Status of the Kelp Beds in 2021 and 2022:

Orange County and San Diego County

Prepared for the Region Nine Kelp Survey Consortium

MBC Aquatic Sciences

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Prepared by:

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EXECUTIVE SUMMARY

Aerial imaging surveys of the giant kelp beds off Orange and San Diego counties were conducted for the Region Nine Kelp Survey Consortium by MBC Aquatic Sciences on eight occasions over a two-year period: on March 28, July 16-17 and September 29, 2021, on January 2, April 8, August 8, and October 22, 2022, and on January 23, 2023. The maximum surface canopy observed during 2021 and 2022 was quantified from color infrared photos of each kelp bed. To supplement the aerial surveys, vessel surveys of all 24 bed beds were conducted on seven occasions over the two-year period to observe any surface canopy present and subsurface kelp (as indicated by the fathometer). More detailed in-water surveys were conducted at nine kelp beds over the two-year period to observe any subsurface kelp present and to document bottom conditions.

The total kelp canopy throughout Region Nine decreased by 23% from 2020 to 2021 (3.9 km^2 in 2020 compared to 3.0 km^2 in 2021) and decreased by an additional 37% from 2021 to 2022 (3.0 km^2 in 2021 compared to 1.9 km^2 in 2022), resulting in an overall decrease of 51% over the two-year period. This is the sixth time in the past seven years that the total kelp canopy was less than the long-term average (6.9 km^2 for period from 1967 to 2022), following nine years (2007 through 2015) with above average total kelp canopy. Eleven kelp beds were observed in 2021 with visible surface canopy, including four kelp beds that increased in size in 2021, four that reappeared, and three that decreased in size. Three kelp beds disappeared in 2021. The La Jolla and Point Loma kelp beds were the largest in Region Nine, accounting for 88% of the total canopy coverage in 2021. Only six kelp beds were observed in 2022 with visible surface canopy, including one kelp bed that increased in size in 2022 and five that decreased in size. Five kelp beds disappeared in 2022. In 2022, the La Jolla and Point Loma kelp beds were again the largest in Region Nine, accounting for 97% of the total canopy coverage. Ten kelp beds that displayed no surface canopy in 2020 continued to be absent in 2021 and 2022.

Visual observations during the three vessel surveys conducted in Year One (February 1, February 17, and March 10, 2022) indicated that surface canopy was present at more than half of the kelp beds (14), including most kelp beds from Corona del Mar to San Mateo Point, Barn Kelp, from Leucadia to Solana Beach, and at La Jolla and Point Loma (Table 6). Subsurface kelp was also observed at all of these kelp bed locations, as well as at two kelp beds without any visible surface canopy (North Carlsbad and Agua Hedionda).

Visual observations during the four vessel surveys conducted in Year Two (December 1 and 15, 2022, and January 27 and February 2, 2023) indicated that surface canopy was present at less than half of the kelp beds (11), including most kelp beds from Corona del Mar to Dana Point/Salt Creek, North Carlsbad, from Leucadia to Solana Beach, and at La Jolla and Point Loma (Table 7). Subsurface kelp was also observed at most of these kelp bed locations (although only old holdfasts were observed on the bottom at Dana Point/Salt Creek). Old holdfasts were also observed on the bottom at Horno Canyon and Barn Kelp (two locations without any observable surface canopy), but there was no evidence of any recruitment of young individuals).

Sea surface water temperatures throughout Region Nine were generally warmer than average in 2021 during the months of January, February, November, and December, and warmer than average in 2022 from January through mid-April. In addition, sea surface daily temperature values during these two

years rarely fell below 14°C. Nutrient availability is generally greater when temperatures are below this threshold and conditions would be expected to be more favorable for kelp growth. There were also a relatively low number of days with cold surface temperatures (lower than 14°C) and a relatively high number of days with warm surface temperatures (greater than 16°C). These factors probably created conditions unfavorable for kelp growth, contributing to the decreases in total kelp canopy observed in 2021 and 2022. Nutrient Quotient values were lower in 2021 and 2022 than in 2020, which also may have contributed to these declines.

I - INTRODUCTION

Giant kelp (*Macrocystis pyrifera*) beds along most of the southern California mainland coast have been mapped quarterly by the Region Nine Kelp Survey Consortium (RNKSC) since 1983. The RNKSC participants agreed that the monitoring program would be methodologically based upon aerial kelp surveys that were conducted since 1967 by the late Dr. Wheeler J. North.

I.1 - REGION NINE KELP BEDS

The RNKSC program area extends from Abalone Point in northern Laguna Beach in Orange County southward to the U.S./Mexico Border in San Diego County, and recognizes 24 existing or historic kelp beds (Figure 1, Appendix A). Kelp beds associated with harbors, marinas, or hard substrate also are surveyed. Region Nine supports what are usually the two largest kelp beds in southern California, the La Jolla and Point Loma kelp beds. There are eight ocean outfalls located within the geographical area surveyed on behalf of the RNKSC, including three outfalls that are shared by two different agencies (Oceanside/Fallbrook, Encina Power Plant/Poseidon, and San Elijo/Escondido) (Figure 1).

One of the objectives of the RNKSC program is to answer several basic monitoring questions regarding the status of kelp beds within the region:

1. What is the maximum areal extent of the coastal kelp bed canopy each year?

2. What is the variability of the coastal kelp bed canopy over time?

3. Are coastal kelp beds disappearing? If yes, what are the factors that could contribute to the disappearance?

4. Are new kelp beds forming?

I.2 - KELP BIOLOGY

If spores and suitable rocky substrate are available, giant kelp can quickly colonize surfaces and grow within a wide range of environmental conditions. Giant kelp grows rapidly and becomes reproductive in less than one year, with population dynamics largely driven by changes in the oceanographic environment, such as temperature and nutrient levels. If not removed prematurely by storms or grazers, large vegetative fronds eventually produce a terminal meristem, stop growing, and senesce. Individual fronds usually live no more than four to nine months, and individual kelp can live up to approximately nine years (Schiel & Foster, 2015). Detailed information on kelp biology is presented in Appendix B.

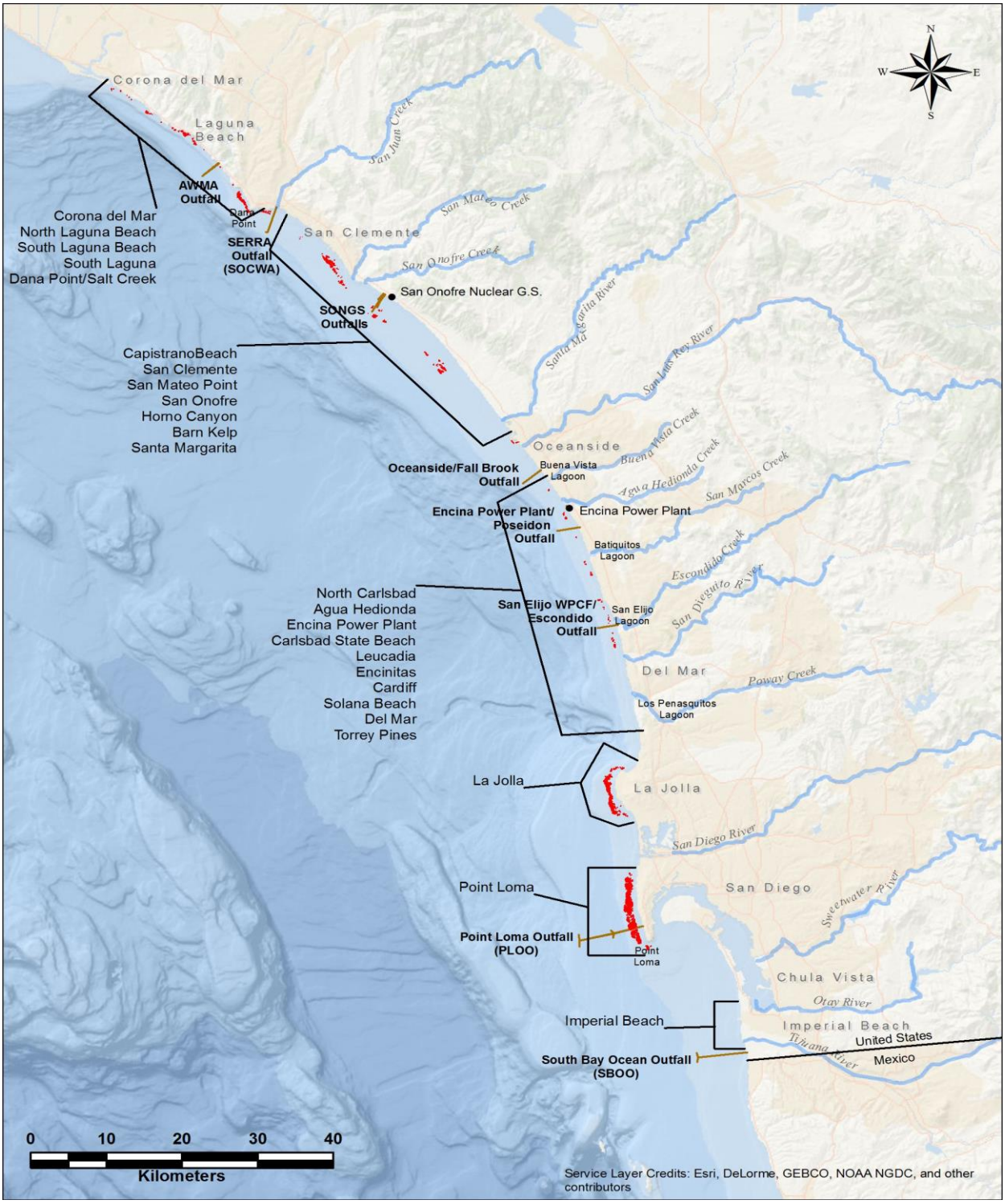


Figure 1. Location of ocean outfalls and designated kelp beds within the Region Nine survey area (red illustrates the approximate areas where surface canopy may occur in a given year within each kelp bed).

II - MATERIALS AND METHODS

II.1 - KELP DATA COLLECTION

II.1.A - AERIAL SURVEYS

In the early-1960s, when kelp surveys began, the surface area of coastal kelp beds was calculated via aerial photography by the late Dr. Wheeler J. North of the California Institute of Technology (Pasadena). Later MBC continued the surveys using a method following that of Dr. North's, as it provided a consistent approach for comparing kelp bed size (North 2001). MBC has continued to use this same methodology for the Region Nine surveys since inception of the program in 1983.

In 2021 and 2022, Ecoscan Resource Data conducted quarterly overflights of the coastline on behalf of the RNKSC from Newport Harbor (Orange County) to the U.S./Mexico border (San Diego County). Direct downward-looking photographs of the kelp beds were taken from an aircraft modified by Ecoscan Resource Data to facilitate aerial photography. Approximately 200 to 225 high-contrast digital color and infrared photos were taken during each survey. Prior to each survey, the flight crew assessed the weather, marine conditions, and sun angle to schedule surveys on dates when optimum photos could be captured. The pilot targeted the following conditions:

- Weather: greater than a 15,000' ceiling throughout the entire survey range and wind less than 10 knots,
- Marine: sea/swell less than 1.5 m and tide range less than +1.0' Mean Lower Low Water (MLLW) during the survey,
- Sun angle greater than 30 degrees from vertical.

Aerial surveys were flown on March 28, July 16-17, and September 29, 2021, on January 2, April 8, August 8, and October 22, 2022, and on January 23, 2023 (Tables 1 and 2). The flight path and flight data report from each quarterly aerial survey are included in Appendix C.

II.1.B - KELP DATA ANALYSIS

All photographs were reviewed after each overflight and the canopy surface area of each kelp bed was ranked in size by subjectively comparing the extent of canopy coverage shown in the photographs to the average historical bed size and photographs from previous surveys (Table 2). The ranking scale ranged from 0 for no kelp, 0.5 for minimal kelp, 1 for well below average kelp, 1.5 for somewhat below average kelp, 2 for below average kelp, 2.5 for average kelp, 3 for above average kelp, 3.5 for somewhat above average kelp, and 4 for well above average kelp. These rankings allowed the archiving of the quarterly survey slides for later retrieval and assembly of a digitized photo-mosaic of each kelp bed that represented the greatest areal extent for each survey year. Individual beds in the composite were selected for detailed evaluation and the surface area of all visible kelp canopies in each distinct kelp bed was calculated.

All digital photographs from the quarterly survey that displayed the greatest areal coverage in 2021 and in 2022 were digitally assembled into a composite photo-mosaic that provided a regional view of entire kelp bed areas. Photos of kelp beds that displayed the greatest canopy coverage during a single survey were used to make photo-mosaics. Data from one or two surveys were usually used for the photo-mosaics to provide the best estimate of maximum canopy coverage for the year. The Photoshop mosaics were then transferred to Geographic Information System (GIS; ArcGIS 10.3.1)

geo-referencing and placed into specific California Department of Fish and Wildlife (CDFW) geo-spatial shape files. Each mosaic was geo-referenced to match several prominent features (usually more than three) on the map and converted to Universal Transverse Mercator (UTM), or another acceptable coordinate system, and subsequently converted to a geo-referenced JPEG file. Surface canopy areas were calculated using the image classification function, an extension to the ArcGIS program. The kelp beds from the photos were then layered on standard base maps to facilitate inter-annual comparisons. The "Hard Substrate" layer on the base maps (shown as lightly shaded areas on the maps in Appendix A) was obtained through the CDFW Biogeographic Information and Observation System.

The "Average Bed Area Per Year" (ABAPY) was plotted with results from individual beds to compare canopy sizes and patterns of growth/decline to averages for particular regions. Those regions were: CDFW lease bed 9 in Orange County and CDFW lease beds 5, 6, 7, and 8 in San Diego County (Figure 2). Kelp beds off La Jolla (CDFW lease bed 4, Figure 2) and Point Loma (CDFW lease beds 2 and 3, Figure 2) were treated separately because they are typically much larger beds which would dominate the ABAPY if included with the smaller beds, potentially skewing the data presentation and masking any changes occurring in the smaller beds. Each ABAPY was calculated by summing the annual canopy estimates for the relevant beds during each year and dividing the total by the number of beds included.

II.1.C - VESSEL SURVEYS

Vessel surveys of all 24 designated kelp beds are conducted annually to observe all RNKSC kelp beds. Vessel surveys of all 24 bed beds were conducted on February 1, February 17, and March 10, 2022 (surveys were delayed until 2022 due to adverse ocean conditions) and on December 1 and December 15, 2022, and January 27 and February 2, 2023 (two surveys were delayed until 2023 due to adverse ocean conditions) to observe any surface canopy present and subsurface kelp (as indicated by the fathometer). Surveys were conducted on different tidal stages. More detailed in-water surveys were conducted by biologist-divers at nine kelp beds: Encinitas and Carlsbad State Beach (on February 1, 2022), Capistrano Beach (February 17, 2022), North Laguna Beach and South Laguna (March 10, 2022), San Mateo Point (December 1, 2022), Horno Canyon and Barn Kelp (December 15, 2022), and Dana Point/Salt Creek (January 27, 2023) to observe any subsurface kelp present and to document bottom conditions. Field data sheets for vessel surveys are included in Appendix C.

Visual observations of the surface canopy included:

- Extent and density of the bed,
- Tissue color: ranges from pale yellow (indicating poor nutrient uptake) to dark brown (indicating good nutrient intake),
- Frond length on the surface,
- Presence/absence of apical meristems (scimitar = growing tips),
- Extent of encrustations by hydroids or bryozoans,
- Sedimentation on fronds,
- Any evidence of disease, such as holes or black rot,
- Age composition of fronds: young, mature, or senile.

Table 1. Kelp bed overflights in 2021.

Quarter	Target Date	Actual Date	Comments
1st Quarter	**January to March 2021**	March 28, 2021	Excellent conditions for photos and observations during overflight
2nd Quarter	**April to June 2021**	July 16-17, 2021	Excellent conditions for photos and observations during overflight (survey delayed due to foggy conditions during month of June)
3rd Quarter	**July to September 2021**	September 29, 2021	Excellent conditions for photos and observations during overflight
4th Quarter	**October to December 2021**	January 2, 2022	Excellent conditions for photos and observations during overflight (survey delayed due to adverse weather conditions during month of December)

Table 2. Kelp bed overflights in 2022.

Quarter	Target Date	Actual Date	Comments
1st Quarter	**January to March 2022**	April 8, 2022	Excellent conditions for photos and observations during overflight (survey delayed due to adverse weather conditions during month of March)
2nd Quarter	**April to June 2022**	August 8, 2022	Excellent conditions for photos and observations during overflight (survey delayed due to foggy conditions during months of June and July)
3rd Quarter	**July to September 2022**	October 22, 2022	Excellent conditions for photos and observations during overflight (survey delayed due to foggy conditions during month of September)
4th Quarter	**October to December 2022**	January 23, 2023	Excellent conditions for photos and observations during overflight (survey delayed due to delays in repairs required for aircraft radio)

Table 3. Rankings assigned to kelp beds from aerial photographs from 2021 Region Nine surveys between Newport Harbor and Imperial Beach.

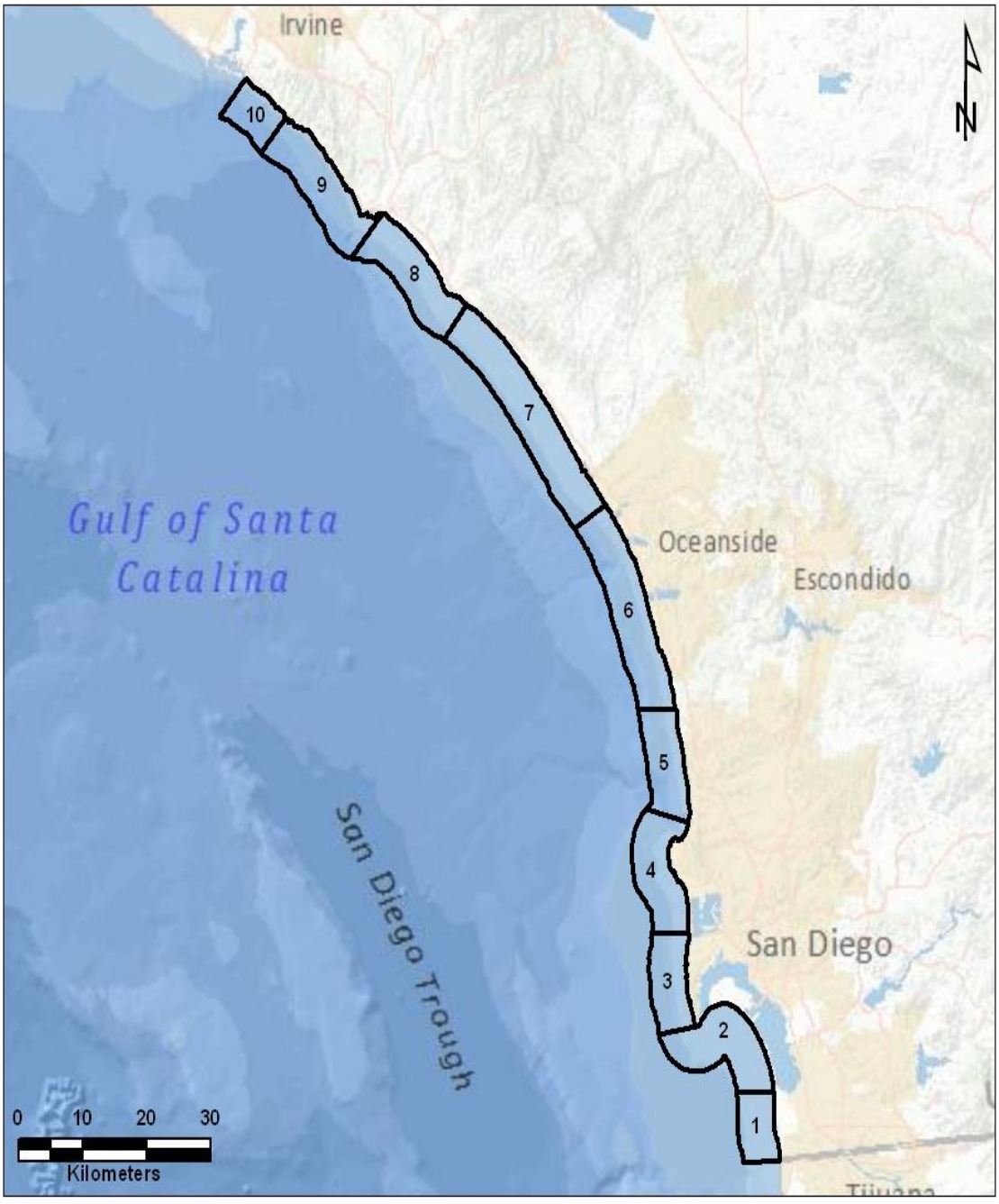
	2021 Surveys			
Kelp Beds	March 28, 2021	July 16-17, 2021	September 29, 2021	January 2, 2022
Newport Harbor*	–	–	–	–
Corona del Mar	0.5	–	–	–
North Laguna Beach	1.0	0.5	1.0	1.5
South Laguna Beach	1.0	–	–	0.5
South Laguna	–	–	–	0.5
Salt Creek-Dana Point	1.0	–	–	0.5
Dana Marina*	–	–	–	–
Capistrano Beach	0.5	–	–	1.0
San Clemente	1.0	–	–	0.5
San Mateo Point	–	–	–	0.5
San Onofre	–	–	–	–
Pendleton Reefs*	–	–	–	–
Horno Canyon	–	–	–	–
Barn Kelp	1.5	–	–	2.0
Santa Margarita	–	–	–	–
Oceanside Harbor*	–	–	–	–
North Carlsbad	–	–	–	–
Agua Hedionda	–	–	–	–
Encina Power Plant	–	–	–	–
Carlsbad State Beach	–	–	–	–
Leucadia (North, Central, South)	–	–	–	–
Encinitas	–	–	–	–
Cardiff	–	–	–	–
Solana Beach	–	–	–	0.5
Del Mar	–	–	–	–
Torrey Pines	–	–	–	–
La Jolla Upper	–	–	2.0	–
La Jolla Lower	1.5	1.5	2.0	1.0
Point Loma Upper	1.5	1.5	2.0	3.0
Point Loma Lower	0.5	1.5	2.0	2.0
Imperial Beach	–	–	–	–

Ranking values: 0.5 = trace or very small amount of kelp present; 1 = well below average;
1.5 = somewhat below average; 2 = below average; 2.5 = average;
3 = above average; 3.5 = somewhat above average; and 4 = well above average.
* = not a designated kelp bed
NI = No Image; X=no overflight conducted in Central Region
"-" = no kelp present
Green highlight = survey utilized to quantify surface canopy area

Table 4. Rankings assigned to kelp beds from aerial photographs from 2022 Region Nine surveys between Newport Harbor and Imperial Beach.

Kelp Beds	2022 Surveys			
	April 8, 2022	August 8, 2022	October 22, 2022	January 23, 2023
Newport Harbor*	–	–	–	–
Corona del Mar	0.5	–	–	–
North Laguna Beach	1.5	0.5	–	–
South Laguna Beach	0.5	0.5	–	0.5
South Laguna	0.5	0.5	–	–
Salt Creek-Dana Point	–	0.5	–	–
Dana Marina*	–	–	–	–
Capistrano Beach	–	–	–	–
San Clemente	–	–	–	–
San Mateo Point	–	–	–	–
San Onofre	–	–	–	–
Pendleton Reefs*	–	–	–	–
Horno Canyon	–	–	–	–
Barn Kelp	–	–	–	–
Santa Margarita	–	–	–	–
Oceanside Harbor*	–	–	–	–
North Carlsbad	–	–	–	–
Agua Hedionda	–	–	–	–
Encina Power Plant	–	–	–	–
Carlsbad State Beach	–	–	–	–
Leucadia (North, Central, South)	–	–	–	–
Encinitas	–	–	–	–
Cardiff	–	–	–	–
Solana Beach	–	–	–	0.5
Del Mar	–	–	–	–
Torrey Pines	–	–	–	–
La Jolla Upper	1.0	1.5	0.5	–
La Jolla Lower	1.0	1.5	0.5	–
Point Loma Upper	1.0	1.0	0.5	–
Point Loma Lower	1.0	2.5	1.5	0.5
Imperial Beach	–	–	–	–

Ranking values: 0.5 = trace or very small amount of kelp present; 1 = well below average;
1.5 = somewhat below average; 2 = below average; 2.5 = average;
3 = above average; 3.5 = somewhat above average; and 4 = well above average.
* = not a designated kelp bed
NI = No Image
"-" = no kelp present
Green highlight = survey utilized to quantify surface canopy area



Source: California Department of Fish and Wildlife (https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=134676&inline).

Figure 2. Administrative kelp bed lease areas in the Region Nine study area.

III - RESULTS

III.1 – SUMMARY

Maps showing the areal extent of RNKSC surface canopy coverage in 2021 and 2022 are provided in Appendix A. Tables displaying the historical canopy coverage for Region Nine from 1983 through 2022 life history information for giant kelp, and historical kelp surveys (including Crandall's maps) are provided in Appendix B. The flight path and flight data reports from each quarterly aerial survey in 2021 and 2022, and field data sheets from vessel surveys are included in Appendix C. Composite photographs of the extent of kelp surface canopy throughout Region Nine in 2021 and 2022 are included in Appendix D. Sea surface temperatures at Newport Pier, Oceanside, Point Loma, and Scripps Pier for 2021 and 2022 are presented in Appendix E.

In 2021, most kelp beds in the RNKSC region attained maximum surface canopy area for the year during either the first or fourth quarterly surveys, except that the La Jolla kelp bed peaked during the third quarter (Table 3). The total amount of kelp canopy coverage in the RNKSC region was 3.0 km^2 in 2021, decreasing by 24% from 3.9 km^2 in 2020. Of the 24 designated RNKSC kelp beds, 11 displayed surface canopy, including four that reappeared, four that increased in size, and three that decreased in size in 2021. Three kelp beds disappeared in 2021. The largest beds were the La Jolla (0.7 km^2) and Point Loma (1.9 km^2) kelp beds, which accounted for 88% of the total RNKSC kelp coverage in 2021. Seven kelp beds (of the 11 with visible surface canopy) were smaller than 10% of their maximum size recorded since 1983. Only four kelp beds were larger than 10% of their historical maximum size in 2021 (Figure 3).

In 2022, kelp beds in the RNKSC region attained maximum surface canopy for the year during the first or second quarterly surveys (Table 4). The total amount of kelp coverage in the RNSKC region in 2022 was 1.9 km^2 in 2022, decreasing by 36% from 2021. Of the 24 designated RNKSC kelp beds, six displayed surface canopy, including one that increased in size and five that decreased in size. Five kelp beds disappeared in 2022. The largest beds were the La Jolla (0.4 km^2) and Point Loma (1.4 km^2) kelp beds, which accounted for 98% of the total RNKSC kelp coverage in 2022. Five kelp beds (of the seven with visible surface canopy) were smaller than 10% of the maximum size recorded since 1983. Only two kelp beds were larger than 10% of their historical maximum size in 2022 (Figure 3).

III.2 - SIZE OF KELP BEDS IN REGION NINE

The following is a synopsis of the status of each of the 24 designated individual kelp beds in Region Nine during the 2021 and 2022 survey years based upon the quarterly surveys. Information also is presented on several other areas where kelp beds were present. The comparison of canopy coverage between 2020, 2021, and 2022 for each kelp bed is presented in Table 5, and comparison to historical maximum size is presented for these three years in Figure 3. Historical canopy coverage since 1911 is presented in Appendix B (Table B.3). Visual observations of the kelp beds recorded in Tables 6 and 7 are based on vessel surveys conducted on February 1, February 17, March 10, December 1, and December 15, 2022, and January 27, 2023.

Field data sheets from the in-water surveys conducted by biologist-divers at nine kelp beds are included in Appendix C. The results are summarized in the sections below for Encinitas and Carlsbad State Beach (dives on February 1, 2022), Capistrano Beach (dive on February 17, 2022), North Laguna Beach and South Laguna (dives on March 10, 2022), San Mateo Point (dive on December 1, 2022), Horno Canyon and Barn Kelp (dives on December 15, 2022), and Dana Point/Salt Creek (dive on January 27, 2023).

Table 5. Comparison of the canopy coverage of the Region Nine kelp beds from Laguna Beach to Imperial Beach (kelp beds listed north to south) during 2020. 2021, and 2022.

Kelp Bed	2020 (km^2)	2021 (km^2)	2022 (km^2)	Percentage Difference (from 2020 to 2022)
North Laguna Beach	**0.022**	**0.031**	**0.040**	**+82%**
South Laguna Beach	**0.001**	**0.012**	**0.005**	**+400%**
South Laguna	**0**	**0.005**	**0.001**	**Reappeared**
Dana Point/Salt Creek	**0.005**	**0.017**	**0.002**	**-60%**
Capistrano Beach	**0**	**0.006**	**0**	**No change**
San Clemente	**0.009**	**0.004**	**0**	**Disappeared**
San Mateo Point	**0**	**0.007**	**0**	**Disappeared**
San Onofre	**0**	**0**	**0**	**No change**
Horno Canyon	**0.003**	**0**	**0**	**Disappeared**
Barn Kelp	**0.234**	**0.262**	**0**	**Disappeared**
Santa Margarita	**0**	**0**	**0**	**No change**
North Carlsbad	**0**	**0**	**0**	**No change**
Agua Hedionda	**0**	**0**	**0**	**No change**
Encina Power Plant	**0**	**0**	**0**	**No change**
Carlsbad State Beach	**0**	**0**	**0**	**No change**
Leucadia	**0.006**	**0**	**0**	**Disappeared**
Encinitas	**0.0003**	**0**	**0**	**Disappeared**

Table 5 (continued)

Kelp Bed	2020 (km^2)	2021 (km^2)	2022 (km^2)	Percentage Difference (2020 to 2022)
Cardiff	**0**	**0**	**0**	**No change**
Solana Beach	**0**	**0.6**	**0**	**No change**
Del Mar	**0**	**0**	**0**	**No change**
Torrey Pines	**0**	**0**	**0**	**No change**
La Jolla	**1.094**	**0.725**	**0.446**	**-59%**
Point Loma	**2.545**	**1.882**	**1.417**	**-44%**
Imperial Beach	**0**	**0**	**0**	**No change**
TOTAL	**3.919**	**2.964**	**1.911**	**-51%**

III.2.A - NEWPORT BEACH TO ABALONE POINT, LAGUNA BEACH

Newport Harbor. This is not a designated kelp bed. Kelp was not observed within the harbor in 2021 or 2022.

Corona del Mar. This is a designated kelp bed within the Central Region but is included here for information purposes. This kelp bed disappeared in 2020 but reappeared in 2021. It decreased by 57% from 0.007 km^2 in 2021 to 0.003 km^2 in 2022 (Table 5).

South from Newport Harbor, giant kelp grows in several small beds collectively referred to as the Corona del Mar kelp bed, or sometimes called the Newport/Irvine Coast kelp bed. There was no visible surface canopy in this area from 1992 through 2002, but the kelp bed was observed every subsequent year until 2020 (Figure 4). This kelp bed reappeared in 2021 but declined in size in 2022.

This kelp bed was only 1.6% of the maximum size attained in 2011 and less than 1% of maximum size in 2022 (Figure 3).

During the March 2022 vessel survey (Table 6), the Corona del Mar surface canopy was estimated at approximately 100 x 300 meters with scattered density. Tissue color was 80% dark brown and 20% medium brown, with 15% encrustation on fronds, and 25% apical meristems were observed. The kelp was composed of approximately 10% senile, 60% mature, and 30% young fronds. Subsurface kelp was limited to several individuals. During the January 2023 vessel survey (Table 7), scattered surface canopy was estimated to range over approximately 75 x 250 meters to 100 x 200 meters. Tissue color

was once again dark and medium brown, with <5% encrustation on fronds, and no apical meristems were observed. The kelp was composed of approximately 5% senile and 95% mature fronds. Subsurface kelp was observed throughout the area.

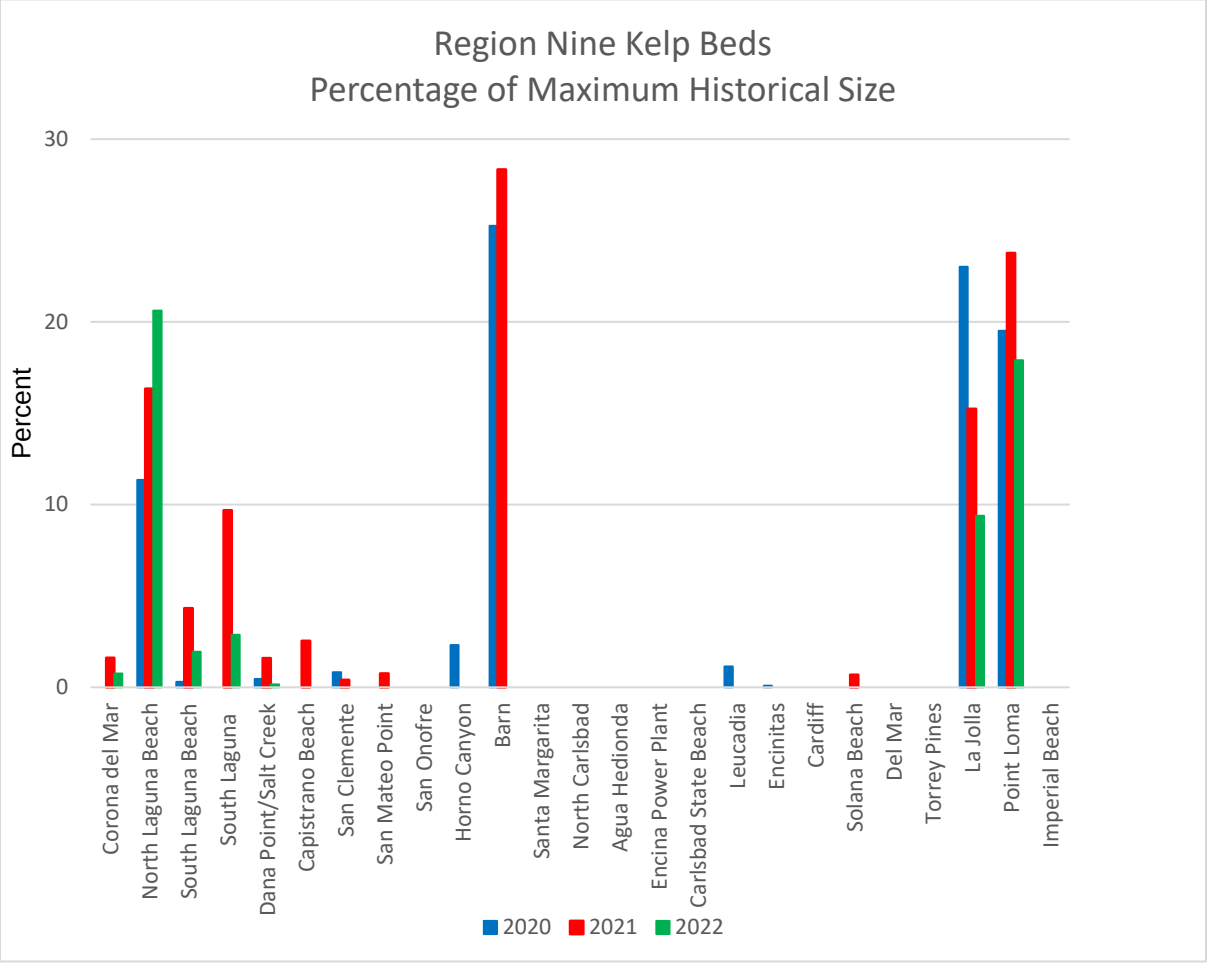


Figure 3. Region Nine kelp canopy coverage in 2020, 2021, and 2022 compared to historical maximum size of each kelp bed.

III.2.B - ABALONE POINT TO CAPISTRANO BEACH

There are five kelp beds located between Abalone Point and Capistrano Beach.

North Laguna Beach/South Laguna Beach. The North Laguna Beach kelp bed increased in size by 41%, from 0.022 km^2 in 2020 to 0.031 km^2 in 2021 (Table 5). This kelp bed increased by another 29% to 0.040 km^2 in 2022, representing an 82% increase overall from 2020 to 2022. The canopy area in 2021 was 16% of the maximum recorded in 2012 and 21% of the maximum in 2022 (Figure 3). The South Laguna Beach kelp bed increased in size by 1,100%, from 0.001 km^2 in 2020 to 0.012 km^2 in 2021 (Table 5). This kelp bed decreased in size by 58% to 0.005 km^2 in 2022, representing a 400%

increase overall from 2020 to 2022. The canopy area in 2021 was 4% of the maximum recorded in 2013 and 2% of the maximum in 2022 (Figure 3).

The North and South Laguna Beach beds were rarely visible after the early 1990s until 2008, when they were reestablished as a result of restoration efforts (Figure 4). The North Laguna Beach kelp bed was the only bed in the RNKSC to increase in size in both 2021 and 2022, while the South Laguna Beach kelp bed increased in size from 2020 to 2021 but declined from 2021 to 2022 (Table 5).

During the March 2022 vessel survey (Table 6), surface canopy was scattered in the North Laguna Beach kelp bed over an area of approximately 200 x 300 meters. Tissue color was 50% medium yellow and 50% dark yellow with 10% encrustation on fronds, and 10% apical meristems were observed. The kelp was composed of 30% senile, 50% mature and 20% young fronds. During the January 2023 vessel survey (Table 7), scattered canopy was observed over an area of approximately 200 x 200 meters. Tissue color was once again medium or dark yellow, with 20 to 25% encrustation on fronds, and very few apical meristems were observed. The kelp was composed of 40% senile, 50% mature, and 10% young fronds.

During the March 2022 dive survey offshore of the Heisler Park area, nine old holdfasts were observed on the bottom in the North Laguna Beach kelp bed, with approximately 30% juvenile fronds. The bottom was composed of rugose boulders of various sizes spaced approximately two meters apart, as well as some large piles of boulders. Kelp fronds were 20% dark yellow and 80% medium yellow in midwater and bottom areas, with approximately 10% bryozoan encrustation and 10% grazed tissues. Areas with plate rock and cobble between the boulders supported kelp and brown algae (*Laminaria*, *Pterygophora*, and *Cystoseira*). Other algae observed on the bottom included *Plocamium*, *Callophyllis*, *Fucus*, and *Corallina*. Fish observed included kelp bass, barred sandbass, garibaldi, California barracuda, blacksmith, and kelp rockfish. Four red urchins were observed along a 50-meter transect line.

During the March 2022 vessel survey (Table 6), surface canopy was scattered in the South Laguna Beach kelp bed over an area of approximately 200 x 500 meters. Tissue color was 50% medium yellow and 50% dark yellow with 10% encrustation on fronds, and 10% apical meristems were observed. The kelp was composed of 30% senile, 50% mature and 20% young fronds. During the January 2023 vessel survey (Table 7), scattered canopy was observed over a smaller area of approximately 200 x 200 meters. Tissue color was once again medium or dark yellow, with 25 to 30% encrustation on fronds, and very few apical meristems were observed. The kelp was composed of 5% senile and 95% mature fronds.

South Laguna. This kelp bed disappeared in 2019 and was absent in 2020 but reappeared in 2021 (Table 5). It decreased by 80% from 0.005 km^2 in 2021 to 0.001 km^2 in 2022.

The canopy area in 2021 was 10% of the maximum recorded in 2018 and only 3% of the maximum in 2022 (Figure 3).

Surface canopy was visible at the South Laguna kelp bed from 2007 through 2018, and in 2018 reached the maximum size recorded since RNKSC surveys began in 1983 (Appendix B.3; Figure 4). This kelp bed has been absent or very small in size for the past four years (Figure 4).

No surface canopy was observed at South Laguna during the March 2022 or January 2023 vessel surveys (Table 6 and Table 7). No subsurface kelp was observed in January 2023.

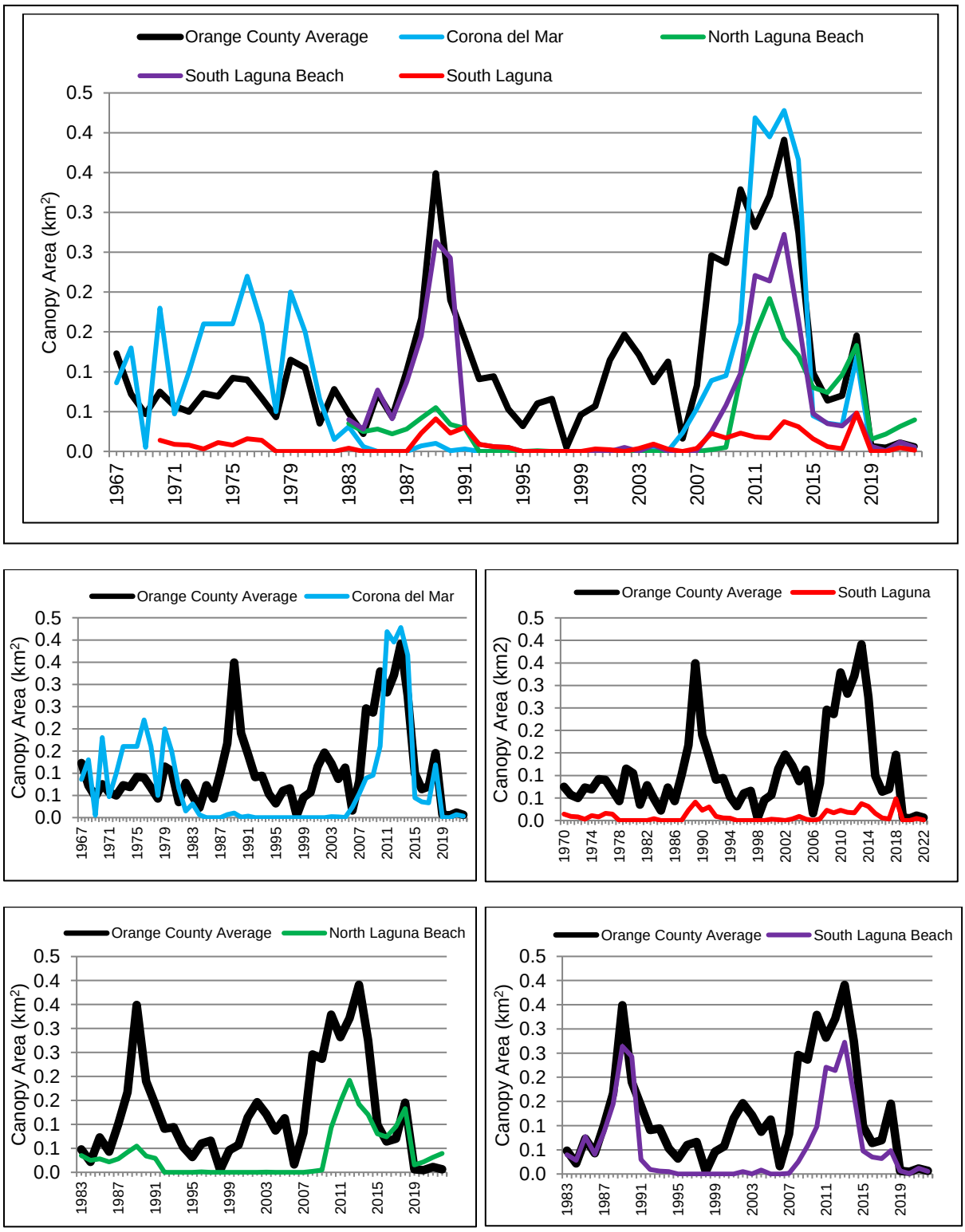


Figure 4. Average Orange County ABAPY compared to canopy coverage of the kelp beds from Corona del Mar to South Laguna from 1967 through 2022 (upper graph), and comparison of ABAPY to canopy coverage of each individual kelp bed (lower four graphs).

Table 6. Visual observations of Region Nine kelp beds for Year One vessel surveys (February 1, February 17, and March 10, 2021).

Kelp Bed	Surface Canopy		Subsurface Kelp
	Extent	Appearance	
Corona del Mar	canopy estimated at 100 x 300 meters, but scattered density	80% dark brown, 20% medium brown; 10% senile, 60% mature, 30% young; 15% encrustation; 25% apical meristems	several individuals
North Laguna Beach	surface kelp canopy estimated at 300 x 200 meters, but scattered density	50% dark yellow, 50% medium yellow; 30% senile, 50% mature, 20% young; 10% encrustation; 10% apical meristems	**See text for dive survey results**
South Laguna Beach	canopy estimated at 200 x 500 meters, but scattered kelp	50% dark yellow, 50% medium yellow; 40% senile, 50% mature, 10% young; 10% encrustation; 10% apical meristems	scattered individuals
South Laguna	none		**See text for dive survey results**
Dana Point/Salt Creek	canopy estimated at 0.25 to 1 mile, but scattered density	100% medium yellow; 10% senile, 90% mature; 30% encrustation; no apical meristems	dense kelp
Capistrano Beach	canopy estimated at 0.25 x 0.5 miles, but scattered kelp	90% dark yellow, 10% medium yellow; 50% senile, 50% mature; 40% encrustation, mostly subsurface; no apical meristems	**See text for dive survey results**
San Clemente	canopy estimated at 0.25 x 1 mile, but scattered kelp	10% dark yellow, 50% medium yellow, 40% light yellow; 90% senile, 10% mature; 40% encrustation; no apical meristems	several individuals
San Mateo Point	canopy estimated at 100 x 100 meters, but scattered kelp	10% dark yellow, 80% medium yellow, 10% light yellow; 90% senile, 10% mature; 30% encrustation; no apical meristems	several individuals
San Onofre	none		none
Pendleton Reefs	none		none
Horno Canyon	none		none
Barn Kelp	scattered canopy	80% medium yellow, 20% dark yellow; 90% senile, 10% mature; slight encrustation; no apical meristems	scattered kelp individuals, up to 40 feet tall
Santa Margarita	none		none
North Carlsbad	none		very few individuals, up to 25 feet tall

Table 6 (continued)

Kelp Bed	Surface Canopy		Subsurface Kelp
	Extent	Appearance	
Agua Hedionda	none		few scattered individuals, up to 25 feet tall
Encina Power Plant	none		none
Carlsbad State Beach	none		**See text for dive survey results**
Leucadia-north	canopy estimated at 100 x 300 meters, but very scattered kelp	70% medium yellow, 30% light yellow; 80% senile, 20% mature; 20% encrustation; no apical meristems	scattered individuals @ 20 feet tall
Leucadia-central	none		scattered individuals, up to 20 feet tall
Leucadia-south	canopy estimated at 50 x 30 meters, but scattered kelp	medium to light yellow; 30% senile, 70% mature; 40% encrustation; 10% apical meristems	Scattered individuals
Encinitas	canopy estimated at 75 x 75 meters	no observations were possible since surface canopy had been pushed below the surface by currents	**See text for dive survey results**
Cardiff	canopy estimated at 200 x 200 meters, but very scattered kelp	50% medium yellow, 50% light yellow; 80% senile, 20% mature; 80% encrustation; no apical meristems	very scattered individuals, up to 25 feet tall
Solana Beach	canopy estimated at 200 x 200 meters, but very scattered kelp	50% medium yellow, 50% light yellow; 80% senile; 20% mature; 10% encrustation; no apical meristems	very scattered individuals, up to 20 feet tall
Del Mar	none		none
Torrey Pines	none		none
La Jolla North	none		scattered subsurface kelp
La Jolla South	canopy estimated at 0.75 x 2 miles. but scattered kelp	80% dark yellow, 15% medium yellow, 5% light yellow; 15% senile, 85% mature; 40% encrustation; no apical meristems	scattered subsurface kelp
Point Loma North	canopy estimated at 0.75 x 2 miles, scattered to medium density	80% dark yellow, 10% medium yellow, 10% light yellow; 30% senile, 65% mature, 5% young; 30% encrustation; 10% apical meristems	dense subsurface kelp
Point Loma South	canopy estimated at 0.75 x 2 miles, scattered to medium density	80% dark yellow, 10% medium yellow, 10% light yellow; 20% senile, 75% mature, 5% young; 10% encrustation; 5% apical meristems	dense subsurface kelp
Imperial Beach	none		none

Table 7. Visual observations of Region Nine kelp beds for Year Two vessel surveys (December 1 and December 15, 2022, January 27 and February 2, 2023).

Kelp Bed	Surface Canopy		Subsurface Kelp
	Extent	Appearance	
Corona del Mar	canopy estimated at 100 x 200 meters to 75 x 250 meters, but scattered kelp	Dark to medium yellow; 5% senile, 95% mature; <5% encrustation; no apical meristems	present throughout area
North Laguna Beach	canopy estimated at 200 x 200 meters, but scattered kelp	Dark to medium yellow; 10% senile, 90% mature; 20-25% encrustation; very few apical meristems	present throughout area
South Laguna Beach	canopy estimated at 200 x 200 meters, but scattered kelp	dark to medium yellow; 5% senile, 95% mature; 25-30% encrustation; very few apical meristems	present throughout area
South Laguna	none		none
Dana Point/Salt Creek	canopy estimated at 100 x 30 meters, but very scattered kelp	100% dark yellow; 70% senile, 20% mature, 10% young; no encrustation; no apical meristems	**See text for dive survey results**
Capistrano Beach	none		few scattered individuals
San Clemente	none		present throughout area
San Mateo Point	none		**See text for dive survey results**
San Onofre	none		none
Pendleton Reefs	none		none
Horno Canyon	none		**See text for dive survey results**
Barn Kelp	none		**See text for dive survey results**
Santa Margarita	none		none
North Carlsbad	canopy estimated at 20 x 20 m in a single patch	80% medium brown, 20% light brown; 70% senile, 20% mature, 10% young; 40% encrustation; 10% apical meristems	several scattered kelp individuals on reef area
Agua Hedionda	none		none
Encina Power Plant	none		none
Carlsbad State Beach	none		none

Table 7 (continued)

Kelp Bed	Surface Canopy		Subsurface Kelp
	Extent	Appearance	
Leucadia-north	canopy estimated at 1,000 x 300 meters, but scattered kelp with one dense patch	70% medium brown, 30% light brown; 70% senile, 20% mature, 10% young; 30% encrustation; 10% apical meristems	scattered individuals
Leucadia-central	canopy estimated at 15 x 35 meters, but very scattered kelp	70% medium brown, 30% light brown; 70% senile, 20% mature, 10% young; 30% encrustation; 10% apical meristems	scattered individuals
Leucadia-south	canopy estimated at 30 x 70 meters, but very scattered kelp	70% medium brown, 30% light brown; 70% senile, 20% mature, 10% young; 30% encrustation; 10% apical meristems	very scattered individuals
Encinitas	canopy estimated at 500 x 300 meters, scattered kelp with some dense patches	90% medium brown, 10% light brown; 70% senile, 20% mature, 10% young; 40% encrustation; 10% apical meristems	scattered individuals
Cardiff	canopy estimated at 1,000 x 400 meters, but scattered kelp	80% medium brown, 20% light brown; 80% senile, 10% mature, 10% young; 30% encrustation; 10% apical meristems	scattered individuals
Solana Beach	canopy estimated at 200 x 200 meters, but scattered kelp	80% medium brown, 20% light brown; 70% senile; 20% mature, 10% young; 40% encrustation; 10% apical meristems	scattered individuals
Del Mar	none		none
Torrey Pines	none		none
La Jolla	canopy estimated at 3,000 x 700 meters. but very scattered kelp	80% medium brown, 20% light brown; 80% senile, 10% mature, 10% young; 10% encrustation; 10 apical meristems	present throughout area
Point Loma	canopy estimated at 8,500 x 1,000 meters, but scattered kelp	80% medium brown, 20% light brown; 90% senile, 10% mature; 10% encrustation; 10% apical meristems	dense subsurface kelp, 30-tall individuals in southern portion
Imperial Beach	none		none

During the March 2022 dive survey offshore from 1,000 Steps Beach, no kelp was observed in midwater or bottom areas. Algae on the bottom included rhodophytes, *Phyllospadix*, *Pterygophora*, *Laminaria*, and *Cystoseira*. The bottom was composed of one square meter boulders spaced approximately one meter apart, with some cobble. Fish observed included kelp bass, barred sandbass, sheepshead, senorita, California scorpionfish, and blacksmith. Urchins were present in moderate density (approximately three individuals per square meter).

Dana Point/Salt Creek. This kelp bed increased in size by 240%, from 0.005 km^2 in 2020 to 0.017 km^2 in 2021 (Table 5). It decreased in size by 88% to 0.002 km^2 in 2022, representing a 60% decrease in size overall from 2020 to 2022.

The canopy area in 2021 was only 2% of the maximum size attained in 2008, and less than 1% of the maximum in 2022 (Figure 3).

Although the Dana Point/Salt Creek kelp bed reappeared in 2020, the surface canopy area has been relatively small over the past three years (Figure 5).

During the March 2022 vessel survey (Table 6), the Dana Point/Salt Creek surface canopy was estimated to extend over an area of approximately 0.25 to 1.0 miles with scattered density. Tissue color was 100% medium yellow with 30% encrustation on fronds, and no apical meristems were observed. The kelp was composed of 10% senile and 90% mature fronds. Dense subsurface kelp was observed. During the January 2023 vessel survey (Table 7), surface canopy was much smaller, extending over an estimated area of approximately 30 x 100 meters with scattered density. Tissue color was 100% dark yellow, with no encrustation on fronds and no apical meristems. The kelp was composed of 70% senile, 20% mature, and 10% young fronds.

During the December 2022 dive survey, several old kelp holdfasts were observed on the bottom, but no recruitment of young kelp individuals was noted. Kelp fronds were medium to light yellow in midwater and bottom areas, with only slight encrustation. Approximately 50% of the tissues observed in midwater and bottom areas were grazed, and numerous *Norrisia* snails were observed on kelp. The bottom was composed of plate rock, with small boulders, cobble, sand, and small rocks in the grooves and troughs between the plates. Small numbers of red (fewer than 20 individuals) and purple (fewer than 10 individuals) were observed. Algae present on the bottom included coralline algae, rhodophytes, *Pterygophora*, *Laminaria*, *Cystoseira*, and *Egregia*. Fish observed included kelp bass, barred sandbass, sheepshead, and kelp rockfish.

No kelp was observed along the breakwaters in Dana Point Harbor (Appendix A.47) in 2021 or 2022. This is not a designated kelp bed.

Capistrano Beach. This kelp bed disappeared in 2019 and was absent in 2020 but reappeared in 2021 (Table 5). However, it disappeared once again in 2022.

Surface canopy in 2021 was only 2.5% of the maximum attained in 1989 and was absent in 2022 (Figure 3).

This kelp bed was present nearly every year from 1999 to 2018 (with the exception of 2005) but has been absent three of the past four years (Appendix B.3; Figure 5).

Scattered surface canopy was observed over an estimated area of 0.25 x 0.5 miles during the February 2022 vessel survey (Table 6). Tissue color was 10% medium yellow and 90% dark yellow with 40% encrustation, and no apical meristems were observed. The kelp was composed of 50% senile and 50% mature fronds. During the February 2022 dive survey, 13 holdfasts were observed. Tissue color was 50% light yellow and 50% medium yellow with 90% encrustation in midwater areas, and 50% medium yellow and 50% dark yellow with no encrustation in bottom areas. Recruitment was represented by one individual less than two meters tall. The bottom was composed of large, scattered boulders with smaller rocks in between. Algae included rhodophytes, *Pterygophora*, *Laminaria*, and *Cystoseira*. Fish included kelp bass, sargo, garibaldi, blacksmith, sheepshead, barred sandbass, and blackeye goby. Invertebrates included sea cucumbers and Kellet's whelk, and two purple urchins were observed. No surface canopy was observed during the December 2022 vessel survey (Table 7). A few individuals were noted in subsurface areas.

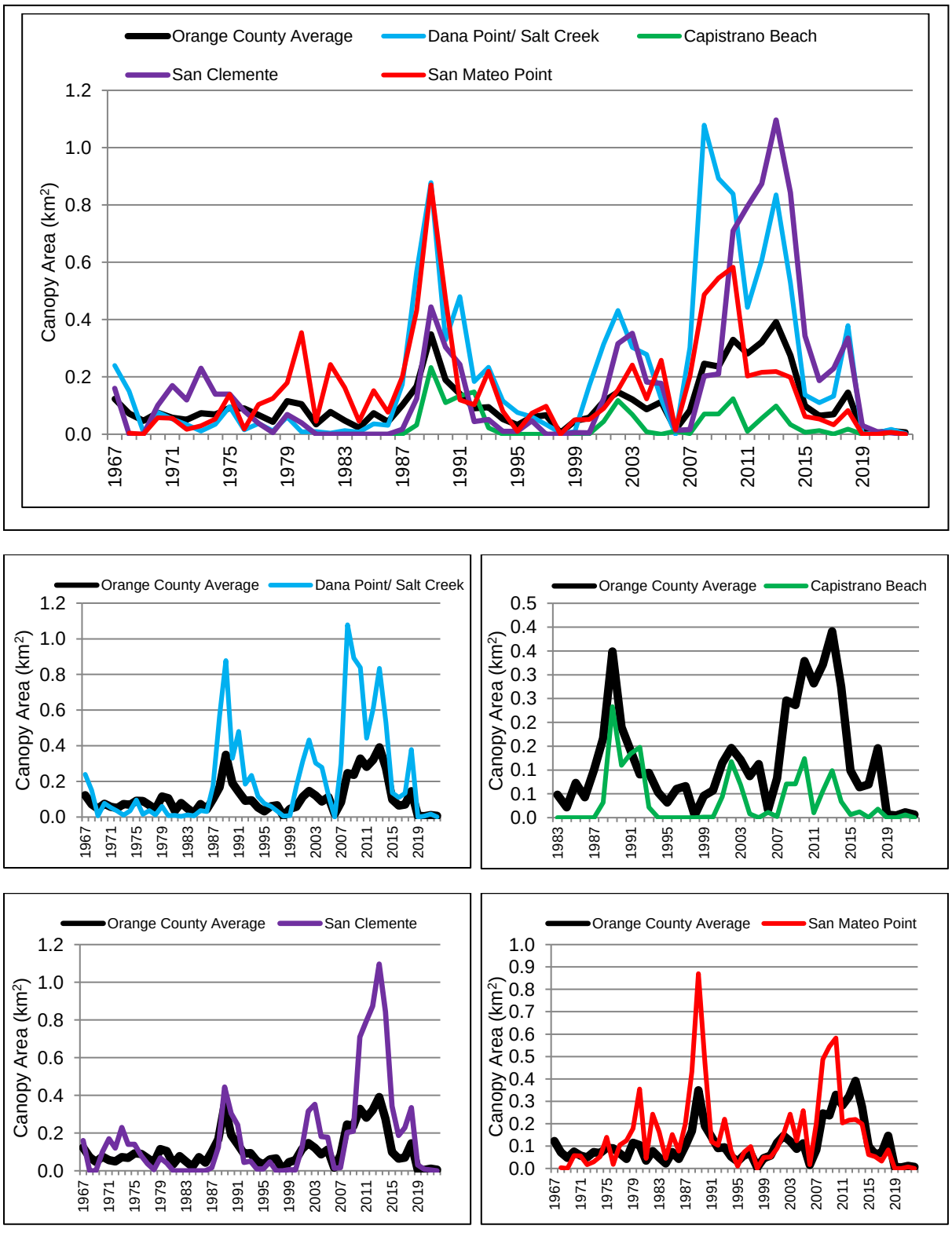


Figure 5. Average Orange County ABAPY compared to the canopy coverage of the kelp beds from Dana Point/Salt Creek to San Mateo Point from 1967 through 2022 (upper graph), and comparison of ABAPY to canopy coverage of each individual kelp bed (lower four graphs).

III.2.C - SAN CLEMENTE TO SAN ONOFRE

Three kelp beds are located between San Clemente and San Onofre.

San Clemente. This kelp bed decreased in size by 56%, from 0.009 km^2 in 2020 to 0.004 km^2 in 2021, but disappeared in 2022 (Table 5). The canopy area in 2021 was less than 1% of the maximum recorded in 2013 and disappeared in 2022 (Figure 3).

This kelp bed was present every year from 1999 to 2021; however, it was very small in 2021 and disappeared in 2022 for the first time since 1998 (Appendix B.3; Figure 5).

No surface canopy or subsurface kelp was visible at the San Clemente kelp bed during the February or December 2022 vessel surveys (Tables 6 and 7).

San Mateo Point. This kelp bed disappeared in 2020, reappeared in 2021, then disappeared once again in 2022 (Table 5). The surface canopy in 2021 was less than 1% of the maximum attained in 1987 and absent in 2022 (Figure 3).

This kelp bed was present nearly every year from 1983 to 2019 (with the exception of 1998), but was absent for two of the past three years (Appendix A.50; Figure 5).

Surface canopy was scattered over an estimated area of 100 x 100 meters during the February 2022 vessel survey (Table 6). Tissue color was 10% dark yellow, 80% medium, and 10% light yellow with approximately 30% encrustation, and no apical meristems were observed. The kelp was composed of 90% senile and 10% mature fronds. Many subsurface individuals were present.

No surface canopy was observed during the December 2022 vessel survey (Table 6). No kelp was observed in midwater or bottom areas during the December 2022 dive survey. The bottom was composed of 55% boulder, 35% cobble, and 10% sand. Coralline algae was present on the hard bottom. Ocean whitefish and barred sandbass were present, as well as 33 wavy turban snails (*Megastraea undosa*). Numerous red urchins (29) and purple urchins (29) were observed.

San Onofre. This kelp bed disappeared in 2020 and was absent in 2021 and 2022 (Table 5).

Surface canopy was observed at the San Onofre kelp bed nearly every year from 1983 to 2019 (with the exception of 2006). However, this kelp bed has been absent for the past three years (Appendix A.50; Figure 6).

No surface or subsurface kelp was observed during the February 2022 or December 2022 vessel surveys (Tables 6 and 7).

III.2.D - HORNO CANYON TO SANTA MARGARITA RIVER

Three kelp beds are located between Horno Canyon and the Santa Margarita River.

Horno Canyon. This kelp bed reappeared in 2020, but disappeared once again in 2021 and was absent in 2022 (Table 5).

Surface canopy has been observed in 15 of the past 30 years, including nearly every year from 207 to 2018 (except in 2019) (Figure 6).

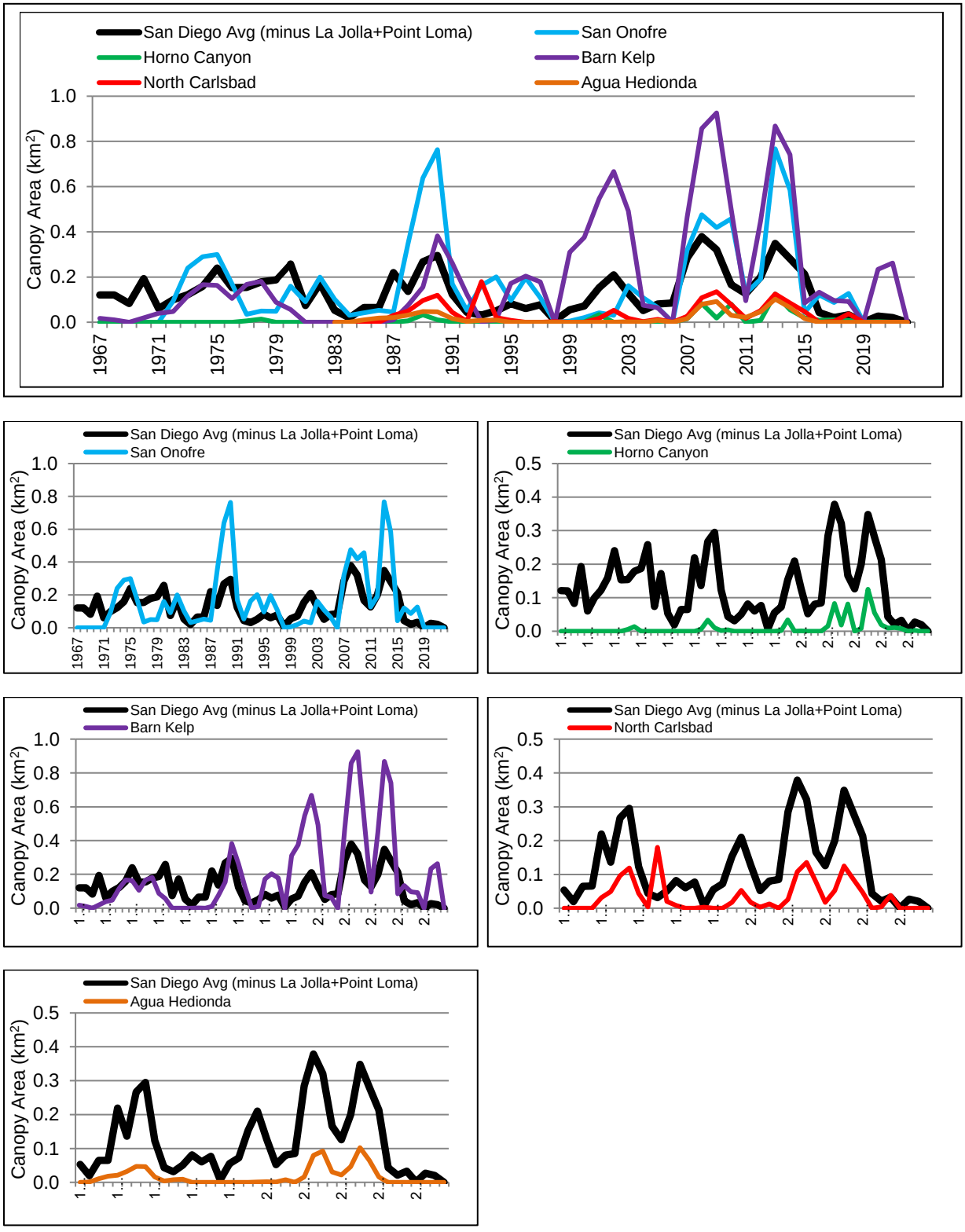


Figure 6. Comparisons between the San Diego average ABAPY and canopy coverage of the kelp beds from San Onofre to Agua Hedionda from 1967 to 2022 (upper graph), and comparison of ABAPY to canopy coverage of each individual kelp bed (lower five graphs).

No surface or subsurface canopy was visible during the February 2022 vessel survey (Table 6), nor during the December 2022 vessel survey (Table 7). During the December 2022 dive survey, seven adult and 4 sub-adult holdfasts were observed on the bottom, but no recruitment of young individuals was noted. Tissue color was 25% light yellow, 25% medium yellow, and 50% dark yellow in midwater and bottom areas, with 100% encrustation on blades in midwater and 80% in bottom areas. The bottom was composed of 10% boulder, 30% cobble, and 60% sand. Algae included rhodophytes, *Pterygophora*, *Laminaria*, and *Desmarestia*. No fish were observed. Large invertebrates included kelp crab, rock crab, decorator crab, and dove snails.

In addition, the Pendleton Artificial Reef (PAR), which is not a designated kelp bed, is just upcoast from Horno Canyon. No surface canopy or subsurface kelp was observed at this location during the vessel surveys of February 2022 or December 2022.

Barn Kelp. This kelp bed increased in size by 12%, from 0.234 km^2 in 2020 to 0.262 km^2 in 2021, then disappeared in 2022 (Table 5). The surface canopy in 2021 was 28% of the maximum attained in 2009 and absent in 2022 (Figure 3).

Surface canopy has been observed at this kelp bed most years from 1988 to 2021 (with the exception of 1998, 2016, and 2019) (Figure 6).

Scattered surface canopy was observed during the February 2022 vessel survey (Table 6). Tissue color was 80% medium yellow and 20% dark yellow with slight encrustation on fronds, with no apical meristems observed. The kelp bed was composed of 90% senile and 10% mature fronds. Scattered individuals were noted on the bottom.

No surface canopy was observed during the December 2022 vessel survey (Table 7). During the December 2022 dive survey, several kelp holdfasts were observed on the bottom, but no recruitment of young kelp individuals was noted. Kelp fronds were 50% medium and 50% dark yellow in midwater and bottom areas, with 50% encrustation (including 10% with bryozoans). The bottom was composed of 45% plate rock, 3% boulders, 20% cobble, and 5% sand. Red and purple urchins were observed under plate rocks. Algae present on the bottom included coralline algae, rhodophytes, *Pterygophora*, *Laminaria*, and *Chondracan*. Fish observed included kelp bass, barred sandbass, blacksmith, sheepshead, ocean whitefish, garibaldi, senorita, painted greenling, giant sea bass, halfmoon, rock wrasse, black perch, and black-eyed goby. Large invertebrates included gorgonians, stalked tunicates, spiny lobster, Kellet's whelk, wavy turban snail, Norris's kelp snail, two-spot octopus, and giant keyhole limpet.

Santa Margarita. This kelp bed was not observed during 2019 and has been absent since (Table 5).

The Santa Margarita kelp bed is a small bed that occasionally forms a canopy off the Santa Margarita River mouth (Appendix A.56). However, surface canopy has only been observed during three years since 1983 (1991, 1992, and 2013) (Appendix B.3).

No surface canopy or subsurface kelp was visible at Santa Margarita during the February 2022 or February 2023 vessel surveys (Tables 6 and 7).

No kelp was observed in Oceanside Harbor (Appendix A.57; Table 3) in 2021 or 2022. This is not a designated kelp bed.

III.2.E - NORTH CARLSBAD TO CARLSBAD STATE BEACH

There are four kelp beds located between North Carlsbad and Carlsbad State Beach.

North Carlsbad. This kelp bed disappeared in 2019 and has been absent since (Table 5).

The North Carlsbad kelp bed usually comprises of several small beds (Appendices A.58 and A.59). Visible surface canopy had been recorded nearly every year from 2001 to 2018 (with the exception of 2006 and 2016), but has been absent for the past four years (Figure 6).

During the February 2022 vessel survey (Table 6), no surface canopy was observed at the North Carlsbad kelp bed, but a few scattered kelp individuals (up to 25-feet tall) were recorded in subsurface areas. During the February 2023 vessel survey (Table 7), a single small patch of surface canopy (approximately 20 x 20 meters) was observed, as well as several scattered individuals on subsurface reef areas.

Agua Hedionda. This kelp bed was not observed in 2019 and has been absent since (Table 5).

Visible surface canopy was observed at the Agua Hedionda kelp bed from 2002 through 2015 (Figure 6). However, no surface canopy has been recorded since 2016.

No surface canopy was observed at the Agua Hedionda kelp bed during the February 2022 vessel survey, but a few scattered individuals up to 25 feet tall were noted in subsurface areas (Table 6). No surface or subsurface kelp was observed during the February 2023 vessel survey (Table 7).

Encina Power Plant. This kelp bed disappeared in 2019 and has been absent since (Table 5).

The Encina Power Plant kelp bed was much smaller in size from 2016 to 2018 compared to the period from 2007 to 2015, and finally disappeared in 2019 (Appendix A.60, Figure 7).

No surface canopy or subsurface kelp was observed at the Encina Power Plant kelp bed during the February 2022 or February 2023 vessel surveys (Tables 6 and 7).

Carlsbad State Beach. This kelp bed was not observed in 2019 and has been absent since (Table 5).

The Carlsbad State Beach (Carlsbad State Park) kelp bed was present nearly every year from 2007 to 2015 (with the exception of 2016), but disappeared in 2018 and has been absent since (Figure 7).

No surface canopy was observed at the Carlsbad State Beach kelp bed during the February 2022 vessel survey (Table 6). No subsurface kelp was observed during the February 2022 dive survey. The bottom was composed of soft rock reef, as well as some patches of sandstone covered with sand. Algae observed included rhodophytes, *Corallina*, *Pterygophora*, *Egregia*, and *Cystoseira*. Fish observed included kelp bass and sheepshead. Three purple urchins were observed.

No surface or subsurface kelp was observed during the February 2023 vessel survey (Table 7).

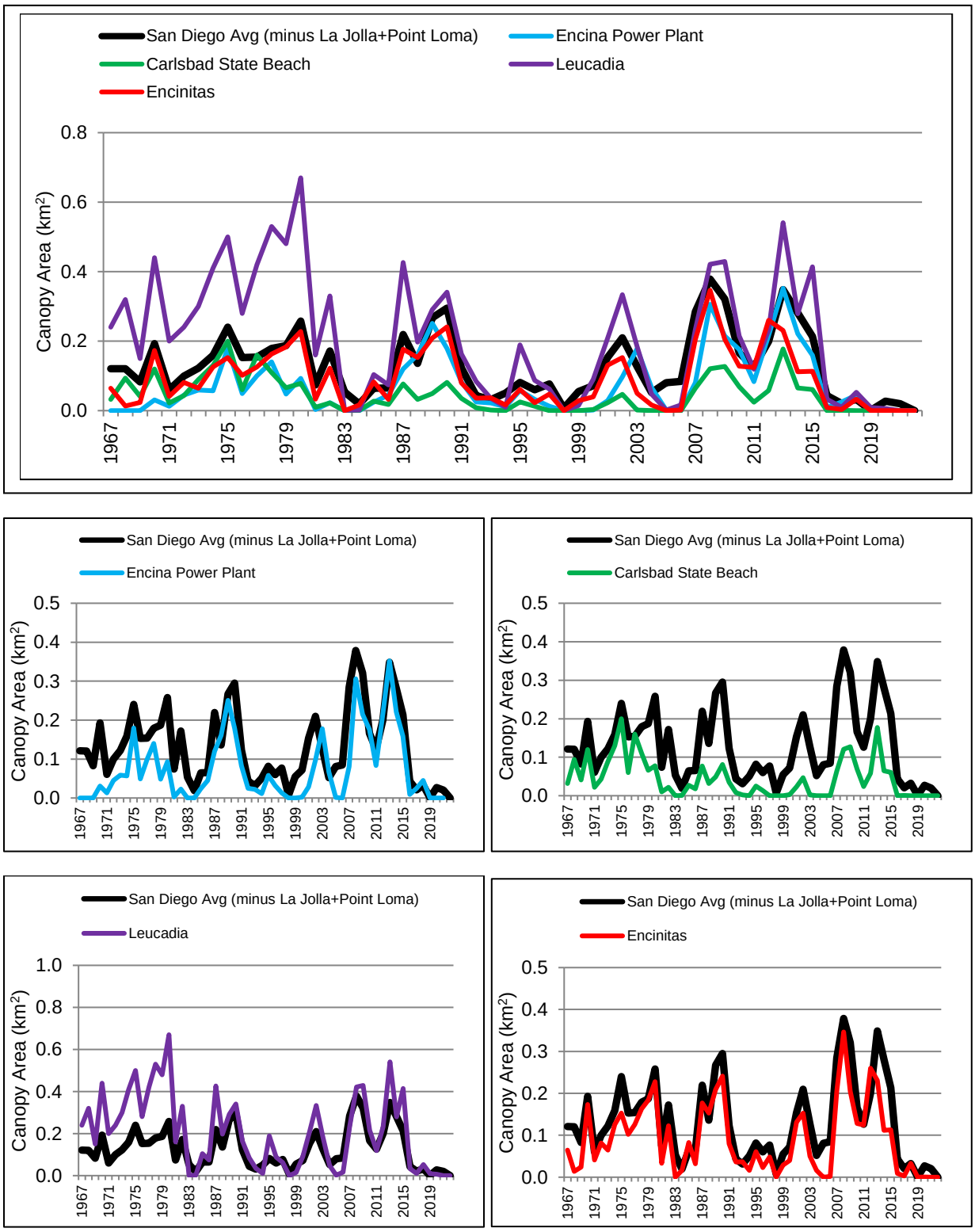


Figure 7. Comparisons between the San Diego average ABAPY and canopy coverage of the kelp beds from Encina Power Plant to Encinitas from 1967 to 2022 (upper graph), and comparison of ABAPY to canopy coverage of each individual kelp bed (lower four graphs).

III.2.F - LEUCADIA TO TORREY PINES

Leucadia. This kelp bed disappeared in 2021 and was absent in 2022 (Table 5).

The Leucadia kelp bed comprises the North, Central, and South Leucadia kelp beds, which are surveyed as three separate beds because of distinct breaks in the beds (Appendices A.62 and A.63). Surface canopy was observed in this kelp bed nearly every year from 1983 to 2020 (with the exception of 1998), but it has been absent the past two years (Figure 7).

Scattered surface canopy was observed over a 100 x 300 meter area of the North Leucadia kelp bed in February 2022 (Table 6). Tissue color was 30% light yellow and 70% medium yellow, the kelp was composed of 80% senile and 20% mature fronds with 20% encrustation, and no apical meristems were observed (Table 6). Scattered individuals up to 20 feet tall were observed in subsurface areas. Scattered surface canopy with some dense patches was observed over a larger area of 300 x 1,000 meters in February 2023 (Table 7). Tissue color was 30% light brown and 70% medium brown, the kelp was composed of 70% senile, 20% mature and 10% young fronds with 30% encrustation, and 10% apical meristems were observed. Scattered individuals were observed in subsurface areas.

No surface canopy was observed in the Central Leucadia kelp bed during the February 2022 vessel survey, but a few scattered individuals up to 20 feet tall were observed in subsurface areas. Very scattered surface canopy was observed over a smaller area of 15 m x 35 meters in February 2023 (Table 7). A few scattered individuals were observed in subsurface areas.

Scattered surface canopy was observed over a 30 x 50 meter area of the South Leucadia kelp bed during the February 2022 vessel survey (Table 6). Tissue color was light to medium yellow, the kelp was composed of 30% senile and 70% mature fronds with 40 % encrustation, and 10% apical meristems were observed. A few scattered individuals were observed in subsurface areas. During the February 2023 vessel survey, scattered surface canopy was observed over a slightly larger area of 30 x 70 meters (Table 7). Once again, only a few scattered individuals were observed in subsurface areas.

Encinitas. This kelp bed reappeared in 2020 but disappeared once again in 2021 and was absent in 2022 (Table 5).

Surface canopy has been observed in this kelp bed most years from 1984 to 2020 (with the exception of 1998, 2005, and 2019), but it was absent the past two years (Figure 7).

During the February 2022 vessel survey, no actual surface canopy was observed at the Encinitas kelp bed; however, it appeared that kelp estimated to extend over an area of 75 x 75 meters had been pushed just below the surface by currents (Table 6).

