Status of the Kelp Beds in 2021: Orange and San Diego Counties

Prepared for the Region Nine Kelp Survey Consortium (RNKSC)

Prepared by MBC Aquatic Sciences

September 14, 2022

KELP DATA COLLECTION

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. In 2021, 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. Kelp bed overflights of Region Nine were conducted on March 28, 2021 (First Quarter), July 16-17, 2021 (Second Quarter), September 29, 2021 (Third Quarter) and January 2, 2022 (Fourth Quarter).

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 1). 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. The photo-mosaics were then transferred to a Geographic Information System (GIS; ArcGIS 10.3.1) to geo-reference them, and placed into specific California Department of Fish and Wildlife (CDFW) geo-spatial shape files. Surface canopy areas were calculated using the image classification function, an extension to the ArcGIS program.

Vessel surveys are conducted annually to observe all RNKSC kelp beds. The vessel surveys for the 2021 survey year were delayed due to adverse weather conditions during December 2021. They were conducted on February 1, 2022 from Imperial Beach to Oceanside, on February 17, 2022 from Barn Kelp to Salt Creek-Dana Point, and on March 10, 2022 from Corona del Mar to South Laguna. During the vessel surveys, biologists visually located each kelp bed by the main surface canopies present, or in the absence of surface kelp, relied upon latitude and longitude coordinates for canopies present during prior years. The presence of subsurface kelp was also recorded via visual observations from the vessel and fathometer readings. During the vessel

surveys, more detailed in-water surveys were conducted by biologist-divers at the Carlsbad, Encinitas, and Capistrano Beach kelp beds.

Four of the 25 designated kelp beds surveyed in Region Nine peaked during the first quarter, one kelp bed peaked during the third quarter, and seven kelp beds peaked during the fourth quarter of the 2021-2022 survey period (Table 1). In the northernmost portion of Region Nine (from Corona del Mar to San Mateo Point), seven of the eight designated kelp beds increased in size from 2020 to 2021 (Table 2). The San Clemente kelp bed was the only designated kelp bed in this area to decrease in size. Of the 17 remaining Region Nine kelp beds to the south (San Onofre to Imperial Beach), two kelp beds increased in size (including one that reappeared in 2021), while five kelp beds decreased in size (including three that disappeared in 2021) No surface canopy was observed in the 10 remaining kelp beds in 2020 or 2021.

Across the entire region, the total amount of surface kelp canopy in 2021 was lower than the 2020 level, and was the lowest total recorded since 2006 (Figure 1). Surface canopy was observed at 12 of the designated kelp beds in Region Nine in 2021 – surface canopy was greater than 15% of the historical maximum size at only four of these kelp beds (16.3% of maximum at North Laguna Beach, 28.3% of maximum at Barn Kelp, 15.2% of maximum at La Jolla, and 23.8% of maximum at Point Loma (Figure 2). Of the remaining eight kelp beds with visible surface canopy in 2021, the size of one was less than 10% of the historical maximum extent and the other seven were less than 5% of the historical maximum.

MONITORING QUESTIONS

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

1. What is the maximum areal extent of the coastal kelp bed canopies each year?
    - maximum total kelp canopy covered 2.986 km^2 in 2021.

2. What is the variability of the coastal kelp bed canopy over time?
    - maximum total kelp canopy decreased in size in 2021 by 24% (from 3.919 km^2 to 2.986 km^2);
    - nine kelp beds increased in size (by 12 to 1,100%), including five kelp beds that reappeared in 2021;
    - six kelp beds decreased in size (by 26 to 56%), including three kelp beds that disappeared in 2021.

3. Are coastal kelp beds disappearing? If yes, what are the factors that could contribute to the disappearance?
    - three kelp beds disappeared in 2021 (Horno Canyon, Leucadia, and Encinitas)
    - no kelp canopy was observed in 14 kelp beds in either 2020 or 2021, including 10 designated kelp beds and four non-designated kelp beds (Newport Harbor, Dana Harbor, Pendleton Reefs, and Oceanside Harbor).

- Sea surface water temperatures at Oceanside were higher than normal throughout most of 2021, although temperatures were relatively cold in February and March (Figure 3). Nutrient availability at Oceanside, based on Nutrient Quotient scores calculated from monthly average sea surface temperatures, was higher in January, February and March of 2021 than during these three months in 2020 (scores of 4 points each month in 2021 compared to 2 points in 2020) (Table 3). However, despite apparently favorable conditions for kelp during the early months of 2021, the relatively small kelp beds present at Horno Canyon, Leucadia and Encinitas kelp beds in 2020 (surface canopy areas of 0.003, 0.006, and 0.0003 km^2, respectively) disappeared for unknown reasons in 2021.

4. Are new kelp beds forming?
    - five kelp beds reappeared in 2021 (Corona del Mar, South Laguna, Capistrano Beach, San Mateo Point, and Solana Beach).
    - Sea surface water temperatures were lower than normal at Newport Pier in late February and throughout most of March 2021; however temperature data was not available for the last week of January or for most of February (Figure 4). Nutrient availability at Newport was higher in January, February and March of 2021 than during these three months in 2020 (scores of 4 points each month in 2021 compared to 2 points in 2020) (Table 3). These cool water temperatures and nutrient availability may have contributed to the reappearance of the Corona del Mar and Capistrano Beach kelp beds during the first quarter overflight on March 28, 2021. The South Laguna and San Mateo kelp beds reappeared during the fourth quarter overflight on January 2, 2022. Although sea surface water temperatures were higher than average during November and December 2021 at Newport Pier (Figure 4), cool water temperatures (14.6 to 15.5^oC) occurred during the second half of December and may have contributed to the reappearance of these two kelp beds, although nutrient availability was not very high (score of 2 points) in December 2021. The Solana Beach kelp bed also reappeared during the fourth quarter overflight. Although sea surface water temperatures were generally higher than average during November and December 2021 at Scripps Pier (Figure 5), cool water temperatures (14.7 to 15.7^oC) occurred during the second half of December and nutrient availability was higher in December 2021 than the previous year (score of 2 points in December 2021 versus 1 point in 2020) (Table 5), which may have contributed to the reappearance of this kelp bed.

Table 1. Rankings assigned to kelp beds from aerial photographs from 2021 Region Nine surveys between Newport Harbor and Imperial Beach.

Kelp Beds	2021 Surveys			
	March 28, 2021	July 16-17, 2021	September 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
Red highlight = survey utilized to quantify surface canopy area

Table 2. Comparison of canopy coverage of Region Nine kelp beds from Newport Harbor to Imperial Beach (kelp beds listed north to south) during 2020 and 2021.

Kelp Bed	2020 (km^2)	2021 (km^2)	Percentage Difference
Newport Harbor *	-	-	no change
Corona Del Mar	-	0.007	reappeared
North Laguna Beach	0.022	0.031	+41
South Laguna Beach	0.001	0.012	+1,100
South Laguna	-	0.005	reappeared
Salt Creek-Dana Point	0.005	0.017	+240
Dana Marina *	-	-	no change
Capistrano Beach	-	0.006	reappeared
San Clemente	0.009	0.004	-56
San Mateo Point	-	0.007	reappeared
San Onofre	-	-	no change
Pendleton Reefs *	-	-	no change
Horno Canyon	0.003	-	disappeared
Barn Kelp	0.234	0.262	+12
Santa Margarita	-	-	no change
Oceanside Harbor *	-	-	no change
North Carlsbad	-	-	no change
Agua Hedionda	-	-	no change
Encina Power Plant	-	-	no change
Carlsbad State Beach	-	-	no change
Leucadia (North, Central, South)	0.006	-	disappeared
Encinitas	0.0003	-	disappeared
Cardiff	-	-	no change
Solana Beach	-	0.006	reappeared
Del Mar	-	-	no change

Table 2 (continued)

Kelp Bed	2020 (km^2)	2021 (km^2)	Percentage Difference
Torrey Pines	-	-	no change
La Jolla	1.094	0.725	-34
Point Loma	2.545	1.882	-26
Imperial Beach	-	-	no change
TOTAL	**3.919**	**2.964**	**-24%**

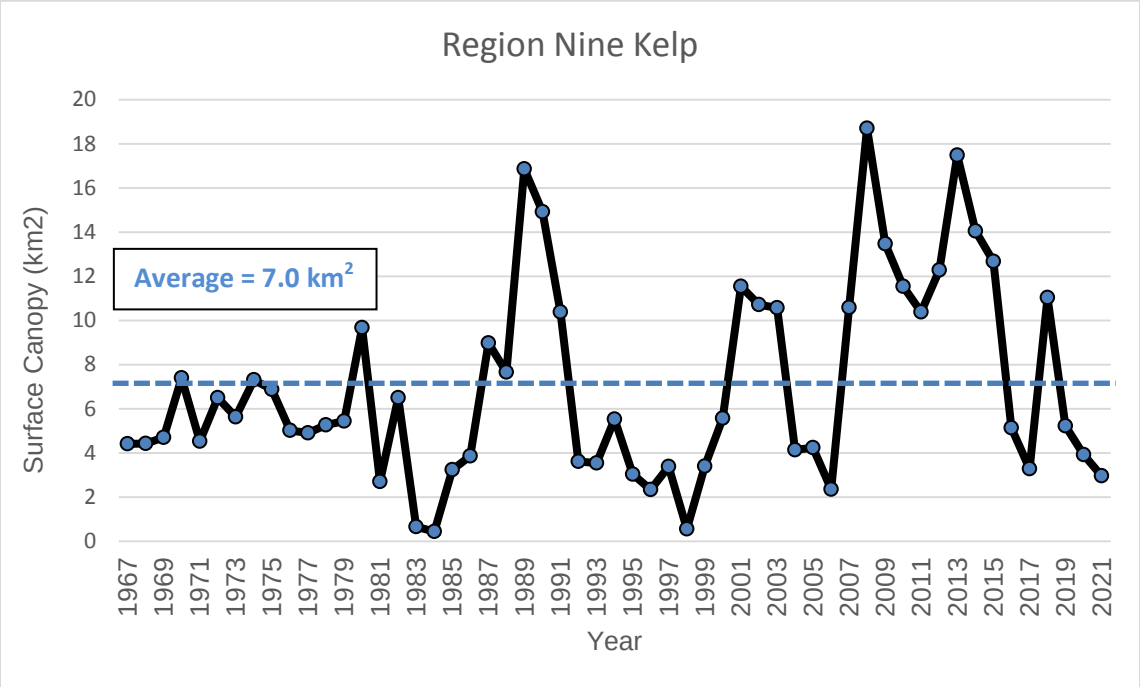


Figure 1. Combined canopy coverage of all kelp beds in Region Nine from Corona del Mar to Imperial Beach from 1967 to 2021. (Blue line=average total canopy area from 1967 through 2021)

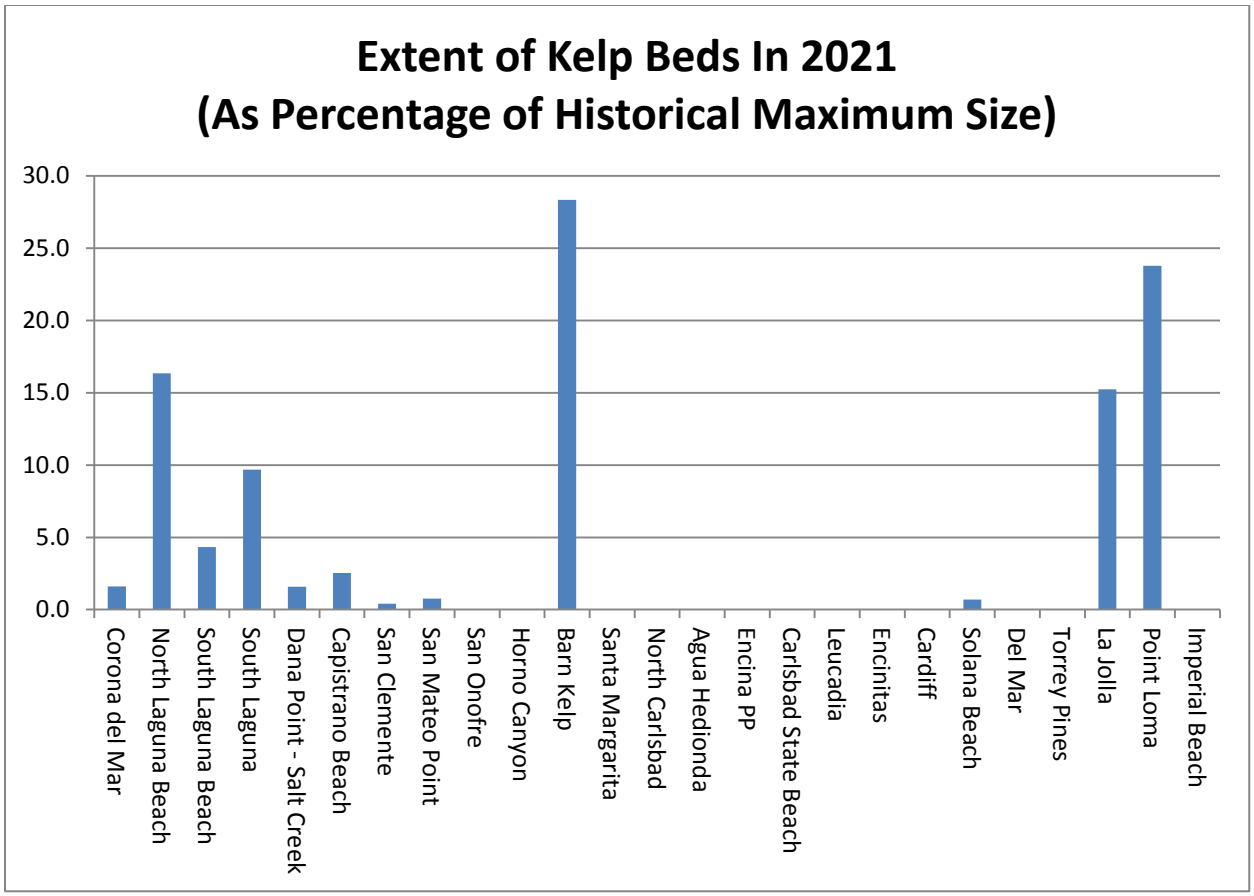


Figure 2. Extent of kelp bed canopy coverage in Region Nine from Corona del Mar to Imperial Beach in 2021 (as a percentage compared to the historical maximum size of each kelp bed).

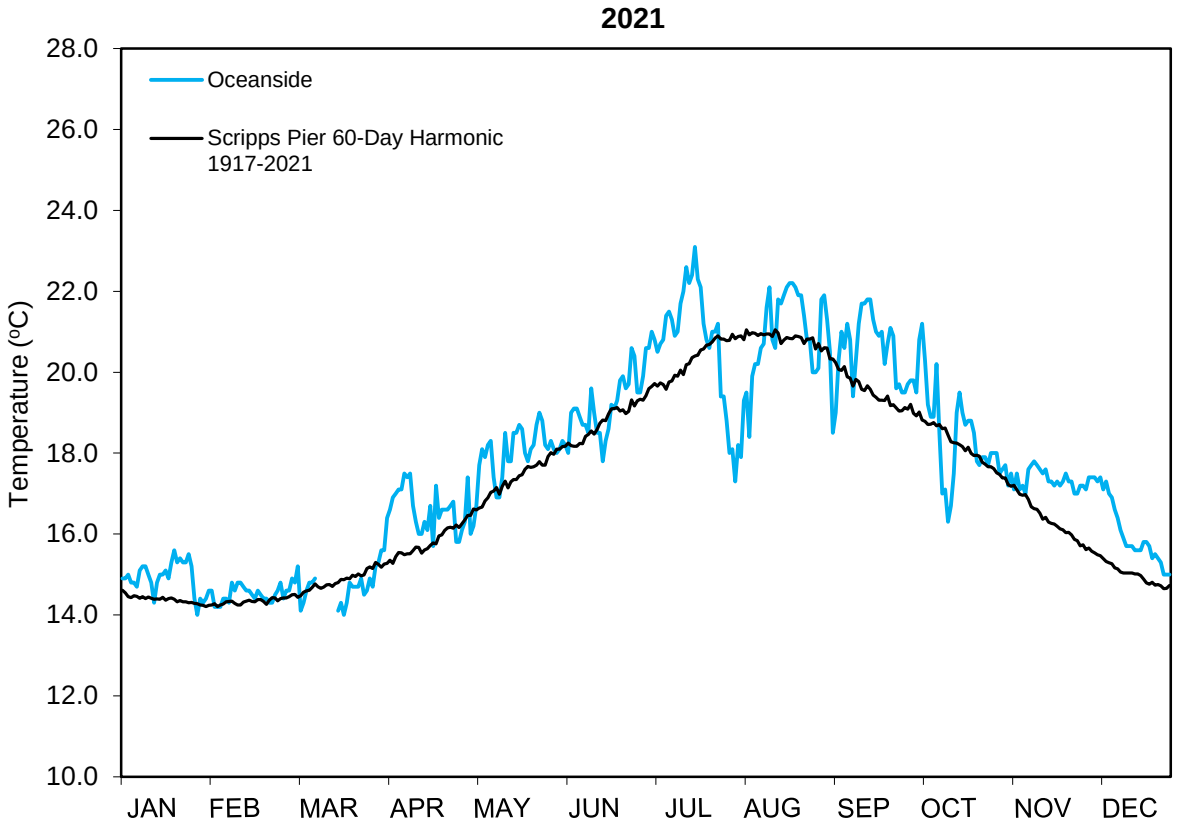


Figure 3. Sea surface temperatures at Oceanside in 2021 compared to the long-term (1917 to 2021) 60-day harmonic curve for Scripps Pier.

