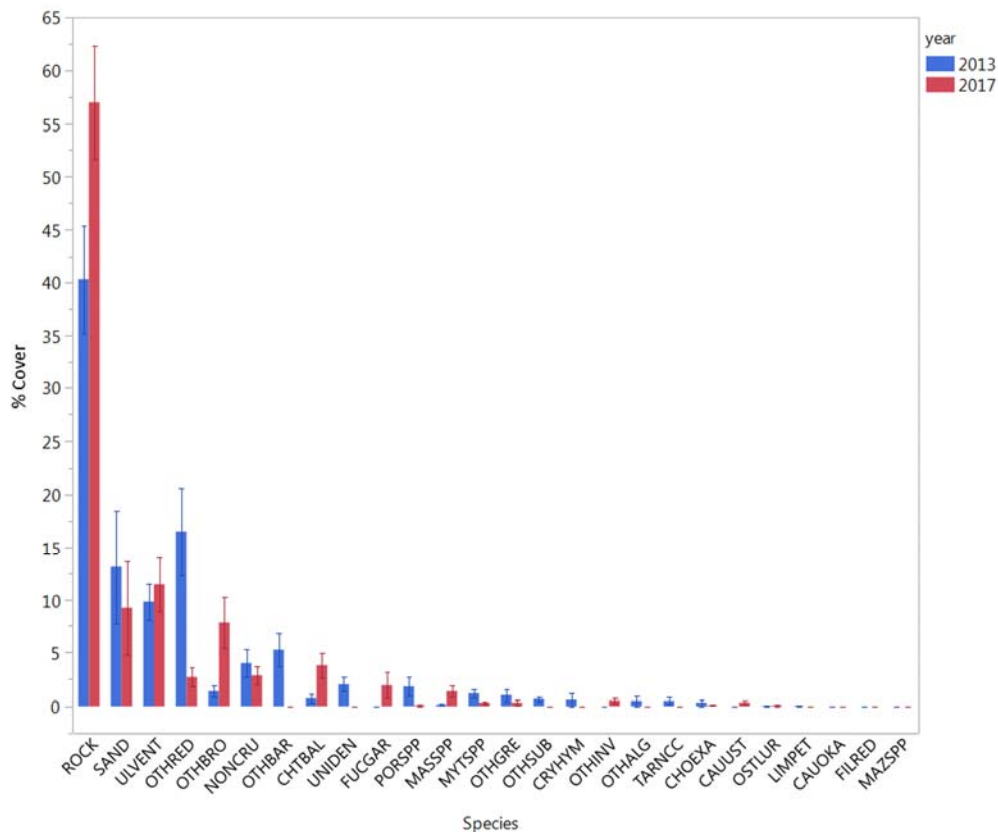


Figure 1: Average percent cover of species in quadrats along 5 transects at Pt. Isabel in Richmond, CA for CDFW photos taken in 2013 (blue) and UCSC field data collected in 2017 (red). Error bars = standard error. See Appendix I for species code definitions.

