2015
SOUTHERN CALIFORNIA BIGHT REGIONAL EEGLRASS SURVEYS

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2015
SOUTHERN CALIFORNIA BIGHT REGIONAL EEGLRASS SURVEYS

December 2015

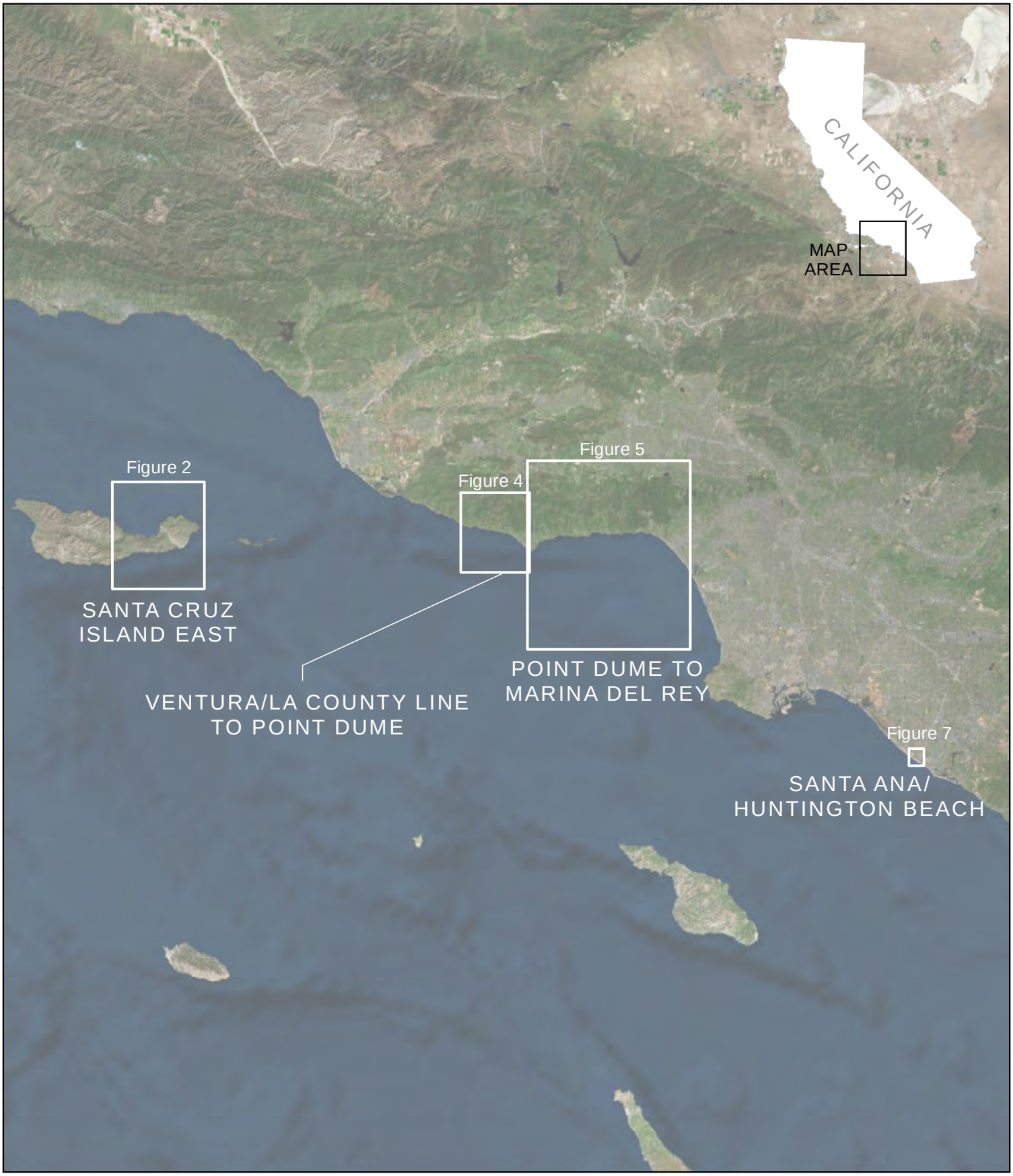
SUMMARY

Merkel & Associates, Inc. (M&A) was contracted by NOAA/National Marine Fisheries Services (NMFS) to conduct comprehensive eelgrass (*Zostera marina*) surveys in nearshore areas of the Southern California Bight in support of development of a superior understanding of regional eelgrass distribution patterns and, eventually, regional-scale dynamics. This contracted work is one key element to a broader effort to develop a comprehensive understanding of eelgrass distribution as a benchmark to support implementation of *Recommendations for a Southern California Regional Eelgrass Monitoring Program* (Bernstein, *et al.* 2011). Concurrent with this survey effort, there are a number of parallel efforts underway by other entities in a manner that will assist in developing the regional benchmark. While the regional monitoring program calls for a "Benchmark Year" survey for the region, funding practicalities and multiple party participation levels have not allowed for the single season completion of the full regional benchmark survey. For this reason, the benchmark will be developed across multiple seasons.

Areas surveyed under this contract focused on open coastal areas that have historically been under investigated and for which comprehensive eelgrass inventories have not previously been completed. Survey areas included the northern portions of Santa Monica Bay from Marina del Rey to Point Dume, Point Dume to the Los Angeles County/Ventura County border, and the eastern end of Santa Cruz Island in the Northern Channel Islands (Figure 1). In total, surveys covered approximately 34 miles of the mainland coast and 26 miles of coastline on Santa Cruz Island. In addition, M&A also completed a supporting inventory of eelgrass within the Santa Ana River, the adjacent Santa Ana River Marsh, and the Huntington Beach Wetlands Complex. Surveys covered approximately 339 acres of the marsh and estuarine complex (Figure 1).

The distribution of eelgrass identified in this survey is as outlined as follows:

Survey Area	2015 Eelgrass Coverage (Acres)
Northern Santa Monica Bay (Marina del Rey to Point Dume)	13.7
Point Dume to Los Angeles/Ventura County Line	21.1
Eastern Santa Cruz Island (North Side)	121.7
Eastern Santa Cruz Island (South Side)	66.5
Lower Santa Ana River	7.8
Santa Ana River Marsh (Northern and Southern)	>0.1
Huntington Beach Wetlands/Talbert & Huntington Beach Channels	20.4



2015 Eelgrass Inventory Areas

Southern California Bight Regional Eelgrass Surveys

Figure 1

BACKGROUND

Eelgrass is a community structuring plant that forms expansive meadows or smaller beds in both subtidal and intertidal habitats in shallow coastal bays and estuaries, as well as within semi-protected shallow soft bottom environments of the open coast. Eelgrass vegetated areas are recognized as important ecological communities because of their multiple biological and physical values (e.g. major food source in nearshore marine systems, important structural environment for resident bay and estuarine species, etc.). As a result, eelgrass is considered a "foundation", or habitat forming species. Eelgrass is a major source of primary production in nearshore marine systems, underpinning detrital-based food webs. In addition, several organisms directly graze upon eelgrass or consume epiphytes and epifauna supported by eelgrass plant structures, thus contributing to the system at multiple trophic levels. Eelgrass beds are also a source of secondary production.

Eelgrass beds function as habitat and nursery areas for commercially and recreationally important open ocean marine fish and invertebrates and provide critical structural environments for resident bay and estuarine species, including abundant fish and invertebrates. Eelgrass supports juvenile fish as well as mature, often predatory, fish that hunt along the margins of the bed's protective structure. Besides providing important habitat for fish, eelgrass is considered to be an important resource supporting migratory birds during critical migration periods. Eelgrass is particularly important to waterfowl such as black brant that feed nearly exclusively on the plants and to a number of other species that make a diet of both eelgrass and the epiphytic growth that occurs on the leaves.

In addition to its habitat and resource value, eelgrass traps and removes suspended particulates, improves water clarity, and reduces erosion by stabilizing the sediment. Eelgrass facilitates nutrient cycling and oxygenates the water column during daylight hours. Eelgrass also has the potential to act as a significant means of sequestering carbon.

Besides the critical resource values and ecosystem functions of eelgrass, it is uniquely suited to serve as a sentinel indicator of overall ecosystem condition. Eelgrass is an easily and repeatably monitored widely distributed integrator of environmental conditions that responds to natural and anthropogenic stressors that are chronic in nature. Eelgrass is robust with respect to short-term environmental fluctuations within normal or near normal environmental ranges. However, eelgrass does respond to physical damage or short-term presence of high toxicity discharge events.

Because of the ecosystem importance of eelgrass, its presence at critical land-sea coastal interface area, and its capacity to serve as an indicator of system health and regional trends, in 2010 NMFS funded the development of a regional monitoring program to track trends in eelgrass habitat as a tool to assist in management decisions and tracking effects of climate changes on critical coastal waters. Under this program, NMFS and a number of regional stakeholders worked collaboratively to develop recommendations for Southern California regional eelgrass monitoring. The ultimate result of this effort was Southern California Coastal Water Research Project Technical Report #632 *Recommendations for a Southern California Regional Eelgrass Monitoring Program* (Bernstein, *et al.* 2011). In addition to laying a framework for regional eelgrass monitoring, this report also identified

significant gaps in the knowledge base regarding spatial distribution and extent of eelgrass within some coastal systems and most substantially in open coastal and Channel Island environments.

The regional eelgrass monitoring program identified in Bernstein, *et al.* (2011) is strongly based on a structure similar to the adopted and presently employed eelgrass monitoring program within San Francisco Bay (Merkel & Associates 2008). The program relies on development of a comprehensive distribution map for eelgrass within the region for a "Benchmark Year" survey to which annual subsampling along fixed belt transects may be scaled. This benchmark scaling allows for tracking and assessment of eelgrass distribution patterns and variability over both spatial and temporal scales. However, due to funding practicalities of many agencies and regional partners, the survey participation levels have not allowed for the single season completion of the full regional benchmark survey. For this reason, the benchmark will be developed across multiple seasons. During 2013, comprehensive surveys were conducted by other entities in several other systems including Morro Bay, San Pedro Bay, and Mission Bay. In 2014, the Navy completed comprehensive eelgrass surveys for San Diego Bay and San Clemente Island. A second comprehensive survey was also completed in San Pedro Bay in 2014. In 2015, an additional comprehensive eelgrass survey was completed in Morro Bay. However, even with regular survey efforts underway, there remains an on-going need for complete benchmark inventories throughout the region.

In 2013, NMFS completed comprehensive eelgrass surveys within multiple systems. Surveys were conducted both in recognition of the regional data gaps and in order to leverage multiple programs underway to develop the benchmark condition required for implementation of the regional monitoring program. The systems included Alamitos Bay, Anaheim Bay (including Huntington Harbour), Agua Hedionda Lagoon, Batiquitos Lagoon, and San Dieguito Lagoon. Subsequently, NMFS added the San Gabriel River estuary to the survey list as a sixth site. A total of 1,958 acres of water was surveyed and mapping of 310 acres of eelgrass was conducted within the six systems (Merkel & Associates 2014).

In recognition of the paucity of information within open coastal environments, NMFS contracted with M&A for the current surveys to be performed in nearshore waters and within the northern Channel Islands, as well as to solicit partnering data collection efforts. In parallel with NMFS efforts, the U.S. Navy conducted an October 2014 inventory of eelgrass at the Navy owned San Clemente Island. The investigation revealed 60.9 acres of eelgrass on the island; vastly more than known or anticipated (Merkel & Associates, 2015). This finding also substantively heightened the awareness of the potential scale of nearshore and insular eelgrass beds in southern California. Concurrent with nearshore surveys, M&A also separately completed additional surveys of eelgrass within coastal wetland complexes at the Santa Ana River and Huntington Beach Wetlands complex. These surveys are reported in this report submittal.

The anticipated survey effort was intended to cover from 3,000 to 4,000 acres of mainland coastal and northern Channel Islands waters to map eelgrass. However, the final selection of survey area was to ultimately be coordinated with various partners including the Santa Monica Bay Restoration Commission, the NOAA Channel Islands National Marine Sanctuary, National Park Service, the Army Corps of Engineers, and the U.S. Navy. The final determination was made to survey northern Santa Monica Bay from the Ventura County Line to Marina del Rey and to survey the eastern end of Santa Cruz Island.

SURVEY METHODS

SURVEY TIMING

Eelgrass surveys were conducted in all systems between March 30 and October 18, 2015. Surveys were conducted on the dates indicated in Table 1.

Table 1. Survey Dates for Eelgrass Survey and Ground-truthing

SYSTEM	SURVEY DATES
Northern Santa Monica Bay (Marina del Rey to Point Dume)	10/4-6/2015
Point Dume to Los Angeles/Ventura County Line	10/5-8/2015
Eastern Santa Cruz Island (North Side)	10/15-18/2015
Eastern Santa Cruz Island (South Side)	10/15-16/2015
Lower Santa Ana River and Santa Ana River Marshes	3/30/2015 & 6/19/2015
Huntington Beach Wetlands/Talbert & Huntington Beach Channels	3/30/2015 & 6/18-19/2015

Survey dates were selected to benefit from desired water and weather conditions, including tides and ocean swell that supported the survey methods applied and ground-truthing needs. Surveys were conducted over multiple dates to capture tidal conditions and integrate survey efforts with other survey activities in the same area. Typically, follow-up targeted ground-truthing was conducted after the initial habitat mapping was performed in order to verify mapping in problem areas.

SPATIAL SURVEYS

Eelgrass surveys were conducted using a combination of low tide aerial photography over the Santa Ana River and Huntington Beach Wetlands Complex and interferometric sidescan sonar surveys within coastal and insular waters.

Aerial photographs were processed digitally and rectified prior to digitizing visible eelgrass as a shapefile in ESRI ArcGIS geographic information systems software. Where eelgrass boundaries became unclear due to water depth, a boundary of eelgrass that could be effectively mapped from the aerial photographs was plotted on digital maps that were subsequently loaded into the field survey GPS units for ground truthing. For the Santa Ana River and Huntington Beach Wetlands Complex, ground-truthing was performed by visiting the sites at low tide to verify correct classifications from the aerial imagery and to complete mapping within areas that had been specifically identified as having difficult boundaries to discern.

Sonagraphic surveys were undertaken in navigable waters using an interferometric sidescan sonar system. The interferometric sidescan system is a dual channel hull mounted sonar operating at 468 kHz that integrates a vessel motion sensor to correct for vessel pitch, heave, and roll; a sound velocity sensor that corrects for speed of sound in water related to density differences resulting from changes in temperature and salinity; and a dual antenna differential GPS that provides vessel positioning and correction for vessel yaw. Because the position of the interferometric sidescan sonar head is rigidly fixed to the vessel, the positional error is dramatically reduced from that associated with other mapping methodologies, including traditional towed sidescan sonar. With the survey system utilized in this effort, absolute postitional error for eelgrass mapping is

approximately ±1-2 meters. The relative positional error is estimated at ±0.5-1 meter as the GPS error is substantially nullified across short distances. The interferometric sidescan was set to survey out 40 meters on the port and starboard channels such that the full swath width was nominally 80 meters. Where beds were identified, surveys were conducted by navigating parallel track lines such that sonar swath the nadir gap that occurs directly below the survey vessel from the prior pass was covered with the subsequent pass.