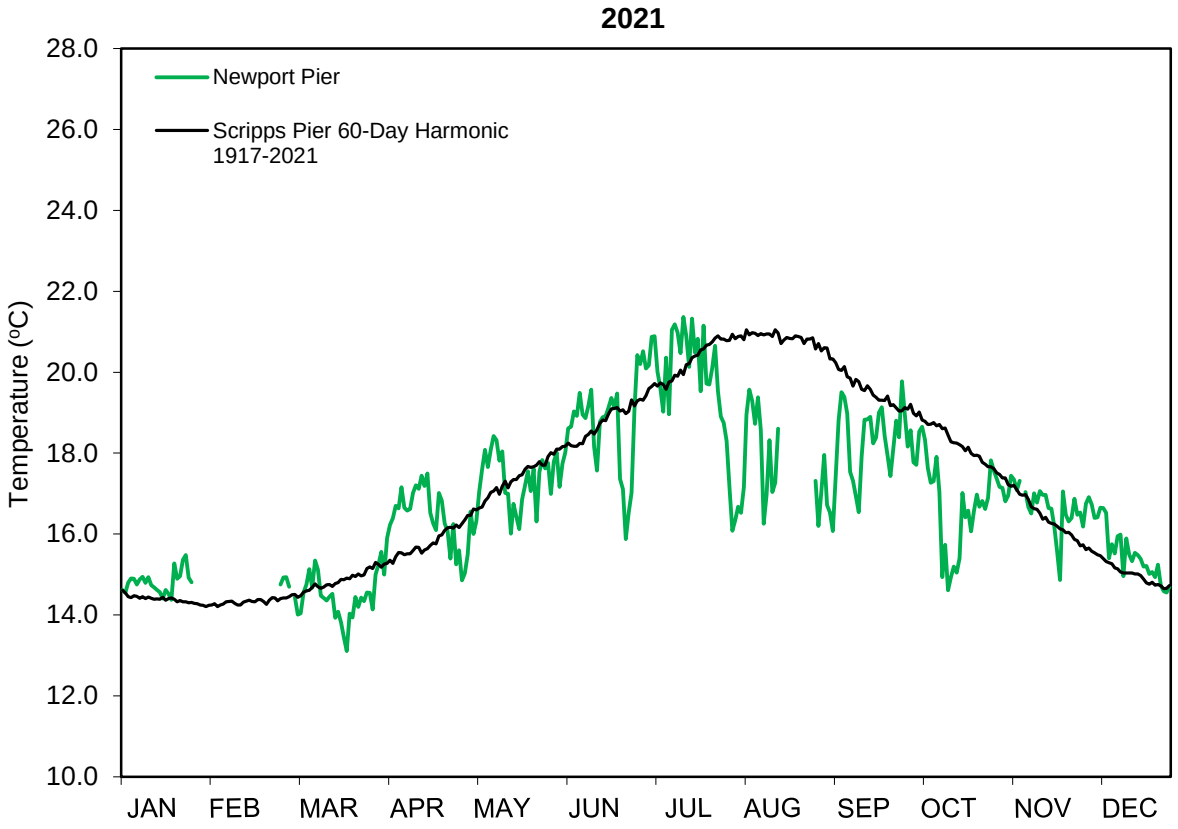


Figure 4. Sea surface temperatures at Newport Pier in 2021 compared to the long-term (1917 to 2021) 60-day harmonic curve for Scripps Pier.

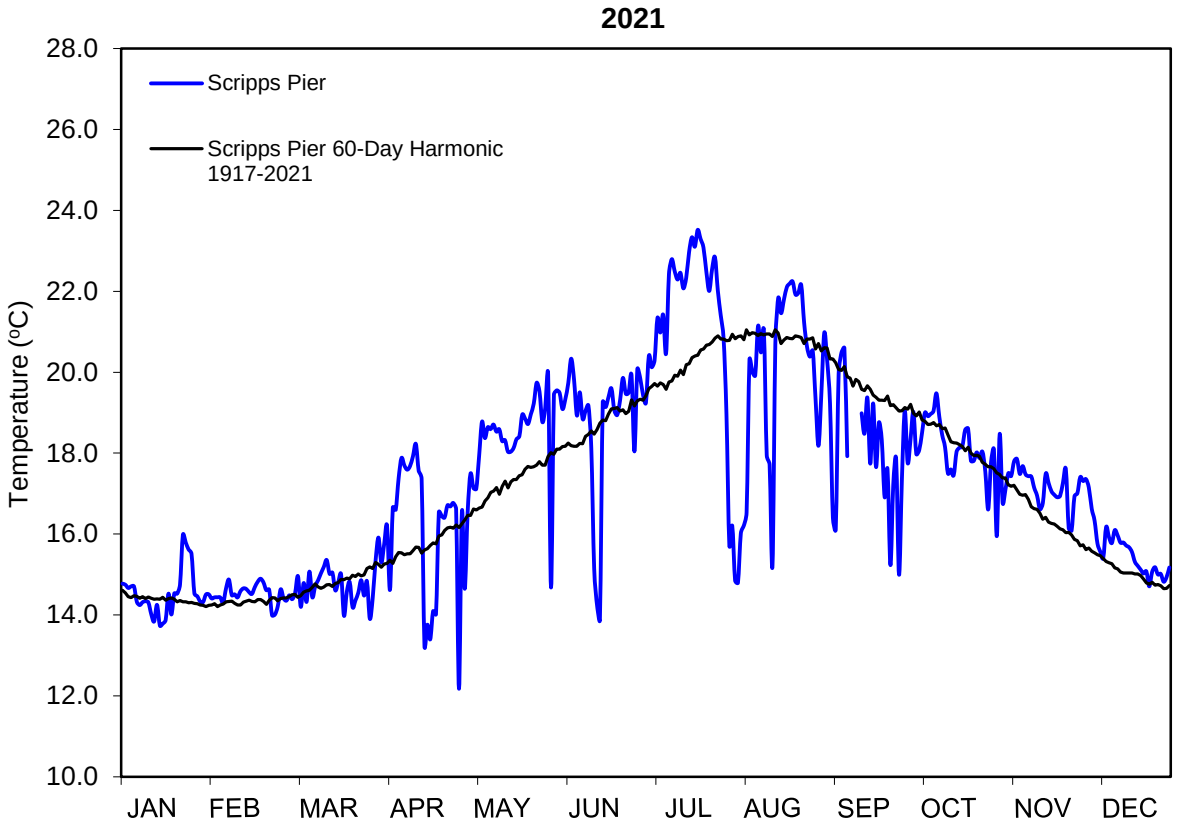


Figure 5. Sea surface temperatures at Scripps Pier in 2021 compared to the long-term (1917 to 2021) 60-day harmonic curve for Scripps Pier.

Table 3. Comparison of Nutrient Quotient Scores at Oceanside during 2020 and 2021.

Month	2020	2021
January	2 pts	4 pts
February	2 pts	4 pts
March	1 pt	4 pts
April	1 pt	1 pt
November		1 pt
December	1 pt	1 pt

Table 4. Comparison of Nutrient Quotient Scores at Newport Pier during 2020 and 2021.

Month	2020	2021
January	2 pts	4 pts
February	2 pts	4 pts
March	2 pts	4 pts
April	1 pt	1 pt
May		1 pt
October		1 pt
November	2 pts	1 pt
December	2 pts	2 pts

Table 5. Comparison of Nutrient Quotient Scores at Scripps Pier during 2020 and 2021.

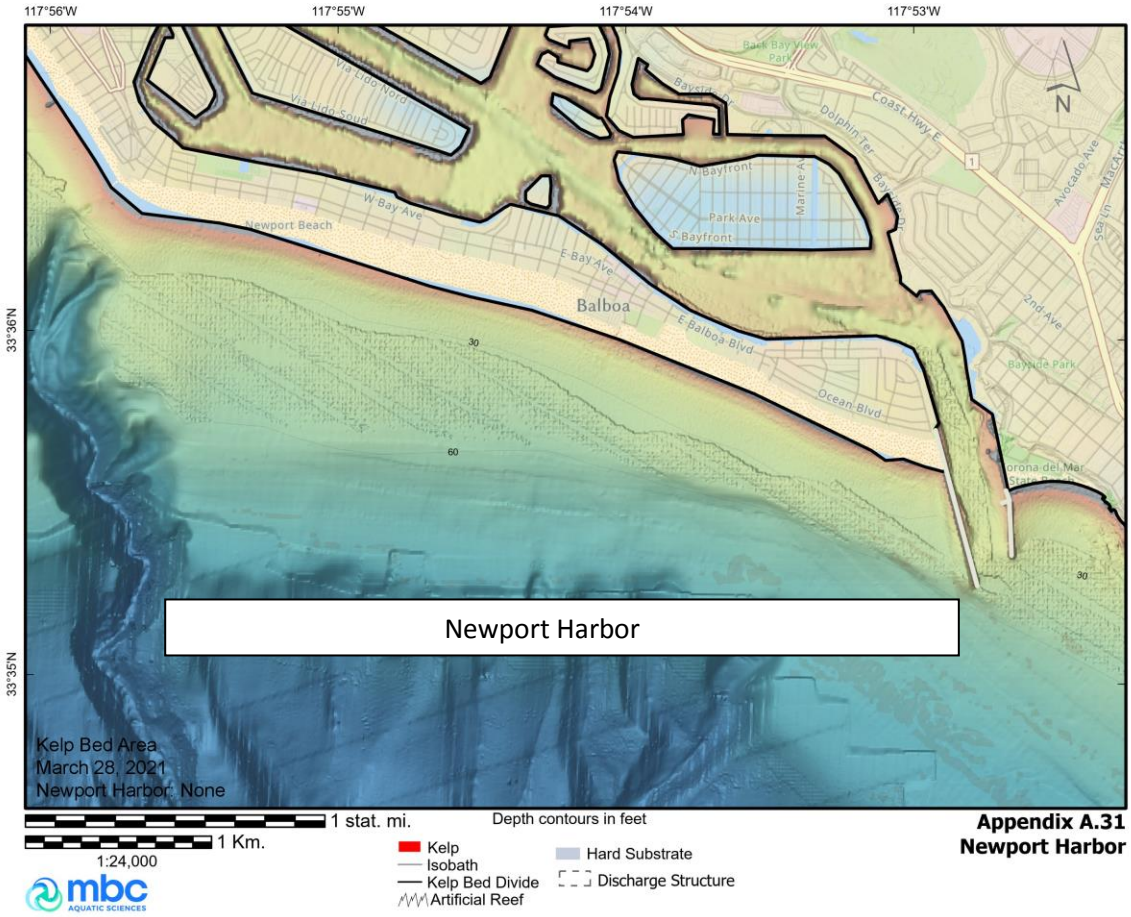
Month	2020	2021
January	2 pts	4 pts
February	2 pts	4 pts
March	1 pt	4 pts
April		1 pt
December	1 pt	2 pts

Appendix 1.

Aerial Photographs of Kelp Beds in Region Nine in 2021

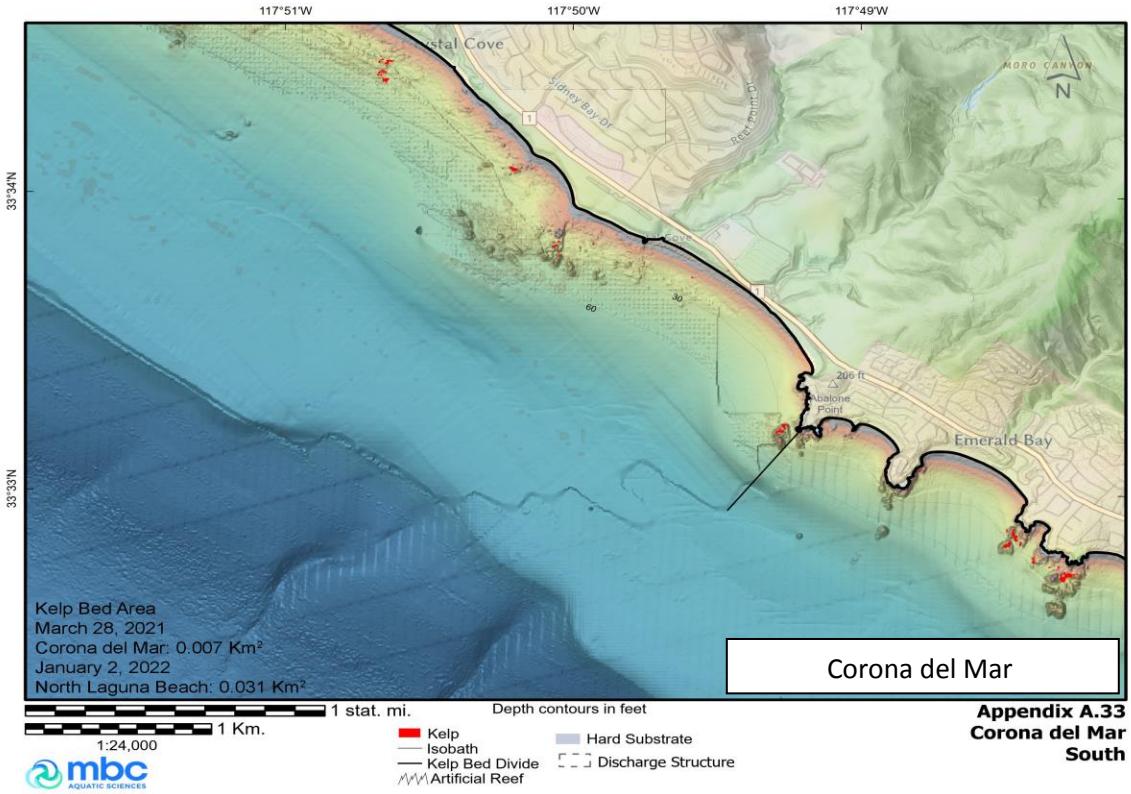
(photographs provided for kelp beds with visible surface canopy in 2021 and for the quarter with the maximum surface canopy for the year)

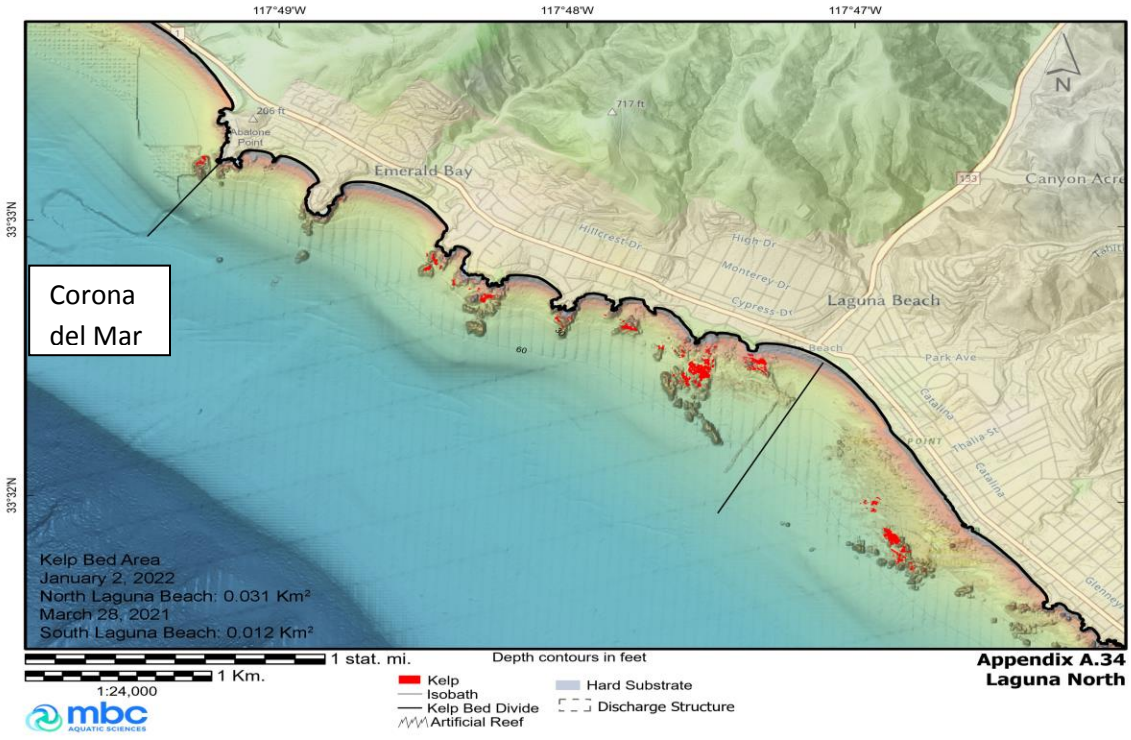
1) **Newport Harbor (not a designated kelp bed)**