During the February 2022 dive survey six kelp individuals were observed on the bottom in the Encinitas kelp bed and some juvenile fronds were present. Tissue color was light to medium yellow with approximately 20% encrustation. No recruitment of new kelp was noted. The bottom was composed of solid rock, as well as some large piles of boulders. Kelp fronds were light to medium yellow in midwater and bottom areas, with approximately 50% encrustation in midwater areas and 20% in bottom areas and 20% grazed tissues. Algae observed included rhodophytes, *Corallina*, *Laminaria*, *Pterygophora*, and *Cystoseira*; feather boa kelp and golden gorgonians were also present. Fish observed included kelp bass and sheepshead. No urchins were observed.

Scattered surface canopy with some dense patches was observed over a larger area of 300 x 500 meters during the February 2023 vessel survey (Table 7). Tissue color was 10% light and 90% medium brown, the kelp was composed of 70% senile, 20% mature, and 10% young fronds with 40% encrustation, and 10% apical meristems were observed.

Cardiff. This kelp bed disappeared in 2019 and has been absent since (Table 5).

The Cardiff kelp bed was relatively large from 2007 to 2015 but declined in size considerably during the period from 2016 to 2018 and finally disappeared in 2019 (Appendix A.64; Figure 8).

Very scattered surface canopy was estimated to extend over an area of approximately 200 x 200 meters during the February 2022 vessel survey (Table 6). Tissue color was 50% light yellow and 50% dark yellow with 80% encrustation. The kelp was composed of 80% senile and 20% mature fronds. A few, very scattered individuals up to 20 feet tall were noted on the bottom. The scattered surface canopy covered a larger area of approximately 1,000 x 400 meters during the February 2023 vessel survey (Table 7). Tissue color was 20% light brown and 80% medium brown with 40% encrustation, and 10% apical meristems were observed. The kelp was composed of 80% senile, 10% mature, and 10% young fronds. A few scattered individuals were noted on the bottom.

Solana Beach. This kelp bed that disappeared in 2019 and was still absent in 2020, but reappeared in 2021, then disappeared once again in 2022 (Table 5).

The Solana Beach kelp bed was present every year from 1984 to 2018 but has been absent in three of the four years since (Appendices A.64 and A.65; Figure 8).

Very scattered surface canopy was observed at the Solana Beach kelp bed during the February 2022 vessel survey, covering an estimated area of 200 x 200 meters (Table 6). Kelp fronds were 50% light yellow and 50% medium yellow with 10% encrustation, and no apical meristems were observed. Kelp fronds were 80% senile and 20% mature. A few scattered individuals up to 20 feet tall were noted on the bottom. Scattered surface canopy was observed over approximately 200 x 200 meters during the vessel survey of February 2023 (Table 7). Kelp fronds were 20% light brown and 80% medium brown with 40% encrustation, and 10% apical meristems were observed. Kelp fronds were 70% senile, 20% mature, and 10% young. A few scattered individuals up to 20 feet tall were noted on the bottom.

Del Mar. This kelp bed was not observed in 2019 and has been absent since (Table 5).

The Del Mar kelp bed (Appendices A.66 and A.67) is typically one of the smallest beds in Region Nine. Surface canopy was present each year from 2007 to 2015, but this kelp bed disappeared in 2016 and has been absent since (Appendices A.66 and A.67; Figure 8).

No surface canopy or subsurface kelp was observed at the Del Mar kelp bed during the February 2022 or February 2023 vessel surveys (Tables 6 and 7).

Torrey Pines. This kelp bed was not observed in 2019 and has been absent since (Table 5).

The Torrey Pines kelp bed appeared as a small trace of kelp during La Niña conditions in 1988 and 1989. It reappeared in 2006 with a canopy area of 0.010 km^2 with scattered giant kelp concentrations approximately 1.5 km, 3.5 km, and 5 km north of Scripps Pier. Small canopies were observed in various locations in the area from 2008 through 2013, but this bed disappeared in 2014 and has been absent since (Appendix B.3). No surface canopy or subsurface kelp was visible during the February 2022 or February 2023 vessel surveys (Tables 6 and 7).

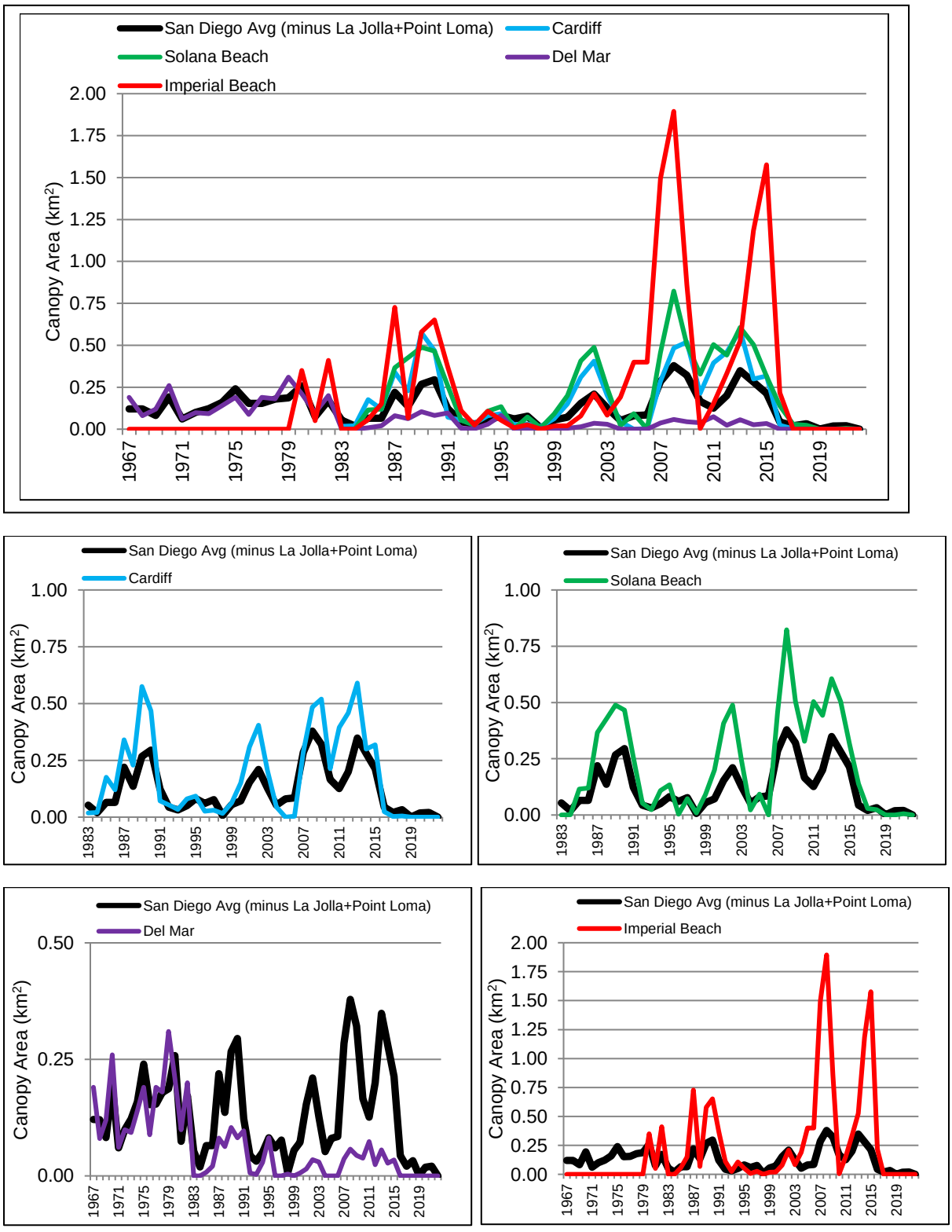


Figure 8. Comparisons between the San Diego average ABAPY and canopy coverage of the kelp beds from Cardiff to Imperial Beach from 1967 to 2022 (upper graph), and comparison of ABAPY to canopy coverage of each individual kelp bed (lower four graphs).

III.2.G - LA JOLLA

La Jolla. This kelp bed decreased in size by 34%, from 1.094 km^2 in 2020 to 0.725 km^2 in 2021; it decreased by another 28% to 0.446 km^2 in 2022, representing an overall decrease of 59% from 2020 to 2022 (Table 5). The canopy area in 2021 was 15% of the maximum recorded in 1989 and 9% of the maximum in 2022 (Figure 3).

The La Jolla kelp bed is composed of two canopies: northern La Jolla and southern La Jolla. Between southern La Jolla and Upper Point Loma (offshore Mission Bay), nearshore habitat is mostly sand and kelp does not grow in this area (Appendices A.70 and A.71). The La Jolla kelp bed was much smaller from 2016 through 2022 (ranging in size from 0.446 km^2 to 1.566 km^2) than the levels observed from 2013 to 2015 (2.790 km^2 to 4.006 km^2) (Figure 9). This kelp bed has decreased in size each year since 2018.

No surface canopy was observed at the La Jolla North kelp bed during the February 2022 vessel survey (Table 6). However, scattered subsurface kelp was present. Scattered surface canopy was observed at the La Jolla South kelp bed over an estimated area of 0.75 x 2 miles. Tissue color was 5% light yellow, 15% medium yellow, and 80% dark yellow with 40% encrustation, and no apical meristems were observed. The kelp bed was composed of 15% senile and 85% mature fronds. Subsurface kelp was noted throughout the area.

Very scattered surface canopy was observed in the La Jolla kelp beds during the vessel survey of February 2023, covering an estimated area of 700 x 3,000 meters (Table 7). Tissue color was 20% light brown and 80% dark brown with 10% encrustation, and 10% apical meristems were observed. The kelp bed was composed of 80% senile, 10% mature, and 10% young fronds. Subsurface kelp was noted throughout the area.

III.2.H - POINT LOMA TO CORONADO BEACH

Point Loma. This kelp bed decreased in size by 26%, from 2.545 km^2 in 2020 to 1.882 km^2 in 2021; it decreased by another 25% to 1.417 km^2 in 2022, representing an overall decrease of 44% from 2020 to 2022 (Table 5). The canopy area in 2021 was 24% of the maximum recorded in 2018 and 18% of the maximum in 2022 (Figure 3).

The Point Loma kelp bed comprises many, usually contiguous, kelp canopies ranging from depths of 5 to greater than 30 meters during years with sufficient nutrients. *Pelagophycus porra* is prevalent beyond about 30 meters depth at Point Loma (Turner et al. 1967). It is the largest bed in Region Nine. Although the maximum canopy area was recorded in 2018 (7.9 km^2), this kelp bed has decreased in size every year since, reaching the smallest size in 2022 (1.4 km^2) that has been recorded since 1998 (Appendices A.71 through A.74; Figure 9).

Scattered to medium density surface canopy was observed over an area approximately 0.75 x 2 miles at both the Point Loma North and South kelp beds during the February 2022 vessel survey (Table 6). Tissue color was 10% light yellow, 10% medium yellow, and 80% dark yellow with 10 to 30% encrustation, and 5 to 10% apical meristems were observed. Dense subsurface kelp was noted throughout both areas. Scattered surface canopy was observed over an area of approximately 1,000 x 8,500 meters in the Point Loma kelp bed during the February 2023 vessel survey (Table 7). Tissue color was 20% light brown and 80% medium brown with 10% encrustation, and 10% apical meristems were observed. Subsurface kelp was noted throughout both areas.

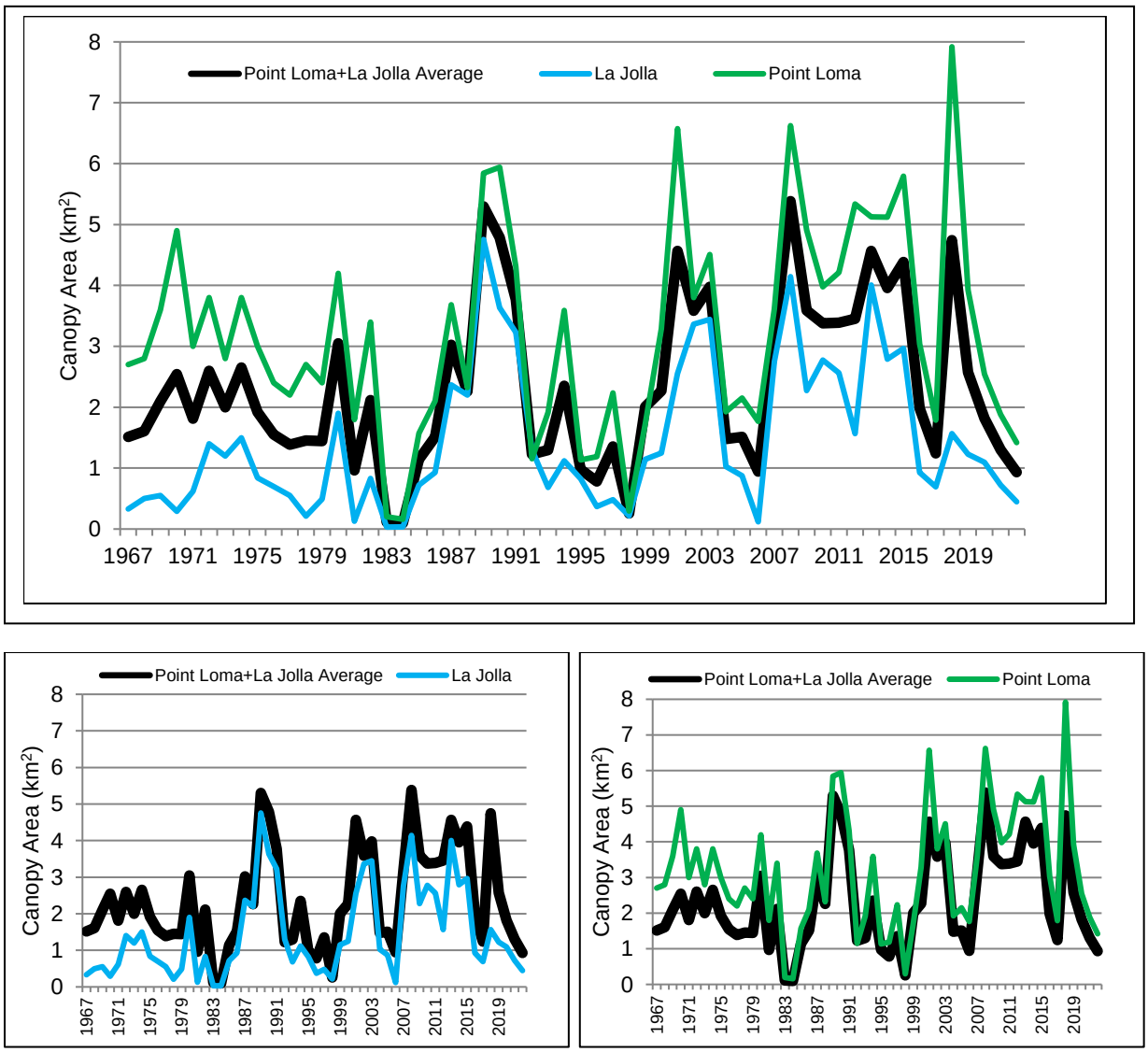


Figure 9. Comparisons between the Point Loma/La Jolla Average ABAPY and canopy coverage of the La Jolla and Point Loma kelp beds from 1967 to 2022 (upper graph), and comparison of ABAPY to canopy coverage of each individual kelp bed (lower two graphs).

III.2.I - CORONADO BEACH TO U.S./MEXICO BORDER

No kelp was observed at Coronado Beach (Appendix A.76) or Silver Strand (Appendix A.77) in 2021 or 2022; neither are designated kelp beds.

Imperial Beach. This kelp bed was not observed in 2019 and has been absent since (Table 5).

The Imperial Beach kelp bed was present nearly every year from 1985 to 2016 (with the exception of 1998) but disappeared in 2017 and has been absent since (Appendices A.79 and A.80; Figure 8). No surface or subsurface kelp was visible at the Imperial Beach kelp bed during the February 2022 or February 2023 vessel surveys (Tables 6 and 7).

IV - DISCUSSION

IV.1 - REGION NINE KELP BEDS

One objective of the RNKSC program is to answer several basic monitoring questions regarding the status of kelp beds within the region:

1. What is the maximum areal extent of the coastal kelp bed canopy each year?

- The total kelp canopy covered 3.0 km^2 in 2021 and 1.9 km^2 in 2022.

2. What is the variability of the coastal kelp bed canopy over time?

- The total kelp canopy decreased in size in 2021 by 23% (from 3.9 km^2 to 3.0 km^2) and by an additional 37% in 2022 (from 3.0 km^2 to 1.9 km^2), representing an overall decrease in size of 51% from 2020 to 2022;
- Four kelp beds with visible surface canopy in 2020 increased in size in 2021 and one kelp bed with visible surface canopy in 2021 increased in size in 2022;
- Three kelp beds with visible surface canopy present in 2020 decreased in size in 2021 and five kelp beds with visible surface canopy in 2021 decreased in size in 2022.

3. Are coastal kelp beds disappearing? If yes, what are the factors that could contribute to the disappearance?

- Three kelp beds disappeared in 2021 and five kelp beds disappeared in 2022;
- Nine kelp beds that displayed no surface canopy in 2020 were still absent in 2021 and 2022.
- Above average sea surface temperatures and low nutrient availability may have contributed to the absence of surface canopy at these kelp beds.

4. Are new kelp beds forming?

- Four kelp beds reappeared in 2021; no additional kelp beds reappeared in 2022.

The total kelp canopy in Region Nine covered approximately 3.0 km^2 in 2021 and 1.9 km^2 in 2022. The total kelp canopy was smaller in size than the long-term average in six of the past seven years, following nine years (2007 through 2015) with above average total kelp (Figure 10). The largest kelp beds were the La Jolla and Point Loma kelp beds, which accounted for 88 % of the total canopy coverage in 2021 and 97% in 2022. Only two kelp beds in 2022 were greater than 10% of the maximum extent recorded since 1983: North Laguna Beach at 21% of maximum and Point Loma at 18% (Figure 3).

Vessel surveys of all Region Nine kelp beds for 2021 were conducted during the following year due to weather delays (February 1 and 17, and March 20, 2022). Vessel surveys for 2022 were conducted partly at the end of the year (December 1 and 15, 2022) and partly during the following year due to weather delays (January 27 and February 2, 2023). Surface canopy was observed at approximately half of the kelp beds (Tables 6 and 7). Subsurface kelp was also recorded at many of these kelp bed locations, as well as at a few kelp beds without any visible surface canopy.

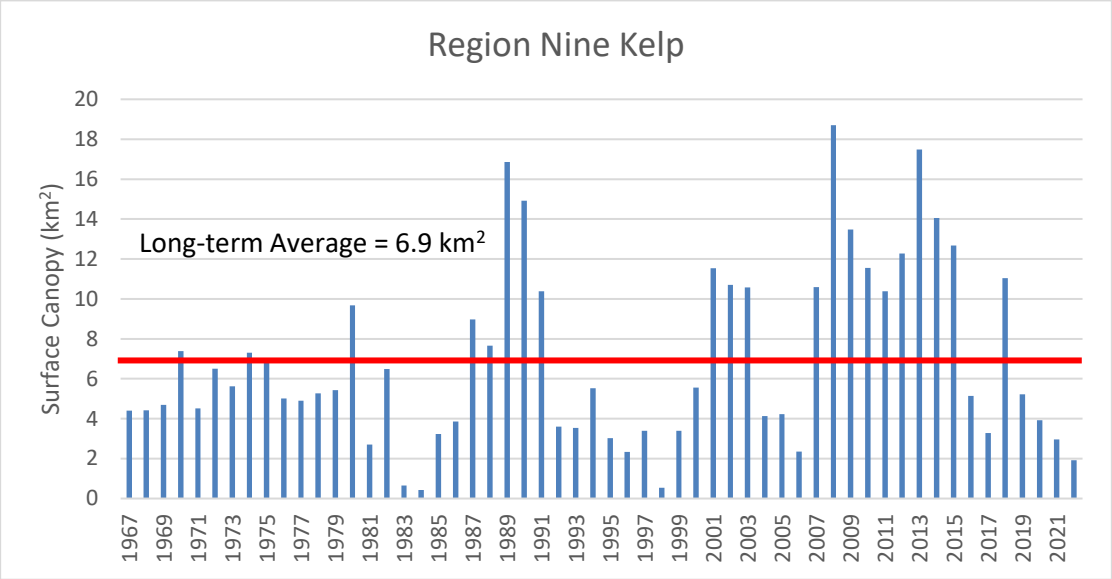


Figure 10. Combined canopy coverage of all kelp beds off Orange and San Diego Counties from 1967 through 2022.

IV.2 – ENVIRONMENTAL VARIABLES

The productivity and growth of giant kelp forests along the west coast of the United States has been shown to be limited by dissolved inorganic nitrogen, mainly in the form of nitrate (Wheeler and North, 1980; Zimmerman and Kremer, 1984). In the upper ocean (depths less than 200 meters), nitrate concentrations were strongly dependent on density and temperature (Kamykowski and Zentara, 1986). However, temperature apparently accounted for less than half of the variability in canopy area or density of giant kelp within the California Current System (CCS) (North et al, 1993; Tegner et al, 1996). Seawater density has been shown to predict nitrate concentrations in nearshore southern California ocean waters better than temperature and has been utilized to identify the relative contributions of nitrate concentrations within the CCS from different source waters, primarily including subarctic water, upwelled undercurrent water, subtropical water, and surface runoff (Lynn and Simpson, 1987; Parnell et al, 2010).

IV.2.A - WATER TEMPERATURE

Sea surface temperature (SST) data are discussed below and have been used as a proxy for nutrient availability (water temperature is inversely related to nutrient availability). Although there appears to be good evidence that seawater density also can be used as a proxy, and in some cases, may predict nutrient availability better than temperature (Parnell et al 2010), long-term measurements of density were not available for broad areas of Region Nine. In contrast, nearshore temperature measurements have been ongoing for decades, resulting in readily accessible data sets.

Table 8. Canopy coverage (km^2) of the kelp beds from Laguna Beach to Imperial Beach (kelp beds listed from north to south) from 2013 through 2022.

Kelp Bed	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
N Laguna Beach	0.142	0.120	0.080	0.074	0.096	0.133	0.015	0.022	0.031	0.040
S Laguna Beach	0.273	0.165	0.048	0.035	0.032	0.131	0.007	0.001	0.012	0.005
South Laguna	0.038	0.031	0.016	0.006	0.003	0.048	-	-	0.005	0.001
Dana Pt/Salt Creek	0.835	0.528	0.137	0.110	0.133	0.379	-	0.005	0.017	0.002
Capistrano Beach	0.099	0.034	0.007	0.012	0.0004	0.018	-	-	0.006	-
Total F&W 9	**1.385**	**0.879**	**0.287**	**0.237**	**0.264**	**0.709**	**0.022**	**0.028**	**0.071**	**0.048**
San Clemente	1.097	0.843	0.343	0.187	0.229	0.335	0.031	0.009	0.004	-
San Mateo Point	0.219	0.199	0.062	0.053	0.033	0.083	0.0001	-	0.007	-
San Onofre	0.767	0.584	0.043	0.120	0.087	0.127	0.001	-	-	-
Total F&W 8	**2.083**	**1.627**	**0.449**	**0.359**	**0.349**	**0.545**	**0.032**	**0.009**	**0.011**	**0.000**
Horno Canyon	0.125	0.055	0.019	0.010	0.011	0.008	-	0.003	-	-
Barn Kelp	0.868	0.741	0.085	0.133	0.096	0.092	-	0.234	0.262	-
Santa Margarita	0.080	-	-	-	-	-	-	-	-	-
Total F&W 7	**1.073**	**0.795**	**0.104**	**0.143**	**0.107**	**0.100**	**0.000**	**0.237**	**0.262**	**0.000**
North Carlsbad	0.125	0.086	0.047	-	0.004	0.038	-	-	-	-
Agua Hedionda	0.102	0.065	0.016	-	-	-	-	-	-	-
Encina Power Plant	0.352	0.221	0.159	0.009	0.025	0.045	-	-	-	-
Carlsbad State Bch	0.178	0.065	0.061	-	0.001	-	-	-	-	-
Total F&W 6	**0.757**	**0.437**	**0.282**	**0.009**	**0.031**	**0.083**	**0.000**	**0.000**	**0.000**	**0.000**
Leucadia	0.541	0.279	0.414	0.033	0.010	0.053	0.009	0.006	-	-
Encinitas	0.231	0.112	0.113	0.009	0.003	0.033	-	0.0003	-	-
Cardiff	0.590	0.299	0.318	0.024	0.003	0.005	-	-	-	-
Solana Beach	0.606	0.504	0.316	0.138	0.029	0.024	-	-	0.006	-
Del Mar	0.056	0.027	0.034	-	-	-	-	-	-	-
Torrey Pines	0.081	-	-	-	-	-	-	-	-	-
Total F&W 5	**2.106**	**1.221**	**1.195**	**0.204**	**0.045**	**0.114**	**0.009**	**0.006**	**0.006**	**0.000**
La Jolla F&W 4	**4.006**	**2.790**	**2.968**	**0.927**	**0.694**	**1.566**	**1.227**	**1.094**	**0.725**	**0.446**
Point Loma F&W 3&2	**5.127**	**5.121**	**5.806**	**3.037**	**1.787**	**7.920**	**3.924**	**2.545**	**1.882**	**1.417**
Imperial Beach F&W 1	**0.526**	**1.183**	**1.576**	**0.217**	**-**	**-**	**-**	**-**	**-**	**-**
TOTAL	**17.064**	**14.053**	**12.667**	**5.134**	**3.277**	**11.037**	**5.213**	**3.919**	**2.964**	**1.911**

Red denotes warm-water years, **blue** denotes cold-water years, and neutral years are in **black**

"-" = no canopy area

Oceanographic data from shore stations, data buoys, and thermistor strings were used to determine potential effects on kelp bed extent during the study year. These data sources included:

- Data from automated shore stations at Newport Pier and Scripps Pier. At these locations, automated samplers measured conductivity, water temperature, and fluorometry at a frequency of one to four minutes. Samplers were mounted at a depth of two meters MLLW at Newport Pier, and at five meters MLLW at Scripps Pier. These data were made available in real time via the Southern California Coastal Ocean Observation System (SCCOOS) website (www.sccoos.org).

- Data from the National Data Buoy Center (NDBC) for Oceanside and Point Loma South were available in real time via the NDBC website (www.ndbc.noaa.gov). These data buoys recorded water temperature, and wave height, period, and direction at least every 30 minutes (frequency varies for each buoy) from approximately one meter below the waterline.

- Data provided by the City of San Diego's Ocean Monitoring Program from a thermistor string approximately 3.8 kilometers west-northwest of Point Loma in 60 meters of water (City of San Diego 2023). Sensors recorded water temperature at four-meter intervals from near the sea surface to a depth of 54 meters MLLW.

- Data provided by the Orange County Sanitation District from a monitoring station offshore of the Orange County coastline (Station 2106) in 75 meters of water (Orange County Sanitation District, 2023). Sensors recorded water temperature at five-meter intervals from the sea surface to near the bottom (a depth of 75 meters MLLW).

SSTs for 2021 and 2022 from Newport Pier, Oceanside, Scripps Pier, and Point Loma South, as well as the Scripps Pier long-term harmonic mean, are presented in Figure 11. Graphs of SST values at each of these individual locations are presented in Appendix E.

In 2021, SST values were usually warmer than average during January and February, as well as during November and December (Figure 11). Below average SST values were recorded at times from March through October, but much warmer than average SST values were also often observed during these months. The highest surface water temperatures were recorded in July, August, and September 2021. In 2022, SST values were warmer than average for nearly all of January, February, and March, as well as the first half of April (Figure 11). Below average SST values were recorded at times from March through December, but much warmer than average SST values were also often observed during these months. The warmest surface water temperatures were recorded in July, August, and September, with higher maximum temperatures in 2022 than in 2021 during these months.

Daily SST values rarely fell below 14^{o}C, below which nutrient availability is favorable for kelp forest growth (Leichter et al., 2023), at Newport Pier in 2021 (only a few occasions in March) and not at all in 2022. At Scripps Pier, daily SST values were below this threshold occasionally in January (four times), February (one time), March (two times), and April (three times) in 2021, as well as occasionally in March (one time) and April (three times) in 2022. Daily SST values did not fall below this threshold at Oceanside or Point Loma at any time during 2021 or 2022.

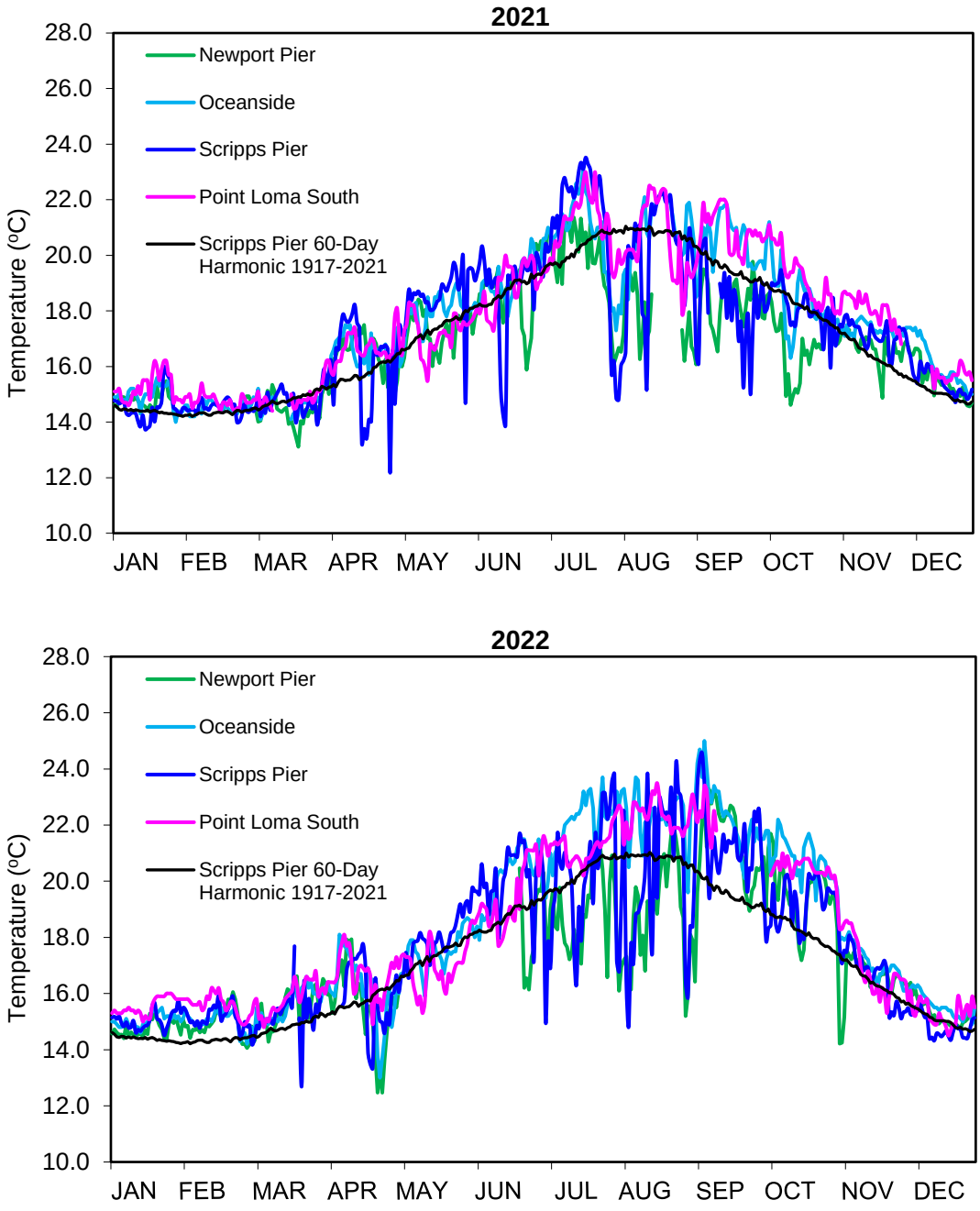


Figure 11. Daily sea surface temperatures (SSTs) at Newport Pier, Oceanside, Scripps Pier, and Point Loma South for 2021 with the long-term harmonic mean for Scripps Pier SIO 60-Day Harmonic calculated from 1917 through 2021, and for 2022 with the long-term harmonic mean for Scripps Pier 60-day harmonic calculated from 1917 through 2022).

Source: Southern California Coastal Ocean Observation System (SCCOOS) (www.sccoos.org) and National Data Buoy Center (NDBC) (www.ndbc.noaa.gov).

Temperature monitoring was accomplished via a thermistor string deployed off Point Loma in 2021 (data were missing in January and from late July through mid-September) and 2022 (data available from March through December only from a depth of approximately 45 meters to 60 meters, and no data available from October through December). In 2021, subsurface water temperatures (greater than 10 meters depth) were often less than 14ºC from February through July (and often colder), and often below 14ºC at depths of 20 to 30 meters from mid-September through December (Figure 12). Water temperatures were often warmer than 17ºC at depths shallower than 10 to 20 meters from May through mid-July and from mid-September through November 2021, as well as in January and February 2022.

Water temperatures offshore of the Orange County coastline at Station 2106 were nearly always warm (above 14ºC) from the surface down to a depth of 15 meters throughout 2021 and 2022, except during late February 2021 when temperatures throughout the entire water column were cooler than 14ºC (Figure 13). Water temperatures in the upper 15 meters of the water column usually exceeded 16ºC from April through December 2021, and from April through June 2022 (no data available for the July through December 2022 period). Water temperatures at depth greater than 30 meters were nearly always cool (below 14ºC) throughout 2021 and 2022, except during early January 2022 when temperatures were slightly warmer. Cold temperatures (below 12ºC) were recorded below a depth of 60 meters throughout 2021 and 2022.

The number of days with daily SST values less than 14ºC was very low in 2021 and 2022 (well below the long-term mean from 1994 to 2020) at Newport Pier and Scripps Pier, as has been the case each year since 2013 (Figure 14). At Newport Pier, there were only 5 days with SST values below 14ºC in 2021, and only 4 days in 2022, compared to a range of 56 to 64 such days during the three-year period from 2011 to 2013. At Scripps Pier, there were 12 days with SST values below 14ºC in 2021, and only 4 days in 2022, compared to a range of 51 to 72 such days during the three-year period from 2011 to 2013.

The numbers of days with daily SST values greater than 16ºC in 2021 and 2022 at Newport Pier (221 and 184 days, respectively) and Scripps Pier (226 and 218 days, respectively) were similar to 2020 levels, but higher than the values recorded in 2011 (159 days at Newport Pier and 128 days at Scripps Pier). The numbers of days with daily SST values greater than 18ºC in 2021 and 2022 at Newport Pier (87 and 107 days, respectively) and Scripps Pier (140 and 148 days, respectively) were also higher than in 2011 (63 days at Newport Pier and 46 days at Scripps Pier). This was also the case for daily SST values greater than 20ºC in 2021 and 2022 at Newport Pier (22 and 49 days, respectively) and Scripps Pier (52 and 84 days, respectively) compared to 2011 values (5 days at Newport Pier and 13 days at Scripps Pier).

In 2021 and 2022, the mean annual SST values at Newport Pier (16.9ºC and 17.2ºC) were lower than in 2020 (17.4ºC), but still higher than the long-term average (16.9ºC) (Table 9). The mean annual SST values in 2021 and 2022 at Scripps Pier (17.3ºC and 17.7ºC) were also lower than in 2020 (18.8ºC). In addition, the annual mean for 2021 was lower than the long-term average for the first time since 2013 and was equal to the long-term average for the first time since 2016.

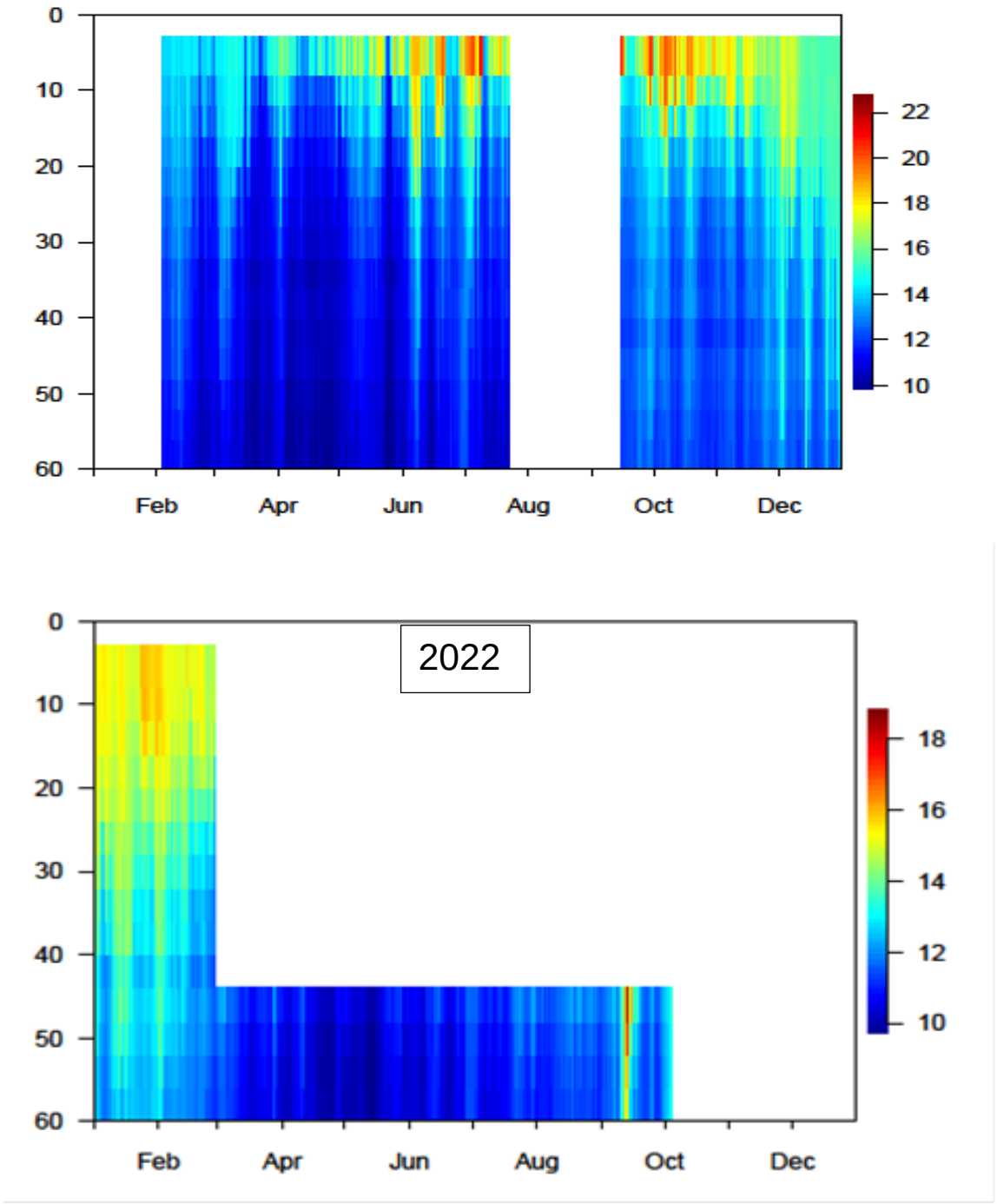


Figure 12. Temperatures (°C) throughout the water column (near surface to a depth of 60 m) off Point Loma during 2021 and 2022.

Note: white areas = no data recorded.

Source: City of San Diego, 2023.

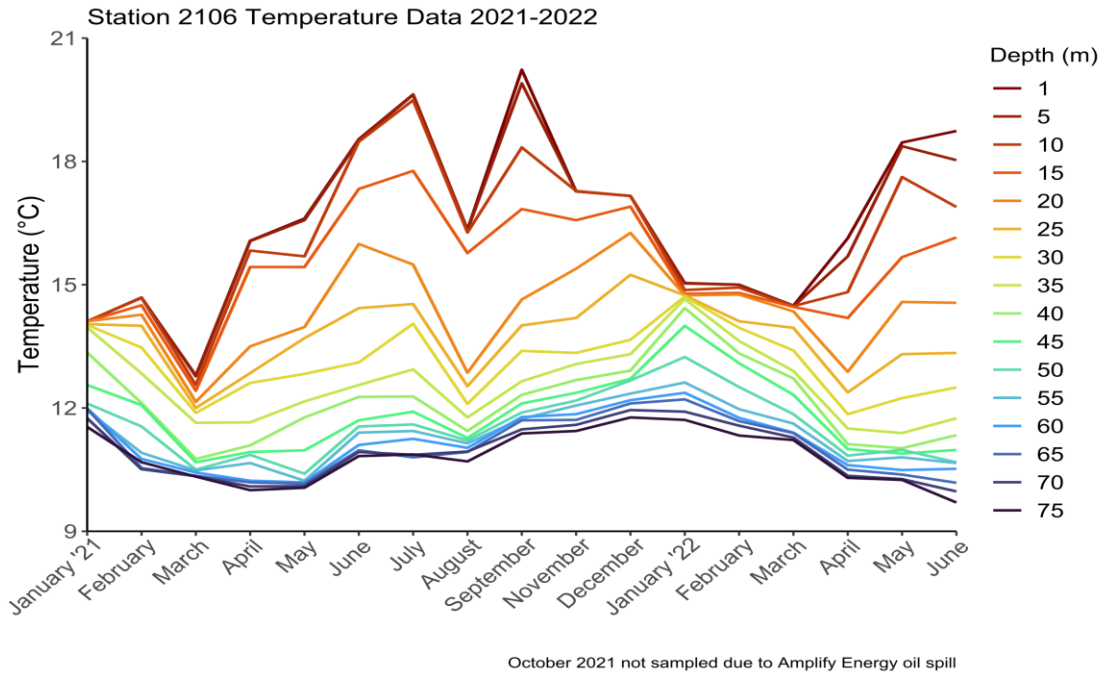


Figure 13. Temperatures (°C) throughout the water column (near surface to a depth of 75 m) off Orange County at Station 2106 during 2021 and 2022.

Source: Orange County Sanitation District, 2023.

Table 9. Comparison of mean temperature from 1994 through 2022 versus annual mean temperature from 2013 through 2022 at Newport Pier and Scripps Pier.

		Annual Mean SST (°C)									
	Mean SST (°C) (1994–2022)	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Newport Pier	16.6	16.7	18.0	18.4	17.8	17.8	17.9	17.6	17.4	16.9	17.2
Scripps Pier	17.7	17.0	18.8	18.9	17.7	17.9	18.6	17.8	18.8	17.3	17.7

Note: red cells indicate years above the long-term mean and blue cells indicate years below the long-term mean.

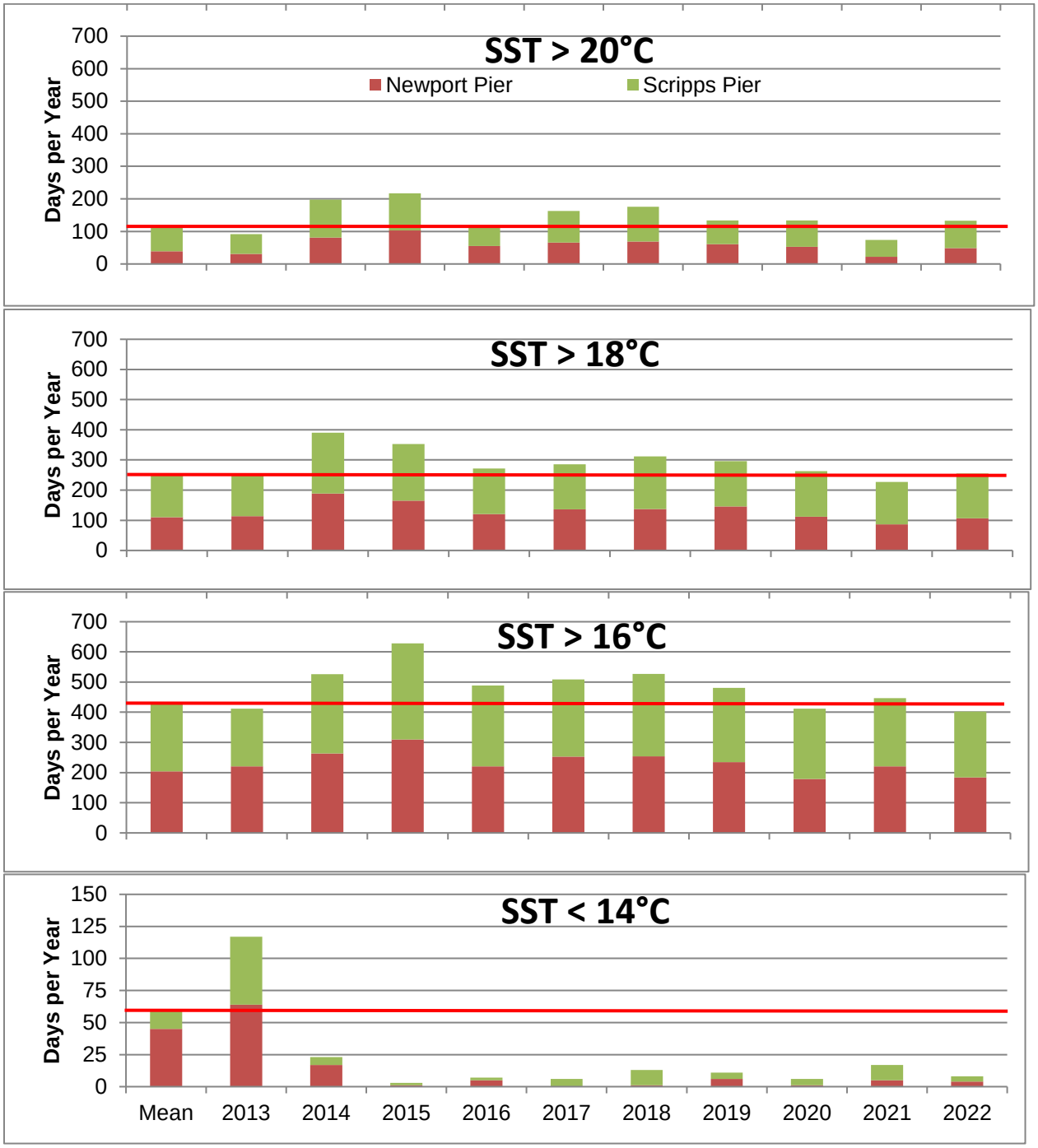


Figure 14. Number of days with SSTs >20°C, >18°C, >16°C, and <14°C at Newport Pier and Scripps Pier from 2011 to 2020, and the mean from 1994 to 2019 (red line).

IV.2.B - NUTRIENTS

The Nutrient Quotient (NQ) Index described by North and MBC (2001) provides a useful indicator of the amount of nitrate that is theoretically available for uptake by kelp (in micrograms-per-gram per-hour) (Haines and Wheeler 1978; Gerard 1982). This method allows for an inter-annual comparison of the nutrients available to kelp, making it possible to pinpoint those years when nutrients were either abundant or depleted, and to establish possible temporal trends.

This index is calculated for the 12-month period from July 1 through June 30 (i.e., the 2021 NQ Index values shown on Figure 16 correspond to the period from July 1, 2021 to June 30, 2022, while the 2022 NQ Index values correspond to the period from July 1, 2022 to June 20, 2023). The NQ Index was calculated for each of four locations (Newport Pier, Oceanside, Scripps Pier, and Point Loma) by averaging the early-morning SST values at each station for each of the 12 months, assigning a point score to each monthly SST average (1 point if the average falls between 16.01 and 17.00ºC, 2 points if between 15.01 and 16.00ºC, 4 points if between 14.01 and 15.00ºC, 8 points if between 13.01 and 14.00ºC, and 14 points if between 12.01 and 13.00ºC. The NQ for the 12-month period was the sum of the monthly point scores.

The NQ calculations for four locations in Region Nine in 2021/2022 and in 2022/2023 are shown in Tables 10 and 11. The 2021/2022 NQ Index was calculated to be 17 for Newport Pier, 8 for Oceanside, 10 for Scripps Pier, and 10 for Point Loma (Table 10). The NQ Index for Newport Pier was identical to the value for 2020/2021, while the NQ Indices for Oceanside, Scripps Pier, and Point Loma were lower than the 2020/2021 values (14, 14, and 12, respectively) (Figure 15). The 2022/2023 NQ Index was calculated to be 28 for Newport Pier, 26 for Oceanside, 28 for Scripps Pier, and 17 for Point Loma (Table 11). The NQ Indices for Newport Pier, Scripps Pier, and Point Loma were the highest values recorded since 2011, while the NQ Index for Oceanside was the highest value ever recorded (since 2009, when values were first calculated for this location) (Figure 15).

However, these high index values for 2022/2023 are primarily due to the very low surface water temperatures recorded in January through May of 2023, which would have no influence on kelp canopies in calendar year 2022. If the nutrient index were to be recalculated for calendar year 2022, the values would be 16 for Newport Pier, 8 for Oceanside, 6 for Scripps Pier, and 8 for Point Loma, similar to the values calculated for the 2021/2022 period.

Historically, nutrient availability has shifted from waters with sufficient nitrate prior to the 1976/1977 regime shift, to depleted conditions thereafter (Parnell et al. 2010). The sensitivity of kelp canopies to nutrient limitation appeared to have increased after 1977 and was evident by the strong correlation of seawater density (δt) and density of giant kelp (Parnell et al. 2010). Unfortunately, density data were not available throughout the RNKSC region. The NQ index recorded during the 1997/1998 El Niño indicated a particularly bad year for kelp beds in the Southern California Bight. During that season, NQ values ranged from 3 to 11. In contrast, during 1988/1989, a year in which kelp beds reached their maximum extents in several decades, NQ values ranged from 27 to 39 (Figure 15). The variability in SSTs and nutrients was driven by prevailing flow characteristics and bathymetric features that resulted in periodic upwelling along the rocky shores of the coastline, particularly at the Dana Point, La Jolla, and Point Loma kelp beds.

Table 10. Nutrient Quotient calculations for period from July 2021 to June 2022.

Sites	Monthly Average Temperature Ranges (°C) (Weighting Factor Per Month)					Total Nutrient Quotient (Calculation Formula)
	12.01 to 13.00 (14 pts)	13.01 to 14.00 (8 pts)	14.01 to 15.00 (4 pts)	15.01 to 16.00 (2 pts)	16.01 to 17.00 (1 pt)	
Newport Pier			Jan 2022 Feb 2022	Dec 2021 Mar 2022 Apr 2022	Oct 2021 Nov 2021 May 2022	**17** (4 pts x 2) + (2 pts x 3) + (1 pt x 3)
Oceanside				Jan 2022 Feb 2022 Mar 2022	Dec 2021 Apr 2021	**8** (2 pts x 3) + (1 pt x 2)
Scripps Pier				Dec 2021 Jan 2021 Feb 2021 Mar 2021 Apr 2022		**10** (2 pts x 5) + (1 pt x 0)
Point Loma				Dec 2021 Jan 2022 Feb 2022 Mar 2022	Apr 2022 May 2022	**10** (2 pts x 4) + (1 pt x 2)

Table 11. Nutrient Quotient calculations for period from July 2022 to June 2023.

Sites	Monthly Average Temperature Ranges (°C) (Weighting Factor Per Month)					Total Nutrient Quotient (Calculation Formula)
	12.01 to 13.00 (14 pts)	13.01 to 14.00 (8 pts)	14.01 to 15.00 (4 pts)	15.01 to 16.00 (2 pts)	16.01 to 17.00 (1 pt)	
Newport Pier		Feb 2023 Mar 2023	Jan 2023 Apr 2023	Dec 2022	Nov 2022 May 2023	**28** (8 pts x 2) + (4 pts x 2) + (2 pts x 1) + (1 pt x 2)
Oceanside		Feb 2023 Mar 2023	Jan 2023 Apr 2023	Dec 2022		**26** (8 pts x 2) + (4 pts x 2) + (2 pts x 1) + (1 pt x 0)
Scripps Pier		Feb 2023 Mar 2023	Dec 2022 Jan 2023 Apr 2023		June 2023	**29** (8 pts x 2) + (4 pts x 3) + (2 pts x 0) + (1 pt x 1)
Point Loma			Feb 2023 Mar 2023 Apr 2023	Dec 2022 Jan 2023	May 2023	**17** (4 pts x 3) + (2 pts x 2) + (1 pt x 1)

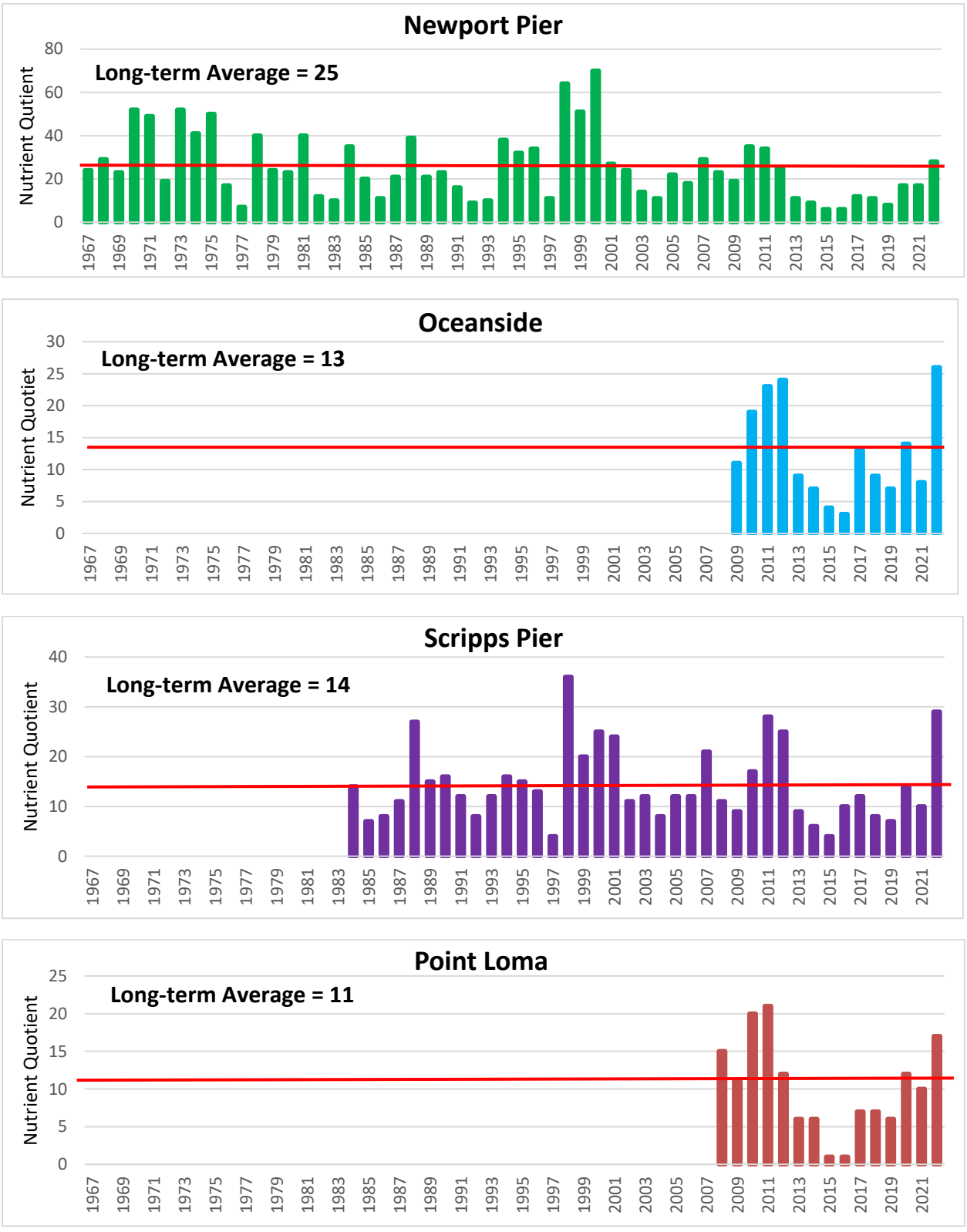


Figure 15. Nutrient Quotient (NQ) values in Region Nine, 1967 to 2022 (red line = long-term mean for site).

IV.2.C - UPWELLING

The frictional stress of equatorial wind on the ocean's surface, combined with the effect of the earth's rotation, causes water in the surface layer to move away from the western coast of continental land masses. This offshore moving water is replaced by water which upwells, or flows, toward the surface, from depths of 50 to 100 meters or more. Upwelled water is cooler and saltier than the original surface water, and typically has much greater concentrations of nutrients, such as nitrates, phosphates and silicates, that are key to sustaining biological production.

Upwelling in 2021 (at a location approximately 161 km west of Solana Beach) usually increased each month from January through May, then decreased through December (Figure 16). In 2022, upwelling increased each month from January through June, then decreased through December. Upwelling was greater than the long-term average every month in 2021 (with the exception of August), and most months in 2022 (with the exception of February, June, August, and September) (Figure 17). Upwelling was strongest in both 2021 and 2022 from May through July, and weakest in January, November, and December in 2021 and in January, February, November, and December in 2022.

IV.2.D - ENVIRONMENTAL INDICES

The El Niño/Southern Oscillation (ENSO) is the most important coupled ocean-atmosphere phenomenon affecting inter-annual climate variability. ENSO can be monitored via the Multivariate ENSO Index (MEI), which is based on a suite of six variables observed over the tropical Pacific Ocean, including sea-level pressure, zonal and meridional components of the surface winds, sea surface temperatures, surface air temperatures, and the total cloudiness fraction of the sky (https://www.esri.noaa.gov/psd/enso/mei/). Negative values of the MEI represented the cold ENSO phase (i.e., La Niña), while positive MEI values represented the warm ENSO phase (El Niño).

The North Pacific Gyre Oscillation (NPGO) is a climate pattern that is based on sea surface height variability in the Northeast Pacific Ocean. The NPGO is significantly correlated with fluctuations of salinity, nutrients, and chlorophyll-a measured in long-term observations in the California Current and Gulf of Alaska. Fluctuations in the NPGO are driven by regional and basin-scale variations in wind-driven upwelling and horizontal advection, which are the fundamental processes controlling salinity and nutrient concentrations. Nutrient fluctuations drive concomitant changes in phytoplankton concentrations and may result in similar variability in higher trophic levels (http://www.o3d.org/npgo/).

The Pacific Decadal Oscillation (PDO) is a long-lived El Niño-like pattern of Pacific climate variability. The PDO and ENSO have similar spatial climate fingerprints but exhibit very different behavior in time. While twentieth century PDO events typically persist for 20 to 30 years, typical ENSO events tend to persist for only 6 to 18 months. A "cool" PDO regime persisted from 1890 through 1924 and again from 1947 through 1976, while a "warm" PDO regime dominated from 1923 through 1946 and from 1977 through the mid-1990s. Warm eras correlate with enhanced coastal ocean biological productivity in Alaska and inhibited productivity off the west coast of the United States, while cold PDO eras produce the opposite effect (**https://www.ncdc.noaa.gov.teleconnections/pdo**). Causes for PDO fluctuations are not currently known.

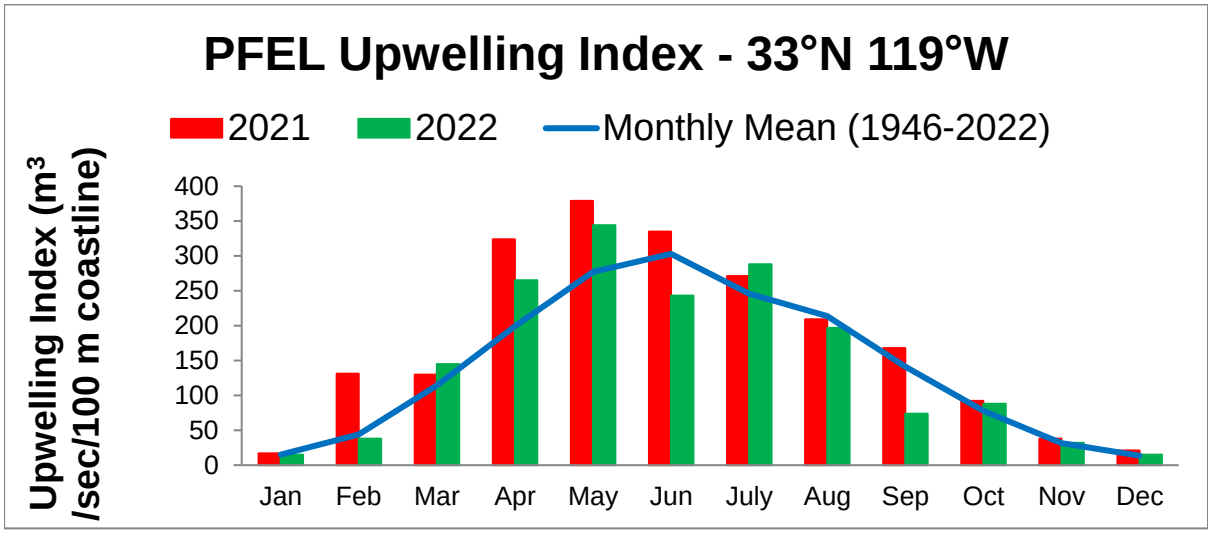


Figure 16. Monthly PFEL upwelling index at 33ºN 119ºW for 2021 and 2022 (compared to 75-year monthly mean from 1946 through 2022).

Source: https://coastwatch.pfeg.noaa.gov/erddap/griddap/erdUI33mo.html.

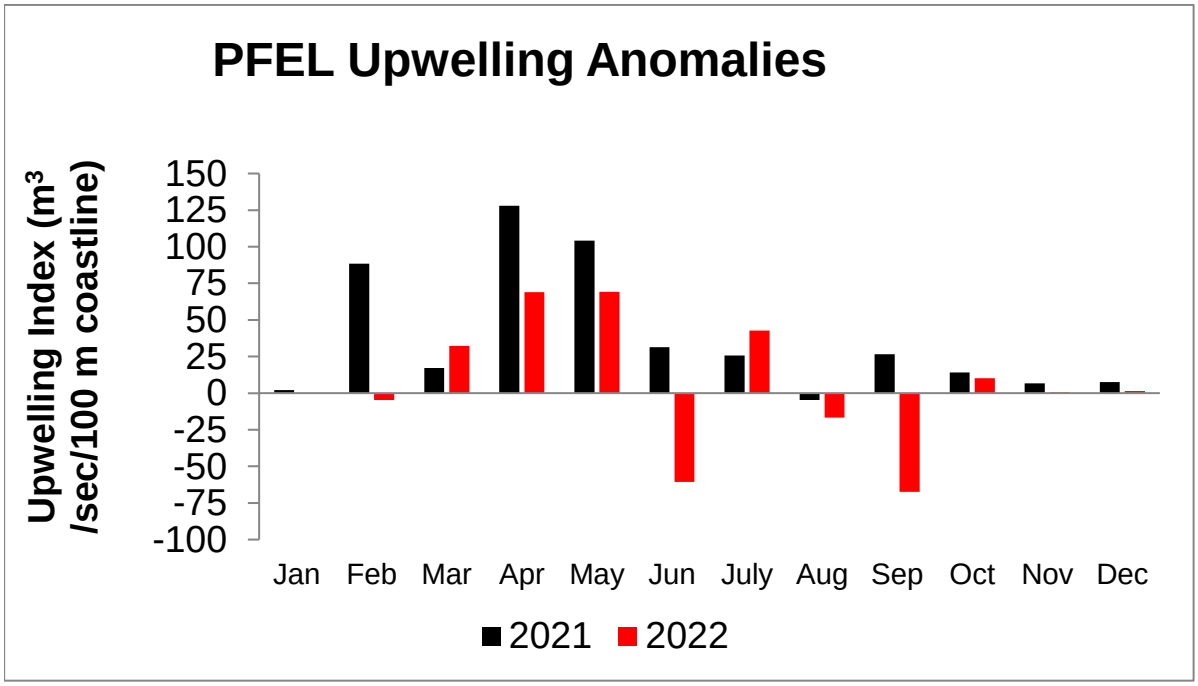


Figure 17. Daily Upwelling Index anomalies at 33°N 119°W for 2021 and 2022 (positive values indicate upwelling greater than the long-term mean from 1946 through 2020; negative values indicate upwelling less than long-term mean).

Source: https://coastwatch.pfeg.noaa.gov/erddap/griddap/erdUI33mo.html.

The MEI Index transitioned from negative (cold phase, or La Niña condition) to positive (warm phase, or El Niño condition) in April 2014, then back to negative in September 2016 (Figure 18). The MEI Index shifted to positive once again in May 2018 and throughout 2019, before transitioning back to negative in early 2020. The MEI Index has remained negative since 2020 (through early 2023). The PDO became positive in early 2014 (Figure 19; Mantua 2017; NOAA-ESRL 2018) and remained mostly positive through mid-2017, but has been mostly negative since then (through May 2023). The NPGO changed from positive to negative in October 2013 and has stayed negative for most of the time since then through early 2023 (although it was positive for five months in 2016) (Figure 20; Di Lorenzo 2017).

The negative MEI Index and PDO values since 2018 could indicate a return to cold water conditions. But the strongly negative NPGO values in 2020 may have been indicative of lower productivity along the Pacific coast during that period (Di Lorenzo et al. 2008; Leising et al. 2015). However, since 2020, NPGO values have been less negative, perhaps indicating greater productivity.

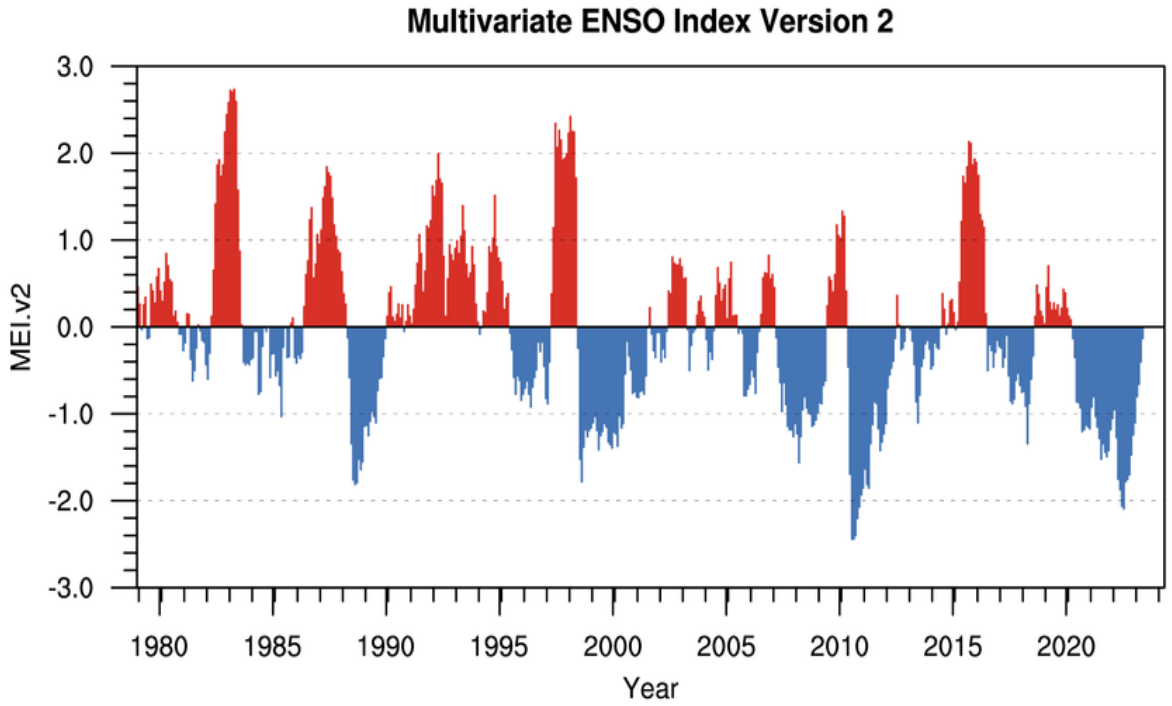


Figure 18. The Multivariate Enso Index (MEI) from 1979 through 2023.

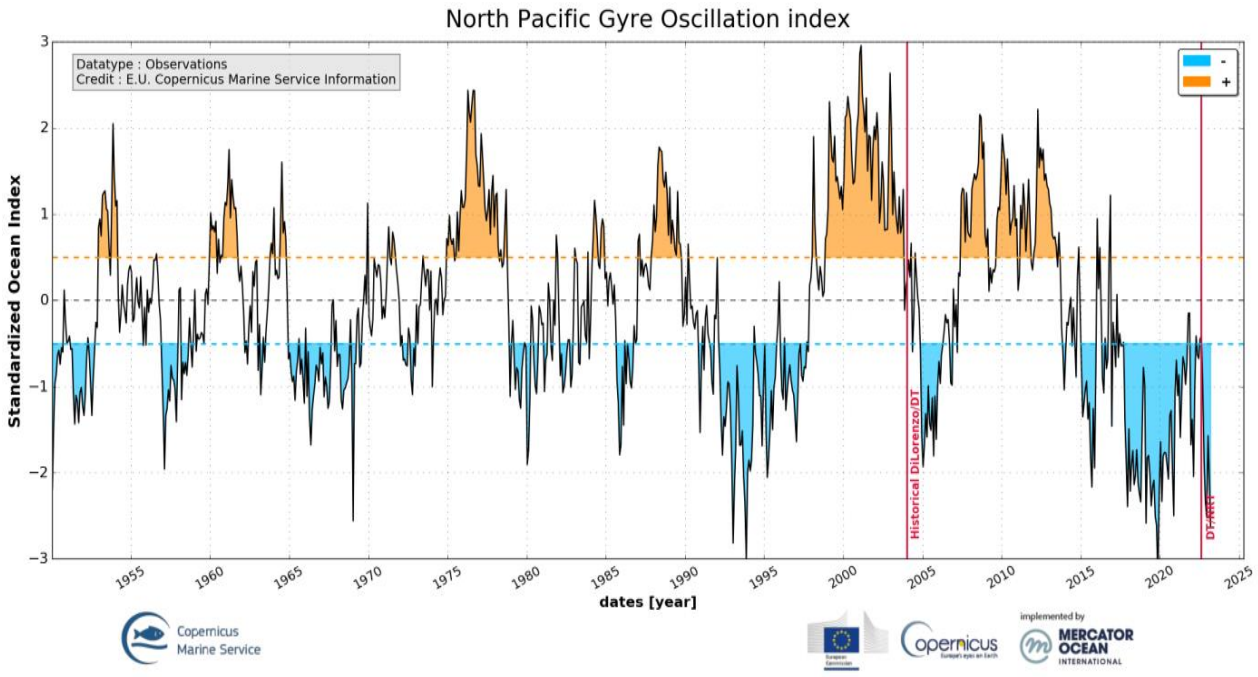


Figure 19. The North Pacific Gyre Oscillation Index (NPGO) from 1950 through 2023.

Source:https:/marine.copernicus.eu/access-data/ocean-monitoring-indicators/north-pacific-gyre-observations-reprocessing

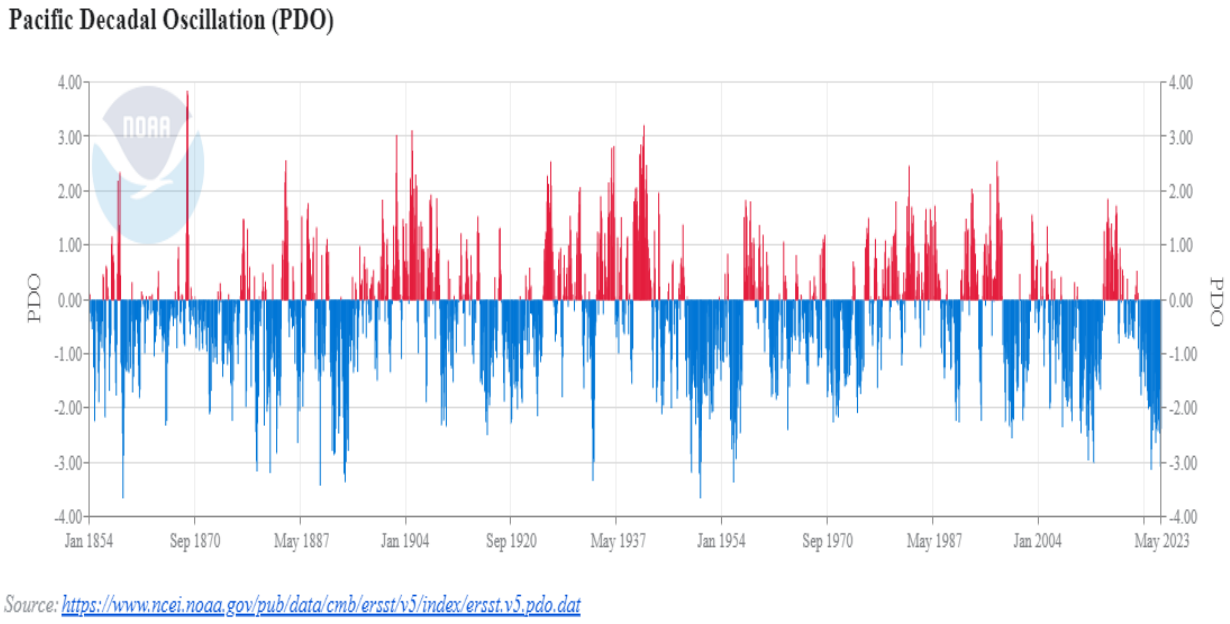


Figure 20. The Pacific Decadal Oscillation Index (PDO) from 1854 through 2023.

Source: https:://www.ncei.noaa.gov/pub/data/cmb/ersst/v5/index/ersst.v5.pdo.dat

IV.2.E - WAVE HEIGHTS

Sea and swell height data from Coastal Data Information Program (CDIP) data buoys located off Oceanside and Point Loma were available in real time via the CDIP website (http://www.cdip.ucsd.edu). The Oceanside buoy is located at 33 10.765' N and 117 28.277' W, approximately 4 nautical miles west-southwest of Oceanside Harbor. The Point Loma buoy is located at 32 31.002' N and 117 25.512' W, approximately 15.5 nautical miles west of Imperial Beach Pier. Table 12 shows the occurrence of large waves (defined as 3 meters or more) in 2021 and 2022 at these two locations, based on the maximum wave height recorded each day by the buoys. The California coastal wave monitoring and prediction system predicts average swell heights each day within offshore and nearshore areas of the Southern California Bight based on buoy observations. Swell height predictions for several dates in 2021 and 2022 when the largest maximum waves occurred are shown in Figures 19 to 25.

The direction of swells off Oceanside in 2021 and 2022 was predominately from the south-southwest (202.5º), approximately 48% of the time in 2021 and 40% of the time in 2022 (Table 12), compared to 46% of the time in 2020. Waves also approached from the south (180º) approximately 16% of the time in 2021 and 20% of the time in 2022, compared to 19% of the time in 2020. Offshore of Point Loma, waves approached from the south-southwest approximately 24% of the time in 2021 and approximately 19% of the time in 2022, compared to 26% in 2020. Waves approached from the south approximately 22% of the time in 2021 and approximately 17% of the time in 2022, compared to 24% of the time in 2020.

High-energy waves that negatively affect kelp beds usually are low-frequency, high-amplitude waves approaching from the west (180º). Off Oceanside, waves approached from the west approximately 17% of the time in 2021 and approximately 16% of the time in 2022, compared to 16% of the time in 2020. Off Point Loma, waves approached from the west approximately 28% of the time in 2021 and approximately 27 % of the time in 2022, compared to 25% of the time in 2020.

The occurrence of large waves (3 meters or more) off Oceanside and off Point Loma in 2021 and 2022 are shown in Table 13. The largest waves off Oceanside in 2021 were recorded on January 26th (4.4 meters), March 16th (4.7 meters), and December 14th and December 15th (5.7 and 4.6 meters, respectively). Smaller waves were recorded in 2022, with a maximum of 3.6 meters on both April 13th and May 8th. Waves exceeding three meters were only recorded in January, February, March, May, and December of 2021, and every month in 2022, except in January, June, and August. The largest waves off Point Loma in 2021 were recorded on January 25th (5.6 meters), December 14th and 15th (5.7 and 5.2 meters, respectively), and in 2022 on March 4th, 5th, and 6th (4.9, 5.2, and 5.6 meters, respectively), March 20th and 21st (5.5 and 5.8 meters, respectively), March 30th (4.8 meters), April 12th and 13th (5.6 and 4.7 meters, respectively), and May 8th and 9th (4.9 and 5.4 meters, respectively). Waves exceeding three meters were recorded every month in 2021 (with the exception of July) and every month in 2022.

Table 12. Direction of swells in 2021 and 2022. Source: http://cdip.ucsd.edu.

Direction	Oceanside		Pont Loma South	
	2021	2022	2021	2022
West-northwest (292.5º)	2%	2%	12%	11%
West (270º)	17%	16%	28%	37%
West-southwest (247.5º)	8%	11%	6%	8%
Southwest (225º)	9%	12%	7%	7%
South-southwest (202.5º)	48%	40%	24%	19%
South (180º)	16%	20%	22%	17%
South-southeast (157.5º)			1%	1%

Wave and swell heights produced by major storms follow:

- The storm that occurred on January 25, 2021 produced wave heights off Oceanside of 3.2 meters maximum and off Point Loma of 5.6 meters maximum (Table 13). This resulted in predicted swell heights up to 3 feet along most of the coastline throughout Region Nine, with swell heights up to 4 feet in offshore areas (Figure 21).
- The storm that occurred on March 16, 2021 produced wave heights off Oceanside of 4.7 meters maximum (no data available for Point Loma), resulting in predicted swells up to 2 feet along the coastline near Oceanside and areas to the north, with swells up to 4 feet along the coastline from Oceanside to San Diego, as well as in most offshore areas (Figure 22).
- The storm that occurred on December 14/15, 2021 produced wave heights off Oceanside of up to 5.7 and 4.6 meters maximum on the 14th and 15th, respectively, and wave heights off Point Loma of up to 5.7 and 5.2 meters maximum on the 14th and 15th, respectively; unfortunately, swell height data is not available for the coastline on that date.

Table 13. Large waves (≥3 meters) in 2021 and 2022.