For the completion of eelgrass surveys within the nearshore and insular areas, a baseline route was navigated along the 5 fathom line (9 meters or -30 feet MLLW) through the entire survey area. This depth was selected because it generally fell within the core depth range for previously reported eelgrass beds within Santa Monica Bay (Tom Ford, Santa Monica Bay Restoration Commission) and Broad Beach (Merkel & Associates 2015), as well as those beds previously noted in shallows on Santa Cruz Island (Engle & Miller 2003). It also occurs on the NOAA navigation charts for the survey area, so it was easy to select an initial survey route to follow the shoreline. Because Santa Cruz Island has also been noted to host deeper eelgrass beds driven by the exposure environment, a return pass was made in deeper waters on the south side of the island at approximately 12 meters (-40 feet) MLLW using predicted tides and the vessel's single beam fathometer to follow the contour. These "prospecting" swaths were used to identify the presence of eelgrass beds that were subsequently mapped to the full extent of the beds later in the survey period.

It is known that the combination of eelgrass bed prospecting within reasonable depth ranges with subsequent mapping of the identified beds has the potential to miss some beds that fall outside of the normal depth distribution. However, it is believed that the potential for missing significant amounts of eelgrass through this methodology is generally low since most of the identified eelgrass beds spanned several vertical feet from the top of the bed to the bottom of the bed. Further, as more depth range data is collected and analyzed, the capacity to target prospecting efforts to be even more efficient is expected to increase.

GROUND-TRUTHING

Ground truthing was completed by a combination of visual surface surveys by naked eye and use of an Aqua Scope II™, as well as inspection of the bottom using an ROV and drop camera verification methods. Ground-truthing occurred at the time of initial survey for the nearshore and island surveys and during a subsequent post-mapping investigation for the Santa Ana River and Huntington Beach Wetlands Complex.

The intensity of ground truthing varied across the survey area based on a variety of factors. Most specifically, ground truthing in the wetland complex focused on verification that polygons that had been mapped from aerial photographs were all eelgrass and that where aerials were not adequate to map eelgrass boundaries, ground-truthing was used to complete the mapping effort. For the coastal and insular mapping, eelgrass was verified by spot checks using the tools identified above. Areas believed to be eelgrass were specifically targeted for verification. This was done first to verify correct interpretation of acoustic signature and second to determine boundaries between hard bottom low relief reef features and eelgrass beds.

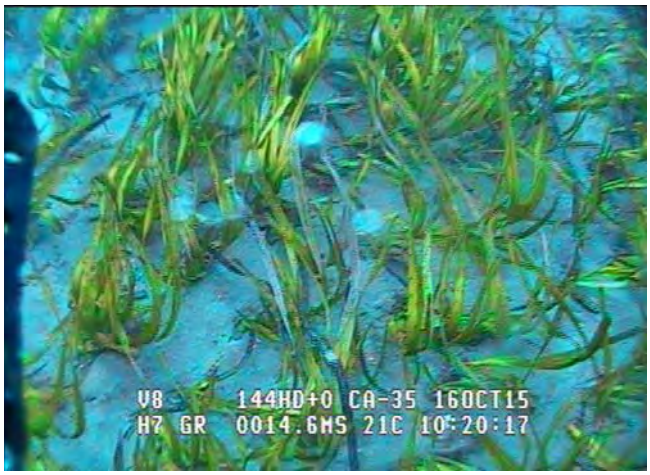
Ground-truthing was also beneficial in identification of the species of eelgrass present within the survey areas. Within the Santa Ana River and Huntington Beach Wetlands Complex, all of the

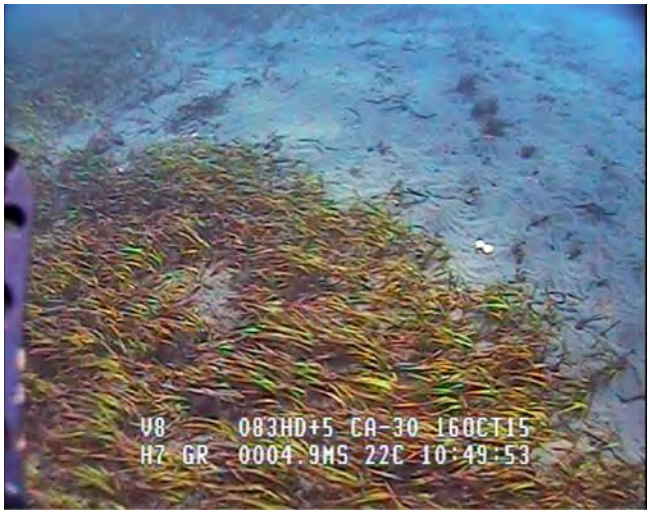
observed eelgrass was common eelgrass (*Zostera marina*), while ground-truthing the open coastal and insular beds on Santa Cruz Island revealed only Pacific eelgrass (*Z. pacifica*).

The ground-truthing in the open coastal environments revealed substantial differences in eelgrass shoot density within the various beds observed; however, none of the beds supported tall plants, with most of the plants appearing to be less than 0.5 meter (1.6 feet) in length. This is generally slightly shorter than leaves within Santa Cruz Island beds as reported by Engle & Miller (2003). However, as no formal measurements were taken during the present inventory, the observed short blade length should not be considered definitive.

In general, both mainland and insular eelgrass beds were noted to occur in relatively clean sandy environments. Along the northern side of Santa Cruz Island some of the shallower beds were found in a coarse sand and shell hash. The epiphytic loading on beds varied substantially across all areas investigated. The deeper beds did not always have a lower epiphytic load as is often the case within sheltered inland bays and estuaries. Epiphytes ranged from ephemeral green algae to longer lived bryozoan, serpulid worms, and even some crustose coralline algae.

There was no observed evidence of wasting disease caused by the slime mold *Labyrinthula zosterae* on any of the plants observed during ground truthing in the open coastal waters on either the mainland or Santa Cruz Island. Unfortunately, no effort was put into identification of wasting disease signs within the Santa Ana River and Huntington Beach Wetlands.





Examples of eelgrass bed on eastern Santa Cruz Island during ground-truthing during October 2015 surveys. The beds reflect screen shots of a transect run from deep to shallow through Scorpion Anchorage.

SURVEY RESULTS

EASTERN SANTA CRUZ ISLAND

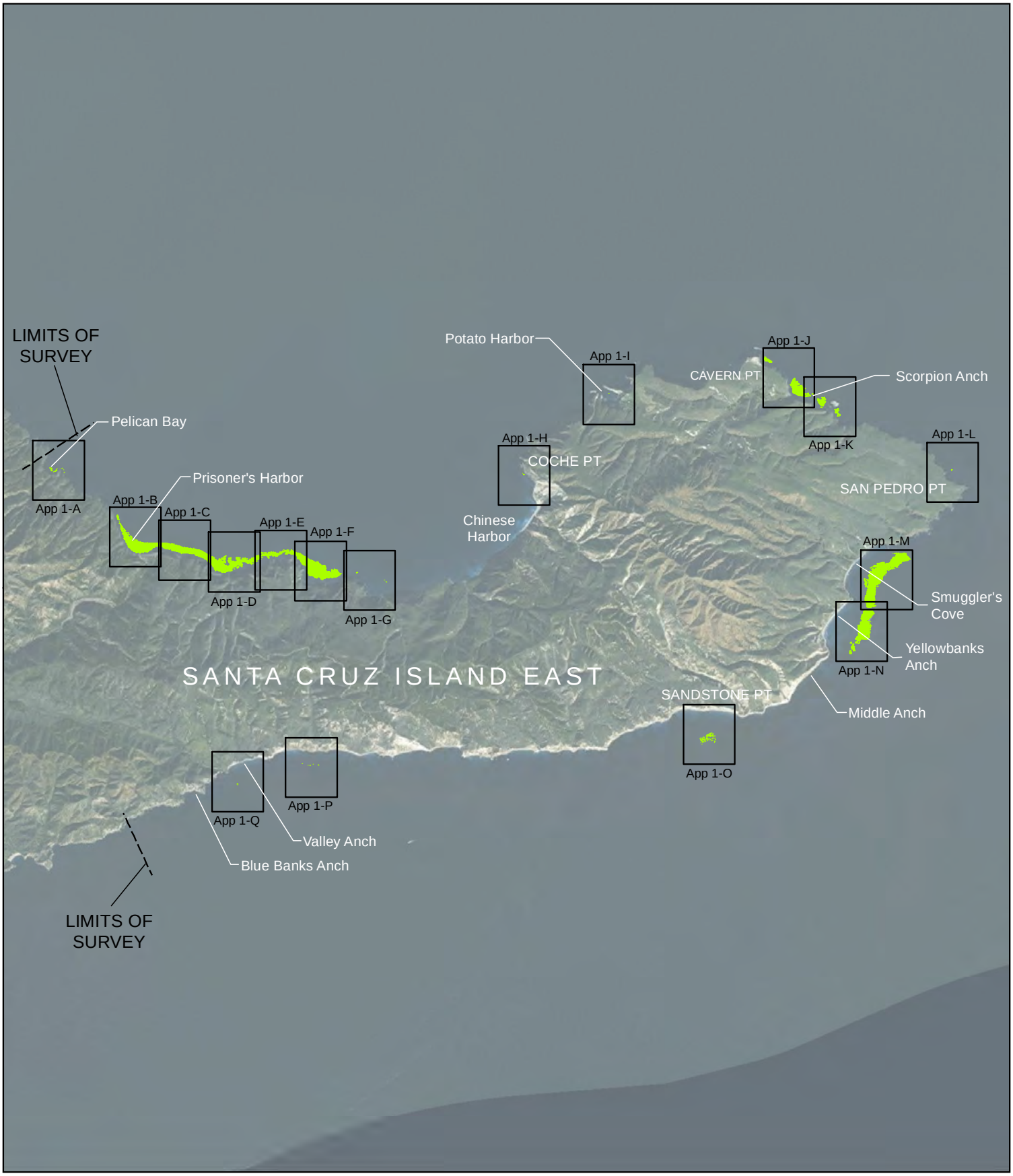
Eelgrass surveys were conducted along 26 miles of the eastern shoreline of Santa Cruz Island. These surveys revealed the presence of 188.2 acres of eelgrass (121.7 acres on the northern side of the island and 66.5 acres on the southern side of the island). Eelgrass on eastern Santa Cruz Island was previously reported at Prisoners Harbor, Canada del Agua, Aguaje Escondido, Scorpion Anchorage, Little Scorpion Anchorage, Smugglers Cove, and Yellowbanks Anchorage (Engel & Miller 2003). It is not possible to determine precisely how much eelgrass was previously noted in these areas as data have been reported by abundance levels representing bed size classes. Beds at Prisoner's Harbor and Smuggler's Cove have been identified as the largest beds historically and continue to be the largest beds on the east end of the island. However, in addition to the previously noted eelgrass beds, all of which were present in October 2015, smaller eelgrass beds were noted at Pelican Bay, west of Coche Point, within Potato Harbor, east of Cavern Point, north of San Pedro Point, west of Sandstone Point, and in the vicinity of Valley Anchorage (Figure 2). The individual beds were also mapped along with bathymetry in feet MLLW (Appendix 1-A through 1-Q) where they have been plotted

The depth distribution of eelgrass beds within the Channel Islands was previously explored by Engle & Miller (2003), and it was noted that depth ranges on Santa Cruz Island vary by swell exposure level. During the present survey, this pattern was again verified with the protected north side of the island supporting a much shallower and broader depth distribution than the more exposed southern side of the island. On the north side of the island, eelgrass depth distribution was from -4 to -50 feet MLLW. Conversely, on the more energetic south side of the island, eelgrass ranged from -28 to -58 feet deep (Figure 3).

The peak occurrence of eelgrass on the north side of the island occurred at -25 feet, with over 90 percent of the eelgrass occurring within a depth range from -12 feet to -38 feet MLLW. On the south side of the island, eelgrass reached its peak occurrence at -47 feet MLLW, with over 90 percent of the eelgrass occurring within a depth range from -37 to -52 feet MLLW.

The distribution of eelgrass in small patches throughout a number of protected and semi-protected coves on the eastern end of the island suggests that there may be similar small beds scattered along the shore on the western end of the island. At the present time, only Forney's Cove at the northwestern tip of Santa Cruz Island is reported to host eelgrass beds on the west side of the island. However, it is likely there are other small occurrences of eelgrass on both the north and south side of the western island.

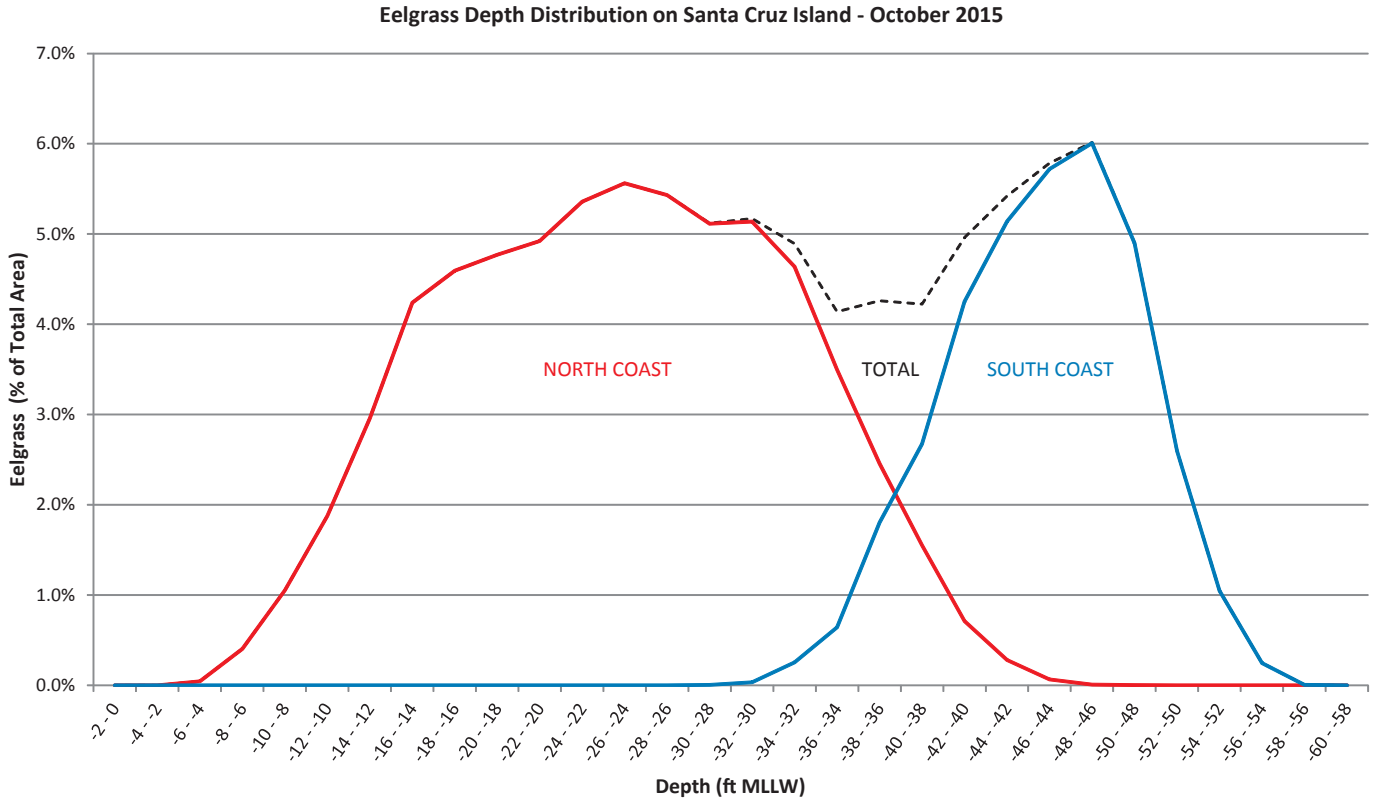
Based on the depth distribution information developed for the east end of the island, it is expected that eelgrass on the west end of the island will tend towards the deeper end of the eelgrass depth range and that any prospecting along the shoreline for smaller beds should employ a search along the approximately -35 foot contour and a second search along the -45 foot contour. These contours should have a very high potential of detecting small beds that have not previously been detected and should also cross through the core of the Forney's Cove eelgrass beds as previously reported by Engle & Miller (2003).