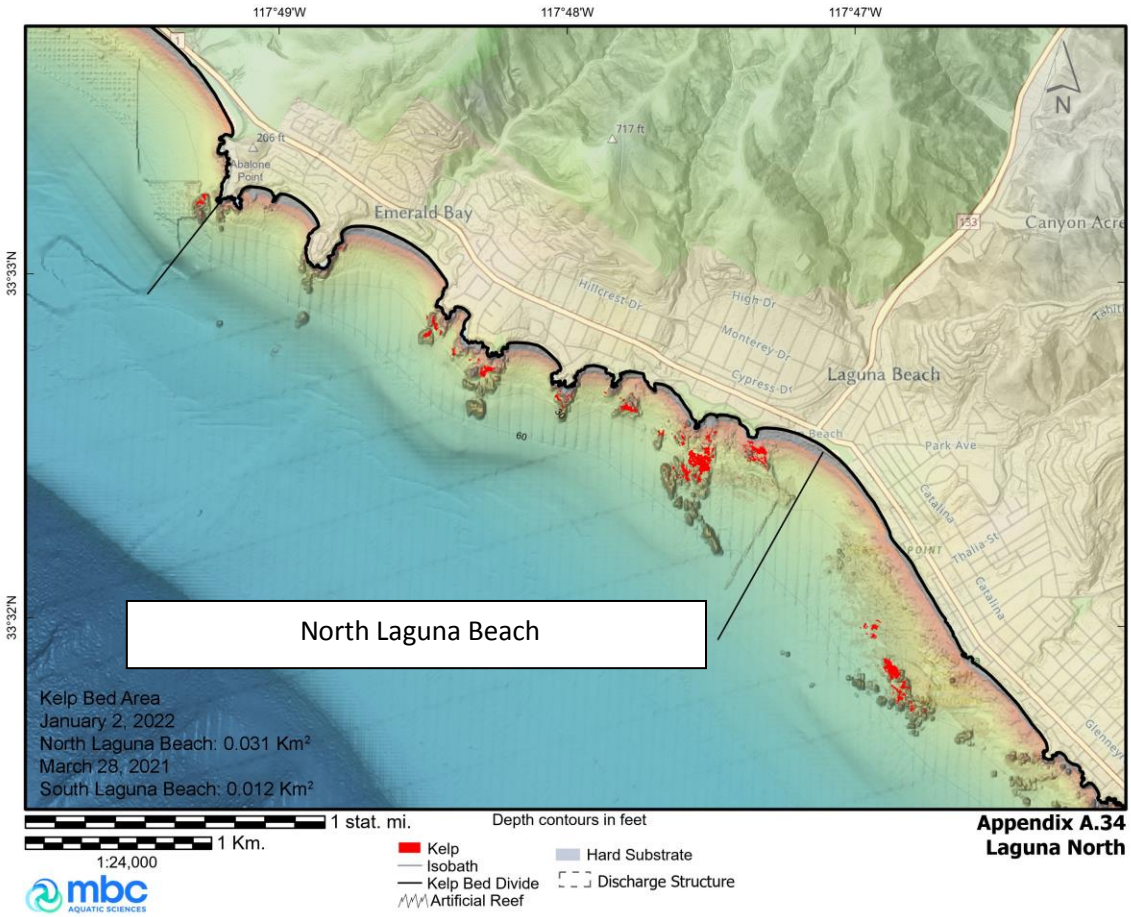
Appendix A.31
Newport Harbor

2) Corona del Mar



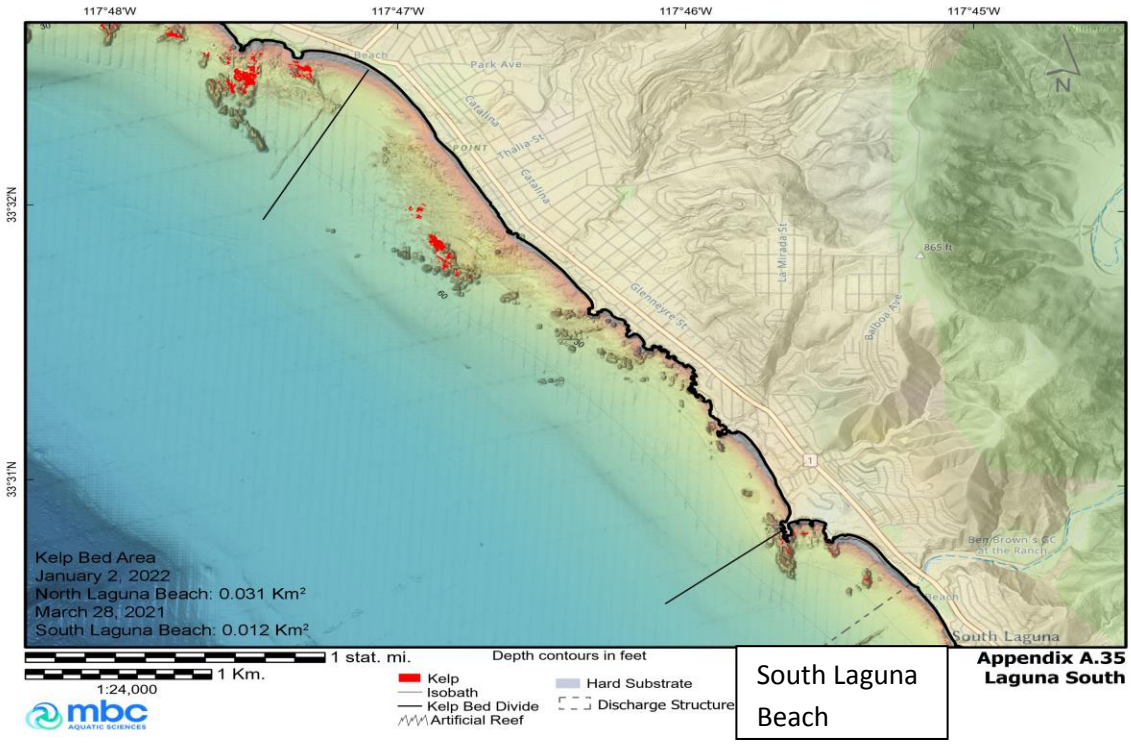


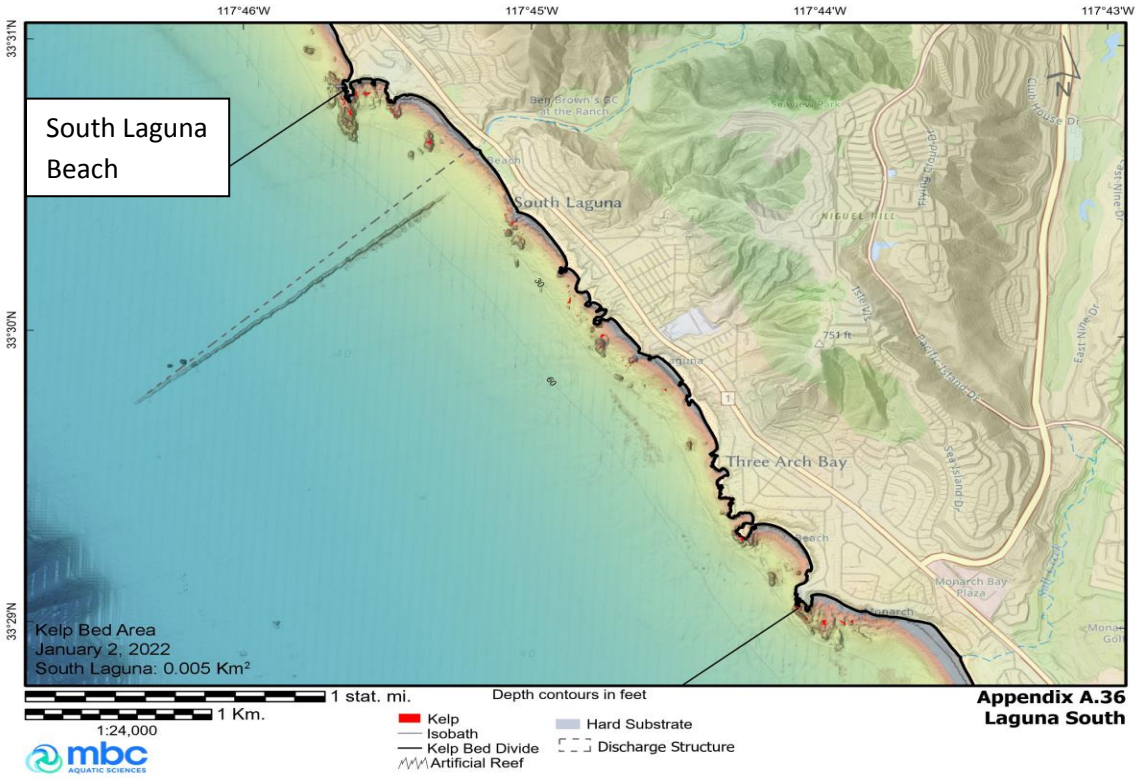
3) North Laguna Beach



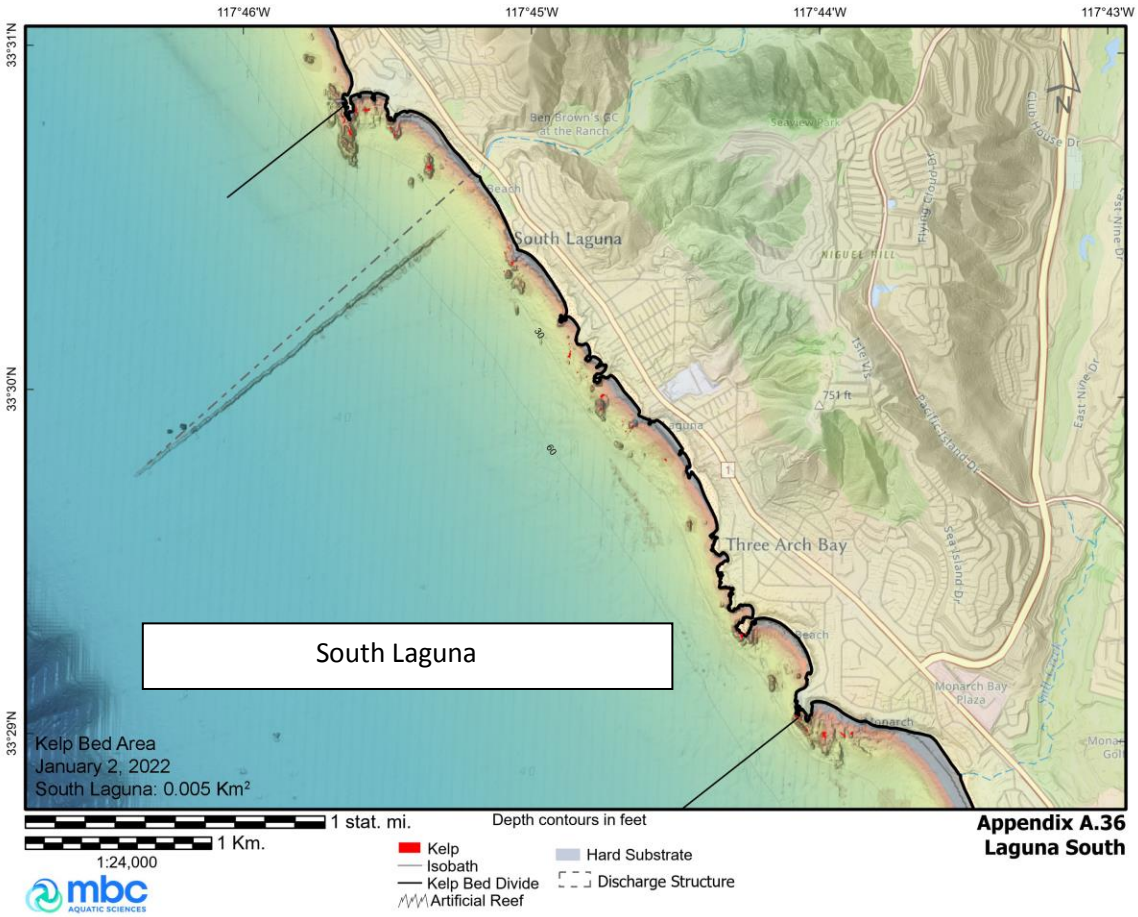
Appendix A.34
Laguna North

4) South Laguna Beach

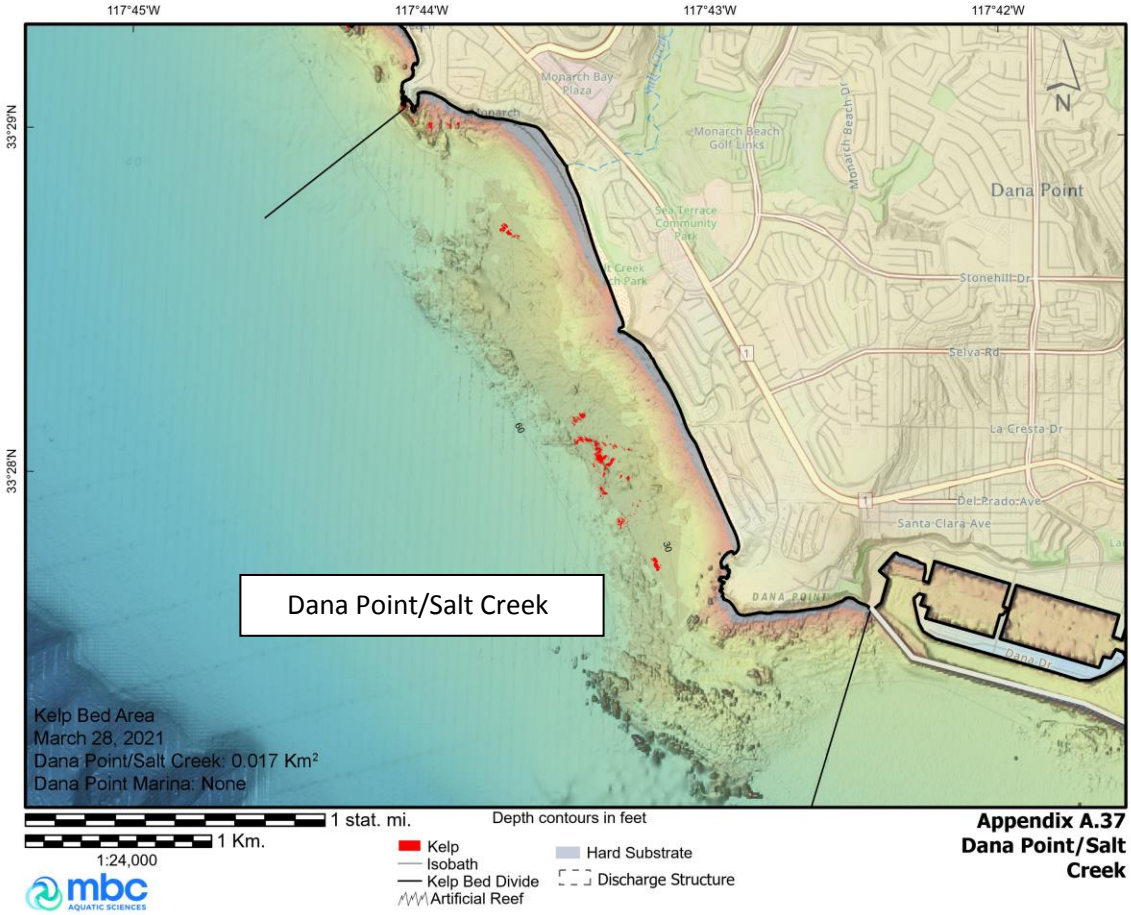




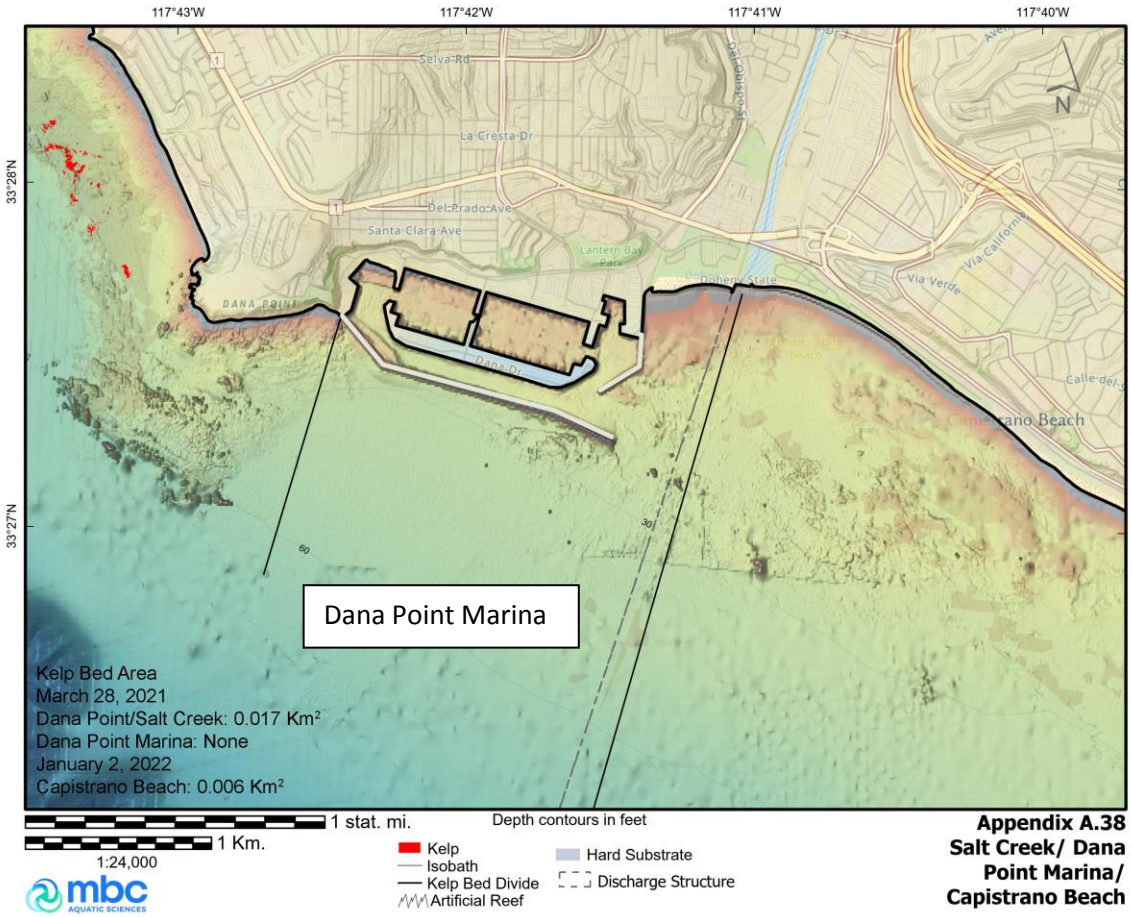
5) South Laguna



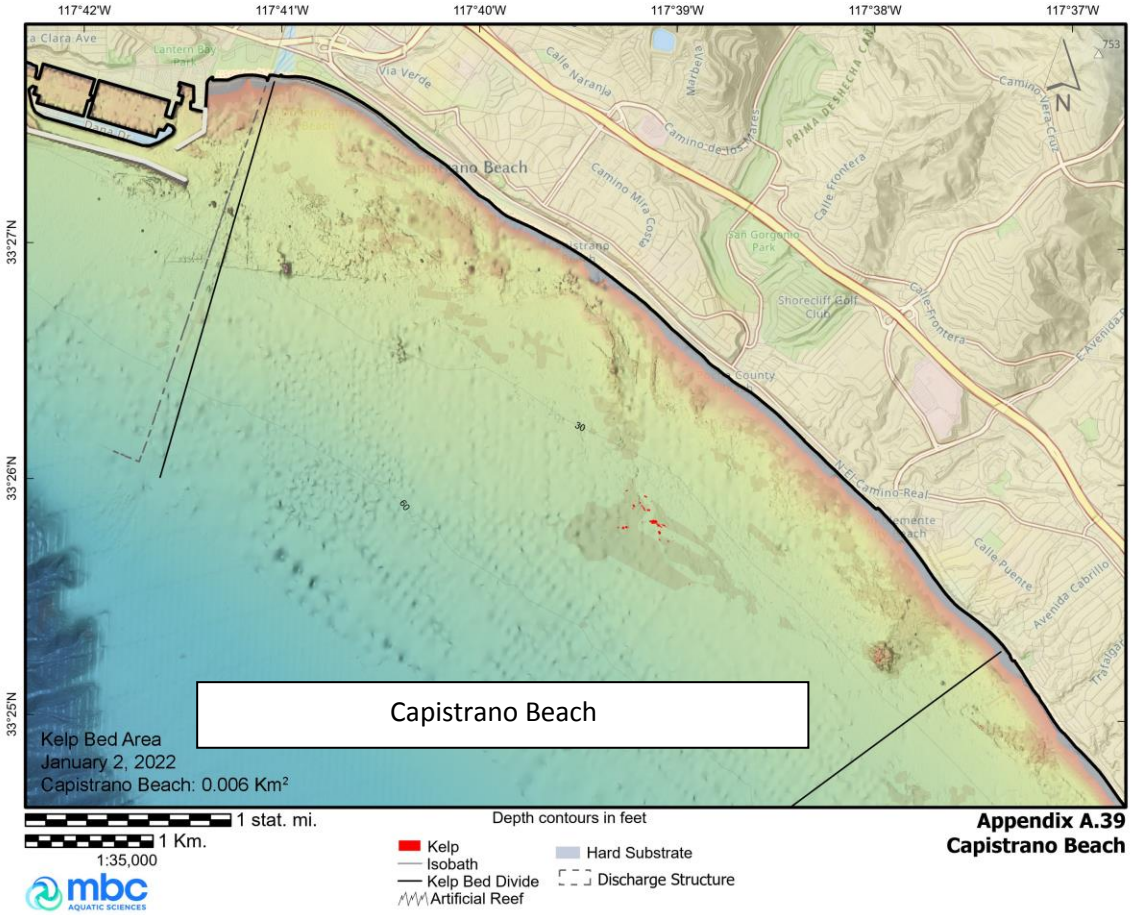
6) Dana Point-Salt Creek



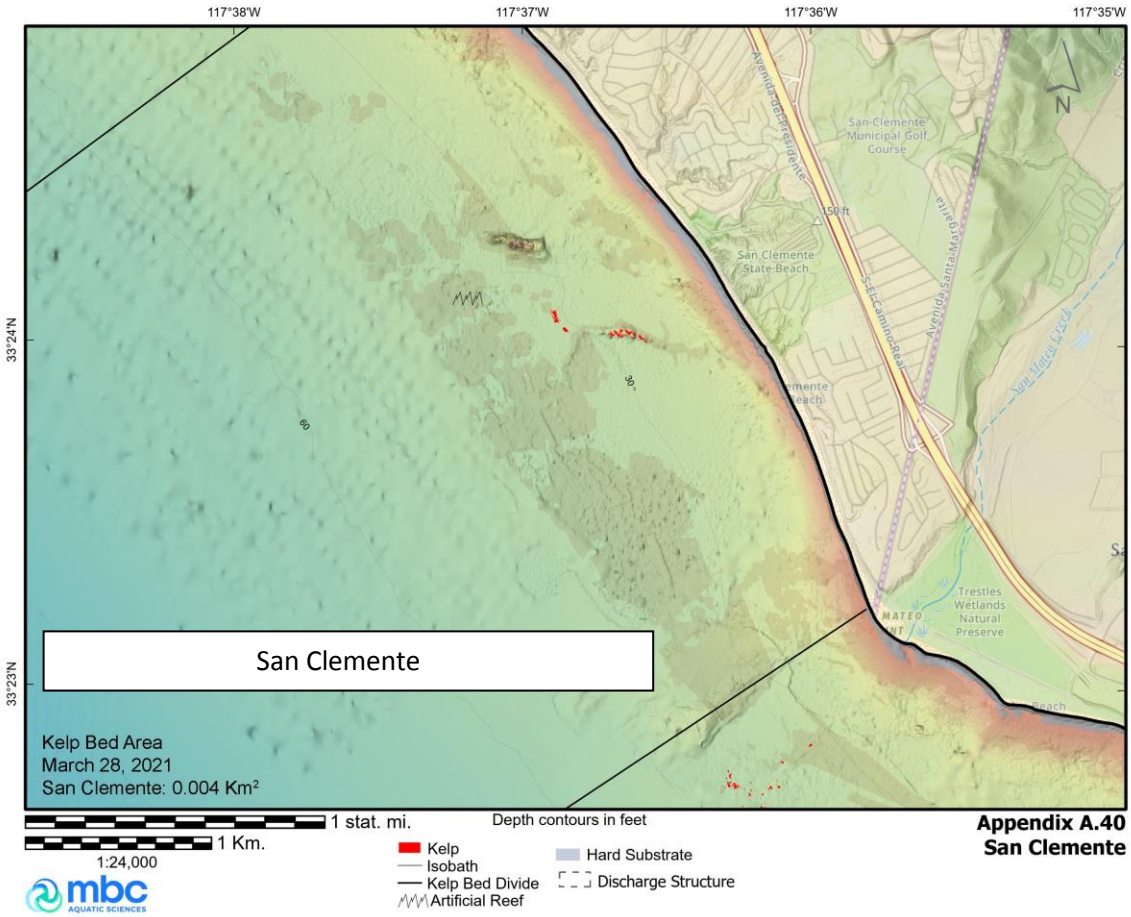
7) Dana Point Marina (not a designated kelp bed)