Dates and Locations in 2021			Dates and Locations in 2022		
	Oceanside (meters)	Point Loma South (meters)		Oceanside (meters)	Point Loma South (meters)
1/1/21	3.0	4.2	**1/1/22**		4.4
1/2/21		3.6	**1/5/22**		3.5
1/3/21		3.9	**1/12/22**		3.6
1/4/21		3.3	**1/13/22**		3.6
1/5/21		3.3	**1/14/22**		3.1
1/6/21		3.6	**1/15/22**		3.7
1/7/21		3.5	**1/16/22**		3.3
1/8/21		3.3	**1/25/22**		3.1
1/11/21		4.0	**2/15/22**		3.1
1/12/21		3.7	**2/16/22**	3.3	3.4
1/13/21		3.2	**2/22/22**		3.6
1/14/21		3.6	**2/23/22**	3.2	4.3
1/15/21		3.1	**2/24/22**		4.4
1/17/21		3.6	**3/1/22**		3.0
1/18/21		3.3	**3/3/22**		3.1
1/19/21		3.4	**3/4/22**		4.9
1/24/21		3.2	**3/5/22**		5.2
1/25/21	3.2	5.6	**3/6/22**		5.6
1/26/21	4.4		**3/10/22**		3.1
1/27/21		3.7	**3/14/22**		3.2
1/29/21		3.3	**3/16/22**		3.4
1/30/21		3.3	**3/17/22**		4.3

Table 13 (continued). Large waves (≥3 meters) in 2021 and 2022.

Dates and Locations in 2021			Dates and Locations in 2022		
	Oceanside (meters)	**Point Loma South (meters)**		**Oceanside (meters)**	**Point Loma South (meters)**
2/2/21		3.3	**3/18/22**		3.1
2/12/21	3.2		**3/20/22**		5.5
2/13/21		3.1	**3/21/22**	3.2	5.8
2/14/21	3.2		**3/22/22**		3.2
2/17/21	3.0		**3/29/22**		4.3
2/20/21		3.3	**3/30/22**	3.3	4.8
2/21/21	3.3		**3/31/22**		3.5
2/27/21		3.0	**4/4/22**		3.2
2/28/21		3.0	**4/5/22**		3.5
3/3/21	3.3	3.2	**4/6/22**		3.8
3/4/21	3.5	3.3	**4/9/22**		3.4
3/7/21		3.5	**4/10/22**		4.0
3/8/21		3.2	**4/11/22**		3.8
3/9/21		3.7	**4/12/22**	4.5	5.6
3/11/21	3.2	3.0	**4/13/22**	3.6	4.7
3/12/21		3.1	**4/14/22**		3.1
3/13/21		3.1	**4/20/22**		3.1
3/15/21	3.1		**4/22/22**		4.6
3/16/21	4.7		**4/23/22**		4.9
3/22/21		3.4	**4/24/22**		4.5
3/23/21	3.7	3.7	**4/25/22**		3.1

Table 13 (continued). Large waves (≥3 meters) in 2021 and 2022.

Dates and Locations in 2021			Dates and Locations in 2022		
	Oceanside (meters)	Point Loma South (meters)		Oceanside (meters)	Point Loma South (meters)
3/24/21		3.5	**4/26/22**		3.2
4/11/21		3.2	**4/27/22**		3.5
4/21/21		3.3	**4/28/22**		3.3
4/22/21		3.1	**4/29/22**		3.4
5/2/21		3.2	**5/1/22**		3.6
5/4/21		3.2	**5/2/22**		3.7
5/20/21	3.2	3.7	**5/7/22**		3.3
5/21/21	3.3		**5/8/22**	3.6	4.9
5/22/21	3.0		**5/9/22**		5.4
5/26/21		3.1	**5/10/22**	3.2	3.7
6/10/21		3.0	**5/11/22**	3.1	4.1
6/11/21		3.6	**5/12/22**	3.2	3.3
6/22/21		3.6	**5/17/22**		3.3
6/25/21		3.0	**5/18/22**		3.1
6/28/21		3.0	**5/20/22**		3.1
8/20/21		3.0	**5/21/22**		3.1
9/14/21		3.1	**5/30/22**	3.2	3.2
9/28/21		3.0	**5/31/22**		3.5
9/29/21		3.1	**6/14/22**		3.4
10/1/21		3.2	**7/19/22**	3.1	3.3
10/3/21		3.2	**8/1/22**		3.3

Table 13 (continued). Large waves (≥3 meters) in 2021 and 2022.

Dates and Locations in 2021			Dates and Locations in 2022		
	Oceanside (meters)	**Point Loma South (meters)**		**Oceanside (meters)**	**Point Loma South (meters)**
10/11/21		3.2	**8/2/22**		3.2
10/12/21		3.9	**8/7/22**		3.7
10/13/21		3.3	**9/9/22**		3.4
10/24/21		3.6	**9/11/22**	3.1	3.3
10/25/21		3.6	**10/23/22**	3.9	3.7
10/27/21		3.9	**10/24/22**		3.7
11/5/21		4.2	**11/2/22**		3.8
11/6/21		3.9	**11/3/22**	5.0	6.1
11/7/21		3.1	**11/4/22**	4.4	4.6
11/8/21		3.3	**11/8/22**		3.9
12/14/21	5.7	5.7	**11/9/22**		3.6
12/15/21	4.6	5.2	**11/10/22**		3.2
12/16/21		3.6	**11/29/22**		3.4
12/24/21	3.0	3.2	**12/11/22**	3.2	3.7
12/25/21		4.1	**12/12/22**		4.0
12/26/21		3.2	**12/13/22**		3.6
12/27/21		3.0	**12/27/22**		3.8
12/28/21	3.2	3.0	**12/28/22**		3.8
12/30/21		3.1	**12/29/22**		3.7
			12/30/22		3.3

- The storm that occurred on March 4/5/6, 2021 produced relatively small wave heights off Oceanside on the 4th (less than 3 meters maximum), but no data is available for the 5th and 6th, and wave heights off Point Loma of up to 4.9, 5.2, and 5.6 meters maximum on the 4th, 5th, and 6th, respectively. On March 4th, swells up to 2 to 3 feet were predicted along the coastline near Oceanside and to the north and in offshore areas, while swells up to 4 feet were predicted along the coastline south of Oceanside and up to 5 feet along coastline of San Diego, as well as 4 to 5 foot swells in offshore areas (Figure 23). Larger swells were predicted on March 5th, up to 4 feet along the coastline near Oceanside and most of the coastline to the north and in offshore areas, and up to 6 feet along the coastline south of Oceanside and the San Diego coastline, as well as in offshore areas. Predicted swells were smaller on March 6th, up to 2 feet along the coastline near Oceanside and to the north, as well as in offshore areas, and up to 4 feet along the coastline south of Oceanside and the San Diego coastline, as well as in offshore areas.
- The storm that occurred on March 21, 2022 produced wave heights off Oceanside of 3.2 meters maximum and off Point Loma of 5.8 meters maximum. This resulted in predicted swells up to 4 feet maximum along most of the coastline north of San Diego and in offshore areas, with larger predicted swells up to 6 feet maximum along most of the San Diego coastline and offshore (Figure 24).
- The storm on April 12, 2022 produced wave heights off Oceanside of 4.5 meters maximum and off Point Loma of 5.6 meters maximum. This resulted in swell heights up to 2 feet along the coastline near Oceanside and to the north, as well as offshore, and swells up to 4 feet along the coastline south of Oceanside and the San Diego coastline, as well as in offshore areas (Figure 25).
- The storm on May 8/9, 2022 produced wave heights off Oceanside of 3.6 meters maximum on the 8th (no data available on the 9th) and off Point Loma of 4.9 and 5.4 meters on the 8th and 9th, respectively. On May 8th, this resulted in swell heights up to 4 feet maximum along the entire Region Nine coastline, with swells up to a maximum of 4 to 6 feet in offshore areas (Figure 26). On May 9th, swell heights were also up to 4 feet maximum along the coastline near Oceanside and to the north and in offshore areas, but larger swells at up to 6 feet maximum along the coastline south of Oceanside and the San Diego coastline, as well as in offshore areas.
- The storm on November 3/4, 2022 produced wave heights off Oceanside of 5.0 and 4.4 meters maximum on the 3rd and 4th, respectively, and off Point Loma of 6.1 and 4.6 meters maximum on the 3rd and 4th, respectively. On November 3rd, this resulted in swell heights up to 2 feet maximum along the coastline near Oceanside and to the north, as well as in offshore areas, and swells up to 4 feet along the coastline near San Diego and in offshore areas (Figure 27). On May 9h, swells up to 2 feet maximum once again were recorded along the coastline near Oceanside and to the north, as well as in offshore areas, but swells were smaller at up to 3 feet maximum along the coastline south of Oceanside and along the San Diego coastline, as well as in offshore areas.

As was the case in 2020, storms in 2021 and 2022 occasionally produced swells up to 6 feet along the Region Nine coastline. However, most storms during all three years usually produced smaller swells up to a maximum of 4 feet along the coastline.

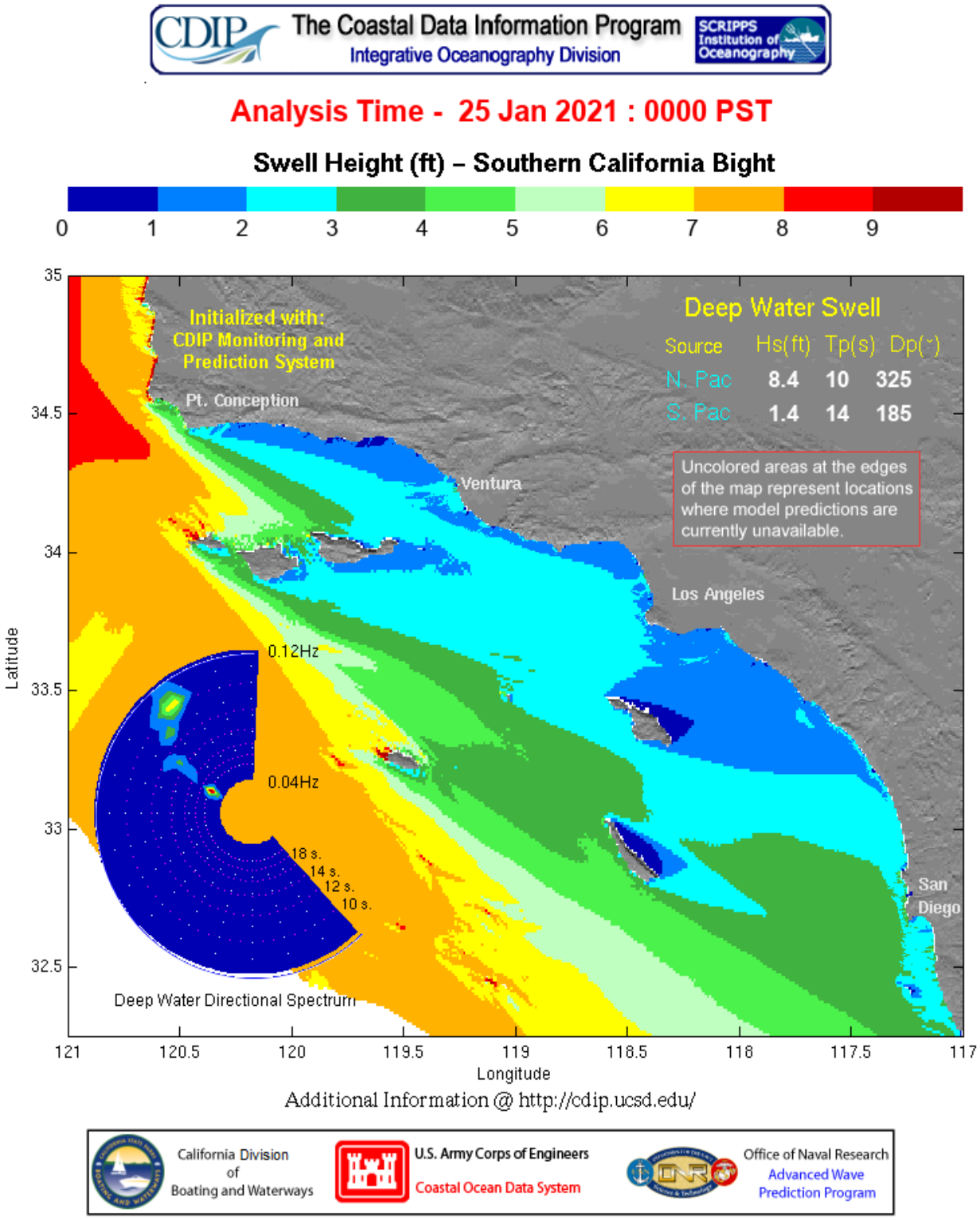


Figure 21. Swell height and direction in the Southern California Bight on January 25, 2021. Source: Coastal Data Information Program (CDIP), http://cdip.ucsd.edu/.

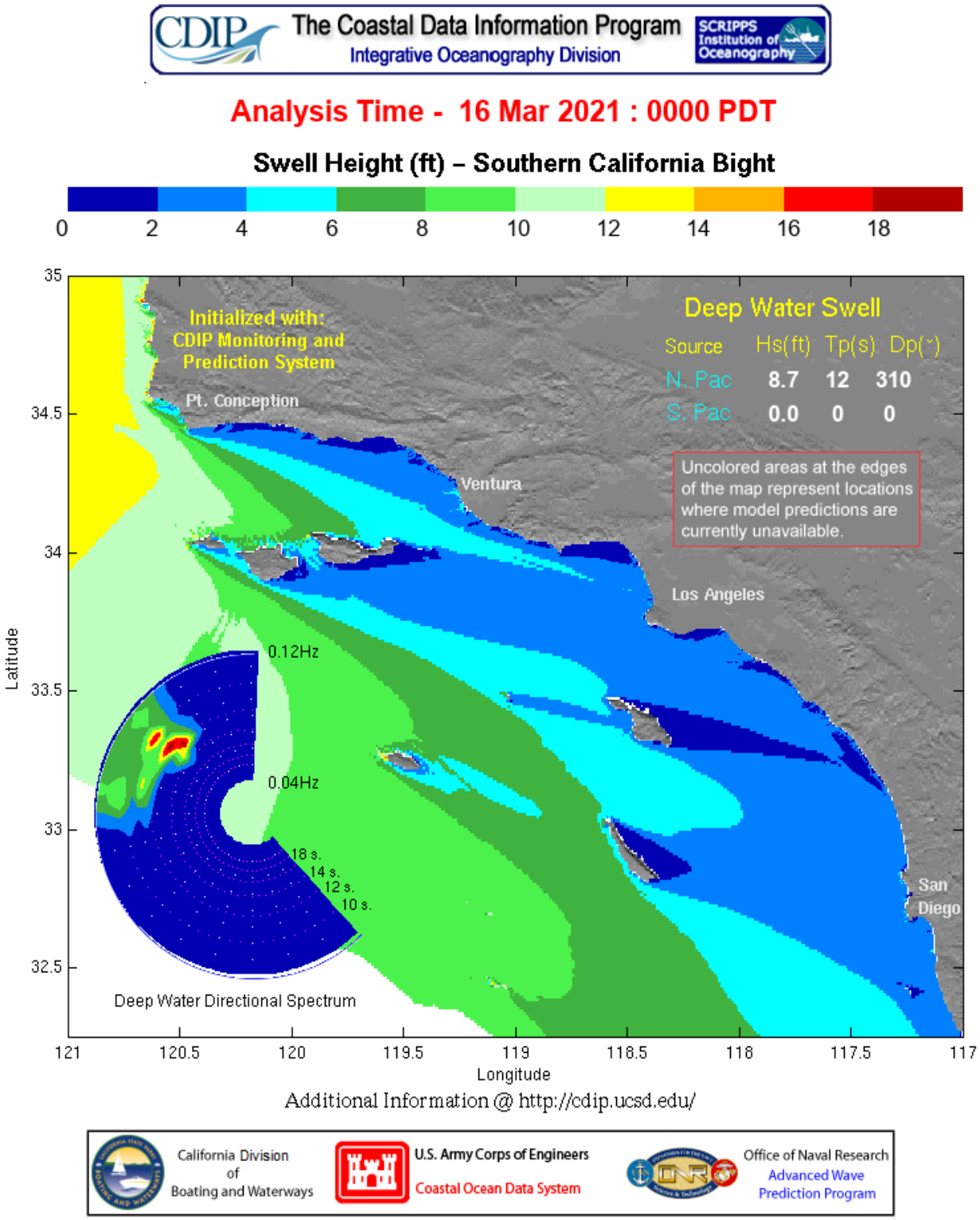


Figure 22. Swell height and direction in the Southern California Bight on March 16, 2020. Source: Coastal Data Information Program (CDIP), http://cdip.ucsd.edu/.

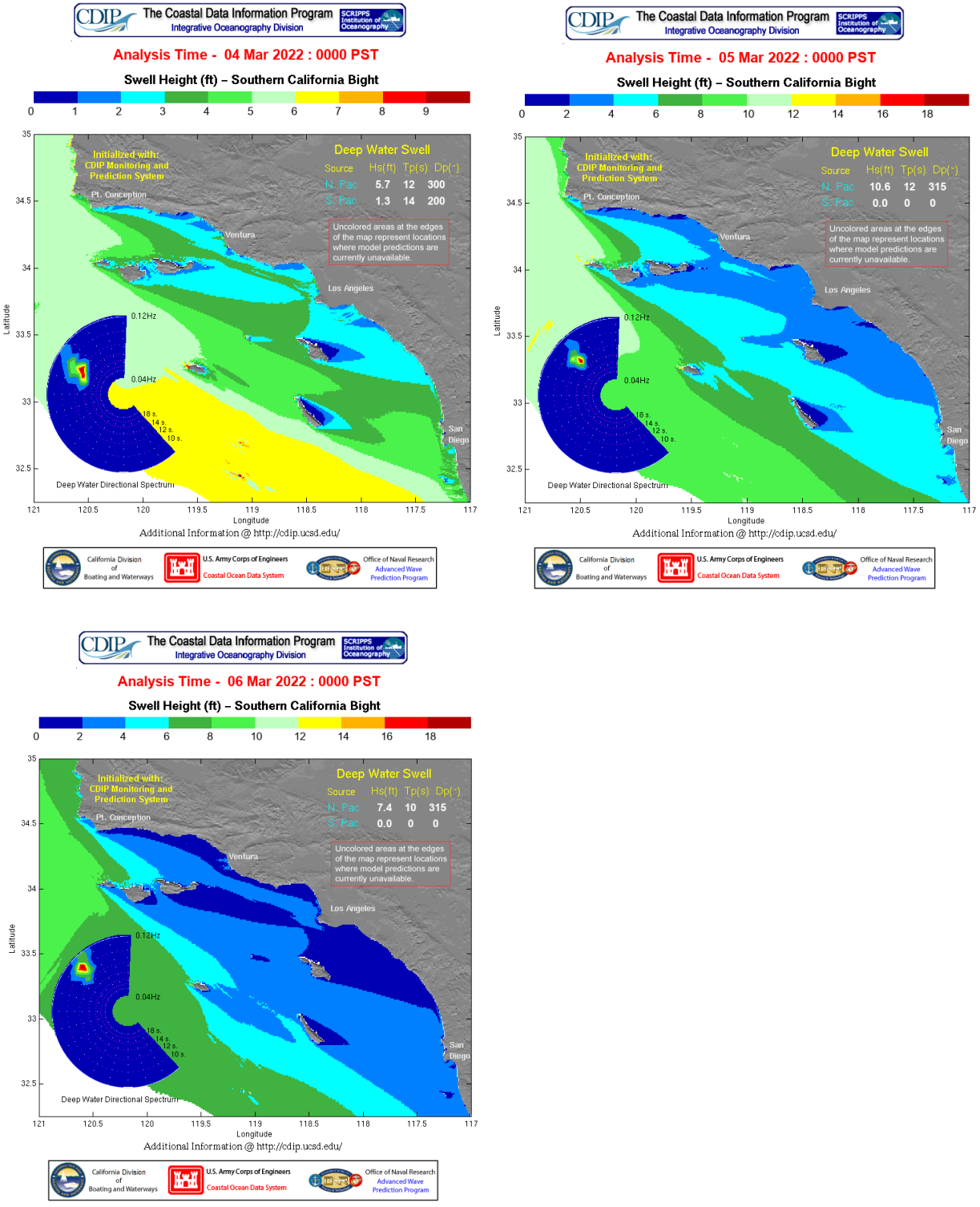


Figure 23. Swell height and direction in the Southern California Bight on March 4, 5 and 6, 2022. Source: Coastal Data Information Program (CDIP), http://cdip.ucsd.edu/.

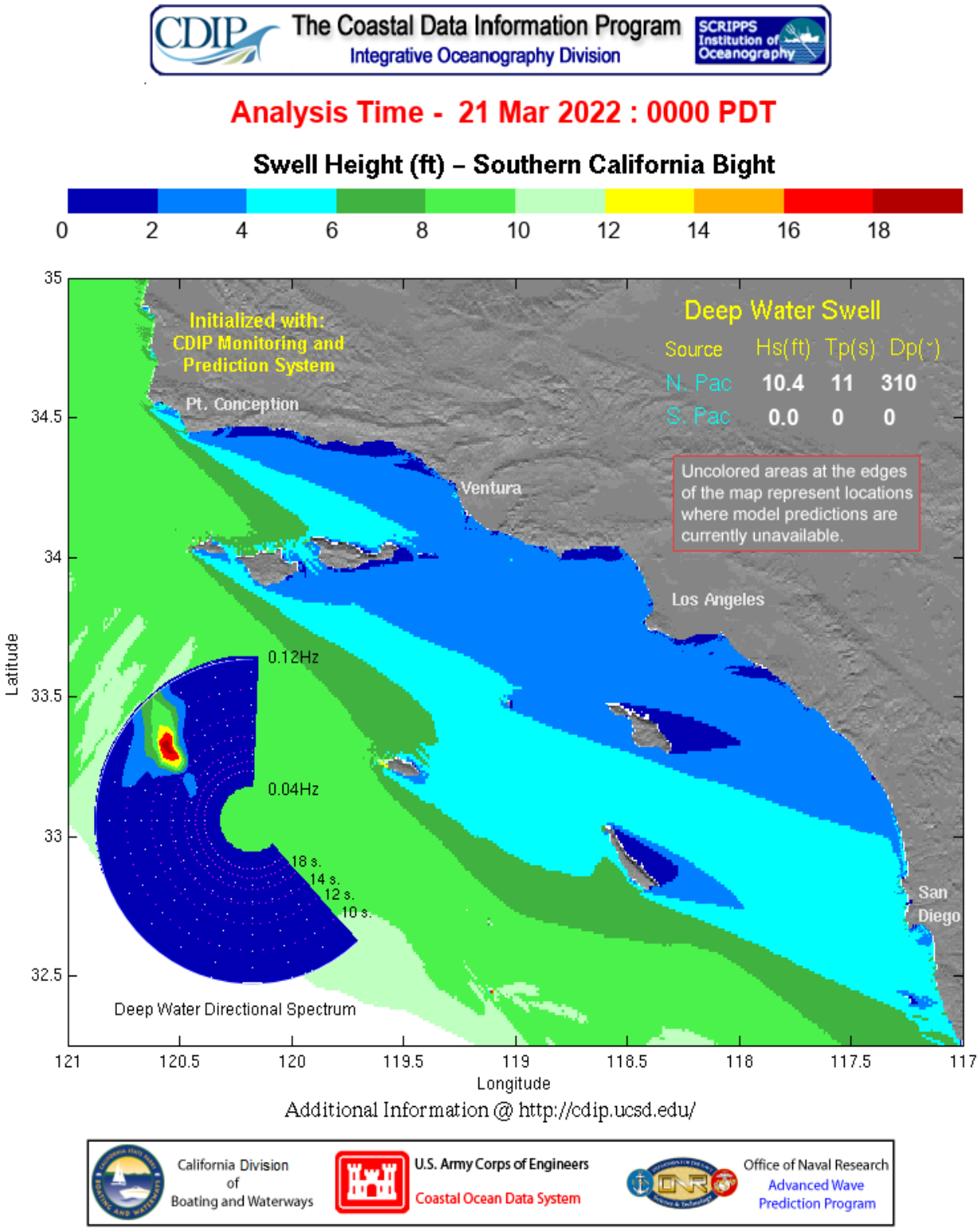


Figure 24. Swell height and direction in the Southern California Bight on March 21, 2022. Source: Coastal Data Information Program (CDIP), http://cdip.ucsd.edu/.

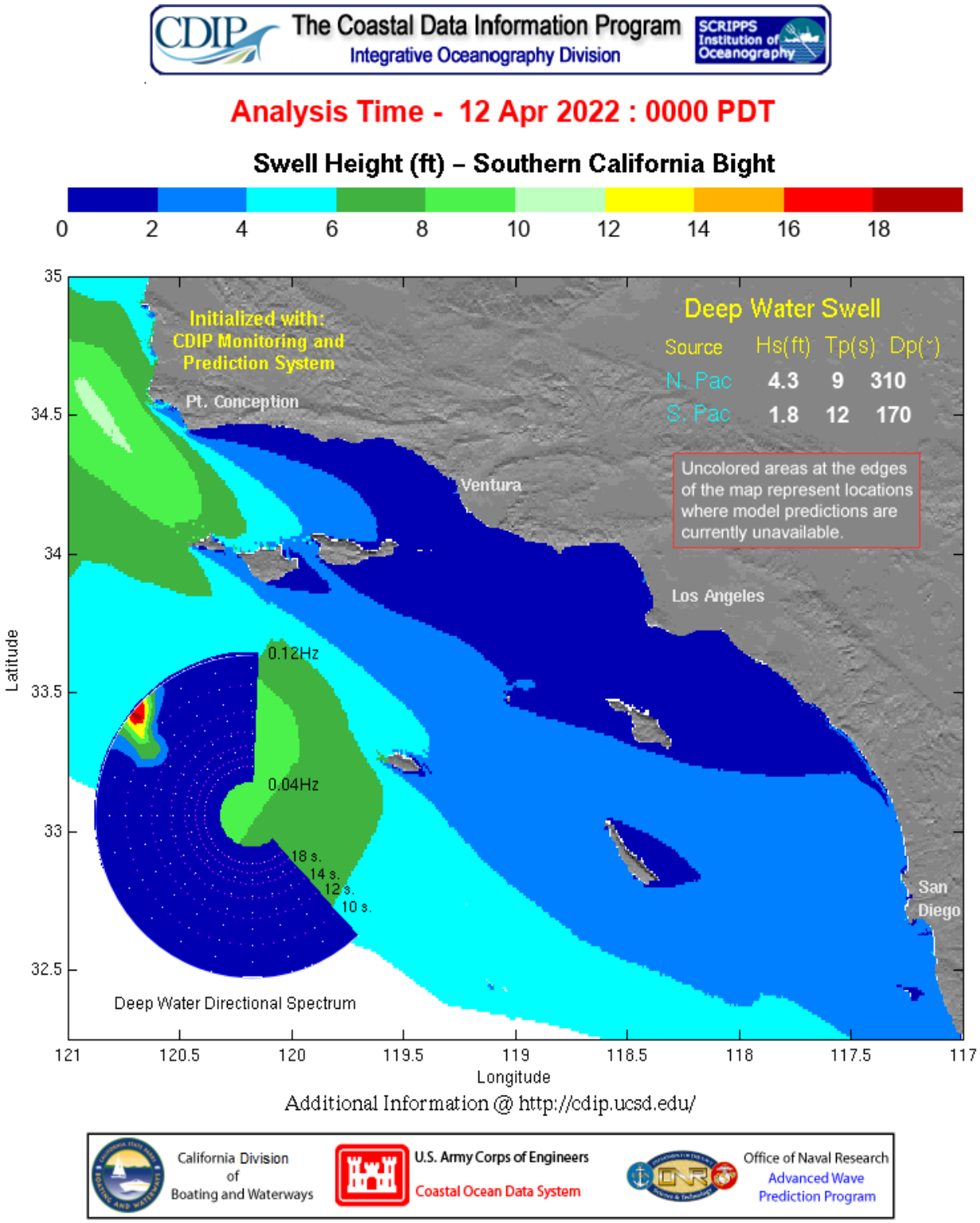


Figure 25. Swell height and direction in the Southern California Bight on April 12, 2022. Source: Coastal Data Information Program (CDIP), http://cdip.ucsd.edu/.

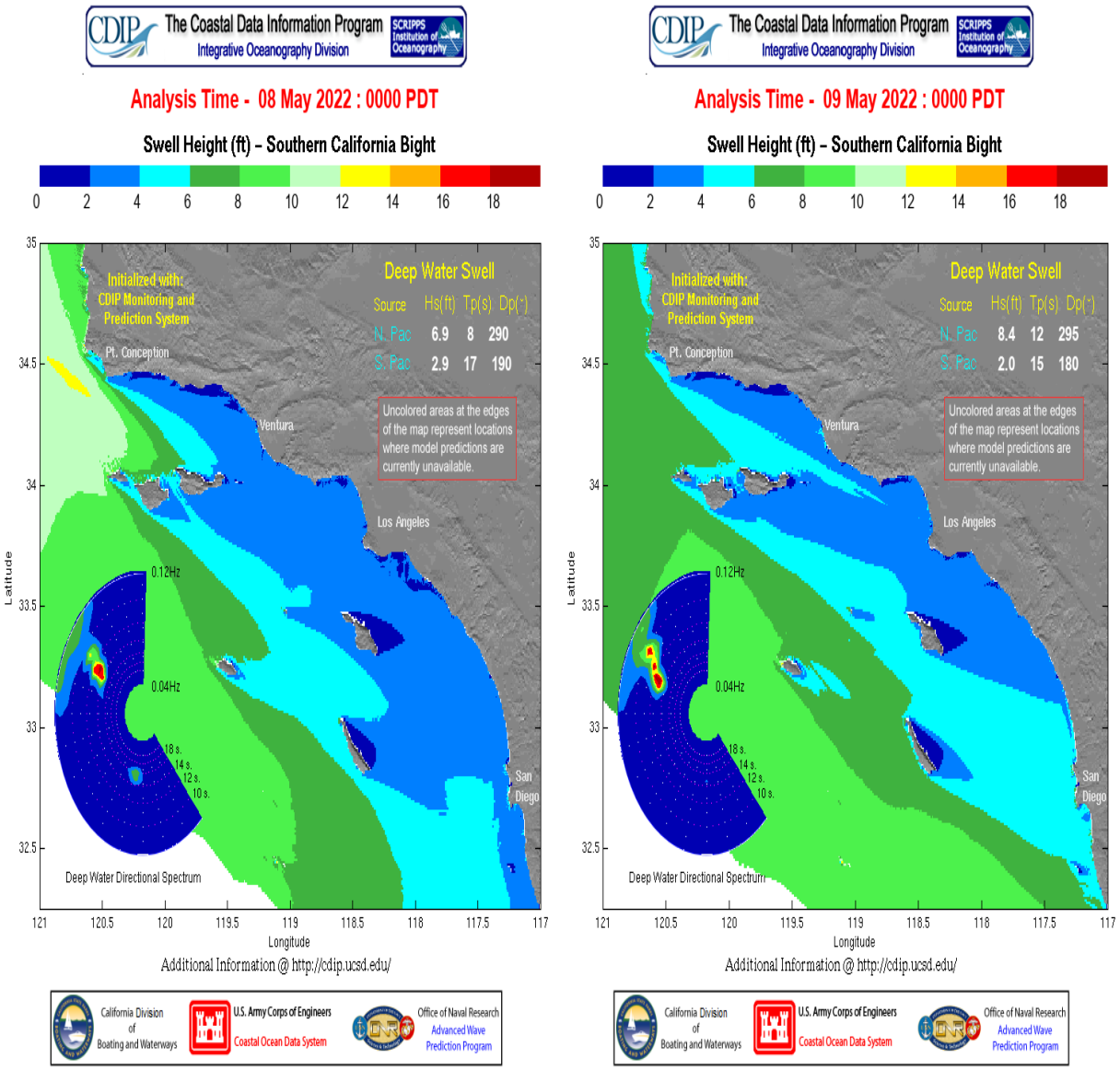


Figure 26. Swell height and direction in the Southern California Bight on May 8 and 9, 2022. Source: Coastal Data Information Program (CDIP), http://cdip.ucsd.edu/.

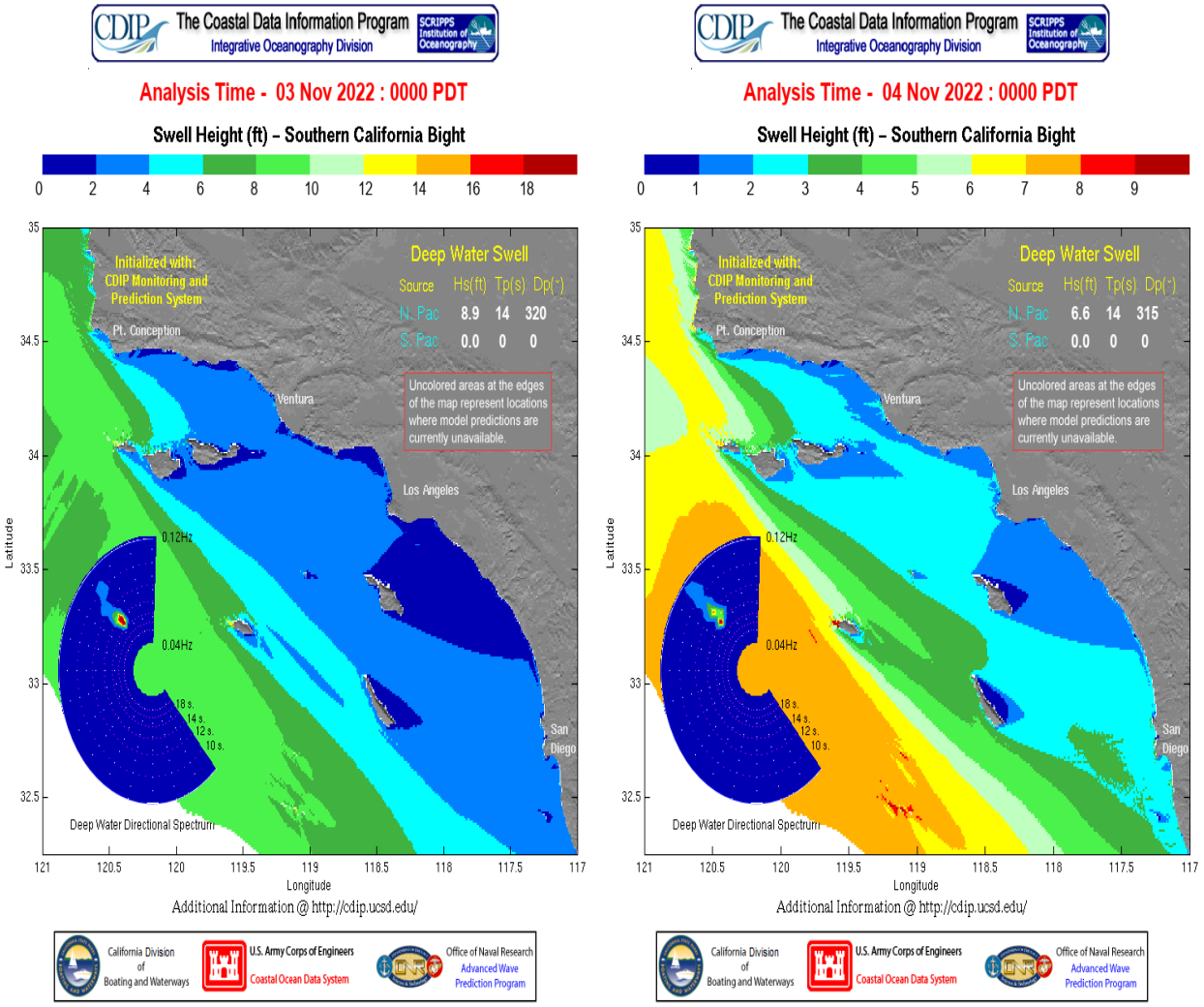


Figure 27. Swell height and direction in the Southern California Bight on November 3 and 4, 2022.

Source: Coastal Data Information Program (CDIP), http://cdip.ucsd.edu/.

IV.2.F - RAINFALL

Periods of sustained high turbidity in southern California waters often result from high rainfall. Rainfall data for 2021 and 2022 for Costa Mesa and San Diego are shown in Figure 28.

The total amount of rainfall in 2021 was well below average for Costa Mesa (8.9 inches compared to an average of 13.3 inches) and for San Diego (7.8 inches compared to an average of 10.3 inches). Although rainfall during the month of December was well above average in Costa Mesa, it was well below average during January, February, March, April, and November, resulting in lower than normal rainfall for the year. Rainfall was above average during the months of August, September, October, and December in San Diego, but was slightly below average in January and March, and well below average in February, April, and May, once again resulting in lower than normal rainfall for the year. Total rainfall was even lower in 2022 for Costa Mesa (3.8 inches) and San Diego (5.9 inches). Rainfall in Costa Mesa was normal in September and November, but well below average most other months. Rainfall in San Diego was above average during the month of September, and close to average for the months of March, November, and December. These low annual rainfall levels were unlikely to generate any extended periods of high turbidity and would not be expected to have affected kelp beds in 2021 or 2022.

IV.2.G - PHYTOPLANKTON

Harmful Algal Bloom (HAB) data were available in real time for certain locations via the SCCOOS website (www.sccoos.org). However, no data on domoic acid concentrations were available for 2021 or 2022.

High concentrations of phytoplankton can effectively exclude light from all but the shallowest depths, which could limit photosynthetic activity at depth and may have been responsible for a portion of the severe impacts on the kelp bed resources observed in 2005 and 2006 (Gallegos and Jordan 2002, Gallegos and Bergstrom 2005).

At Newport Pier, high concentrations of the *Pseudo-nitzschia seriata* group were recorded from January through May 2021 and in February 2022, but concentrations were relatively low for most of the period from June through December of 2021 and most of 2022 (Figure 29). The peak concentration of *Pseudo-nitzschia delicatissima* group was recorded in May 2021, with relatively low concentrations for most of 2021 and 2022. At Scripps Pier, high concentrations of the *Pseudo-nitzschia seriata* group were recorded in April 2021, and April and May 2022 (Figure 30). High concentrations of the *Pseudo-nitzschia delicatissima* group were recorded from January through May 2021, and from January through August 2022. The phytoplankton concentrations recorded in 2021 and 2022 appear unlikely to have impacted kelp beds.

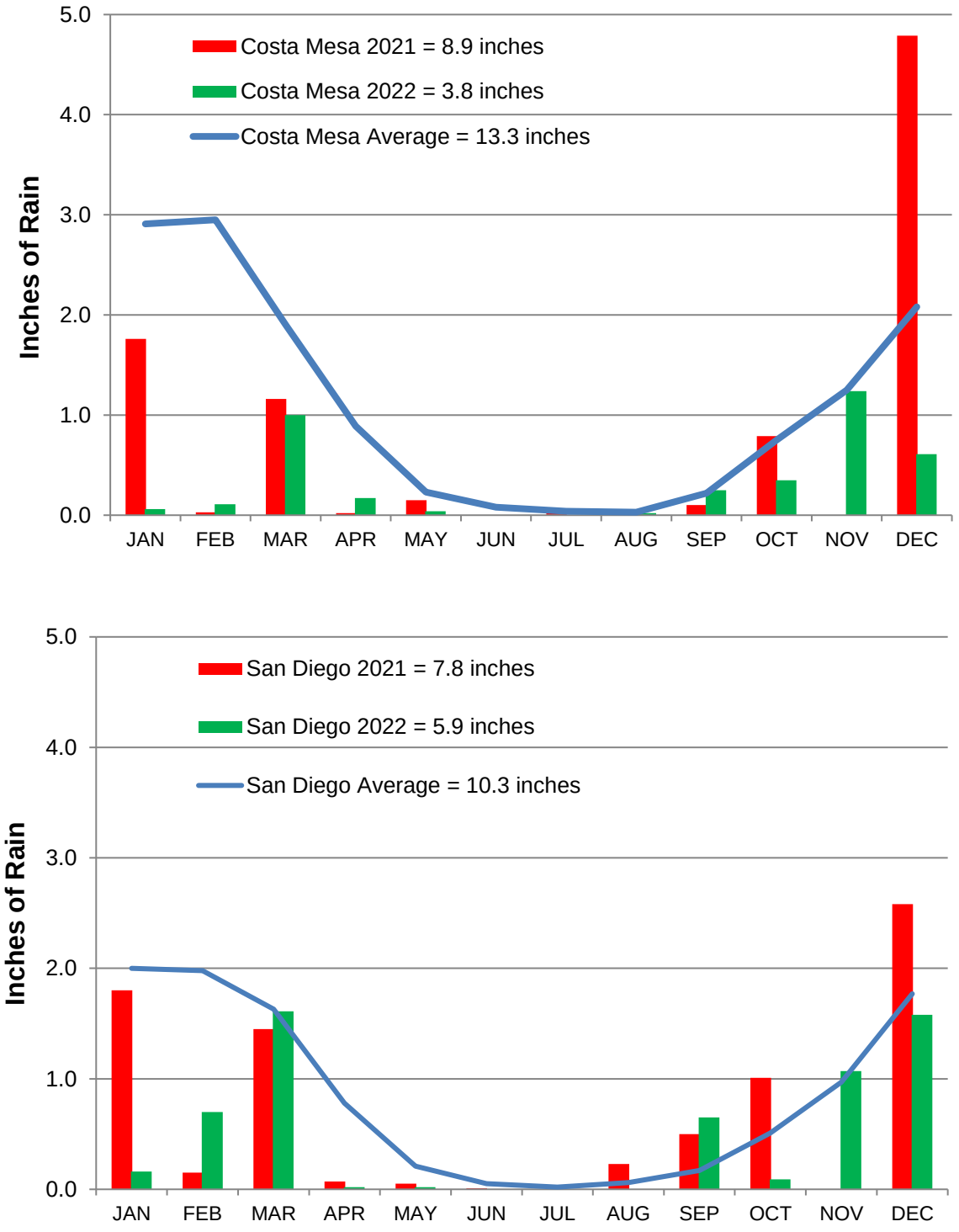


Figure 28. Monthly rainfall for 2021 and 2022 and historical average monthly rainfall recorded for Costa Mesa (John Wayne Airport and San Diego (Lindbergh Field).

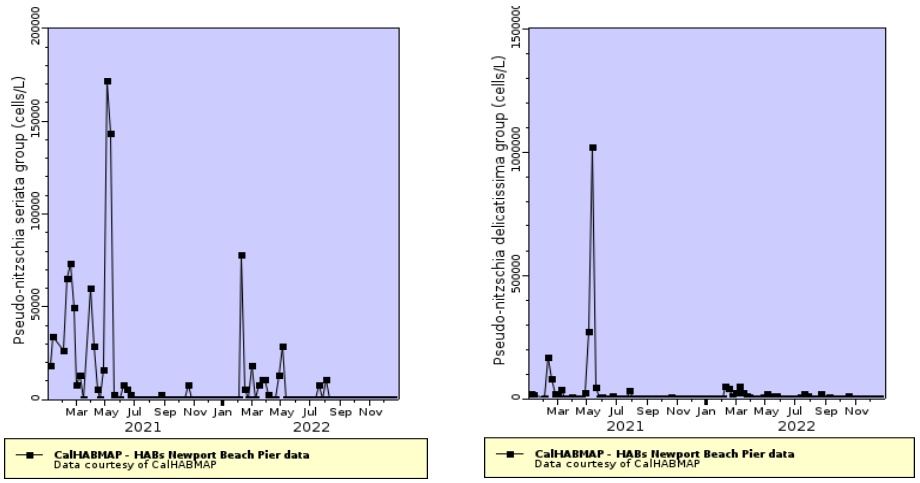


Figure 29. Phytoplankton Concentrations at Newport Pier in 2021 and 2022.

Source: https://sccoos.org/harmful-algal-bloom/

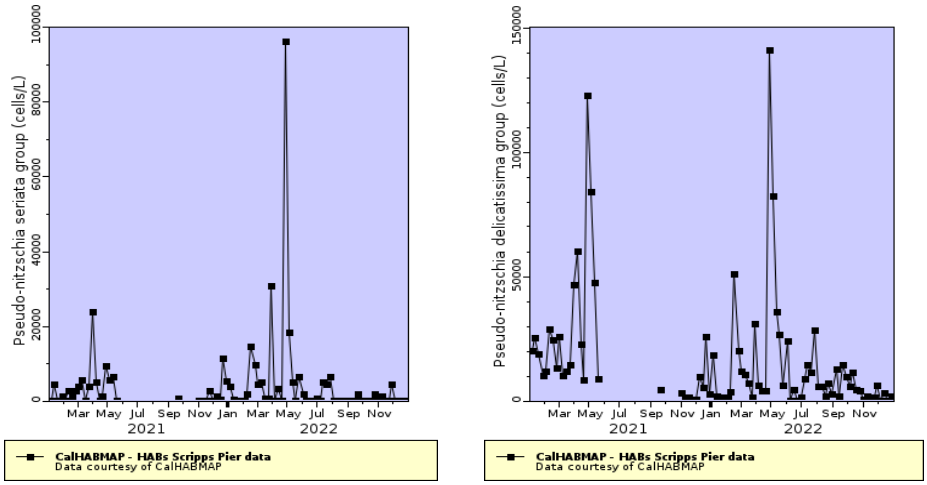


Figure 30. Phytoplankton Concentrations at Scripps Pier in 2021 and 2022.

Source: https://sccoos.org/harmful-algal-bloom/

IV.3 - KELP RESTORATION

Kelp forest restoration aims to reverse the loss of these ecologically and economically important coastal ecosystems. To be successful, restoration projects must first mitigate or remove the cause of decline, which can include ocean warming, overgrazing, habitat destruction, pollution, and overfishing. If there is sufficient propagule supply, removing grazers, adding hard substrate, remediating water quality, or a combination of each, may be enough to restore populations. Additional actions are required when local propagule supply is insufficient or recruitment is limited. Methods to overcome these barriers include introducing reproductive material or donor plants into degraded areas via seeding or transplanting. Notwithstanding these advances, most kelp restoration projects to date have been small scale and short in duration (less than 2 years), and academically motivated. As a result, questions remain about how the field of kelp restoration can meet its goal of restoring populations at scales that match those of degradation or loss (Eger et al., 2020).

General ecosystem restoration principles are well-established and can help guide kelp restoration. These steps involve defining clear goals and criteria to evaluate success, which then allows for (1) designing and (2) implementing the project, followed by (3) evaluating programs to determine if the performance criteria are met. If criteria are not met, these previous steps allow for (4) identifying reasons for failure and (5) using adaptive management to remediate the project to meet its goals (Eger et al., 2020).

Substantial financial resources are needed to support restoration activity. Ecosystem restoration is cost and labor intensive, with median costs of hundreds of thousands of dollars per hectare in marine ecosystems. In addition, failure to engage with local stakeholders is likely to negatively influence the success of restoration projects. Strong institutional support (national, regional, or local) from trusted institutions (such as non-governmental organizations, private industry, and community groups) can increase community support for and participation in restoration projects. In addition, government institutions often have considerable resources to fund projects, as well as the legal authority to mandate restoration work and incentivize restoration projects (Eger et al., 2020).

The protection and restoration of California's kelp forests has emerged as a top priority for the California Ocean Protection Council (OPC) and the California Department of Fish and Wildlife (CDFW). Efforts initiated in 2019 and 2020 are providing resource managers with critical monitoring data, an enhanced understanding of the drivers of kelp loss and persistence, and science-based evaluations of potential kelp restoration approaches. However, significant knowledge gaps remain. In support of OPC's Strategic Plan to Protect California's Coast and Ocean 2020-2025, an Interim Action Plan was developed to summarize current state-supported kelp research and restoration initiatives, as well as other relevant efforts in California; highlight key knowledge gaps; and outline priorities for action in kelp research and monitoring, policy development, restoration, and community engagement (California Ocean Protection Council, 2021). Those priorities include: completing pilot efforts; developing science-based metrics for tracking kelp forest ecosystem health; implementing statewide kelp forest monitoring based on those metrics; initiating the development of a kelp restoration and management plan, which will include a restoration "toolkit"; and engaging with California's coastal communities and Native American Tribes. OPC has developed this interim Action Plan in partnership with CDFW to serve as a starting point for discussion between resource managers, the academic community, California Native American Tribes, coastal stakeholders (including the diving and fishing communities), and members of the public.

IV.3.1 Orange County

The Orange County Giant Kelp Restoration Project began in 2002 with an aim to restore historical giant kelp forests along the Orange County Coastline via outreach and education. Orange County Coastkeeper worked with volunteers to grow, plant, and monitor giant kelp in northern Orange Country. Restoration sites, control sites, and a reference site were chosen in Crystal Cove State Park (Newport Beach), Heisler Park (Laguna Beach) and Salt Creek (Dana Point). Volunteers working with marine biologist Nancy Caruso also removed sea urchins that had overpopulated kelp reefs, relocating them to deeper water. Following these projects, there was more kelp in the area than had been observed for the previous 30 years. However, the warm water conditions since 2013 have contributed to decreases in the sizes of kelp beds in these areas. One factor that may be impeding recovery of the kelp beds is the abundance of an invasive species known as devil weed (*Sargassum horneri*). This species forms dense beds and may crowd out giant kelp. Nancy Caruso (Get Inspired, Inc) is currently seeking permission from CDFW to remove devil weed from a number of experimental sites to determine whether this action would promote recovery of giant kelp. However, since these areas fall within a marine protected area, legislative action would be required to allow this work to proceed.

IV.3.2 San Diego County

Beginning in 2002, the kelp beds at San Clemente were enhanced by the placement of approximately 50 small artificial reefs (each measuring 40 m x 40 m) on barren sand at depths of about 12 to 15 m. Kelp immediately recruited to these reefs, and canopies in the shape of small squares were visible during most of the aerial surveys of 2002 and 2003. In early 2008, Southern California Edison (SCE) added additional reef material (covering 0.712 km^2 in total) and kelp recruited to the new reefs in late 2008. However, SCE determined that the 174-acre San Clemente reef was only sustaining approximately half the volume of fish required by its 1991 agreement with the California Coastal Commission (required to support 28 tons of fish and 150 acres of kelp forest annually for 32 years). Monitoring results indicated that the reef was not on a trajectory to meet the mitigation goal for kelp area (although this was met from 2010 through 2015, it was not met in 2009 or 2016) and fish standing stock (was not met from 2009 through 2016).

In February 2019, the Coastal Commission approved the SCE proposal to construct an additional 210-acre kelp reef to expand the existing 174-acre Wheeler North Reef. The project started in July 2019, but was paused in October 2019 at the beginning of the lobster season. Construction resumed in early June 2020 and was completed in July 2020, ahead of schedule. The reef now encompasses 376 acres, stretching from Seal Rock to Dana Point. According to scientists from the University of California, Santa Barbara, Marine Science Institute, monitoring data collected in 2021 for the Wheeler North Reef indicated that it was meeting most performance expectations (food chain support, resident fish density, young-of-year density, fish species richness, fish reproductive rates, fish production, sessile invertebrate percent cover, mobile invertebrate density, and total invertebrate species richness), but did not meet the standards for algal percent cover or algal species richness.

A revised method for calculating mitigation credits was adopted in 2019. The annual standing stock of fish and acreage of giant kelp at Wheeler North Reef are measured each year and will be summed over time until they reach a cumulative total equivalent to the annual target x the number of years of San Onofre Nuclear Generating Station (SONGS) operations (32 years). The reef produced 34 acres of kelp in 2019, 4 acres in 2020, and 47 acres in 2021, as well as 18 tons of fish standing stock in 2019, 22 tons in 2020, and 28 tons in 2021. In total, 4,800 acres of giant kelp area credit will be required for mitigation plus 896 tons of fish standing stock credit (presentation to San Onofre Community Engagement Panel on May 19, 2022 by representatives of SONGS).

IV.4 - KELP HARVESTING

The California Department of Fish and Wildlife (CDFW) has designated 87 administrative kelp beds located offshore of California's mainland coast and surrounding the Channel Islands. These kelp beds contain giant kelp (*Macrocystis*) or bull kelp (*Nereocystis*), or a combination of both. As of November 2016, each kelp bed falls within one of the four management categories: open, leasable, lease only, or closed (Table 14). Kelp areas 1 and 2 are open, 3 is leased, 4, 5, and 6 are leasable (except for portions that are closed within marine protected areas), 7, 8, and 9 are open (except for portions of 9 that are closed within marine protected areas), and 10 is closed (see Figure 2 for designated kelp areas).

Table 14. Administrative management categories for California kelp beds.

Open	Available to harvest by all commercial kelp harvesters	33 kelp beds
Leasable	Available to harvest by commercial kelp harvesters until an exclusive lease is granted by the California Fish and Wildlife Commission, then only available to lessee	28 kelp beds (5 currently leased)
Lease only	Commercial harvest of kelp is prohibited unless an exclusive lease is granted by the California Fish and Wildlife Commission	3 kelp beds
Closed	Commercial harvest of kelp is prohibited	18 kelp beds

Approximately 41% of the State's kelp beds have been designated as available for leasing, while approximately 38% have been designated as available for kelp harvest by any licensed kelp harvester (ensuring that smaller kelp harvesters have access to kelp and are not shut out by lease agreements). Approximately 21% of kelp beds are closed to kelp harvesting, as harvest has been deemed too potentially disruptive to the environment.

All commercial harvesters of marine algae must purchase an annual commercial kelp harvester license and abide by commercial algae harvest regulations (California Code of Regulations, Title 14, Sections 165 and 165.5). In 2020, 32 licenses were issued in California (13 for giant kelp). The license must specify the intent to participate in specified seaweed harvesting categories. The categories differ in the intended use. Historically (prior to 2011), the categories were edible seaweed, kelp, and agar. Algae harvested as edible seaweed must be used for human consumption, while algae harvested as kelp can be used for purposes other than human consumption, e.g., feed for cultivated abalone. Algae harvested as agar historically were harvested for agar extraction, although this is not a current use. In 2011, the Department split the kelp category on the licenses into giant kelp and bull

kelp and added “bull kelp human consumption” as an option for edible seaweed to better understand kelp targets and intended uses.

Eelgrass (*Zostera* species) and surfgrass (*Phyllospadix* species) are prohibited from commercial harvest. There currently are no provisions for the commercial harvest of other large kelps, such as elk kelp (*Pelagophycus*), feather boa kelp (*Egregia*), or members of the genus *Pterygophora*. Members of the genera *Porphyra*, *Laminaria*, *Monostrema*, and other aquatic plants utilized fresh or preserved as human food are classified as edible seaweeds. Agar-bearing marine algae are defined as members of the genera *Gelidium*, *Pterocladia*, *Gracilaria*, *Iridaea*, *Gloiopeltis*, and *Gigartina*. Edible and agar algae harvesting are governed by CDFW regulations.

Kelp harvesters may not cut attached giant and bull kelp at a depth greater than four feet below the sea surface at the time of cutting, may not allow cut kelp to escape from harvest, must weigh and report the amount harvested, and must pay a royalty to the State for each wet ton of kelp harvested. A Commission-approved Kelp Harvest Plan is required for kelp bed lease holders and for the mechanical harvest of kelp in all locations where harvest is allowed.

The California Fish and Game Commission adopted regulation amendments and new regulations for commercial harvest of kelp and other marine algae that became effective on January 1, 2023. The revised regulations include California Code of Regulations Title 14, sections 165 and 165.5, Appendix A, and the new Section 705.1.These regulations include temporary changes that expire on Jan. 1, 2026. The changes aim to reduce harvest pressure on bull kelp, which is in decline in Sonoma and Mendocino counties.

The new regulations pertain to all commercial harvest of marine algae. The more substantive changes pertaining to licensing and reporting requirements include:

- The harvesting license is now known as the Kelp Harvesting License and Drying Application, and will include a drying option for those who dry their harvest.
- Monthly harvest reports will require reporting the number of individuals harvesting for the business during the reporting period, and central latitude/longitude coordinates of bull kelp harvest locations.
- The Commercial Kelp Harvester’s Monthly Report will require separating reporting weights for bull kelp and giant kelp harvest.

In the future, CDFW also plans to review its Royalty Rates and License Fees schedule for commercial harvesters. The royalty rates for kelp were established roughly 25 years ago at $1.71 per wet ton, and the rates for edible seaweed and agar were established roughly 35 years ago at $24 and $17 per wet ton, respectively.

Recreational harvest of marine algae for personal use is permitted in California. Those harvesting for personal use must abide by the regulations governing the recreational harvest. The daily bag limit for recreational harvesters of marine algae is 10 pounds wet weight in the aggregate. Commonly harvested kelp and marine algae include bull kelp (*Nereocystis luetkeana*), giant kelp (*Macrocystis pyrifera*), grapestone or Turkish washcloth (*Mastocarpus papillatus*), bladderwrack (*Fucus distichus*), kombu (*Laminaria setchellii*), wakame (*Alaria marginata*), sea cabbage or sweet kombu (*Saccharina sessilis*), bladder chain kelp or sea fern (*Stephanocystis osmundacea*), nori *Pyropia* spp.), and sea lettuce (*Ulva* spp.). Recreational harvest regulations are under review (Rebecca Flores-Miller, personal communication). Recreational harvesters are prohibited from harvesting or disturbing eelgrass (*Zostera* spp.), surfgrass (*Phyllospadix* spp.), and sea palm (*Postelsia palmaeformis*). Marine

aquatic plants may not be cut or harvested in state marine reserves. Regulations may prohibit cutting or harvesting of marine aquatic plants within state marine conservation areas and state marine parks (California Code of Regulations, Title 14, Section 632b). The extent of recreational kelp harvest is unknown as recreational marine alga harvesters are not required to report harvest data and the Department does not monitor the number of recreational harvesters or the amount of their harvest. Department staff estimated that prior to 2000, less than 25 tons were harvested annually by recreational and Tribal users (**http://wildlife.ca.gov/Conservation/Marine/Kelp/Commercial-Harvest**).

Commercial marine algae harvest data are shown in Figure 31 for the period from 1931 to 2020 (**https://marinespecies.wildlife.ca.gov/kelp/the-fishery/**). Kelp harvesting peaked in the 1970s, exceeding 150,000 metric tons per year in some years.

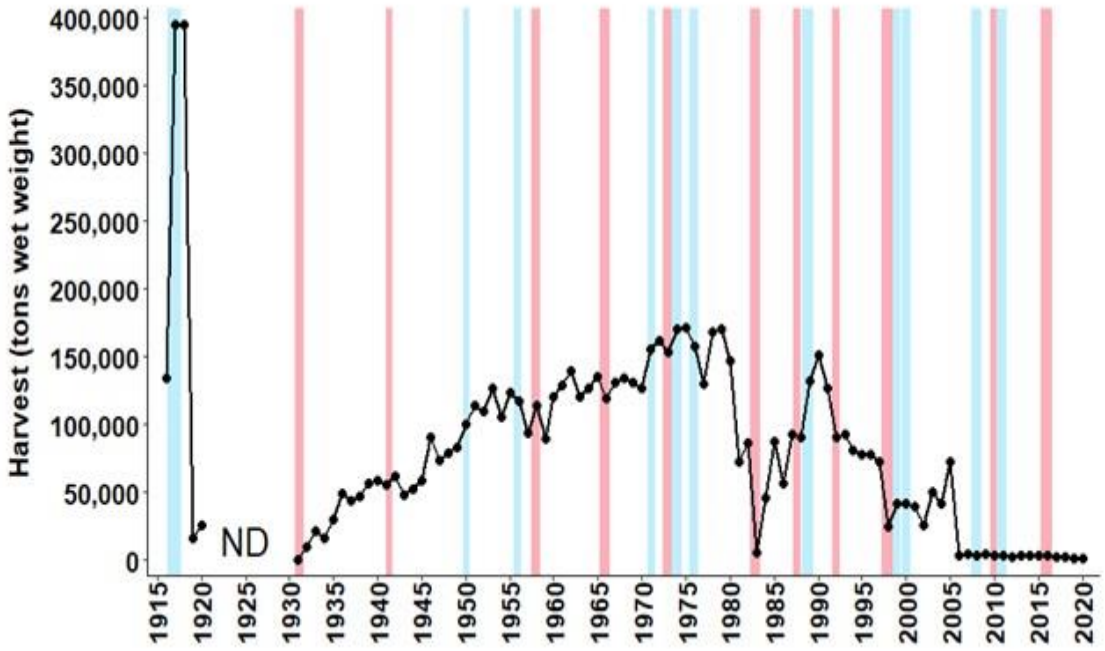


Figure 31. Commercial kelp harvest landings for giant and bull kelp from 1931 through 2020 (most is giant kelp). Red bars indicate El Niño conditions (warm phase of ENSO) and blue bars La Niña (cool phase).

Source: https://marinespecies.wildlife.ca.gov/kelp/the-fishery/.

However, kelp harvesting has been relatively low (less than 5,000 to 10,000 metric tons per year) since 2006. It is unlikely that this low amount of kelp harvesting would have any impact on the health of the kelp beds in Region Nine.

Table 15 illustrates how the RNKSC kelp bed designations correspond to the State of California's administrative lease kelp bed designations. Multiple RNKSC kelp beds fall within each of lease areas 5 through 9. Lease area 4 contains the La Jolla kelp bed, lease areas 2 and 3 contain the Point Loma kelp bed, and lease area 1 contains the Imperial Beach kelp bed.

Table 15. Region Nine kelp bed designations compared to California Department of Fish and Wildlife kelp bed designations.

F & W Lease Area	Region Nine Kelp Bed Designations
Bed 1	Imperial Beach
Beds 2 and 3	Point Loma
Bed 4	La Jolla
Bed 5	Leucadia, Encinitas, Cardiff, Solana Beach, Del Mar, Torrey Pines
Bed 6	North Carlsbad, Agua Hedionda, Encina Power Plant, Carlsbad State Beach
Bed 7	Horno Canyon, Barn Kelp, Santa Margarita
Bed 8	San Clemente, San Mateo Point, San Onofre
Bed 9	North Laguna Beach, South Laguna Beach, South Laguna, Dana Point/Salt Creek, Capistrano Beach

V - CONCLUSIONS

The total kelp canopy in Region Nine declined in both 2021 and 2022, decreasing by 51% overall since 2020. The total kelp canopy was smaller in size than the long-term average, which has occurred in six of the past seven years. The largest kelp beds in Region Nine were the La Jolla and Point Loma kelp beds. Only two kelp beds (North Laguna Beach and Point Loma) in 2022 were larger than 10% of their maximum extent recorded since 1983.

SST values throughout Region Nine were generally warmer than average in 2021 during the months of January, February, November, and December, and warmer than average in 2022 from January through mid-April. In addition, sea surface daily temperature values during these two years rarely fell below 14°C, the threshold below which nutrient availability is favorable to kelp forest growth. There were also a relatively low number of days with cold surface temperatures (lower than 14°C) and a relatively high number of days with warm surface temperatures (greater than 16°C). These factors probably created conditions unfavorable for kelp growth, contributing to the decreases in total kelp

canopy observed in 2021 and 2022. Nutrient Quotient values were lower in 2021 and 2022 than in 2020, which also may have contributed to these declines.

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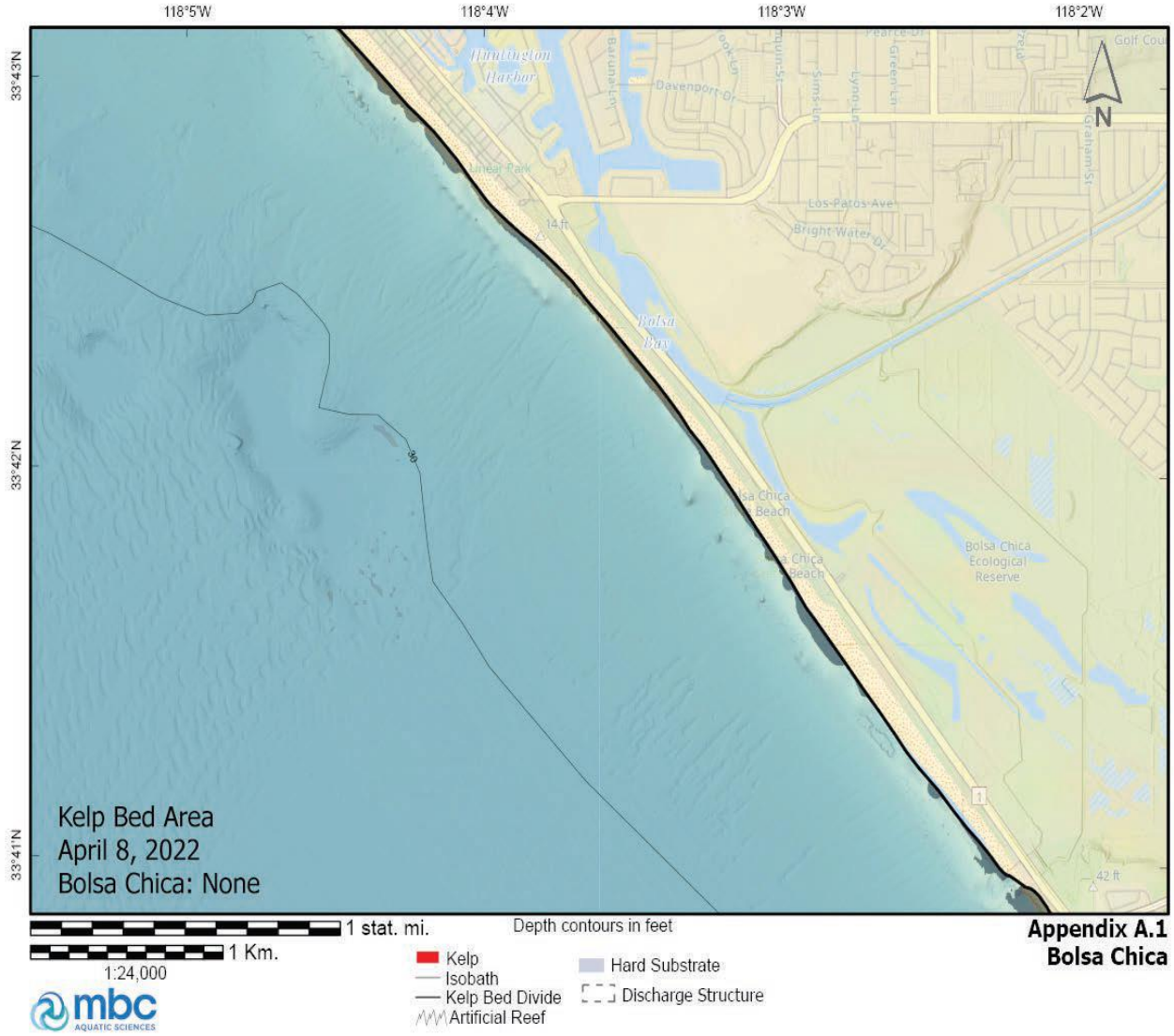
APPENDIX A

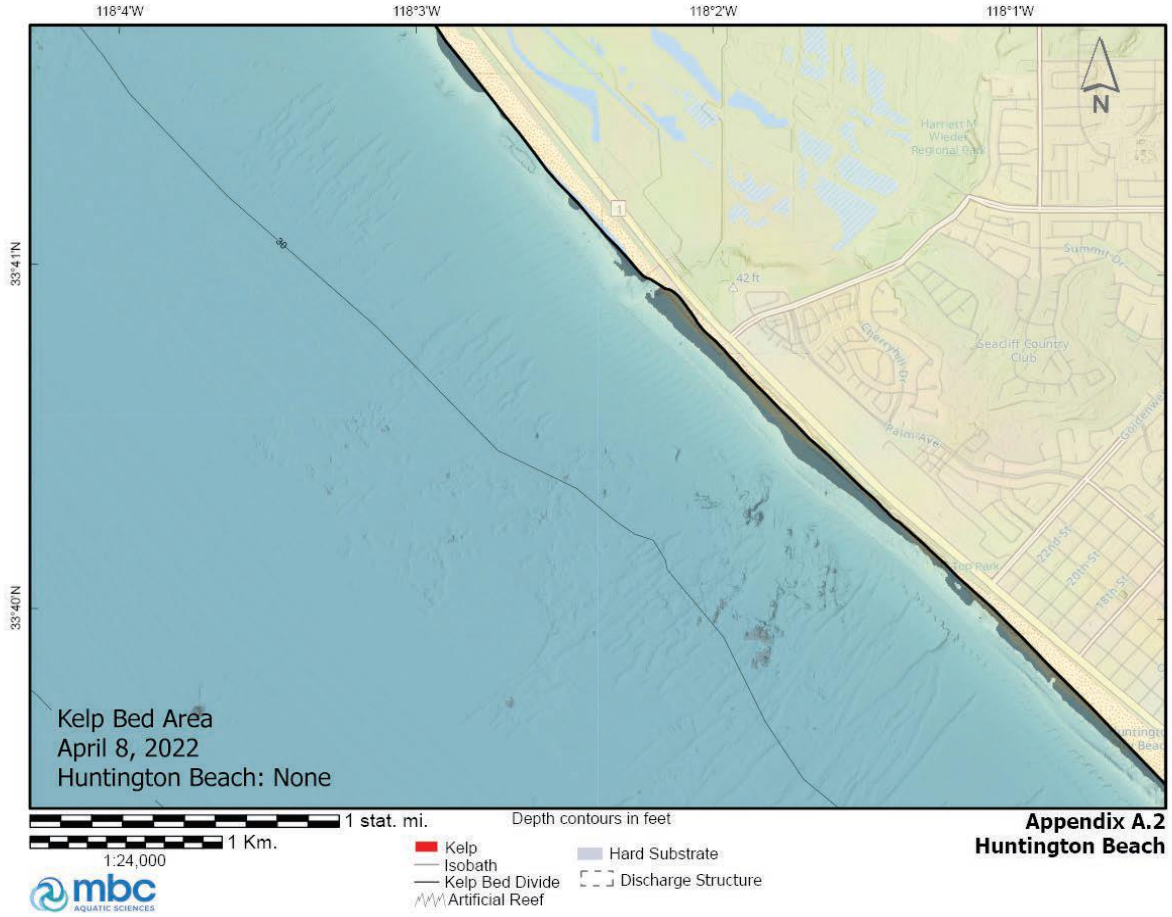
KELP CANOPY MAPS

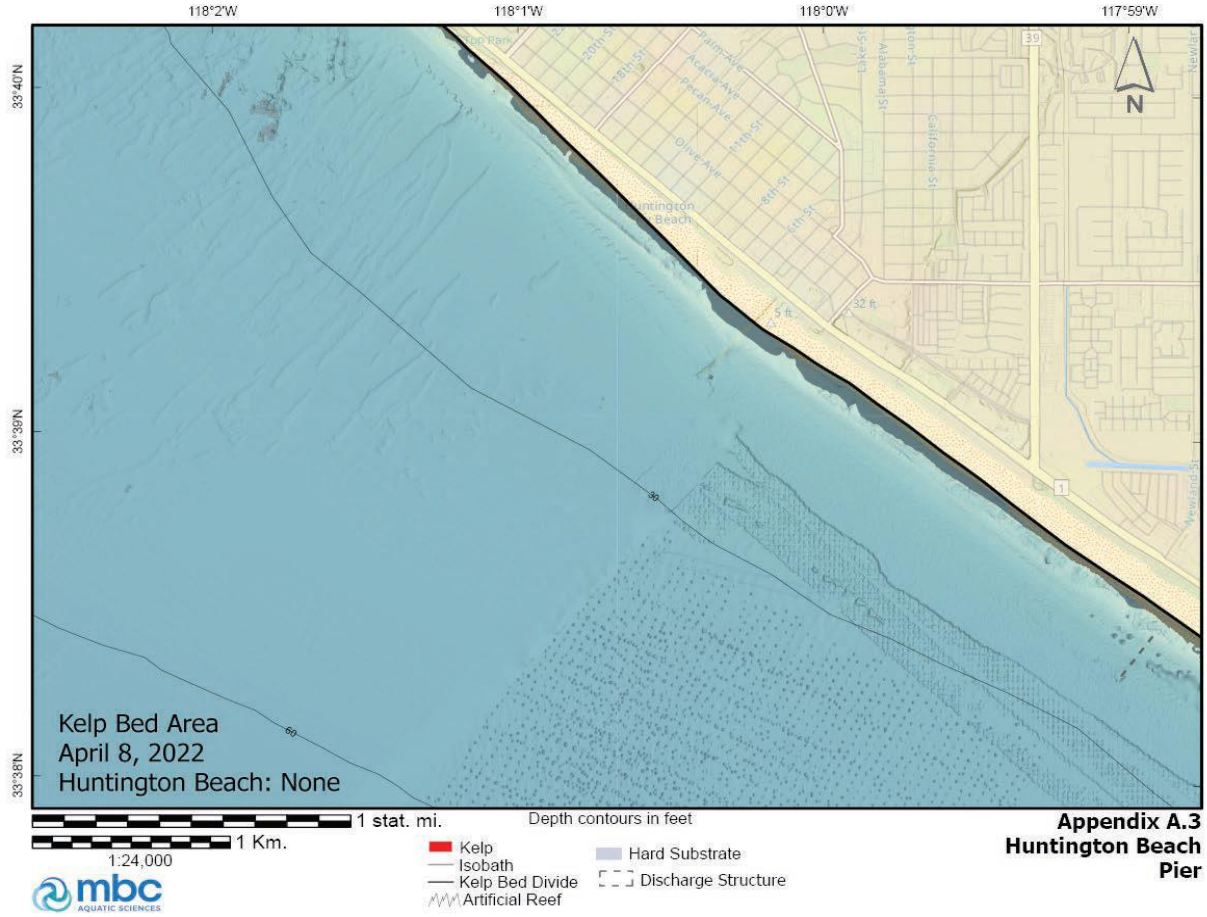
(A.1 TO A.46)



Appendix A.1
Bolsa Chica

Page A-1


118°4'W
118°3'W
118°2'W
118°1'W
33°41'N
33°40'N
N
Harriett M. Wieder Regional Park
42 ft
Seacliff Country Club
Kelp Bed Area
April 8, 2022
Huntington Beach: None
1 stat. mi.
1 Km.
1:24,000
Depth contours in feet
Kelp
Isobath
Kelp Bed Divide
Artificial Reef
Hard Substrate
Discharge Structure
Appendix A.2
Huntington Beach