RAW SPECIES DATA
Non-metric MDS

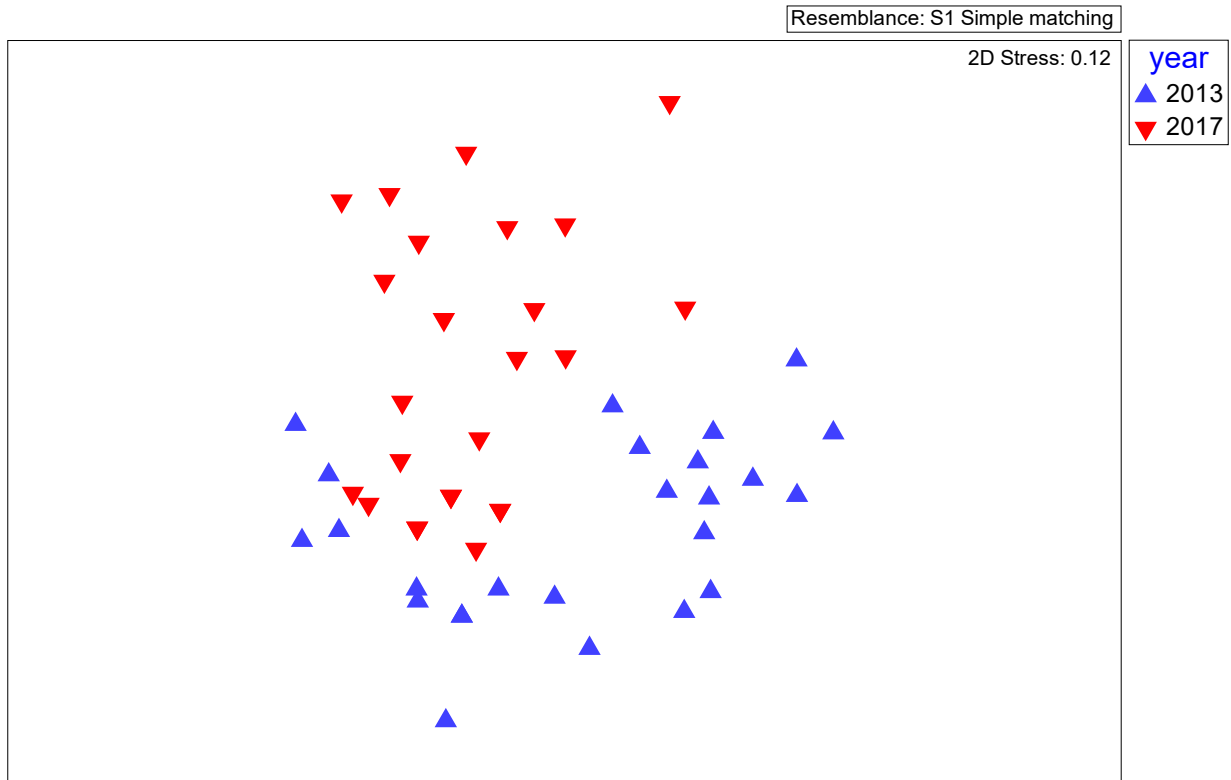


Figure 2: Multidimensional scaling plot for raw quadrat data from CDFW photos taken in 2013 (blue) and UCSC data collected in 2017 (red) at Pt. Isabel. Points closer together are more similar than points that are far apart.