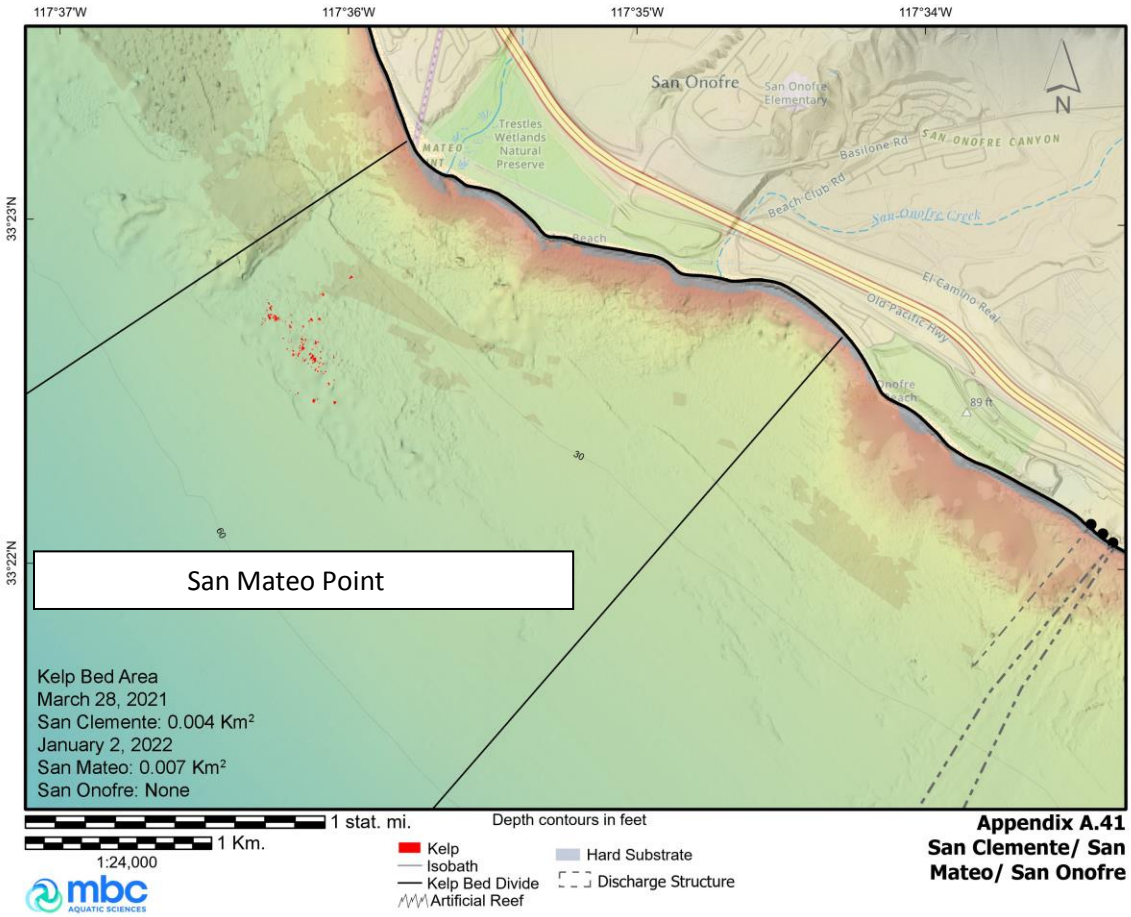
8) Capistrano Beach



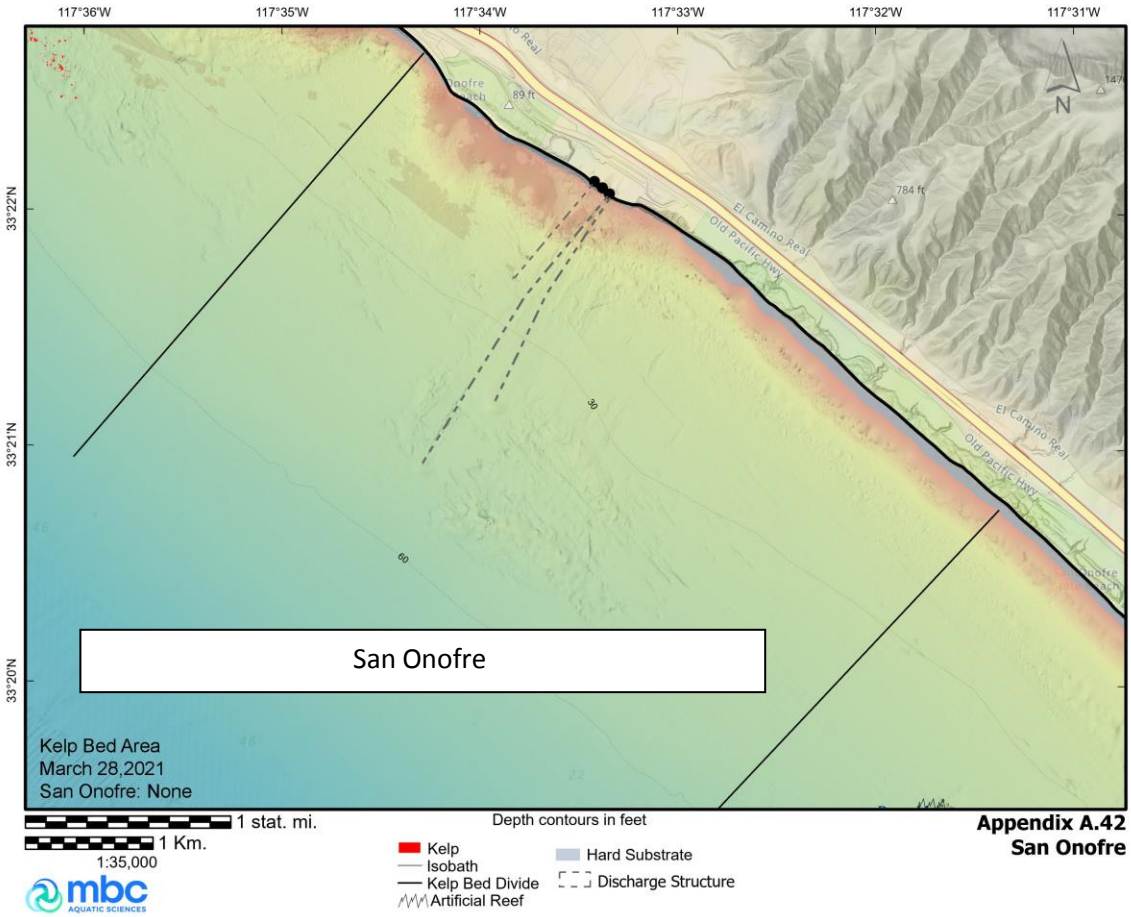
9) San Clemente



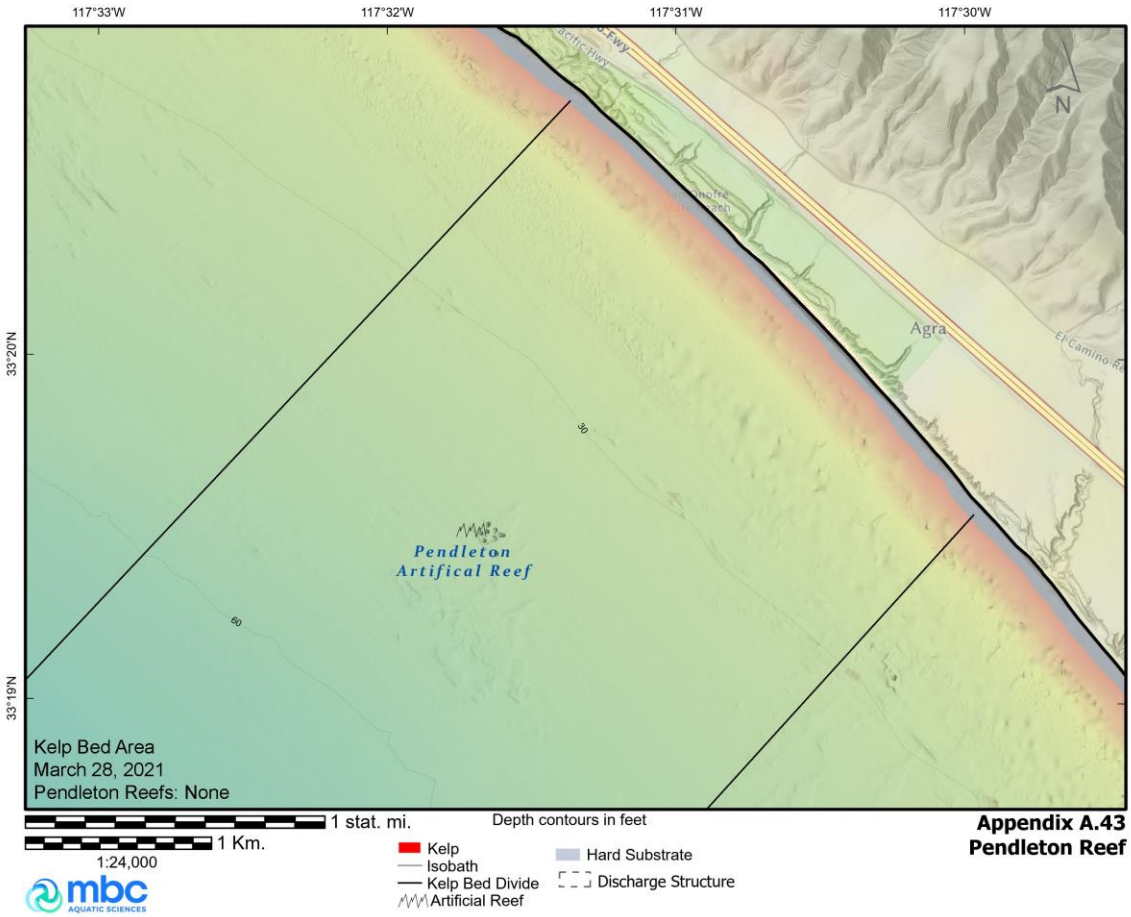
10) San Mateo Point



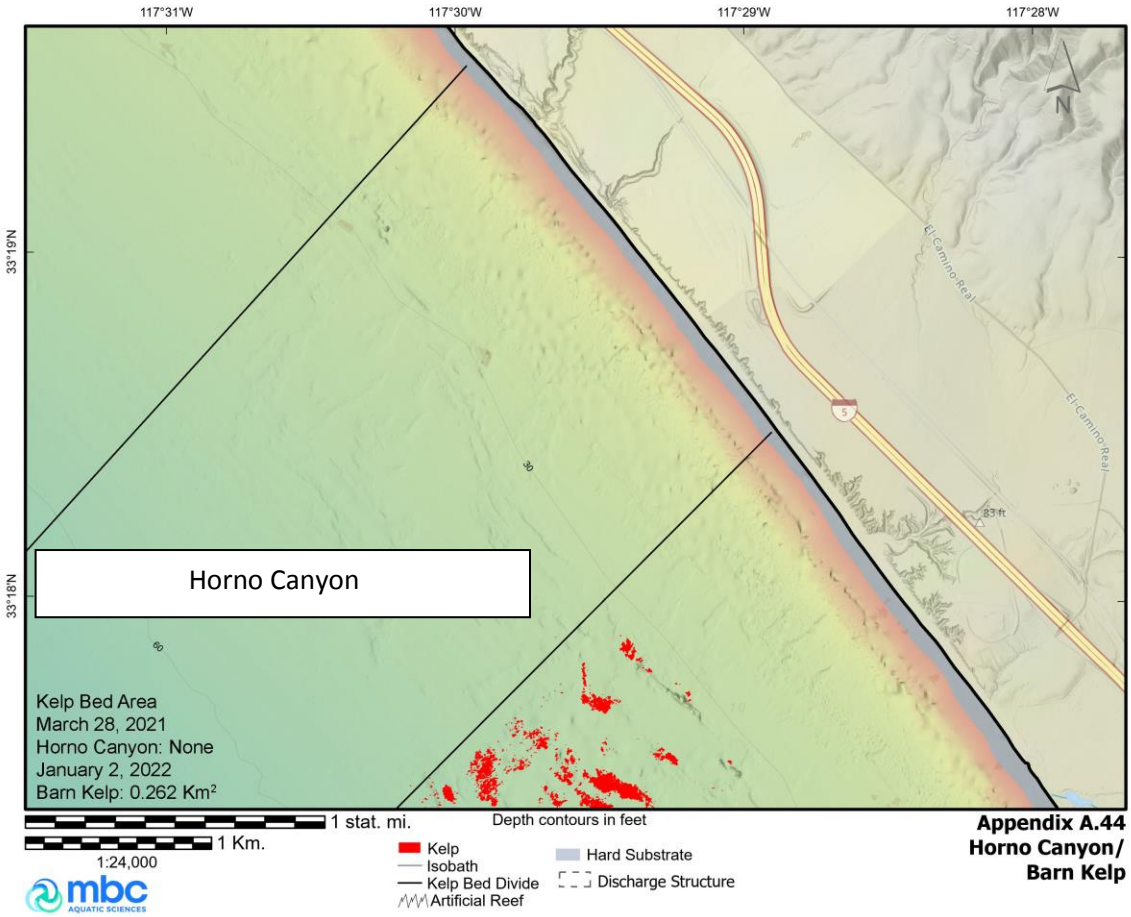
11) San Onofre



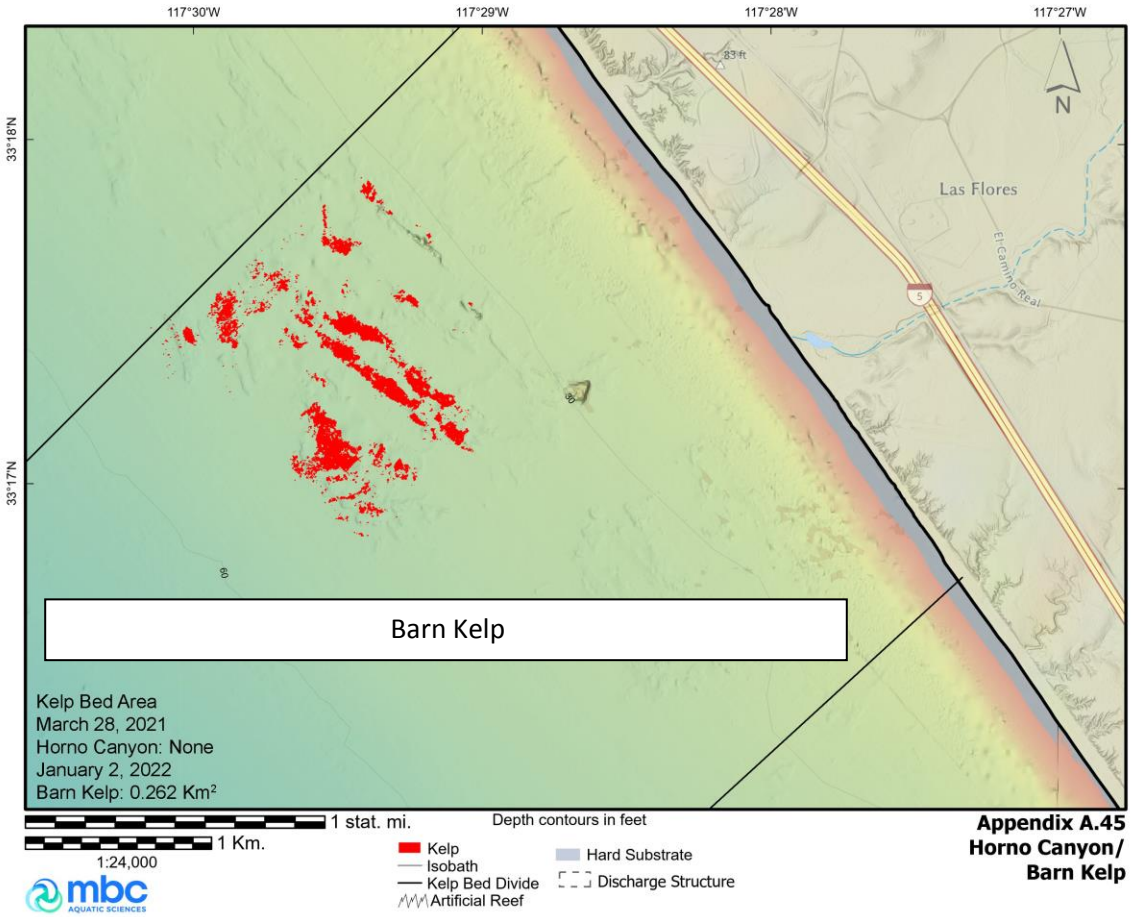
12) Pendleton Reefs (not a designated kelp bed)



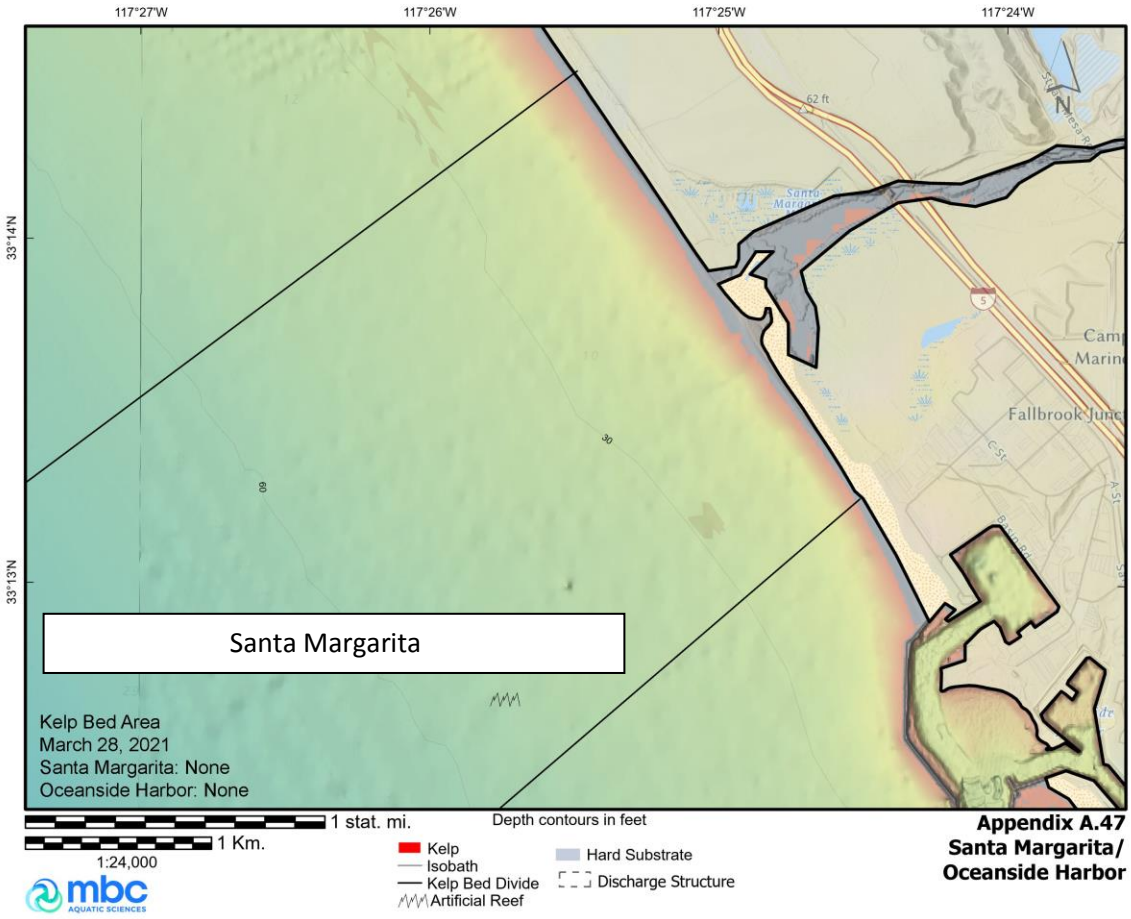
13) Horno Canyon