Appendix A.3
Huntington Beach Pier

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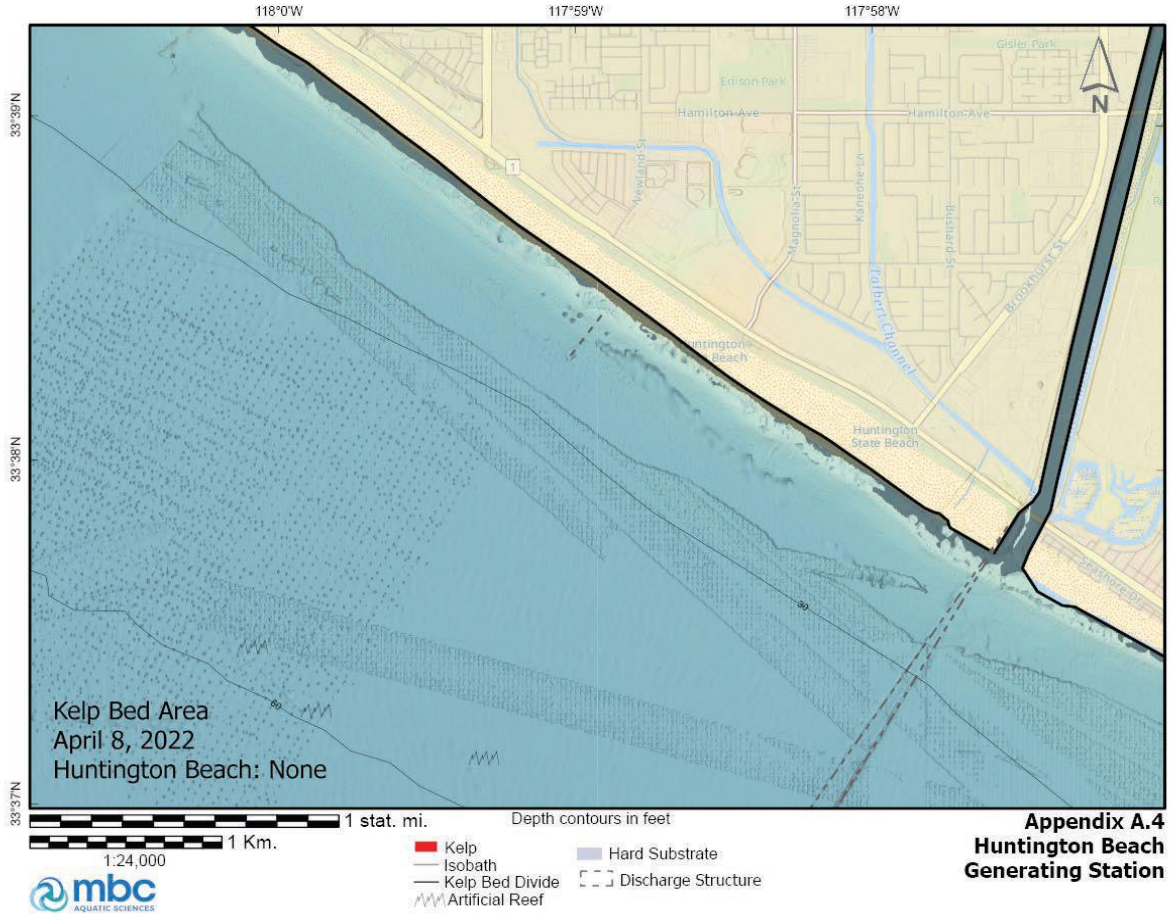
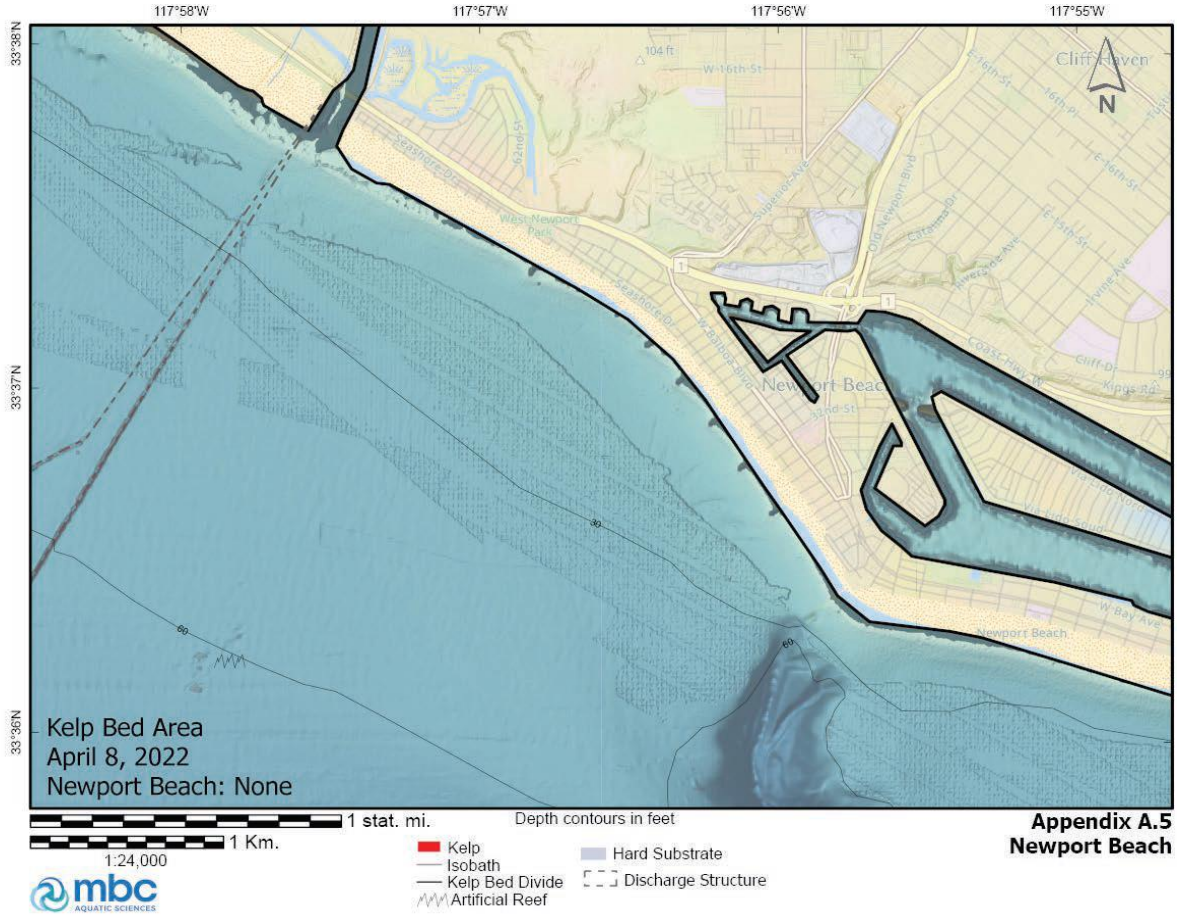
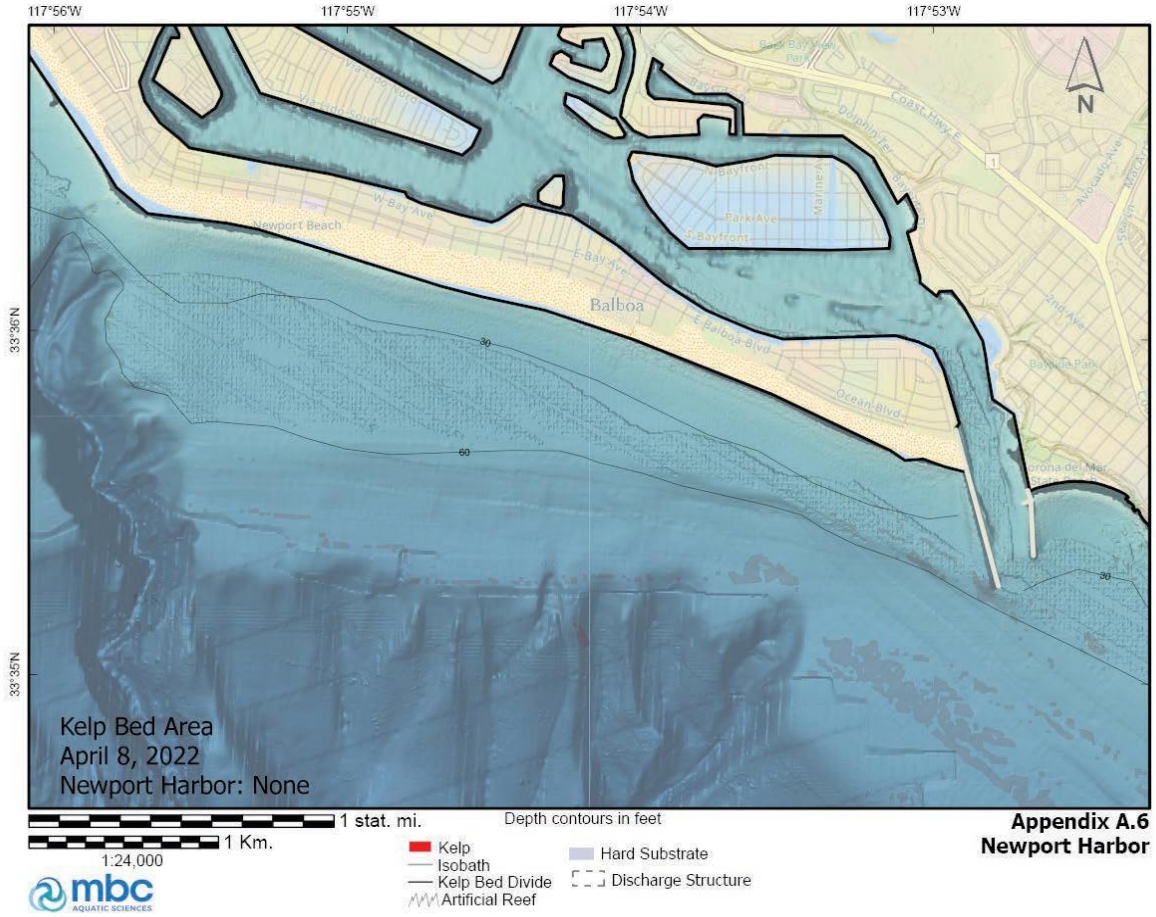
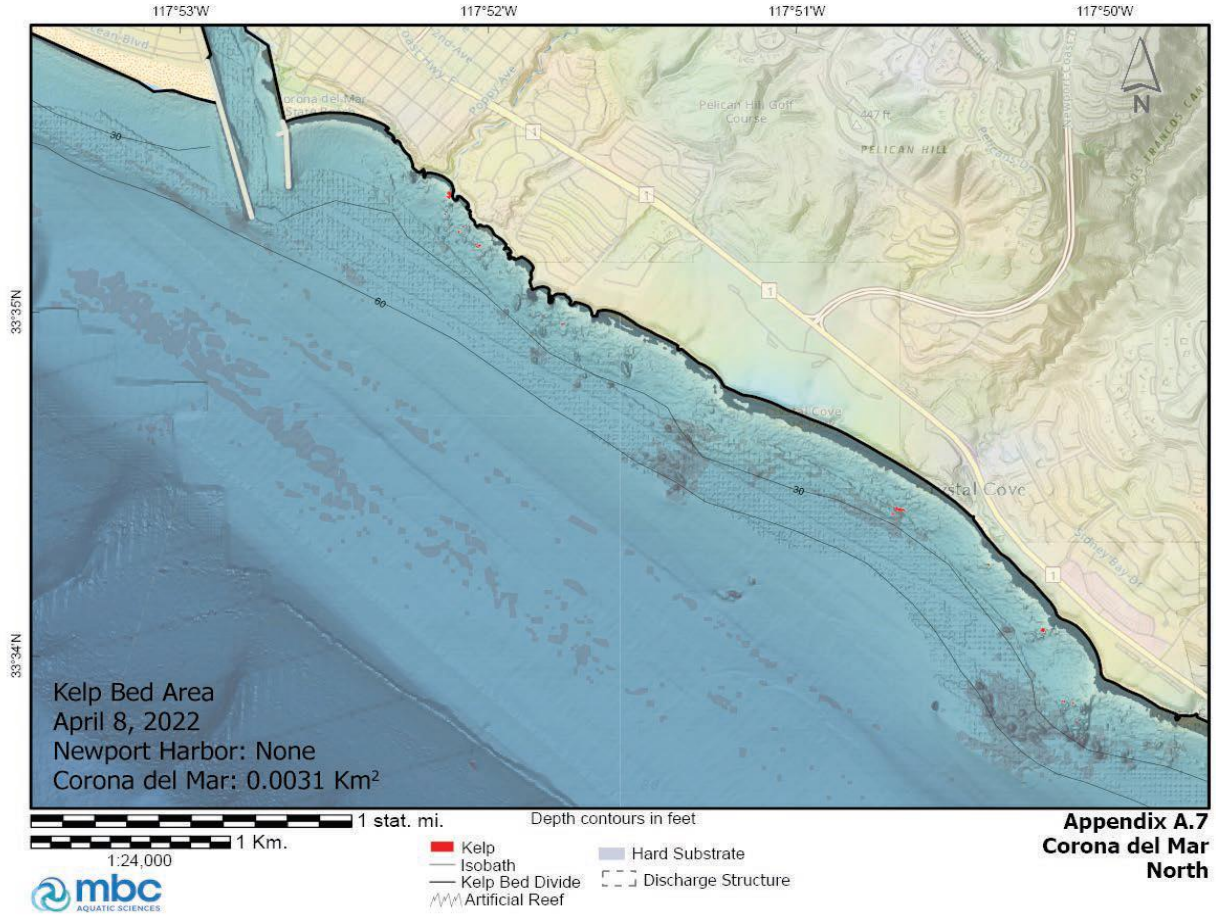


Appendix A.4
Huntington Beach Generating Station

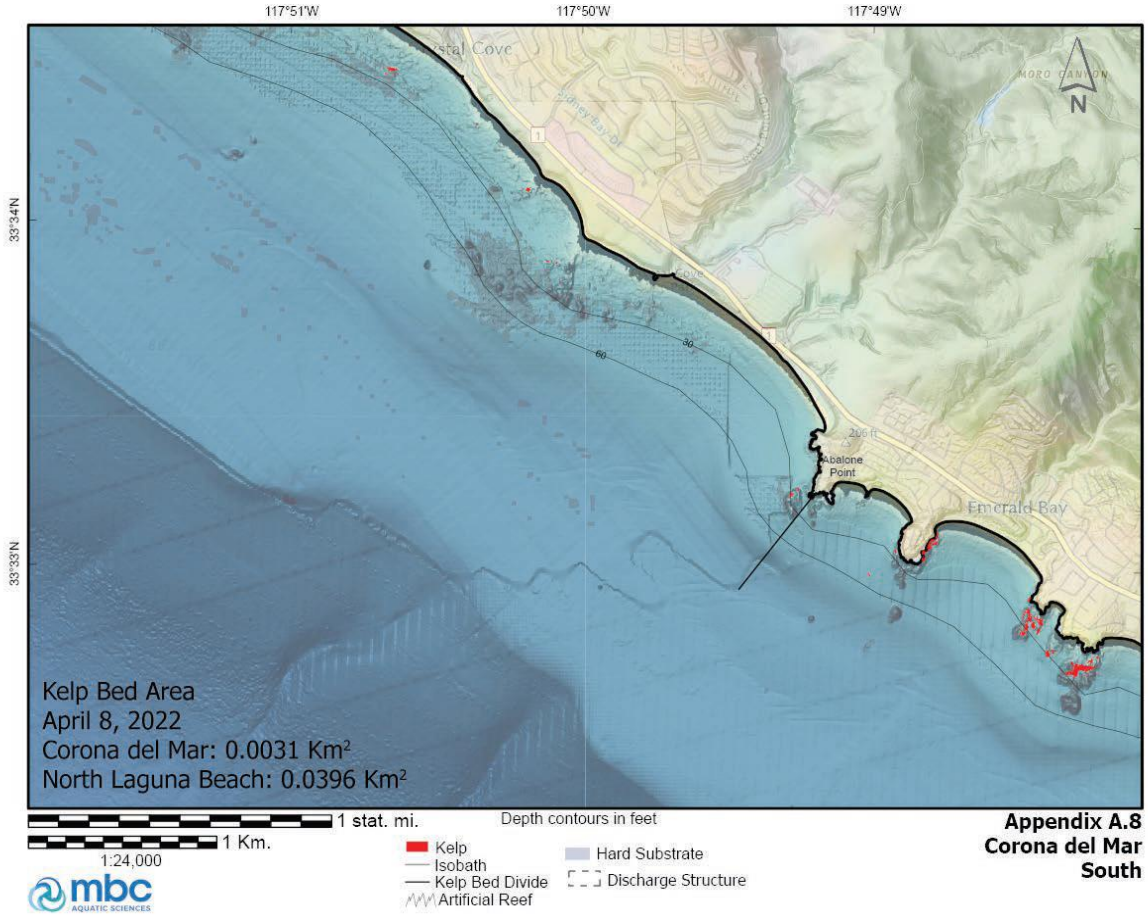

117°58'W
117°57'W
117°56'W
117°55'W
33°38'N
33°37'N
33°36'N
N
Kelp Bed Area
April 8, 2022
Newport Beach: None
1 stat. mi.
1 Km.
1:24,000
Depth contours in feet
Kelp
Isobath
Kelp Bed Divide
Artificial Reef
Hard Substrate
Discharge Structure
Appendix A.5
Newport Beach

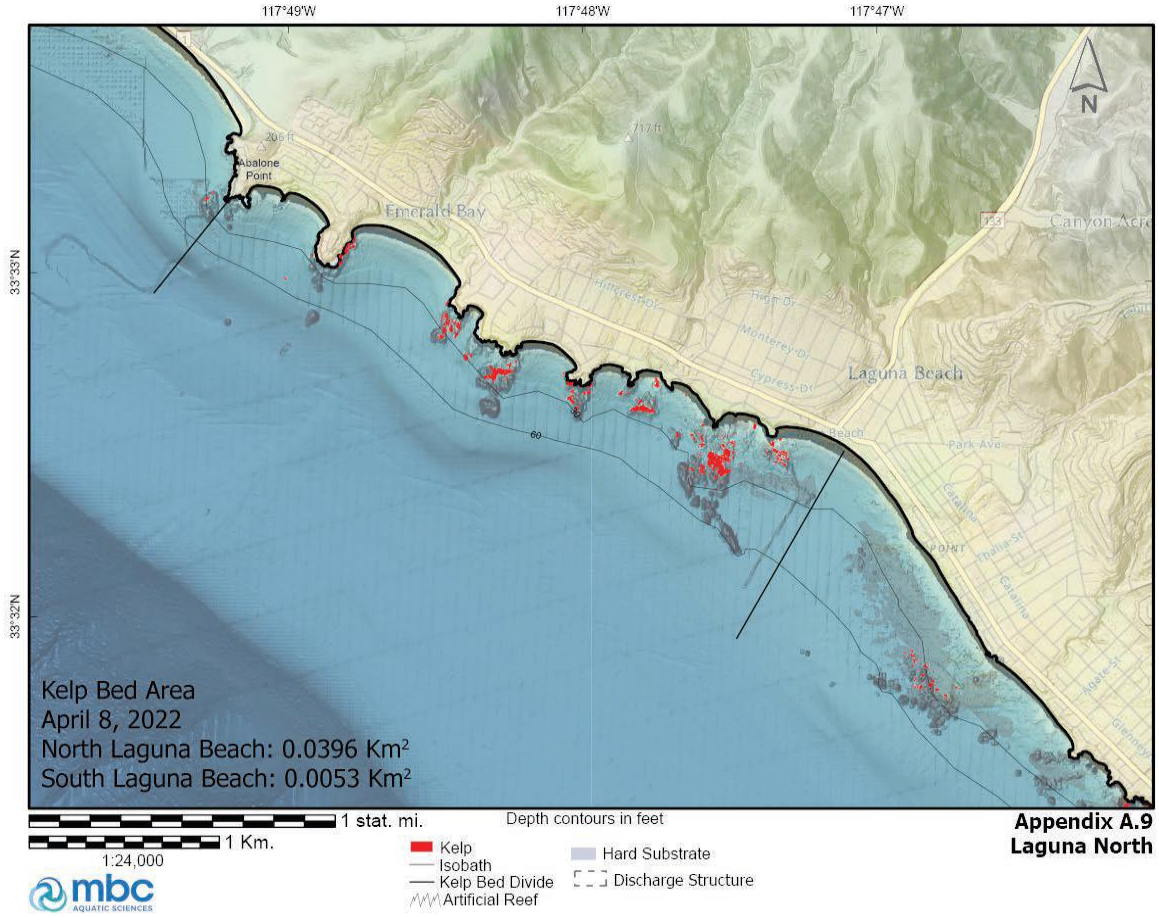


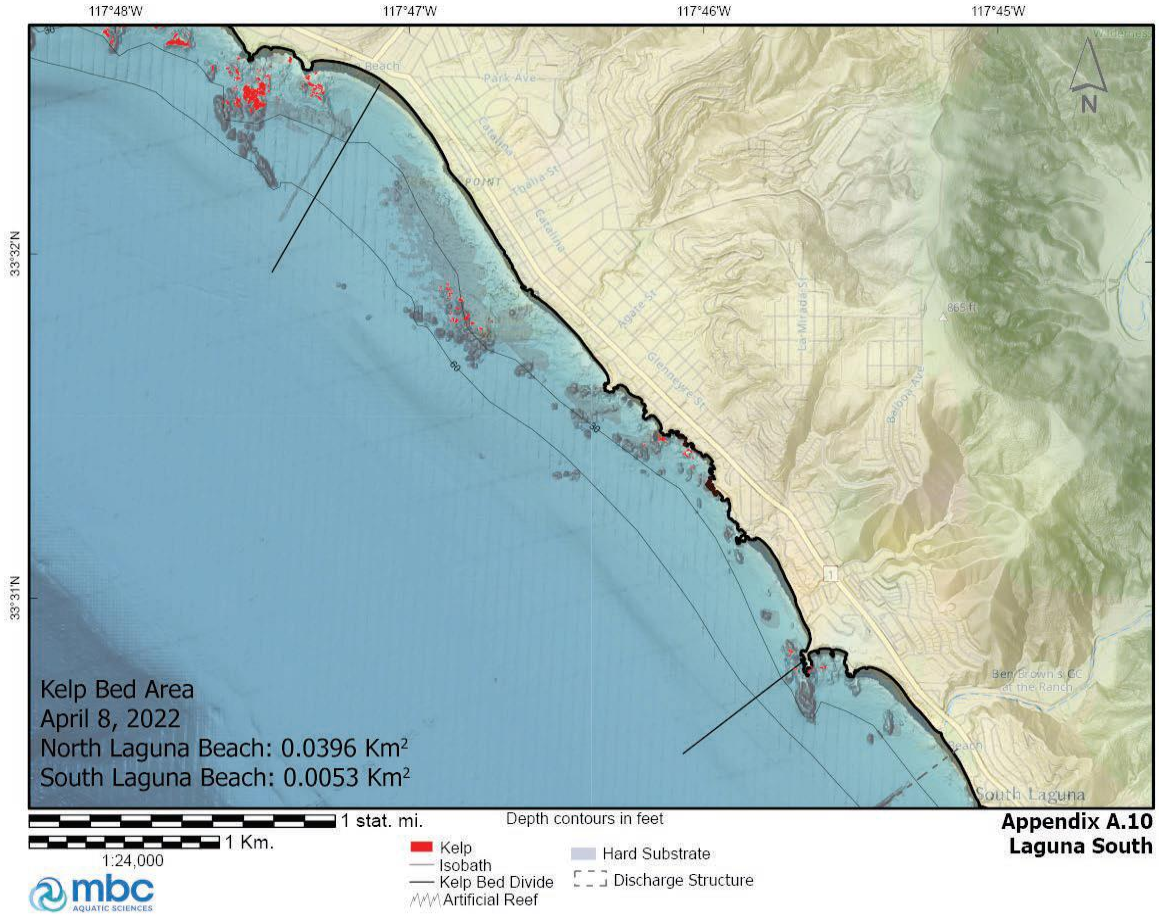
Appendix A.6
Newport Harbor


117°53'W
117°52'W
117°51'W
117°50'W
33°35'N
33°34'N
N
Pelican Hill Golf Course
PELICAN HILL
Corona del Mar
Kelp Bed Area
April 8, 2022
Newport Harbor: None
Corona del Mar: 0.0031 Km²
1 stat. mi.
1 Km.
1:24,000
Depth contours in feet
Kelp
Isobath
Kelp Bed Divide
Artificial Reef
Hard Substrate
Discharge Structure
mbc
AQUATIC SCIENCES
Appendix A.7
Corona del Mar
North

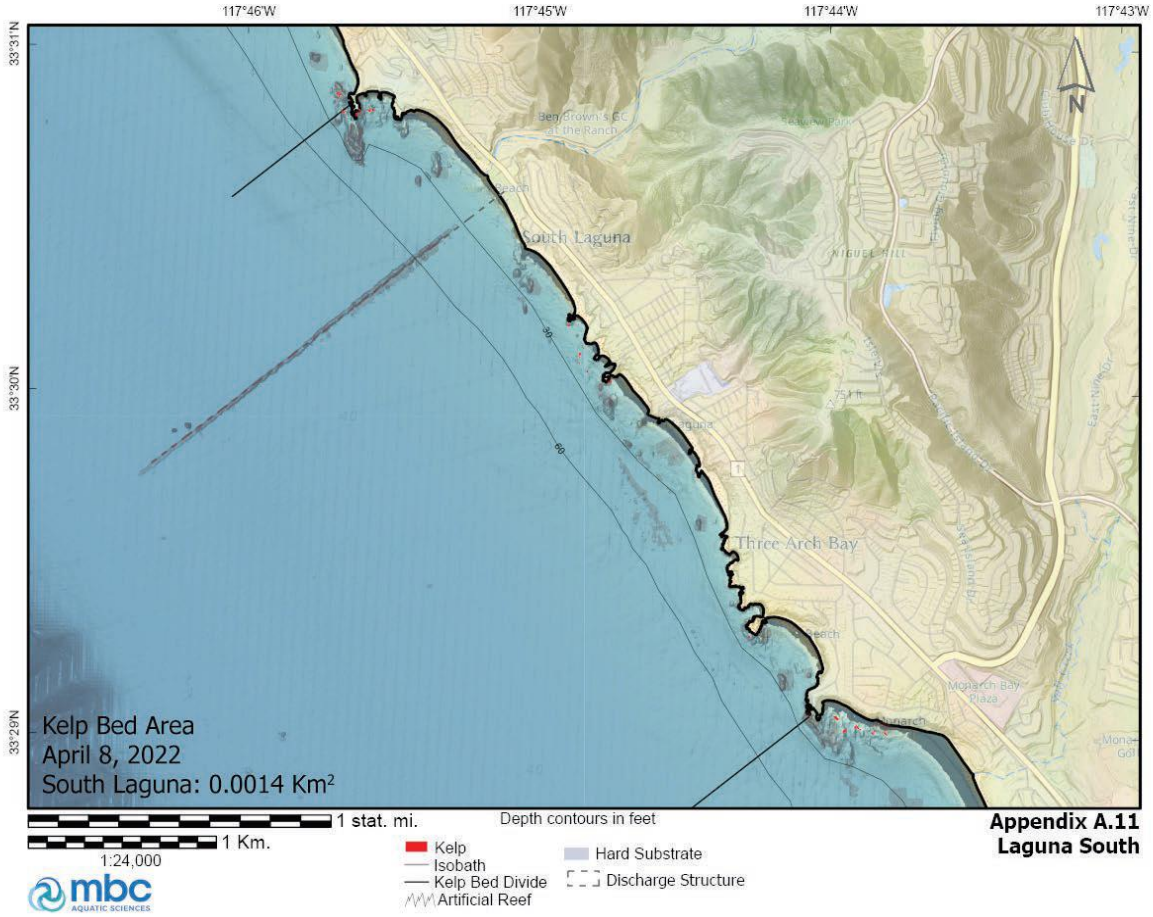
Page A-7

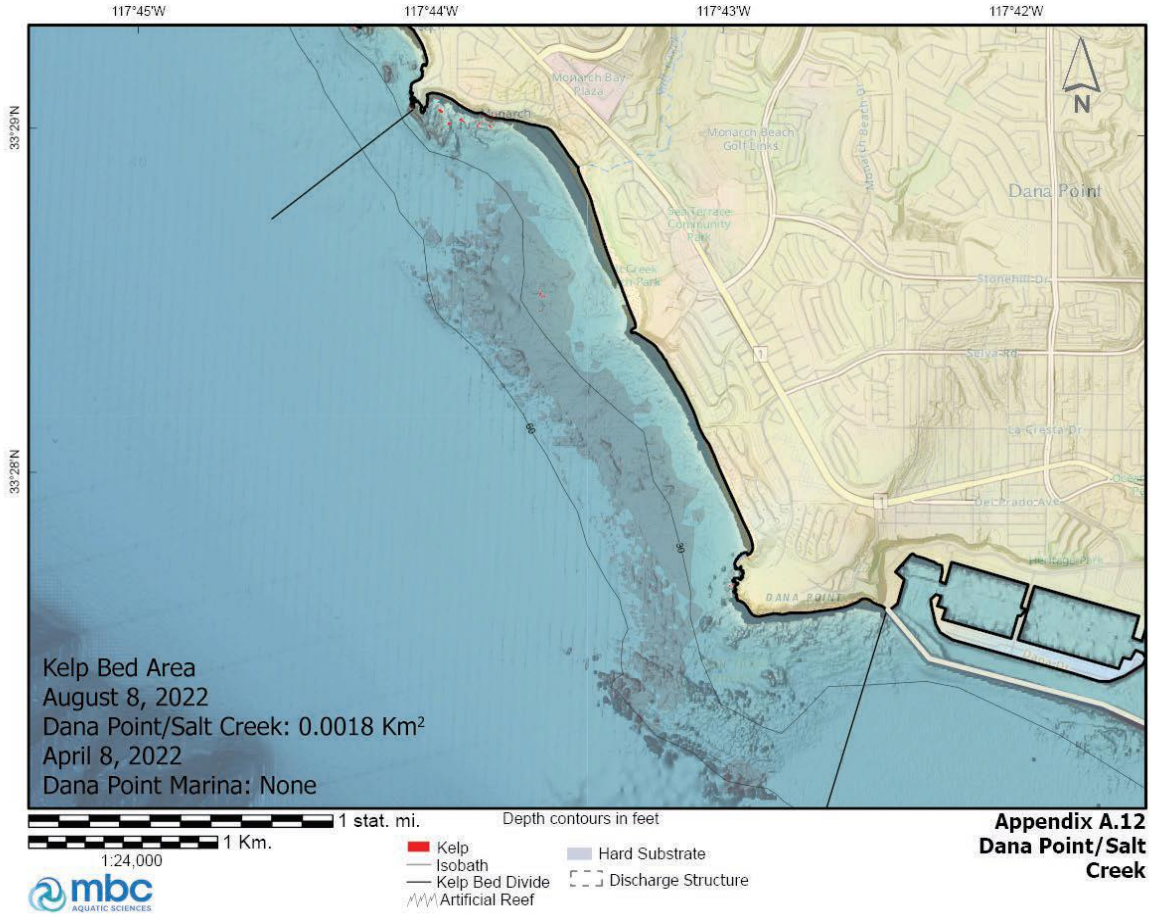

117°51'W
117°50'W
117°49'W
33°34'N
33°33'N
N
Abalone Point
Emerald Bay
Kelp Bed Area
April 8, 2022
Corona del Mar: 0.0031 Km²
North Laguna Beach: 0.0396 Km²
1 stat. mi.
1 Km.
1:24,000
Depth contours in feet
Kelp
Isobath
Kelp Bed Divide
Artificial Reef
Hard Substrate
Discharge Structure
Appendix A.8
Corona del Mar
South

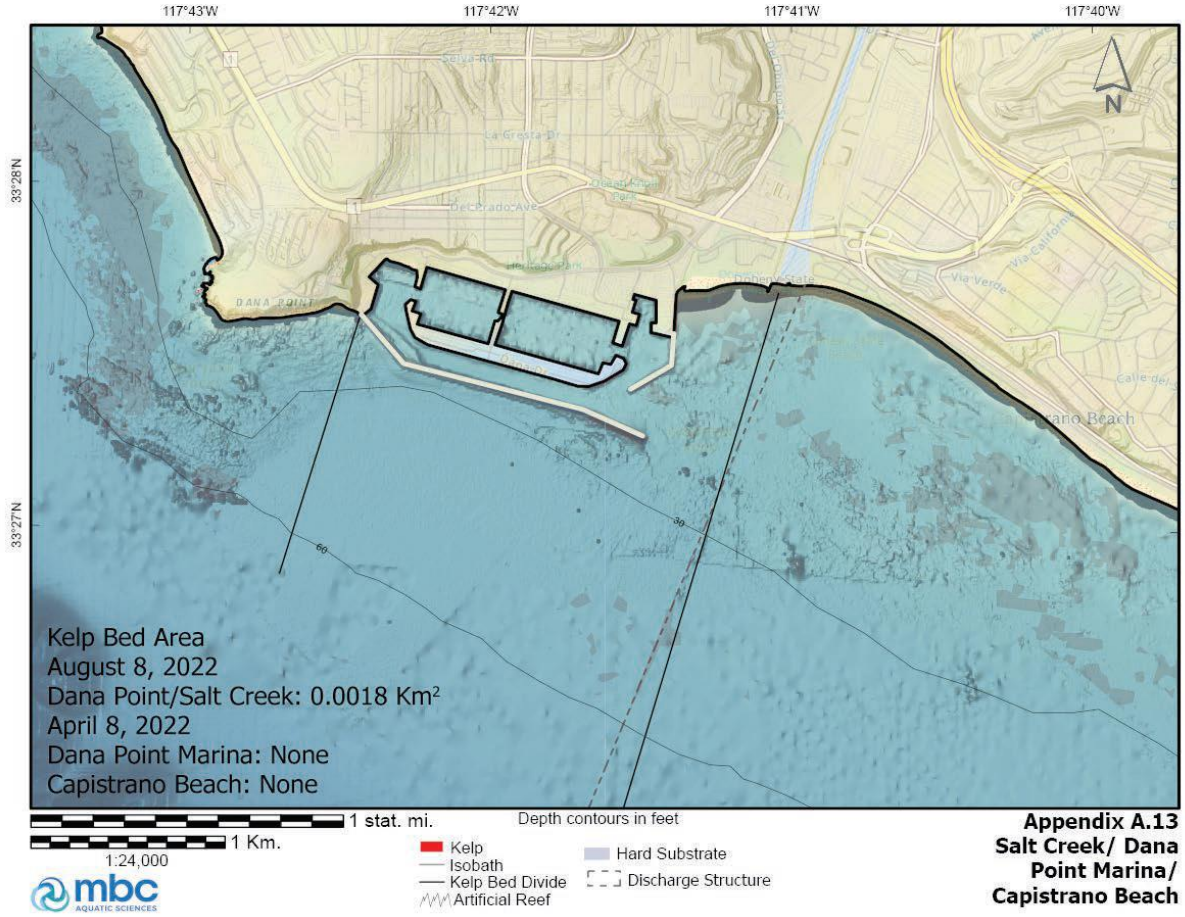

117°49'W
117°48'W
117°47'W
33°33'N
33°32'N
N
Abalone Point
206 ft
717 ft
Emerald Bay
Laguna Beach
Park Ave
Cypress Dr
Monterey Dr
Ruby Dr
Kelp Bed Area
April 8, 2022
North Laguna Beach: 0.0396 Km²
South Laguna Beach: 0.0053 Km²
1 stat. mi.
1 Km.
1:24,000
Depth contours in feet
Kelp
Isobath
Kelp Bed Divide
Artificial Reef
Hard Substrate
Discharge Structure
mbc
AQUATIC SCIENCES
Appendix A.9
Laguna North



Appendix A.10
Laguna South

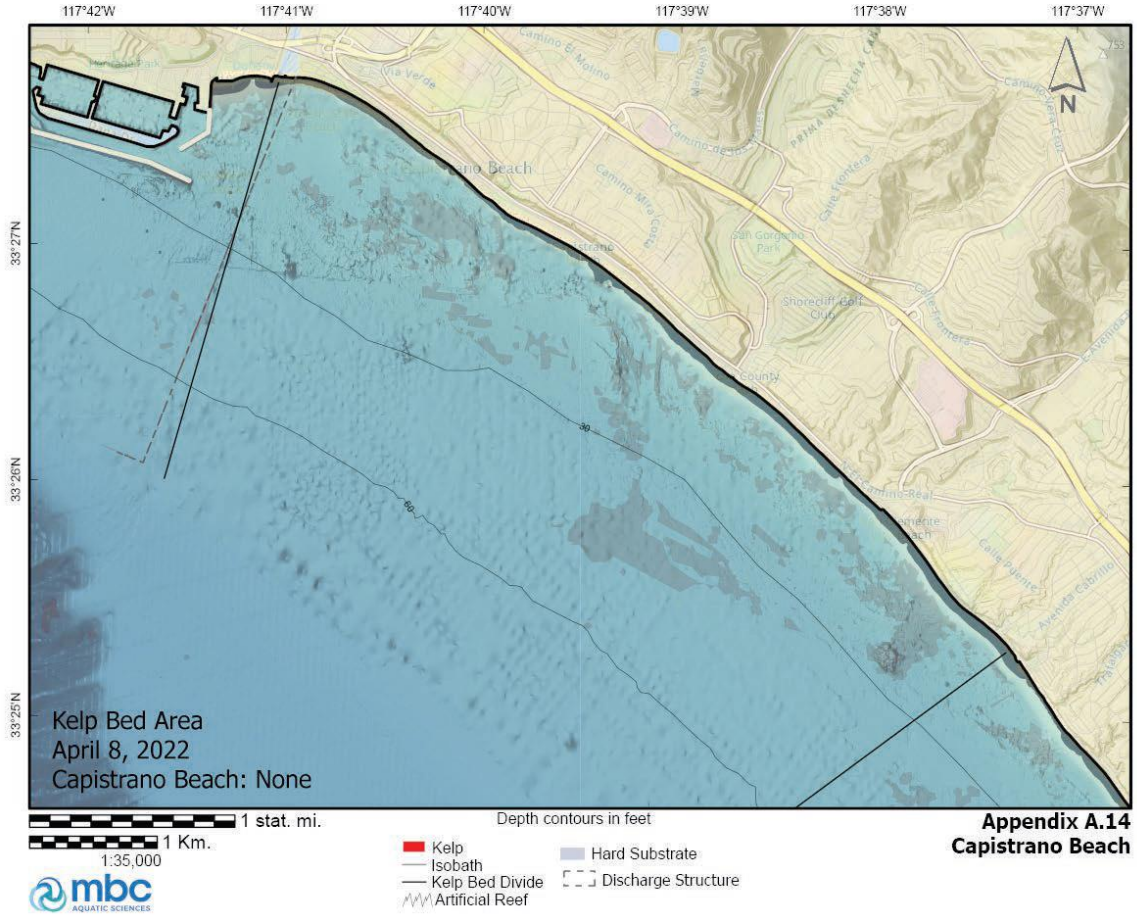

117°46'W
117°45'W
117°44'W
117°43'W
33°31'N
33°30'N
33°29'N
N
South Laguna
Three Arch Bay
Kelp Bed Area
April 8, 2022
South Laguna: 0.0014 Km²
1 stat. mi.
1 Km.
1:24,000
Depth contours in feet
Kelp
Isobath
Kelp Bed Divide
Artificial Reef
Hard Substrate
Discharge Structure
Appendix A.11
Laguna South

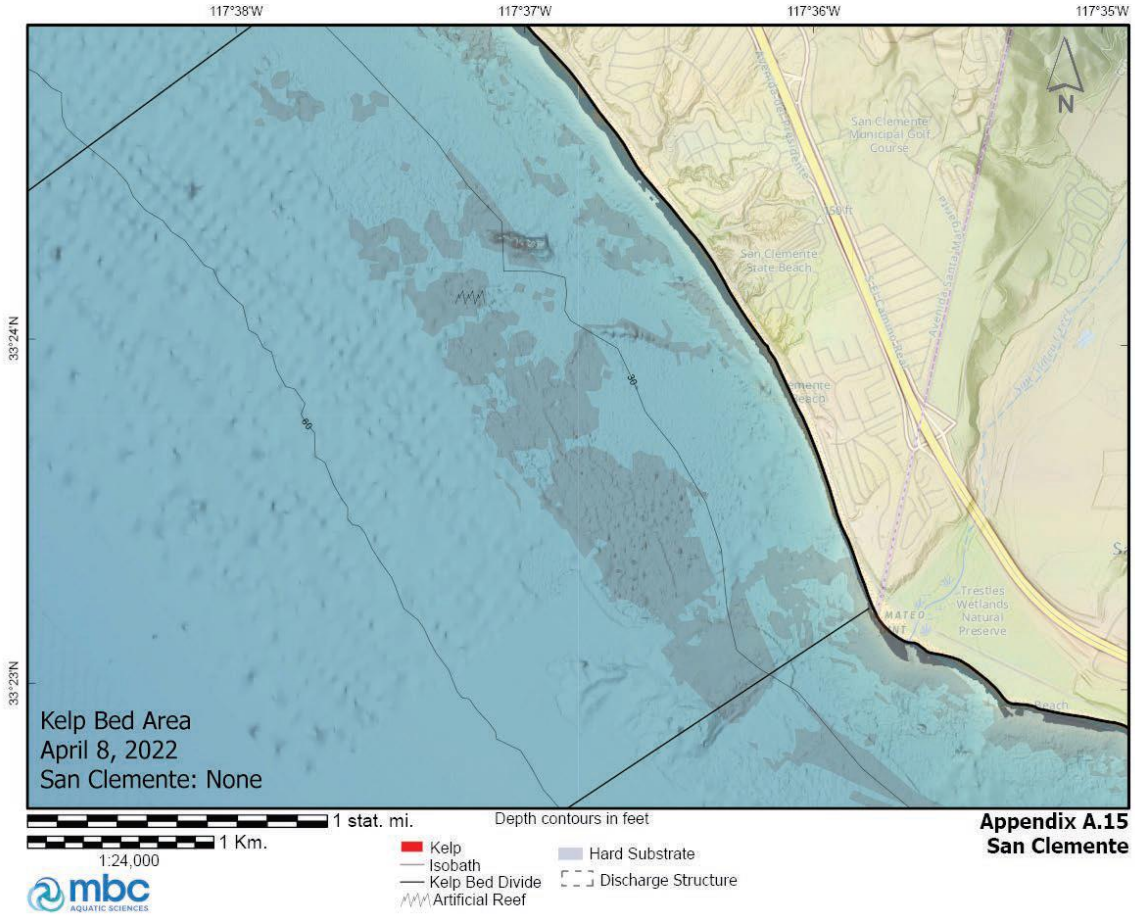

117°45'W
117°44'W
117°43'W
117°42'W
33°29'N
33°28'N
N
Dana Point
Kelp Bed Area
August 8, 2022
Dana Point/Salt Creek: 0.0018 Km²
April 8, 2022
Dana Point Marina: None
1 stat. mi.
1 Km.
1:24,000
Depth contours in feet
Kelp
Isobath
Kelp Bed Divide
Artificial Reef
Hard Substrate
Discharge Structure
Appendix A.12
Dana Point/Salt Creek

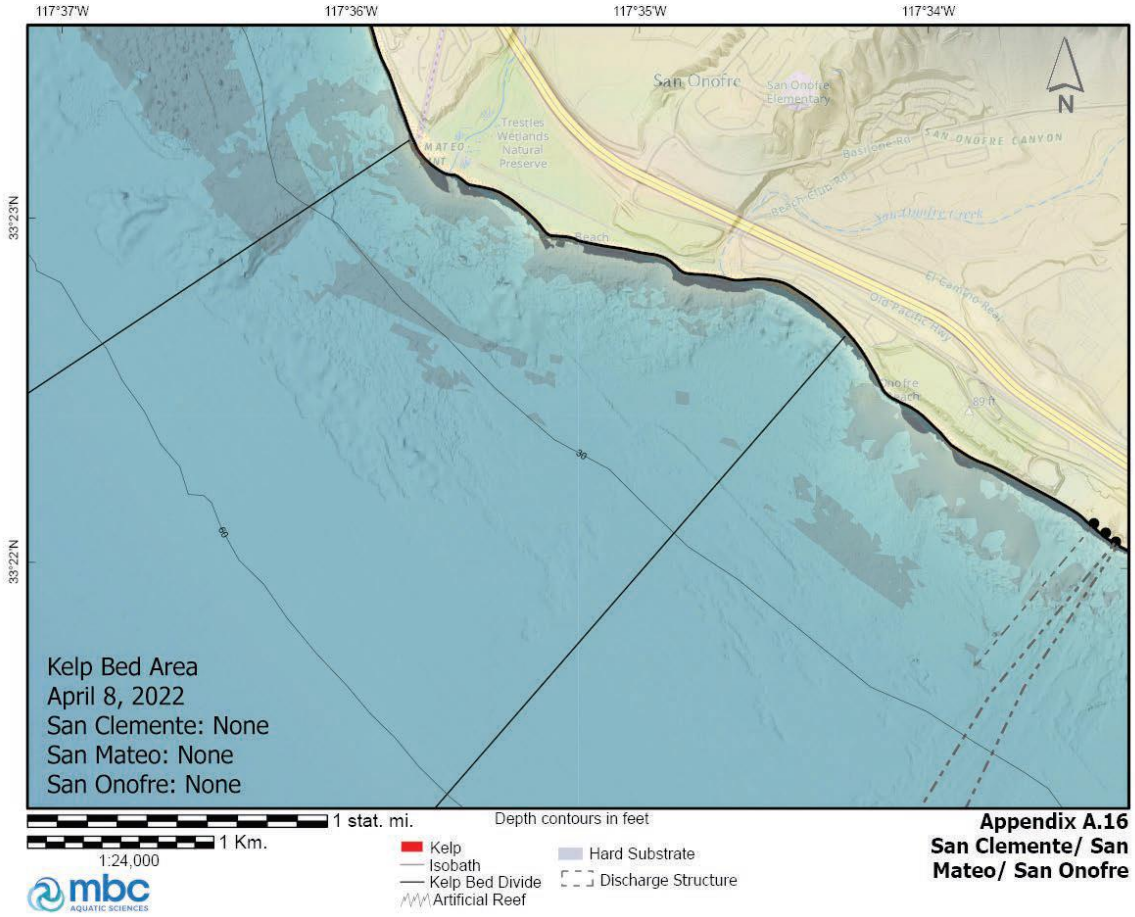


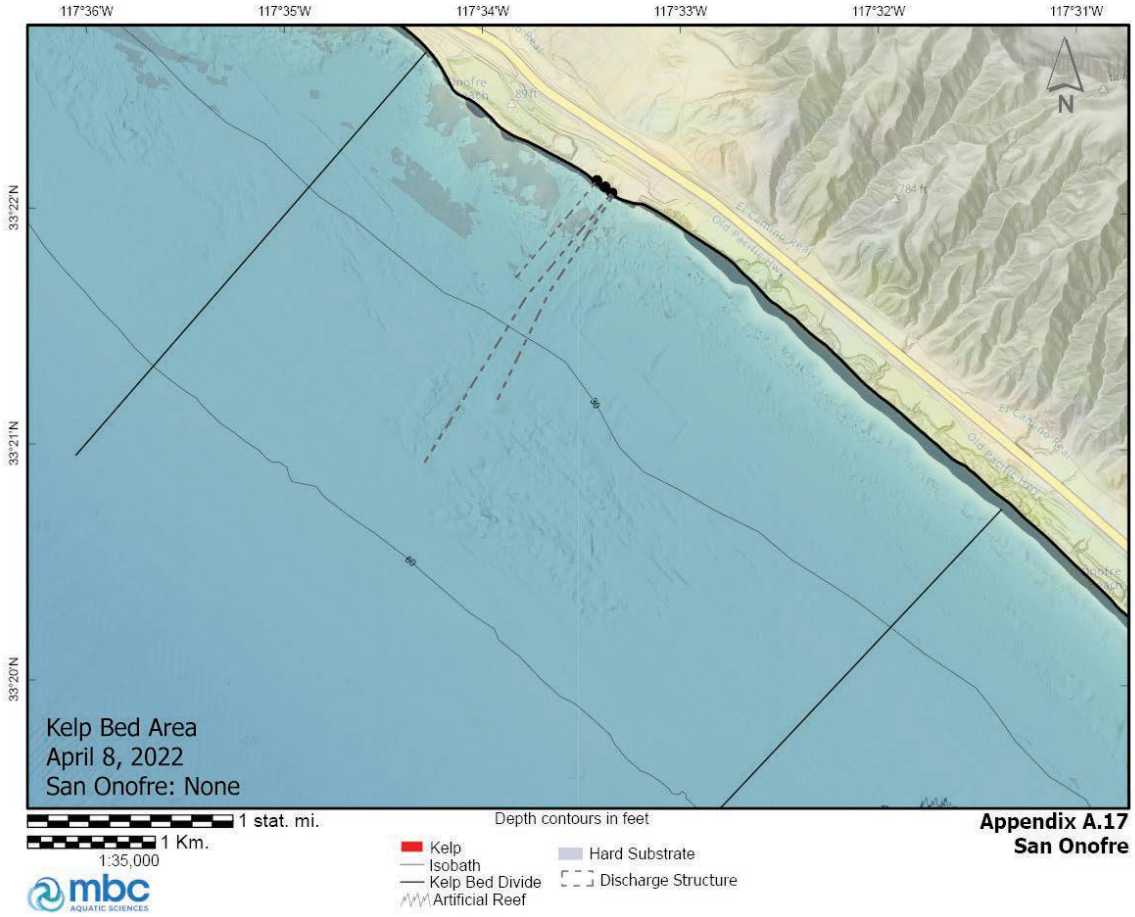
Appendix A.13
Salt Creek/ Dana Point Marina/ Capistrano Beach

Page A-13

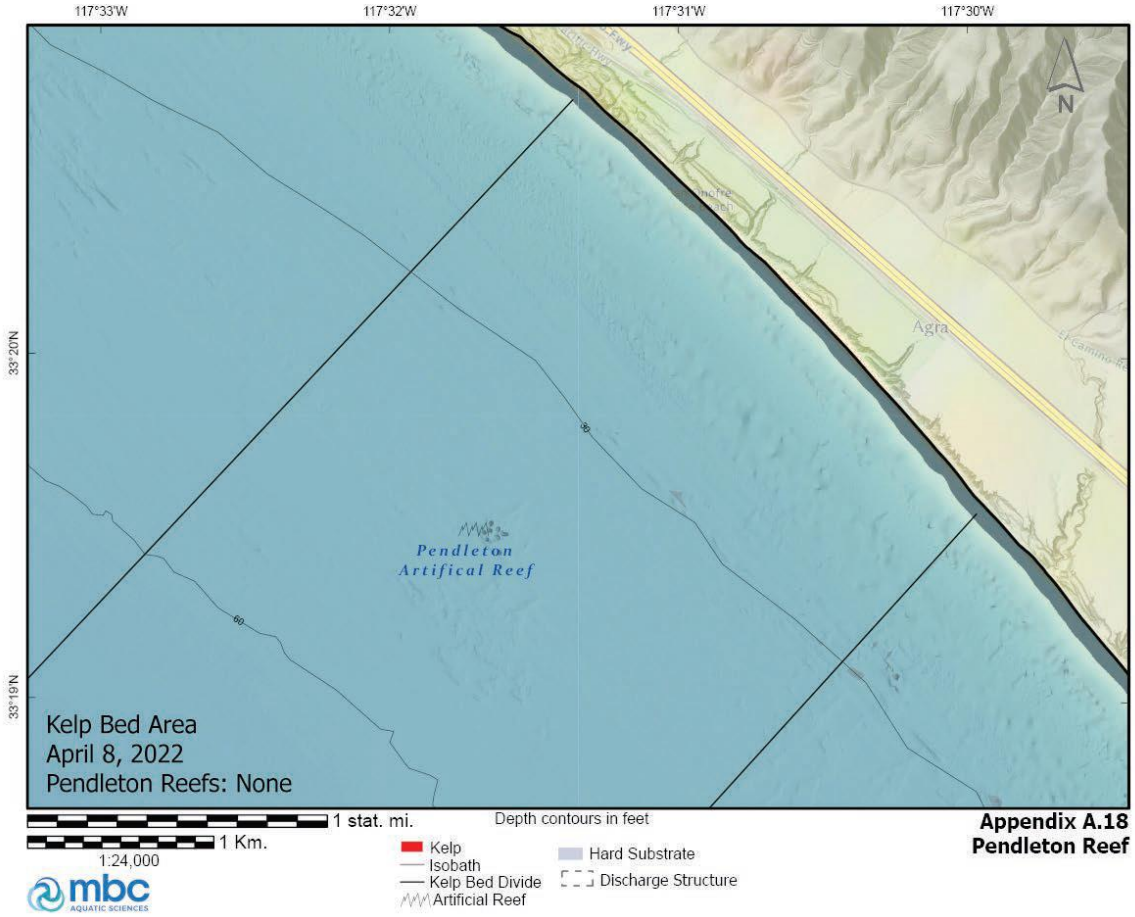

117°42'W
117°41'W
117°40'W
117°39'W
117°38'W
117°37'W
33°27'N
33°26'N
33°25'N
N
Kelp Bed Area
April 8, 2022
Capistrano Beach: None
1 stat. mi.
1 Km.
1:35,000
Depth contours in feet
Kelp
Isobath
Kelp Bed Divide
Artificial Reef
Hard Substrate
Discharge Structure
Appendix A.14
Capistrano Beach


117°38'W
117°37'W
117°36'W
117°35'W
33°24'N
33°23'N
N
San Clemente Municipal Golf Course
San Clemente State Beach
Trestles Wetlands Natural Preserve
Kelp Bed Area
April 8, 2022
San Clemente: None
1 stat. mi.
1 Km.
1:24,000
Depth contours in feet
Kelp
Isobath
Kelp Bed Divide
Artificial Reef
Hard Substrate
Discharge Structure
mbc AQUATIC SCIENCES
Appendix A.15
San Clemente

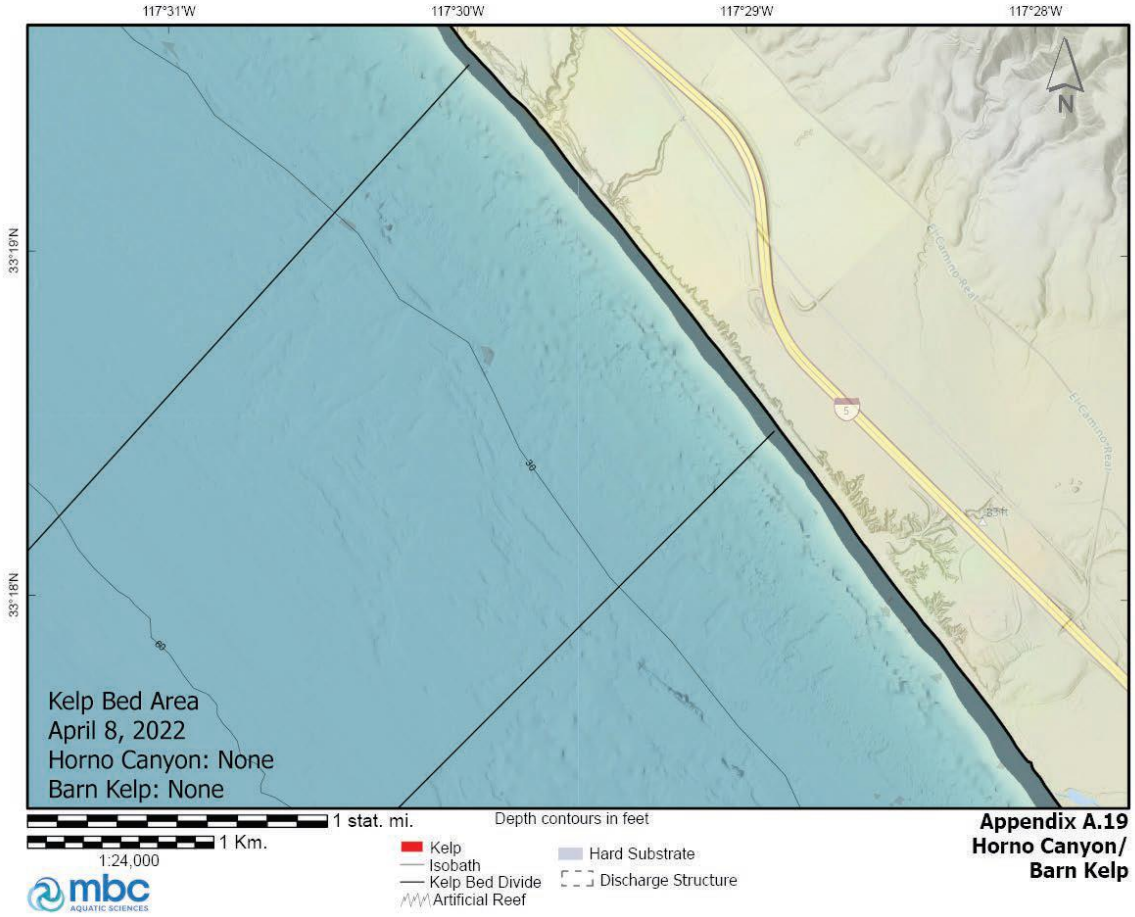

117°37'W
117°36'W
117°35'W
117°34'W
33°23'N
33°22'N
N
San Onofre
San Onofre Elementary
Trestles Wetlands Natural Preserve
SAN ONOFRE CANYON
Basilone Rd
Beach Club Rd
San Onofre Creek
El Camino Real
Old Pacific Hwy
Onofre Beach
89 ft
30
60
Kelp Bed Area
April 8, 2022
San Clemente: None
San Mateo: None
San Onofre: None
1 stat. mi.
1 Km.
1:24,000
mbc
AQUATIC SCIENCES
Depth contours in feet
Kelp
Isobath
Kelp Bed Divide
Artificial Reef
Hard Substrate
Discharge Structure
Appendix A.16
San Clemente/ San Mateo/ San Onofre


117°36'W
117°35'W
117°34'W
117°33'W
117°32'W
117°31'W
33°22'N
33°21'N
33°20'N
N
Kelp Bed Area
April 8, 2022
San Onofre: None
1 stat. mi.
1 Km.
1:35,000
Depth contours in feet
Kelp
Isobath
Kelp Bed Divide
Artificial Reef
Hard Substrate
Discharge Structure
Appendix A.17
San Onofre

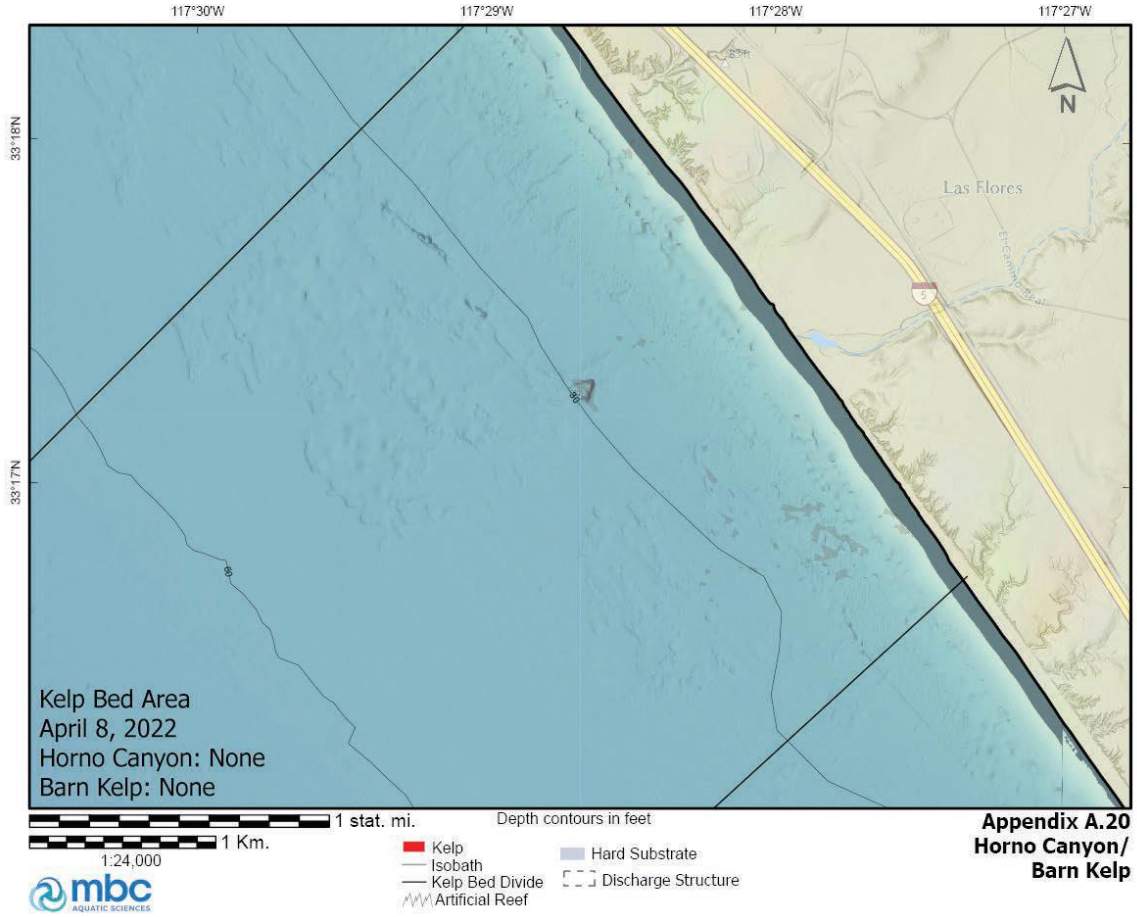
Page A-17

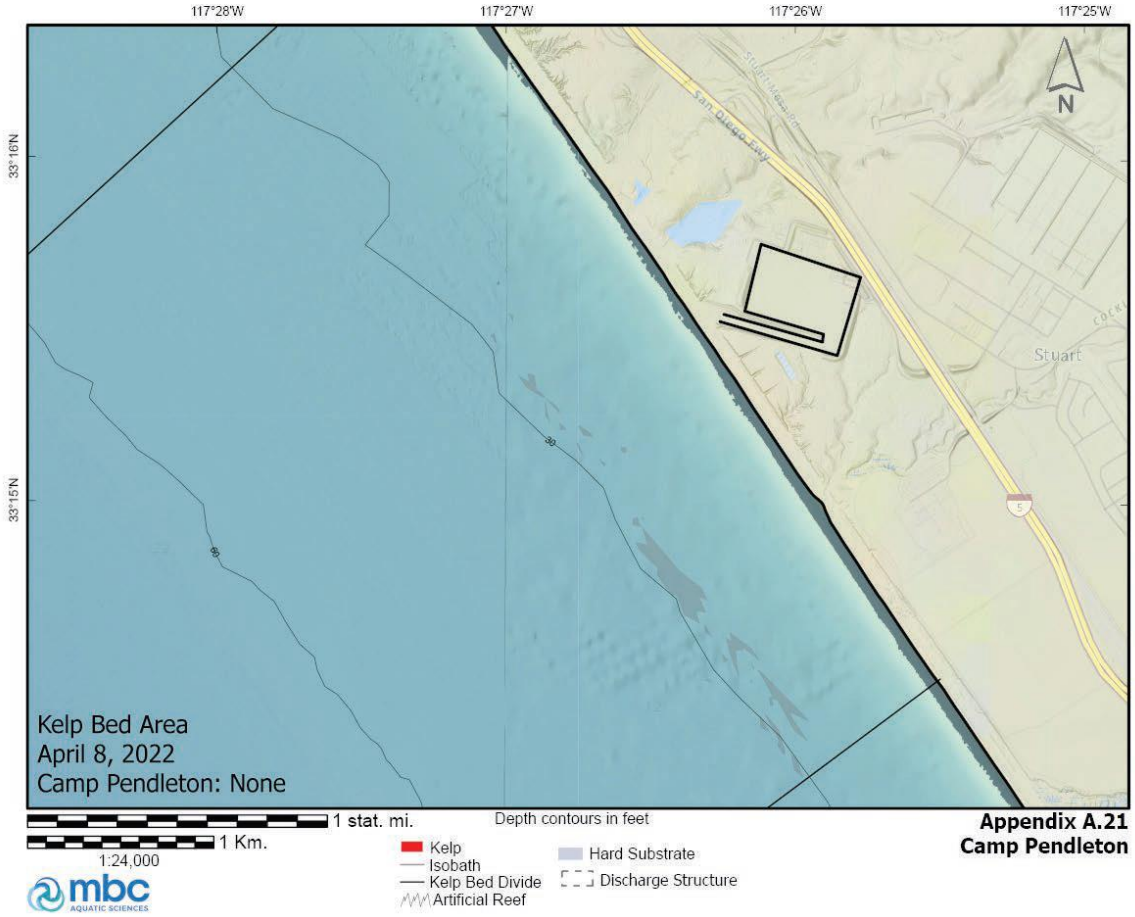


Appendix A.18
Pendleton Reef

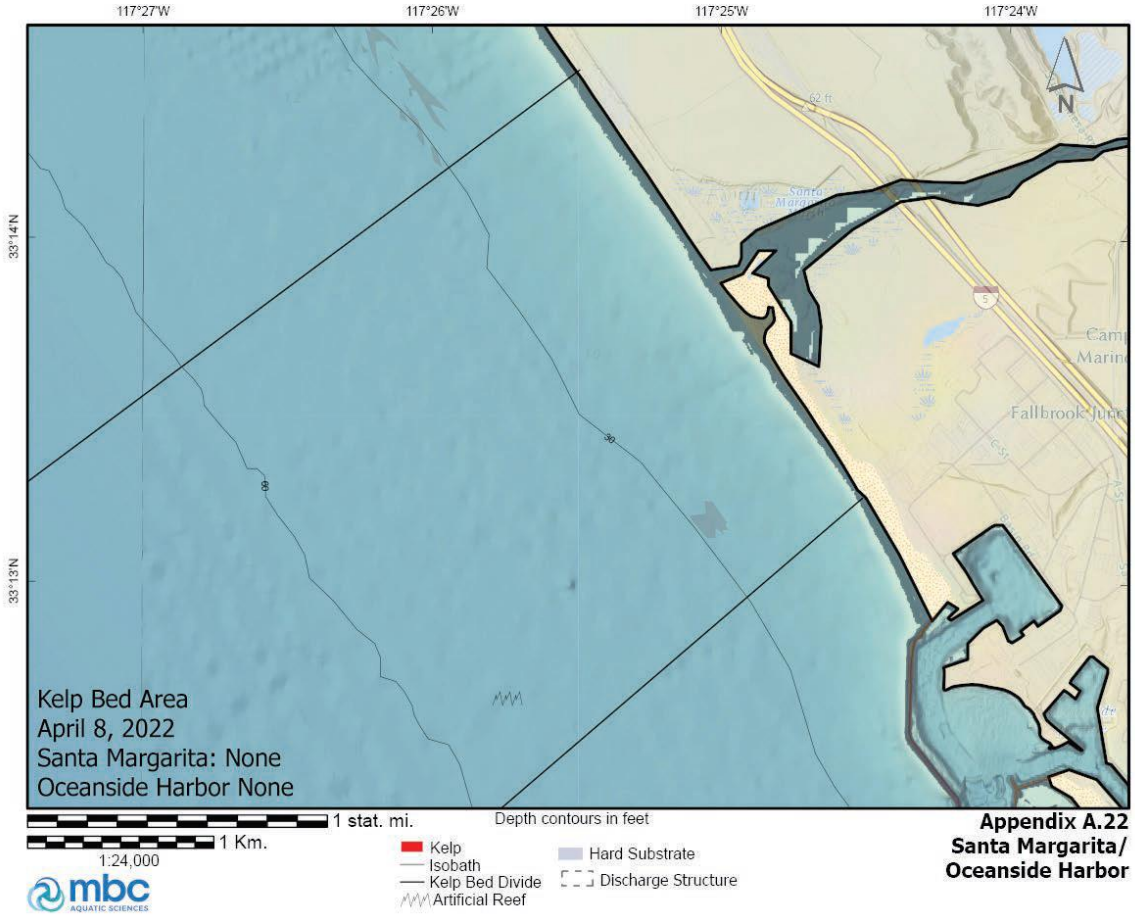

117°31'W
117°30'W
117°29'W
117°28'W
33°19'N
33°18'N
N
Kelp Bed Area
April 8, 2022
Horno Canyon: None
Barn Kelp: None
1 stat. mi.
1 Km.
1:24,000
Depth contours in feet
Kelp
Isobath
Kelp Bed Divide
Artificial Reef
Hard Substrate
Discharge Structure
Appendix A.19
Horno Canyon/
Barn Kelp

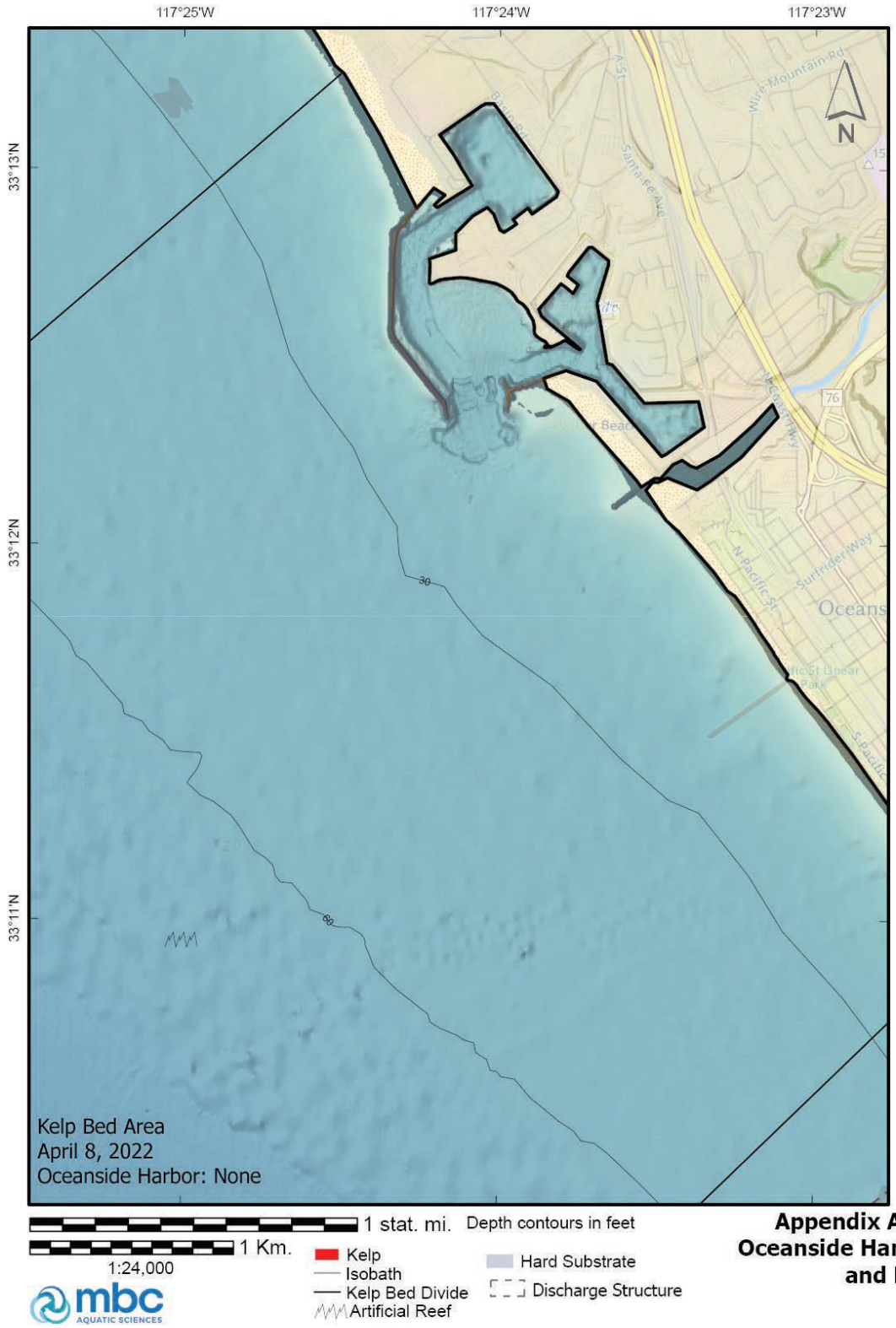
Page A-19


117°30'W
117°29'W
117°28'W
117°27'W
33°18'N
33°17'N
N
Las Flores
Kelp Bed Area
April 8, 2022
Horno Canyon: None
Barn Kelp: None
1 stat. mi.
1 Km.
1:24,000
Depth contours in feet
Kelp
Isobath
Kelp Bed Divide
Artificial Reef
Hard Substrate
Discharge Structure
Appendix A.20
Horno Canyon/
Barn Kelp


117°28'W
117°27'W
117°26'W
117°25'W
33°16'N
33°15'N
N
Stuart
Kelp Bed Area
April 8, 2022
Camp Pendleton: None
1 stat. mi.
1 Km.
1:24,000
Depth contours in feet
Kelp
Isobath
Kelp Bed Divide
Artificial Reef
Hard Substrate
Discharge Structure
Appendix A.21
Camp Pendleton

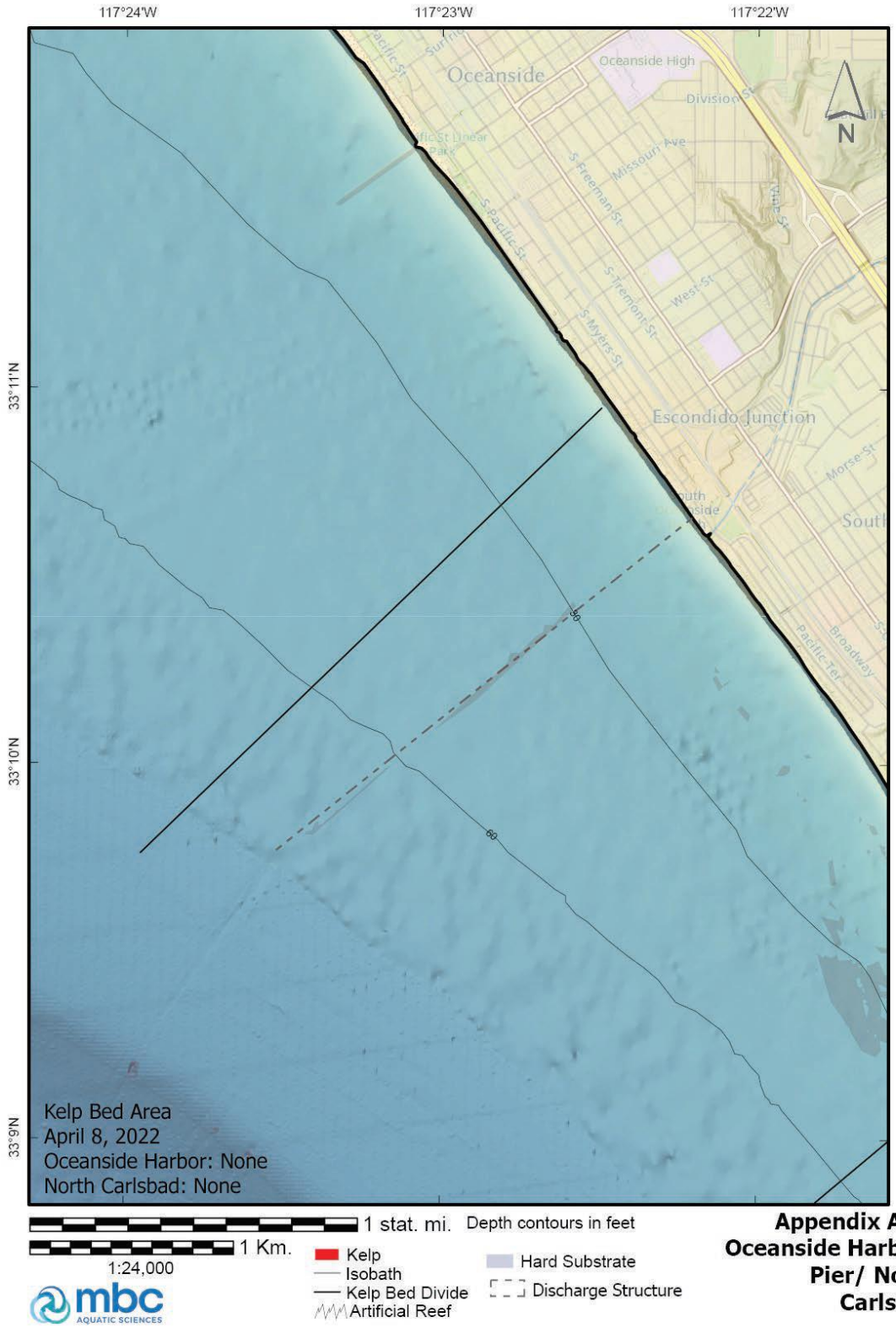
Page A-21


117°27'W
117°26'W
117°25'W
117°24'W
33°14'N
33°13'N
N
Kelp Bed Area
April 8, 2022
Santa Margarita: None
Oceanside Harbor None
1 stat. mi.
1 Km.
1:24,000
Depth contours in feet
Kelp
Isobath
Kelp Bed Divide
Artificial Reef
Hard Substrate
Discharge Structure
Appendix A.22
Santa Margarita/
Oceanside Harbor

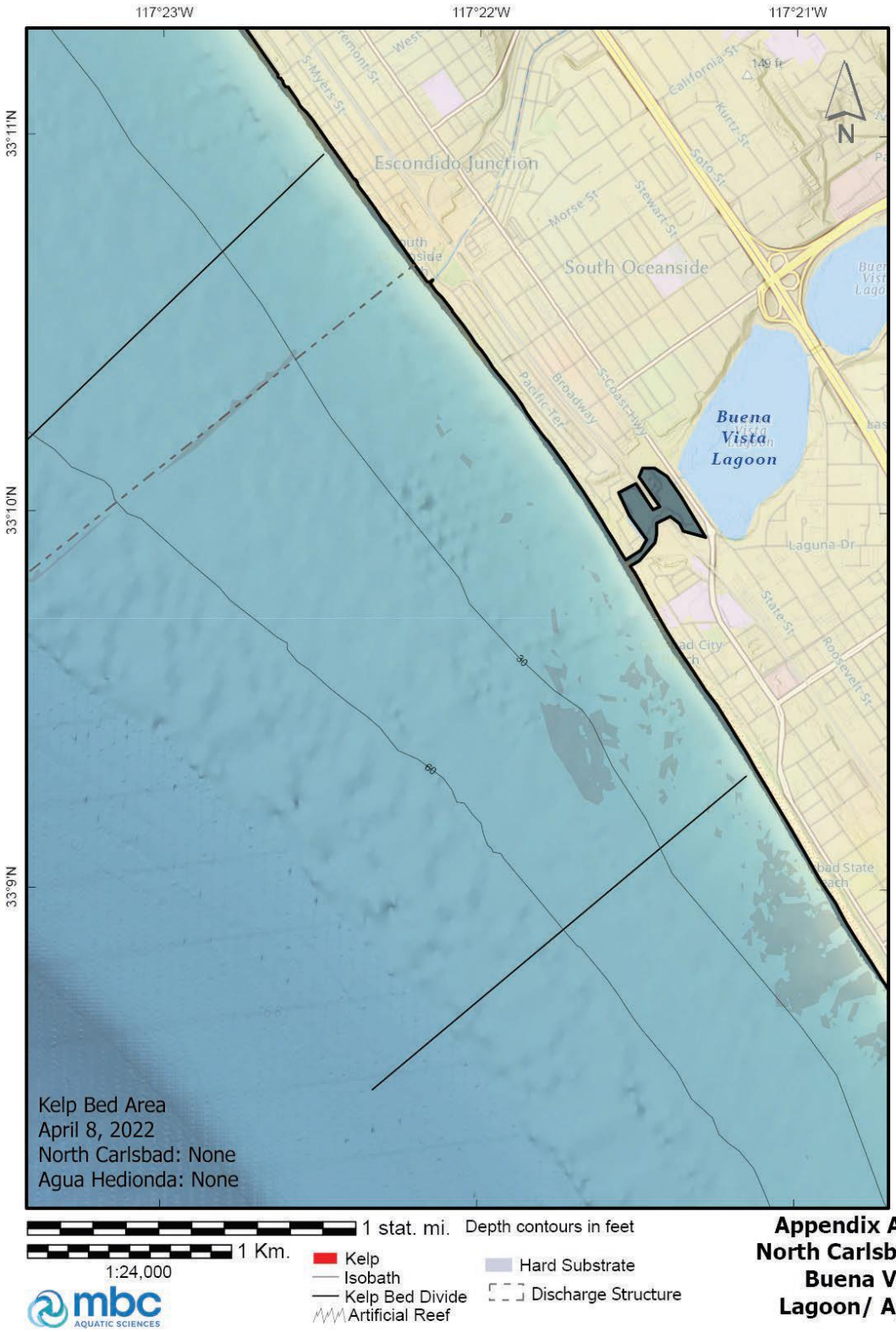


Appendix A.23
Oceanside Harbor and Pier

Page A-23

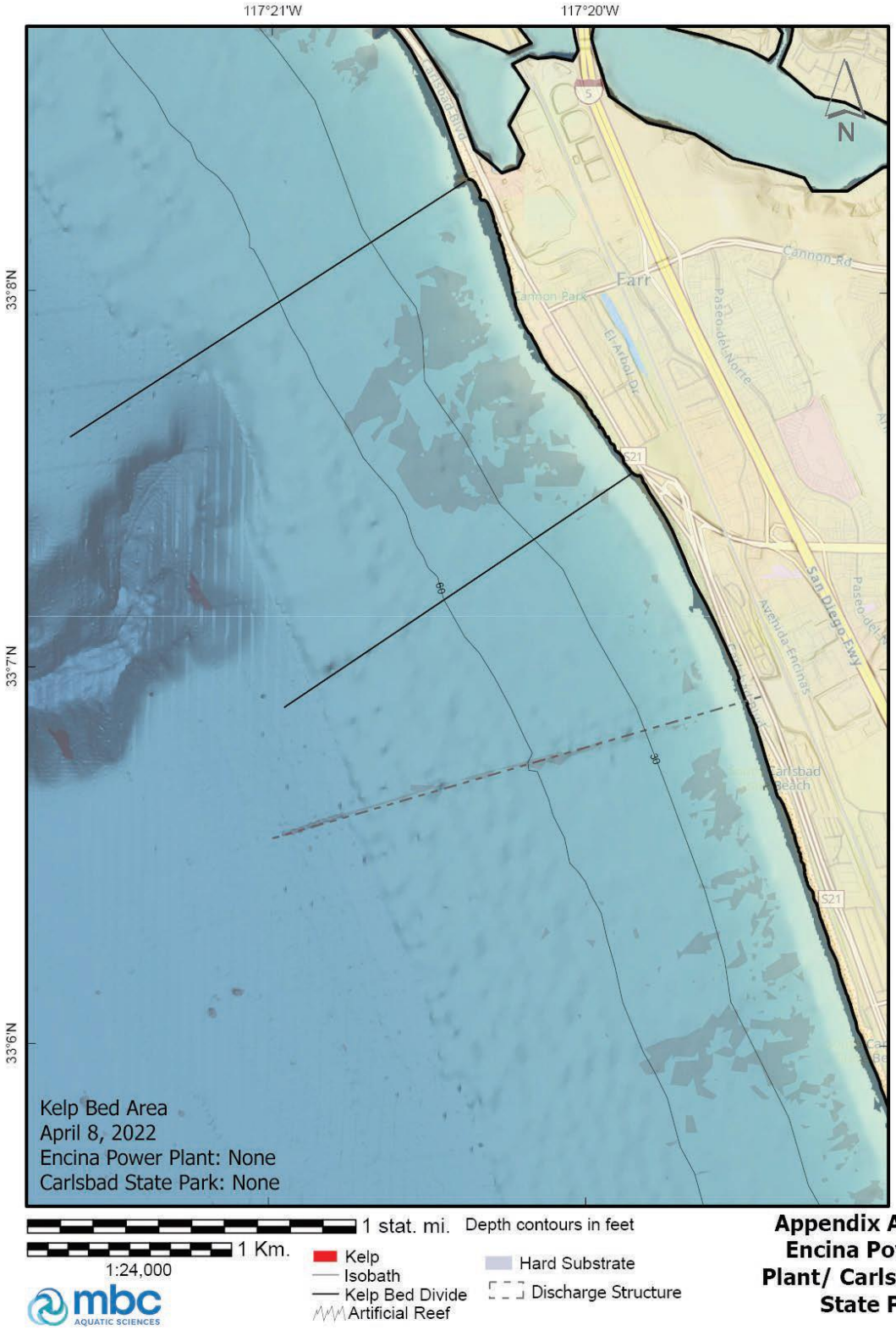

117°24'W
117°23'W
117°22'W
33°11'N
33°10'N
33°9'N
Oceanside
Oceanside High
Escondido Junction
N
Kelp Bed Area
April 8, 2022
Oceanside Harbor: None
North Carlsbad: None
1 stat. mi.
1 Km.
1:24,000
Depth contours in feet
Kelp
Isobath
Kelp Bed Divide
Artificial Reef
Hard Substrate
Discharge Structure
mbc
AQUATIC SCIENCES
Appendix A.24
Oceanside Harbor/
Pier/ North
Carlsbad