PRESENCE/ABSENCE SPECIES DATA

Non-metric MDS

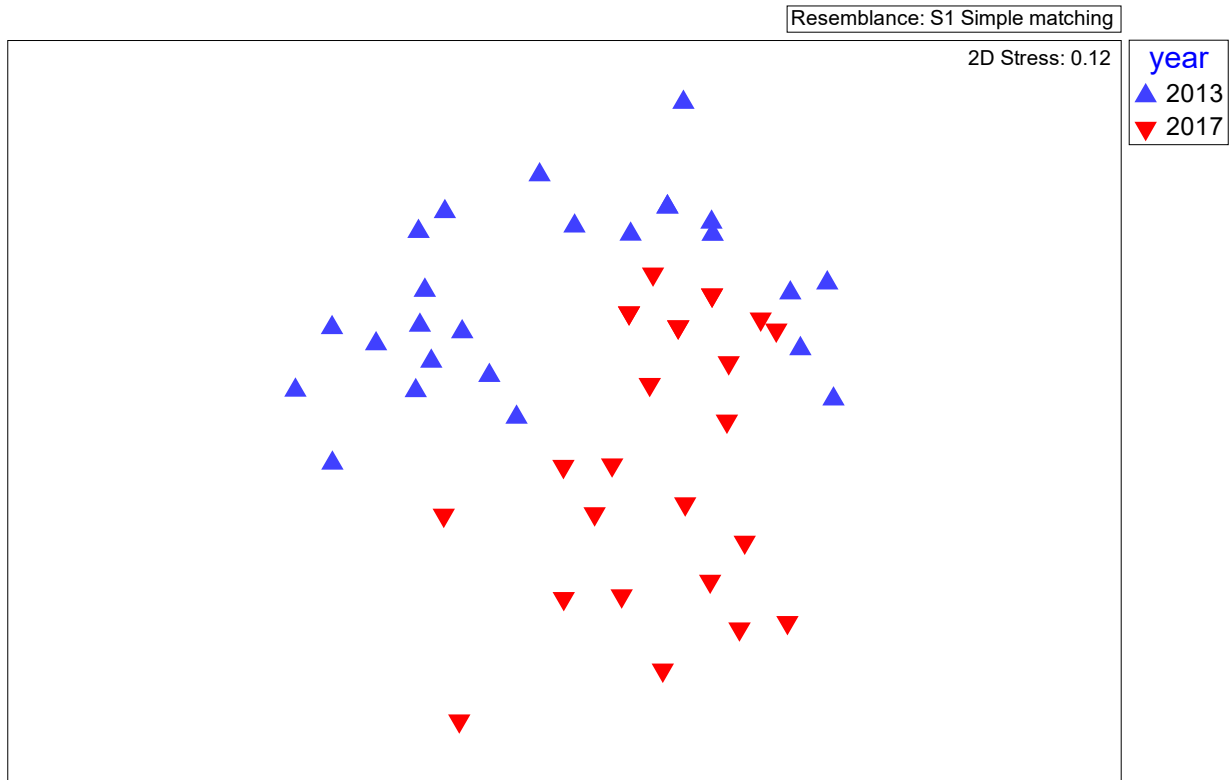


Figure 3: Multidimensional scaling plot for presence/absence data from CDFW photos taken in 2013 (blue) and UCSC data collected in 2017 (red) at Pt. Isabel. Points closer together are more similar than those that are far apart.

Species richness ($p < 0.02$) and species diversity ($p < 0.03$) were also significantly different between 2013 and 2017 at Pt. Isabel (figure 4).