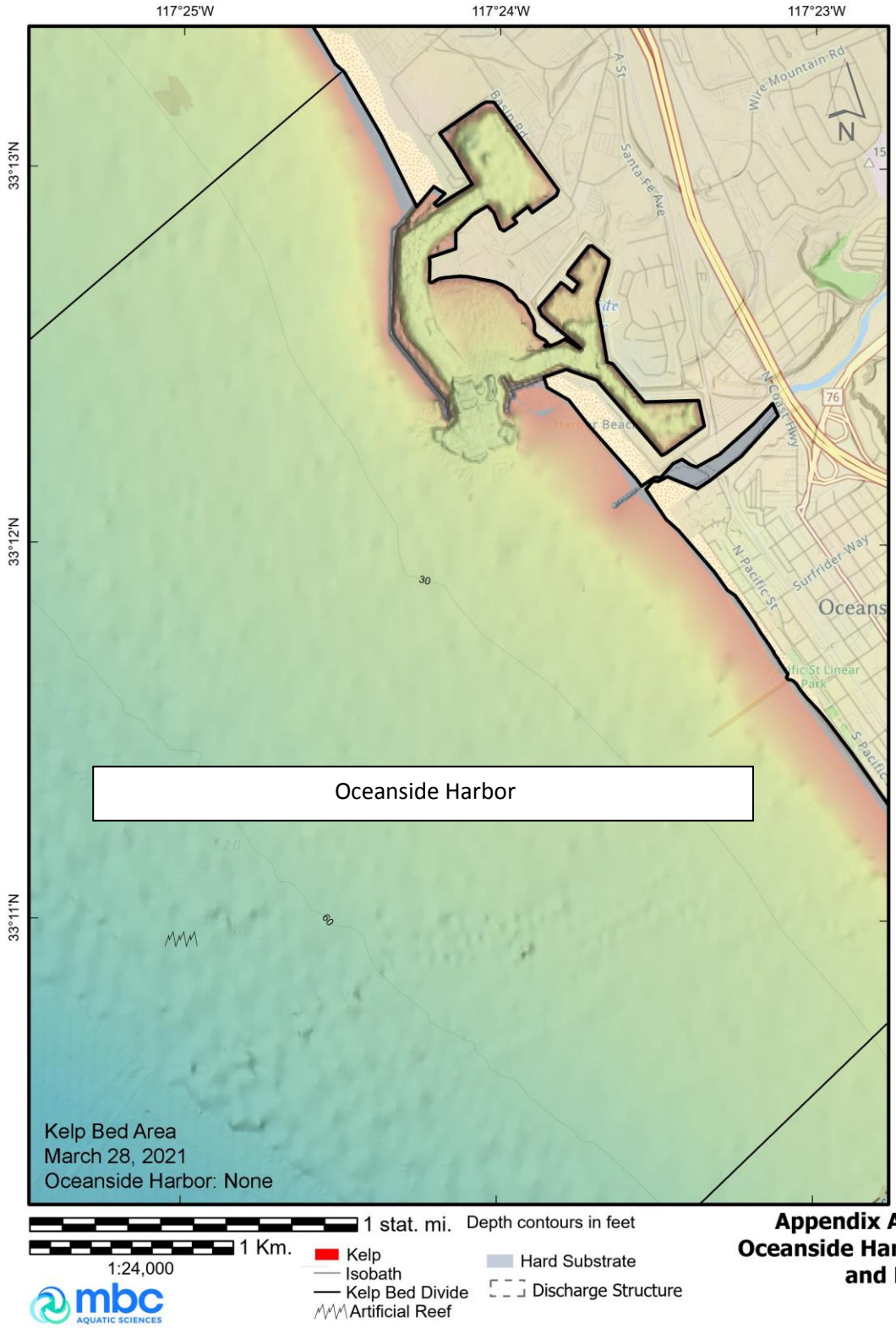
14) Barn Kelp


117°30'W
117°29'W
117°28'W
117°27'W
33°18'N
33°17'N
83 ft
N
Las Flores
El Camino Real
5
60
60
Barn Kelp
Kelp Bed Area
March 28, 2021
Horno Canyon: None
January 2, 2022
Barn Kelp: 0.262 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.45
Horno Canyon/
Barn Kelp

15) Santa Margarita

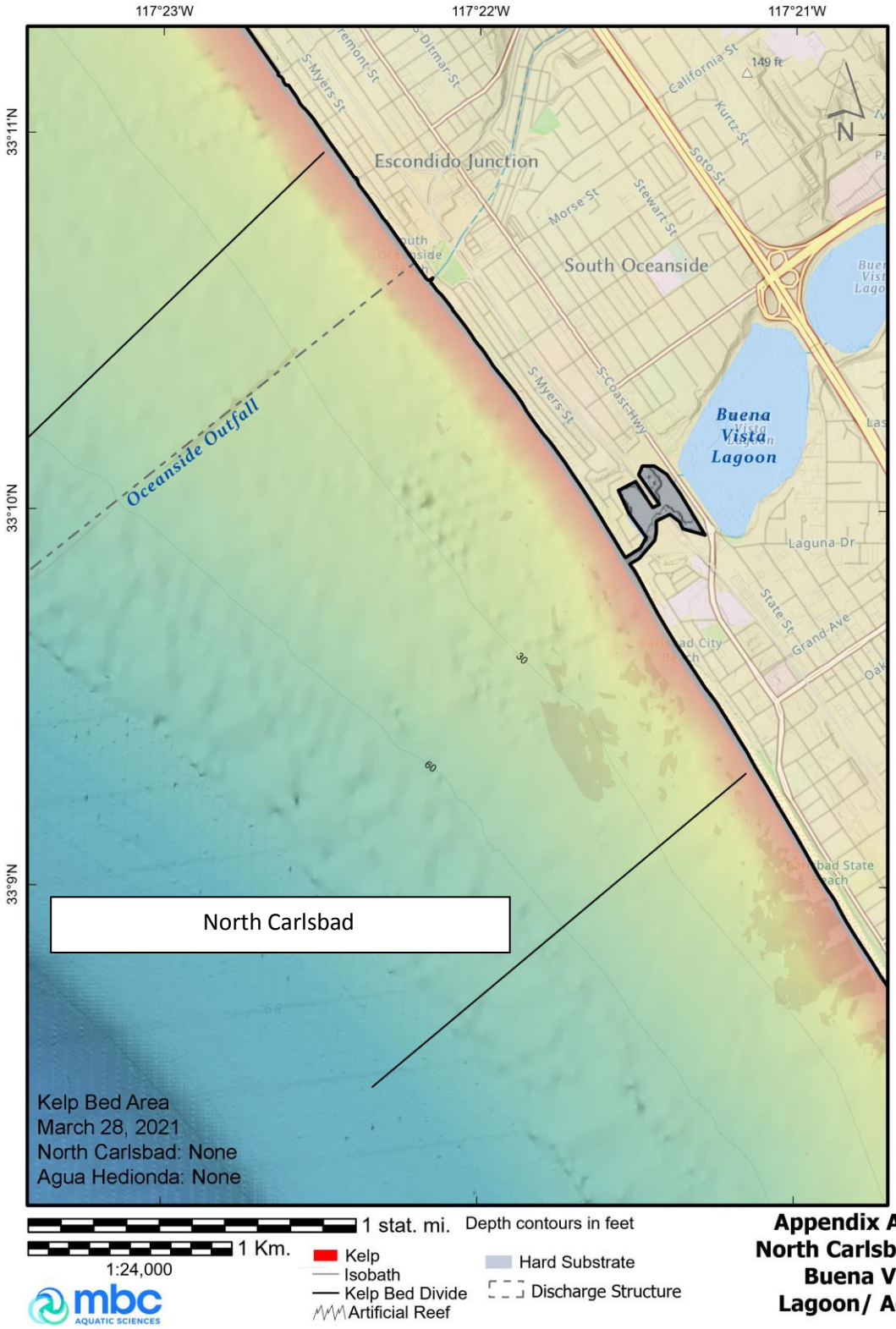


16) Oceanside Harbor (not a designated kelp bed)