Page A-24

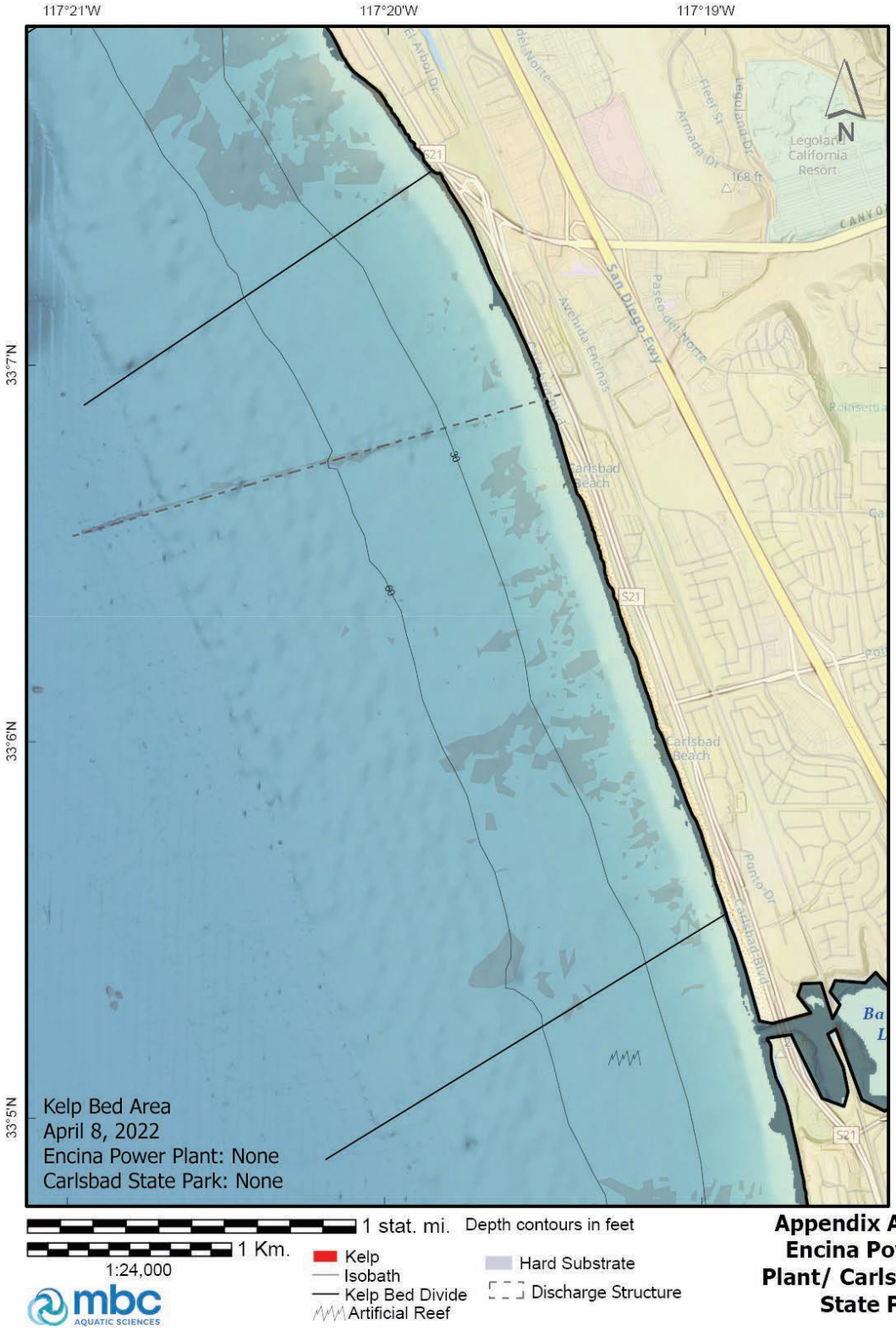


Appendix A.25
North Carlsbad/ Buena Vista Lagoon/ Agua

Page A-25

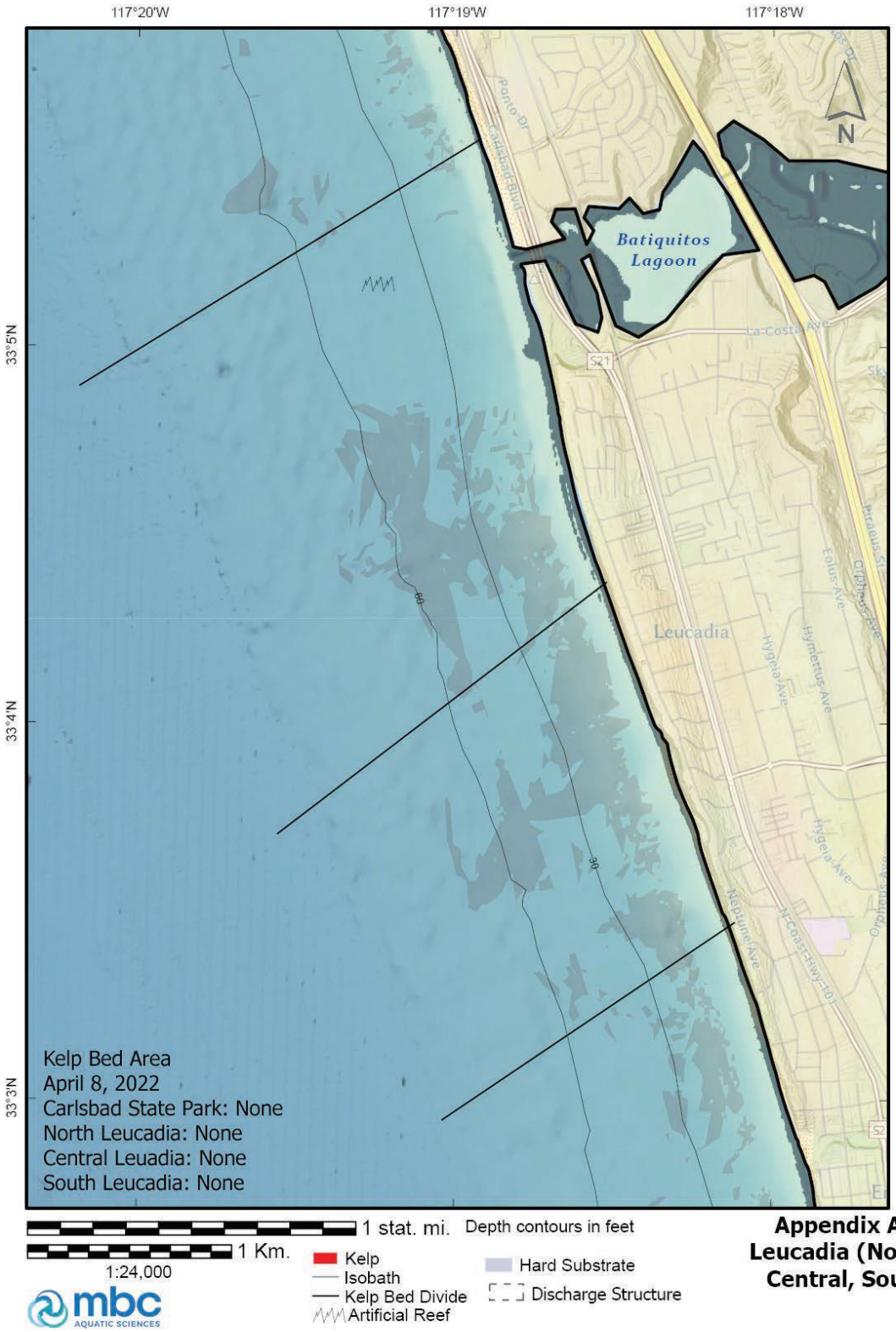

117°21'W
117°20'W
33°8'N
33°7'N
33°6'N
N
Cannon Rd
Farr
Cannon Park
El Arbol Dr
Paseo del Norte
S21
San Diego Fwy
Avenida Encinas
Carlsbad Beach
60
90
Kelp Bed Area
April 8, 2022
Encina Power Plant: None
Carlsbad State Park: None
1 stat. mi.
1 Km.
1:24,000
Depth contours in feet
Kelp
Isobath
Kelp Bed Divide
Artificial Reef
Hard Substrate
Discharge Structure
mbc
AQUATIC SCIENCES
Appendix A.26
Encina Power
Plant/ Carlsbad
State Park

Page A-26



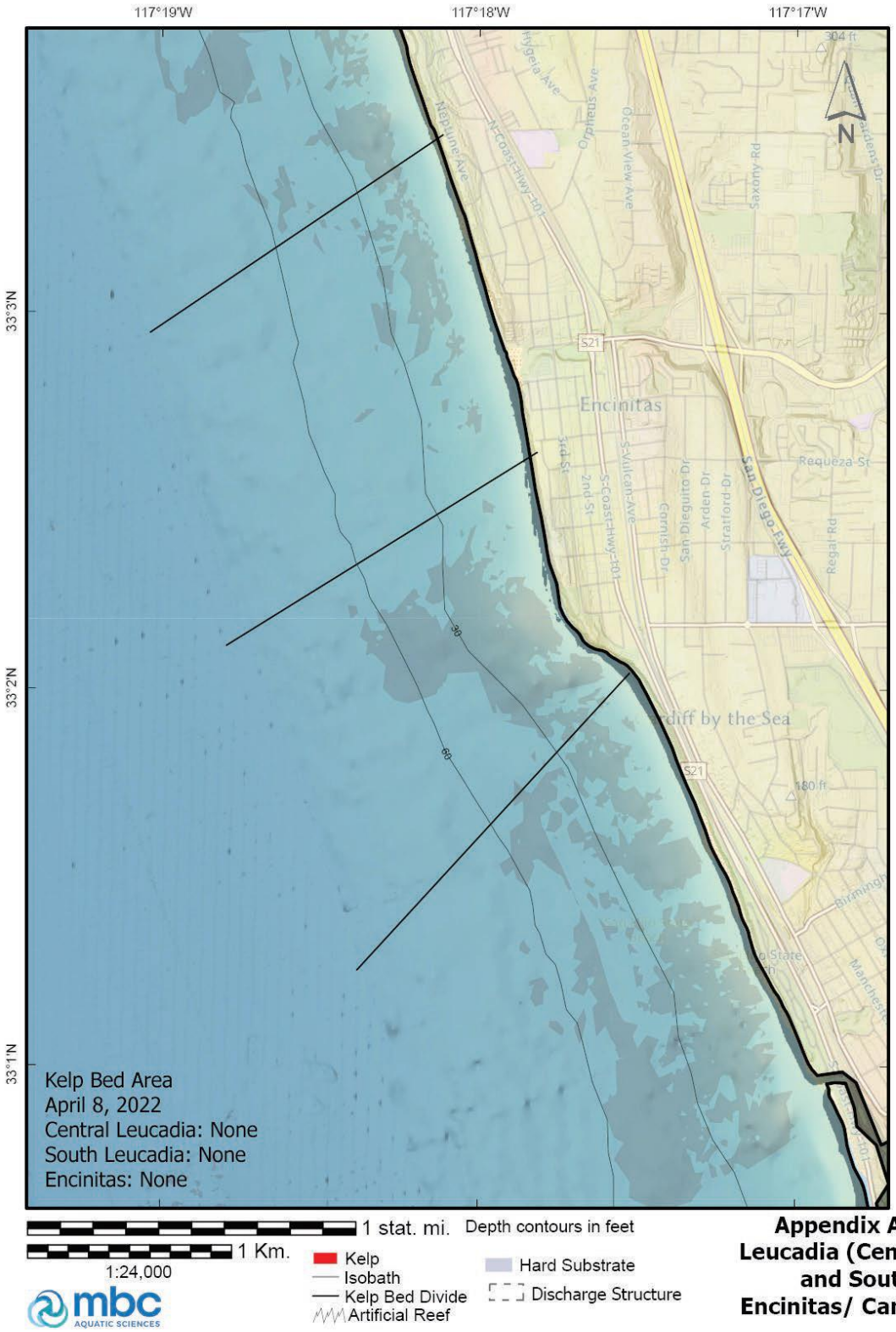
Appendix A.27
Encina Power Plant/ Carlsbad State Park

Page A-27



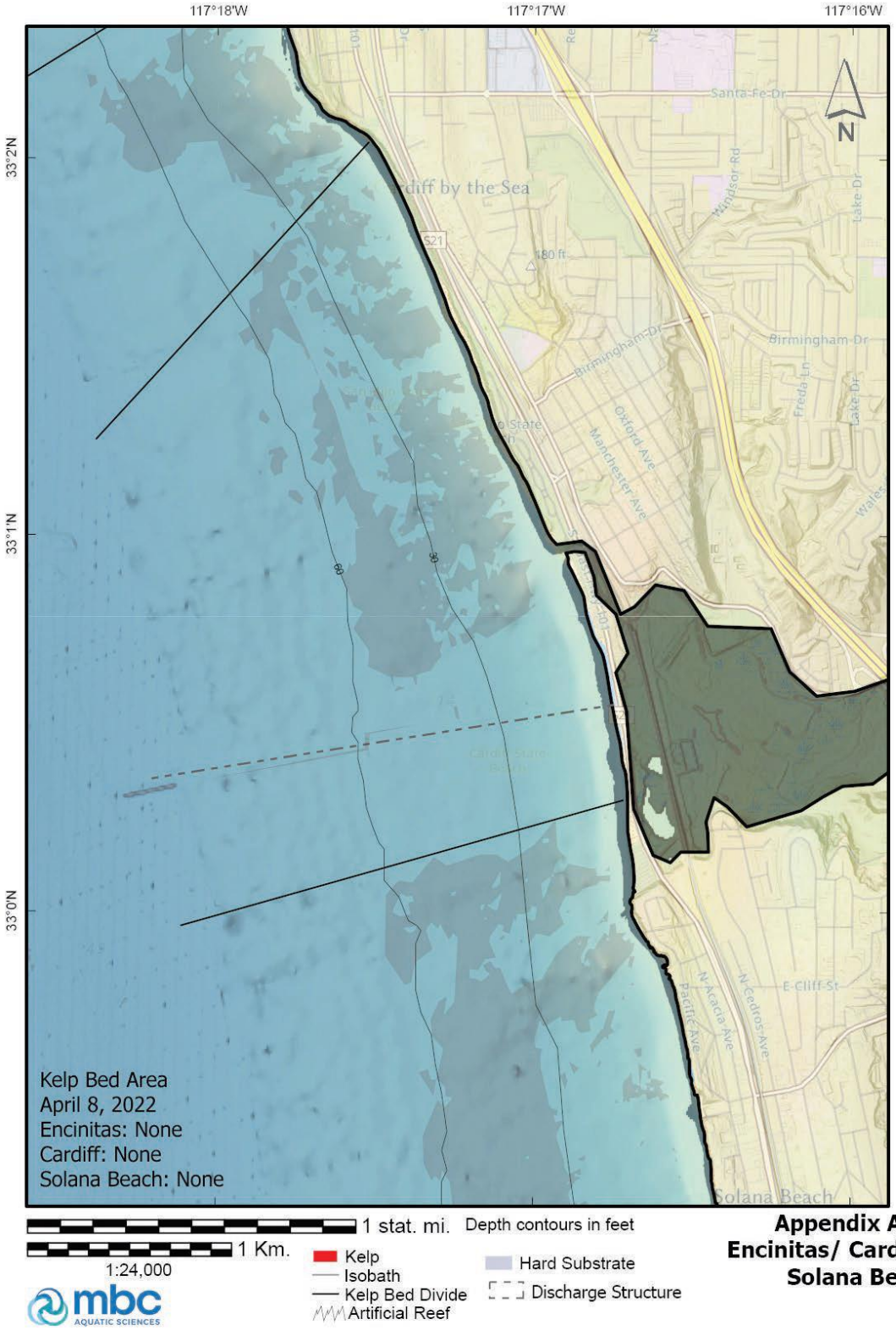
Appendix A.28
Leucadia (North, Central, South)

Page A-28



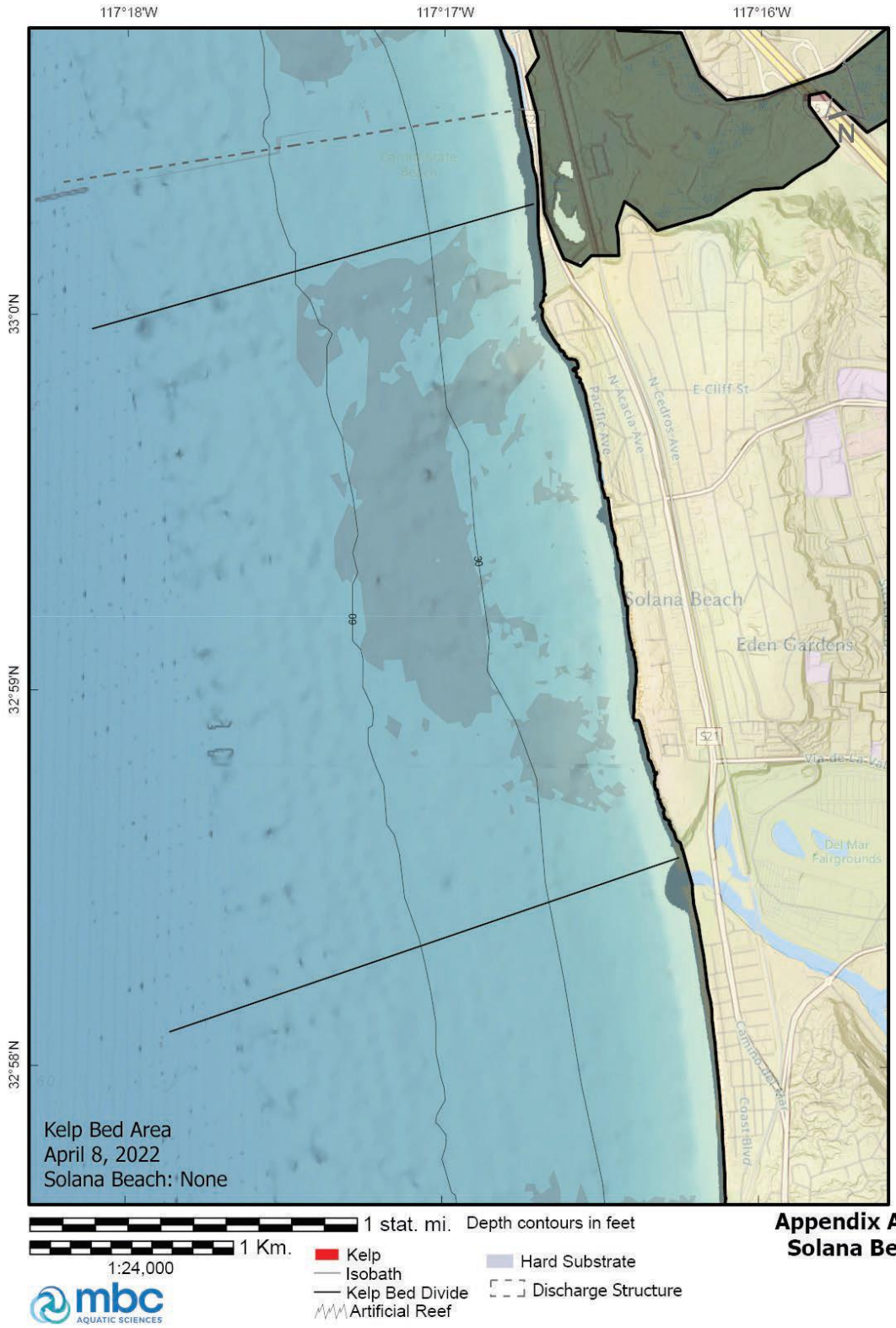
Appendix A.29
Leucadia (Central and South)/ Encinitas/ Cardiff

Page A-29

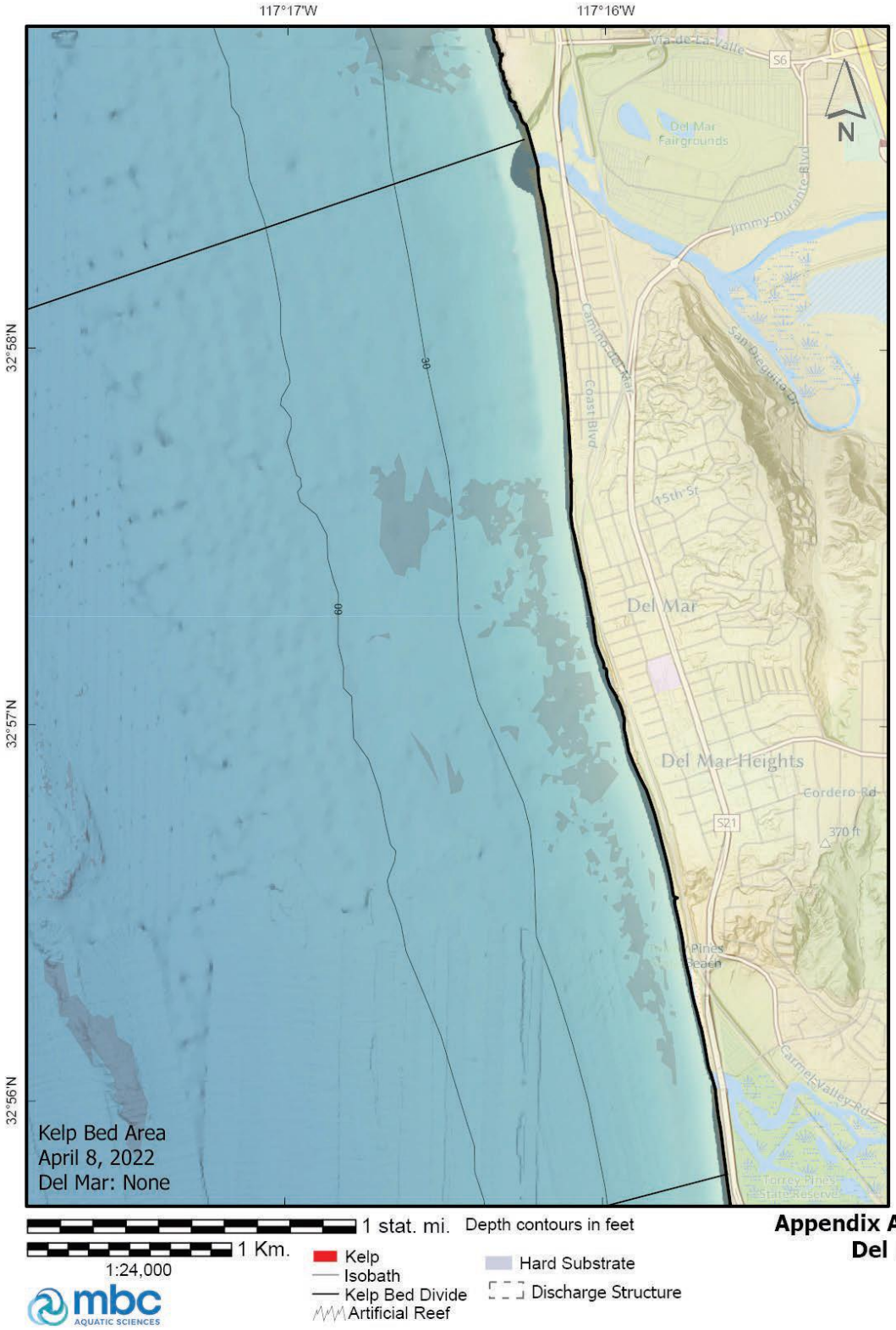


Appendix A.30
Encinitas/ Cardiff/
Solana Beach

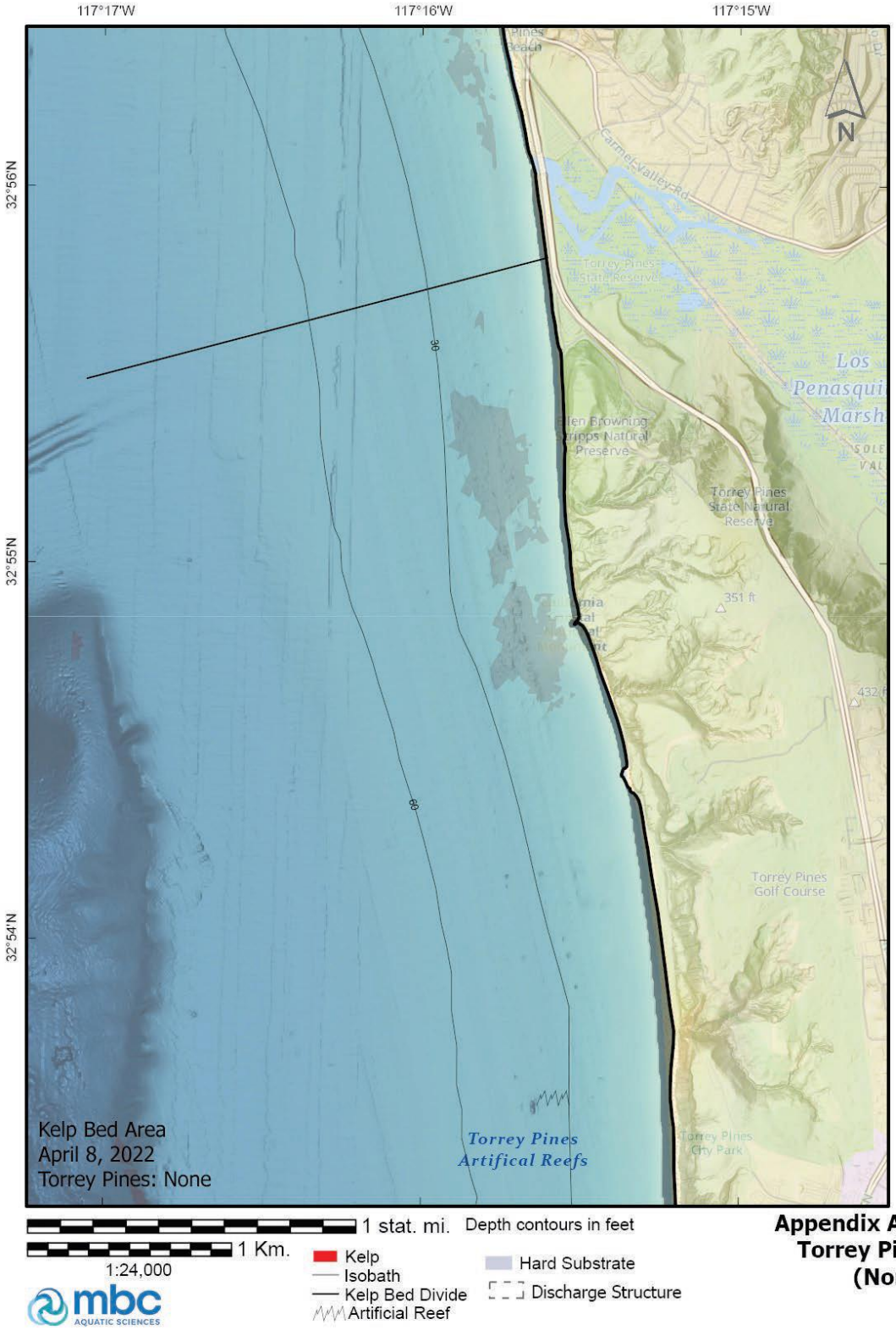
Page A-30



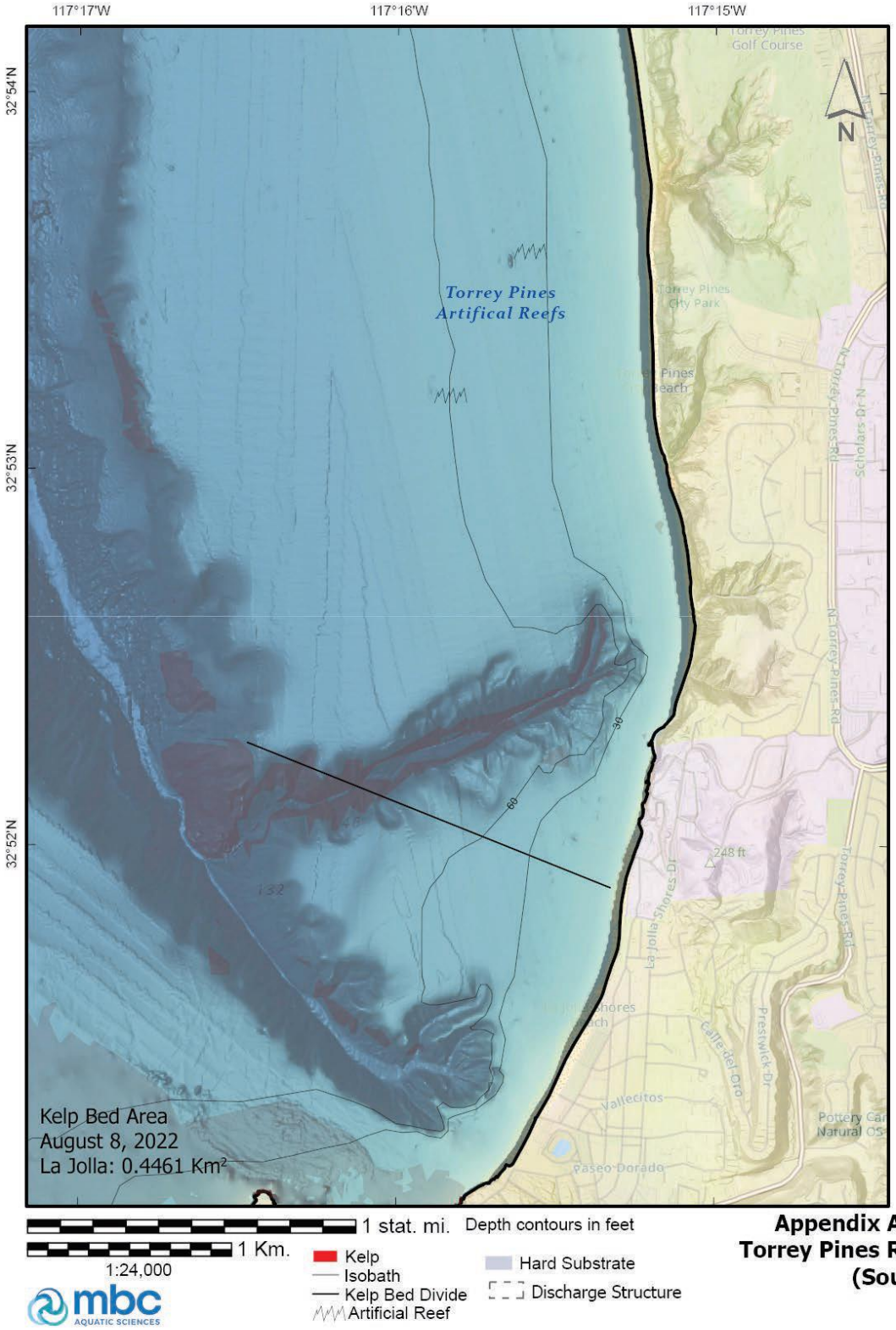
Appendix A.31
Solana Beach



Appendix A.32
Del Mar

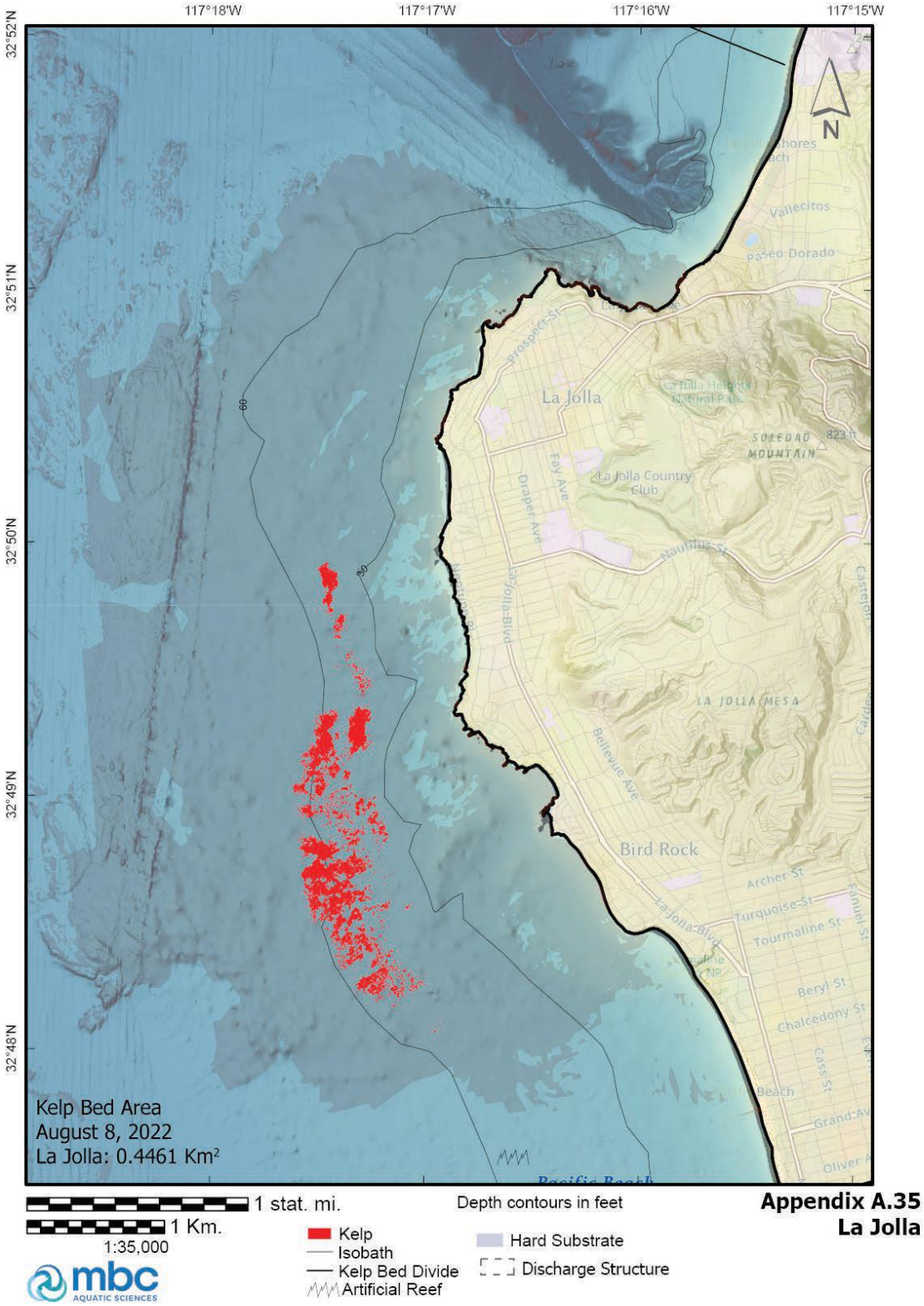


Appendix A.33
Torrey Pines (North)

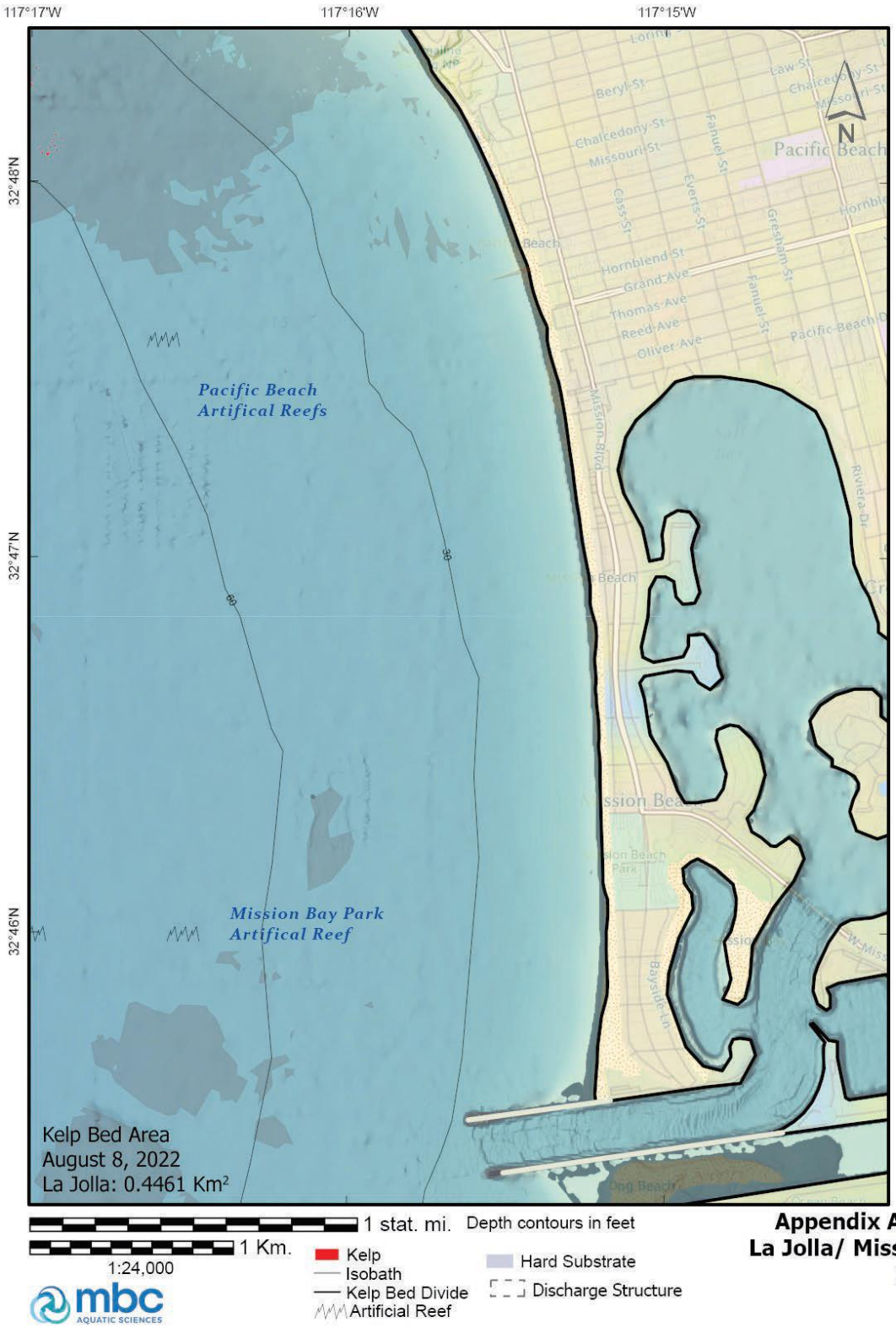


Appendix A.34
Torrey Pines Reef (South)

Page A-34

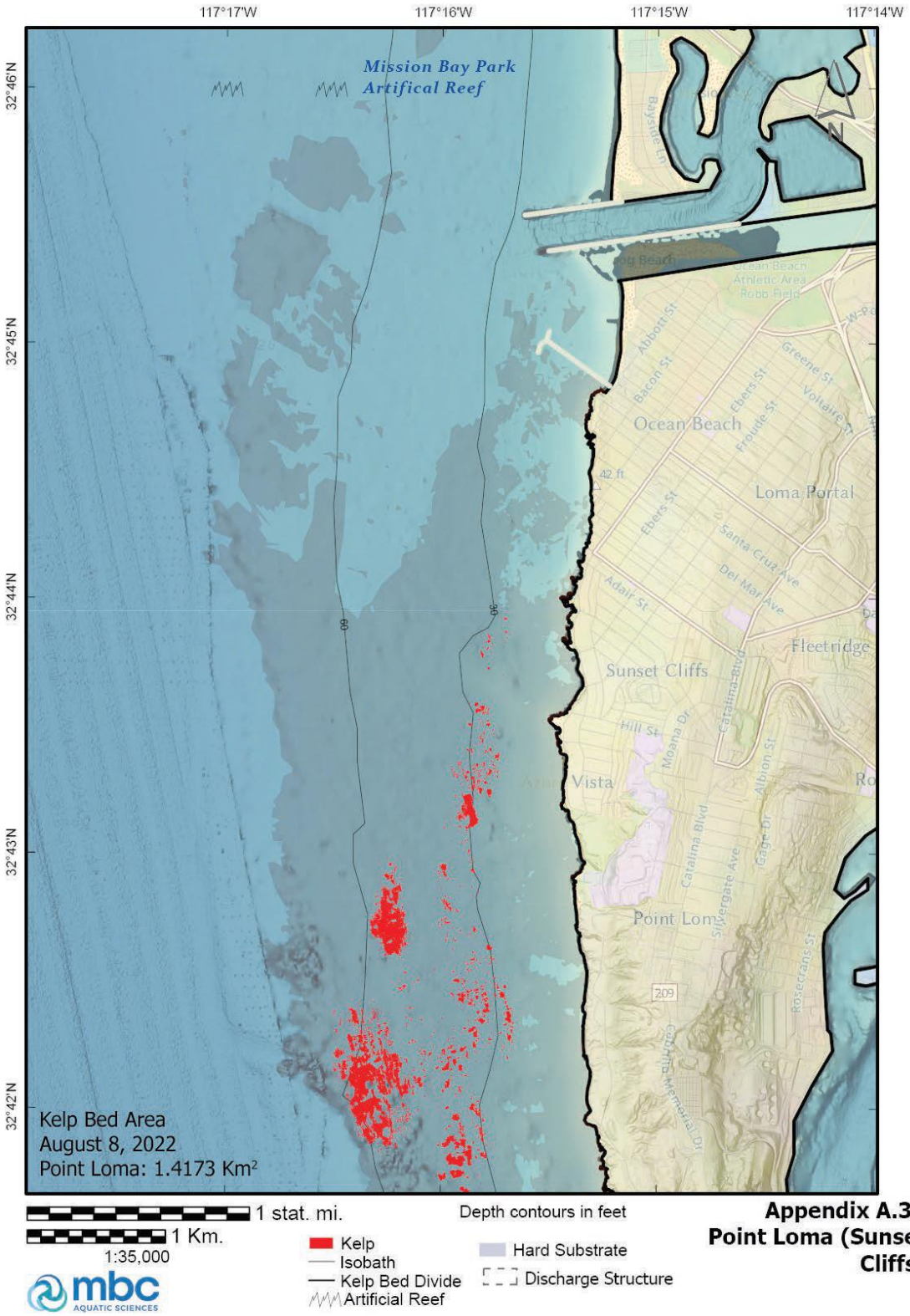


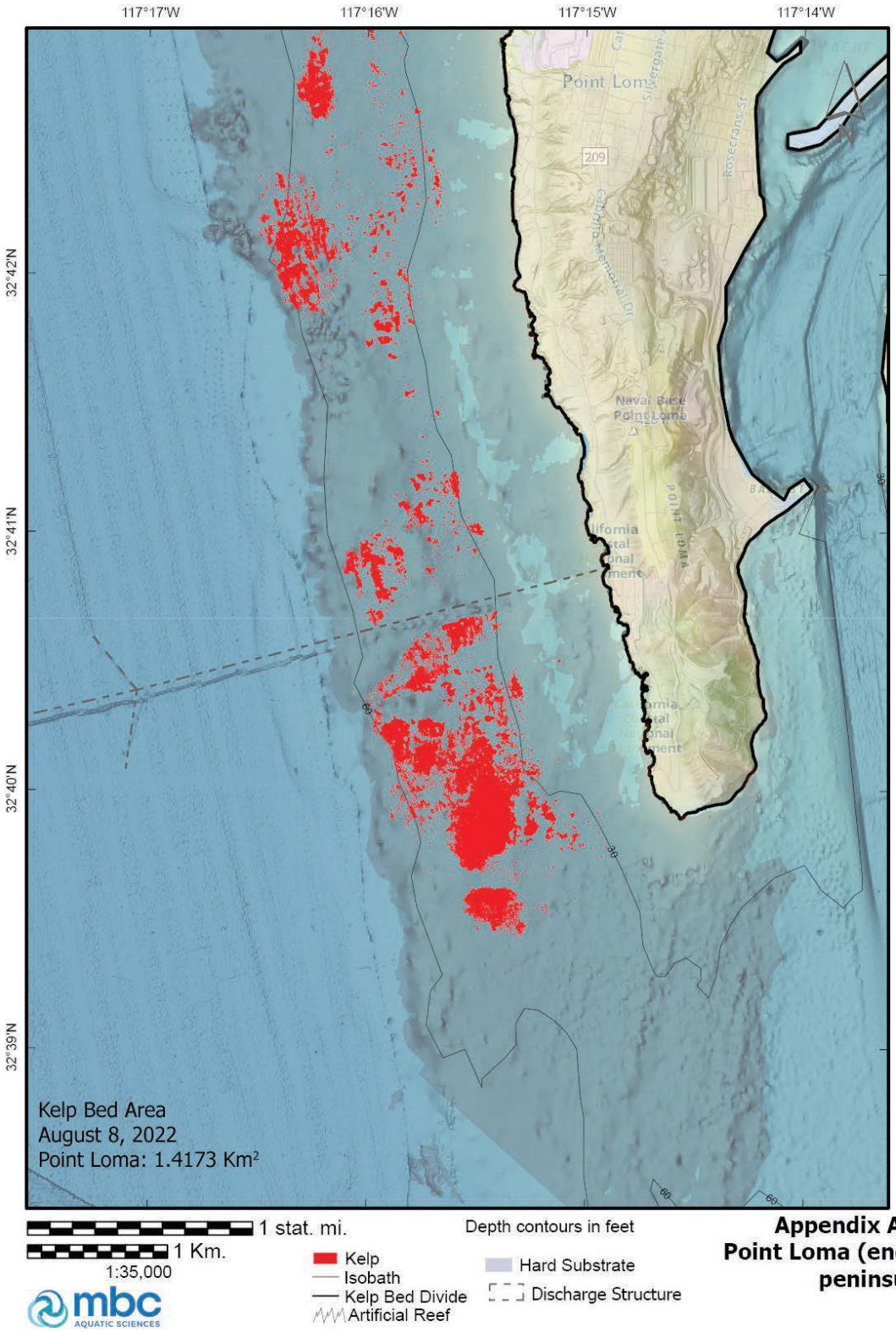
Appendix A.35
La Jolla



Appendix A.36
La Jolla/ Mission Bay

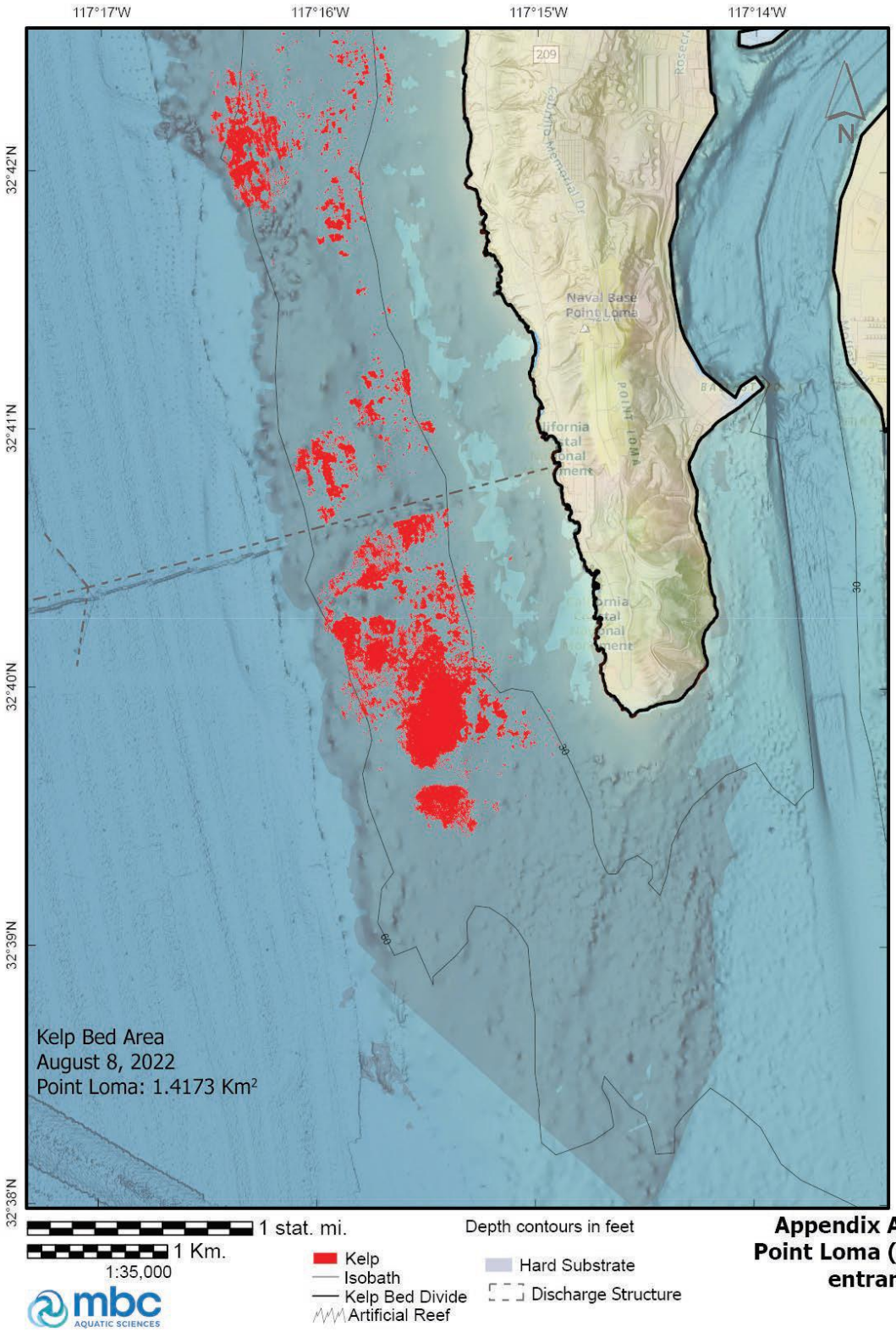
Page A-36

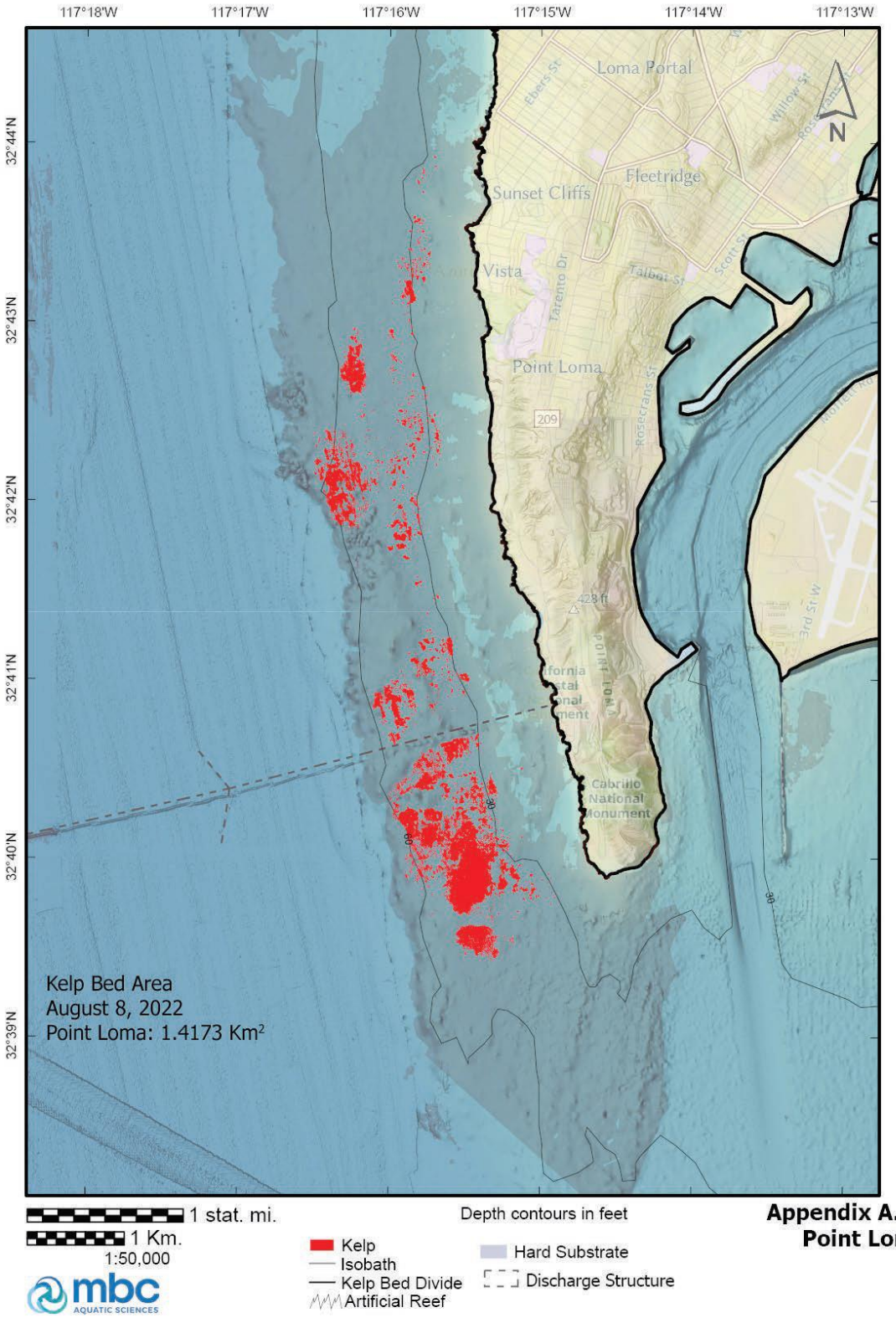

117°17'W
117°16'W
117°15'W
117°14'W
32°46'N
32°45'N
32°44'N
32°43'N
32°42'N
Mission Bay Park
Artifical Reef
Ocean Beach
Loma Portal
Sunset Cliffs
Fleetridge
Point Loma
Kelp Bed Area
August 8, 2022
Point Loma: 1.4173 Km²
1 stat. mi.
1 Km.
1:35,000
Depth contours in feet
Kelp
Isobath
Kelp Bed Divide
Artificial Reef
Hard Substrate
Discharge Structure
Appendix A.37
Point Loma (Sunset Cliffs)



Appendix A.38
Point Loma (end of peninsula)

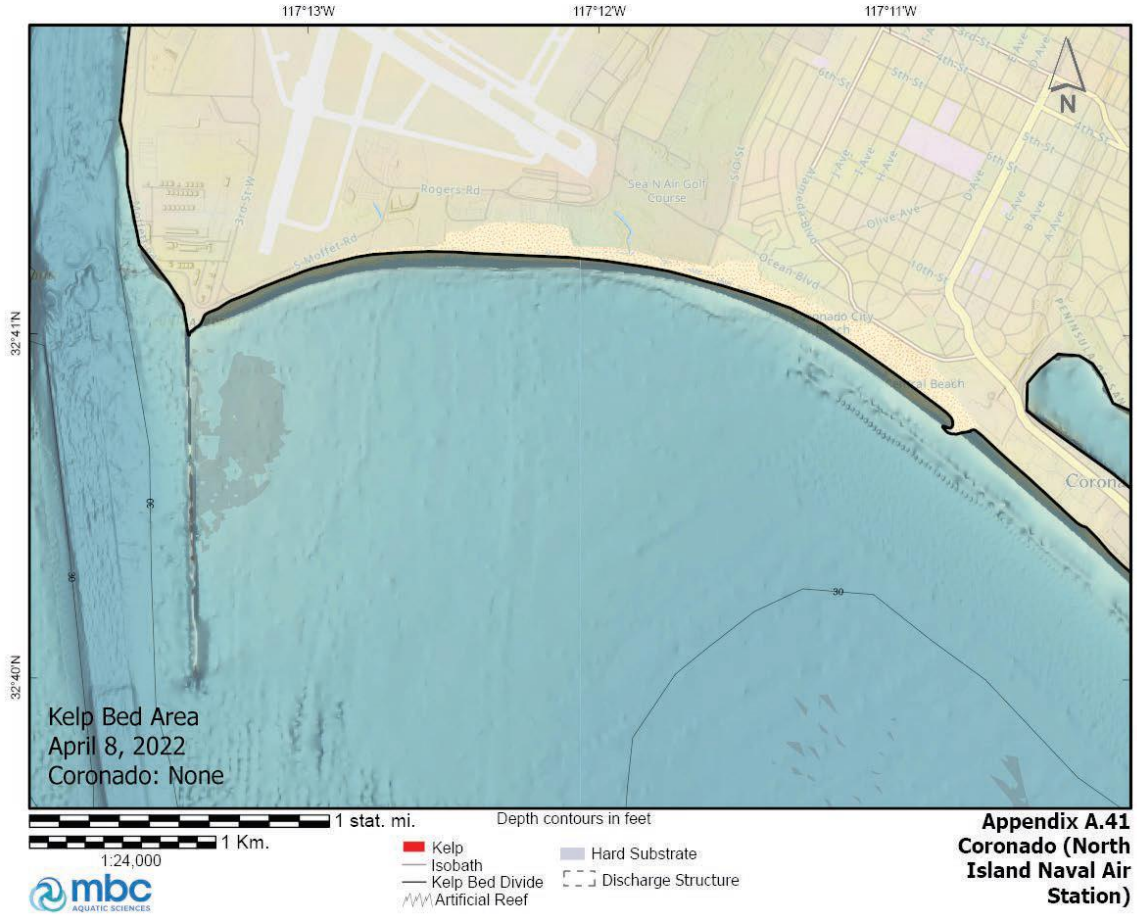
Page A-38


117°17'W
117°16'W
117°15'W
117°14'W
32°42'N
32°41'N
32°40'N
32°39'N
32°38'N
N
Naval Base Point Loma
POINT LOMA
Kelp Bed Area
August 8, 2022
Point Loma: 1.4173 Km²
1 stat. mi.
1 Km.
1:35,000
mbc AQUATIC SCIENCES
Kelp
Isobath
Kelp Bed Divide
Artificial Reef
Depth contours in feet
Hard Substrate
Discharge Structure
Appendix A.39
Point Loma (bay entrance)

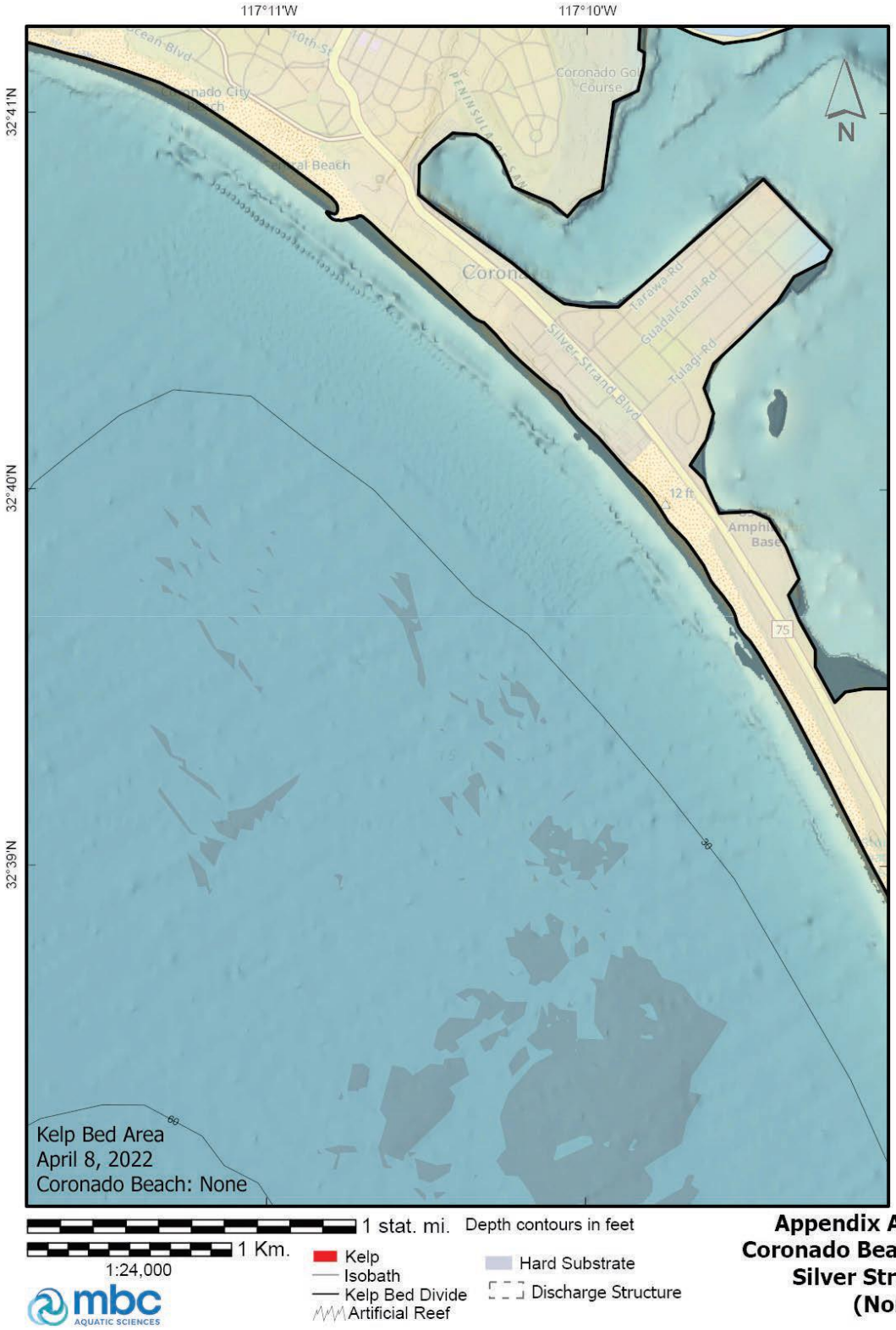


Appendix A.40
Point Loma

Page A-40

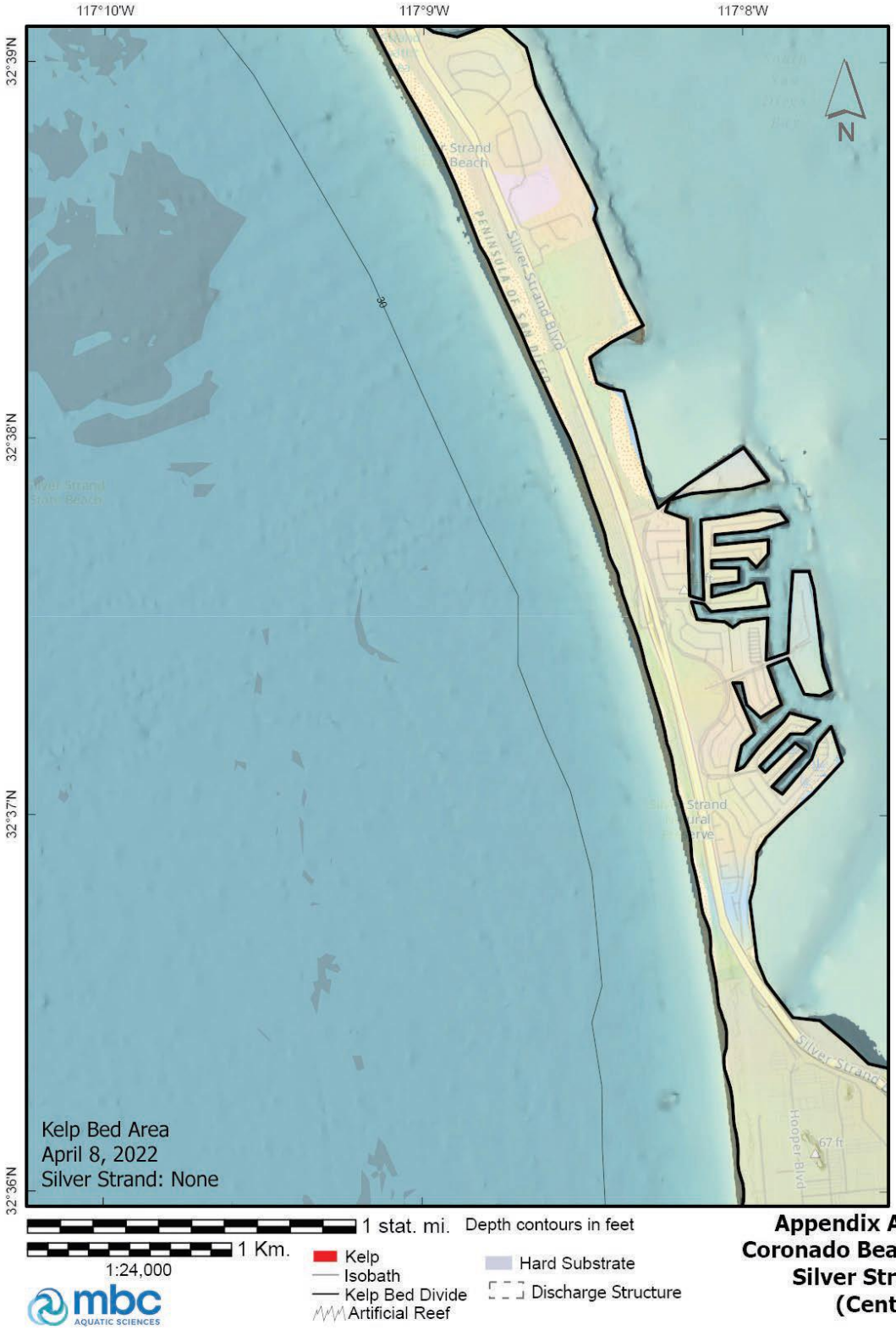


Appendix A.41
Coronado (North Island Naval Air Station)



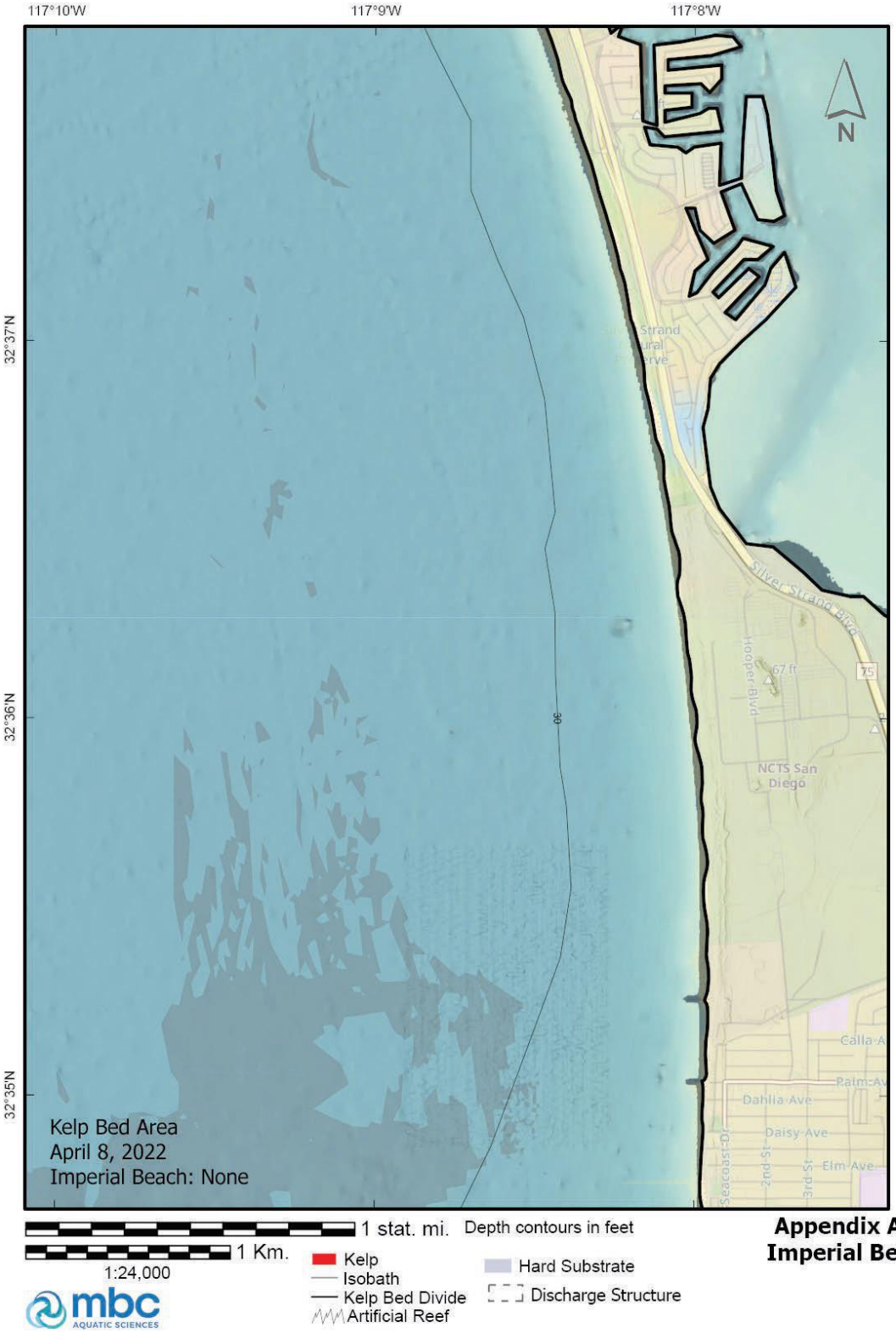
Appendix A.42
Coronado Beach/
Silver Strand
(North)

Page A-42



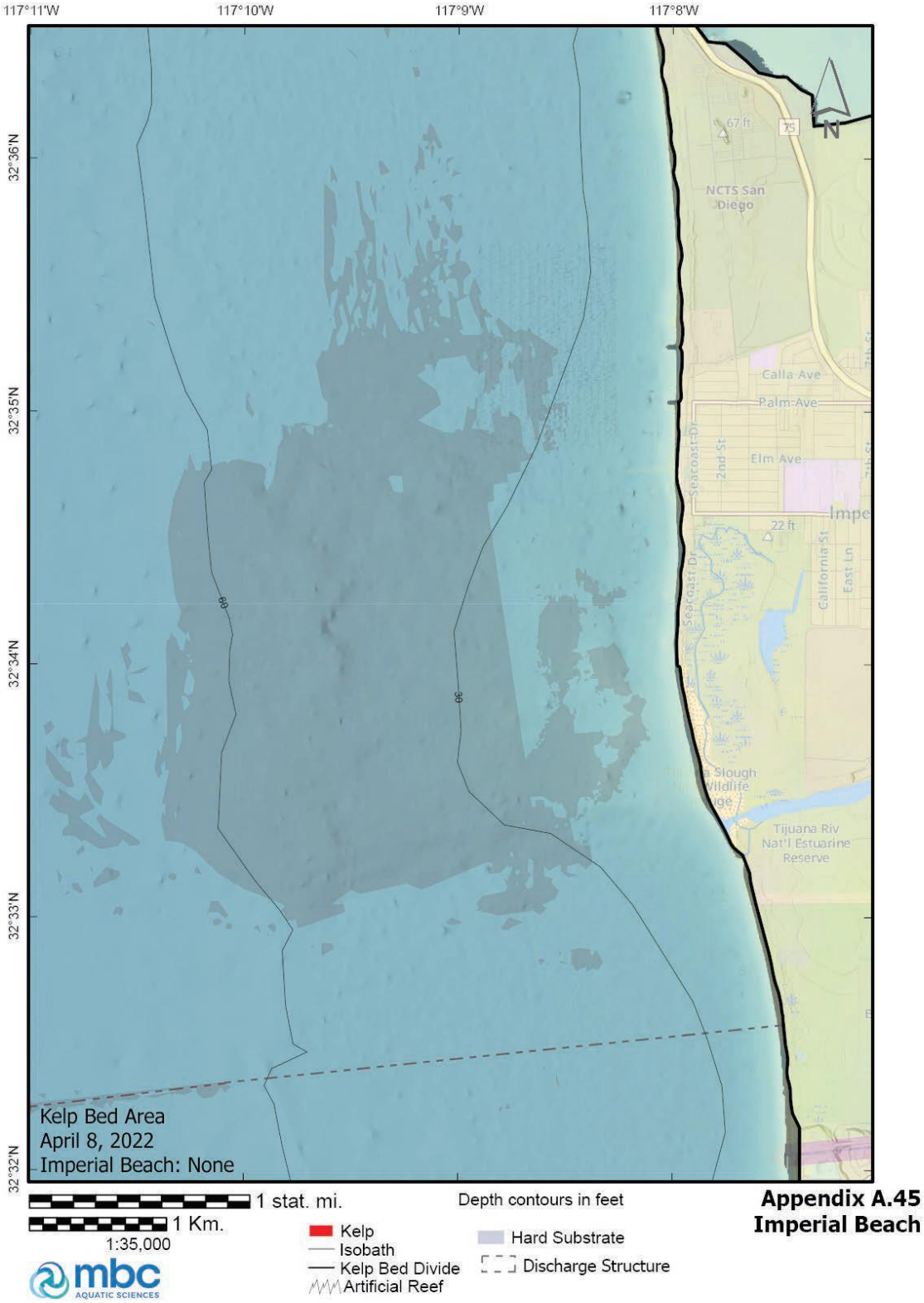
Appendix A.43
Coronado Beach/
Silver Strand
(Central)

Page A-43



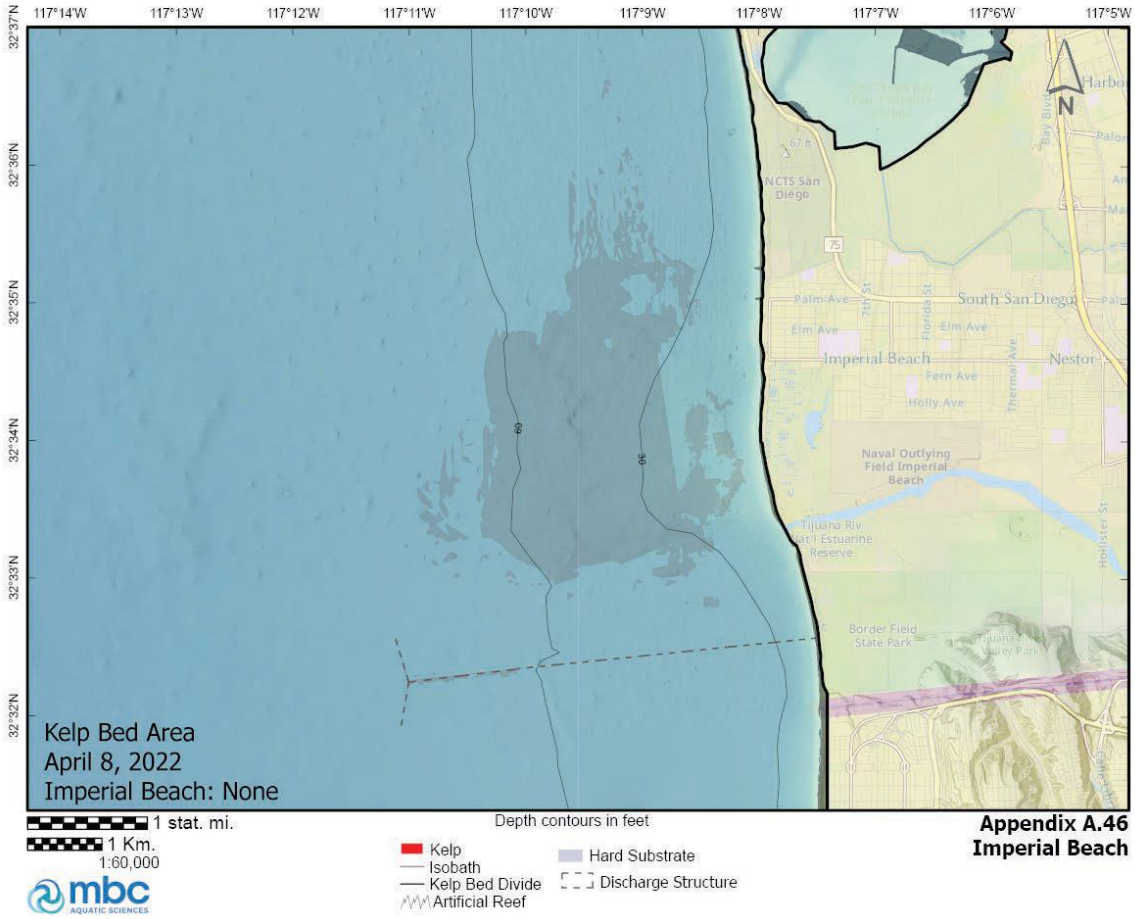
Appendix A.44
Imperial Beach

Page A-44



Appendix A.45
Imperial Beach

Page A-45


117°14'W
117°13'W
117°12'W
117°11'W
117°10'W
117°9'W
117°8'W
117°7'W
117°6'W
117°5'W
32°37'N
32°36'N
32°35'N
32°34'N
32°33'N
32°32'N
N
NCTS San Diego
South San Diego
Imperial Beach
Nestor
Palm Ave
Elm Ave
Fern Ave
Holly Ave
Naval Outlying Field Imperial Beach
Tijuana Riv Nat'l Estuarine Reserve
Border Field State Park
Kelp Bed Area
April 8, 2022
Imperial Beach: None
1 stat. mi.
1 Km.
1:60,000
Depth contours in feet
Kelp
Isobath
Kelp Bed Divide
Artificial Reef
Hard Substrate
Discharge Structure
Appendix A.46
Imperial Beach

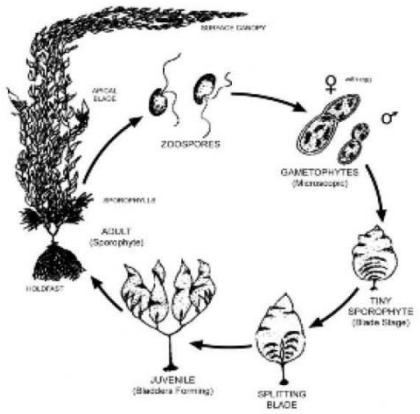
APPENDIX B

LIFE HISTORY OF GIANT KELP
HISTORICAL KELP SURVEYS
CRANDALL'S MAPS

LIFE HISTORY OF GIANT KELP

Kelp consists of a number of species of brown algae, of which 10 are typically found from Point Conception to the Mexican Border (the Southern California Bight [SCB]). Compared to most other algae, kelp species can attain remarkable size and long life span (Kain 1979; Dayton 1985; Reed et al. 2006). Along the central and southern California coast, giant kelp *Macrocystis pyrifera* is the largest species colonizing rocky (and in some cases sandy) subtidal habitats, and is the dominant canopy-forming kelp. Giant kelp is a very important component of coastal and island communities in southern California, providing food and habitat for numerous animals (North 1971; Patton and Harmon 1983; Dayton 1985; Foster and Schiel 1985). Darwin (1860) noted the resemblance of the three-dimensional structure of giant kelp stands to that of terrestrial forests. Because of its imposing physical presence, giant kelp biology and ecology have been the focus of considerable research since the early 1900s. Much effort was expended in the early years deciphering its enigmatic life history (Neushul 1963; North 1971; Dayton 1985; Schiel and Foster 1986; Witman and Dayton 2001; Reed et al. 2006). Giant kelp commonly attains lengths of 15 to 25 m and can be found at depths of 30 m. In conditions of unusually good water clarity, giant kelp may even thrive to depths of 45 m (Dayton et al. 1984).