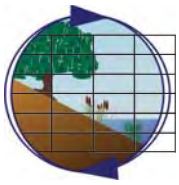


East Santa Cruz Island Overview Map

Southern California Bight Regional Eelgrass Surveys

Figure 2





Santa Cruz Island
Eelgrass Depth Distribution - October 2015
Southern California Bight Regional Eelgrass Surveys

Figure 3

VENTURA/LOS ANGELES COUNTY LINE TO POINT DUME

A 9.3-mile reach of the open coast was surveyed from the Ventura/Los Angeles County Line to the tip of Point Dume. This reach of the mainland coastal was determined to support 21.1 acres of eelgrass extending from the county line to Broad Beach, but not along the extent of Zuma Beach that occupies over 3 miles of the total survey segment length (Figure 4). Eelgrass along this segment of shoreline is presented over bathymetry in Appendix 2. To the west of Zuma Beach, the shoreline and subsurface terrain is marked by various short headlands and patchy reefs with interspersed and seaward beds of medium to fine sand. Between the reefs and typically just seaward of the reefs are scattered beds of Pacific eelgrass. While these beds are generally patchy in growth form, at a landscape level, they appear to run relatively continuously from Point Lechuza at Broad Beach to the end of the survey area.

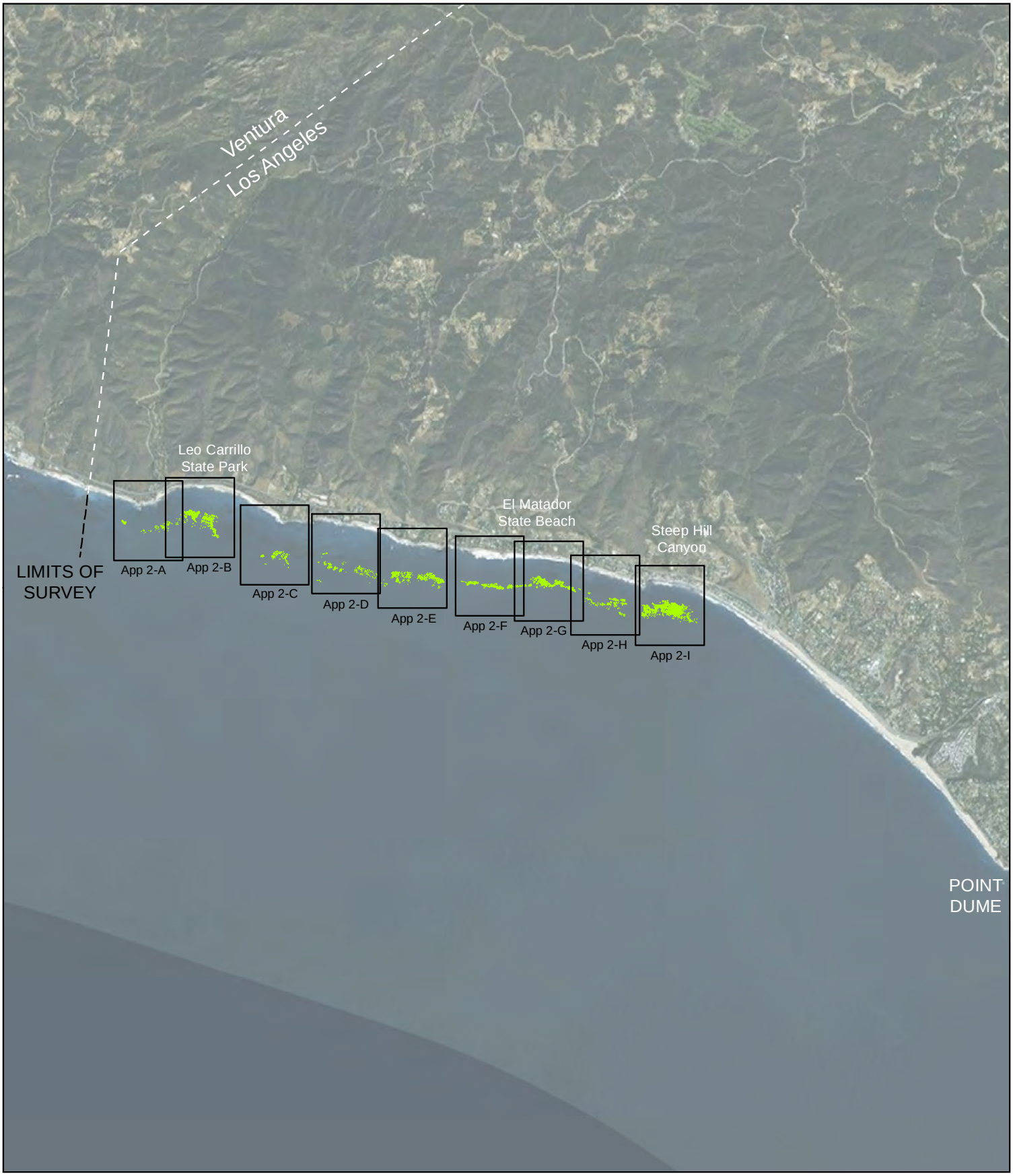
POINT DUME TO MARINA DEL REY

From the tip of Point Dume to Marina del Rey, a 24.5-mile segment of the Santa Monica Bay shoreline was surveyed for eelgrass. Within this segment of the shore, a total of 13.7 acres of Pacific eelgrass was mapped (Figure 5). This eelgrass occurs in disjunct beds off of Malibu Bluffs Park and extending from Corral State Beach westerly along Latigo Shores. Notably, a previously reported large eelgrass bed in Paradise Cove was found to consist of only a handful of scattered plants in October 2015. Eelgrass along this shoreline is presented over bathymetry in Appendix 2.

The depth distribution of eelgrass on the mainland coast revealed a pattern different from that observed on Santa Cruz Island. The shoreline areas west of Point Dume would be expected to be more exposed than areas to the east of Point Dume; and thus, eelgrass beds would be expected to be deeper. However, there is little difference in the shallow edge of eelgrass beds east or west of Point Dume, with beds extending as shallow as -20 feet MLLW to the east of Point Dume and -22 feet MLLW to the west of the point (Figure 6). What is of greater note is that eelgrass extends much deeper to the west (-58 feet MLLW) of Point Dume than to the east of Point Dume (-40 feet MLLW).

The depth distribution of eelgrass east of Point Dume is consistent and narrow, with 90 percent of all of the mapped eelgrass occurring between -26 and -33 feet MLLW. Conversely, to the west of Point Dume, 90 percent of all of the eelgrass extends between -26 and -39 feet MLLW. The skewed occurrence of eelgrass towards deeper environments west of Point Dume suggests that light may be a factor limiting eelgrass to the east of Point Dume as both east and west of Point Dume the bottom below the eelgrass beds tends to continue as a gradually sandy slope that would otherwise be suitable habitat to support eelgrass.

Based on the observations of eelgrass to the west and east of Point Dume, there is little to suggest that eelgrass experiences significantly greater swell energy environments based on the presence of Point Dume. In fact, the wave shadow of Point Conception and the northern Channel Islands severely restricts the potential for direct wave impact within any part of the study area for northwesterly or westerly waves passing through the Santa Barbara Channel. For southwesterly waves, the western side of Point Dume is somewhat more exposed than the areas east of Point Dume. However, both sides of Point Dume experience similar wave environments from direct southerly swell.



Ventura/LA County to Point Dume Overview Map

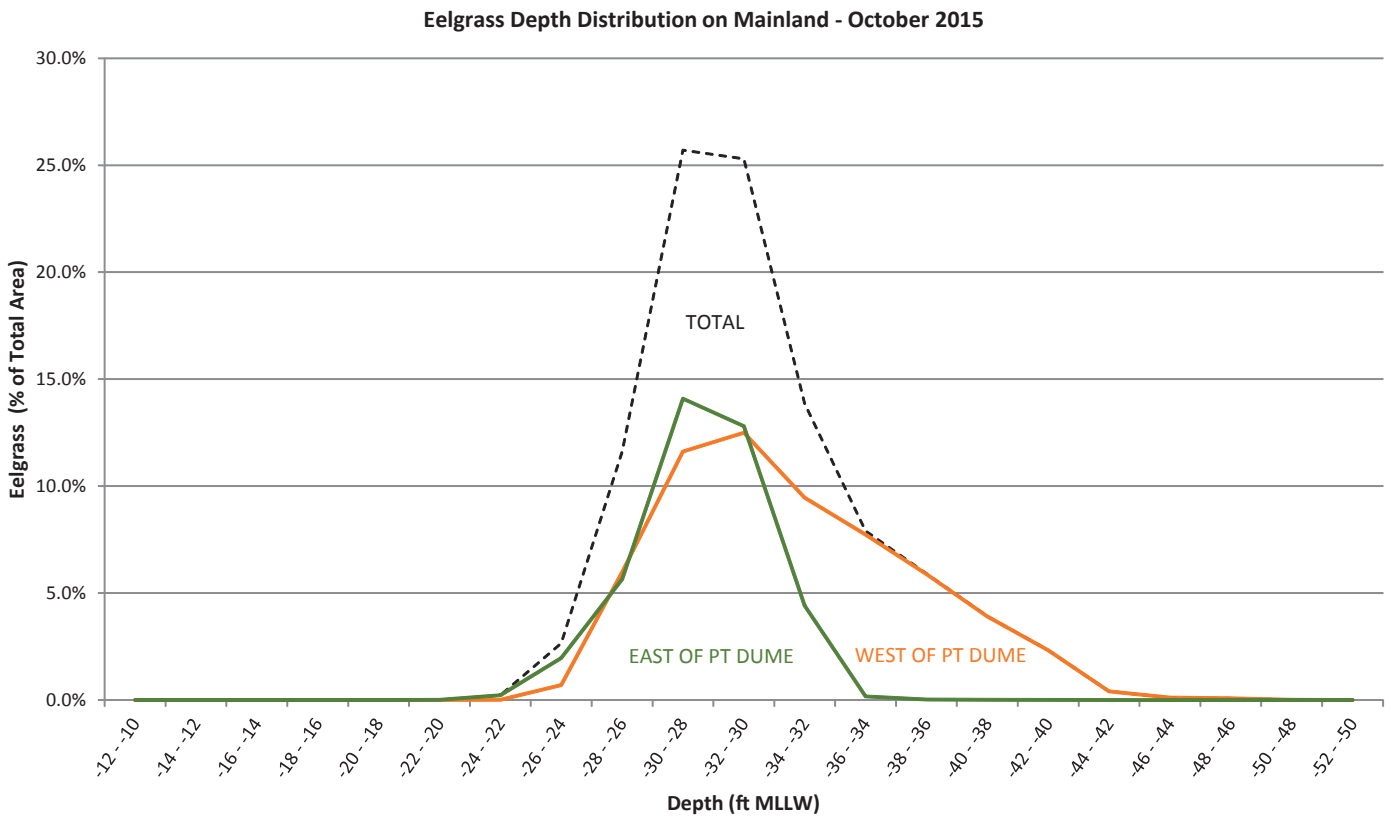
Southern California Bight Regional Eelgrass Surveys

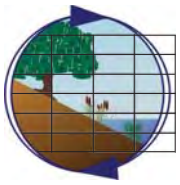
Figure 4

Point Dume to Marina Del Rey Overview Map

Southern California Bight Regional Eelgrass Surveys

Figure 5





Mainland
Eelgrass Depth Distribution - October 2015
Southern California Bight Regional Eelgrass Surveys

Figure 6

SANTA ANA RIVER/HUNTINGTON BEACH WETLANDS COMPLEX

The Santa Ana River wetlands complex has been fragmented, drained, channelized, and otherwise modified significantly through time. Historically, the Santa Ana River met the coastline within a broad estuary and saline marsh complex that covered much of Huntington Beach and portions of Newport Bay, including much of the lower elevations of Banning Ranch. In recent decades, restoration of portions of the marsh complex has been undertaken by numerous parties including the Huntington Beach Wetlands Conservancy and the Army Corps of Engineers. Funding for this work has included grants from NOAA, Coastal Conservancy, and others. As an element of flood control projects and habitat restoration, a priority has been to maintain the tidal inlets of the Santa Ana River and Talbert Channel. This action, coupled with broader habitat restoration efforts, has now resulted in the development of considerable eelgrass habitat within the systems. Within the Huntington Beach Wetlands Complex including Talbert Marsh, Brookhurst Marsh, and Magnolia Marsh, as well as the lower Talbert Channel and Huntington Beach Channel, there was 21.1 acres of eelgrass mapped in 2015. This eelgrass generally occurred within the flood control channels and deeper excavated channel system of the restored marshlands. The eelgrass present was all *Zostera marina* and grew in dense beds across the shallow channels.

The Santa Ana River estuary consists of the main river channel and the northern and southern Santa Ana River Marsh. This system is connected to the Pacific by a separate jetty defined inlet than is the Huntington Beach Wetlands Complex. The channel was cleared by the Army Corps of Engineers in 2004-2005 and has subsequently been influenced by considerable sediment shifting and depositing in a flood shoal and bars along the channel. In August 2004, the channel supported very scattered eelgrass based on inspection of aerial photographs taken for the design of the adjacent Huntington Beach Wetlands Complex (K. Merkel, pers. obs.). It is estimated that less than 0.1 acre of eelgrass occurred in the lower river at that time, although the extent of eelgrass was not mapped.