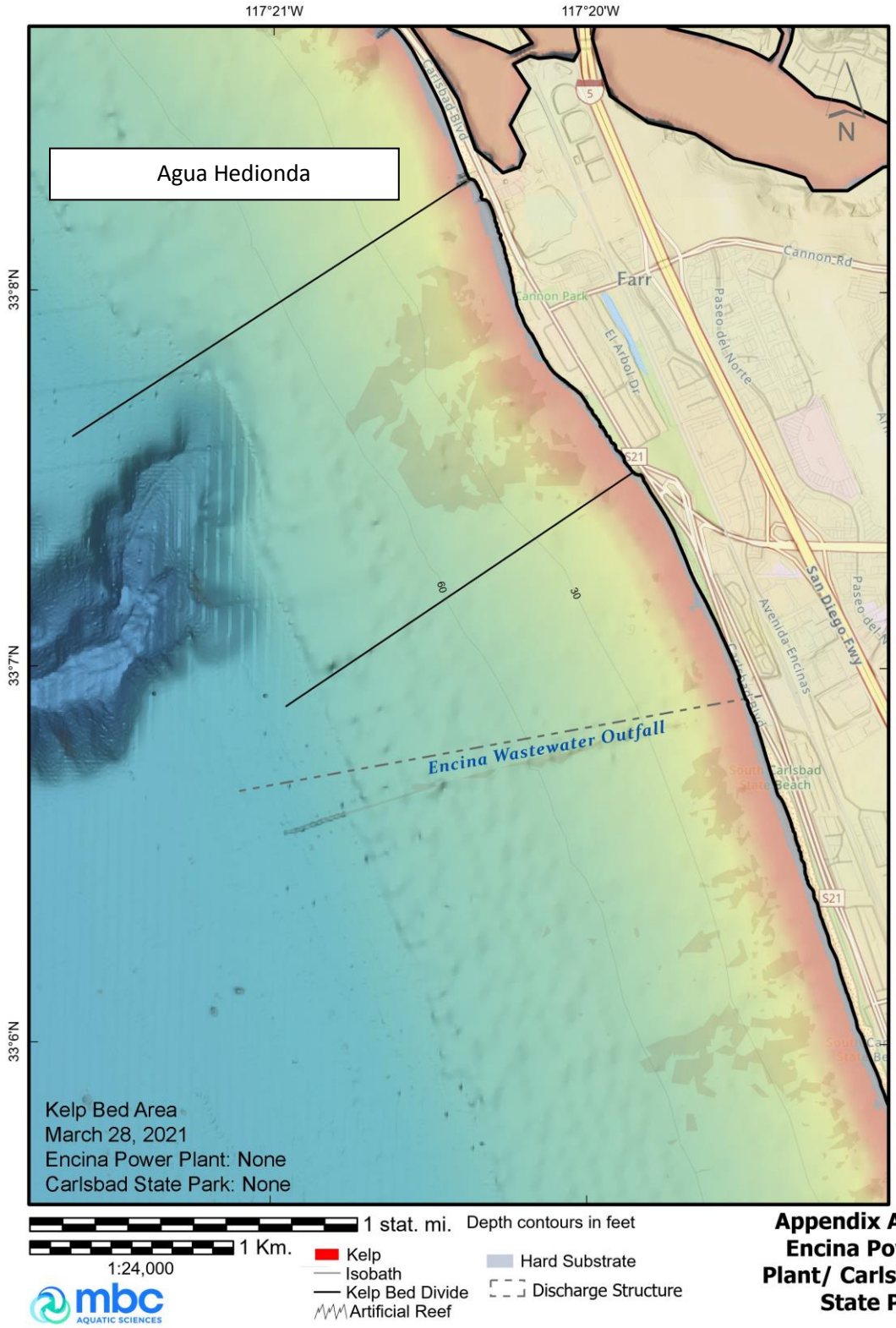
Appendix A.48
Oceanside Harbor and Pier

17) North Carlsbad



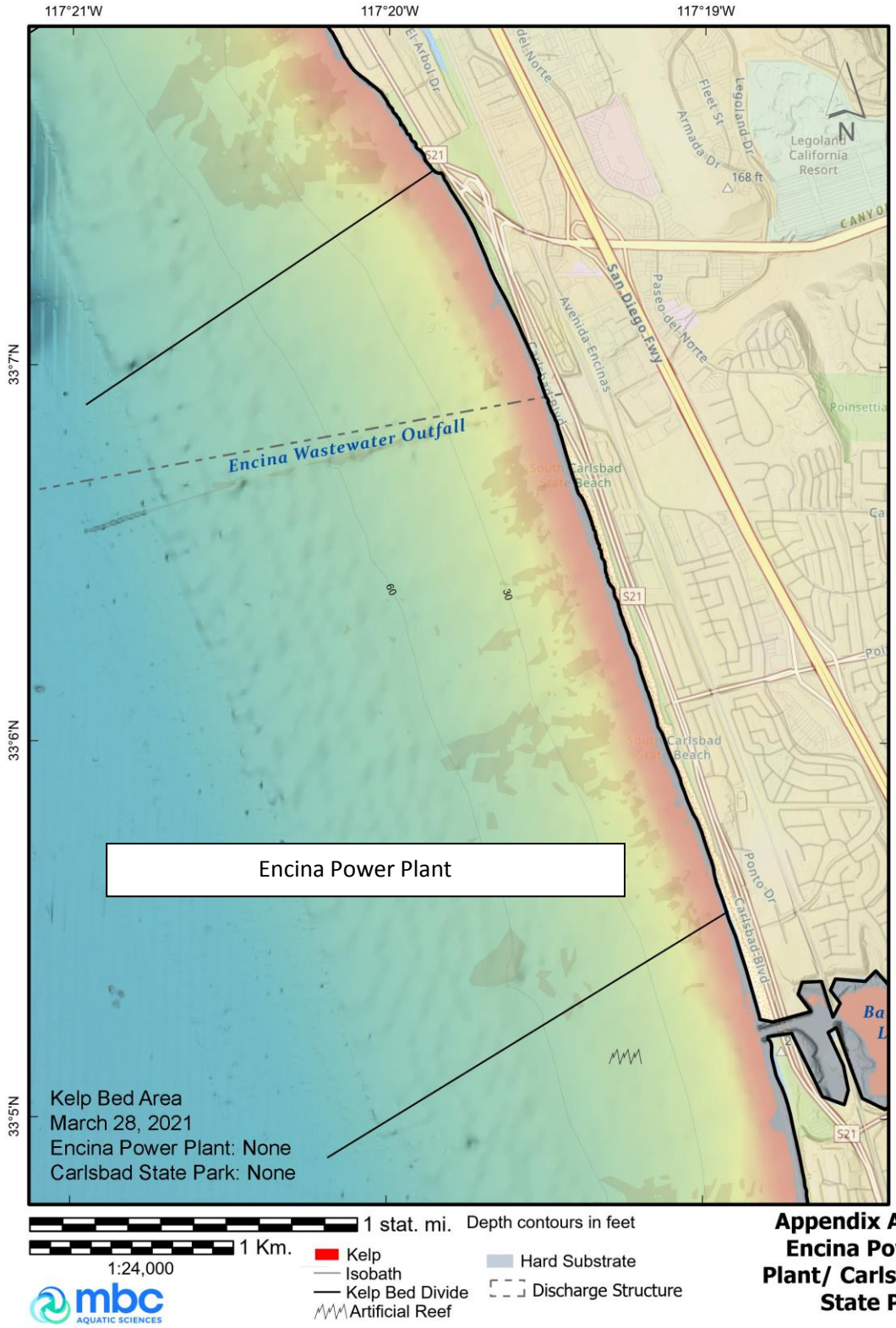
Appendix A.50
North Carlsbad/
Buena Vista
Lagoon/ Agua

18) Agua Hedionda



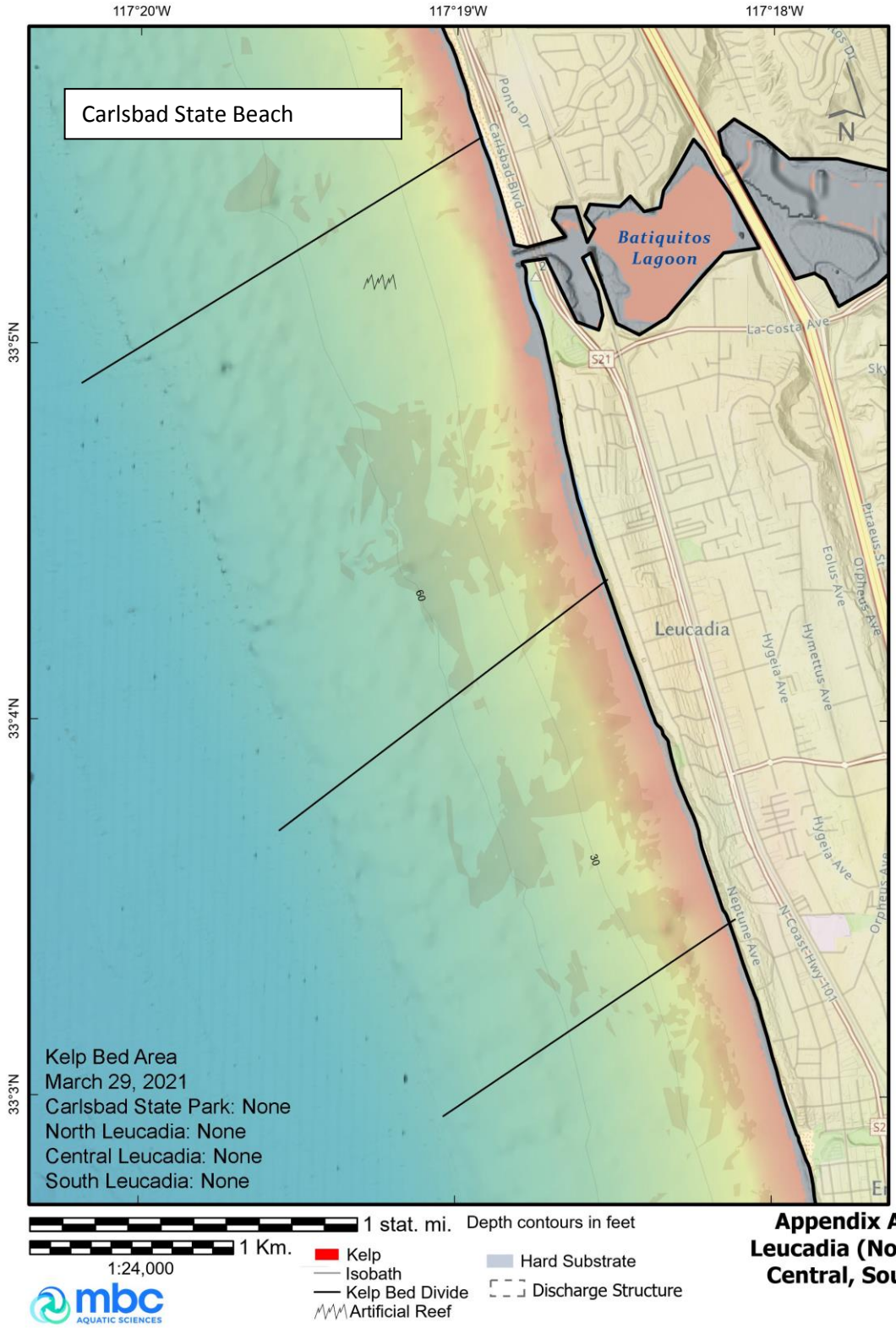
Appendix A.51
Encina Power Plant/ Carlsbad State Park

19) Encina Power Plant



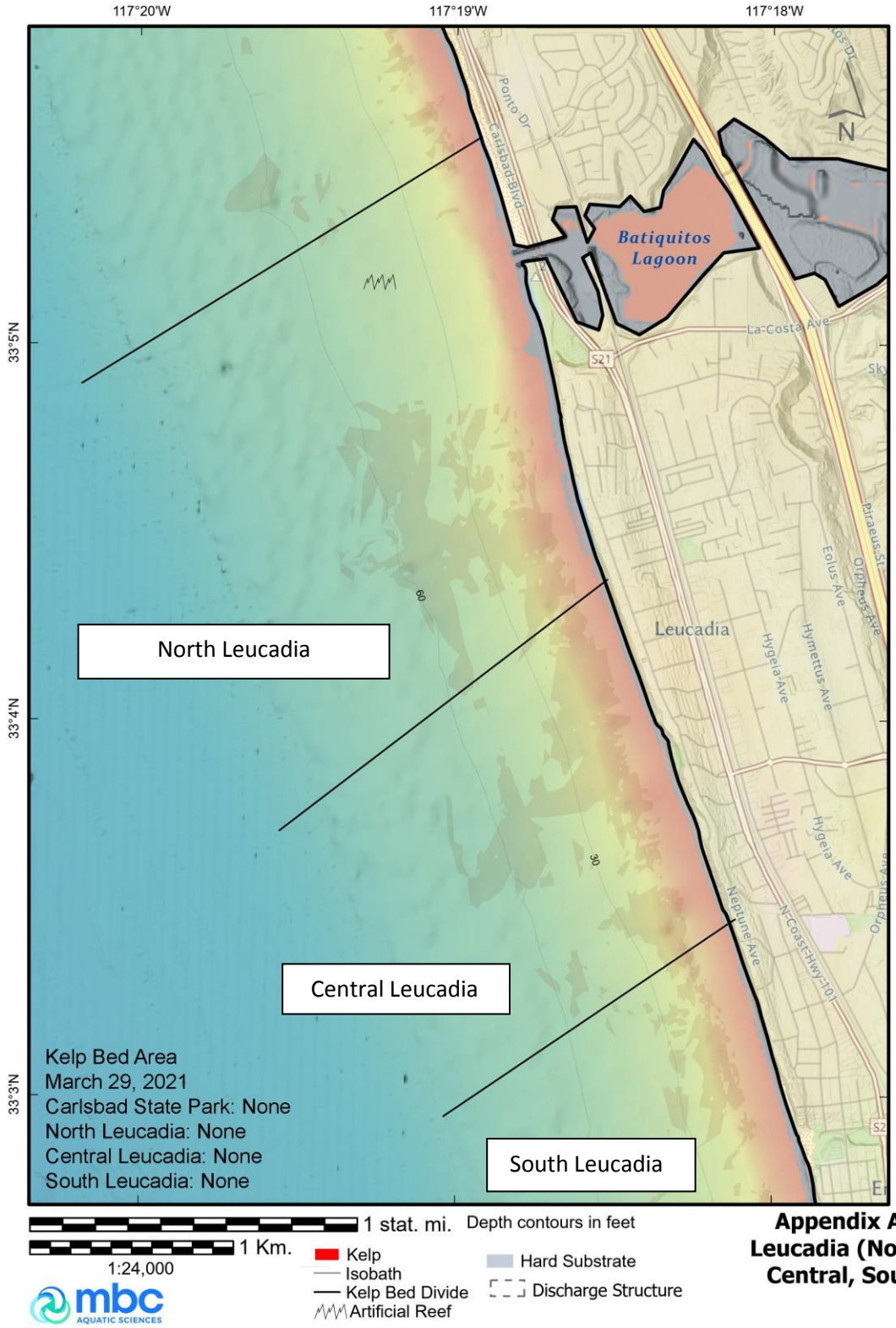
Appendix A.52
Encina Power Plant/ Carlsbad State Park