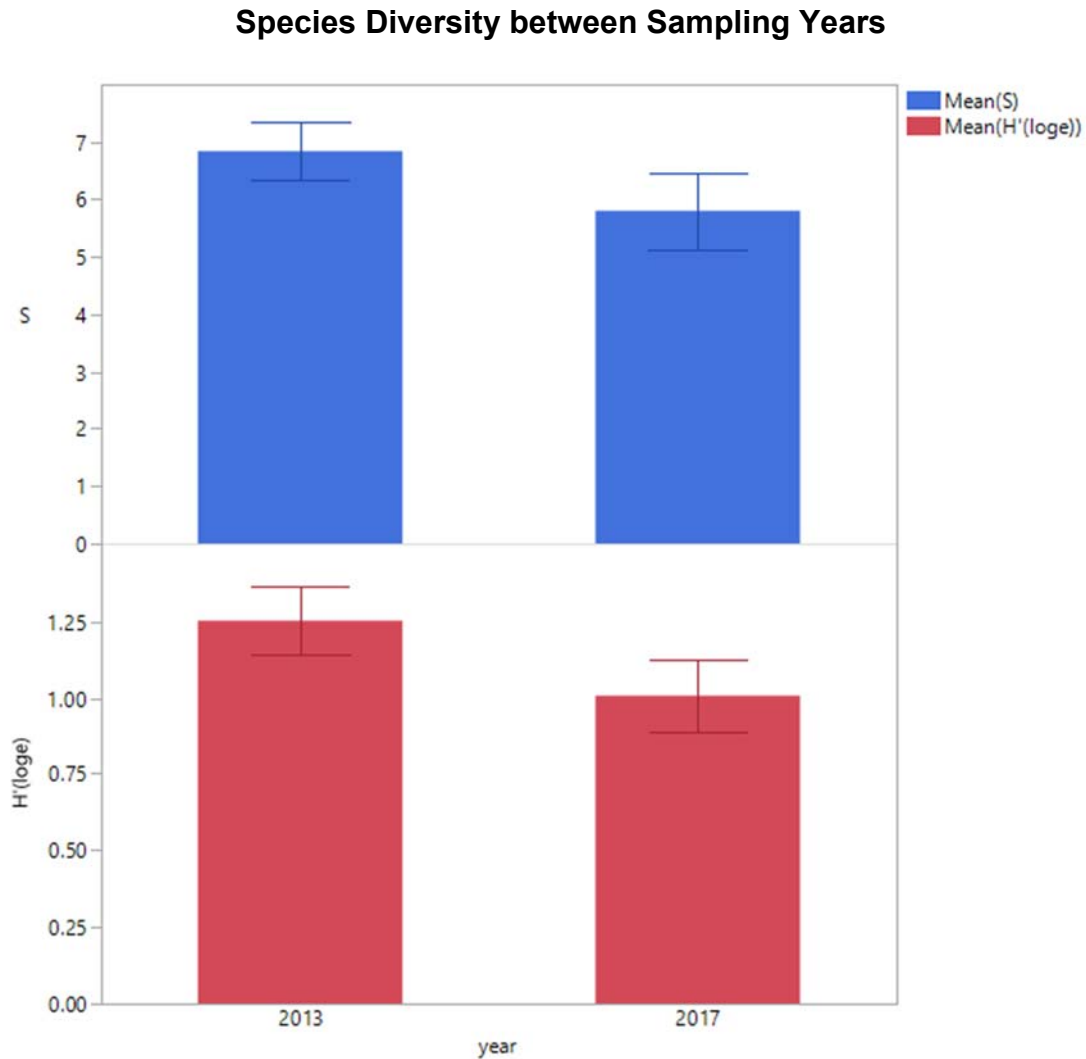


Figure 4: Average species richness (S, blue) between sample years 2013 and 2017. Along with average species diversity (H', red) between sampling years 2013 and 2017 at Pt. Isabel. Error bars = standard error.

Conclusion

Over the three years of this contract with CDFW-OSPR, UCSC collected baseline data for 6 sites within the SF Bay. These data will be crucial in the event of any future disturbances to the area.

Summary of Deliverables

Over the contract period of 1/19/16 to 6/30/18, the following deliverables were provided to the CDFW-OSPR:

- Annual summary of each year's surveys (Appendix II)
- Final summary of the project (herein)
- Access to GPS information, photos, data sheets, and data analyses ([https://marine.egnyte.com/app/index.do#storage/files/1/Shared/MARINE_Interna I_Resources/Oil_Spill/Oil_Spill_OSPR_NRDA/SF_Baseline](https://marine.egnyte.com/app/index.do#storage/files/1/Shared/MARINE_Interna%20I_Resources/Oil_Spill/Oil_Spill_OSPR_NRDA/SF_Baseline))
- Data analysis on previous field data collected by CDFW-OSPR staff (herein).

References

Raimondi, P. T., Orr, D., Bell, C., George, M., Worden, S., Redfield, M., Gaddam, R. Anderson, L., and D. Lohse. Determination of the extent and type of injury to rocky intertidal algae and animals one year after the initial spill (Cosco Busan): a report prepared for OSPR (California Fish and Game). 2009.

Raimondi, P. T., Miner, C. M., Orr, D., Bell, C., George, M., Worden, S., Redfield, M., Gaddam, R. Anderson, L., and D. Lohse. Determination of the extent and type of injury to rocky intertidal algae and animals during and after the initial spill (Dubai Star): a report prepared for California Department of Fish and Game Office of Spill Prevention and Response (DFG-OSPR). 2011.

Appendix I

Species Code	Species Code Definition
ROCK	Rock
SAND	Sand
ULVENT	<i>Ulva/Enteromorpha</i>
OTHRED	Other Red Alga
OTHBRO	Other Brown Alga
NONCRU	Noncoraline Crust
OTHBAR	Other Barnacle Spp
CHTBAL	<i>Chthamalus/Balanus</i>
UNIDEN	Unidentified
FUCGAR	<i>Fucus distichus</i>
PORSPP	<i>Pyropia</i> spp
MASSPP	<i>Mastocarpus</i> spp
MYTSPP	<i>Mytilus</i> spp
OTHGRE	Other Green Alga
OTHSUB	Other Substrate
CRYHYM	<i>Cryptopleura/Hymenena</i>
OTHINV	Other Invertebrate
OTHALG	Other Algae
TARNCC	Tar/Noncoraline Crust (too dark to tell)
CHOEXA	<i>Chondracanthus exasperatus</i>
CAUUST	<i>Caulacanthus ustulatus</i>
OSTLUR	<i>Ostrea lurida</i>
LIMPET	Limpet
CAUOKA	<i>Caulacanthus okamurae</i>
FILRED	Filamentous Red Alga
MAZSPP	<i>Mazzaella</i> spp

Appendix Table 1: Species code definitions used in Figure 1.

Appendix II
Past annual summaries and monthly reports

UCSC Baseline Rocky Intertidal Survey (CDFW Agreement # P1575003)

FY2015-2016 Annual Report (July 2015 - June 2016)

Project Description

Under this three-year agreement with CDFW, UCSC is conducting baseline rocky intertidal surveys in San Francisco Bay. For each year, this work involves selecting two survey sites in coordination with CDFW OSPR Natural Resource Damage Assessment (NRDA) staff, conducting the surveys, providing access to the data, and conducting data analysis. In addition to data from these surveys, UCSC will also score photos from one site previously surveyed by CDFW OSPR NRDA staff. A final summary of all activities and an update to the online mapping tool will also be completed.