Since the completion of the Corps' channel excavation, a shallow flat basin has developed in the mainstem of the Santa Ana River estuary behind the littoral flood shoal at the mouth of the river and downstream of most of the fluvial bars. This basin supported 7.8 acres of eelgrass in 2015 (Figure 7). Within the northern and southern portions of the Santa Ana River Marsh (defined by separate tidal inlets to the mainstem of the River), a combined total of less than 0.1 acre of eelgrass occurs within a scattered number of small patches that are mostly defined by single of a sparse few plants (Figure 7). The presence of eelgrass within the marshes generally diminishes with distance from the tidal inlet to the river channel. No bathymetric mapping was performed with this system since data were collected by aerial photographs rather than vessel.

The Santa Ana River eelgrass beds are likely to be highly variable and transitory in nature due to the immense flood damage they likely suffer during normal seasonal storm events as well as large storm flows. The present broad extent of eelgrass (7.8 acres) within the Santa Ana River is likely an anomalous condition for this estuary and the result of a persistent drought over the past few years with no substantial flood events passing through the system. Because the river mouth is located only 1,200 feet (360 meters) down coast from the Huntington Beach Wetland Complex ocean inlet at Talbert Marsh, regular recolonization by eelgrass is expected to be common, even after large storms completely eliminate eelgrass from the system. As a result, this system may experience intermittent extirpation and recolonization events through time.

Santa Ana River/Huntington Beach Wetalnd Complex
Eelgrass Distribution March 2015

Southern California Bight Regional Eelgrass Surveys

Figure 7

DISCUSSION

SUMMARY OF SURVEY RESULTS

The results of the 2015 eelgrass surveys conducted under this inventory effort are summarized in Table 2. In total, 251.2 acres of eelgrass was mapped during the 2015 inventory. Surveys covered approximately 34 miles of the mainland coast in Santa Monica Bay and Basin, 26 miles of coastline on Santa Cruz Island in the northern Channel Islands, and approximately 339 acres of the marsh and estuarine complex at the Santa Ana River and Huntington Beach Wetlands Complex.

Table 2. Eelgrass Coverage by Inventory Area

Survey Area	2015 Eelgrass Coverage (Acres)
Northern Santa Monica Bay (Marina del Rey to Point Dume)	13.7
Point Dume to Los Angeles/Ventura County Line	21.1
Eastern Santa Cruz Island (North Side)	121.7
Eastern Santa Cruz Island (South Side)	66.5
Lower Santa Ana River	7.8
Santa Ana River Marsh (Northern and Southern)	>0.1
Huntington Beach Wetlands/Talbert & Huntington Beach Channels	20.4

In all instances, the extent of eelgrass observed within the survey areas was greater than anticipated based on prior reports of and incidental observations of eelgrass. As was noted in the 2014 survey of San Clemente Island, historically eelgrass on the Channel Islands and on the open mainland coast has been considered to be a relatively minor habitat feature in the context of the more extensively inventoried eelgrass beds of enclosed bays and estuaries. However, that perception is proving to be incorrect. In 2013, the statewide estimate for eelgrass was limited to less than 15,000 acres, with open coastal eelgrass and insular eelgrass area being largely unknown (Merkel 2013). Southward from Morro Bay, the documented eelgrass totals less than 5,500 acres (Bernstein et al. 2011). This means that eelgrass on the eastern end of Santa Cruz Island alone totals approximately 3.4 percent of the previously documented eelgrass in southern California. In addition, the documented eelgrass from the Navy's survey of San Clemente Island and the previously noted occurrences on the broader Channel Islands (Engle & Miller 2003) suggests that the insular eelgrass in southern California may contribute much more substantially than previously believed. This is especially true when considering the relatively high number of larger size class beds reported in Engle & Miller (2003) on Santa Rosa and Santa Catalina Island and that, thus far, both Santa Cruz and San Clemente Island eelgrass has been more extensive within the recorded beds and more widely distributed than previously recorded.

While largely omitted from regional inventories and habitat management consideration, the open coastal beds may be of great importance for a multitude of reasons. First, these beds are much more substantial in scale than once believed. Second, because of the high productivity of eelgrass, it would contribute considerable detritus to the nearshore food web of the islands and support more abundant and diverse benthic invertebrate communities than unvegetated sand bottom where instability and low levels of organic carbon can limit benthos. Further, the nursery functions of eelgrass are well documented within mainland habitats, and abundant observations of juvenile fish within insular eelgrass beds suggest these beds may be equally important to island fish

populations. In addition, eelgrass beds on the islands provide foraging areas for fish, mobile and sessile invertebrates, and diving birds. These areas may also provide habitat for migratory turtles.

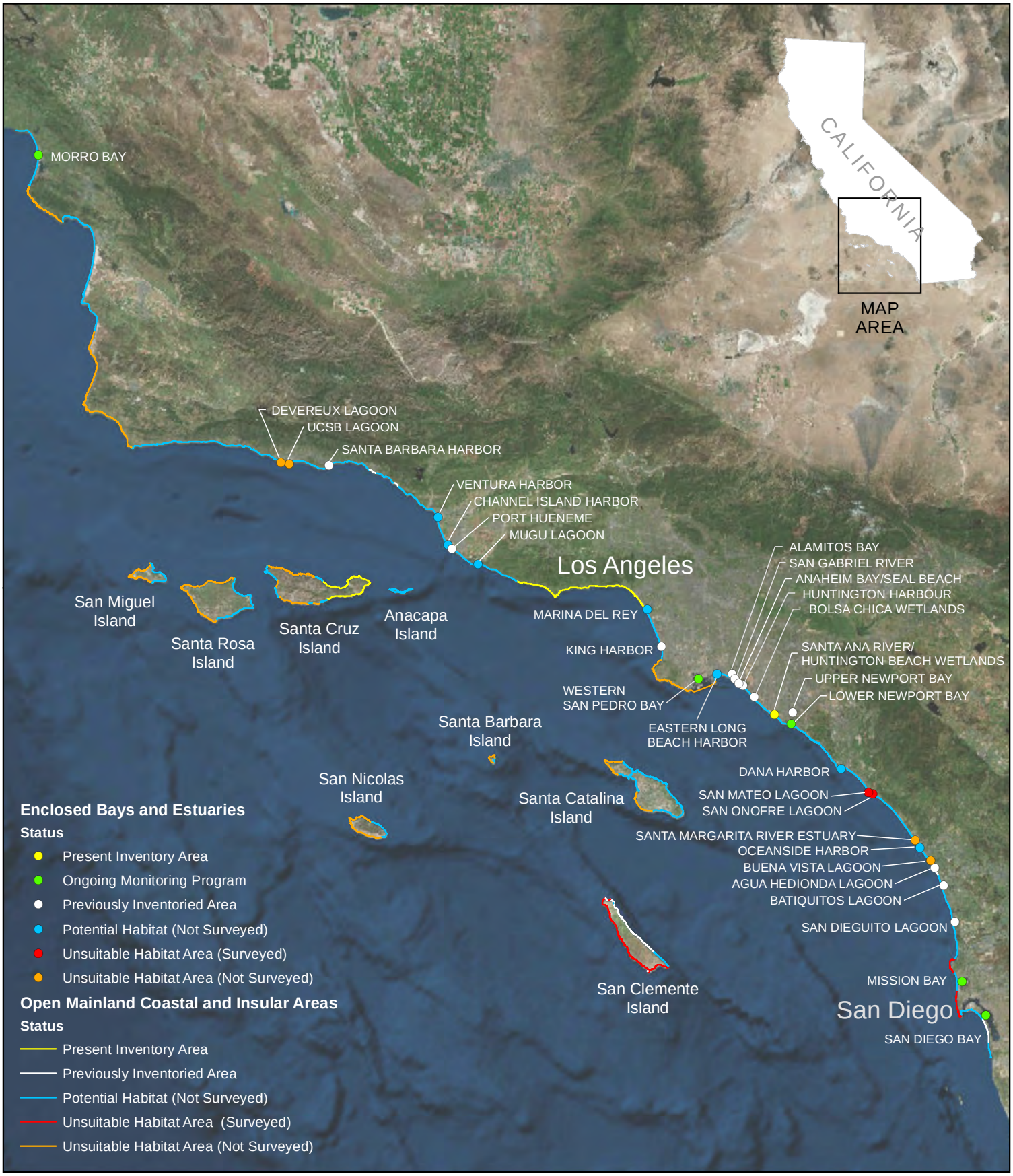
Within insular and open coastal environments, the production capacity of eelgrass and the detrital trapping character of eelgrass beds may provide tremendous benefits in otherwise resource poor sandy environments. Considerable effort has been put towards quantifying the value of eelgrass ecosystem services, including services of sequestering carbon and nutrients. One recent estimate suggests that a hectare of eelgrass sequesters 98.6 tons of carbon and 466 kg of nitrogen more than an unvegetated sea floor (Cole & Moksnes 2015). This would suggest that these relatively large open coastal beds may have service values well beyond the environments within which they persist.

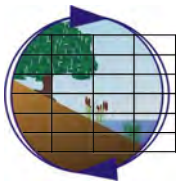
In addition to providing ecosystem services of a similar nature to enclosed bays and estuaries, open coastal and insular beds may also be somewhat buffered against stressors that can seriously damage beds within enclosed bays and estuaries. These include thermal stress, high turbidity levels and algal blooms, dredging and waste spills, as well as disease. This buffering against losses from environmental stressors that typically affect enclosed bays and estuaries would assist to retain eelgrass ecosystem functions in the face of continued losses in enclosed waters. Conversely, these open coastal beds would be susceptible to different stressors of persistent red tides or significant coastal storm damage. What is clear is that open coastal and insular eelgrass beds have the potential to perform substantially different from that within enclosed bays and estuaries.

REGIONAL INVENTORY STATUS

Since the completion of *Recommendations for a Southern California Regional Eelgrass Monitoring Program* (Bernstein, *et al.* 2011), considerable efforts have been made to fill eelgrass data gaps. These have included completion of a number of surveys in un-investigated surveys, as well as expanding inventories to open coastal and island environments. Figure 8 depicts the 2015 status of data and data gaps in regional eelgrass inventories. At the present time, nearly all of the enclosed bays and estuaries have been examined comprehensively with at least one full survey. Those that have not been surveyed exhaustively include a number of regularly closed systems that are considered to be unsuitable habitat and the following: Ventura Harbor, Channel Islands Harbor, Mugu Lagoon, Dana Harbor, and Oceanside Harbor (Figure 8). Several of these systems have had some level of survey completed, but no comprehensive inventories have been completed in these areas.

On the mainland, shoreline surveys have been completed over the current segment of Santa Monica Bay to the Ventura County Line, as well as along portions of the City of San Diego, a small section of Carpenteria, and Ventura County. However, the vast majority of the coastline has not been surveyed at this time. Segments from Point Conception to the Santa Barbara/Ventura County Line have the greatest potential to add significantly to the known total area of open coastal eelgrass. However, there is eelgrass known or reported to occur in many scattered areas along the open coast, particularly where there is some swell protection. On the islands, every island supports some area where there is potential for eelgrass to occur. However, in general, the westerly exposures of the islands are not expected to support eelgrass.





2015 Regional Survey Status

Southern California Bight Regional Eelgrass Surveys

Figure 8

LIMITATIONS ON SURVEY APPLICATIONS

The completed surveys are intended to provide a benchmark survey condition against which subsampling surveys in accordance with the 2011 regional eelgrass monitoring recommendations may be used to track trends in eelgrass on a system segment, system, and regional basis. The surveys have been conducted for resource monitoring and management purposes in a regional context. The surveys are not suited to application in project specific impact evaluations. Application of such surveys to this purpose may over or underestimate eelgrass within project areas. For this reason, users of this document are strongly cautioned regarding the applicability of the data for purposes beyond the intended use.