20) Carlsbad State Beach



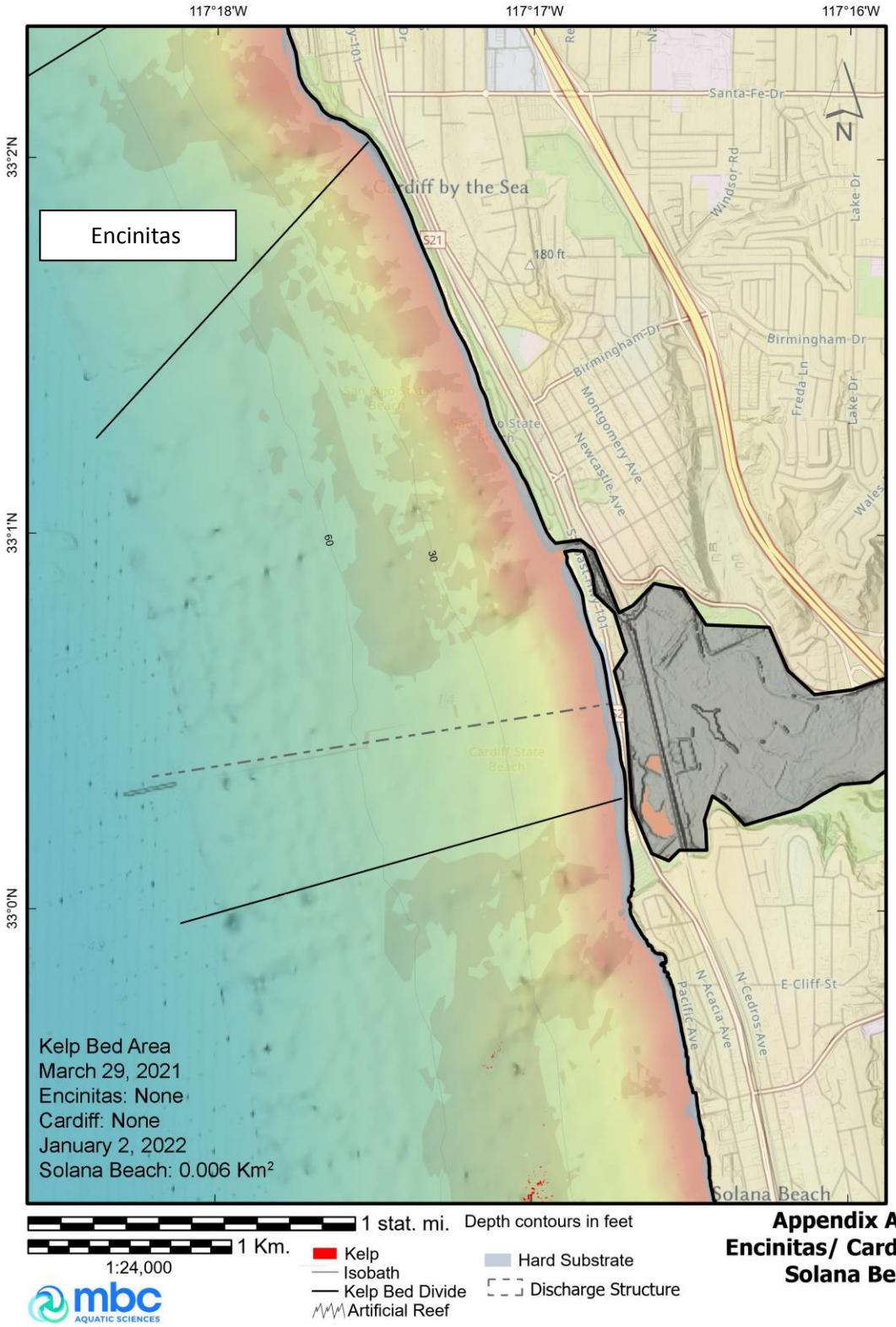
Appendix A.53 Leucadia (North, Central, South)

21) Leucadia



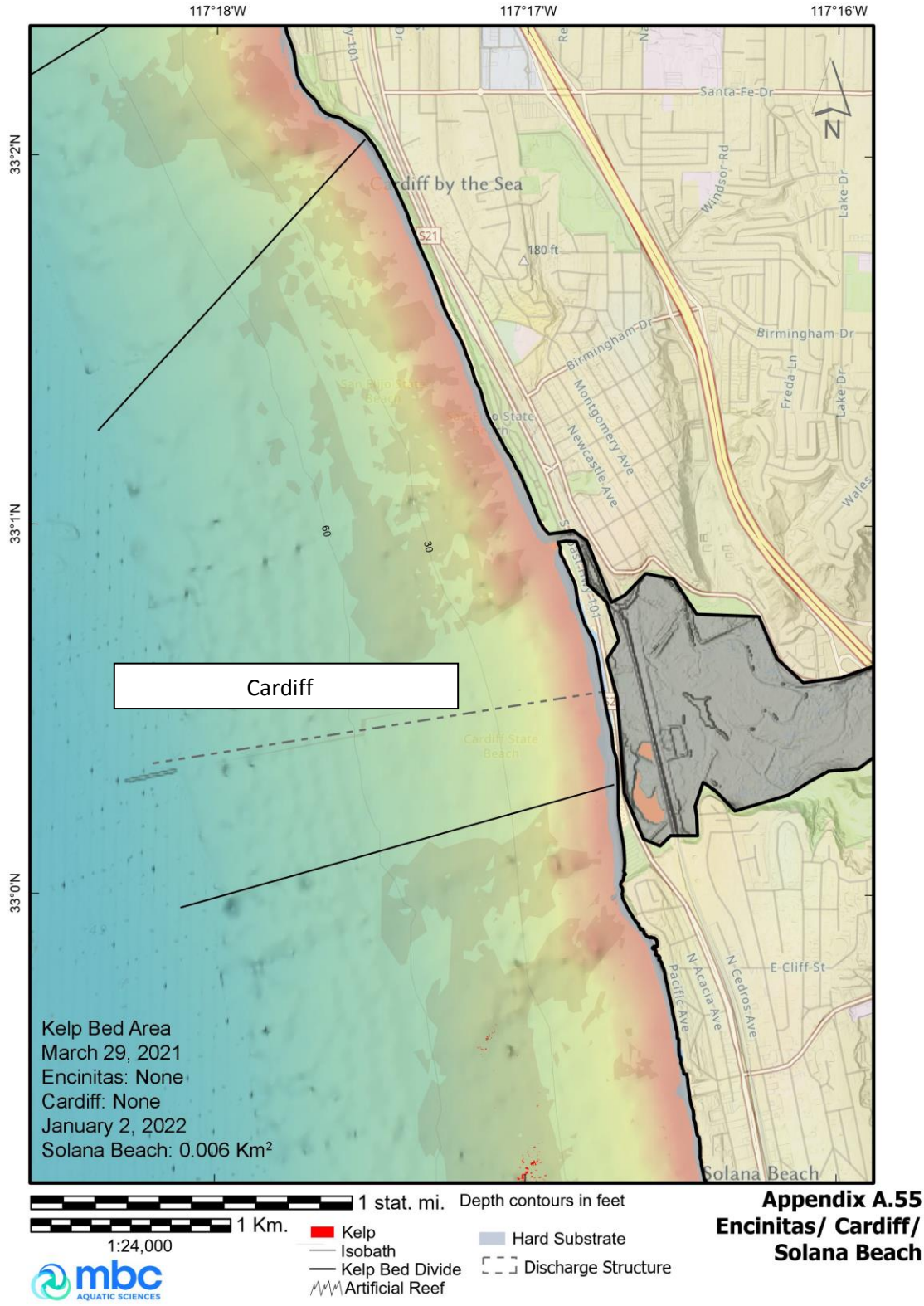
Appendix A.53 Leucadia (North, Central, South)

22) Encinitas



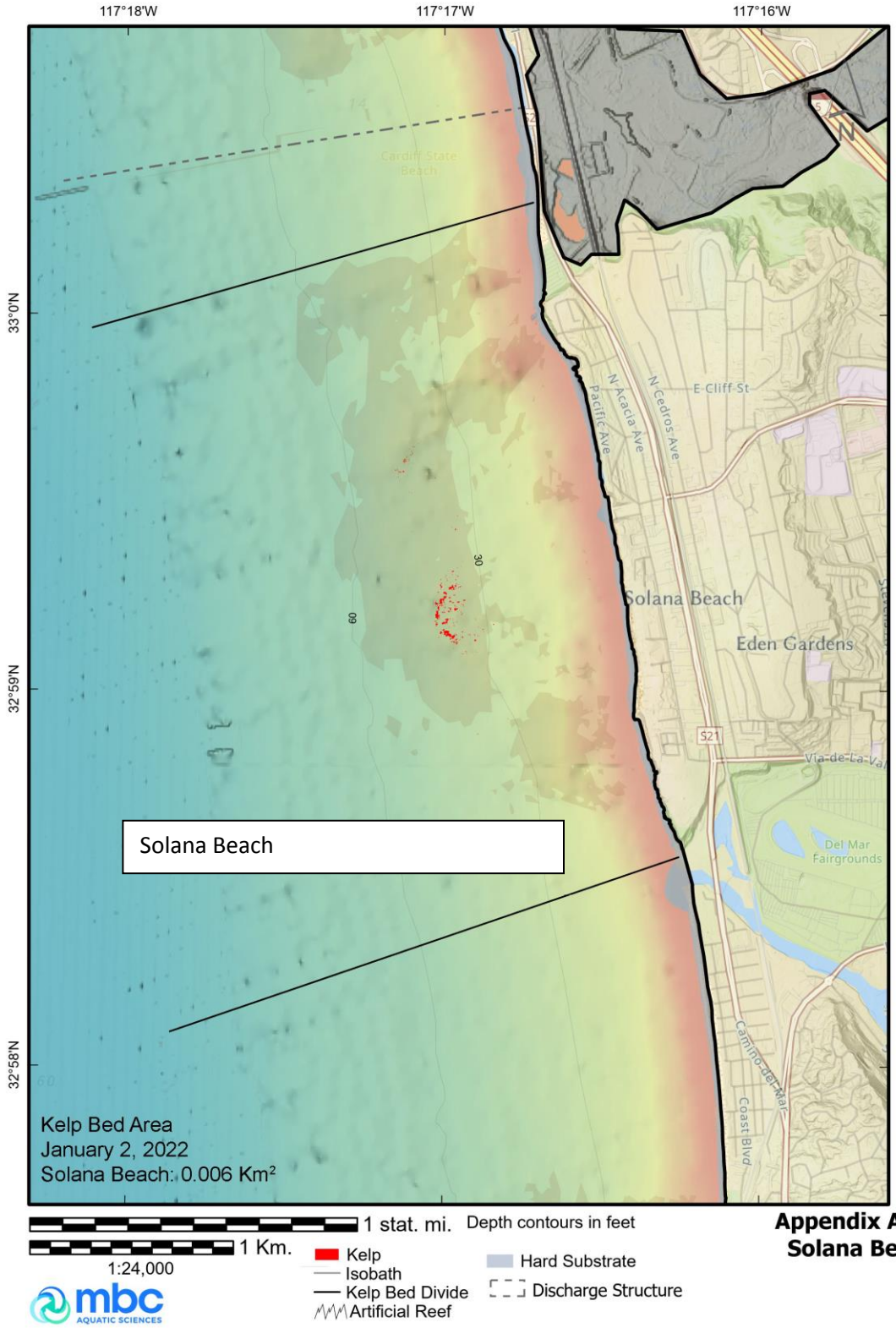
Appendix A.55
Encinitas/ Cardiff/ Solana Beach

23) Cardiff



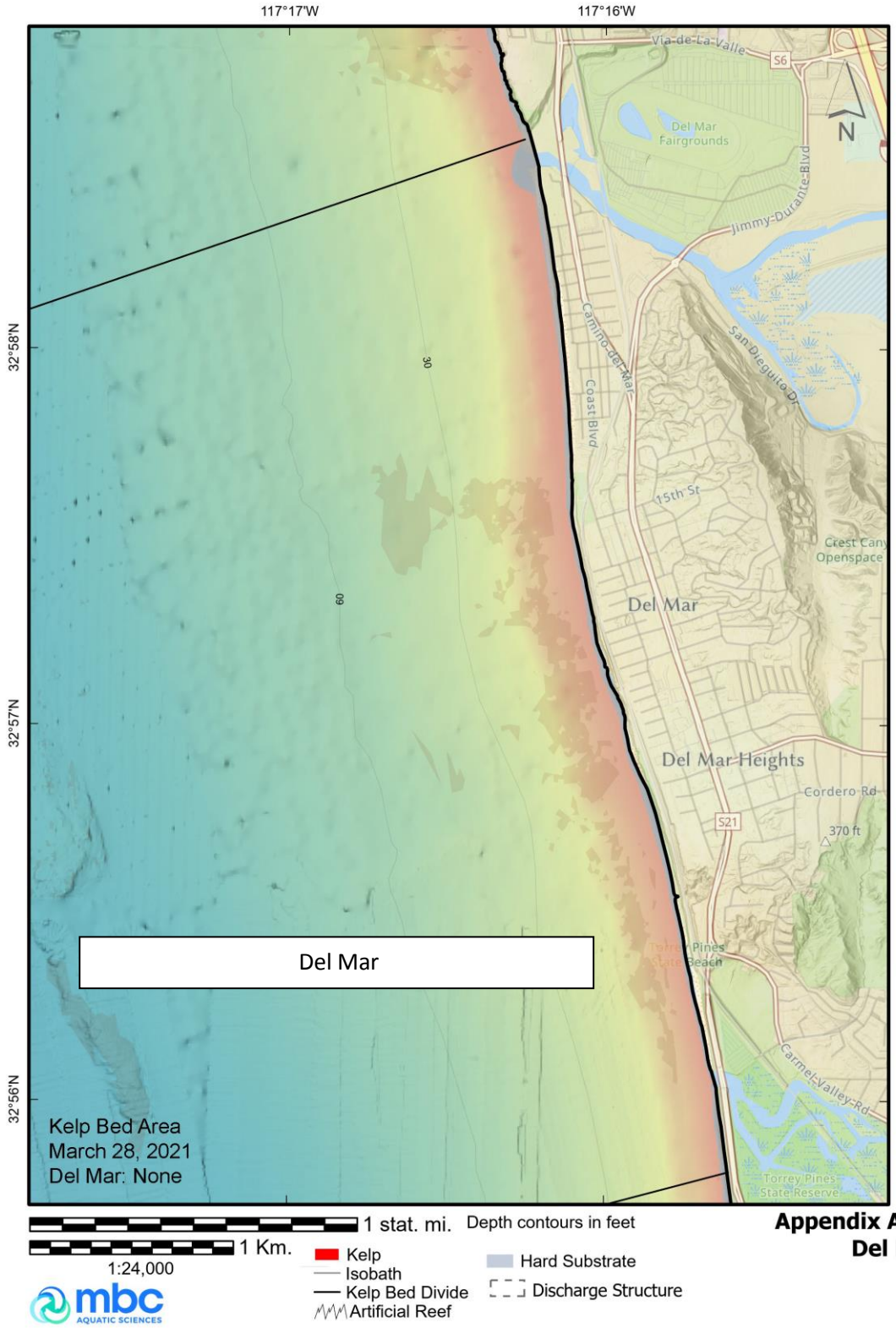
Appendix A.55
Encinitas/ Cardiff/ Solana Beach