Giant kelp may form beds wherever suitable substrate occurs, typically on rocky, subtidal reefs (North 1971). Such substrate must be free of continuous sediment intrusion. Giant kelp beds can form in sandy-bottom habitats protected from direct swells where individuals will attach to worm tubes; this occurs along portions of the Santa Barbara coastline (Bedford 2001). Like terrestrial plants, algae undergo photosynthesis and therefore require light energy to generate sugars. For this reason, light availability at depth is an important limiting factor to giant kelp growth. Greater water clarity normally occurs at the offshore islands, and as a result, giant kelp is commonly found growing there in depths exceeding 30 m. Along the mainland coast, high biological productivity, terrestrial inputs and nearshore mixing result in greater turbidity and hence lower light levels. Consequently, giant kelp generally does not commonly grow deeper than 20 m along the coastal shelf, although exceptional conditions off San Diego produce impressively large beds that can grow vigorously beyond 30 m.



Appendix B.1 Life cycle for giant kelp.

Giant kelp has a complex life cycle and undergoes a heteromorphic alternation of generations, where the phenotypic expression of each generation does not resemble the generation before or after it (Appendix B.1). The stage of giant kelp that is most familiar is the adult canopy-forming diploid sporophyte generation. Sporophyll blades at the base of an adult giant kelp release zoospores, especially in the presence of cold, nutrient-rich waters. These zoospores disperse into the water column and generally settle a short distance from the parent sporophyte (Reed et al. 1988). Within three weeks, the zoospores mature into microscopic male and female gametophytes that in turn produce sperm and eggs. This second generation does not resemble the sporophyte. The life cycle is completed when fertilization of the gametophyte egg develops into the adult sporophyte

stage. Successful completion of the life cycle relies on the persistence of favorable conditions throughout the process.

Giant kelp grows in groups called forests because erect bundles of fronds (stipes and blades) resemble tree trunks, and spreading canopies at the sea surface represent the stems and leaves (Dawson and Foster 1982). *Macrocystis* anchors to rocks (or occasionally in sand) by a holdfast, and new fronds, comprised of stipes and attached blades, grow up to the sea surface at rapid rates. Giant kelp is known as a biological facilitator (Bruno and Bertness 2001), where its three-dimensional structure and the complexity of its holdfast provides substrate, refuge, reduction of physical stress, and a food source for many fishes (Carr 1989) and invertebrates (Duggins et al. 1990). Stands of giant kelp can also affect flow characteristics in the nearshore zone, and enhance recruitment (Duggins et al. 1990), thus increasing animal biomass. For these reasons, giant kelp is also of great importance to sport and commercial fisheries.

HISTORICAL KELP SURVEYS

Giant kelp bed size and health are known to be highly variable but there has been a downward trend in canopy coverage since the inception of surveying in 1911 (Crandall 1912). In 1911, a mapping expedition of canopy-forming kelps along most of the Pacific coast was conducted to determine the amount of potash (potassium carbonate, an essential ingredient in explosives at the time) potentially available from the kelp. Using rowboats, compass, and sextants to triangulate positions, U.S. Army Captain William Crandall produced one of the most complete surface density kelp maps of the west coast of North America. Using this methodology, all of the existing kelp beds in the Central Region and Region Nine areas were mapped and these measurements have been used to define a baseline for southern California kelp beds (Appendices B.2 and B.3).

Despite the value of Crandall's maps, the accuracy of his measurements was questioned (Hodder and Mel 1978 [SAI 1978], Neushul 1981). These authors contended that measurement errors might have resulted from using a rowboat and triangulations from shore to compute the bed perimeters, particularly on very large beds such as Palos Verdes, Point Loma, and La Jolla. Although Crandall's ability to accurately triangulate a position was adequate, his measurements of large beds resulted from fewer fixed points and estimation of the area between points. Modern aerial surveys reveal numerous holes and a fair degree of patchiness in such beds. Crandall's estimates did not account for these natural gaps and therefore the 1911 survey probably overestimated the size of these larger beds. Given this ambiguity, Crandall's measurements should be viewed qualitatively rather than as quantitative estimates comparable to aerial survey data taken since the 1920s. However, the data are a very good approximation to use as a baseline. Anecdotal reports from area stakeholders reported by Cameron (1915) indicate kelp beds in 1911 were in fairly poor condition compared to previous years.

Although the historical El Niño Southern Oscillation (ENSO) index suggests that the five years prior to 1911 were favorable to the kelp, the Pacific Decadal Oscillation (PDO) (another environmental metric that has historical data extending back to that period) is in agreement with Cameron's 1915 statement. While the PDO is a poor predictor of oceanographic conditions in the Southern California Bight (Di Lorenzo et al. 2008), it does correlate with sea surface temperature (SST). Therefore, it provides some insight into the local hydrographic conditions at the time. The annual mean PDO was slightly negative between 1909 and 1911, before transitioning to a warm phase from 1912 through 1915. This is suggestive, but not conclusive, of lower nutrient concentrations in 1912–1915 that would result in poor kelp growth. To add further credibility to the premise that beds were larger than current trends would indicate, aerial photos of Palos Verdes kelp beds taken in 1928 (measured by North in 1964) found the area to be more than 10% larger than Crandall reported in 1911.

In 1964, Dr. Wheeler North, working for the State Water Quality Control Board (1964), re-measured Crandall's Palos Verdes charts and found the 2.66 square nautical miles (Nm^2 [9.12 km^2]) Crandall reported to be very similar to his measurement of 2.42 Nm^2, but North's measurement did not include much of Malaga Cove (that added an additional 0.130 Nm^2 of kelp to the Palos Verdes beds), resulting in North's measurement of about 2.55 Nm^2 (Appendices B.4-B.10; Crandall Maps).

Due to the large sizes reported by Crandall, Neushul (1981) assumed there was a scaling error, re-measured the maps, and calculated a value that was 10% less than Crandall's original measurement. However, Neushul (1981) wrote that his measurements resulted in

Appendix B.2 Kelp beds of the California coast as described by Crandall in 1911.

Crandall Sheet (Map in report) No.	Kelp Bed No.	Density	Bed Name 2013	Area Square Nautical Miles	Area Square Statute Miles	Area Square Kilometers
Sheet 52		Medium	Imperial Beach	0.287	0.3801	0.9844
Sheet 18	1	Very Heavy.	Point Loma	5.400	7.1516	18.5226
	2	Very Heavy.	La Jolla	2.300	3.0461	7.8893
Sheet 17	3	Medium	Del Mar	0.240	0.3178	0.8232
		N. Present	No Solana Beach	0.000	0.0000	0.0000
		N. Present	No Cardiff	0.000	0.0000	0.0000
	4	Medium	Encinitas 30% (0.970)	0.291	0.3854	0.9982
	4	Medium	Leucadia 50% (0.970)	0.485	0.6423	1.6636
	4	Medium	Carlsbad St Bch 20%	0.194	0.2569	0.6654
	5	Medium	Encina Power	0.125	0.1655	0.4288
	5	Medium	Agua Hedionda	0.125	0.1655	0.4288
	6	Medium	Carlsbad	0.140	0.1854	0.4802
	7	Medium	Santa Margarita	0.250	0.3311	0.8575
	8	Thin	Barn Kelp	0.370	0.4900	1.2691
	9	Thin	Barn Kelp	0.080	0.1059	0.2744
	10	Thin	Barn Kelp	0.260	0.3443	0.8918
	11	Thin	Horno Canyon	0.050	0.0662	0.1715
	12	Thin	San Onofre	0.110	0.1457	0.3773
	13	Thin	San Onofre	0.130	0.1722	0.4459
	14	Thin	San Onofre	0.060	0.0795	0.2058
	15	Thin	San Mateo	0.360	0.4768	1.2348
Sheet 14, 15, and 16	16	Thin	San Clemente	0.060	0.0795	0.2058
	17	Medium	Capistrano	0.240	0.3178	0.8232
	18	Medium	Doheny	0.220	0.2914	0.7546
	19	Medium	Dana Point/Salt Creek	0.340	0.4503	1.1662
		N. Present	Laguna Beach	0.000	0.0000	0.0000
	20	Medium	Corona Del Mar	0.220	0.2914	0.7546
	21	Medium	Cabrillo to Port Bend	0.760	1.0065	2.6069
	22	Thin	Portuguese Bend	0.100	0.1324	0.3430
	23	Thin	Point Vicente, PV	0.070	0.0927	0.2401
	24	Medium	PV Pt to Flat Rk, PV	1.600	2.1190	5.4882
	25	Medium	Malaga Cove, PV	0.130	0.1722	0.4459
Chart 13	1	Thin	Sunset Beach	0.280	0.3708	0.9604
	2	Thin	Topanga (50%)	0.005	0.0066	0.0172
	2	Thin	Las Tunas (50%)	0.005	0.0066	0.0172
	3	Thin	Big Rock	0.005	0.0066	0.0172
	4	Thin	Las Flores	0.004	0.0053	0.0137
	5	Thin	La Costa	0.006	0.0079	0.0206
		N. Present	Malibu Point	0.000	0.0000	0.0000
	6	Thin	Puerco/Amarillo (10%)	0.100	0.1324	0.3430
	6	Thin	Latigo Canyon (13%)	0.130	0.1722	0.4459
	6	Thin	Escondido Wash (17%)	0.170	0.2251	0.5831
	6	Thin	Paradise Cove (40%)	0.400	0.5297	1.3720
Chart 13	6	Thin	Point Dume (20%)	0.200	0.2649	0.6860
	7	Thin	Lechuza (33%)	0.037	0.0485	0.1255
	7	Thin	Pescador/Piedra (67%)	0.073	0.0971	0.2515
	8	Medium	Nicolas Canyon (33%)	0.367	0.4855	1.2575
	8	Medium	Leo Carillo (67%)	0.733	0.9712	2.5153
		N. Present	Deer Crk	0.000	0.0000	0.0000
Totals				17.512	23.192	60.068

only slight improvements from what Crandall measured: "*The smaller areas obtained by measurements from more recent maps of southern California kelp beds probably reflect both a slight increase in mapping precision over Crandall's methods, and an actual decrease in size.*" In 2004, Crandall's original maps of Palos Verdes were re-measured by MBC Applied Environmental Sciences (MBC) using computer-aided spatial estimation software (including Malaga Cove), and the resulting area (2.57 Nm^2) was about 3% smaller but very similar to that reported by Crandall (2.66 Nm^2). Therefore, the actual sizes of the beds that Crandall

reported were probably relatively accurate because the areal survey extent and configuration he reported was subsequently confirmed from contemporary charts (Hodder and Mel 1978, Neushul 1981).

Thus, Crandall's kelp bed areas are retained as the baseline estimate, and the total regional area was probably larger from 1928–1934 than the area Crandall measured in 1911. Based on the sizes of the Palos Verdes beds in 1928 (9.912 km^2) and La Jolla kelp beds in 1934 (8.161 km^2) from aerial photos that North measured in 1964 (SWQCB 1964), the bed sizes were well above Crandall's measurements of 9.124 km^2 (2.66 Nm^2) for Palos Verdes (including the bed at Malaga Cove) and 7.889 km^2 (2.3 Nm^2) for La Jolla. This lends credence to Cameron's comment that kelp harvesters reported that the beds were at minimal levels at the time of Crandall's survey, and suggests even larger losses have occurred over time (Cameron 1915).

The next complete kelp survey of the southern California region was not undertaken until 1955. By that time, the beds in the Central Region had decreased greatly (to 6.750 km^2), and were only 36% of that recorded in 1911 (18.815 km^2). Beds in Region Nine were similarly reduced to 40% (16.310 km^2) of the 1911 total of 41.563 km^2. The most significant loss during this period was that of Sunset Kelp (offshore of Santa Monica); Sunset Kelp covered almost 1.0 km^2 in 1911, but was very small by 1955. The Sunset kelp bed remained small or completely missing through the intervening years, and the Palos Verdes beds were also small, having decreased sometime after 1945. By 1947, the Palos Verdes beds were only 3.6 km^2, and further to 1.5 km^2 by 1953. During an aerial survey conducted in 1963, kelp canopies were in very poor condition, with Palos Verdes covering only 0.180 km^2 and the La Jolla and Point Loma beds covering only 0.9 km^2. Exceptionally good conditions in 1967 resulted in a total of 7.856 km^2 of kelp canopy coverage in the Central Region, but this was only about 42% of the estimate from 1911. Palos Verdes kelp beds south of Point Vicente were missing, but north of Point Vicente, they totaled almost 1.0 km^2. In Region Nine, similar results were observed in 1967 with the La Jolla/Point Loma kelp beds covering 3.03 km^2 and the total for the region only 4.4 km^2. La Jolla kelp bed was only about 0.330 km^2 in 1967, and it stayed small until after 1975, when it became a consistently large kelp bed (over 1 km^2) through most of the next four decades.

Restoration activities began in 1974 by the Kelp Habitat Improvement Project. At that time, the Palos Verdes beds were only 0.015 km^2. In 1975, after restoration, those beds began increasing and covered 4.6 km^2 during the exceptionally favorable conditions in 1989 (North and Jones 1991). The impetus provided by the 1989 La Niña resulted in almost 6 km^2 of kelp canopy in the Central Region and more than 16 km^2 in Region Nine, but kelp coverage decreased to less than one-third of these totals during the subsequent two decades. In 2009 (Central) and 2008 (Region Nine), favorable conditions again increased canopy totals to about 6.5 km^2 in the Central Region and 18.7 km^2 in Region Nine, larger than they had been since 1967 and 1955, respectively (Appendix B.3).

The Imperial Beach kelp bed south of San Diego measured 0.984 km^2 in 1911, and was never again measured to be larger than about 0.727 km^2 for the rest of the century (occurring in 1987, Appendix B.3). However, by the end of 2007, Imperial Beach kelp bed measured 1.493 km^2 (Appendix B.3, MBC 2011b), almost 50% greater than what Crandall measured, lending further credence to Cameron's (1915) statement that beds were in poor condition in 1911 compared to earlier years. It therefore follows that the Palos Verdes, La Jolla, and Point Loma kelp beds of Central and Region Nine prior to 1911 were likely much larger than they are today.

As these measurements indicate, most of the beds remain smaller than those of a century ago. Ongoing surveys attempt to determine what environmental factors have changed in the intervening years to cause such large declines.

Appendix B.3 Historical canopy coverage of the kelp beds from Laguna Beach to Imperial Beach from 1911 through 2019. Values represent an estimate of coverage utilizing varying methods over the years.

	Canopy Area (km²)											
Kelp Bed	**1911**	**1934**	**1941**	**1955***	**1959***	**1963***	**1967**	**1970**	**1975**	**1980**	**1983**	**1984**
North Laguna Beach	Tr	ND	ND	p	0.160	ND	0.001	0.011	0.003	0.036	0.035	0.025
South Laguna Beach	Tr	ND	ND	p	ND	ND	0.001	0.011	0.003	0.036	0.040	0.028
South Laguna	Tr	ND	ND	p	0.180	0.020	—	0.014	0.008	—	0.004	-
Dana Point-Salt Creek	1.166	ND	ND	p	p	p	0.240	0.077	0.096	0.008	0.013	0.007
Capistrano Beach	1.578	ND	ND	p	p	p	0.080	0.050	0.070	0.020	—	—
Total F&W 9	2.744	—	—	2.020	0.340	0.020	0.322	0.163	0.180	0.100	0.092	0.060
San Clemente	0.206	ND	ND	6.310	3.710	0.010	0.080	0.050	0.070	0.020	—	—
San Mateo Point	1.235	ND	ND	p	p	p	—	0.057	0.140	0.360	0.163	0.045
San Onofre	1.029	ND	ND	p	p	p	—	—	0.300	0.160	0.102	0.031
Total F&W 8	2.470	—	—	6.310	3.710	0.010	0.080	0.107	0.510	0.540	0.265	0.076
Horno Canyon	0.172	ND	ND	ND	ND	ND	—	—	—	—	—	—
Barn Kelp	2.435	ND	ND	1.370	ND	0.130	0.017	0.019	0.160	0.056	—	—
Santa Margarita	0.858	ND	ND	ND	ND	ND	—	—	—	—	—	—
Total F&W 7	3.465	—	—	1.370	—	0.130	0.017	0.019	0.160	0.056	—	—
North Carlsbad	0.480	ND	ND	2.620	2.520	1.180	0.009	0.060	0.100	0.120	—	—
Agua Hedionda	0.429	ND	ND	p	p	p	—	0.006	0.036	0.019	—	0.001
Encina Power Plant	0.429	ND	ND	p	p	p	—	0.025	0.144	0.074	—	0.002
Carlsbad State Beach	0.499	ND	ND	p	p	p	0.032	0.120	0.200	0.078	—	—
Total F&W 6	1.837	—	—	2.620	2.520	1.180	0.041	0.211	0.480	0.291	—	0.003
Leucadia	1.996	ND	ND	p	p	p	0.240	0.440	0.500	0.670	0.001	0.002
Encinitas	0.832	ND	ND	p	p	p	0.065	0.173	0.153	0.228	—	0.016
Cardiff	ND	ND	ND	0.340	0.400	0.160	0.125	0.337	0.297	0.442	0.018	0.021
Solana Beach	ND	ND	ND	p	p	p	0.290	0.490	0.560	0.690	—	0.001
Del Mar	0.823	ND	ND	p	p	p	0.190	0.260	0.190	0.210	—	—
Torrey Pines	—	—	—	—	—	—	—	—	—	—	—	—
Total F&W 5	3.651	—	—	0.340	0.400	0.160	0.910	1.700	1.700	2.240	0.019	0.040
La Jolla F&W 4	7.889	8.161	7.847	1.660	6.490	0.640	0.330	0.290	0.840	1.900	0.032	0.034
Point Loma F&W 3&2	18.523	11.465	8.286	1.990	0.610	0.240	2.700	4.900	3.000	4.200	0.200	0.160
Imperial Beach F&W 1	0.984	ND	ND	ND	ND	ND	—	—	—	0.350	—	—
TOTAL	41.563	19.626	16.133	16.310	14.070	2.380	4.400	7.390	6.870	9.327	0.608	0.373

NOTE: * = Incomplete Data; Tr = Trace <100 m^2 ; ND = No Data; p = part of above value; "—" = 0

red = warm year El Nino; **blue** = cold year La Nina; **black** = neutral year

Sources: 1934, 1941 from SWQCB (1964); 1955, 1959, 1963 from Neushul (1981); MBC (2007b-2012b, 2013-2017).

Appendix B.3 (Cont.).

	Canopy Area (km²)											
Kelp Bed	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
North Laguna Beach	0.028	0.022	0.028	0.042	0.055	0.034	0.029	—	—	—	—	0.001
South Laguna Beach	0.077	0.041	0.087	0.145	0.264	0.243	0.093	0.056	0.028	—	—	—
South Laguna	—	—	—	0.023	0.041	0.023	0.030	0.009	0.006	0.005	—	—
Dana Point-Salt Creek	0.036	0.031	0.174	0.568	0.878	0.329	0.480	0.184	0.234	0.116	0.076	0.061
Capistrano Beach	—	—	—	0.032	0.233	0.110	0.134	0.148	0.022	—	—	—
Total F&W 9	0.141	0.094	0.289	0.810	1.471	0.739	0.766	0.397	0.290	0.121	0.076	0.062
San Clemente	—	—	0.017	0.124	0.444	0.304	0.243	0.044	0.051	0.010	0.010	0.047
San Mateo Point	0.152	0.077	0.200	0.432	0.870	0.472	0.120	0.103	0.220	0.080	0.010	0.073
San Onofre	0.042	0.053	0.045	0.348	0.638	0.763	0.170	0.053	0.163	0.201	0.096	0.196
Total F&W 8	0.194	0.130	0.262	0.904	1.952	1.539	0.533	0.200	0.434	0.291	0.116	0.316
Horno Canyon	—	—	—	0.006	0.033	0.010	0.018	0.040	—	—	—	—
Barn Kelp	—	—	—	0.008	0.116	0.382	0.262	0.124	0.002	0.010	0.172	0.204
Santa Margarita	—	—	—	—	—	—	0.049	0.009	—	—	—	—
Total F&W 7	—	—	—	0.014	0.149	0.392	0.329	0.173	0.002	0.010	0.172	0.204
North Carlsbad	—	—	0.031	0.049	0.096	0.119	0.044	0.004	0.018	0.020	0.008	—
Agua Hedionda	0.011	0.018	0.021	0.032	0.047	0.046	0.016	0.004	0.012	0.004	0.008	0.009
Encina Power Plant	0.024	0.045	0.120	0.161	0.251	0.179	0.083	0.025	0.022	0.011	0.058	0.032
Carlsbad State Beach	0.027	0.018	0.077	0.032	0.049	0.081	0.035	0.008	0.002	0.011	0.025	0.013
Total F&W 6	0.062	0.081	0.249	0.274	0.443	0.425	0.178	0.041	0.054	0.046	0.099	0.054
Leucadia	0.104	0.074	0.426	0.197	0.291	0.341	0.163	0.084	0.035	0.010	0.189	0.087
Encinitas	0.083	0.032	0.177	0.153	0.209	0.241	0.080	0.036	0.037	0.016	0.061	0.023
Cardiff	0.176	0.120	0.340	0.229	0.575	0.468	0.072	0.054	0.034	0.080	0.092	0.026
Solana Beach	0.115	0.120	0.367	0.427	0.488	0.466	0.257	0.053	0.023	0.108	0.134	0.003
Del Mar	0.008	0.021	0.081	0.063	0.104	0.082	0.097	0.006	0.003	0.029	0.082	—
Torrey Pines	—	—	—	Tr	Tr	—	—	—	—	—	—	—
Total F&W 5	0.486	0.367	1.391	1.069	1.667	1.598	0.669	0.233	0.132	0.243	0.558	0.139
La Jolla F&W 4	0.720	0.930	2.369	2.200	4.755	3.632	3.230	1.301	0.681	1.119	0.824	0.371
Point Loma F&W 3&2	1.570	2.100	3.682	2.322	5.842	5.943	4.310	1.153	1.917	3.589	1.134	1.187
Imperial Beach F&W 1	0.058	0.150	0.727	0.067	0.579	0.651	0.370	0.111	0.025	0.108	0.053	0.008
TOTAL	3.173	3.702	8.242	7.593	16.279	14.268	10.015	3.498	3.510	5.419	3.032	2.341

Appendix B.3 (Cont.).

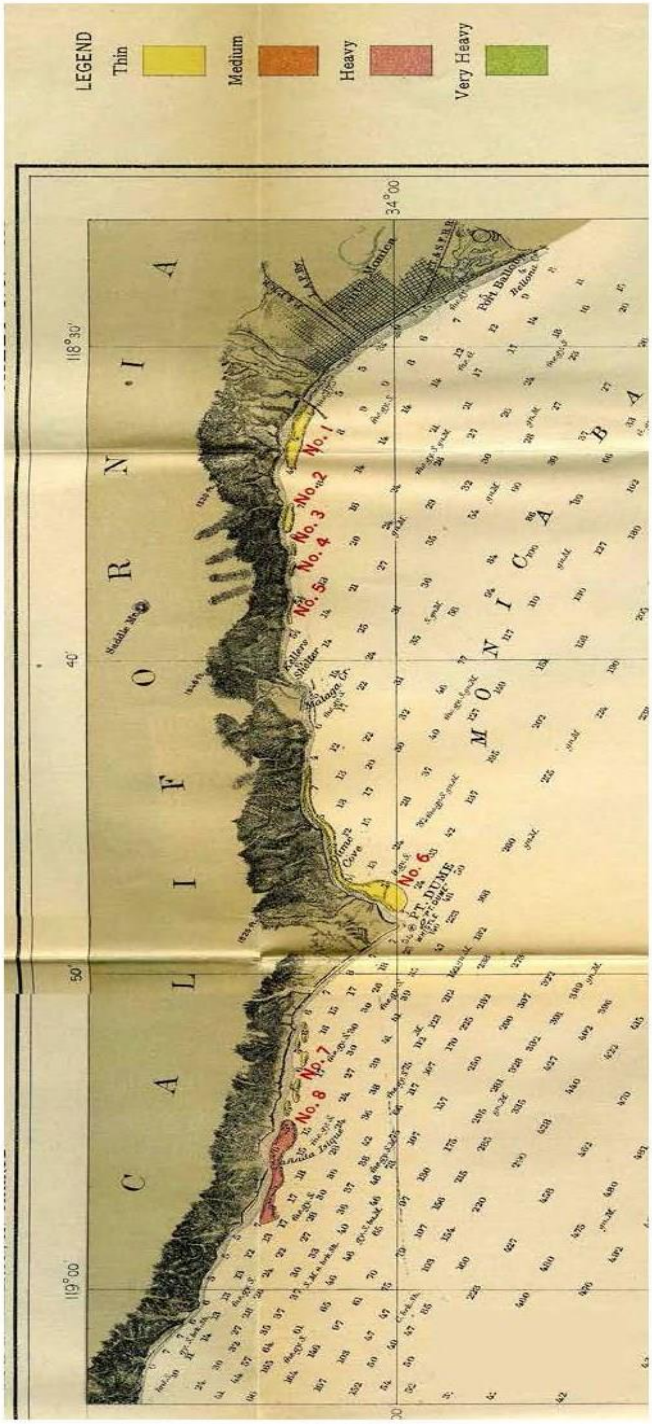
	Canopy Area (km²)											
Kelp Bed	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
North Laguna Beach	—	—	—	—	—	—	0.0004	—	—	—	—	0.002
South Laguna Beach	—	—	—	—	—	0.005	0.0002	0.008	—	—	0.001	0.025
South Laguna	—	—	—	0.003	0.002	<0.001	0.004	0.009	0.003	—	0.004	0.023
Dana Point-Salt Creek	0.034	0.005	0.080	0.170	0.314	0.432	0.303	0.278	0.123	—	0.302	1.068
Capistrano Beach	—	—	<0.001	<0.001	0.044	0.118	0.069	0.008	—	0.011	0.002	0.071
Total F&W 9	0.034	0.005	0.080	0.173	0.359	0.555	0.376	0.303	0.126	0.011	0.309	1.189
San Clemente	—	—	0.006	0.005	0.124	0.316	0.352	0.182	0.178	0.014	0.016	0.203
San Mateo Point	0.098	—	0.051	0.050	0.090	0.155	0.242	0.123	0.258	0.016	0.201	0.487
San Onofre	0.108	<0.001	0.005	0.020	0.041	0.030	0.162	0.109	0.065	—	0.320	0.476
Total F&W 8	0.206	—	0.062	0.075	0.255	0.501	0.755	0.414	0.501	0.030	0.536	1.166
Horno Canyon	—	—	—	0.002	0.034	—	0.001	—	—	—	0.015	0.083
Barn Kelp	0.178	—	0.310	0.375	0.547	0.667	0.492	0.075	0.064	—	0.466	0.858
Santa Margarita	—	—	—	—	—	—	—	—	—	—	—	—
Total F&W 7	0.178	—	0.310	0.377	0.581	0.667	0.494	0.075	0.064	—	0.481	0.941
North Carlsbad	—	0.003	—	—	0.017	0.053	0.017	0.003	0.013	—	0.026	0.108
Agua Hedionda	—	—	—	—	—	<0.001	0.002	0.001	0.008	—	0.016	0.080
Encina Power Plant	0.013	—	—	0.002	0.029	0.097	0.178	0.067	0.001	—	0.081	0.306
Carlsbad State Beach	—	—	—	0.003	0.023	0.047	0.002	0.0001	—	—	0.064	0.121
Total F&W 6	0.013	0.003	—	0.005	0.069	0.197	0.199	0.070	0.023	—	0.187	0.615
Leucadia	0.062	—	0.015	0.090	0.209	0.334	0.185	0.048	0.001	0.016	0.233	0.421
Encinitas	0.048	—	0.029	0.040	0.131	0.153	0.050	0.016	—	0.002	0.205	0.346
Cardiff	0.031	0.016	0.063	0.150	0.309	0.405	0.202	0.045	—	0.004	0.286	0.484
Solana Beach	0.073	0.009	0.091	0.200	0.407	0.488	0.245	0.022	0.093	0.0003	0.457	0.823
Del Mar	Tr	0.004	—	0.006	0.015	0.035	0.030	—	—	—	0.037	0.057
Torrey Pines	—	—	—	—	—	—	—	—	—	0.010	—	0.001
Total F&W 5	0.214	0.029	0.198	0.486	1.071	1.415	0.712	0.131	0.094	0.032	1.218	2.133
La Jolla F&W 4	0.478	0.215	1.146	1.250	2.555	3.366	3.444	1.029	0.873	0.117	2.750	4.145
Point Loma F&W 3&2	2.235	0.295	1.725	3.290	6.574	3.799	4.509	1.924	2.152	1.767	3.616	6.623
Imperial Beach F&W 1	0.027	—	0.019	0.020	0.078	0.210	0.083	0.191	0.400	0.400	1.493	1.895
TOTAL	3.385	0.547	3.540	5.676	11.542	10.710	10.572	4.136	4.233	2.358	10.591	18.706

Appendix B.3 (Cont.).

Kelp Bed	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
North Laguna Beach	0.005	0.093	0.147	0.192	0.142	0.120	0.080	0.074	0.096	0.133	0.015
South Laguna Beach	0.058	0.098	0.221	0.214	0.273	0.165	0.048	0.035	0.032	0.131	0.007
South Laguna	0.017	0.023	0.018	0.017	0.038	0.031	0.016	0.006	0.003	0.048	—
Dana Point-Salt Creek	0.892	0.839	0.442	0.607	0.835	0.528	0.137	0.110	0.133	0.379	—
Capistrano Beach	0.071	0.124	0.010	0.056	0.099	0.034	0.007	0.012	0.0004	0.018	—
Total F&W 9	1.043	1.178	0.838	1.086	1.385	0.879	0.287	0.237	0.264	0.709	0.022
San Clemente	0.210	0.710	0.795	0.874	1.097	0.843	0.343	0.187	0.229	0.335	0.031
San Mateo Point	0.545	0.583	0.203	0.216	0.219	0.199	0.062	0.053	0.033	0.083	0.0001
San Onofre	0.419	0.458	0.127	0.191	0.767	0.584	0.043	0.120	0.087	0.127	0.001
Total F&W 8	1.174	1.750	1.124	1.281	2.083	1.627	0.449	0.359	0.349	0.545	0.032
Horno Canyon	0.018	0.081	—	0.008	0.125	0.055	0.019	0.010	0.011	0.008	—
Barn Kelp	0.926	0.500	0.095	0.442	0.868	0.741	0.085	0.133	0.096	0.092	—
Santa Margarita	—	—	—	—	0.080	—	—	—	—	—	—
Total F&W 7	0.944	0.581	0.095	0.450	1.073	0.795	0.104	0.143	0.107	0.100	0.000
North Carlsbad	0.135	0.078	0.017	0.052	0.125	0.086	0.047	—	0.004	0.038	—
Agua Hedionda	0.092	0.031	0.022	0.046	0.102	0.065	0.016	—	—	—	—
Encina Power Plant	0.215	0.176	0.084	0.216	0.352	0.221	0.159	0.009	0.025	0.045	—
Carlsbad State Beach	0.127	0.069	0.024	0.058	0.178	0.065	0.061	—	0.001	—	—
Total F&W 6	0.569	0.354	0.147	0.372	0.757	0.437	0.282	0.009	0.031	0.083	0.000
Leucadia	0.429	0.215	0.119	0.232	0.541	0.279	0.414	0.033	0.010	0.053	0.009
Encinitas	0.205	0.128	0.124	0.260	0.231	0.112	0.113	0.009	0.003	0.033	—
Cardiff	0.520	0.213	0.395	0.459	0.590	0.299	0.318	0.024	0.003	0.005	—
Solana Beach	0.505	0.328	0.504	0.442	0.606	0.504	0.316	0.138	0.029	0.024	—
Del Mar	0.044	0.038	0.074	0.024	0.056	0.027	0.034	—	—	—	—
Torrey Pines	0.0004	0.003	0.031	0.034	0.081	—	—	—	—	—	—
Total F&W 5	1.703	0.925	1.247	1.452	2.106	1.221	1.195	0.204	0.045	0.114	0.009
La Jolla F&W 4	2.274	2.776	2.565	1.569	4.006	2.790	2.968	0.927	0.694	1.566	1.227
Point Loma F&W 3&2	4.909	3.977	4.212	5.340	5.127	5.121	5.806	3.037	1.787	7.920	3.924
Imperial Beach F&W 1	0.861	0.004	0.152	0.333	0.526	1.183	1.576	0.217	—	—	—
TOTAL	13.476	11.545	10.379	11.882	17.064	14.053	12.667	5.134	3.277	11.037	5.213

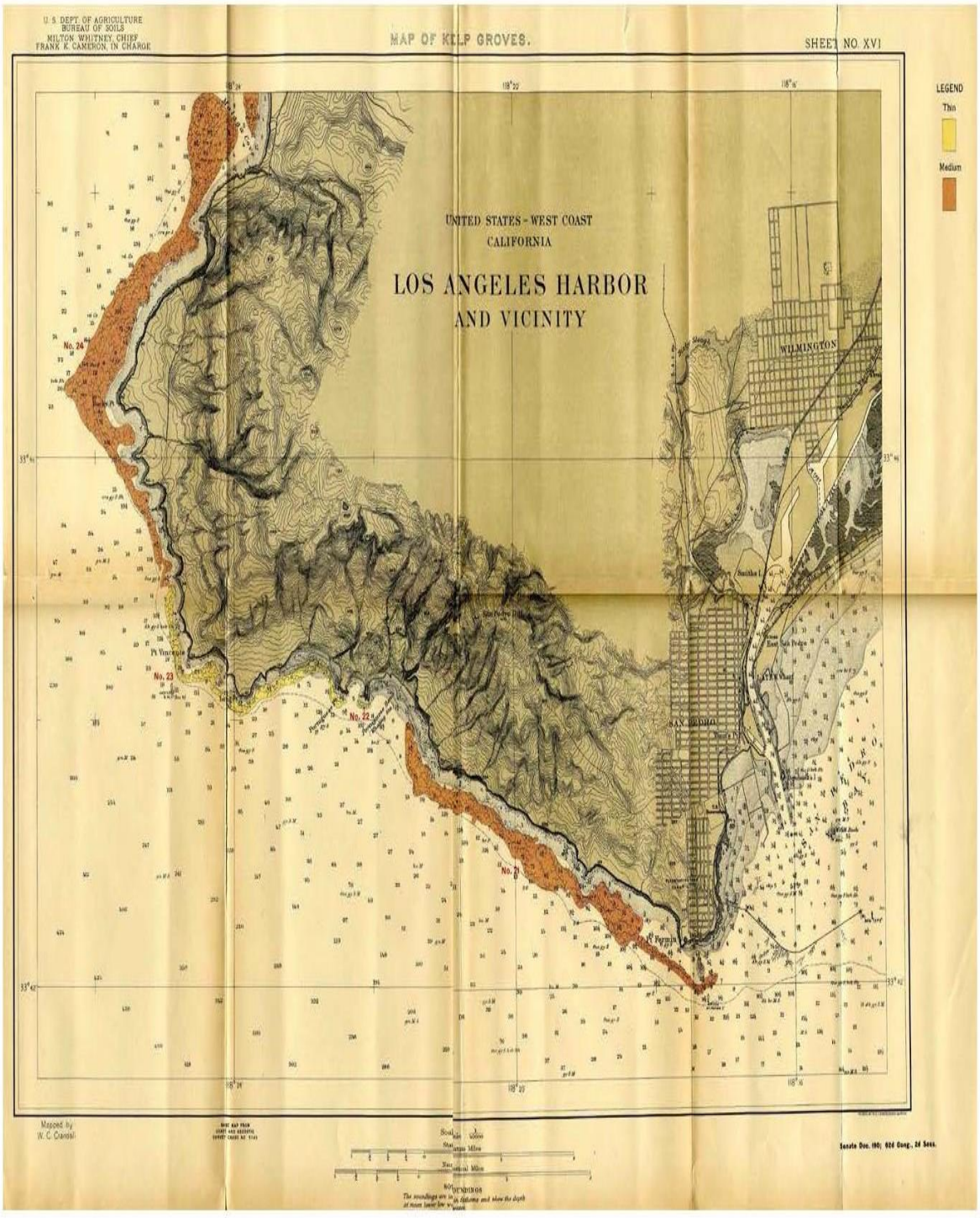
Appendix B.3 (Cont.)

Kelp Bed	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
N Laguna Beach	0.022	0.031	0.040							
S Laguna Beach	0.001	0.012	0.005							
South Laguna	-	0.005	0.001							
Dana Pt/Salt Creek	0.005	0.017	0.002							
Capistrano Beach	-	0.006	-							
Total F&W 9	**0.028**	**0.071**	**0.048**							
San Clemente	0.009	0.004	-							
San Mateo Point	-	0.007	-							
San Onofre	-	-	-							
Total F&W 8	**0.009**	**0.011**	**0.000**							
Horno Canyon	0.003	-	-							
Barn Kelp	0.234	0.262	-							
Santa Margarita	-	-	-							
Total F&W 7	**0.237**	**0.262**	**0.000**							
North Carlsbad	-	-	-							
Agua Hedionda	-	-	-							
Encina Power Plant	-	-	-							
Carlsbad State Bch	-	-	-							
Total F&W 6	**0.000**	**0.000**	**0.000**							
Leucadia	0.006	-	-							
Encinitas	0.0003	-	-							
Cardiff	-	-	-							
Solana Beach	-	0.006	-							
Del Mar	-	-	-							
Torrey Pines	-	-	-							
Total F&W 5	**0.006**	**0.006**	**0.000**							
La Jolla F&W 4	1.094	0.725	0.446							
Point Loma F&W 3&2	2.545	1.882	1.417							
Imperial Beach F&W 1	-	-	-							
TOTAL	**3.919**	**2.964**	**1.911**							



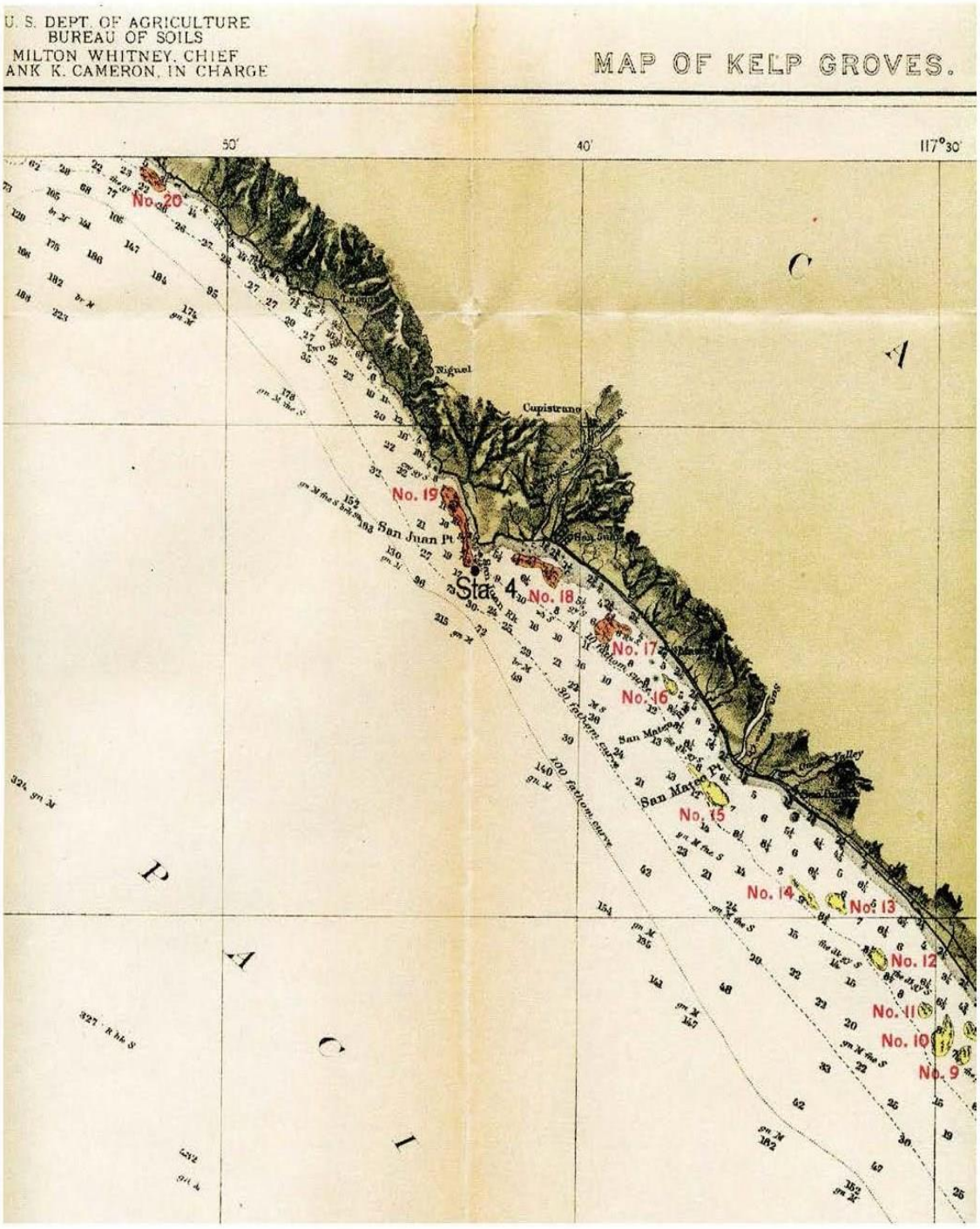
Appendix B.4 Crandall's 1911 kelp survey Deer Creek to Ballona Creek.

Page B-12

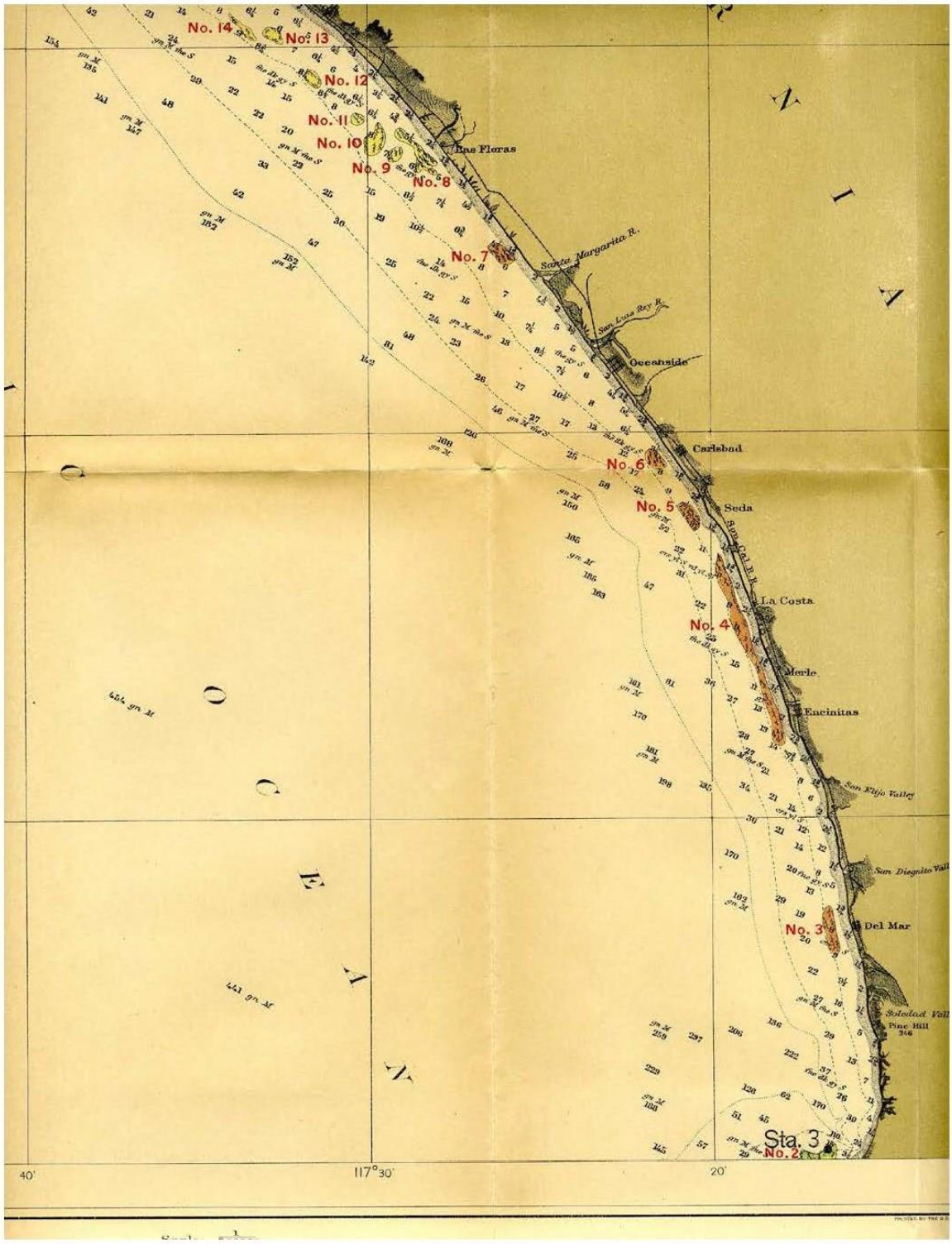


Appendix B.5 Crandall's 1911 kelp survey Palos Verdes to Los Angeles Harbor.

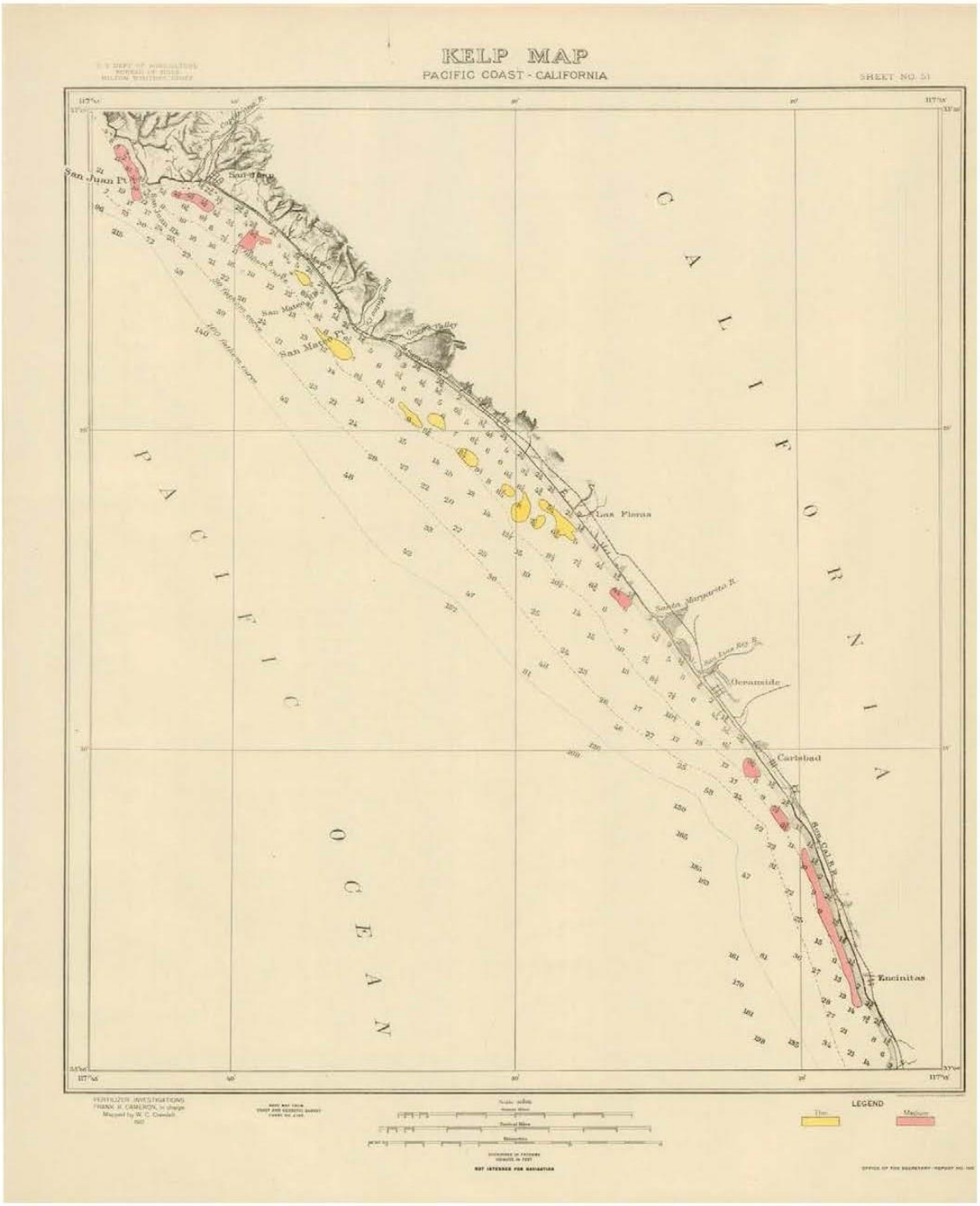
Page B-13



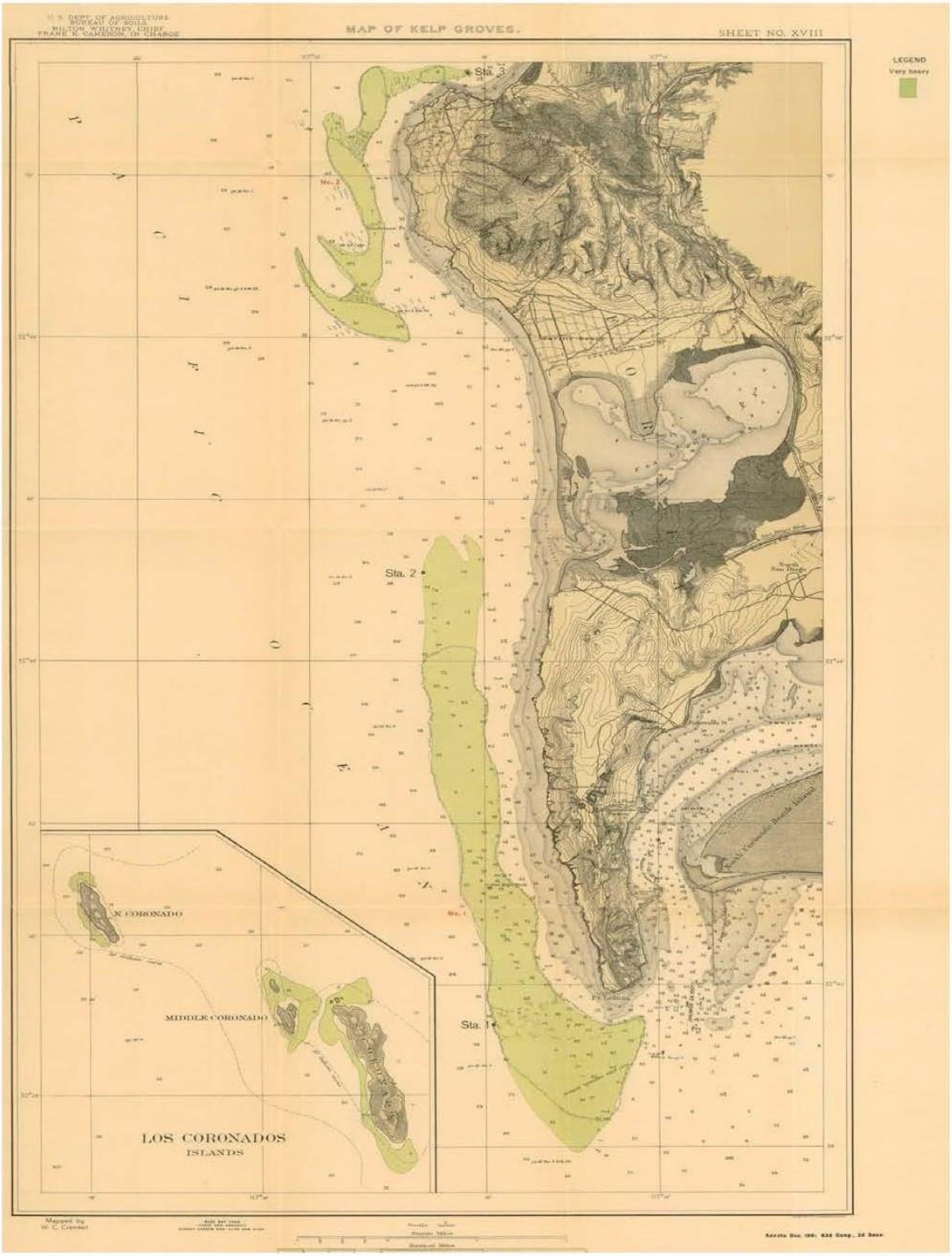
Appendix B.6 Crandall's 1911 kelp bed survey Newport to San Onofre.



Appendix B.7 Crandall's 1911 kelp bed survey San Onofre to Del Mar.

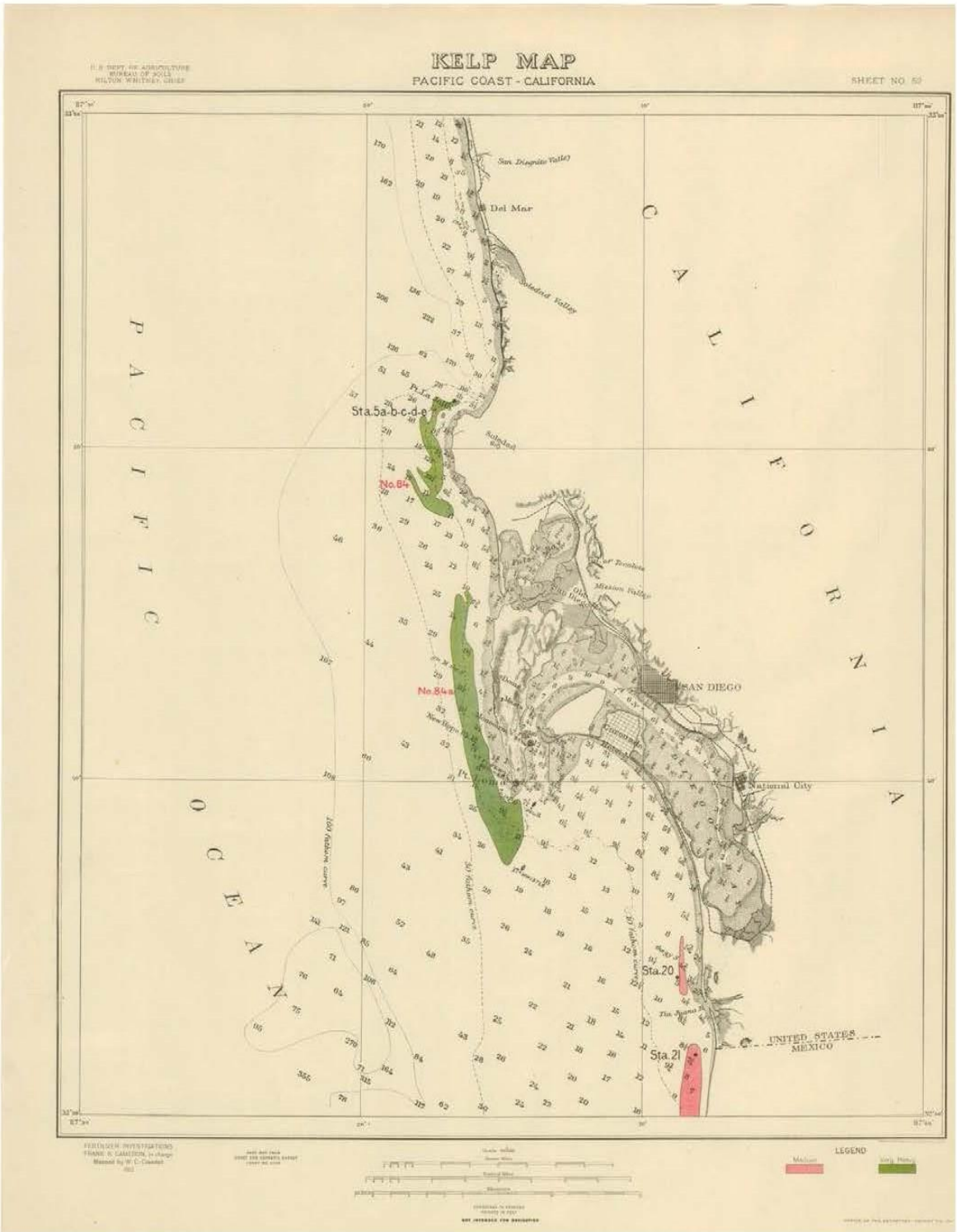


Appendix B.8 Crandall's 1911 kelp bed survey San Juan to Encinitas.



Appendix B.9 Crandall's 1911 kelp bed survey La Jolla to Point Loma.

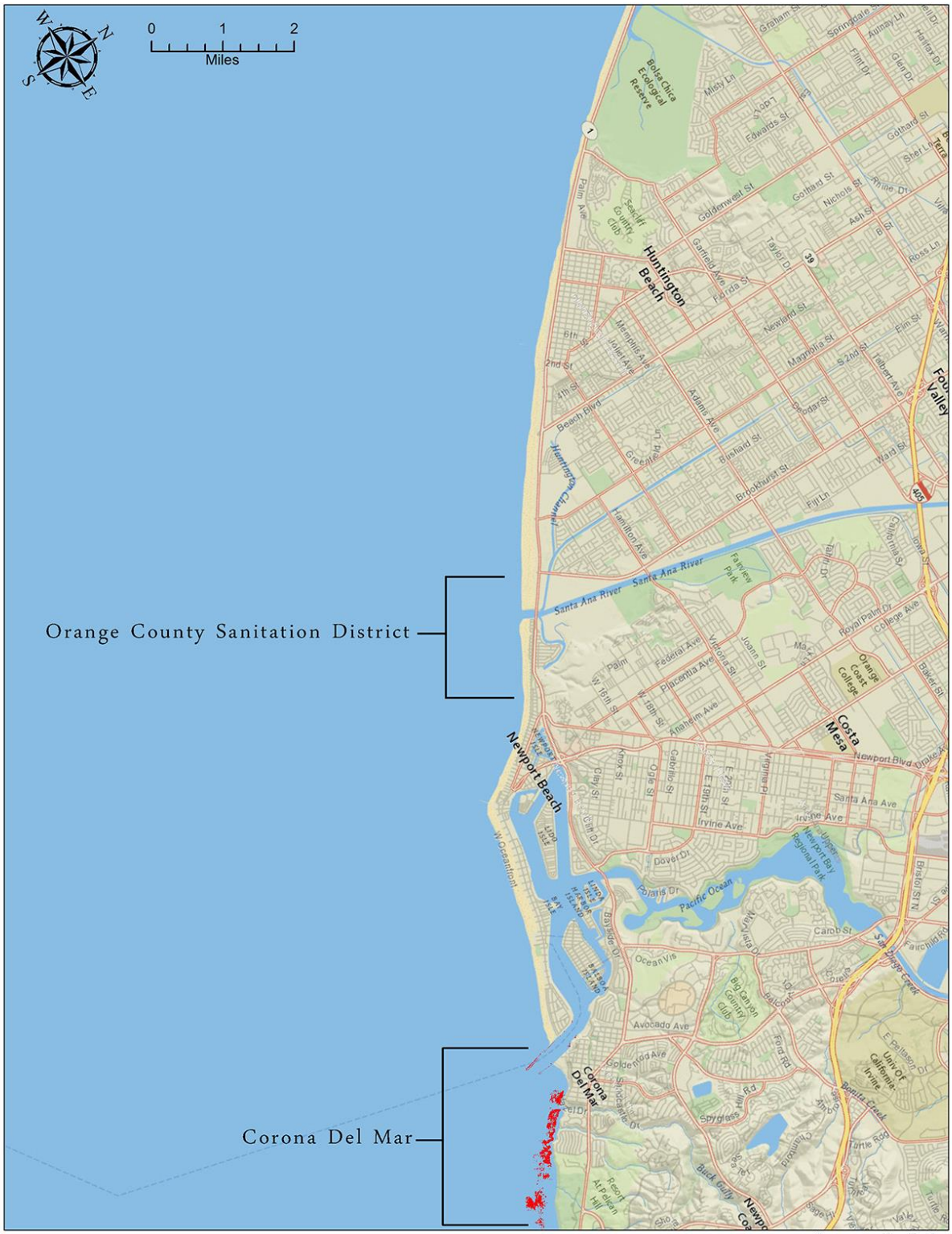
Page B-17



Appendix B.10 Crandall's 1911 kelp bed survey La Jolla to Imperial Beach.

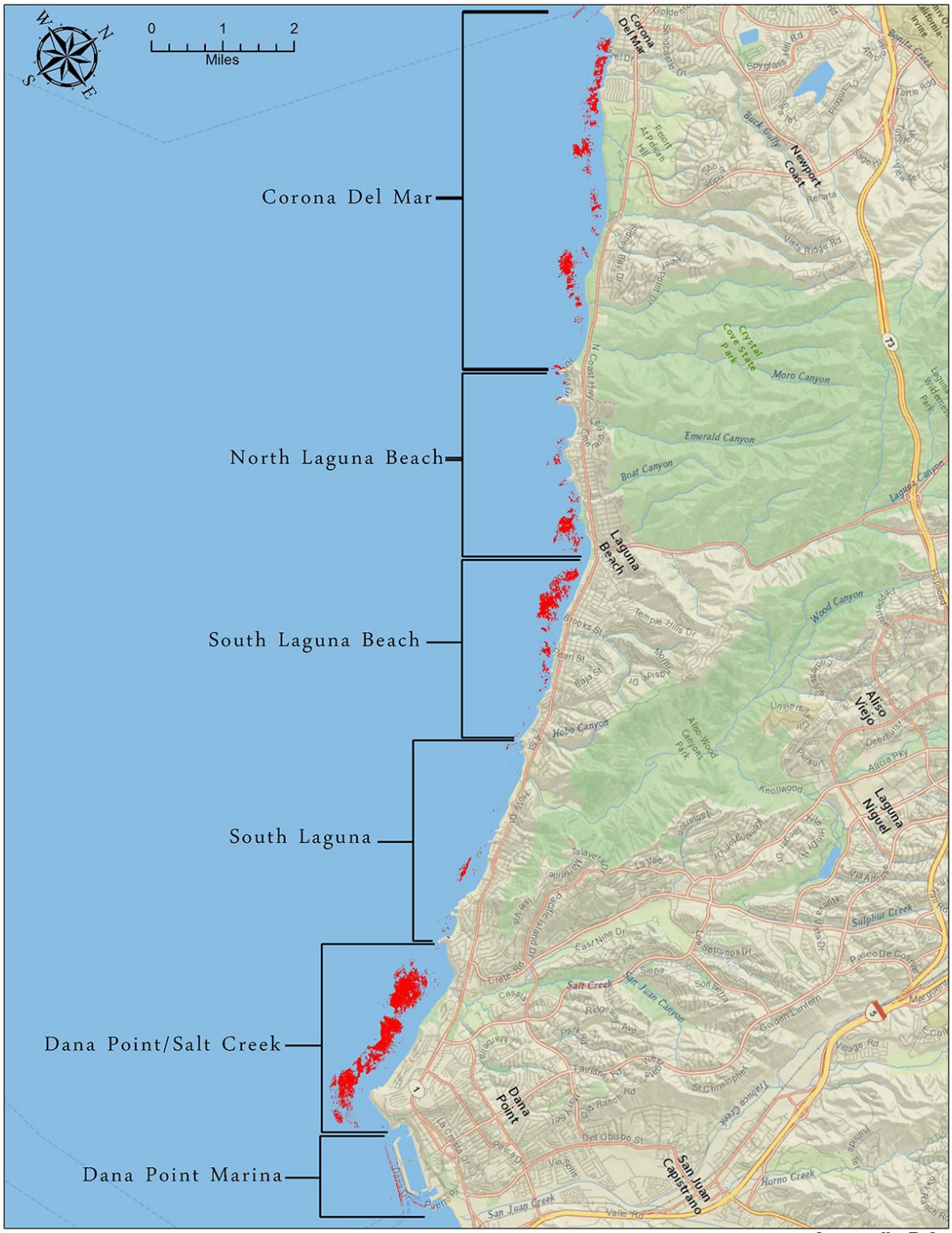
APPENDIX C

FLIGHT PATH
FLIGHT DATA REPORTS
FIELD DATA SHEETS



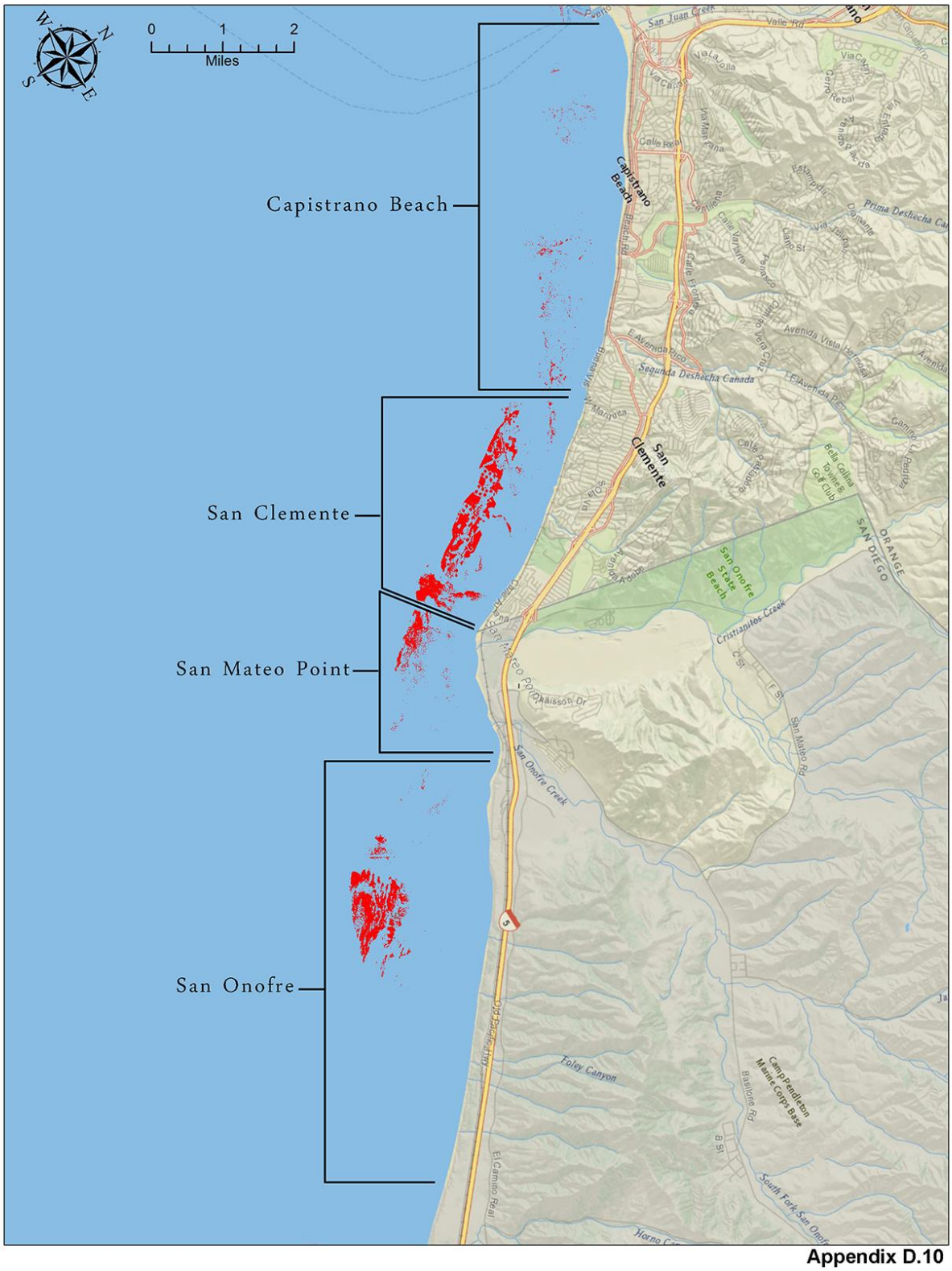
Appendix D.8

Page C-1



Appendix D.9

Page C-2



Appendix D.10

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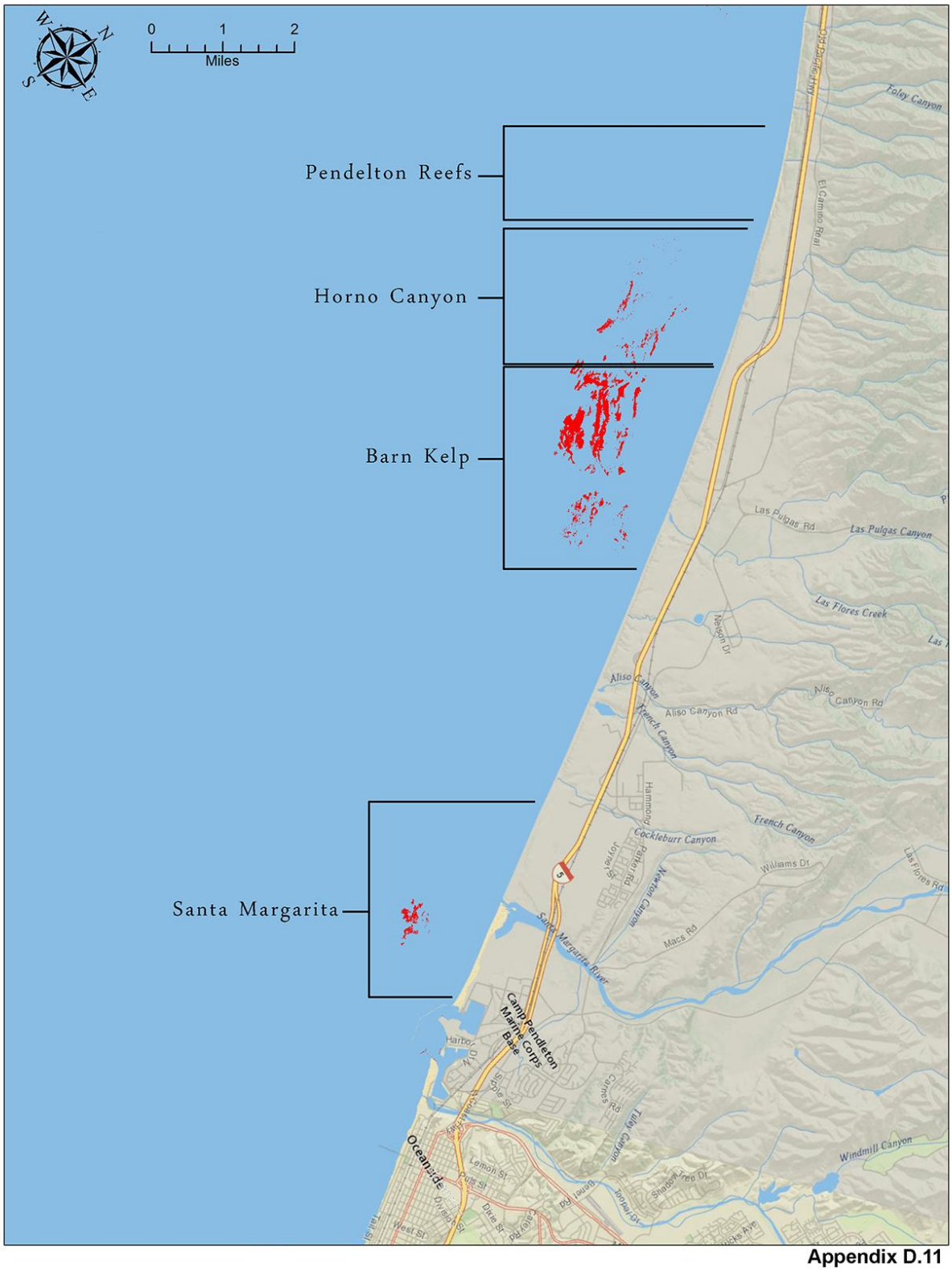
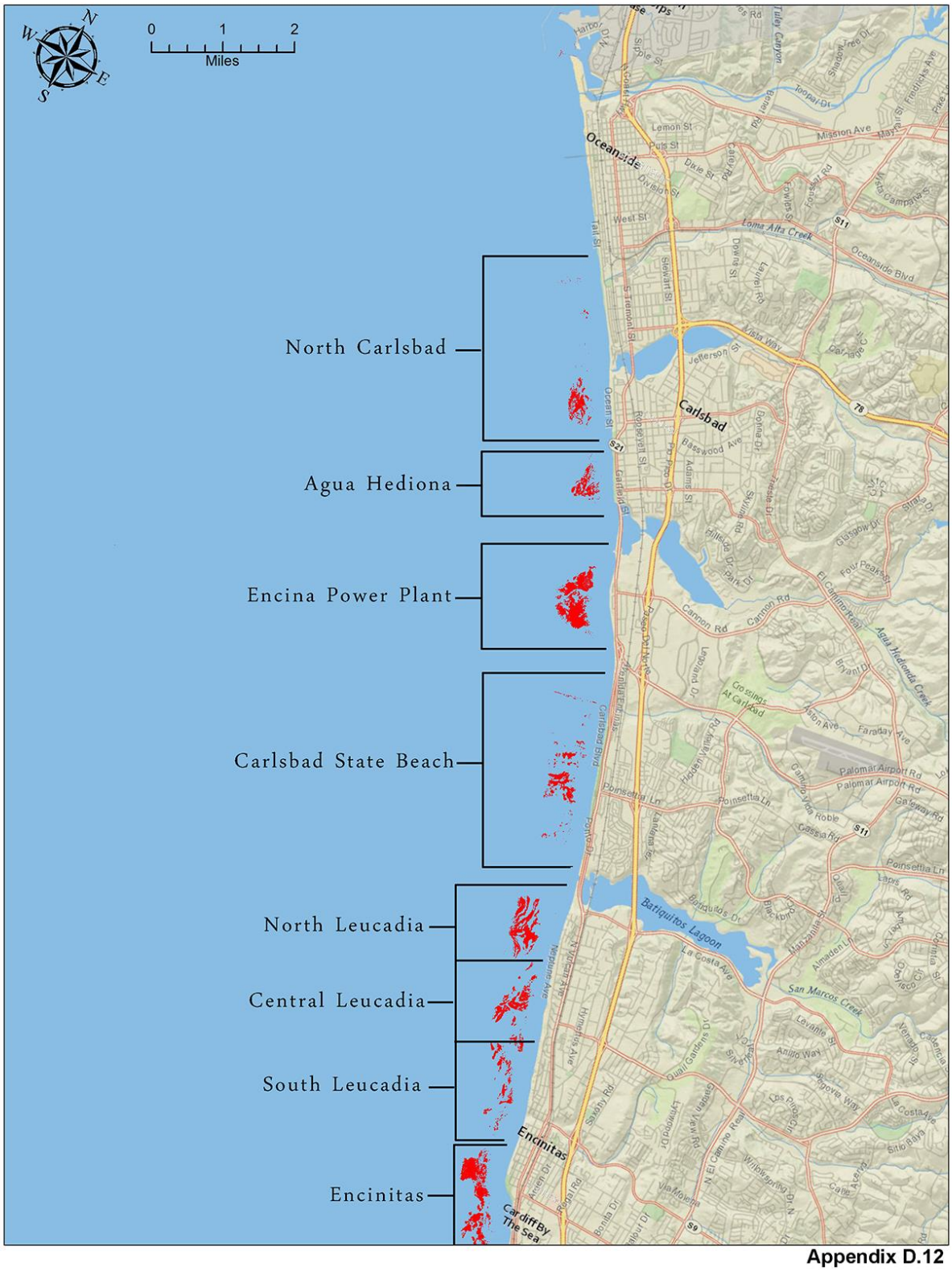