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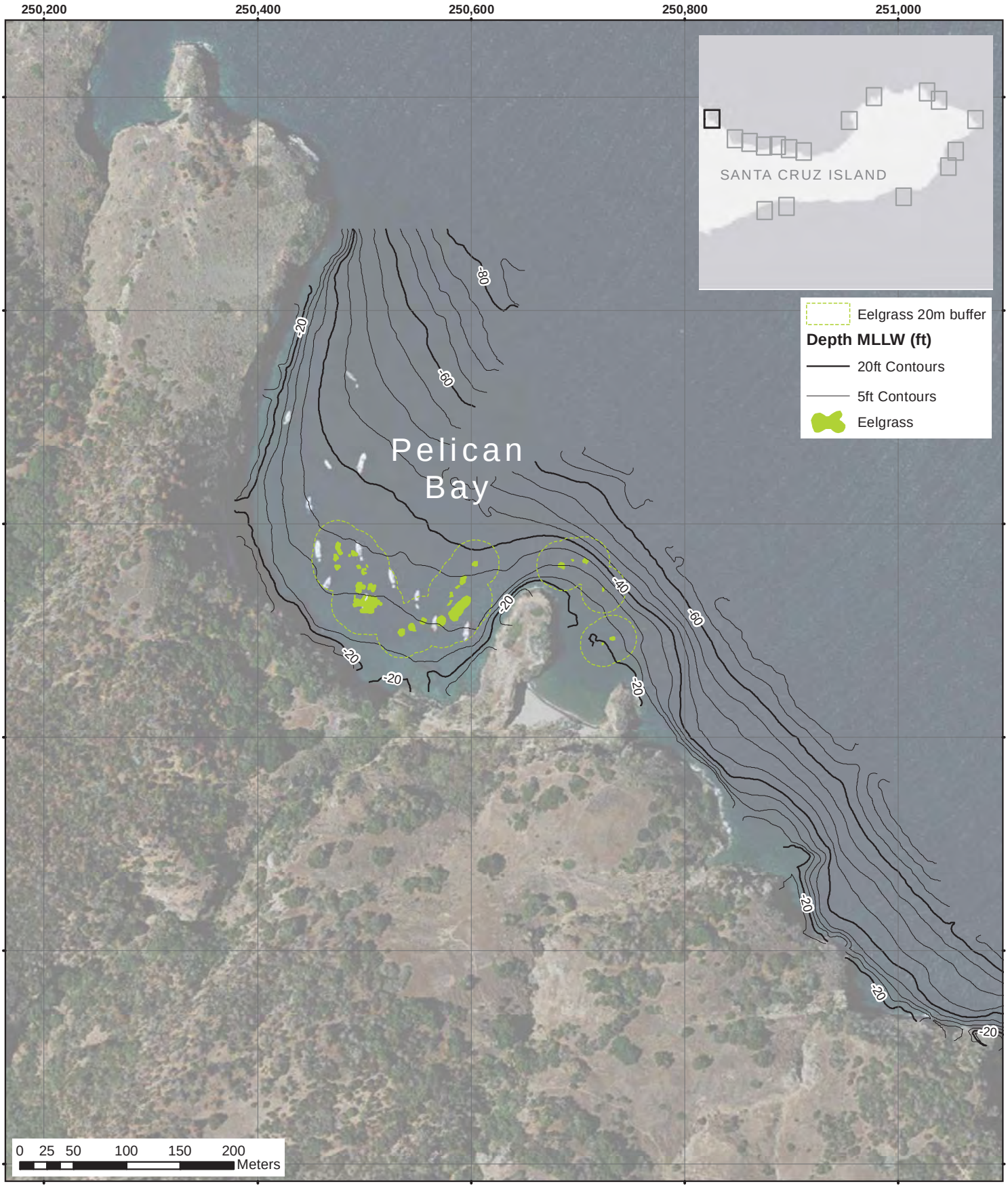
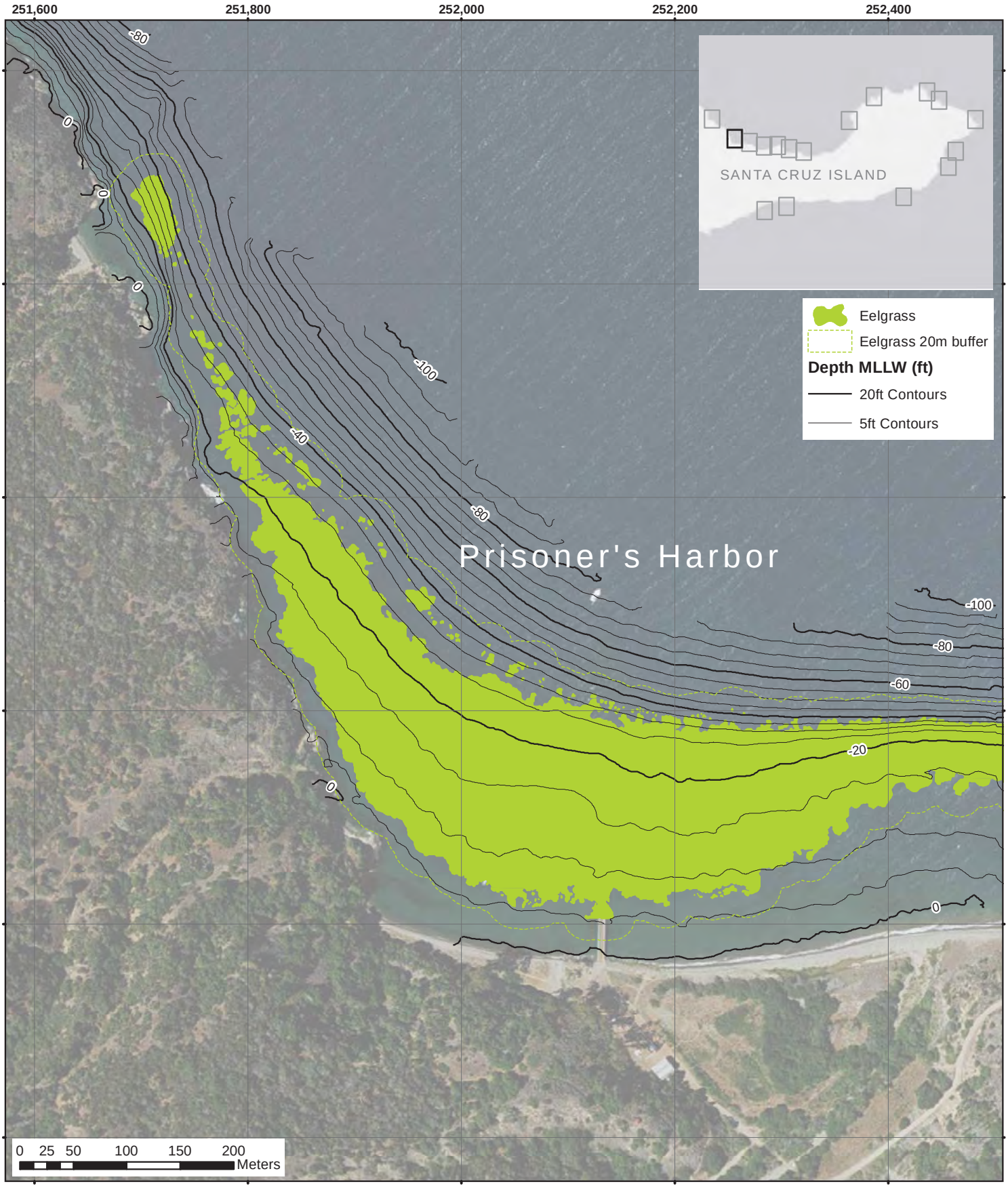
Appendix 1. Eastern Santa Cruz Island Eelgrass Beds – October 2015



Pelican Bay
Eelgrass Distribution - October 2015
Southern California Bight Regional Eelgrass Surveys

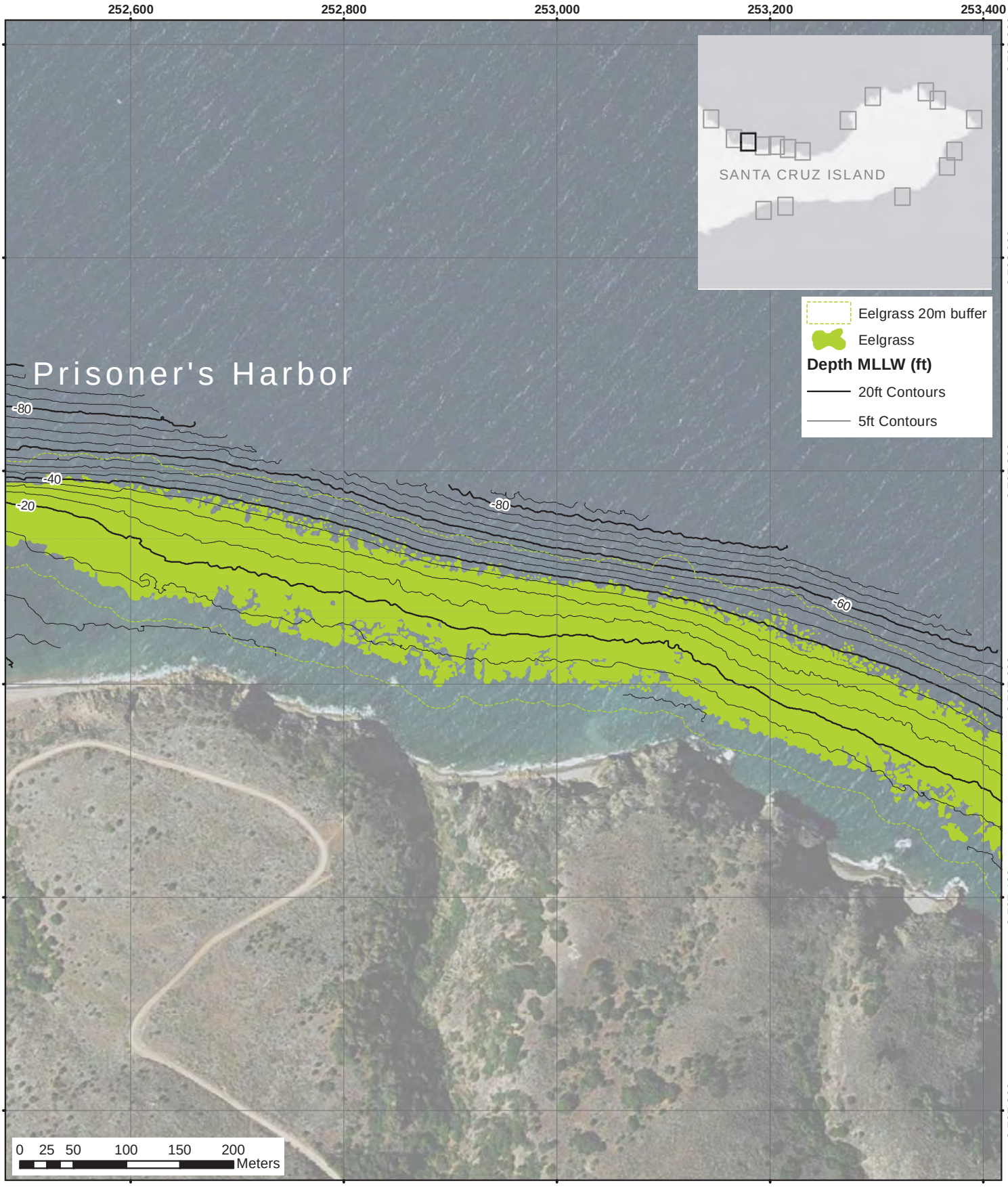
Appendix 1-A



Prisoner's Harbor
Eelgrass Distribution - October 2015
Southern California Bight Regional Eelgrass Surveys

Appendix 1-B

Merkel & Associates, Inc.



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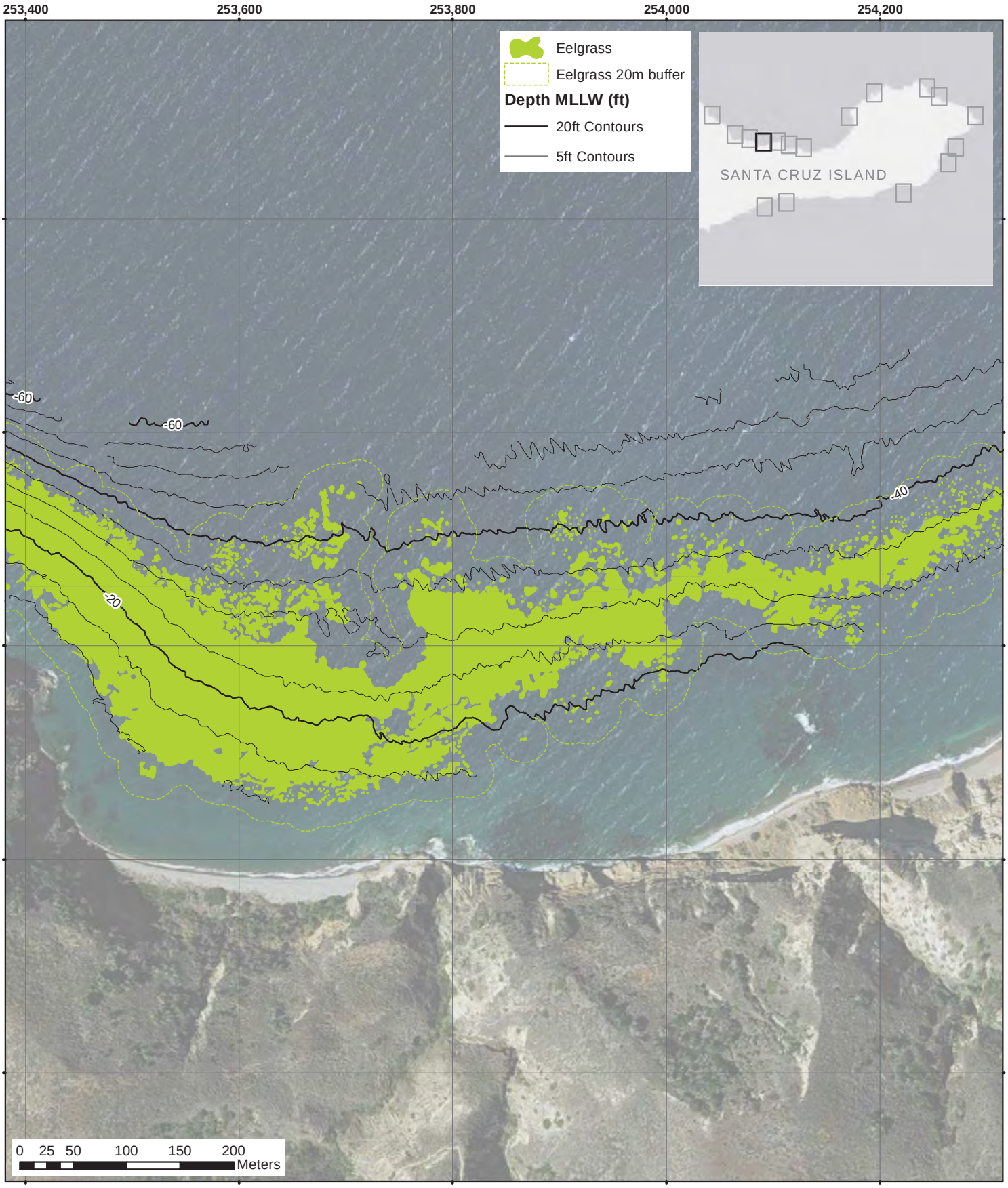
Prisoner's Harbor East
Eelgrass Distribution - October 2015
Southern California Bight Regional Eelgrass Surveys

Appendix 1-C



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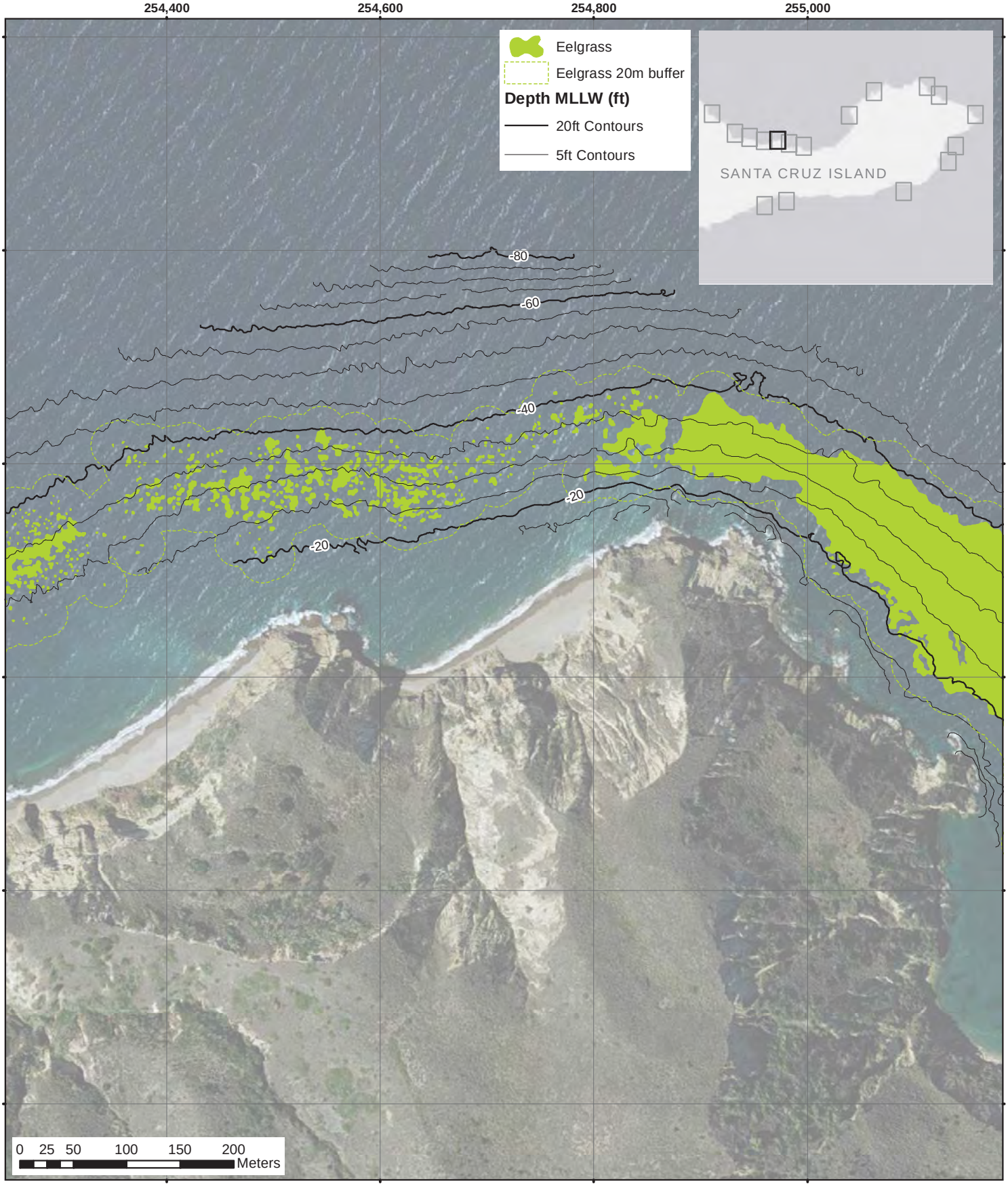
Canada del Agua West
Eelgrass Distribution - October 2015
Southern California Bight Regional Eelgrass Surveys