24) Solana Beach



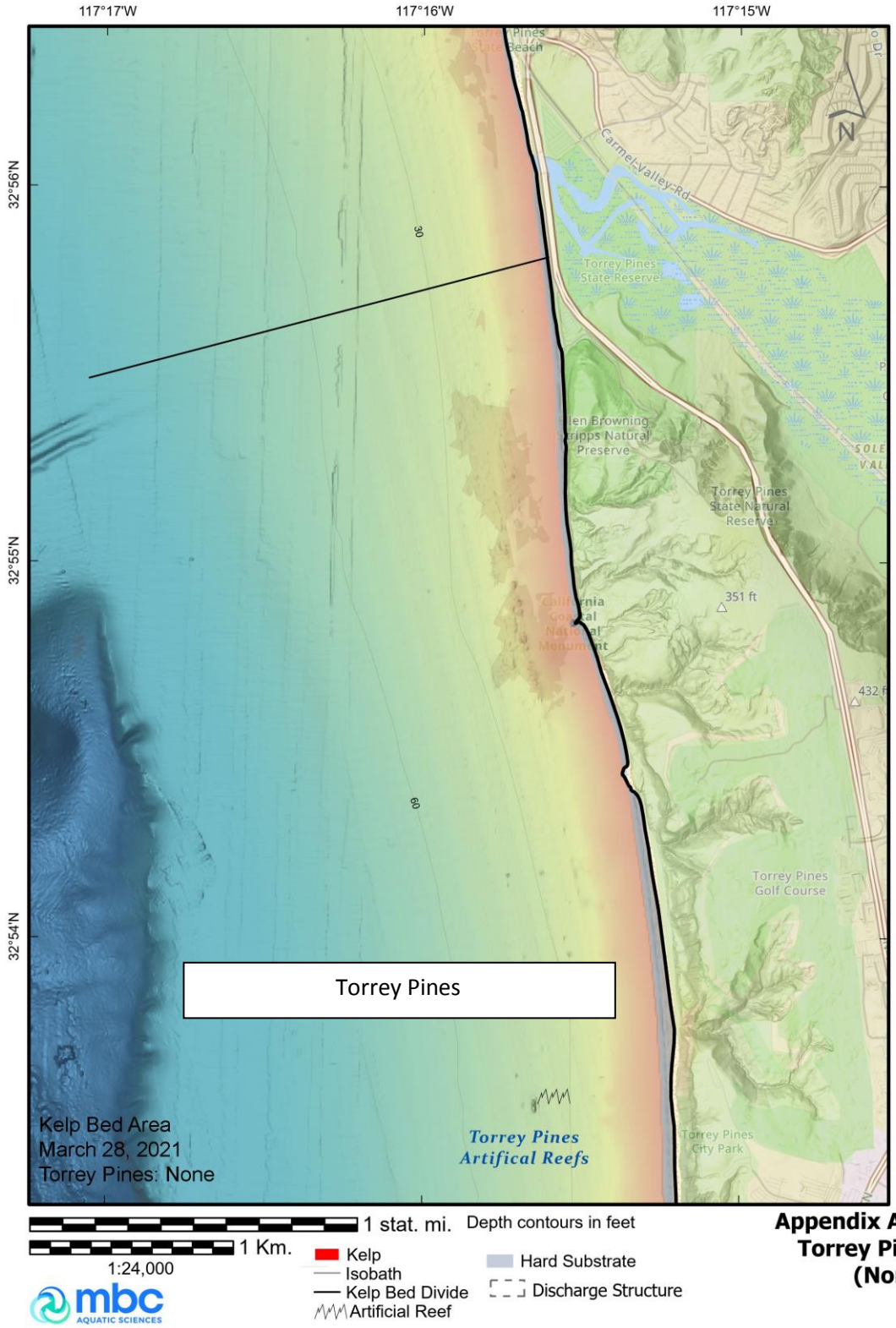
Appendix A.56
Solana Beach

25) Del Mar

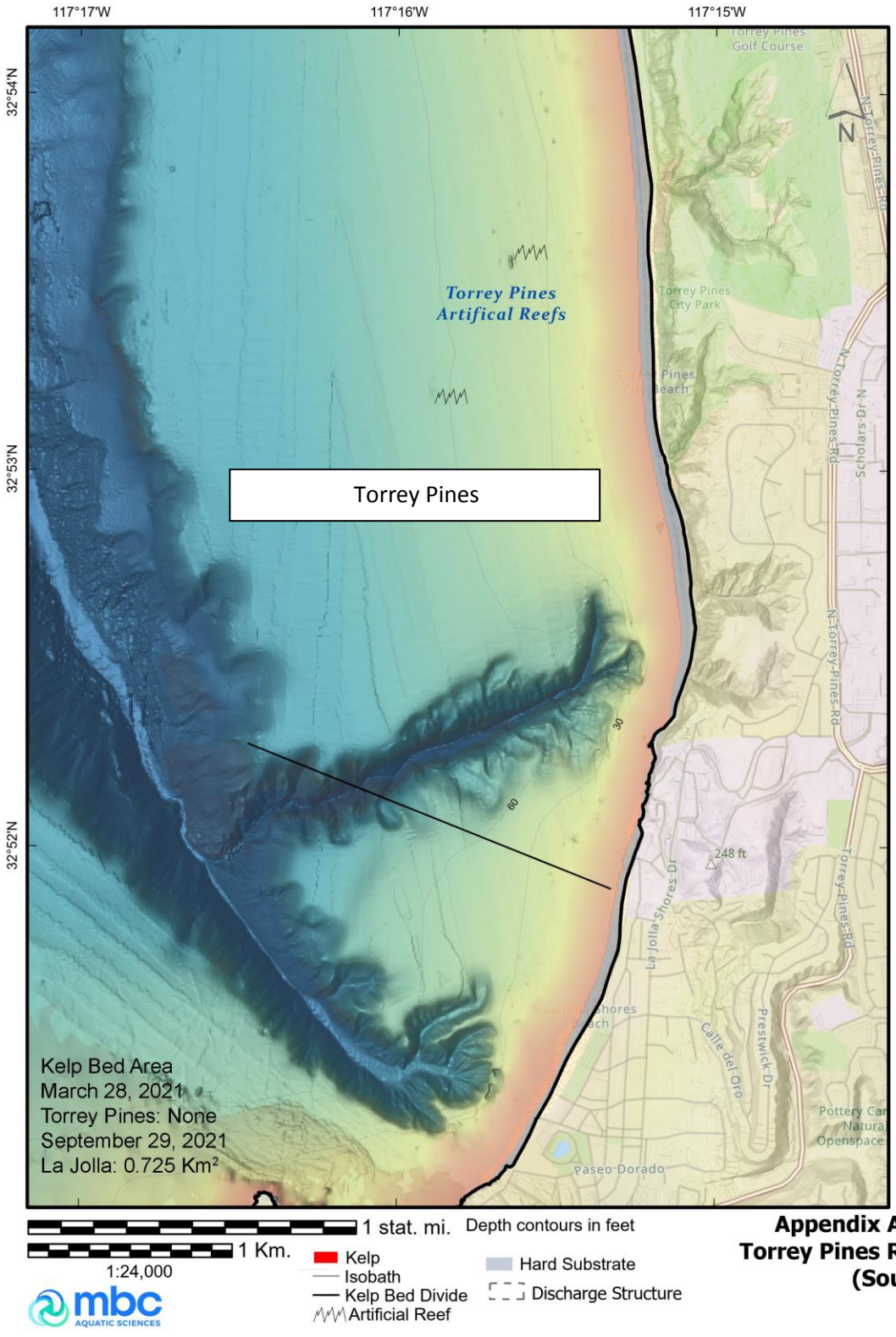


Appendix A.57
Del Mar

26) Torrey Pines

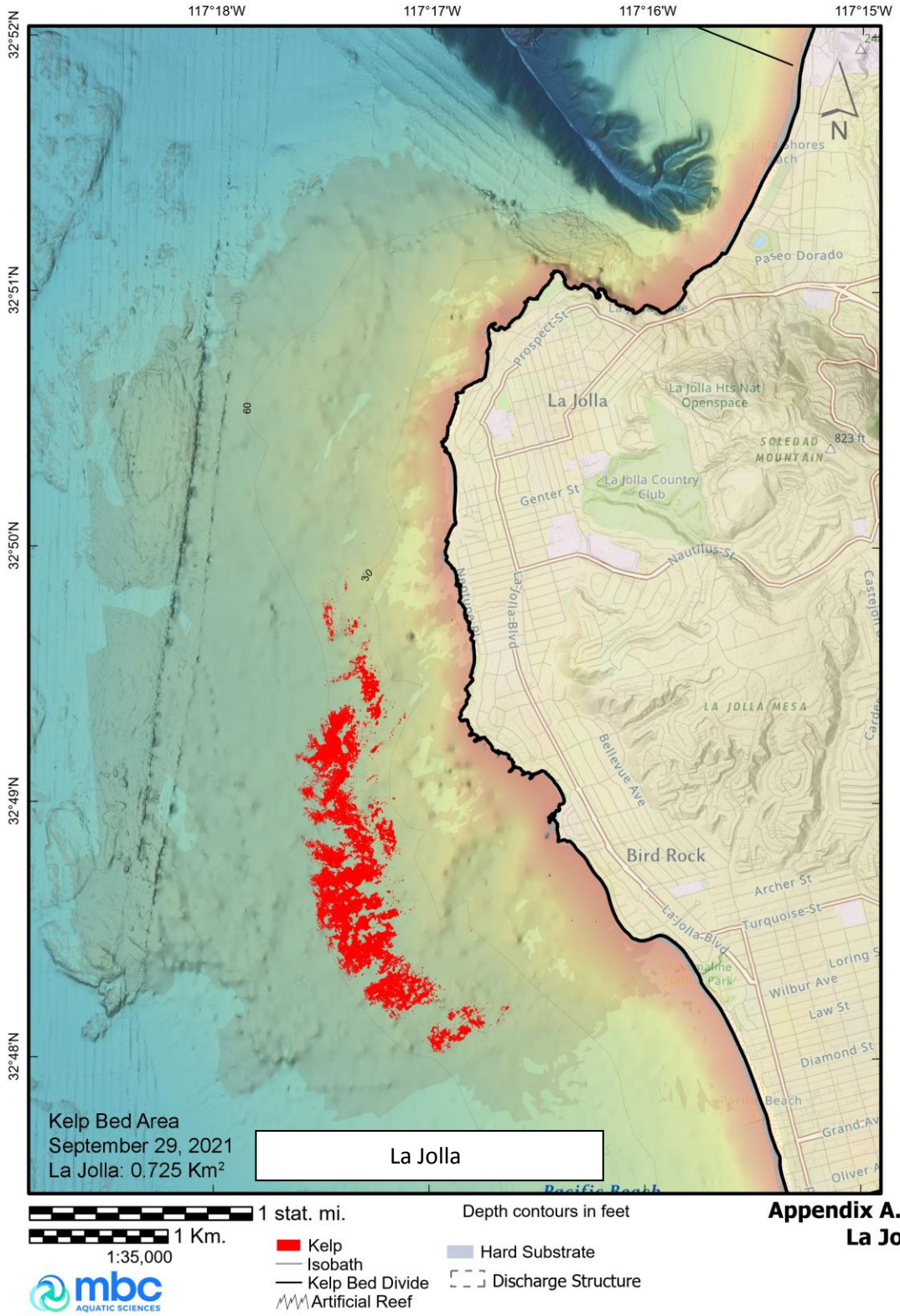


Appendix A.58
Torrey Pines
(North)



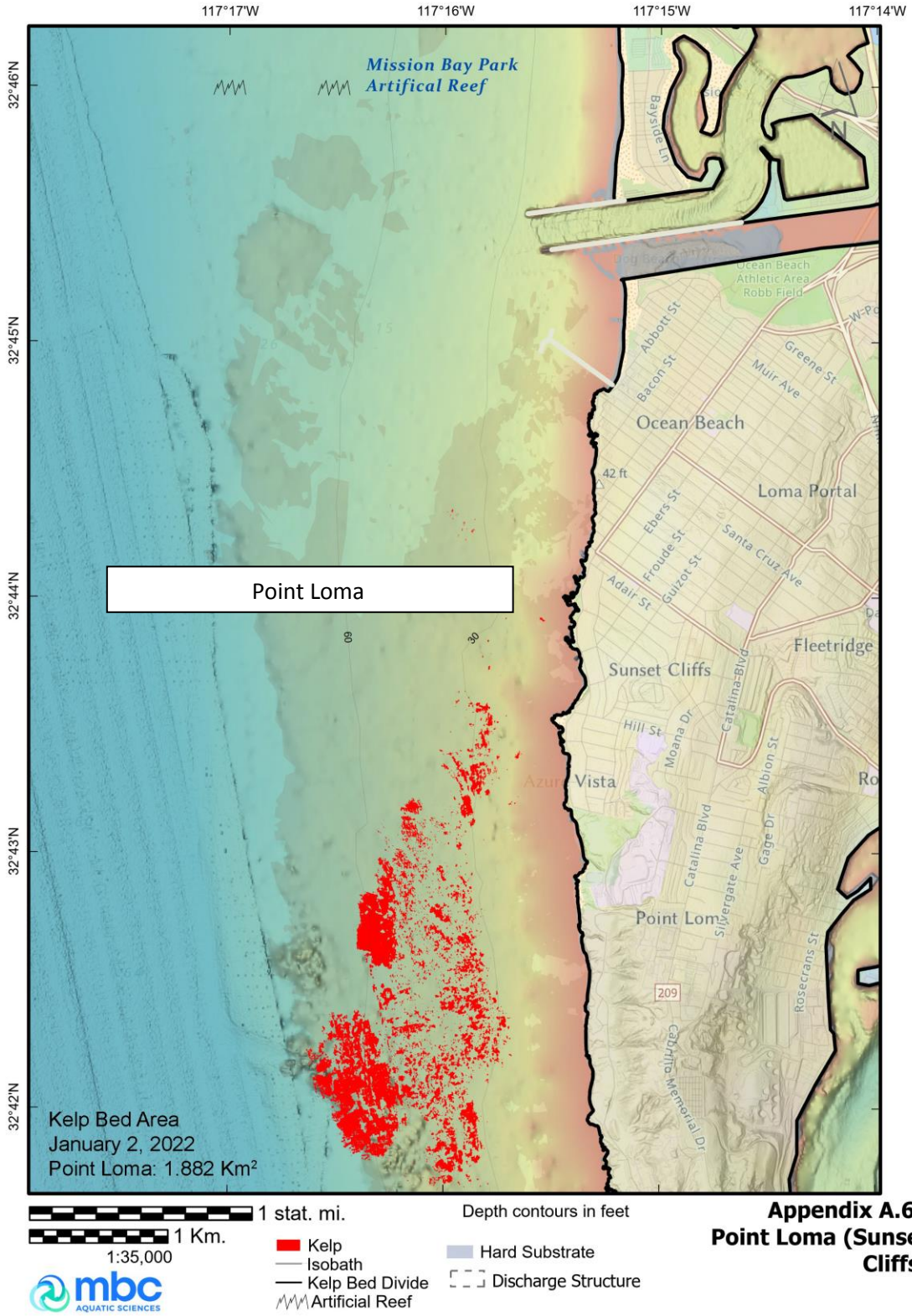
Appendix A.59
Torrey Pines Reef (South)

27) La Jolla

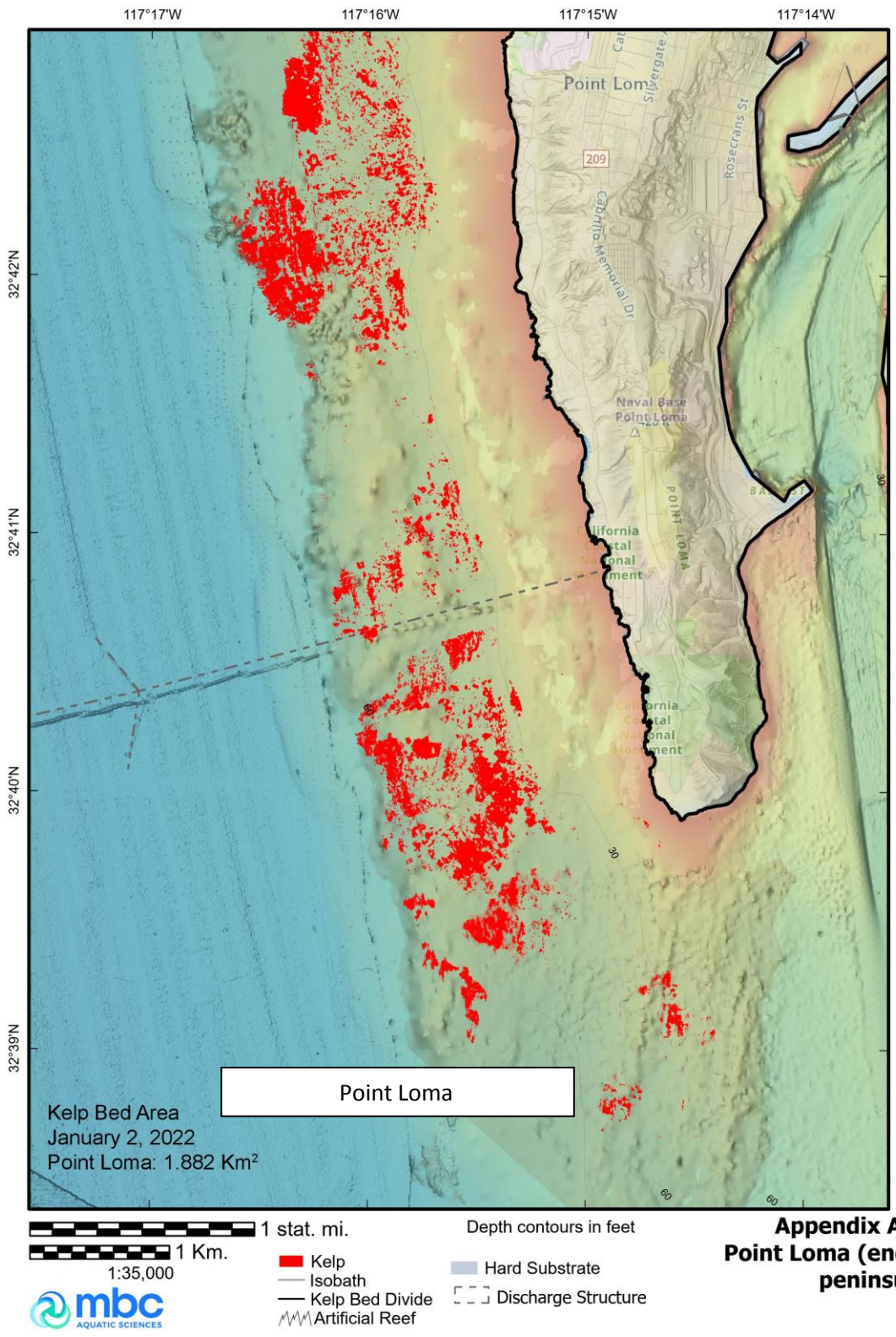


Appendix A.60
La Jolla

28) Point Loma



Appendix A.62
Point Loma (Sunset Cliffs)



Appendix A.63
Point Loma (end of peninsula)

29) Imperial Beach