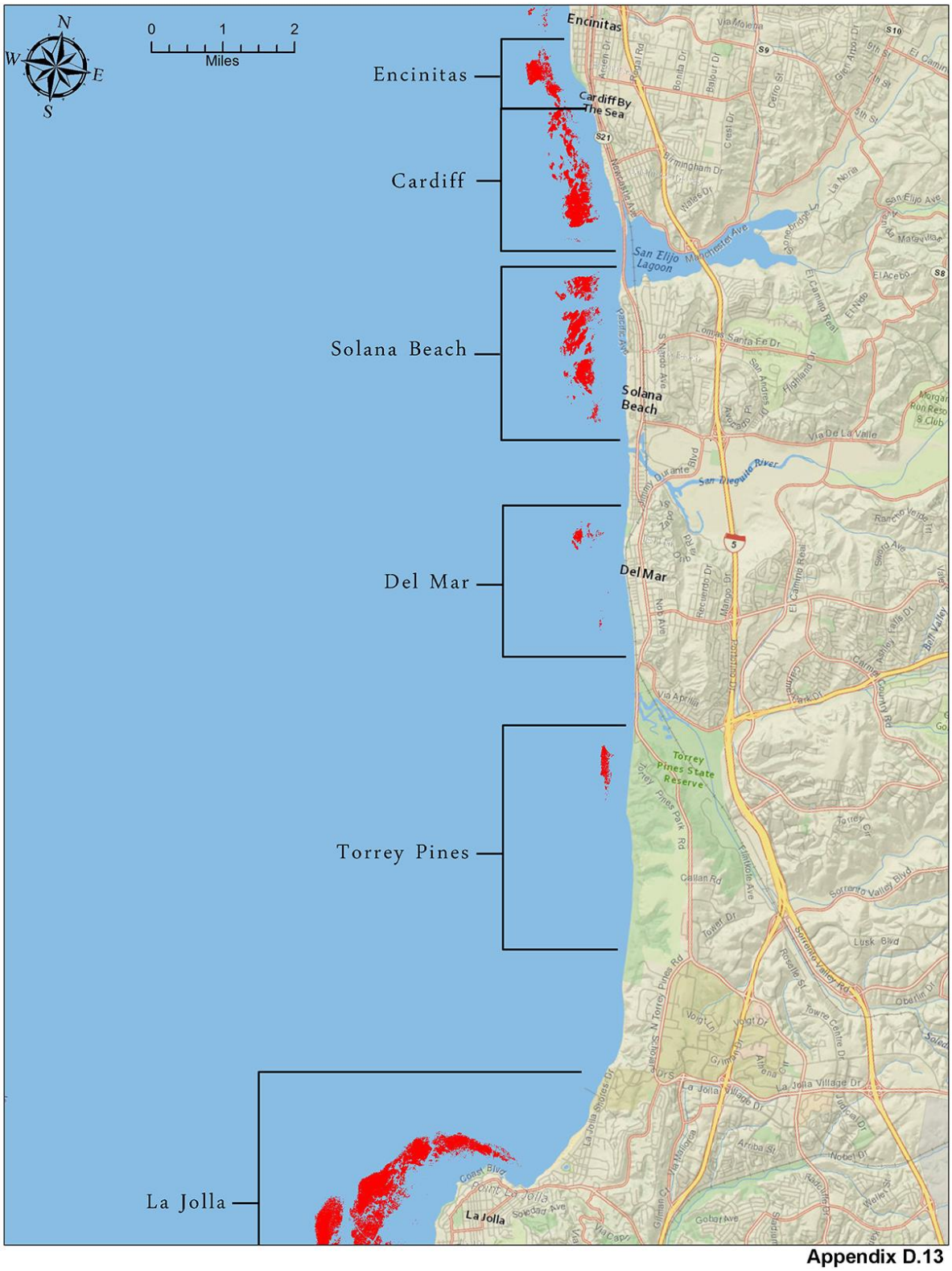
Appendix D.11

Page C-4



Appendix D.12

Page C-5



Appendix D.13

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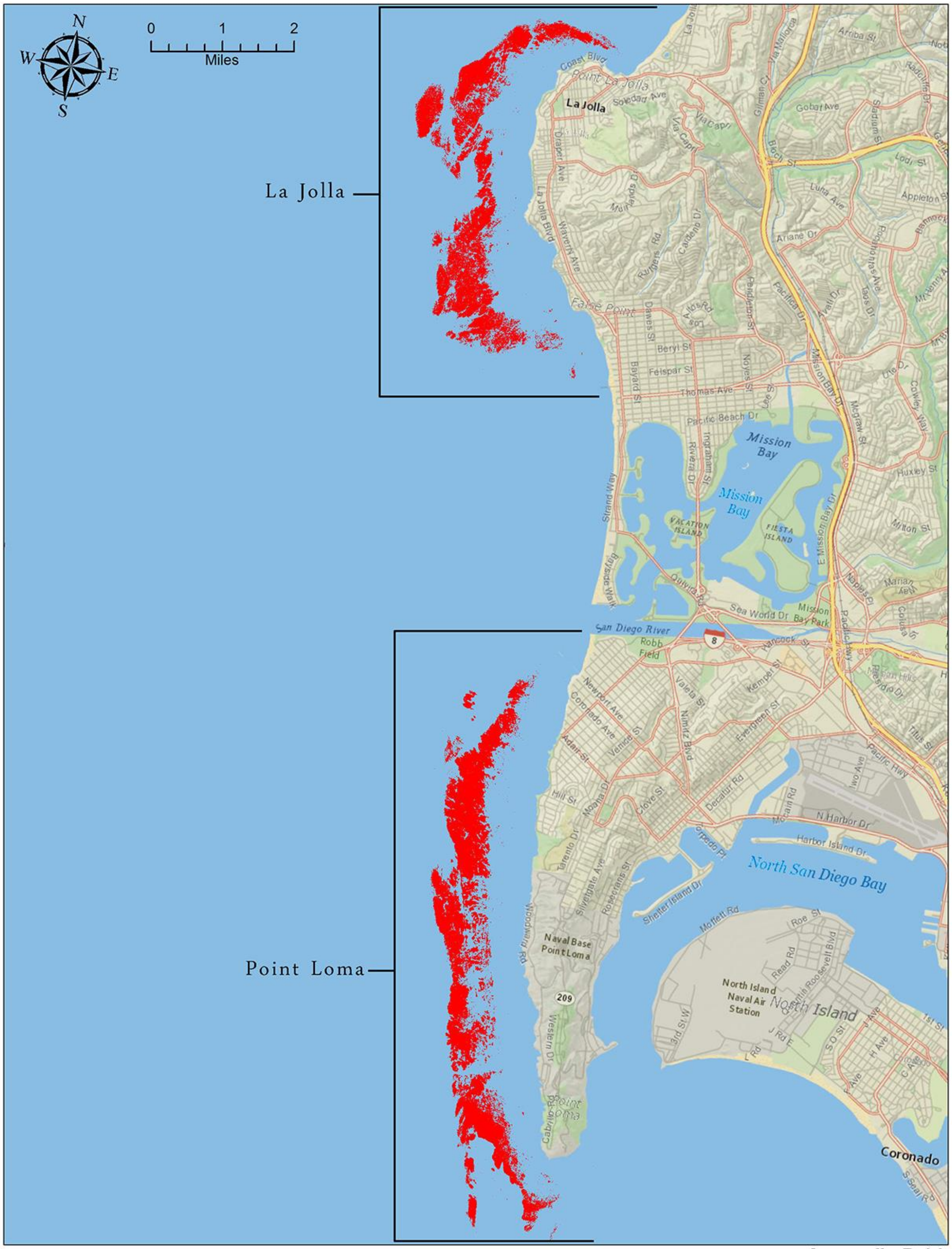

Appendix D.14

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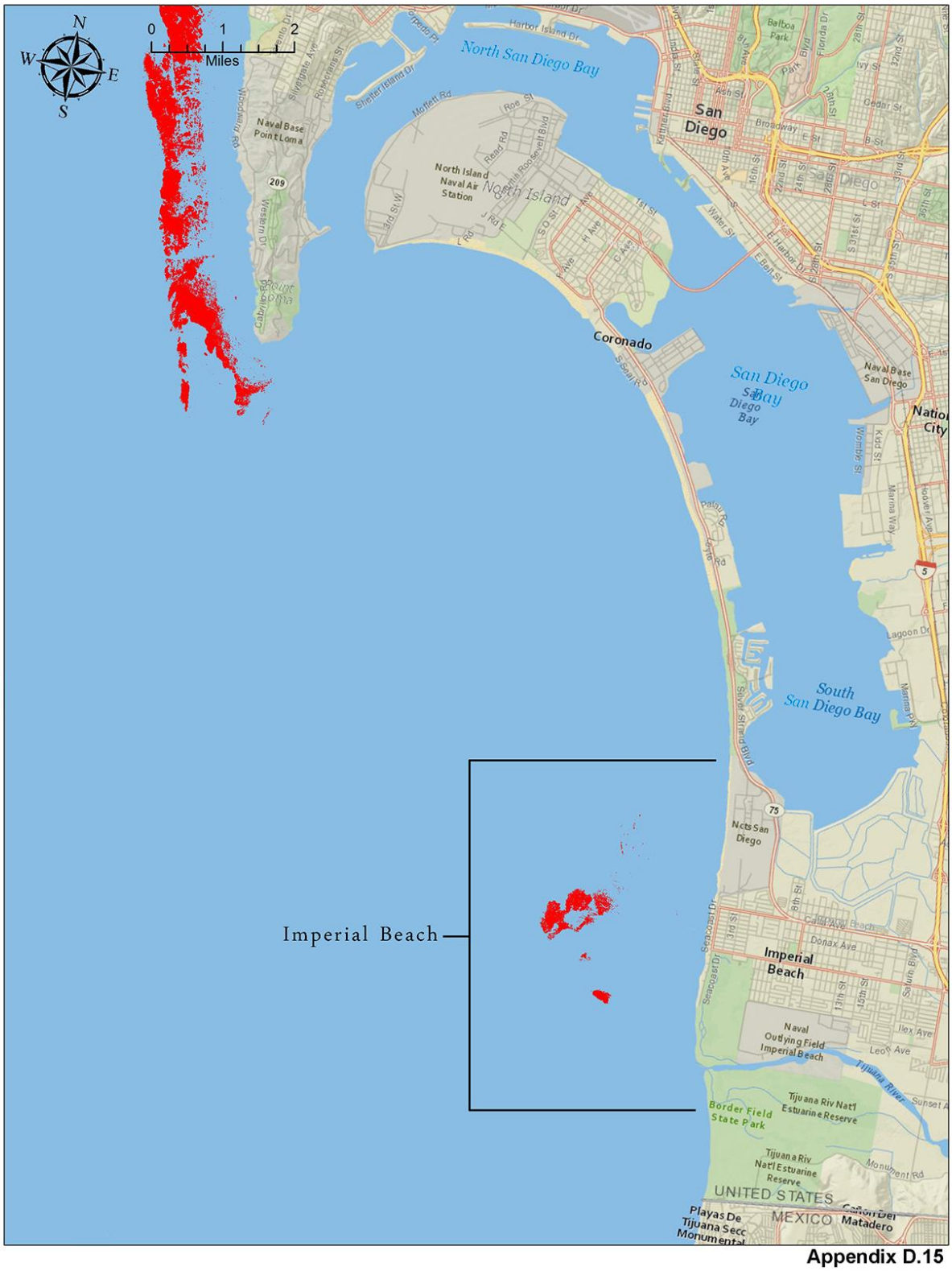

Appendix D.15

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Ecoscan Resource Data
Data Acquisition
Flight Data Report

Contracting Agency/Contact		Contract/Order #/Agency File #	
Contracting Agency:	MBC Applied Environmental Sciences	**Contract/Order #:**	
Division:		**Agency File #:**	
Contact/Title:	Michael Lyons	**Calendar**	
Address:	3000 Redhill Ave.	**Services Ordered:**	3/21
City/State/Zip:	Costa Mesa, CA 92626	**Data Acquisition Completed:**	3/28/21
Phone 1/Phone 2:	(714) 850-4830	**Draft Report Materials Due:**	
Fax/E-Mail:	(714) 850-4840	**Final Report Materials Due:**	4/21

Project Title/Target Resource (s)- Survey Range (s)/Survey Data Flow

Project Title		**California Coastal Kelp Resources - Ventura to Imperial Beach - March 28, 2021**
Target Resource (s)/ Survey Range (s)		Coastal Kelp Canopies Ventura Harbor to Imperial Beach (map pages 57-72)
Survey Data Flow	**Acquisition**	Vertical color IR digital imagery of all coastal kelp canopies within the survey range
	Processing	Survey imagery indexed and delivered to MBC for further processing and analysis
	Analysis	
	Presentation	All survey imagery presented with 8"x10" contact sheets (12 images/per page)

Aerial Resource Survey Flight Data for:		**March 28, 2021**			
Survey Type		**Aircraft/Imagery Data**		**Associated Conditions**	
	Aerial Transportation/Observation	Aircraft:	Cessna 182	Sky Conditions:	Clear
	Photographic Film Imagery - 35 mm	Altitude:	13,500' MSL	Sun Angle:	> 20 degrees from vertical
	Photographic Film Imagery - 70 mm	Speed:	100 kts.	Visibility:	50+ miles
✓	Digital Color/Color Infrared Imagery	Camera:	Nikon D200	Wind:	Less than 5 knots
	Videography	Lenses:	30mm (see note)	Sea/Swell:	3-4 feet
	Radio Telemetry	Film:	Digital Color IR	Time:	1348-1525
	Radiometry/Geophysical Measurements	Angle:	Vertical	Tide:	0.9' (+) to 0.5' (-) MLLW
	Other 1:	Photo Scale:	As Displayed	Shadow:	None
	Other 2:	Pilot:	Unsicker	Other:	
	Other 3:	Photographer:	Van Wagenen	Comments:	Excellent Conditions

Range (s) Surveyed	Ventura Harbor to Imperial Beach.	
Target Resource Observations	Kelp Canopies	As in the December 2020 quarterly survey, kelp canopies throughout the range showed a reduction in surface extent, and the only significant kelp observed was on the north side of the Palos Verdes peninsula and from LaJolla to Pt. Loma.
Imagery Quality/ Comments	Excellent	All surface kelp canopies were photographed within the above range. All of the imagery was judged of excellent quality.
	Lens Note	30mm (digital SLR camera) is similiar focal length to 50mm (35mm film camera) SLR)mera)

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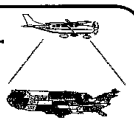

Signed: _____ Bob Van Wagenen, Director

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Ecoscan Resource Data
Data Acquisition
Flight Data Report

Contracting Agency/Contact		Contract/Order #/Agency File #	
Contracting Agency:	MBC Applied Environmental Sciences	Contract/Order #:	
Division:		Agency File #:	
Contact/Title:	Michael Lyons	Calendar	
Address:	3000 Redhill Ave.	Services Ordered:	6/21
City/State/Zip:	Costa Mesa, CA 92626	Data Acquisition Completed:	7/17/21
Phone 1/Phone 2:	(714) 850-4830	Draft Report Materials Due:	
Fax/E-Mail:	(714) 850-4840	Final Report Materials Due:	7/21

Project Title/Target Resource (s)- Survey Range (s)/Survey Data Flow

Project Title		California Coastal Kelp Resources - Ventura to Imperial Beach - July 16, 2021
Target Resource (s)/ Survey Range (s)		Coastal Kelp Canopies Ventura Harbor to Oceanside (map pages 57-68)
Survey Data Flow	Acquisition	Vertical color IR digital imagery of all coastal kelp canopies within the survey range
	Processing	Survey imagery indexed and delivered to MBC for further processing and analysis
	Analysis	
	Presentation	All survey imagery presented with 8"x10" contact sheets (12 images/per page)

Aerial Resource Survey Flight Data for:		July 16, 2021			
	Survey Type	Aircraft/Imagery Data		Associated Conditions	
	Aerial Transportation/Observation	Aircraft:	Cessna 182	Sky Conditions:	Clear
	Photographic Film Imagery - 35 mm	Altitude:	13,500' MSL	Sun Angle:	> 20 degrees from vertical
	Photographic Film Imagery - 70 mm	Speed:	100 kts.	Visibility:	50+ miles
√	Digital Color/Color Infrared Imagery	Camera:	Nikon D200	Wind:	Less than 5 knots
	Videography	Lenses:	30mm (see note)	Sea/Swell:	3-4 feet
	Radio Telemetry	Film:	Digital Color IR	Time:	1608-1537
	Radiometry/Geophysical Measurements	Angle:	Vertical	Tide:	4.5' (+) to 3.7' (+) MLLW
	Other 1:	Photo Scale:	As Displayed	Shadow:	None
	Other 2:	Pilot:	Unsicker	Other:	
	Other 3:	Photographer:	Van Wagenen	Comments:	Excellent Conditions

Range (s) Surveyed		Ventura Harbor to Oceanside. Canopies south of Oceanside were obscurred by coastal fog and not recorded on 7/16. A second survey was conducted on 7/17 within the range of Oceanside to Imperial Beach and all surface canopies (only seen from La Jolla to Point Loma) were recorded
Target Resource Observations	Kelp Canopies	As in the March 2021 quarterly survey, kelp canopies throughout the range showed a reduction in surface extent, and the only significant kelp observed within the range surveyed was on the Palos Verdes penninsula. Small surface canopies were observed from Point Mugu to Point Dume.
Imagery Quality/ Comments	Excellent	All surface kelp canopies were photographed within the above range. All of the imagery was judged of excellent quality.
	Lens Note	30mm (digital SLR camera) is similiar focal length to 50mm (35mm film camera) SLR)mera)

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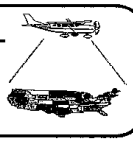

Signed: _____ Bob Van Wagenen, Director

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Ecoscan Resource Data
Data Acquisition
Flight Data Report

Contracting Agency/Contact		Contract/Order #/Agency File #	
Contracting Agency:	MBC Applied Environmental Sciences	**Contract/Order #:**	
Division:		**Agency File #:**	
Contact/Title:	Michael Lyons	**Calendar**	
Address:	3000 Redhill Ave.	**Services Ordered:**	9/21
City/State/Zip:	Costa Mesa, CA 92626	**Data Acquisition Completed:**	9/29/21
Phone 1/Phone 2:	(714) 850-4830	**Draft Report Materials Due:**	
Fax/E-Mail:	(714) 850-4840	**Final Report Materials Due:**	10/21

Project Title/Target Resource (s)- Survey Range (s)/Survey Data Flow

Project Title		**California Coastal Kelp Resources - Newport to Imperial Beach - September 29, 2021**
Target Resource (s)/ Survey Range (s)		Coastal Kelp Canopies Newport to Imperial Beach (map pages 65-72)
Survey Data Flow	**Acquisition** Processing Analysis Presentation	Vertical color IR digital imagery of all coastal kelp canopies within the survey range Survey imagery indexed and delivered to MBC for further processing and analysis All survey imagery presented with 8"x10" contact sheets (12 images/per page)

Aerial Resource Survey Flight Data for:		September 29, 2021			
Survey Type		**Aircraft/Imagery Data**		**Associated Conditions**	
	Aerial Transportation/Observation	Aircraft:	Cessna 182	Sky Conditions:	Clear
	Photographic Film Imagery - 35 mm	Altitude:	13,500' MSL	Sun Angle:	> 20 degrees from vertical
	Photographic Film Imagery - 70 mm	Speed:	100 kts.	Visibility:	50+ miles
√	Digital Color/Color Infrared Imagery	Camera:	Nikon D200	Wind:	Less than 5 knots
	Videography	Lenses:	30mm (see note)	Sea/Swell:	1-3 feet
	Radio Telemetry	Film:	Digital Color IR	Time:	1517-1601
	Radiometry/Geophysical Measurements	Angle:	Vertical	Tide:	4.2' (+) MLLW
	Other 1:	Photo Scale:	As Displayed	Shadow:	None
	Other 2:	Pilot:	Unsicker	Other:	
	Other 3:	Photographer:	Van Wagenen	Comments:	Excellent Conditions

Range (s) Surveyed	Newport to Imperial Beach (map pages 65-72)	
Target Resource Observations	Kelp Canopies	As in the July 2021 quarterly survey, kelp canopies throughout the range showed a reduction in surface extent, and the only significant kelp observed within the range surveyed was between LaJolla and Point Loma.
Imagery Quality/ Comments	Excellent	All surface kelp canopies were photographed within the above range. All of the imagery was judged of excellent quality.
	Lens Note	30mm (digital SLR camera) is similiar focal length to 50mm (35mm film camera) SLR)mera)

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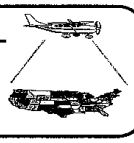

Signed: _____ Bob Van Wagenen, Director

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Ecoscan Resource Data
Data Acquisition
Flight Data Report

Contracting Agency/Contact		Contract/Order #/Agency File #	
Contracting Agency:	MBC Applied Environmental Sciences	**Contract/Order #:**	
Division:		**Agency File #:**	
Contact/Title:	Michael Lyons	**Calendar**	
Address:	3000 Redhill Ave.	**Services Ordered:**	12/21
City/State/Zip:	Costa Mesa, CA 92626	**Data Acquisition Completed:**	1/2/2022
Phone 1/Phone 2:	(714) 850-4830	**Draft Report Materials Due:**	
Fax/E-Mail:	(714) 850-4840	**Final Report Materials Due:**	1/2022

Project Title/Target Resource (s)- Survey Range (s)/Survey Data Flow

Project Title		**California Coastal Kelp Resources - Newport to Imperial Beach - January 2, 2022**
Target Resource (s)/ Survey Range (s)		Coastal Kelp Canopies Newport to Imperial Beach (map pages 65-72)
Survey Data Flow	**Acquisition** Processing Analysis Presentation	Vertical color IR digital imagery of all coastal kelp canopies within the survey range Survey imagery indexed and delivered to MBC for further processing and analysis All survey imagery presented with 8"x10" contact sheets (12 images/per page)

Aerial Resource Survey Flight Data for:		**January 2, 2022**			
Survey Type		**Aircraft/Imagery Data**		**Associated Conditions**	
	Aerial Transportation/Observation	Aircraft:	Cessna 182	Sky Conditions:	Clear
	Photographic Film Imagery - 35 mm	Altitude:	13,500' MSL	Sun Angle:	> 20 degrees from vertical
	Photographic Film Imagery - 70 mm	Speed:	100 kts.	Visibility:	50+ miles
✓	Digital Color/Color Infrared Imagery	Camera:	Nikon D200	Wind:	Less than 5 knots
	Videography	Lenses:	30mm (see note)	Sea/Swell:	1-3 feet
	Radio Telemetry	Film:	Digital Color IR	Time:	1243-1421
	Radiometry/Geophysical Measurements	Angle:	Vertical	Tide:	0.5' (+) to 1.5' (-) MLLW
	Other 1:	Photo Scale:	As Displayed	Shadow:	None
	Other 2:	Pilot:	Unsicker	Other:	
	Other 3:	Photographer:	Van Wagenen	Comments:	Excellent Conditions

Range (s) Surveyed	Newport to Imperial Beach (map pages 65-72)	
Target Resource Observations	Kelp Canopies	Kelp canopies throughout the range showed an increase in surface extent from that observed in the September 2021 survey.
Imagery Quality/ Comments	Excellent	All surface kelp canopies were photographed within the above range. All of the imagery was judged of excellent quality.
	Lens Note	30mm (digital SLR camera) is similiar focal length to 50mm (35mm film camera) SLR)mera)

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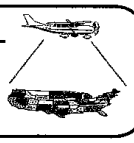

Signed: _____ Bob Van Wagenen, Director

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Ecoscan Resource Data
Data Acquisition
Flight Data Report

Contracting Agency/Contact		Contract/Order #/Agency File #	
Contracting Agency:	MBC Applied Environmental Sciences	**Contract/Order #:**	
Division:		**Agency File #:**	
Contact/Title:	Michael Lyons	**Calendar**	
Address:	3000 Redhill Ave.	**Services Ordered:**	3/2022
City/State/Zip:	Costa Mesa, CA 92626	**Data Acquisition Completed:**	4/8/2022
Phone 1/Phone 2:	(714) 850-4830	**Draft Report Materials Due:**	
Fax/E-Mail:	(714) 850-4840	**Final Report Materials Due:**	4/2022

Project Title/Target Resource (s)- Survey Range (s)/Survey Data Flow

Project Title		**California Coastal Kelp Resources - Newport to Imperial Beach - April 8, 2022**
Target Resource (s)/ Survey Range (s)		Coastal Kelp Canopies Newport to Imperial Beach (map pages 65-72)
Survey Data Flow	**Acquisition** Processing Analysis Presentation	Vertical color IR digital imagery of all coastal kelp canopies within the survey range Survey imagery indexed and delivered to MBC for further processing and analysis All survey imagery presented with 8"x10" contact sheets (12 images/per page)

Aerial Resource Survey Flight Data for:		**April 8, 2022**			
Survey Type		**Aircraft/Imagery Data**		**Associated Conditions**	
	Aerial Transportation/Observation	Aircraft:	Cessna 182	Sky Conditions:	Clear
	Photographic Film Imagery - 35 mm	Altitude:	13,500' MSL	Sun Angle:	> 20 degrees from vertical
	Photographic Film Imagery - 70 mm	Speed:	100 kts.	Visibility:	50+ miles
✓	Digital Color/Color Infrared Imagery	Camera:	Nikon D200	Wind:	Less than 5 knots
	Videography	Lenses:	30mm (see note)	Sea/Swell:	1-3 feet
	Radio Telemetry	Film:	Digital Color IR	Time:	1356 - 1537
	Radiometry/Geophysical Measurements	Angle:	Vertical	Tide:	1.4' (+) to 2.1' (+) MLLW
	Other 1:	Photo Scale:	As Displayed	Shadow:	None
	Other 2:	Pilot:	Unsicker	Other:	
	Other 3:	Photographer:	Van Wagenen	Comments:	Excellent Conditions

Range (s) Surveyed		Newport to Imperial Beach (map pages 65-72)
Target Resource Observations	Kelp Canopies	Kelp canopies throughout the range from Point Mugu to Long Beach showed an slight increase in surface extent from that observed in the January 2022 survey, and a slight reduction in extent from La Jolla to Point Loma.
Imagery Quality/ Comments	Excellent Lens Note	All surface kelp canopies were photographed within the above range. All of the imagery was judged of excellent quality. 30mm (digital SLR camera) is similiar focal length to 50mm (35mm film camera) SLR)mera)

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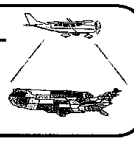

Signed: _____ Bob Van Wagenen, Director

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Ecoscan Resource Data
Data Acquisition
Flight Data Report

Contracting Agency/Contact		Contract/Order #/Agency File #	
Contracting Agency:	MBC Applied Environmental Sciences	**Contract/Order #:**	
Division:		**Agency File #:**	
Contact/Title:	Michael Lyons	**Calendar**	
Address:	3000 Redhill Ave.	**Services Ordered:**	6/2022
City/State/Zip:	Costa Mesa, CA 92626	**Data Acquisition Completed:**	8/8/2022
Phone 1/Phone 2:	(714) 850-4830	**Draft Report Materials Due:**	
Fax/E-Mail:	(714) 850-4840	**Final Report Materials Due:**	8/2022

Project Title/Target Resource (s)- Survey Range (s)/Survey Data Flow

Project Title		**California Coastal Kelp Resources - Newport to Imperial Beach - August 8, 2022**
Target Resource (s)/ Survey Range (s)		Coastal Kelp Canopies Ventura to Imperial Beach (map pages 57-72)
Survey Data Flow	**Acquisition** Processing Analysis Presentation	Vertical color IR digital imagery of all coastal kelp canopies within the survey range Survey imagery indexed and delivered to MBC for further processing and analysis All survey imagery presented with 8"x10" contact sheets (12 images/per page)

Aerial Resource Survey Flight Data for:		**August 8, 2022**			
Survey Type		**Aircraft/Imagery Data**		**Associated Conditions**	
	Aerial Transportation/Observation	Aircraft:	Cessna 182	Sky Conditions:	Clear
	Photographic Film Imagery - 35 mm	Altitude:	13,500' MSL	Sun Angle:	> 20 degrees from vertical
	Photographic Film Imagery - 70 mm	Speed:	100 kts.	Visibility:	50+ miles
√	Digital Color/Color Infrared Imagery	Camera:	Nikon D200	Wind:	Less than 5 knots
	Videography	Lenses:	30mm (see note)	Sea/Swell:	1-3 feet
	Radio Telemetry	Film:	Digital Color IR	Time:	1525 - 1720
	Radiometry/Geophysical Measurements	Angle:	Vertical	Tide:	1.4' (+) to 2.1' (+) MLLW
	Other 1:	Photo Scale:	As Displayed	Shadow:	None
	Other 2:	Pilot:	Unsicker	Other:	
	Other 3:	Photographer:	Van Wagenen	Comments:	Excellent Conditions

Range (s) Surveyed	Newport to Imperial Beach (map pages 65-72)	
Target Resource Observations	Kelp Canopies	Kelp canopies throughout the range showed a slight decrease in surface extent from that observed in the April 2022 survey.
Imagery Quality/ Comments	Excellent Date Note Lens Note	All surface kelp canopies were photographed within the above range. All of the imagery was judged of excellent quality. Camera internal battery weak. Date on EXIF data: 6/11/2022 (disregard). Actual 8/8/2022 30mm (digital SLR camera) is similiar focal length to 50mm (35mm film camera) SLR)mera)

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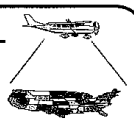

Signed: _____ Bob Van Wagenen, Director

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Ecoscan Resource Data
Data Acquisition
Flight Data Report

Contracting Agency/Contact		Contract/Order #/Agency File #	
Contracting Agency:	MBC Applied Environmental Sciences	**Contract/Order #:**	
Division:		**Agency File #:**	
Contact/Title:	Michael Lyons	**Calendar**	
Address:	3000 Redhill Ave.	**Services Ordered:**	9/22
City/State/Zip:	Costa Mesa, CA 92626	**Data Acquisition Completed:**	10/2/22
Phone 1/Phone 2:	(714) 850-4830	**Draft Report Materials Due:**	
Fax/E-Mail:	(714) 850-4840	**Final Report Materials Due:**	10/22

Project Title/Target Resource (s)- Survey Range (s)/Survey Data Flow

Project Title		**California Coastal Kelp Resources - Ventura to Imperial Beach - October 2, 2022**
Target Resource (s)/ Survey Range (s)		Coastal Kelp Canopies Newport Harbor to Imperial Beach (U.S./Mexican border)
Survey Data Flow	**Acquisition** Processing Analysis Presentation	Vertical color IR imagery of all coastal kelp canopies within the survey range Survey imagery indexed and delivered to MBC in digital format for further processing and analysis

Aerial Resource Survey Flight Data for:	**October 2, 2022**			
Survey Type	**Aircraft/Imagery Data**		**Associated Conditions**	
Aerial Transportation/Observation	Aircraft:	Cessna 182	Sky Conditions:	Clear
Photographic Film Imagery - 35 mm	Altitude:	13,500' MSL	Sun Angle:	> 30 degrees from vertical
Photographic Film Imagery - 70 mm	Speed:	100 kts.	Visibility:	50+ miles
✓ Digital Color/Color Infrared Imagery	Camera:	Nikon D200	Wind:	Calm
Videography	Lenses:	30mm	Sea/Swell:	2-4 feet
Radio Telemetry	Film:	Digital	Time:	1450-1545
Radiometry/Geophysical Measurements	Angle:	Vertical	Tide:	5.1' (+) to 4.8' (+) MLLW
Other 1:	Photo Scale:	As Displayed	Shadow:	None
Other 2:	Pilot:	Unsicker	Other:	
Other 3:	Photographer:	Van Wagenen	Comments:	Optimum Conditions

Range (s) Surveyed	Ventura to Imperial Beach	
Target Resource Observations	Kelp Canopies	The surface kelp canopies were absent throughout the survey range except for isolated plants and small canopies between La Jolla and Pt. Loma.
Imagery Quality/ Comments	Excellent	All of the imagery was judged of excellent quality and was useable for the subsequent maping of the kelp resource.

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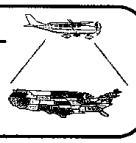

Signed: _____ Bob Van Wagenen, Director

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Ecoscan Resource Data
Data Acquisition
Flight Data Report

Contracting Agency/Contact		Contract/Order #/Agency File #	
Contracting Agency:	MBC Applied Environmental Sciences	**Contract/Order #:**	
Division:		**Agency File #:**	
Contact/Title:	Michael Lyons	**Calendar**	
Address:	3000 Redhill Ave.	**Services Ordered:**	12/22
City/State/Zip:	Costa Mesa, CA 92626	**Data Acquisition Completed:**	1/26/23
Phone 1/Phone 2:	(714) 850-4830	**Draft Report Materials Due:**	
Fax/E-Mail:	(714) 850-4840	**Final Report Materials Due:**	2/23

Project Title/Target Resource (s)- Survey Range (s)/Survey Data Flow

Project Title		**California Coastal Kelp Resources - Ventura to Imperial Beach - January 26, 2023**
Target Resource (s)/ Survey Range (s)		Coastal Kelp Canopies Newport Harbor to Imperial Beach (U.S./Mexican border)
Survey Data Flow	**Acquisition** Processing Analysis Presentation	Vertical color IR imagery of all coastal kelp canopies within the survey range Survey imagery indexed and delivered to MBC in digital format for further processing and analysis

Aerial Resource Survey Flight Data for:		**January 26, 2023**			
Survey Type		**Aircraft/Imagery Data**		**Associated Conditions**	
	Aerial Transportation/Observation	Aircraft:	Cessna 182	Sky Conditions:	Clear
	Photographic Film Imagery - 35 mm	Altitude:	13,500' MSL	Sun Angle:	> 30 degrees from vertical
	Photographic Film Imagery - 70 mm	Speed:	100 kts.	Visibility:	50+ miles
✓	Digital Color/Color Infrared Imagery	Camera:	Nikon D200	Wind:	E 15 kts.
	Videography	Lenses:	30mm	Sea/Swell:	7-9 feet
	Radio Telemetry	Film:	Digital	Time:	1250-1427
	Radiometry/Geophysical Measurements	Angle:	Vertical	Tide:	4.1' (+) to 3.2' (+) MLLW
	Other 1:	Photo Scale:	As Displayed	Shadow:	None
	Other 2:	Pilot:	Unsicker	Other:	
	Other 3:	Photographer:	Van Wagenen	Comments:	Good Conditions

Range (s) Surveyed	Ventura to Imperial Beach	
Target Resource Observations	Kelp Canopies	The surface kelp canopies were absent throughout the survey range except for isolated plants west of Malibu, Palos Verdes and Point Loma.
Imagery Quality/ Comments	Excellent	All of the imagery was judged of excellent quality and was useable for the subsequent maping of the kelp resource.

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Watsonville, CA 95076
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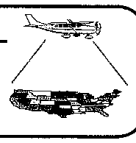

Signed: _____ Bob Van Wagenen, Director

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Field Data Sheet

CONDITION OF MACROCYSTIS BED

mbc AQUATIC SCIENCES

Observer: DJS / JNS
Lat/Long: 33°09.368'N, 117°21.678'W

Date 2/1/2022
Location North Carlsbad
Time 1417
Wind/Direction SSW 7 8km
Current NW 3kn
Weather Cloudy 90%
UW Visibility (est.) 10ft
Swell Ht/Period WSW 2 ft

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent None
Density
Tissue color
% Frond comp. _____ Senile _____ Mature _____ Young _____ Other
Disease
Encrustation
Apical blades
Sediment on blades

Surface Stipe Length None
Depth (offshore) 36 ft
Depth (other[note])

Remarks

Subsurface very few scattered marks reaching ~25 ft tall

UNDERWATER OBSERVATIONS

Midwater

Tissue Color
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues

Bottom

Tissue color
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues
Sporophylls
Juvenile fronds
Holdfasts
Old holdfasts
Recruitment

Community

Litter
Turf algae
Turf invert.
Shrub algae
Large Invert.
Fishes
Disease
Sed. on rocks
Urchin status

Bottom characteristics

REMARKS

Field Data Sheet

CONDITION OF MACROCYSTIS BED

mbc AQUATIC SCIENCES

Observer: DJS, JNS
Lat/Long: 33°13.371'N, 117°25.367'W

Date 2/1/2022
Location Santa Margarita
Time 1437
Wind/Direction SSW 7-8 kn
Current NW 3kn
Weather Cloudy 90%
UW Visibility (est.) 10 ft
Swell Ht/Period WSW 2ft

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent None
Density
Tissue color
% Frond comp. _____ Senile _____ Mature _____ Young _____ Other
Disease
Encrustation
Apical blades
Sediment on blades

Surface Stipe Length None
Depth (offshore) 36 ft.
Depth (other[note])

Remarks

Subsurface None

UNDERWATER OBSERVATIONS

Midwater

Tissue Color
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues

Bottom

Tissue color
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues
Sporophylls
Juvenile fronds
Holdfasts
Old holdfasts
Recruitment

Community

Litter
Turf algae
Turf invert.
Shrub algae
Large Invert.
Fishes
Disease
Sed. on rocks
Urchin status

Bottom characteristics

REMARKS

Field Data Sheet

CONDITION OF MACROCYSTIS BED

mbc AQUATIC SCIENCES

Observer: DJS / JNS
Lat/Long: 33°07.9981N, 117°20.6741W

Date 2/1/2022
Location Encina Power Plant
Time 1405
Wind/Direction SSW 7-8 kn
Current NW 3 kn
Weather Cloudy 90%
UW Visibility (est.) 10 ft
Swell Ht/Period WSW 2 ft

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent None
Density
Tissue color
% Frond comp. _____ Senile _____ Mature _____ Young _____ Other
Disease
Encrustation
Apical blades
Sediment on blades

Surface Stipe Length None
Depth (offshore) 35 ft
Depth (other[note])

Remarks

Subsurface None

UNDERWATER OBSERVATIONS

Midwater
- Tissue Color
- Encrustation
- Disease
- Sediment on blades
- Sinking fronds
- Grazed tissues

Bottom
- Tissue color
- Encrustation
- Disease
- Sediment on blades
- Sinking fronds
- Grazed tissues
- Sporophylls
- Juvenile fronds
- Holdfasts
- Old holdfasts
- Recruitment

Community
- Litter
- Turf algae
- Turf invert.
- Shrub algae
- Large Invert.
- Fishes
- Disease
- Sed. on rocks
- Urchin status

Bottom characteristics

REMARKS

Field Data Sheet

CONDITION OF MACROCYSTIS BED

mbc AQUATIC SCIENCES

Observer: DJS, JNS
Lat/Long: 33°08.729'N, 117°21.163'W

Date: 2/1/2022
Location: Agua Hedionda
Time: 1413
Wind/Direction: SSW 7-8 Kn
Current: NW 3 Kn
Weather: Cloudy 90%
UW Visibility (est.): 10 ft
Swell Ht/Period: 2 ft

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent: None
Density
Tissue color
% Frond comp. _____ Senile _____ Mature _____ Young _____ Other
Disease
Encrustation
Apical blades
Sediment on blades

Surface Stipe Length: None
Depth (offshore): 37 Ft
Depth (other[note])

Remarks

Subsurface Few scattered marks reaching 25Ft tall

UNDERWATER OBSERVATIONS

Midwater
- Tissue Color
- Encrustation
- Disease
- Sediment on blades
- Sinking fronds
- Grazed tissues

Bottom
- Tissue color
- Encrustation
- Disease
- Sediment on blades
- Sinking fronds
- Grazed tissues
- Sporophylls
- Juvenile fronds
- Holdfasts
- Old holdfasts
- Recruitment

Community
- Litter
- Turf algae
- Turf invert.
- Shrub algae
- Large Invert.
- Fishes
- Disease
- Sed. on rocks
- Urchin status

Bottom characteristics

REMARKS

Field Data Sheet

CONDITION OF MACROCYSTIS BED

mbc AQUATIC SCIENCES

Observer: DJS, JNS
Lat/Long: 33°03.170'N, 117°18.381'W

Date 2/1/2022
Location Leucadia South
Time 1240
Wind/Direction SSW 7-8kn
Current NW 3kn
Weather Cloudy 75%
UW Visibility (est.) 10 ft
Swell Ht/Period WSW 2-3ft

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent 50m X 30m
Density Scattered
Tissue color med-light yellow
% Frond comp. 30 Senile 70 Mature ____ Young ____ Other
Disease
Encrustation 40%
Apical blades 10%
Sediment on blades None
Surface Stipe Length 1m
Depth (offshore) 37 Ft
Depth (other[note])
Remarks very scattered and tattered blades

Subsurface Scattered marks

UNDERWATER OBSERVATIONS

Midwater
- Tissue Color
- Encrustation
- Disease
- Sediment on blades
- Sinking fronds
- Grazed tissues

Bottom
- Tissue color
- Encrustation
- Disease
- Sediment on blades
- Sinking fronds
- Grazed tissues
- Sporophylls
- Juvenile fronds
- Holdfasts
- Old holdfasts
- Recruitment

Community
- Litter
- Turf algae
- Turf invert.
- Shrub algae
- Large Invert.
- Fishes
- Disease
- Sed. on rocks
- Urchin status

Bottom characteristics

REMARKS

Field Data Sheet

CONDITION OF MACROCYSTIS BED

mbc AQUATIC SCIENCES

Observer: DJS, JNS
Lat/Long: 33°04.528'N, 117°19.013'W

Date 2/1/2022
Location Leucadia North
Time 1255
Wind/Direction SSW 7-9 kn
Current NW 3kn
Weather Cloudy 75%
UW Visibility (est.) 10 Ft
Swell Ht/Period WSW 2-3ft

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent 100m x 300m L
Density Very scattered
Tissue color Primed yellow, 30% Light yellow
% Frond comp. 80 Senile 20 Mature ____ Young ____ Other
Disease None
Encrustation 20%
Apical blades None
Sediment on blades None

Surface Stipe Length 1m
Depth (offshore) 40 ft
Depth (other[note])

Remarks

Subsurface Scattered marks ~20 ft tall

UNDERWATER OBSERVATIONS

Midwater

Tissue Color
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues

Bottom

Tissue color
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues
Sporophylls
Juvenile fronds
Holdfasts
Old holdfasts
Recruitment

Community

Litter
Turf algae
Turf invert.
Shrub algae
Large Invert.
Fishes
Disease
Sed. on rocks
Urchin status

Bottom characteristics

REMARKS

Field Data Sheet

CONDITION OF MACROCYSTIS BED

Observer: DJS
Lat/Long: 33° 02.091'N, 117° 18.043'W

Date 2/1/2022
Location Encinitas
Time 1150
Wind/Direction SSW 7-8 Kn
Current NW 3 Kn
Weather Cloudy 65°
UW Visibility 10 ft
Swell Ht/Period WSW 2-3 ft

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent None
Density
Tissue color
% Frond comp. _____ Senile _____ Mature _____ Young _____ Other
Disease
Encrustation
Apical blades
Sediment on blades

Remarks 75m x 75m area subsurface; plants pushed down by current

Subsurface very scattered ~1m subsurface

UNDERWATER OBSERVATIONS

Midwater

Tissue Color med-light yellow
Encrustation ~~slight~~ 50%
Disease None
Sediment on blades slight
Sinking fronds Yes 15%
Grazed tissues Yes 70%

Bottom

Tissue color med-light yellow
Encrustation slight ~20%
Disease None
Sediment on blades None
Sinking fronds No
Grazed tissues 10%
Sporophyllis Yes
Juvenile fronds Yes
Holdfasts (2)
Old holdfasts (1)
Recruitment 0

Community

Litter Corallina, Rhodophyta
Turf algae Cystoseira, Pterog. feather
Turf invert. Golden bryozoan, Boa
Shrub algae Laminaria
Large Invert. Navy top Snail, Kelp crab, Sea urchin
Fishes 3 CA Sheephead, 1 K. Bass
Disease None
Sed. on rocks Yes
Urchin status None
+2-spot octopus

Bottom characteristics

Solid rock reef w/ sand channels
low relief

REMARKS 1, 9, 12, 7, 11, 5 (# of stipes) = 6 total plants (1) (2) (2) (1) (2) (1) ≥2m / <2m 40ft depth

Field Data Sheet

CONDITION OF MACROCYSTIS BED

Observer: DJS
Lat/Long: 33°06.125'N, 117°19.544'W

Date 2/1/2022
Location Carlsbad State Beach
Time 1310
Wind/Direction SSW 7-8 Kn
Current NW 3Kn
Weather Cloudy 75%
UW Visibility 10ft
Swell Ht/Period WSW 2-3ft

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent None
Density
Tissue color
% Frond comp. _____ Senile _____ Mature _____ Young _____ Other
Disease
Encrustation
Apical blades
Sediment on blades
Remarks

Subsurface None

UNDERWATER OBSERVATIONS

Midwater
Tissue Color None
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues

Bottom
Tissue color None
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues
Sporophyllis
Juvenile fronds
Holdfasts
Old holdfasts
Recruitment

Community
Litter
Turf algae Corallina, Rhodophyta
Turf invert. Gorgonian-Golden
Shrub algae Eg.Men., Cysto, Ptery, Eisenia arb.
Large Invert. Kelletia, Mega.Unid., Kelp Sm. CAS Stone Chestnut Cowrie
Fishes 15:KB, 4:HM, 5:CASH
Disease ~~Kelpbass/Halfmoon/CAS~~ No sheephead
Sed. on rocks Yes
Urchin status ~~None~~ 3: purple urchin

Bottom characteristics
Soft rock reef w/ sand patches (sandstone covered with sand) low relief

REMARKS 35ft depth

Field Data Sheet

CONDITION OF MACROCYSTIS BED

mbc AQUATIC SCIENCES

Observer: DJS/JNS
Lat/Long: 33°00.846'N, 117°17.373'W (only southend w/ kelp canopy)

Date 2/1/2022
Location Cardiff
Time 1115
Wind/Direction SSW 7-8 Kn
Current NW 3Kn
Weather Cloudy 60%
UW Visibility (est.) 10 ft
Swell Ht/Period WSW 2-3 ft

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent 200m x 200m
Density very scattered
Tissue color 50% med. yellow, 50% light yellow
% Frond comp. 80 Senile 20 Mature ____ Young ____ Other
Disease
Encrustation 80%
Apical blades
Sediment on blades

Surface Stipe Length 1-2m
Depth (offshore) 50 ft
Depth (other[note])

Remarks Some current pushing down on canopy, tattered and heavily encrusted canopy only observed at south end of reef
Subsurface very scattered, few marks up to 25 ft off bottom

UNDERWATER OBSERVATIONS

Midwater
- Tissue Color
- Encrustation
- Disease
- Sediment on blades
- Sinking fronds
- Grazed tissues

Bottom
- Tissue color
- Encrustation
- Disease
- Sediment on blades
- Sinking fronds
- Grazed tissues
- Sporophylls
- Juvenile fronds
- Holdfasts
- Old holdfasts
- Recruitment

Community
- Litter
- Turf algae
- Turf invert.
- Shrub algae
- Large Invert.
- Fishes
- Disease
- Sed. on rocks
- Urchin status

Bottom characteristics

REMARKS

Field Data Sheet

CONDITION OF MACROCYSTIS BED

mbc AQUATIC SCIENCES

Observer: DJS / JNS

Lat/Long: 33°03.856'N, 117°18.640'W

Date 2/1/2022

Location Leucadia-Central

Time 1245

Wind/Direction SSW 7-8kn

Current NW 3kn

Weather Cloudy 75%

UW Visibility (est.) 10 ft

Swell Ht/Period WSW 2-3 ft

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent None

Density

Tissue color

% Frond comp. _____ Senile _____ Mature _____ Young _____ Other

Disease

Encrustation

Apical blades

Sediment on blades

Surface Stipe Length None

Depth (offshore) 36 ft

Depth (other[note])

Remarks

Subsurface scattered marks, plants ~20ft tall

UNDERWATER OBSERVATIONS

Midwater

- Tissue Color
- Encrustation
- Disease
- Sediment on blades
- Sinking fronds
- Grazed tissues

Bottom

- Tissue color
- Encrustation
- Disease
- Sediment on blades
- Sinking fronds
- Grazed tissues
- Sporophylls
- Juvenile fronds
- Holdfasts
- Old holdfasts
- Recruitment

Community

- Litter
- Turf algae
- Turf invert.
- Shrub algae
- Large Invert.
- Fishes
- Disease
- Sed. on rocks
- Urchin status

Bottom characteristics

REMARKS

Field Data Sheet

CONDITION OF MACROCYSTIS BED

mbc AQUATIC SCIENCES

Observer: DJS, JNS
Lat/Long: 32°57.588'N, 117°16.636'W

Date 2/1/2022
Location Del Mar
Time 1055
Wind/Direction SSW 7-8 kn
Current NW 3kn
Weather Cloudy 65%
UW Visibility (est.) 10 ft
Swell Ht/Period WSW 2-3 ft

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent None
Density
Tissue color
% Frond comp. _____ Senile _____ Mature _____ Young _____ Other
Disease
Encrustation
Apical blades
Sediment on blades
Remarks

Surface Stipe Length None
Depth (offshore)
Depth (other[note]) 45 ft (Lat/long) Hard bottom

Subsurface None

UNDERWATER OBSERVATIONS

Midwater

Tissue Color
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues

Bottom

Tissue color
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues
Sporophylls
Juvenile fronds
Holdfasts
Old holdfasts
Recruitment

Community

Litter
Turf algae
Turf invert.
Shrub algae
Large invert.
Fishes
Disease
Sed. on rocks
Urchin status

Bottom characteristics

REMARKS

Field Data Sheet

CONDITION OF MACROCYSTIS BED

mbc AQUATIC SCIENCES

Observer: DJS / GNS
Lat/Long: 32°59.146'N, 117°16.951'W

Date 2/1/2022
Location Solana Beach
Time 1100
Wind/Direction SSW 5-6 kn
Current NW 3kn
Weather Cloudy 60%
UW Visibility (est.) 10 ft
Swell Ht/Period WSW 2-3 ft

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent 200m x 200m
Density Very scattered
Tissue color 50% med yellow, 50% light yellow
% Frond comp. 80% Senile 20% Mature _____ Young _____ Other
Disease None
Encrustation 10%
Apical blades 0%
Sediment on blades None
Remarks scattered and tattered looking

Surface Stipe Length 1-2m
Depth (offshore) 40 ft
Depth (other[note])

Subsurface very scattered subsurface to 20 ft

UNDERWATER OBSERVATIONS

Midwater
- Tissue Color
- Encrustation
- Disease
- Sediment on blades
- Sinking fronds
- Grazed tissues

Bottom
- Tissue color
- Encrustation
- Disease
- Sediment on blades
- Sinking fronds
- Grazed tissues
- Sporophylls
- Juvenile fronds
- Holdfasts
- Old holdfasts
- Recruitment

Community
- Litter
- Turf algae
- Turf invert.
- Shrub algae
- Large Invert.
- Fishes
- Disease
- Sed. on rocks
- Urchin status

Bottom characteristics

REMARKS

Field Data Sheet

CONDITION OF MACROCYSTIS BED

mbc AQUATIC SCIENCES

Observer: DJS, JNS
Lat/Long: 32°51.296'N, 117°16.805'W (North end)

Date 2/1/2022
Location La Jolla North
Time 1020
Wind/Direction SSW 7-8 Kn
Current NW 3kn
Weather Cloudy 70%
UW Visibility (est.) 15 ft
Swell Ht/Period WSW 2-3ft

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent None
Density
Tissue color
% Frond comp. _____ Senile _____ Mature _____ Young _____ Other
Disease
Encrustation
Apical blades
Sediment on blades
Remarks Scattered subsurface, lots of drift kelp

Surface Stipe Length None
Depth (offshore) 70 ft
Depth (other[note]) 60 ft

Subsurface metered to 30 ft of bottom @ 32°50.419'N, 117°17.549'W (west edge)

UNDERWATER OBSERVATIONS

Midwater
- Tissue Color
- Encrustation
- Disease
- Sediment on blades
- Sinking fronds
- Grazed tissues

Bottom
- Tissue color
- Encrustation
- Disease
- Sediment on blades
- Sinking fronds
- Grazed tissues
- Sporophylls
- Juvenile fronds
- Holdfasts
- Old holdfasts
- Recruitment

Community
- Litter
- Turf algae
- Turf invert.
- Shrub algae
- Large Invert.
- Fishes
- Disease
- Sed. on rocks
- Urchin status

Bottom characteristics

REMARKS

Field Data Sheet

CONDITION OF MACROCYSTIS BED

mbc AQUATIC SCIENCES

Observer: DJS, JNS
Lat/Long: 32°55.283'N, 117°15.896'W

Date 2/1/2022
Location Torrey Pines
Time 1043
Wind/Direction SSW 7-8 Kn
Current NW 3 Kn
Weather Cloudy 70%
UW Visibility (est.) 10ft
Swell Ht/Period WSW 2-3ft

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent None
Density
Tissue color
% Frond comp. _____ Senile _____ Mature _____ Young _____ Other
Disease
Encrustation
Apical blades
Sediment on blades

Surface Stipe Length None
Depth (offshore)
Depth (other[note]) 30 ft (Lat/long.) hard bottom

Remarks

Subsurface None

UNDERWATER OBSERVATIONS

Midwater

Tissue Color
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues

Bottom

Tissue color
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues
Sporophylls
Juvenile fronds
Holdfasts
Old holdfasts
Recruitment

Community

Litter
Turf algae
Turf invert.
Shrub algae
Large Invert.
Fishes
Disease
Sed. on rocks
Urchin status

Bottom characteristics

REMARKS

Field Data Sheet

CONDITION OF MACROCYSTIS BED

mbc AQUATIC SCIENCES

Observer: DJS, JNS
Lat/Long: 32°42.271'N, 117°16.495'W (westedge)
32°44.058'N, 117°16.155'W (canopy)

Date 2/1/2022
Location Point Loma North
Time 0925
Wind/Direction SSW 7-8 kn.
Current NW 3 kn
Weather Cloudy 80%
UW Visibility (est.) 20 ft
Swell Ht/Period 2-3 ft WSW

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent 0.75 miles wide x 2 miles long
Density scattered → medium
Tissue color 80% dark yellow, 10% med yellow, 10% light yellow
% Frond comp. 30 Senile 65 Mature 5 Young ____ Other
Disease None
Encrustation 30%
Apical blades 10%
Sediment on blades None

Surface Stipe Length 2m
Depth (offshore)
Depth (other[note])

Remarks Current pushing a lot down, some drift kelp
more scattered than South Pt. Loma
Subsurface metered dense kelp throughout

UNDERWATER OBSERVATIONS

Midwater

Tissue Color
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues

Bottom

Tissue color
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues
Sporophylls
Juvenile fronds
Holdfasts
Old holdfasts
Recruitment

Community

Litter
Turf algae
Turf invert.
Shrub algae
Large Invert.
Fishes
Disease
Sed. on rocks
Urchin status

Bottom characteristics

REMARKS

Field Data Sheet

CONDITION OF MACROCYSTIS BED

mbc AQUATIC SCIENCES

Observer: DJS, JNS

Lat/Long: 32°48.712'N, 117°17.545'W (canopy)
32°48.193'N, 117°16.707'W (Southend)

Date 2/1/2022
Location La Jolla South
Time 1005
Wind/Direction SSW 7-8 kn
Current NW 3kn
Weather Cloudy 80%
UW Visibility (est.) 15 ft
Swell Ht/Period WSW 2-3 ft

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent 2miles long x 0.75miles wide
Density scattered
Tissue color 80% dark yellow, 15% med., 5% light
% Frond comp. 15 Senile 85 Mature _____ Young _____ Other
Disease None
Encrustation 40%
Apical blades 0%
Sediment on blades None

Surface Stipe Length 2-3m
Depth (offshore) 70ft
Depth (other[note]) 50ft canopy

Remarks Current pushing a lot down, lots of drift kelp

Subsurface metered throughout scattered canopy, just subsurface

UNDERWATER OBSERVATIONS

Midwater

Tissue Color
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues

Bottom

Tissue color
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues
Sporophylls
Juvenile fronds
Holdfasts
Old holdfasts
Recruitment

Community

Litter
Turf algae
Turf invert.
Shrub algae
Large Invert.
Fishes
Disease
Sed. on rocks
Urchin status

Bottom characteristics

REMARKS

Field Data Sheet

CONDITION OF MACROCYSTIS BED

mbc AQUATIC SCIENCES

Observer: DJS / JNS

Lat/Long: 32°39.319'N, 117°14.775'W (Subsurface)
32°39.863'N, 117°15.639'W (Canopy start)
32°40.105'N, 117°15.924'W (west edge)

Date: 2/1/2022
Location: Point Loma South
Time: 0900
Wind/Direction: SSW 7-8 Kn
Current: NW 3kn
Weather: cloudy 80%
UW Visibility (est.): 20 Ft
Swell Ht/Period: 3-4 ft WSW

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent: 0.75 miles wide x 2 miles long
Density: Scattered -> Medium
Tissue color: 80% dark yellow, 10% med yellow, 10% light yellow
% Frond comp.: 20 Senile 75 Mature 5 Young ____ Other
Disease: None
Encrustation: 10%
Apical blades: 5%
Sediment on blades: None

SSL 2m
Depth (offshore): 71 Ft
Depth (other): center=40ft

Remarks Current pushing a lot down, lots of drift kelp too

Subsurface metered 0.5 miles south of canopy

UNDERWATER OBSERVATIONS

Midwater

Tissue Color	
Encrustation	
Disease	
Sediment on blades	
Sinking fronds	
Grazed tissues	

Bottom

Tissue color	
Encrustation	
Disease	
Sediment on blades	
Sinking fronds	
Grazed tissues	
Sporophylls	
Juvenile fronds	
Holdfasts	
Old holdfasts	
Recruitment	

Community

Litter	
Turf algae	
Turf invert.	
Shrub algae	
Large Invert.	
Fishes	
Disease	
Sed. on rocks	
Urchin status	

Bottom characteristics

REMARKS

Field Data Sheet

CONDITION OF MACROCYSTIS BED

mbc AQUATIC SCIENCES

Observer: DJS / JNS
Lat/Long: 32°34.668'N, 117°09.435'W

Date 2/1/2022
Location Imperial Beach
Time 0825
Wind/Direction SSW 7-8 kn
Current NW 3 kn
Weather Cloudy 80%
UW Visibility (est.) 2m
Swell Ht/Period WSW 3-4 Ft

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent None
Density
Tissue color
% Frond comp. _____ Senile _____ Mature _____ Young _____ Other
Disease SSL
Encrustation
Apical blades
Sediment on blades
Remarks Drift Kelp

Depth (offshore) 48 Ft
Depth (other)

Subsurface None

UNDERWATER OBSERVATIONS

Midwater
- Tissue Color
- Encrustation
- Disease
- Sediment on blades
- Sinking fronds
- Grazed tissues

Bottom
- Tissue color
- Encrustation
- Disease
- Sediment on blades
- Sinking fronds
- Grazed tissues
- Sporophylls
- Juvenile fronds
- Holdfasts
- Old holdfasts
- Recruitment

Community
- Litter
- Turf algae
- Turf invert.
- Shrub algae
- Large Invert.
- Fishes
- Disease
- Sed. on rocks
- Urchin status

Bottom characteristics

REMARKS

Field Data Sheet

CONDITION OF MACROCYSTIS BED

mbc AQUATIC SCIENCES

Observer: DJS / TED
Lat/Long: N33°17.130', W117°29.043' south end (45ft)
N33°17.289', W117°29.138' Inshore edge (45ft)
N33°17.195', W117°29.589' Offshore edge (52ft)
N33°17.628, W117°29.853' upcoast edge (50ft)

Date 17 Feb 22
Location Barn Kelp
Time 0753
Wind/Direction NE 4 kts
Current NW 1 kt
Weather Clear
UW Visibility (est.) 2 m
Swell Ht/Period 2 ft SW

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent
Density Scattered
Tissue color 80% med. Yellow, 20% dark Yellow
% Frond comp. 90 Senile 10 Mature ____ Young ____ Other
Disease None
Encrustation Slight Subsurface
Apical blades None
Sediment on blades None
Surface Stipe Length 3m
Depth (offshore) 52ft
Depth (other[note])

Remarks All Kelp canopy between

Subsurface Scattered marks up to 40ft, some encrusted (30%)

UNDERWATER OBSERVATIONS

Midwater

Tissue Color
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues

Bottom

Tissue color
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues
Sporophylls
Juvenile fronds
Holdfasts
Old holdfasts
Recruitment

Community

Litter
Turf algae
Turf invert.
Shrub algae
Large Invert.
Fishes
Disease
Sed. on rocks
Urchin status

Bottom characteristics

REMARKS

Field Data Sheet

CONDITION OF MACROCYSTIS BED

mbc AQUATIC SCIENCES

Observer: DJS/TED
Lat/Long: N33°18.116', W117°29.473'W

Date 17 Feb 22
Location Horno Canyon
Time 0830
Wind/Direction NE 4 kts
Current NW 1 kt
Weather Clear
UW Visibility (est.) 2m
Swell Ht/Period 2 ft SW

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent None
Density
Tissue color
% Frond comp. _____ Senile _____ Mature _____ Young _____ Other
Disease
Encrustation
Apical blades
Sediment on blades
Remarks

Surface Stipe Length
Depth (offshore) 35 ft
Depth (other[note])

Subsurface NONE

UNDERWATER OBSERVATIONS

Midwater

Tissue Color
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues

Bottom

Tissue color
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues
Sporophylls
Juvenile fronds
Holdfasts
Old holdfasts
Recruitment

Community

Litter
Turf algae
Turf invert.
Shrub algae
Large Invert.
Fishes
Disease
Sed. on rocks
Urchin status

Bottom characteristics

REMARKS

Field Data Sheet

CONDITION OF MACROCYSTIS BED

mbc AQUATIC SCIENCES

Observer: DJS / TED
Lat/Long: N 33°19.126', W 117°30.295'

Date 17Feb22
Location Pendleton Reefs
Time 0843
Wind/Direction NE 4 kts
Current NW 1kt
Weather Clear
UW Visibility (est.) 2m
Swell Ht/Period 2ft SW

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent None
Density
Tissue color
% Frond comp. _____ Senile _____ Mature _____ Young _____ Other
Disease
Encrustation
Apical blades
Sediment on blades

Surface Stipe Length
Depth (offshore) 35 ft
Depth (other[note])

Remarks

Subsurface None

UNDERWATER OBSERVATIONS

Midwater

Tissue Color
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues

Bottom

Tissue color
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues
Sporophylls
Juvenile fronds
Holdfasts
Old holdfasts
Recruitment

Community

Litter
Turf algae
Turf invert.
Shrub algae
Large Invert.
Fishes
Disease
Sed. on rocks
Urchin status

Bottom characteristics

REMARKS

Field Data Sheet

CONDITION OF MACROCYSTIS BED

mbc AQUATIC SCIENCES

Observer: DJS/ TED
Lat/Long: N 33°20.685', W 117°33.902'

Date: 17 Feb 22
Location: San Onofre
Time: 1145
Wind/Direction: N 5 kts
Current: NW 1 kt
Weather: Clear/Sunny
UW Visibility (est.): 2m
Swell Ht/Period: 2 ft

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent: None
Density
Tissue color
% Frond comp. _____ Senile _____ Mature _____ Young _____ Other
Disease
Encrustation
Apical blades
Sediment on blades

Surface Stipe Length
Depth (offshore): 45 ft
Depth (other[note])

Remarks

Subsurface None

UNDERWATER OBSERVATIONS

Midwater
- Tissue Color
- Encrustation
- Disease
- Sediment on blades
- Sinking fronds
- Grazed tissues

Bottom
- Tissue color
- Encrustation
- Disease
- Sediment on blades
- Sinking fronds
- Grazed tissues
- Sporophylls
- Juvenile fronds
- Holdfasts
- Old holdfasts
- Recruitment

Community
- Litter
- Turf algae
- Turf invert.
- Shrub algae
- Large Invert.
- Fishes
- Disease
- Sed. on rocks
- Urchin status

Bottom characteristics

REMARKS

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Field Data Sheet

CONDITION OF MACROCYSTIS BED

mbc AQUATIC SCIENCES

Observer: DJS / TED
Lat/Long: N33°22.800', W117°36.072' (inshore)
N33°22.719', W117°36.270' (offshore)

Date 17 Feb 22
Location San Mateo
Time 1200
Wind/Direction NE 5 kts
Current NW 1 kt
Weather Clear
UW Visibility (est.) 2m
Swell Ht/Period 2 ft

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent 100m x 100m
Density Scattered
Tissue color 80% med. yellow, 10% dark yellow, 10% light y.
% Frond comp. 90 Senile 10 Mature _____ Young _____ Other
Disease None
Encrustation 30%
Apical blades None
Sediment on blades None

Surface Stipe Length 10-15 ft
Depth (offshore) 43 ft
Depth (other[note])

Remarks

Subsurface Many marks reaching ~10 ft below surface

UNDERWATER OBSERVATIONS

Midwater

Tissue Color
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues

Bottom

Tissue color
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues
Sporophylls
Juvenile fronds
Holdfasts
Old holdfasts
Recruitment

Community

Litter
Turf algae
Turf invert.
Shrub algae
Large Invert.
Fishes
Disease
Sed. on rocks
Urchin status

Bottom characteristics

REMARKS

Field Data Sheet

CONDITION OF MACROCYSTIS BED

mbc AQUATIC SCIENCES

Observer: DJS / TED

Lat/Long: N 33°23.598', W 117°37.004' (downcoast)
N 33°24.847', W 117°38.000' (upcoast)

Date 17Feb22
Location San Clemente
Time 1208
Wind/Direction N 5kt
Current NW 1
Weather Clear
UW Visibility (est.) 2m
Swell Ht/Period 2ft

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent 0.25miles X 1mile
Density scattered
Tissue color 50% med.yellow, 10% darky., 40% lighty.
% Frond comp. 90 Senile 10 Mature _____ Young _____ Other
Disease None
Encrustation 40%
Apical blades None
Sediment on blades None

Surface Stipe Length 2m
Depth (offshore) 48ft
Depth (other[note])

Remarks

Subsurface Many marks subsurface to ~10ft below surface

UNDERWATER OBSERVATIONS

Midwater

Tissue Color
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues

Bottom

Tissue color
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues
Sporophylls
Juvenile fronds
Holdfasts
Old holdfasts
Recruitment

Community

Litter
Turf algae
Turf invert.
Shrub algae
Large Invert.
Fishes
Disease
Sed. on rocks
Urchin status

Bottom characteristics

REMARKS

Field Data Sheet

CONDITION OF MACROCYSTIS BED

mbc AQUATIC SCIENCES

Observer: DJS
Lat/Long: N 33°25.823', W 117°39.255'

Date 17 FEB 22
Location Capistrano Beach
Time 1345
Wind/Direction 6-7 kt W
Current 1 kt W
Weather Clear
UW Visibility (est.) 3m
Swell Ht/Period 2 ft

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent 0.25 miles x 0.5 miles
Density Scattered
Tissue color 90% Dark yellow, 10% med. yellow
% Frond comp. 50 Senile 50 Mature ____ Young ____ Other
Disease None
Encrustation 40%, mostly subsurface
Apical blades None
Sediment on blades None

Surface Stipe Length 3-4m
Depth (offshore) 45 ft
Depth (other[note])

Remarks

Subsurface

UNDERWATER OBSERVATIONS

Midwater (50m END OF TAPE to WEST 270°)

Tissue Color 50% med, 50% light yellow
Encrustation 90%, arthropods
Disease None
Sediment on blades 10%
Sinking fronds None
Grazed tissues 50%

Bottom

Tissue color 50% med, 50% dark yellow
Encrustation None
Disease None
Sediment on blades None
Sinking fronds None
Grazed tissues 10%
Sporophylls ~~All present~~, Some spent (20%)
Juvenile fronds
Holdfasts (13) [23] (14) (40) (15) (2) (20) (23) (13) (13) (18) (12) [23] (13) stipe counts per 13 plants
Old holdfasts 1
Recruitment one plant ~2m tall

Community

Litter Rhodophytes, shells
Turf algae Rhodophytes
Turf invert. Gorgonians
Shrub algae Laminaria, Pterygophora, Cystoseira
Large Invert. W. Seacucumber, Kellet's whelk
Fishes KB, Sargo, H.m., Gari, Blacksmith
Disease CASH, Blackspech. BSB, Blackeye Goby
Sed. on rocks 30%
Urchin status 2: purple urchins

Bottom characteristics

Large scattered boulders
and smaller rocks in between

REMARKS Surge, low vis. (2m), most kelp plant holdfasts anchored in gaps between boulders

Field Data Sheet

CONDITION OF MACROCYSTIS BED

mbc AQUATIC SCIENCES

Observer: DJS / TED
Lat/Long: N 33° 27.632', W 117° 43.302' (Down coast)
N 33° 28.654', W 117° 43.995' (Upcoast)

Date 17 Feb 22
Location Salt Creek / Dana Pt.
Time 1515
Wind/Direction 6-7 kt W
Current 1 kt W
Weather Clear
UW Visibility (est.) 3m
Swell Ht/Period 2 ft

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent 0.25 miles X 1 mile
Density Scattered
Tissue color 20% med. yellow
% Frond comp. 10 Senile 90 Mature ____ Young ____ Other
Disease None
Encrustation 20% Bryozoan, 10% Serpulorbis
Apical blades None
Sediment on blades None

Surface Stipe Length 3m
Depth (offshore) 54 ft
Depth (other[note])

Remarks

Subsurface Dense marks up to 50 ft depth, slight encrustation

UNDERWATER OBSERVATIONS

Midwater

Tissue Color
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues

Bottom

Tissue color
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues
Sporophylls
Juvenile fronds
Holdfasts
Old holdfasts
Recruitment

Community

Litter
Turf algae
Turf invert.
Shrub algae
Large Invert.
Fishes
Disease
Sed. on rocks
Urchin status

Bottom characteristics

REMARKS

Field Data Sheet

CONDITION OF MACROCYSTIS BED

mbc AQUATIC SCIENCES

Observer: DJS, TED
Lat/Long: N 33°31.865', W117°46.890'

Date 17Feb22
Location South Laguna Beach
Time 0850
Wind/Direction 3-4 kt ESE
Current 1 kt N.
Weather Partly Cloudy
UW Visibility (est.) 10Ft
Swell Ht/Period 2ft WSW

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent 200m x 500m
Density Scattered
Tissue color 50% D. Yellow, 50% M. yellow
% Frond comp. 40 Senile 50 Mature 10 Young _____ Other
Disease None
Encrustation 10%
Apical blades 10%
Sediment on blades None

Surface Stipe Length 3-4m
Depth (offshore) 44 Ft
Depth (other[note])

Remarks

Subsurface South Main beach (~20Ft) to ~Brooks St.

UNDERWATER OBSERVATIONS

Midwater

Tissue Color
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues

Bottom

Tissue color
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues
Sporophylls
Juvenile fronds
Holdfasts
Old holdfasts
Recruitment

Community

Litter
Turf algae
Turf invert.
Shrub algae
Large Invert.
Fishes
Disease
Sed. on rocks
Urchin status

Bottom characteristics

REMARKS

Field Data Sheet

CONDITION OF MACROCYSTIS BED

mbc AQUATIC SCIENCES

Observer: DJS, TED — Date 10MAR 22

Lat/Long: N33°32.759', W117°48.403' • 0830 (N.L. Beach 100x200m) — Location North Laguna Beach

TOPSIDE OBSERVATIONS
N 33°32.618', W117°48.298' • Crescent Bay (50m²) — Time 0830
N33°32.611', W117°48.022' • Shaw's (50m²) — Wind/Direction 3-4 ESE
N33°32.611', W117°47.789' • Diver's Cove — Current 1 Kt N.
Kelp Canopy N33°32.414', W117°47.481' • Heisler Park — Weather Partly Cloudy
UW Visibility (est.) 15 ft

Extent 100m x 200m (N.L), 50m²(Crescent), 50m²/Shaw's), Swell Ht/Period 2-3 ft WSW
Density Scattered (ML) / 50m²(Diver's Cove), 200m x 1000m (Heisler)
Tissue color 50% D. yellow, 50% M. yellow
% Frond comp. 30 Senile 50 Mature 20 Young _____ Other
Disease None
Encrustation 10% bryozoan — Surface Stipe Length 2-3m
Apical blades 10% — Depth (offshore) 45ft
Sediment on blades None — Depth (other[note]) _____
Remarks

Subsurface Far point of Heisler = 46 ft depth
South Main Beach (Brooks St.) = 27 ft depth

UNDERWATER OBSERVATIONS Heisler Park Dive: 1134-1202 @ 41ft (N 33°32.414', W117°47.481')

Midwater
Tissue Color 20% Dark Yellow, 80% med. yellow
Encrustation 10% bryozoan
Disease None
Sediment on blades None
Sinking fronds None
Grazed tissues 10%

Bottom
Tissue color 20% Dark Yellow, 80% med. yellow
Encrustation 10% bryozoan
Disease None
Sediment on blades None
Sinking fronds None
Grazed tissues 10%
Sporophylls Present, ~50% spent
Juvenile fronds 30%
Holdfasts (13), (14), (8), (4), (1), (12), (2), (8), (8) n=9 (#)=stipes
Old holdfasts *2
Recruitment None

Community
Litter Small rocks + algae bits
Turf algae Plocamium, Callophyllis, Fucus, Corallina
Turf invert. Turban snails, bryozoan
Shrub algae Laminaria, Ptero., Cysto, Sargassum horneri
Large Invert. CA lobster, Gorgonians, Linckia seastars, Many Fish Baitballs
Fishes KB, CASH, Garibaldi, BSB, BEgoby, CABarracuda, Blacksmith, Kelp Rockfish
Disease None
Sed. on rocks Slight
Urchin status 4: red urchin on 50m transect

Bottom characteristics
Rugose boulders of various sizes spaced ~2m apart w/ some large piles of boulder. Plate rock + cobble between boulders with kelp and macro browns (Laminaria, Ptero, Cysto.)

REMARKS *2 holdfasts eaten(?) away from underneath – no rock/substrate present but both plants still looked healthy

Field Data Sheet

CONDITION OF MACROCYSTIS BED

mbc AQUATIC SCIENCES

Observer: DJS, TED

Date: 10 MAR 22

Lat/Long: N33° 35.260', W117° 52.158' • comm North end (20ft) 0745

Location: Corona Del Mar

N33° 34.547', W117° 51.073' (50m²) P.P. crystal cove subsurface (25ft) 0800

Time: 0745

TOPSIDE OBSERVATIONS

N33° 34.402', W117° 50.666' (200m²) Beach Camber (35ft)

Wind/Direction: 3-4 kt ESE

Current: 1 kt N.

Weather: Partly cloudy

UW Visibility (est.): 15 ft

Swell Ht/Period: 2ft WSW

Kelp Canopy

Extent: 100m X 300m @ North end

Density: Scattered

Tissue color: 80% Dark Brown, 20% med. brown

% Frond comp.: 10 Senile; 60 Mature; 30 Young; ____ Other

Disease: None

Encrustation: 15% bryozoan

Apical blades: 25%

Sediment on blades: None

Surface Stipe Length: 2-3m

Depth (offshore): 25 Ft

Depth (other[note]):

Remarks

Subsurface Marks offshore to 25ft depth (N33° 35.169', W117° 52.057')

UNDERWATER OBSERVATIONS

Midwater

- Tissue Color
- Encrustation
- Disease
- Sediment on blades
- Sinking fronds
- Grazed tissues

Bottom

- Tissue color
- Encrustation
- Disease
- Sediment on blades
- Sinking fronds
- Grazed tissues
- Sporophylls
- Juvenile fronds
- Holdfasts
- Old holdfasts
- Recruitment

Community

- Litter
- Turf algae
- Turf invert.
- Shrub algae
- Large Invert.
- Fishes
- Disease
- Sed. on rocks
- Urchin status

Bottom characteristics

REMARKS

Field Data Sheet

CONDITION OF MACROCYSTIS BED

mbc AQUATIC SCIENCES

Observer: DJS
Lat/Long: N 33°29.667', W 117°44.619

Date 10MAR22
Location South Laguna
Time 0910 (treasure island)
Wind/Direction 0930 (1,000 Steps Beach)
Current
Weather
UW Visibility (est.)
Swell Ht/Period

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent NONE
Density
Tissue color
% Frond comp. _____ Senile _____ Mature _____ Young _____ Other
Disease
Encrustation
Apical blades
Sediment on blades

Surface Stipe Length
Depth (offshore)
Depth (other[note])

Remarks Treasure Island - 30m x 100m very scattered - mostly subsurface

Subsurface

UNDERWATER OBSERVATIONS [1,000 Steps Beach] dive: 1009 - 1039

Midwater

Tissue Color None
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues

Bottom

Tissue color
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues
Sporophylls
Juvenile fronds
Holdfasts None
Old holdfasts
Recruitment

Community

Litter
Turf algae Rhodophytes, Phyllospadix
Turf invert. Bryozoan, Sponges, Hydroid, Sc. worms
Shrub algae Ptero., Laminaria, Cystoc.
Large Invert. Kellet's, lobster, Pyl. urchins, Gorgonians
Fishes KP, SH, BSB, RW, Señorita, CA Sheephead, Wavy T. Senorita, Kelp fish, Blacksmith
Disease None
Sed. on rocks Yes
Urchin status Moderate (~3/m²)

Bottom characteristics @ 47 ft depth
1m² boulders spaced ~ 1m apart
some cobble, lots of bryozoans,
and other brown algae with
sediment on hard substrate
between boulders

REMARKS

Field Data Sheet

CONDITION OF MACROCYSTIS BED

Observer: A.K. Sugimoto, K.P. Mooers
Lat/Long: 33°23.084'N, 117°36.355'W

Date: 1 DEC 22
Location: San Mateo Pt.
Time: 1400
Wind/Direction: 4-5 knots, W.
Current: 1 kt, S
Weather: Partly Cloudy
UW Visibility: 5-6m
Swell Ht/Period: 2 ft SSW, 13 sec.