Appendix 1-D



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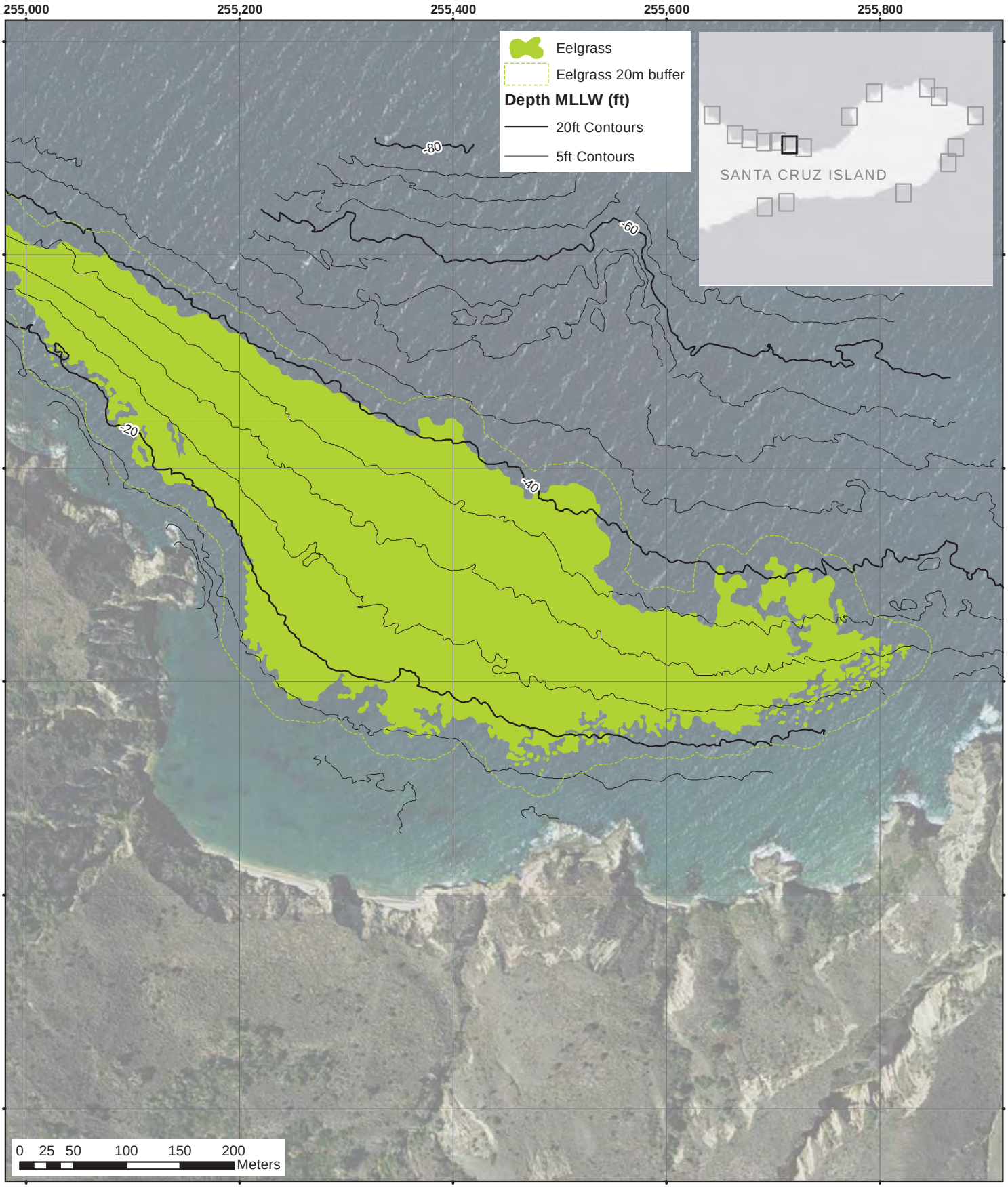
Canada del Agua East
Eelgrass Distribution - October 2015
Southern California Bight Regional Eelgrass Surveys

Appendix 1-E



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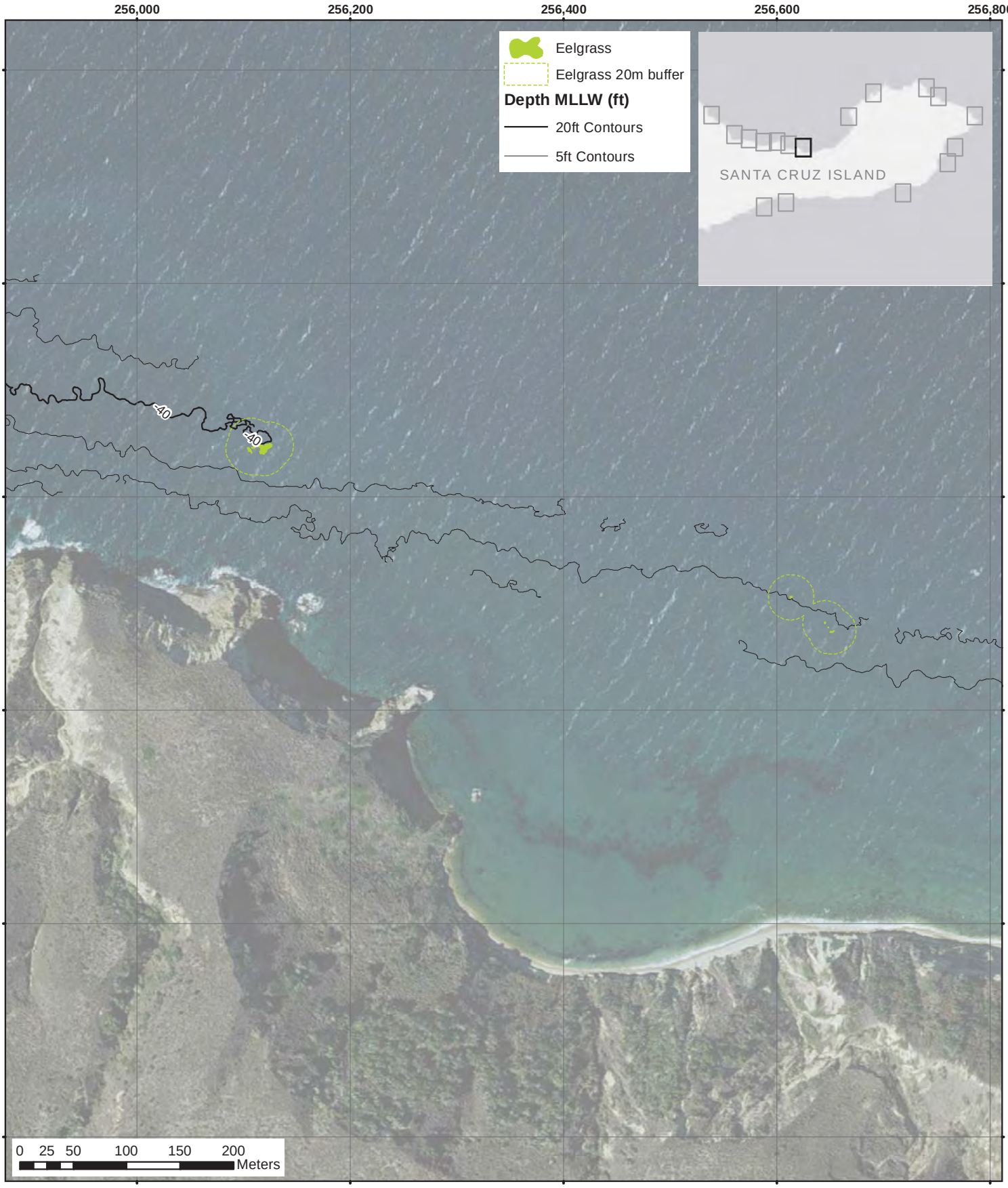
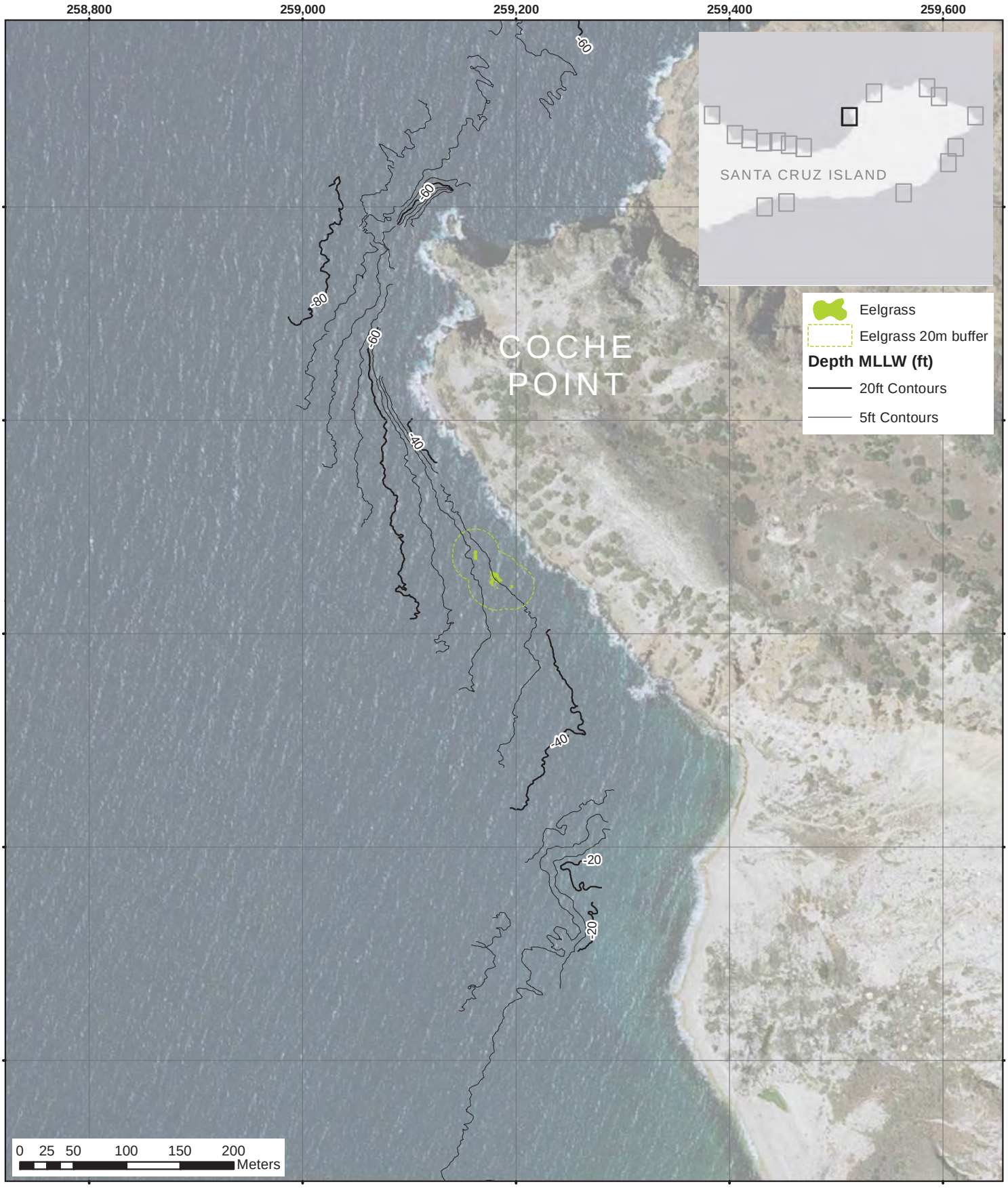
Aguaje Escondido West
Eelgrass Distribution - October 2015
Southern California Bight Regional Eelgrass Surveys