Implementation Status

In FY2015-2016, UCSC identified two sites (Yerba Buena and Treasure Island) to be surveyed in coordination with CDFW OSPR NRDA staff. Surveys at these sites were conducted on April 26th, 2016. Raw data and subsequent data analysis have been provided to CDFW OSPR on May 3rd, 2016 and on June 13th, respectively.

UCSC Baseline Rocky Intertidal Survey (CDFW Agreement # P1575003)

FY2016-2017 Annual Report (July 2016 - June 2017)

Project Description

Under this three-year agreement with CDFW, UCSC is conducting baseline rocky intertidal surveys in San Francisco Bay. For each year, this work involves selecting two survey sites in coordination with CDFW OSPR Natural Resource Damage Assessment (NRDA) staff, conducting the surveys, providing access to the data, and conducting data analysis. In addition to data from these surveys, UCSC will also score photos from one site previously surveyed by CDFW OSPR NRDA staff. A final summary of all activities and an update to the online mapping tool will also be completed.

Implementation Status

In FY2016-2017, UCSC identified two sites (Point Isabel and Point Potrero) to be surveyed in coordination with CDFW OSPR NRDA staff. Surveys at these sites were conducted on February 23rd, 2017. Raw data and subsequent data analysis were provided to CDFW OSPR on March 15th, 2017 and on June 6th, respectively.

UCSC Baseline Rocky Intertidal Survey (CDFW Agreement # P1575003)

FY2017-2018 Annual Report (July 2017 - June 2018)

Project Description

Under this three-year agreement with CDFW, UCSC is conducting baseline rocky intertidal surveys in San Francisco Bay. For each year, this work involves selecting two survey sites in coordination with CDFW OSPR Natural Resource Damage Assessment (NRDA) staff, conducting the surveys, providing access to the data, and conducting data analysis. In addition to data from these surveys, UCSC will also score photos from one site previously surveyed by CDFW OSPR NRDA staff. A final summary of all activities and an update to the online mapping tool will also be completed.

Implementation Status

In FY2017-2018, UCSC identified two sites (Emeryville Marina and San Leandro Marina) to be surveyed in coordination with CDFW OSPR NRDA staff. Surveys at these sites were conducted on February 26th, 2018 and February 27th, 2018, respectively. Raw data and subsequent data analysis were provided to CDFW OSPR on June 25th, 2018 and on July 3rd, 2018, respectively.

UCSC Baseline Rocky Intertidal Survey (CDFW Agreement # P1575003)

FY2017-2018 Monthly Report (February 2018)

Project Description

Under this three-year agreement with CDFW, UCSC is conducting baseline rocky intertidal surveys in San Francisco Bay. Two survey sites (in coordination with CDFW OSPR Natural Resource Damage Assessment staff), were selected and sampled on Feb 26, 2018 and Feb 27, 2018. Surveys were conducted at Emeryville Marina (37.841633, -122.314895) and San Leandro Marina (37.697007, -122.194364) in the San Francisco Bay.

At Emeryville Marina, four people laid out three 50m transect lines: one along the high intertidal zone, one along the mid intertidal zone, and one along the low intertidal zone. Quadrats (50x75cm) were placed every 5m along each of these lines and photos were taken of these quadrats and their contents. Percent cover of sessile intertidal species was estimated in the field within these same quadrats by taking data at 100 evenly spaced points. Mobile invertebrate species were counted in 6 quadrats along each line (18 total per site). The size structure of the intertidal rockweed, *Fucus distichus*, was also investigated by measuring the longest frond of *Fucus* individuals every 2.5 meters along the mid intertidal transect line. Panoramic photographs were also taken.

At San Leandro Marina, the same things (using the same methodology as above) were carried out by four people. The only difference being that *Fucus* size structure was quantified by measuring the longest frond of *Fucus* individuals along a 2m wide swath centered over the mid intertidal transect line (the first 5 individuals encountered within each meter were measured for approximately 100 measurements).

Implementation Status

In FY2017-2018, UCSC identified two sites (Emeryville Marina and San Leandro Marina) to be surveyed in coordination with CDFW OSPR NRDA staff. Surveys at these sites were conducted on Feb 26th, 2018 and Feb 27th, 2018 (respectively). Raw data were provided to CDFW OSPR on June 25th, 2018 and subsequent data analysis was provided July, 3rd 2018.