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent: NONE
Density: Ø
Tissue color:
% Frond comp. _____ Senile _____ Mature _____ Young _____ Other
Disease:
Encrustation:
Apical blades:
Sediment on blades:
Remarks: 31-ft depth

Subsurface NONE

UNDERWATER OBSERVATIONS

Midwater
Tissue Color (NONE)
Encrustation:
Disease:
Sediment on blades:
Sinking fronds:
Grazed tissues:

Bottom
Tissue color (NONE)
Encrustation:
Disease:
Sediment on blades:
Sinking fronds:
Grazed tissues:
Sporophyllis:
Juvenile fronds:
Holdfasts:
Old holdfasts:
Recruitment:

Community
Litter: None
Turf algae: Corralina
Turf invert.: None
Shrub algae: None
Large Invert.: Megastrea undosa (33)
Fishes: O.Whitefish, Barred Sand Bass
Disease: None
Sed. on rocks: None
Urchin status: Red Urchin (29), Purple (29)

Bottom characteristics
55% Boulder
35% Cobble
10% Sand

REMARKS 31 ft depth, 59°F, 5-6m. vis., 1-2 ft relief

Field Data Sheet

CONDITION OF MACROCYSTIS BED

Observer: D.J.Schuessler
Lat/Long: 33°21.690'N, 117°33.563'W

Date 1 DEC 22
Location San Onofre
Time 1145
Wind/Direction 4-5 Knots, W
Current 1 Knot, S
Weather Partly Cloudy
UW Visibility 3-4m
Swell Ht/Period 2ft SSW, 13sec.

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent None
Density
Tissue color
% Frond comp. _____ Senile _____ Mature _____ Young _____ Other
Disease
Encrustation
Apical blades
Sediment on blades
Remarks 45 Ft depth

Subsurface None

UNDERWATER OBSERVATIONS

Midwater
- Tissue Color
- Encrustation
- Disease
- Sediment on blades
- Sinking fronds
- Grazed tissues

Bottom
- Tissue color
- Encrustation
- Disease
- Sediment on blades
- Sinking fronds
- Grazed tissues
- Sporophyllis
- Juvenile fronds
- Holdfasts
- Old holdfasts
- Recruitment

Community
- Litter
- Turf algae
- Turf invert.
- Shrub algae
- Large Invert.
- Fishes
- Disease
- Sed. on rocks
- Urchin status

Bottom characteristics

REMARKS

Field Data Sheet

CONDITION OF MACROCYSTIS BED

Observer: D.J. Schmessler
Lat/Long: 33° 27.225' N, 117° 41.628' W

Date: 15 Dec 22
Location: Dana Pt Marina
Time: 1330
Wind/Direction: 3-4 Kn, SW
Current: 1 Kn, S
Weather: Partly Cloudy
UW Visibility: 2m
Swell Ht/Period: 1 Ft, 16 sec

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent: None
Density:
Tissue color:
% Frond comp. _____ Senile _____ Mature _____ Young _____ Other
Disease:
Encrustation:
Apical blades:
Sediment on blades:
Remarks:

Subsurface: None

UNDERWATER OBSERVATIONS

Midwater
- Tissue Color
- Encrustation
- Disease
- Sediment on blades
- Sinking fronds
- Grazed tissues

Bottom
- Tissue color
- Encrustation
- Disease
- Sediment on blades
- Sinking fronds
- Grazed tissues
- Sporophyllis
- Juvenile fronds
- Holdfasts
- Old holdfasts
- Recruitment

Community
- Litter
- Turf algae
- Turf invert.
- Shrub algae
- Large Invert.
- Fishes
- Disease
- Sed. on rocks
- Urchin status

Bottom characteristics

REMARKS

Field Data Sheet

CONDITION OF MACROCYSTIS BED

Observer: D.J. Schuessler
Lat/Long: 33°26.884'N, 117°40.180'W

Date 15 Dec 22
Location Capistrano Beach
Time 1320
Wind/Direction 3-4 kn, SW
Current 1 kn, S
Weather Partly Cloudy
UW Visibility 2-3 m
Swell Ht/Period 1 Ft, 16 sec

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent None
Density
Tissue color
% Frond comp. _____ Senile _____ Mature _____ Young _____ Other
Disease
Encrustation
Apical blades
Sediment on blades
Remarks 20 ft depth

Subsurface few marks on fathometer

UNDERWATER OBSERVATIONS

Midwater
Tissue Color
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues

Bottom
Tissue color
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues
Sporophyllis
Juvenile fronds
Holdfasts
Old holdfasts
Recruitment

Community
Litter
Turf algae
Turf invert.
Shrub algae
Large Invert.
Fishes
Disease
Sed. on rocks
Urchin status

Bottom characteristics

REMARKS

Field Data Sheet

CONDITION OF MACROCYSTIS BED

Observer: D.J. Schmessler
Lat/Long: 33° 23.734'N, 117°36.938'W

Date 15 Dec 22
Location San Clemente
Time 1310
Wind/Direction 3-4 kn, SW
Current 1 kn, S
Weather Partly Cloudy
UW Visibility 2-3m
Swell Ht/Period 1 ft, 16 sec

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent None
Density
Tissue color
% Frond comp. _____ Senile _____ Mature _____ Young _____ Other
Disease
Encrustation
Apical blades
Sediment on blades
Remarks 35 ft depth

Subsurface marks on fathometer throughout area

UNDERWATER OBSERVATIONS

Midwater
Tissue Color
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues

Bottom
Tissue color
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues
Sporophyllis
Juvenile fronds
Holdfasts
Old holdfasts
Recruitment

Community
Litter
Turf algae
Turf invert.
Shrub algae
Large Invert.
Fishes
Disease
Sed. on rocks
Urchin status

Bottom characteristics

REMARKS

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Field Data Sheet

CONDITION OF MACROCYSTIS BED

mbc AQUATIC SCIENCES

Observer: D.J.Schmeltzer
Lat/Long: 33°20.617'N, 117°31.857'W

Date 15DEC 22
Location Pendleton Reefs
Time 1045
Wind/Direction 3 Kn, S.
Current 1 Kn, S.
Weather Partly Cloudy
UW Visibility (est.) 2-3 m
Swell Ht/Period 1 Ft, 16 sec.

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent None
Density
Tissue color
% Frond comp. _____ Senile _____ Mature _____ Young _____ Other
Disease
Encrustation
Apical blades
Sediment on blades
Surface Stipe Length
Depth (offshore)
Depth (other[note])
Remarks 28 ft depth

Subsurface None

UNDERWATER OBSERVATIONS

Midwater
- Tissue Color
- Encrustation
- Disease
- Sediment on blades
- Sinking fronds
- Grazed tissues

Bottom
- Tissue color
- Encrustation
- Disease
- Sediment on blades
- Sinking fronds
- Grazed tissues
- Sporophylls
- Juvenile fronds
- Holdfasts
- Old holdfasts
- Recruitment

Community
- Litter
- Turf algae
- Turf invert.
- Shrub algae
- Large invert.
- Fishes
- Disease
- Sed. on rocks
- Urchin status

Bottom characteristics

REMARKS

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Field Data Sheet

CONDITION OF MACROCYSTIS BED

Observer: D.J. Schuessler, K.P. Mooers, T.E. Diaz
Lat/Long: N 33°18.322', W 117°30.511'

Date 15 Dec 22
Location Horno Canyon
Time 0950
Wind/Direction 3 kn, S.
Current 1 kn, S.
Weather Partly Cloudy
UW Visibility 15 ft
Swell Ht/Period 1ft, 16 sec.

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent NONE
Density
Tissue color
% Frond comp. _____ Senile _____ Mature _____ Young _____ Other
Disease
Encrustation
Apical blades
Sediment on blades
Remarks

Subsurface

UNDERWATER OBSERVATIONS – HORNO CANYON

Midwater

Tissue Color Dark Yellow 50%, Med. Yellow 25%, Lt. Y. 25%
Encrustation 100% of blades, 30% coverage of Hydroid +/or Bryozoan
Disease None
Sediment on blades 100% of blades, 30% coverage
Sinking fronds None
Grazed tissues 20% of blades grazed

Bottom

Tissue color Dark Yellow 50%, Med. Yellow 25%, Lt. Y. 25%
Encrustation 50% of blades, 50% coverage of Hydroid +/or Bryozoan
Disease None
Sediment on blades 80% of blades, 30% coverage
Sinking fronds None
Grazed tissues Slight
Sporophyllis NONE
Juvenile fronds Yes
Holdfasts Adult(7), Sub. Adult(4) – All w/ 3-6 stipes
Old holdfasts NONE
Recruitment NONE

Community

Litter Shell hash
Turf algae Rhodophytes
Turf invert. Hydroids
Shrub algae Rhodophytes, Pterygophora, (Desmarestia, Laminaria),
Large Invert. Kelp Crab, Rock Crab, Decor. Crab, Dove snails
Fishes NONE
Disease NONE
Sed. on rocks moderate
Urchin status NONE

Bottom characteristics

Boulder	10%
Cobble	30%
Sand	60%

REMARKS < 1 ft reef relief

47 ft depth
55°F
2-3 m, vis.

Field Data Sheet

CONDITION OF MACROCYSTIS BED

Observer: D.J. Schuessler, K.P. Mooers, T.E. Diaz
Lat/Long: N 33°17.087', W 117°29.511'

Date: 15 Dec 22
Location: Barn Kelp
Time: 0820
Wind/Direction: 3 kn, S.
Current: 1-2kn, S.
Weather: Partly Cloudy
UW Visibility: 30 ft (horizontal) - dive
Swell Ht/Period: 1 Ft, 16 sec.

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent: NONE
Density:
Tissue color:
% Frond comp. _____ Senile _____ Mature _____ Young _____ Other
Disease:
Encrustation:
Apical blades:
Sediment on blades:
Remarks:

Subsurface Marks on fathometer throughout area

UNDERWATER OBSERVATIONS – BARN KELP

Midwater

Tissue Color: Dark Yellow 50%, Med. Yellow 50%
Encrustation: 50% of blades, 10% coverage of Bryozoan
Disease: NONE
Sediment on blades: Slight
Sinking fronds: 5%
Grazed tissues: 5%

Bottom

Tissue color: Dark Yellow 50%, Medium Yellow 50%
Encrustation: 50% of blades, 10% coverage of Bryozoan
Disease: NONE
Sediment on blades: Slight
Sinking fronds: NONE
Grazed tissues: Slight
Sporophyllis: Yes
Juvenile fronds: Yes
Holdfasts: Adult (9) 2-9 stipes each, sub-Adult (5) 2-3 stipes each. Predominantly Pterygophora + Laminaria
Old holdfasts: ONE
Recruitment: NONE

Community

Litter: None
Turf algae: Rhodophytes, Corallines
Turf invert.: Hydroids, Tunicates
Shrub algae: Pterygophora, Laminaria, Chondracanthus
Large Invert.: Gorgonians, stalked tunicates, CA Spiny Lobster (* cont.)
Fishes: Blacksmith, Kelp Bass, Barred Sand Bass (** cont.)
Disease: None
Sed. on rocks: Moderate
Urchin status: Purple Urchins, Red Urchins (under plate rocks)

Bottom characteristics

Plate Rock 45%
Boulder 30%
Cobble 20%
Sand 5%

<2 Ft reef relief, 10m vis, 55°F, 49 ft depth

REMARKS * Large Inverts cont.: Kellet's Whelk, Wavy Turban snail, Norris' Kelp Snail, Two-spot octopus, Turban snails, Giant Keyhole Limpet

** Fishes cont.: Ocean Whitefish, CA Sheephead, Garibaldi, Señorita, Painted Greenling, Giant Sea Bass, Halfmoon, Rock Wrasse, Black Perch, Blackeyed Goby

Field Data Sheet

CONDITION OF MACROCYSTIS BED

Observer: A.K. Sugimoto, D.J. Schnessler
Lat/Long: 33°34.407' / -117°50.665'
① Crystal Cove
TOPSIDE OBSERVATIONS
②Little Corona
Kelp Canopy

Date 27-JAN-23
Location Corona Del Mar
Time 1301 – 1315
Wind/Direction 2-3 kn NNW
Current 1kn South
Weather Clear, Sunny
UW Visibility 15 ft
Swell Ht/Period 2 ft 15 sec

Extent ① 200m x 100m, ② 250m x 75m
Density Scattered
Tissue color Dark / Medium Yellow
% Frond comp. 5 Senile 95 Mature _____ Young _____ Other
Disease None
Encrustation Very Little (Bryozoan) < 5%
Apical blades None visible
Sediment on blades None
Remarks ①43 ft @ outer edge, ②27 ft at outer edge

Subsurface Kelp throughout area

UNDERWATER OBSERVATIONS

Midwater
- Tissue Color
- Encrustation
- Disease
- Sediment on blades
- Sinking fronds
- Grazed tissues

Bottom
- Tissue color
- Encrustation
- Disease
- Sediment on blades
- Sinking fronds
- Grazed tissues
- Sporophyllis
- Juvenile fronds
- Holdfasts
- Old holdfasts
- Recruitment

Community
- Litter
- Turf algae
- Turf invert.
- Shrub algae
- Large Invert.
- Fishes
- Disease
- Sed. on rocks
- Urchin status

Bottom characteristics

REMARKS

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Field Data Sheet

CONDITION OF MACROCYSTIS BED

Observer: A.K. Sugimoto, D.J. Schuessler
Lat/Long: 33°32.398'N, 117°47.390'W Heisler Park

Date 27-JAN-23
Location North Laguna Beach
Time 1235
Wind/Direction 2-3 kn NNW
Current 1 kn South
Weather clear, Sunny
UW Visibility 15 ft
Swell Ht/Period 2 ft, 15 sec

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent 200m x 200m
Density Scattered
Tissue color Dark/Medium Yellow
% Frond comp. 10 Senile 90 Mature _____ Young _____ Other
Disease None
Encrustation 20-25% (Bryozoan)
Apical blades Very few
Sediment on blades None
Remarks 50 ft outer edge depth (33°32.397'N, 117°47.627'W)
little grazing
Subsurface Throughout entire area

UNDERWATER OBSERVATIONS

Midwater
- Tissue Color
- Encrustation
- Disease
- Sediment on blades
- Sinking fronds
- Grazed tissues

Bottom
- Tissue color
- Encrustation
- Disease
- Sediment on blades
- Sinking fronds
- Grazed tissues
- Sporophyllis
- Juvenile fronds
- Holdfasts
- Old holdfasts
- Recruitment

Community
- Litter
- Turf algae
- Turf invert.
- Shrub algae
- Large Invert.
- Fishes
- Disease
- Sed. on rocks
- Urchin status

Bottom characteristics

REMARKS

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Field Data Sheet

CONDITION OF MACROCYSTIS BED

Observer: AK. Sugimoto, D.J. Schuessler
Lat/Long: 33°31.798' N, 117°46.858' W
Brooks Street

Date 27-JAN-23
Location South Laguna Beach
Time 1105
Wind/Direction 2-3 kn NNW
Current 1 kn South
Weather Clear, Sunny
UW Visibility 15 ft
Swell Ht/Period 2 ft, 15 sec

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent 200m x 200m
Density Scattered
Tissue color Dark/Medium yellow
% Frond comp. 5 Senile 95 Mature _____ Young _____ Other
Disease None
Encrustation 25-30% (Bryozoan)
Apical blades Very few
Sediment on blades None
Remarks 47 ft @ outer edge

Subsurface Throughout entire area
Kelp visible on sonar @ 15 ft

UNDERWATER OBSERVATIONS

Midwater
- Tissue Color
- Encrustation
- Disease
- Sediment on blades
- Sinking fronds
- Grazed tissues

Bottom
- Tissue color
- Encrustation
- Disease
- Sediment on blades
- Sinking fronds
- Grazed tissues
- Sporophyllis
- Juvenile fronds
- Holdfasts
- Old holdfasts
- Recruitment

Community
- Litter
- Turf algae
- Turf invert.
- Shrub algae
- Large Invert.
- Fishes
- Disease
- Sed. on rocks
- Urchin status

Bottom characteristics

REMARKS

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Field Data Sheet

CONDITION OF MACROCYSTIS BED

Observer: AK, Sugimoto, D.J. Schuessler
Lat/Long: 33°29.695' -117°44.609'
1,000 Steps Beach

Date 27 JAN 23
Location South Laguna
Time 1044
Wind/Direction 2-3 kn NNW
Current 1 kn South
Weather Clear, Sunny
UW Visibility 15 ft
Swell Ht/Period 2 ft, 15 sec

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent None
Density
Tissue color
% Frond comp. _____ Senile _____ Mature _____ Young _____ Other
Disease
Encrustation
Apical blades
Sediment on blades
Remarks Reef @ 42.3 ft

Subsurface None

UNDERWATER OBSERVATIONS

Midwater
Tissue Color
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues

Bottom
Tissue color
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues
Sporophyllis
Juvenile fronds
Holdfasts
Old holdfasts
Recruitment

Community
Litter
Turf-algae
Turf invert.
Shrub algae
Large Invert.
Fishes
Disease
Sed. on rocks
Urchin status

Bottom characteristics

REMARKS

Field Data Sheet

CONDITION OF MACROCYSTIS BED

Observer: DJS / AKS
Lat/Long: N 33°28.050', W 117°43.326'

Date 27 Jan 23
Location Dana Point / Salt Creek
Time 0900
Wind/Direction 2-3 kn NNW
Current 1, South
Weather Clear, Sunny
UW Visibility 15 ft
Swell Ht/Period 2 ft, 15 sec

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent 100m x 30m
Density very scattered
Tissue color Dark yellow
% Frond comp. 70% Senile 20% Mature 10% Young ____ Other
Disease None
Encrustation None
Apical blades
Sediment on blades None
Remarks <20 individual kelp w/ canopy

Subsurface Many marks on fathometer + seen from surface, mid-reef only

Salt Creek Dive: 0932 – 1014

UNDERWATER OBSERVATIONS

Midwater

Tissue Color Med-light yellow
Encrustation slight, Bryozoan
Disease None
Sediment on blades ~20%
Sinking fronds None
Grazed tissues ~50% (many Norrisia snails)

Bottom

Tissue color Med. – Light Yellow
Encrustation Bryozoan on holdfasts
Disease None
Sediment on blades None
Sinking fronds None
Grazed tissues 50%
Sporophyllis Yes
Juvenile fronds Yes
Holdfasts (2), (10), (20), (11), (4), (2)
Old holdfasts 11
Recruitment None

Community

Litter Sand + shell hash
Turf-algae Corralline algae, Rhodophytes
Turf invert. Bryozoans, rock scallop, sponges, Isabellid worm
(*) Shrub algae Rhodophytes, Pterygophora, Laminaria, Cystoseira
Large Invert. CA Spiny Lobster, Norris Snail, Gk Kelpfish
Fishes Kelp Bass, Barred Bass, CA Sheephead
Disease Gk. Kelpfish, Bat Star
Sed. on rocks Slight
Urchin status Red urchins (<20), Purple (<10)

Bottom characteristics

Plate rock with small boulders & cobble, sand and small rocks in grooves and troughs between plate rock

REMARKS (#) of stipes per plant
(*) Rhodophytes, Pterygophora, Laminaria, Cystoseira, Egregia

40 ft depth
2-3 m vis
55°F
2-4 ft relief

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Field Data Sheet

CONDITION OF MACROCYSTIS BED

Observer: AKSugimoto, D.J. Schmessler
Lat/Long: 33°12.984'N/ 117°25.479'W

Date 2Feb23
Location Santa Margarita
Time 1414
Wind/Direction 4-5 Kts WNW
Current 1-2 Kn, N.
Weather Partly cloudy
UW Visibility 2-3m
Swell Ht/Period 2' SW/ 17 sec

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent NONE
Density
Tissue color
% Frond comp. _____ Senile _____ Mature _____ Young _____ Other
Disease
Encrustation
Apical blades
Sediment on blades
Remarks 43.9' depth

Subsurface None

UNDERWATER OBSERVATIONS

Midwater
- Tissue Color
- Encrustation
- Disease
- Sediment on blades
- Sinking fronds
- Grazed tissues

Bottom
- Tissue color
- Encrustation
- Disease
- Sediment on blades
- Sinking fronds
- Grazed tissues
- Sporophyllis
- Juvenile fronds
- Holdfasts
- Old holdfasts
- Recruitment

Community
- Litter
- Turf algae
- Turf invert.
- Shrub algae
- Large Invert.
- Fishes
- Disease
- Sed. on rocks
- Urchin status

Bottom characteristics

REMARKS

Field Data Sheet

CONDITION OF MACROCYSTIS BED

Observer: AKSugimoto, D.J. Schnessler
Lat/Long: 33°09.412' N/117°21.615' W

Date 2 Feb 23
Location North Carlsbad
Time 1349
Wind/Direction 4-5 Kts WNW
Current 1-2 Kn N
Weather Partly cloudy
UW Visibility 1-2 m
Swell Ht/Period 2' SW / 17 sec

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent 20 m x 20 m
Density Single patch
Tissue color 80% Medium brown / 20% Light brown
% Frond comp. 70 Senile 20 Mature 10 Young _____ Other
Disease None
Encrustation 40%
Apical blades 10%
Sediment on blades None
Remarks

Subsurface scattered on reef area

UNDERWATER OBSERVATIONS

Midwater
- Tissue Color
- Encrustation
- Disease
- Sediment on blades
- Sinking fronds
- Grazed tissues

Bottom
- Tissue color
- Encrustation
- Disease
- Sediment on blades
- Sinking fronds
- Grazed tissues
- Sporophyllis
- Juvenile fronds
- Holdfasts
- Old holdfasts
- Recruitment

Community
- Litter
- Turf algae
- Turf invert.
- Shrub algae
- Large invert.
- Fishes
- Disease
- Sed. on rocks
- Urchin status

Bottom characteristics

REMARKS

Field Data Sheet

CONDITION OF MACROCYSTIS BED

Observer: AK Sugimoto, D.J. Schmessler
Lat/Long: 33° 08.688' N / 117° 21.117' W

Date 2 Feb 23
Location Aqua Hedionda
Time 1345
Wind/Direction 4-5 kts WNW
Current 1-2 kn, N
Weather Partly cloudy
UW Visibility 2-3 m
Swell Ht/Period 2' SW / 17 sec

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent NONE
Density
Tissue color
% Frond comp. _____ Senile _____ Mature _____ Young _____ Other
Disease
Encrustation
Apical blades
Sediment on blades
Remarks 35.8' depth

Subsurface None

UNDERWATER OBSERVATIONS

Midwater
- Tissue Color
- Encrustation
- Disease
- Sediment on blades
- Sinking fronds
- Grazed tissues

Bottom
- Tissue color
- Encrustation
- Disease
- Sediment on blades
- Sinking fronds
- Grazed tissues
- Sporophyllis
- Juvenile fronds
- Holdfasts
- Old holdfasts
- Recruitment

Community
- Litter
- Turf algae
- Turf invert.
- Shrub algae
- Large Invert.
- Fishes
- Disease
- Sed. on rocks
- Urchin status

Bottom characteristics

REMARKS

Field Data Sheet

CONDITION OF MACROCYSTIS BED

Observer: AK Sugimoto
Lat/Long: 33°07.608'N/117°20.464'W

Date 2 Feb 23
Location Encina Power Plant
Time 1339
Wind/Direction 4-5 kts WNW
Current 1-2 kn, N.
Weather Partly cloudy
UW Visibility 2-3 m
Swell Ht/Period 2' SW / 17 sec

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent NONE
Density
Tissue color
% Frond comp. _____ Senile _____ Mature _____ Young _____ Other
Disease
Encrustation
Apical blades
Sediment on blades
Remarks 36.4' depth

Subsurface None

UNDERWATER OBSERVATIONS

Midwater
- Tissue Color
- Encrustation
- Disease
- Sediment on blades
- Sinking fronds
- Grazed tissues

Bottom
- Tissue color
- Encrustation
- Disease
- Sediment on blades
- Sinking fronds
- Grazed tissues
- Sporophyllis
- Juvenile fronds
- Holdfasts
- Old holdfasts
- Recruitment

Community
- Litter
- Turf algae
- Turf invert.
- Shrub algae
- Large invert.
- Fishes
- Disease
- Sed. on rocks
- Urchin status

Bottom characteristics

REMARKS

Field Data Sheet

CONDITION OF MACROCYSTIS BED

Observer: AKSugimoto, D.J. Schuessler
Lat/Long: 33006.038'N / 117°19.510'W

Date 2 Feb 23
Location Carlsbad State Beach
Time 1331
Wind/Direction 4-5 kts WNW
Current 1-2 kn, N.
Weather Partly cloudy
UW Visibility 2-3 m
Swell Ht/Period 2' SW / 17 sec

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent NONE
Density
Tissue color
% Frond comp. _____ Senile _____ Mature _____ Young _____ Other
Disease
Encrustation
Apical blades
Sediment on blades
Remarks 32.2' depth

Subsurface None

UNDERWATER OBSERVATIONS

Midwater
- Tissue Color
- Encrustation
- Disease
- Sediment on blades
- Sinking fronds
- Grazed tissues

Bottom
- Tissue color
- Encrustation
- Disease
- Sediment on blades
- Sinking fronds
- Grazed tissues
- Sporophylls
- Juvenile fronds
- Holdfasts
- Old holdfasts
- Recruitment

Community
- Litter
- Turf algae
- Turf invert.
- Shrub algae
- Large Invert.
- Fishes
- Disease
- Sed. on rocks
- Urchin status

Bottom characteristics

REMARKS

Field Data Sheet

CONDITION OF MACROCYSTIS BED

Observer: AKSugimoto, D.J. Schuessler
Lat/Long: 33°03.937'N/ 117°18.690'W (south end canopy start)
33°04.532'N/ 117°19.021'W (north end)
Date 2 Feb 23
Location North Leucadia
Time 1317
Wind/Direction 4-5 kts WNW
Current 1-2 Kn, N
Weather Partly cloudy
UW Visibility 6-7 m
Swell Ht/Period 2' SW / 17 sec

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent 1000m x 300m
Density Scattered w/ one dense patch
Tissue color 70% Medium brown / 30% Light brown
% Frond comp. 70 Senile 20 Mature 10 Young _____ Other
Disease None
Encrustation 30%
Apical blades 10%
Sediment on blades None
Remarks 5-10 ft exent on surface
Depth: 32.5' south end, 37.2' north end
Subsurface scattered marks

UNDERWATER OBSERVATIONS

Midwater
- Tissue Color
- Encrustation
- Disease
- Sediment on blades
- Sinking fronds
- Grazed tissues

Bottom
- Tissue color
- Encrustation
- Disease
- Sediment on blades
- Sinking fronds
- Grazed tissues
- Sporophyllis
- Juvenile fronds
- Holdfasts
- Old holdfasts
- Recruitment

Community
- Litter
- Turf algae
- Turf invert.
- Shrub algae
- Large Invert.
- Fishes
- Disease
- Sed. on rocks
- Urchin status

Bottom characteristics

REMARKS

Field Data Sheet

CONDITION OF MACROCYSTIS BED

Observer: AKSugimoto, D.J. Schuessler
Lat/Long: 33°03.523'N/117°18.566'W

Date 2 Feb 23
Location Central Leucadia
Time 1315
Wind/Direction 4-5 kts WNW
Current 1-2 kn, N
Weather Partly cloudy
UW Visibility 2-3 m
Swell Ht/Period 2' SW / 17 sec

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent 15m x 35 m
Density Very scattered
Tissue color
% Frond comp. _____ Senile _____ Mature _____ Young _____ Other
Disease
Encrustation
Apical blades
Sediment on blades
Remarks 37.9' depth

Subsurface scattered marks

UNDERWATER OBSERVATIONS

Midwater
Tissue Color
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues

Bottom
Tissue color
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues
Sporophyllis
Juvenile fronds
Holdfasts
Old holdfasts
Recruitment

Community
Litter
Turf algae
Turf invert.
Shrub algae
Large Invert.
Fishes
Disease
Sed. on rocks
Urchin status

Bottom characteristics

REMARKS

Field Data Sheet

CONDITION OF MACROCYSTIS BED

Observer: AKSugimoto, D.J. Schmeissler
Lat/Long: 33° 03.033' N/ 117° 18.344' W

Date 2 Feb 23
Location South Leucadia
Time 1312
Wind/Direction 4-5 kts WNW
Current 1-2 kn, N.
Weather Partly cloudy
UW Visibility 2-3 m
Swell Ht/Period 2' SW/ 17 sec

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent 30 m × 70 m
Density Very scattered
Tissue color
% Frond comp. _____ Senile _____ Mature _____ Young _____ Other
Disease
Encrustation
Apical blades
Sediment on blades
Remarks 34.5' depth

Subsurface very scattered marks

UNDERWATER OBSERVATIONS

Midwater
Tissue Color
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues

Bottom
Tissue color
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues
Sporophyllis
Juvenile fronds
Holdfasts
Old holdfasts
Recruitment

Community
Litter
Turf algae
Turf invert.
Shrub algae
Large invert.
Fishes
Disease
Sed. on rocks
Urchin status

Bottom characteristics

REMARKS

Field Data Sheet

CONDITION OF MACROCYSTIS BED

Observer: AK Sugimoto, D.J. Schuessler
Lat/Long: 33°02.099'N / 117°18.154'W (south end canopy start)
33°02.092'N / 117°18.025'W (north end)

Date 2 Feb 23
Location Encinitas
Time 1304
Wind/Direction 2-3 kts NE
Current 1-2 kn, N
Weather Partly cloudy
UW Visibility 6-7 m
Swell Ht/Period 3 ft SW / 17 sec

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent 500m x 300m
Density Scattered w/ some denser patches
Tissue color 90 Medium brown / 10 Light brown
% Frond comp. 70 Senile 20 Mature 10 Young _____ Other
Disease None
Encrustation 40%
Apical blades 10%
Sediment on blades None
Remarks Heavier encrustation on surface blades
Depth: 46.2' south end, 51.3' north end
Subsurface scattered marks

UNDERWATER OBSERVATIONS

Midwater

Tissue Color
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues

Bottom

Tissue color
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues
Sporophyllis
Juvenile fronds
Holdfasts
Old holdfasts
Recruitment

Community

Litter
Turf algae
Turf invert.
Shrub algae
Large Invert.
Fishes
Disease
Sed. on rocks
Urchin status

Bottom characteristics

REMARKS

Field Data Sheet

CONDITION OF MACROCYSTIS BED

Observer: AKsugimoto, D.J. Schmessler
Lat/Long: 33°00.750'N / 117°17.271'W (south end canopy start)
33°00.997'N / 117°17.458'W (north end)

Date 2 Feb 23
Location Cardiff
Time 1255
Wind/Direction 2-3 Kts NE
Current 1-2 Kn, N.
Weather Partly cloudy
UW Visibility 1 m
Swell Ht/Period 3 ft SW / 17 sec

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent 600m x 400m
Density Scattered
Tissue color 80% Medium brown / 20% Light brown
% Frond comp. 80 Senile 10 Mature 10 Young ____ Other
Disease None
Encrustation 30%
Apical blades 10%
Sediment on blades None
Remarks 35.4' south end canopy start
(depth) 43.3' north end
Subsurface scattered marks

UNDERWATER OBSERVATIONS

Midwater
Tissue Color
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues

Bottom
Tissue color
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues
Sporophyllis
Juvenile fronds
Holdfasts
Old holdfasts
Recruitment

Community
Litter
Turf algae
Turf invert.
Shrub algae
Large Invert.
Fishes
Disease
Sed. on rocks
Urchin status

Bottom characteristics

REMARKS

Field Data Sheet

CONDITION OF MACROCYSTIS BED

Observer: AKSugimoto, D.J. Schuessler
Lat/Long: 32° 59.161' N / 117° 16.981' W (south end canopy start)
32° 59.694' N / 117° 17.195' W (north end)

Date 2 Feb 23
Location Solana Beach
Time 1246
Wind/Direction 2-3 kts NE
Current 1-2 kn, N
Weather Partly Cloudy
UW Visibility 2-3 m
Swell Ht/Period 3 ft SW / 17 sec

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent 1000m x 400m
Density Scattered
Tissue color 80% Medium brown / 20% Light brown
% Frond comp. 70 Senile 20 Mature 10 Young ____ Other
Disease None
Encrustation 40%
Apical blades 10%
Sediment on blades None
Remarks 36.0' south end canopy start
(Depth) 44.5' north end
Subsurface Scattered marks

UNDERWATER OBSERVATIONS

Midwater

Tissue Color
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues

Bottom

Tissue color
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues
Sporophyllis
Juvenile fronds
Holdfasts
Old holdfasts
Recruitment

Community

Litter
Turf algae
Turf invert.
Shrub algae
Large Invert.
Fishes
Disease
Sed. on rocks
Urchin status

Bottom characteristics

REMARKS

Field Data Sheet

CONDITION OF MACROCYSTIS BED

Observer: AKSugimoto, D.J.Schuessler
Lat/Long: 32°57.711'N / 117°16.772'W

Date 2 Feb 23
Location Del Mar
Time 1238
Wind/Direction 2-3 kts NE
Current 1-2 kn, N.
Weather Partly Cloudy
UW Visibility 2-3m
Swell Ht/Period 3 ft SW / 17 sec

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent NONE
Density
Tissue color
% Frond comp. _____ Senile _____ Mature _____ Young _____ Other
Disease
Encrustation
Apical blades
Sediment on blades
Remarks 50.5' depth

Subsurface NONE

UNDERWATER OBSERVATIONS

Midwater
Tissue Color
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues

Bottom
Tissue color
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues
Sporophyllis
Juvenile fronds
Holdfasts
Old holdfasts
Recruitment

Community
Litter
Turf algae
Turf invert.
Shrub algae
Large Invert.
Fishes
Disease
Sed. on rocks
Urchin status

Bottom characteristics

REMARKS

Field Data Sheet

CONDITION OF MACROCYSTIS BED

Observer: AKSugimoto, D.J.Schnessler
Lat/Long: 32°54.929' N / 117°15.841' W (outer edge)

Date 2 Feb 23
Location Torrey Pines
Time 1225
Wind/Direction 2-3 Kts NE
Current 1-2 kn, N.
Weather Partly Cloudy
UW Visibility 2-3m
Swell Ht/Period 3 ft SW / 17 sec

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent NONE
Density
Tissue color
% Frond comp. _____ Senile _____ Mature _____ Young _____ Other
Disease
Encrustation
Apical blades
Sediment on blades
Remarks 27.6' outer edge depth

Subsurface NONE

UNDERWATER OBSERVATIONS

Midwater
Tissue Color
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues

Bottom
Tissue color
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues
Sporophyllis
Juvenile fronds
Holdfasts
Old holdfasts
Recruitment

Community
Litter
Turf algae
Turf invert.
Shrub algae
Large Invert.
Fishes
Disease
Sed. on rocks
Urchin status

Bottom characteristics

REMARKS

Field Data Sheet

CONDITION OF MACROCYSTIS BED

Observer: AKS

Lat/Long: 32° 48.261' N / 117° 16.974' W (South end start)
32° 49.936' N / 117° 17.343' W (North end)

Date 2 Feb 23
Location La Jolla
Time 1147
Wind/Direction 2-3 Kts NE
Current 1-2 Kn, N.
Weather Partly cloudy
UW Visibility 2-3m
Swell Ht/Period 3 ft SW / 17 sec

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent 3,000m x 700m
Density Scattered, very
Tissue color 80% Medium brown / 20% Light brown
% Frond comp. 80 Senile 10 Mature 10 Young ____ Other
Disease None
Encrustation 10%
Apical blades 10%
Sediment on blades None
Remarks 47.2' south end canopy start

Subsurface many marks throughout area

UNDERWATER OBSERVATIONS

Midwater
- Tissue Color
- Encrustation
- Disease
- Sediment on blades
- Sinking fronds
- Grazed tissues

Bottom
- Tissue color
- Encrustation
- Disease
- Sediment on blades
- Sinking fronds
- Grazed tissues
- Sporophyllis
- Juvenile fronds
- Holdfasts
- Old holdfasts
- Recruitment

Community
- Litter
- Turf algae
- Turf invert.
- Shrub algae
- Large invert.
- Fishes
- Disease
- Sed. on rocks
- Urchin status

Bottom characteristics

REMARKS

Field Data Sheet

CONDITION OF MACROCYSTIS BED

Observer: AKSugimoto, D.J. Schuessler
Lat/Long: 32°39.944'N / 117°15.211'W (South canopy start)
32°41.930'N / 117°16.358'W (offshore edge)
32°44.656'N / 117°15.738'W (North canopy end)

Date 2 Feb 23
Location Point Loma
Time 0850
Wind/Direction 2-3 kts NE
Current 1-2 Kn, N.
Weather Clear
UW Visibility 2-3m
Swell Ht/Period 3 ft SW / 17 sec

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent 8500 m x 1000 m
Density Scattered
Tissue color 90% Medium brown, 20% Light brown
% Frond comp. 90 Senile 10 Mature ____ Young ____ Other
Disease None
Encrustation 10%
Apical blades 10%
Sediment on blades None
Remarks Mostly grazed
Depth: 68.7' offshore edge
Subsurface 54.9' South end, 30' tall plants (32°38.878'N / 117°14.633'W)

UNDERWATER OBSERVATIONS

Midwater

Tissue Color
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues

Bottom

Tissue color
Encrustation
Disease
Sediment on blades
Sinking fronds
Grazed tissues
Sporophyllis
Juvenile fronds
Holdfasts
Old holdfasts
Recruitment

Community

Litter
Turf algae
Turf invert.
Shrub algae
Large Invert.
Fishes
Disease
Sed. on rocks
Urchin status

Bottom characteristics

REMARKS

Field Data Sheet

CONDITION OF MACROCYSTIS BED

Observer: AK Sugimoto, D.J. Schmessler
Lat/Long: 32°34.575' N / 117°09.478' W

Date 2 Feb 23
Location Imperial Beach
Time 0819
Wind/Direction 2-3 kts NE
Current 1-2 kn. N
Weather Clear
UW Visibility 2-3m
Swell Ht/Period 3 ft SW / 17 sec

TOPSIDE OBSERVATIONS

Kelp Canopy

Extent NONE
Density
Tissue color
% Frond comp. _____ Senile _____ Mature _____ Young _____ Other
Disease
Encrustation
Apical blades
Sediment on blades
Remarks 52' depth

Subsurface NONE

UNDERWATER OBSERVATIONS

Midwater
- Tissue Color
- Encrustation
- Disease
- Sediment on blades
- Sinking fronds
- Grazed tissues

Bottom
- Tissue color
- Encrustation
- Disease
- Sediment on blades
- Sinking fronds
- Grazed tissues
- Sporophyllis
- Juvenile fronds
- Holdfasts
- Old holdfasts
- Recruitment

Community
- Litter
- Turf algae
- Turf invert.
- Shrub algae
- Large Invert.
- Fishes
- Disease
- Sed. on rocks
- Urchin status

Bottom characteristics

REMARKS

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APPENDIX D

KELP CANOPY COMPOSITE AERIAL PHOTOGRAPHS

Photo D-1

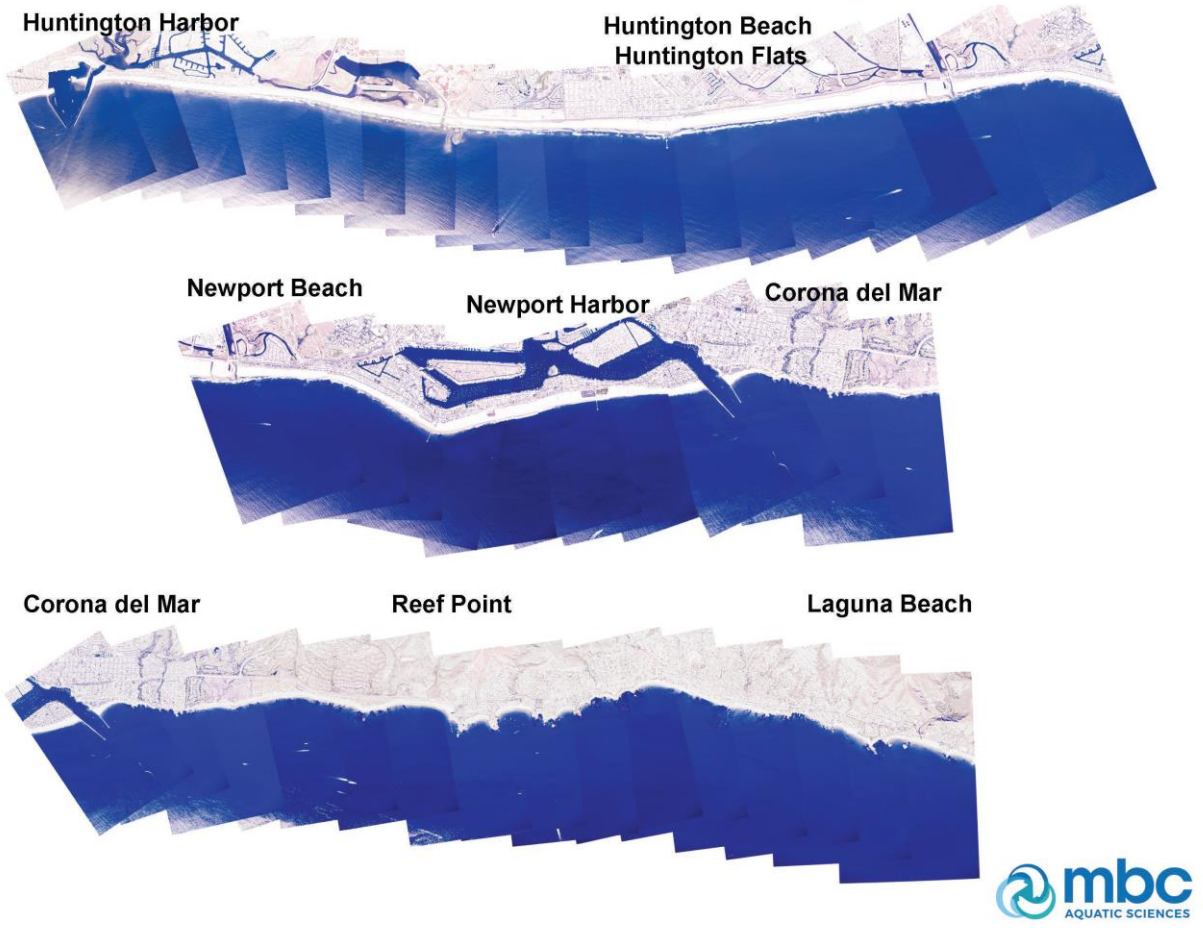

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Photo D-2

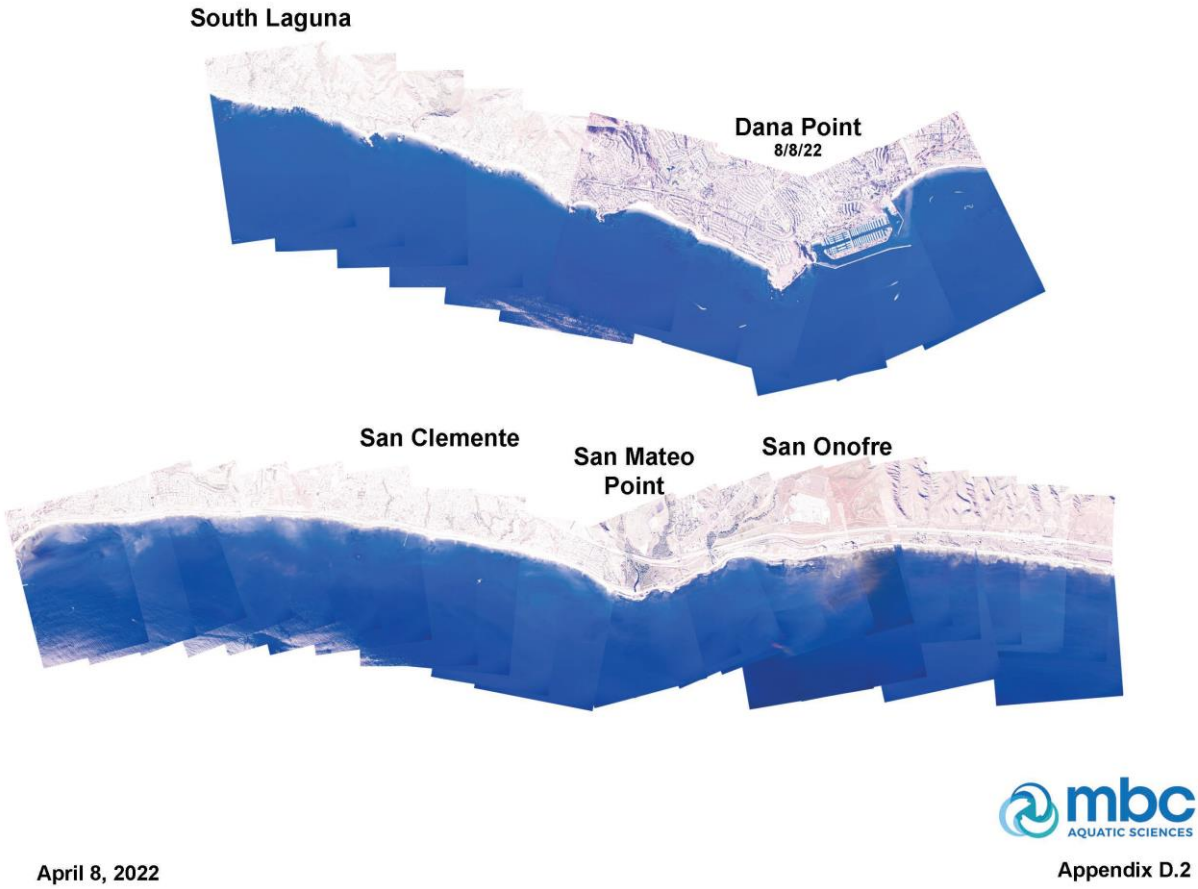

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Photo D-3

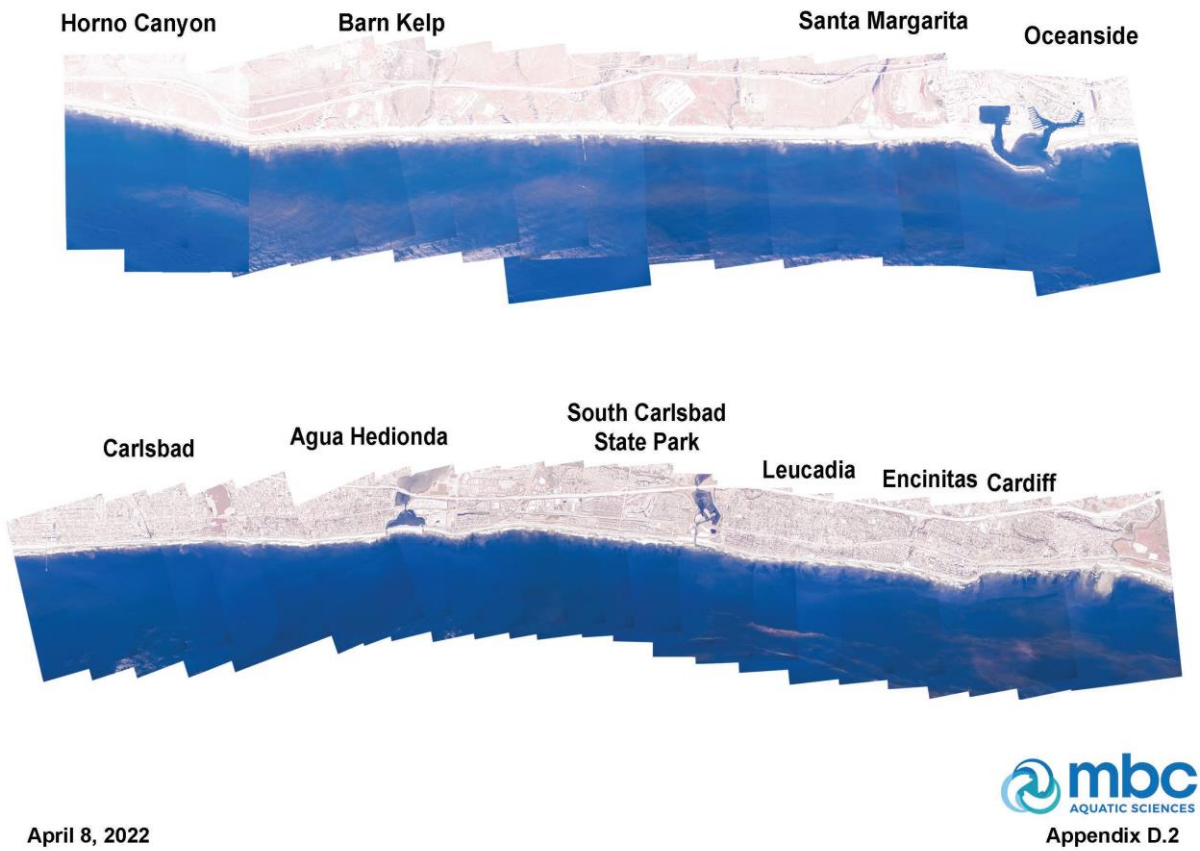

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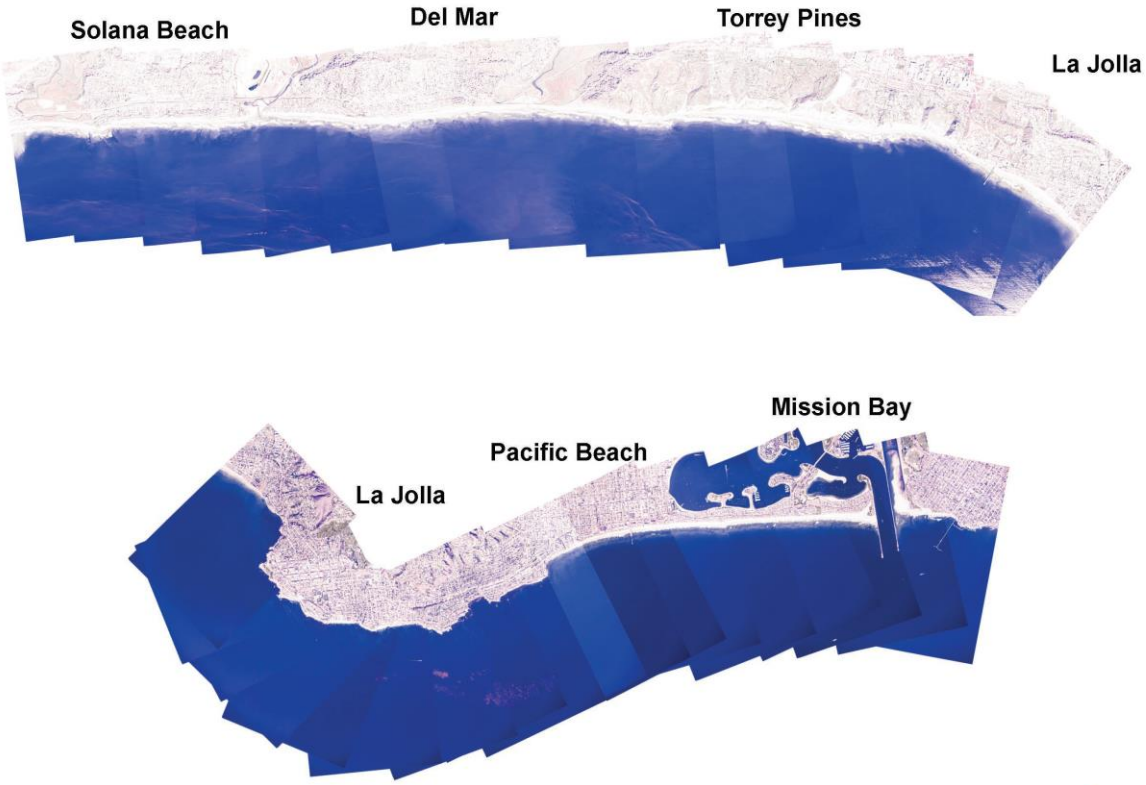
Photo D-4



August 8, 2022

Appendix D.4

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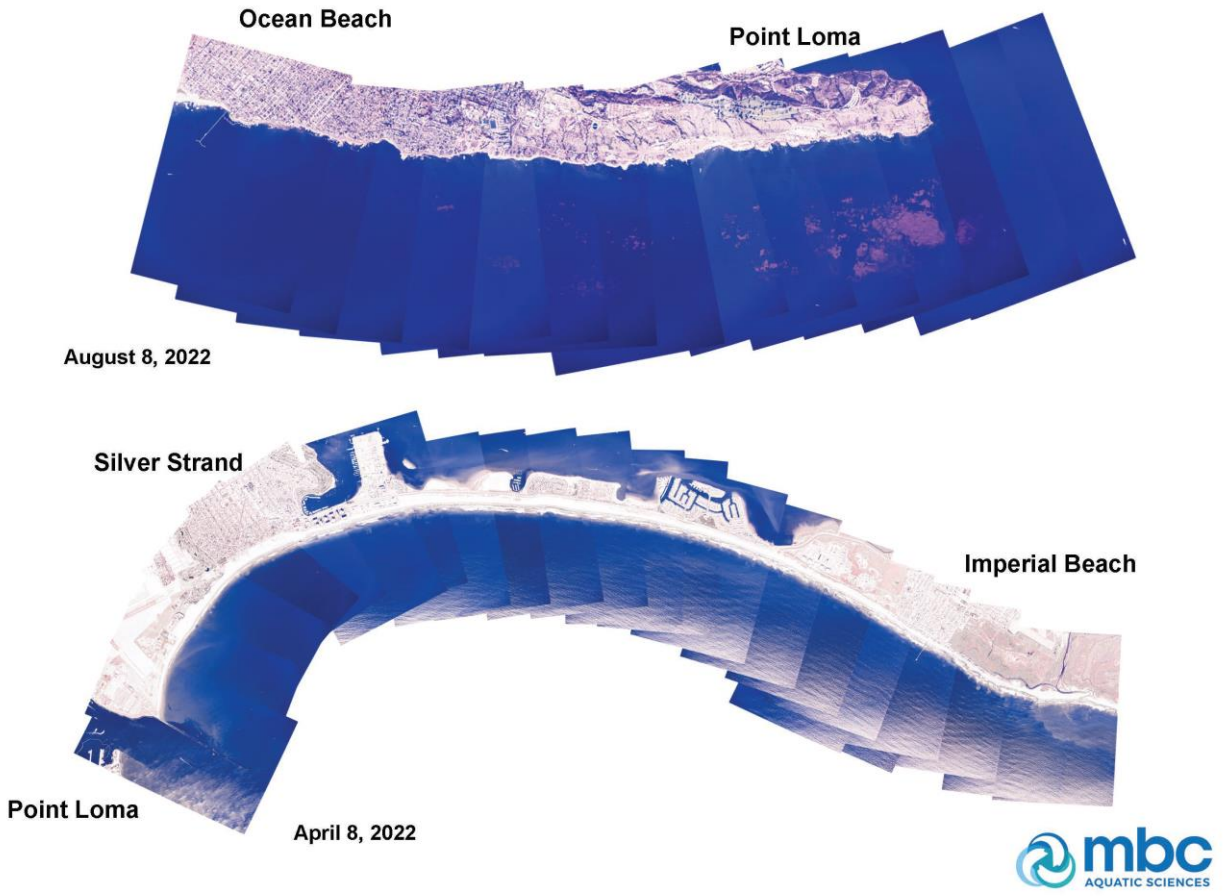
Photo D-6

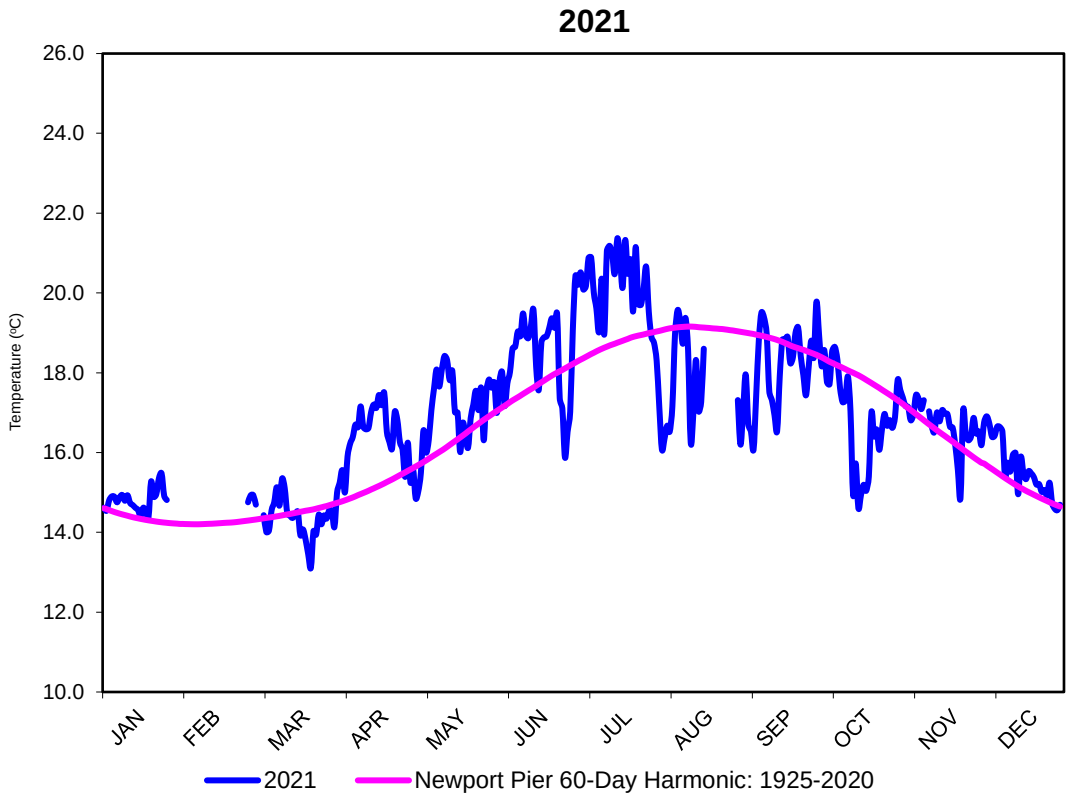


Appendix E.9

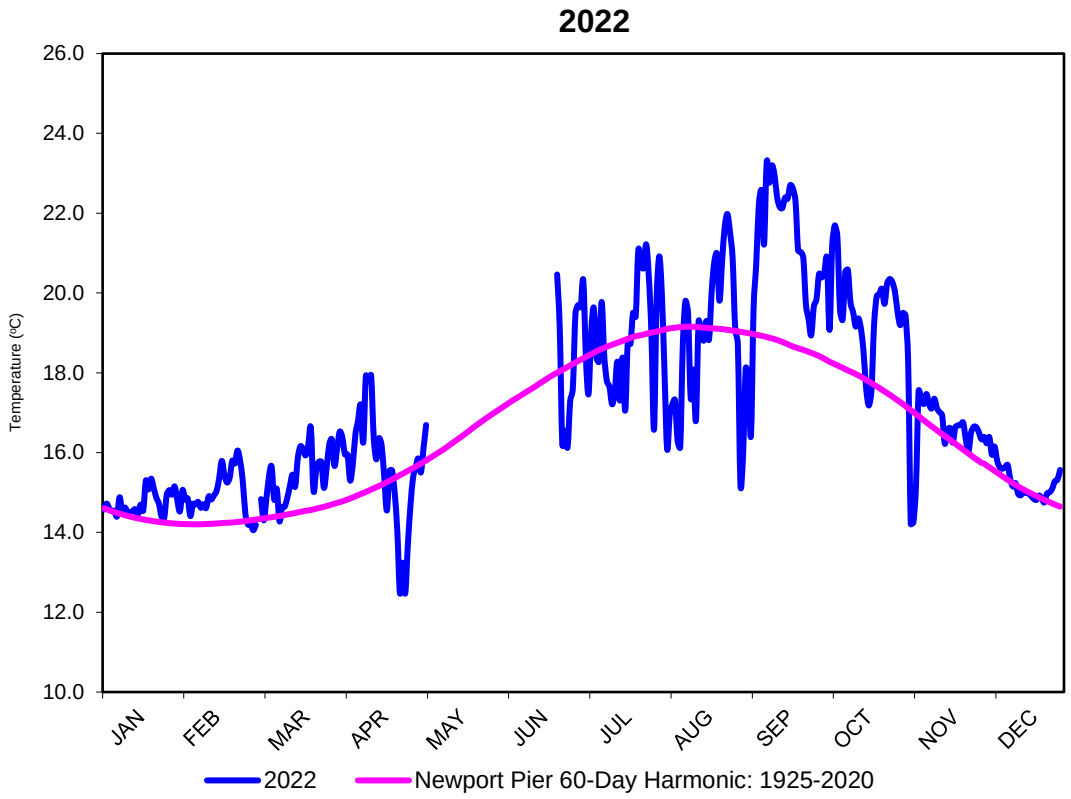
APPENDIX E

SEA SURFACE TEMPERATURES

Appendix E.1 Newport Pier

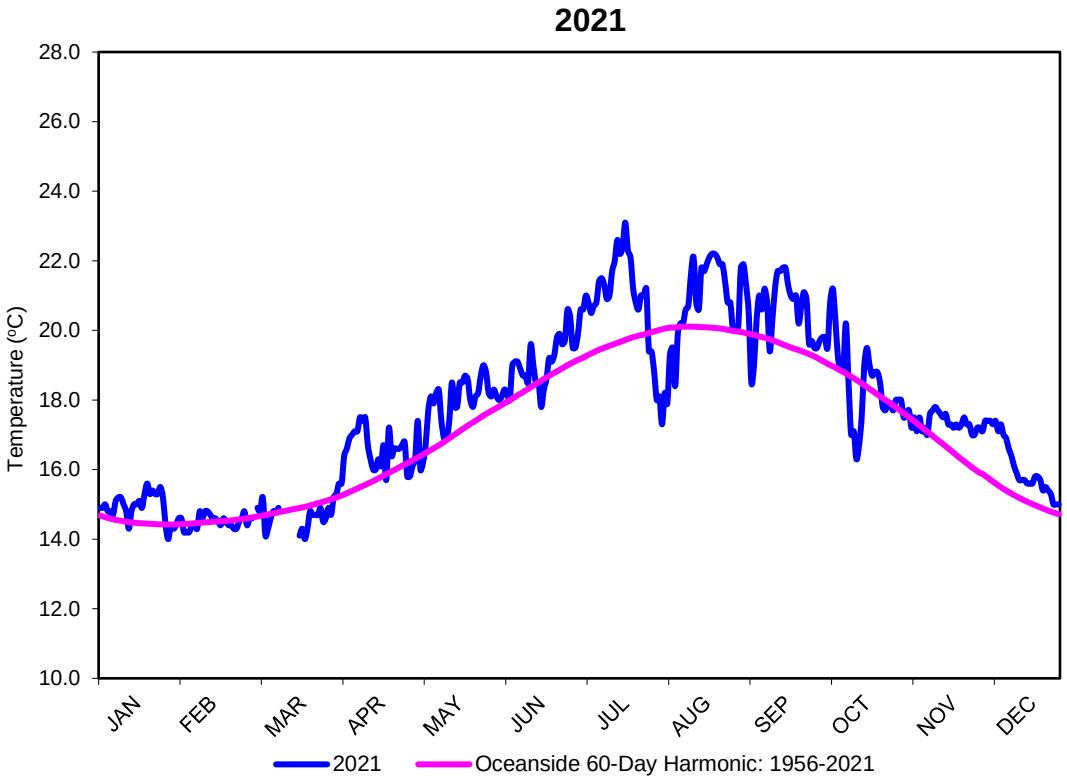


Daily Sea Surface Temperatures (SST) at Newport Pier for 2021.

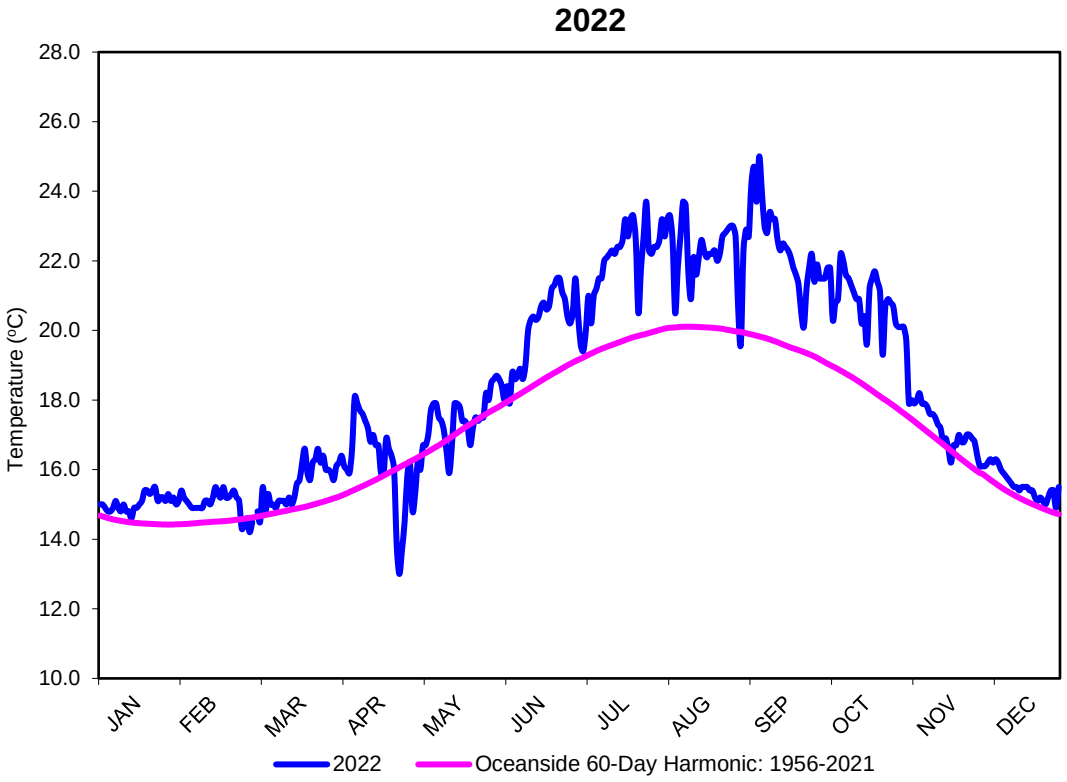


Daily Sea Surface Temperatures (SST) at Newport Pier for 2022.

Appendix E.2 Oceanside

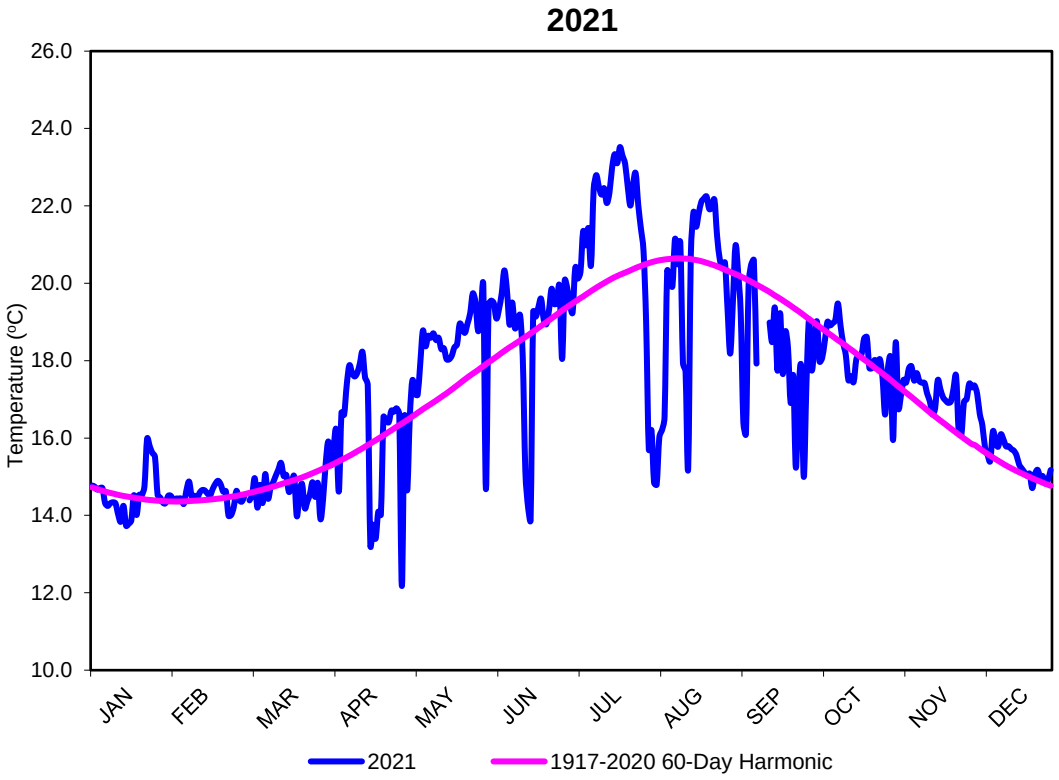


Daily Sea Surface Temperatures (SST) at Oceanside for 2021.



Daily Sea Surface Temperatures (SST) at Oceanside for 2022.

Appendix E.3 Scripps Pier



Daily Sea Surface Temperatures (SST) at Scripps Pier for 2021.

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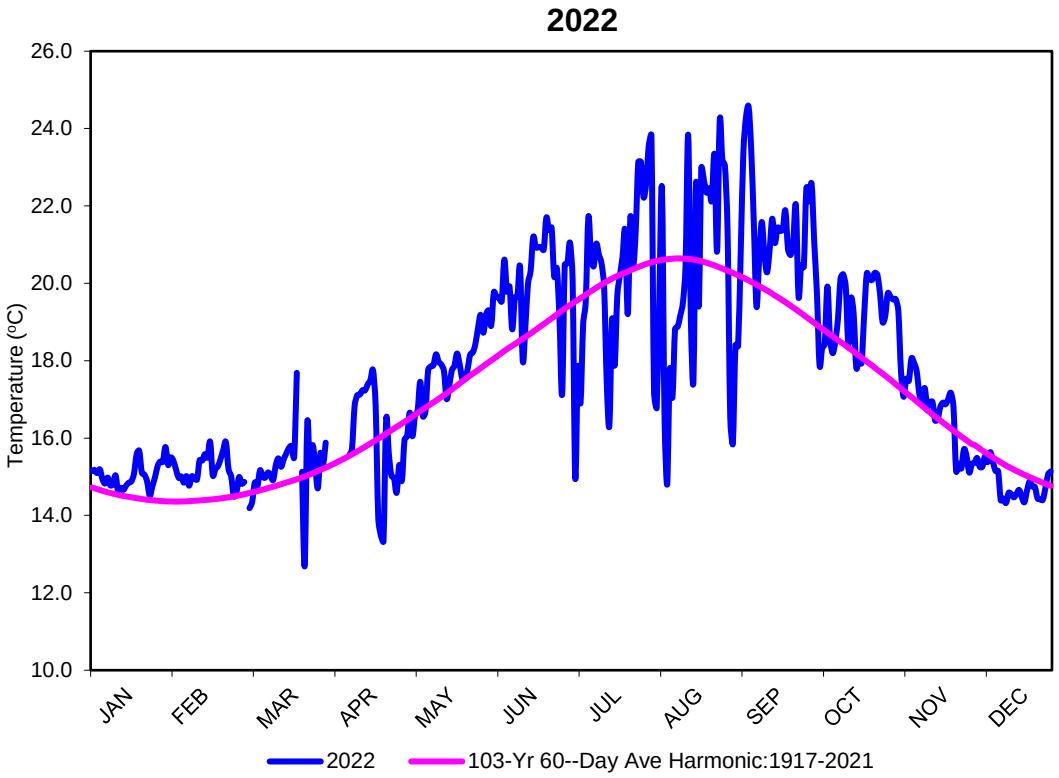

Daily Sea Surface Temperatures (SST) at Scripps Pier for 2022.

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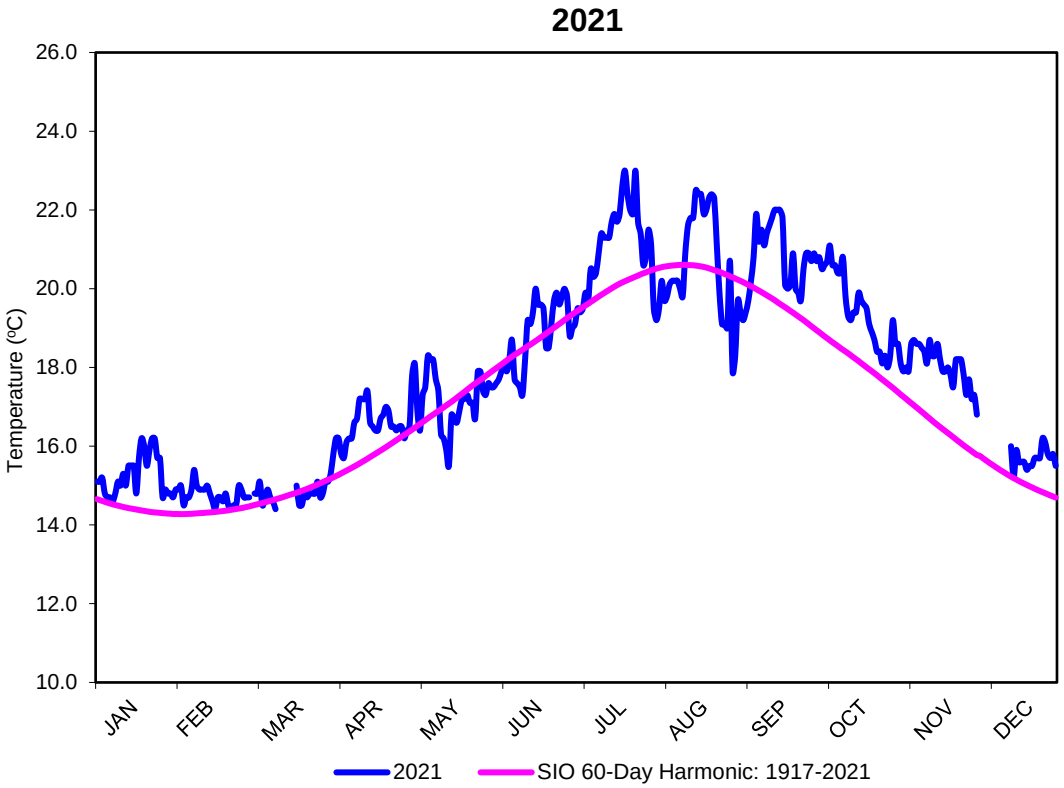
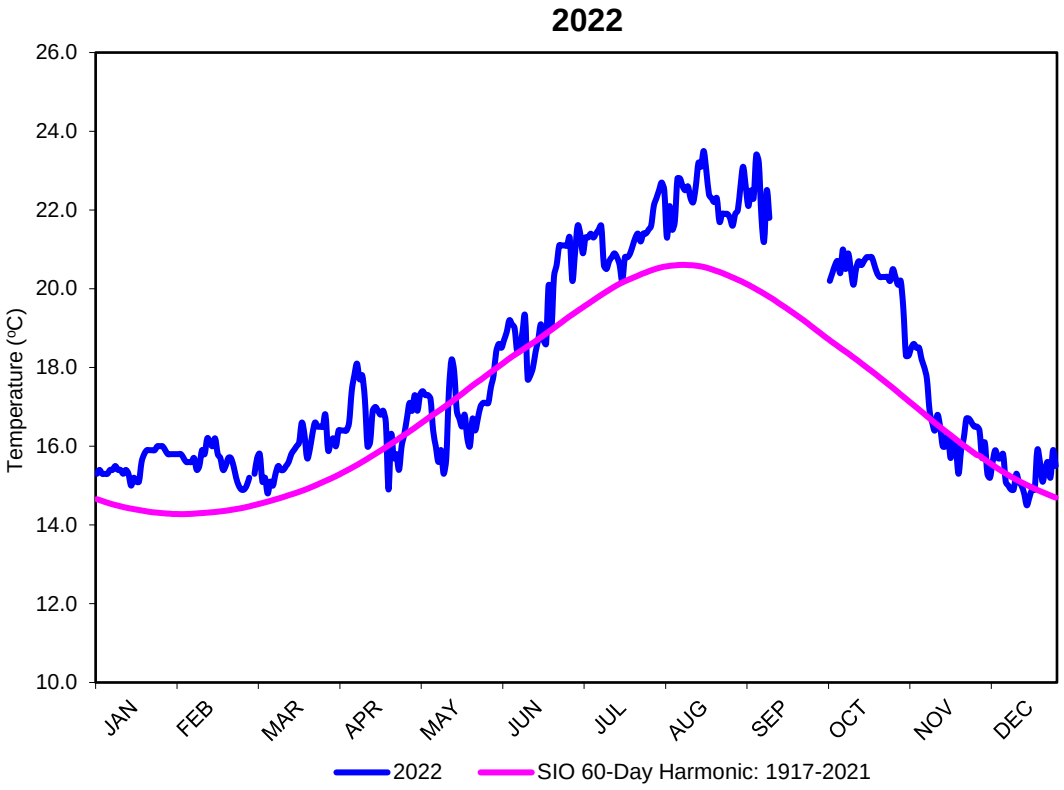
Appendix E.4 Point Loma



Daily Sea Surface Temperatures (SST) at Point Loma South for 2021.



Daily Sea Surface Temperatures (SST) at Point Loma South for 2022.