Appendix 1-F



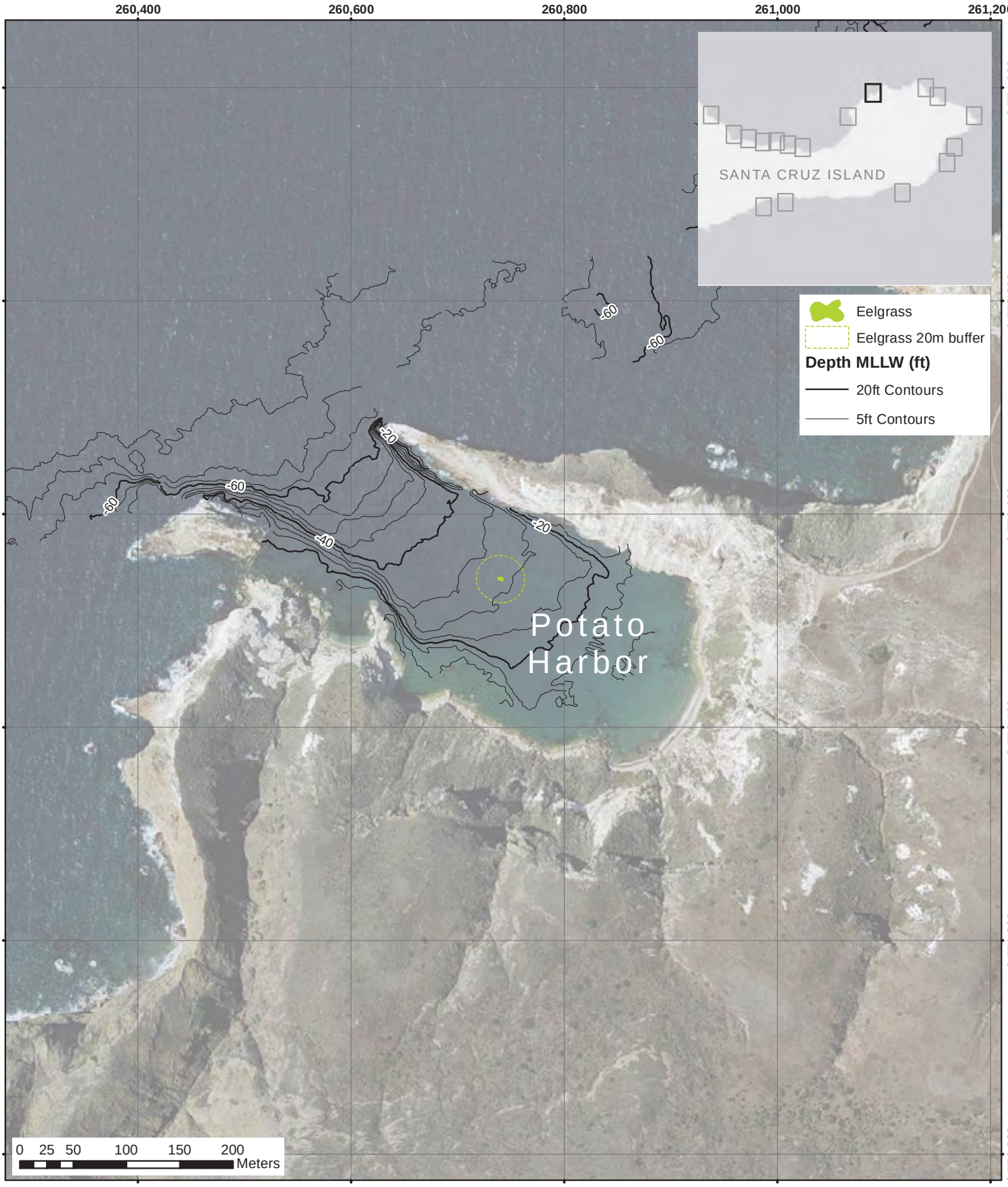
Aguaje Escondido East
Eelgrass Distribution - October 2015
Southern California Bight Regional Eelgrass Surveys

Appendix 1-G



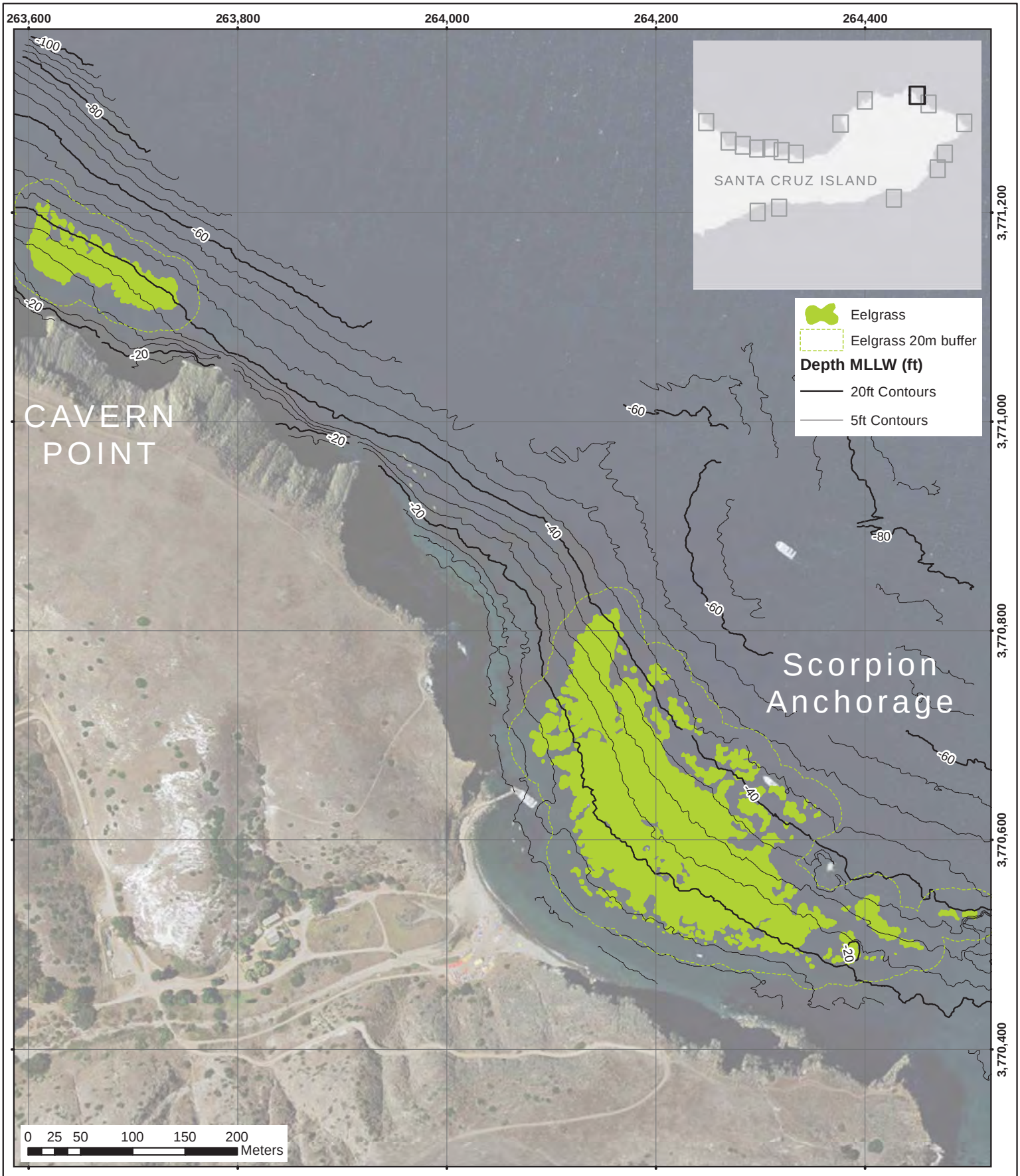
Coche Point
Eelgrass Distribution - October 2015
Southern California Bight Regional Eelgrass Surveys

Appendix 1-H



Potato Harbor
Eelgrass Distribution - October 2015
Southern California Bight Regional Eelgrass Surveys

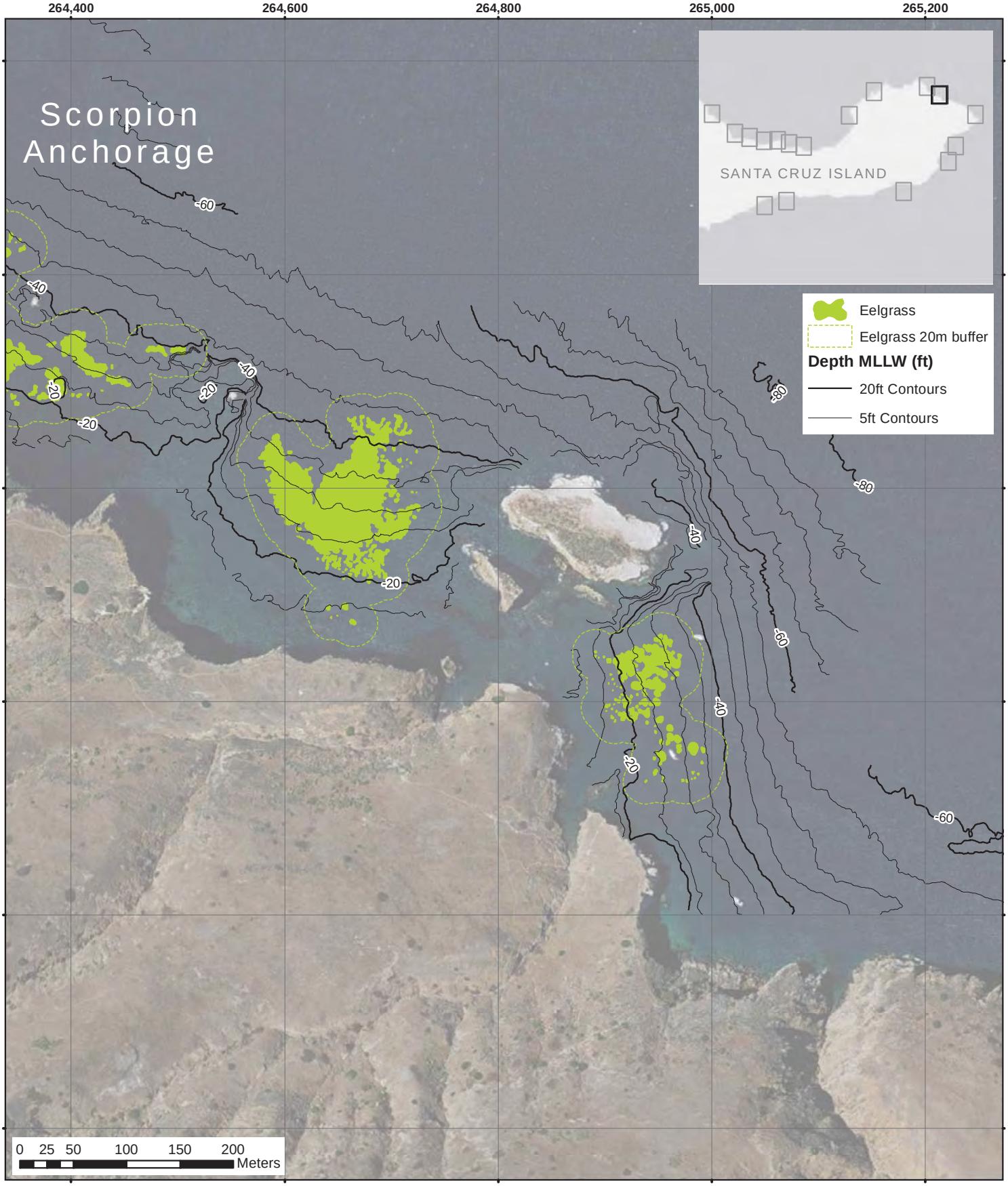
Appendix 1-I

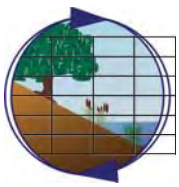


Cavern Point - Scorpion Anchorage West
Eelgrass Distribution - October 2015

Southern California Bight Regional Eelgrass Surveys

Appendix 1-J

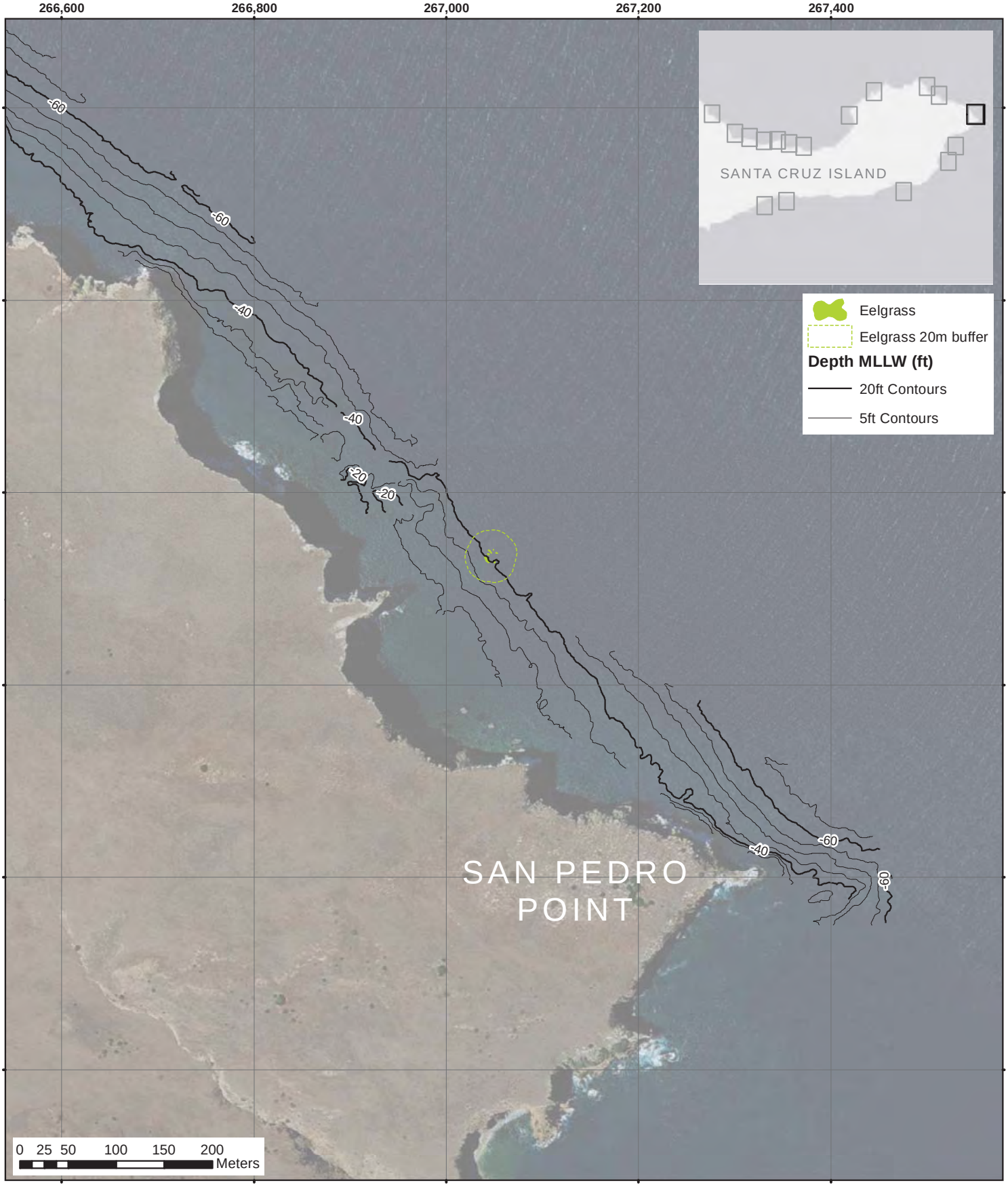




Scorpion Anchorage - Little Scorpion Anchorage Eelgrass Distribution - October 2015

Southern California Bight Regional Eelgrass Surveys

Appendix 1-K



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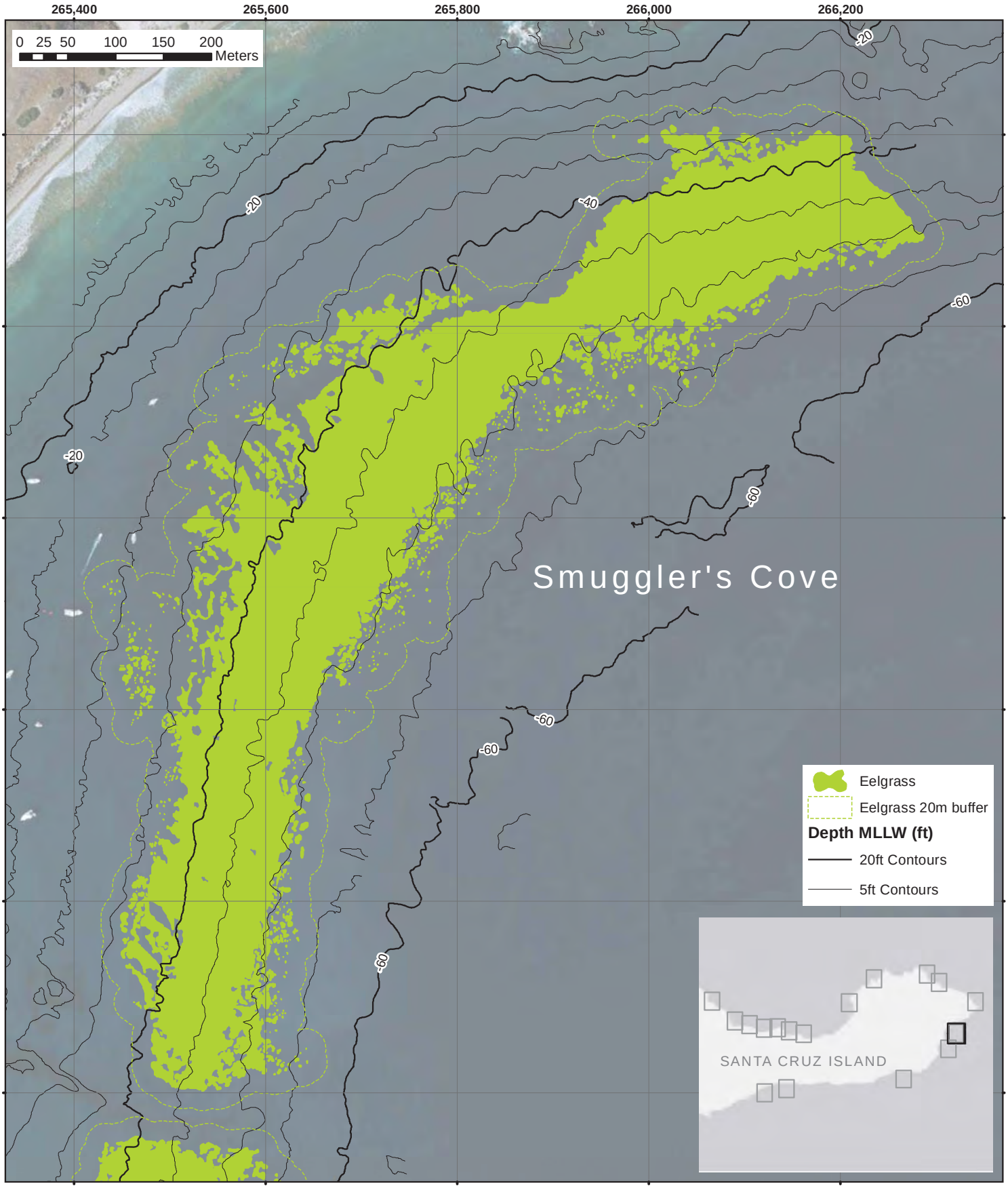
San Pedro Point
Eelgrass Distribution - October 2015
Southern California Bight Regional Eelgrass Surveys

Appendix 1-L



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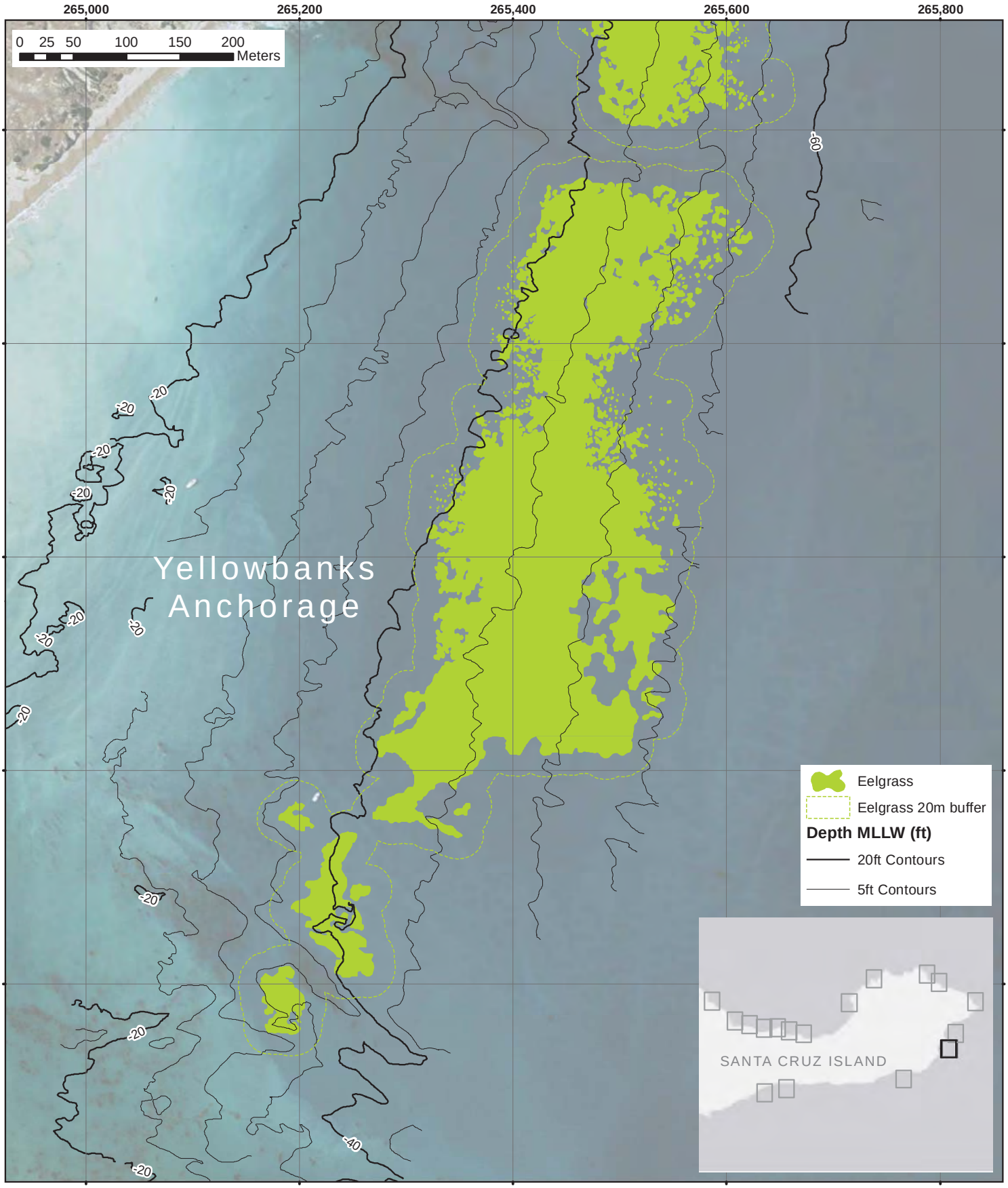
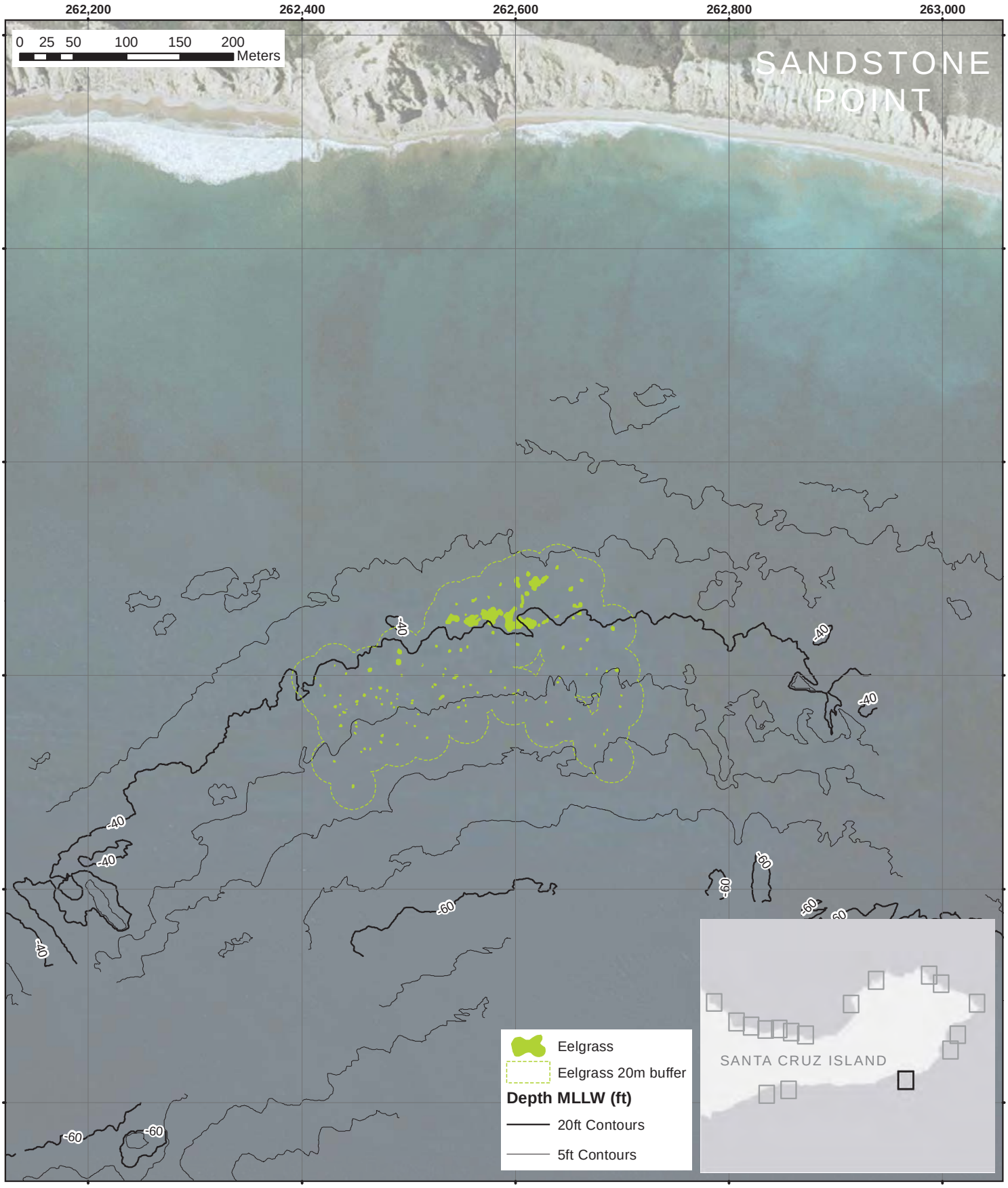
Smuggler's Cove
Eelgrass Distribution - October 2015
Southern California Bight Regional Eelgrass Surveys

Appendix 1-M



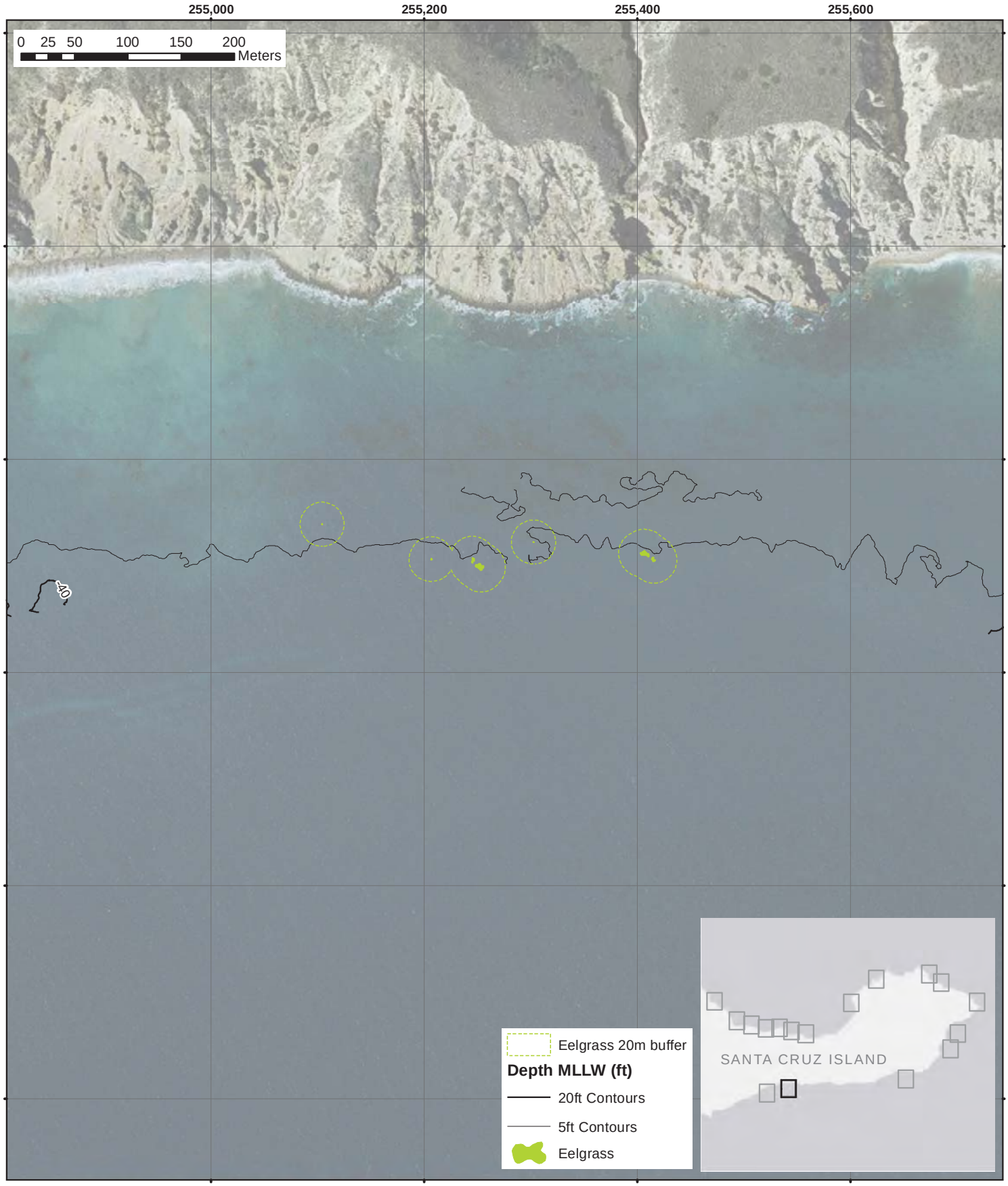
Yellowbanks Anchorage
Eelgrass Distribution - October 2015
Southern California Bight Regional Eelgrass Surveys

Appendix 1-N



Sandstone Point
Eelgrass Distribution - October 2015
Southern California Bight Regional Eelgrass Surveys

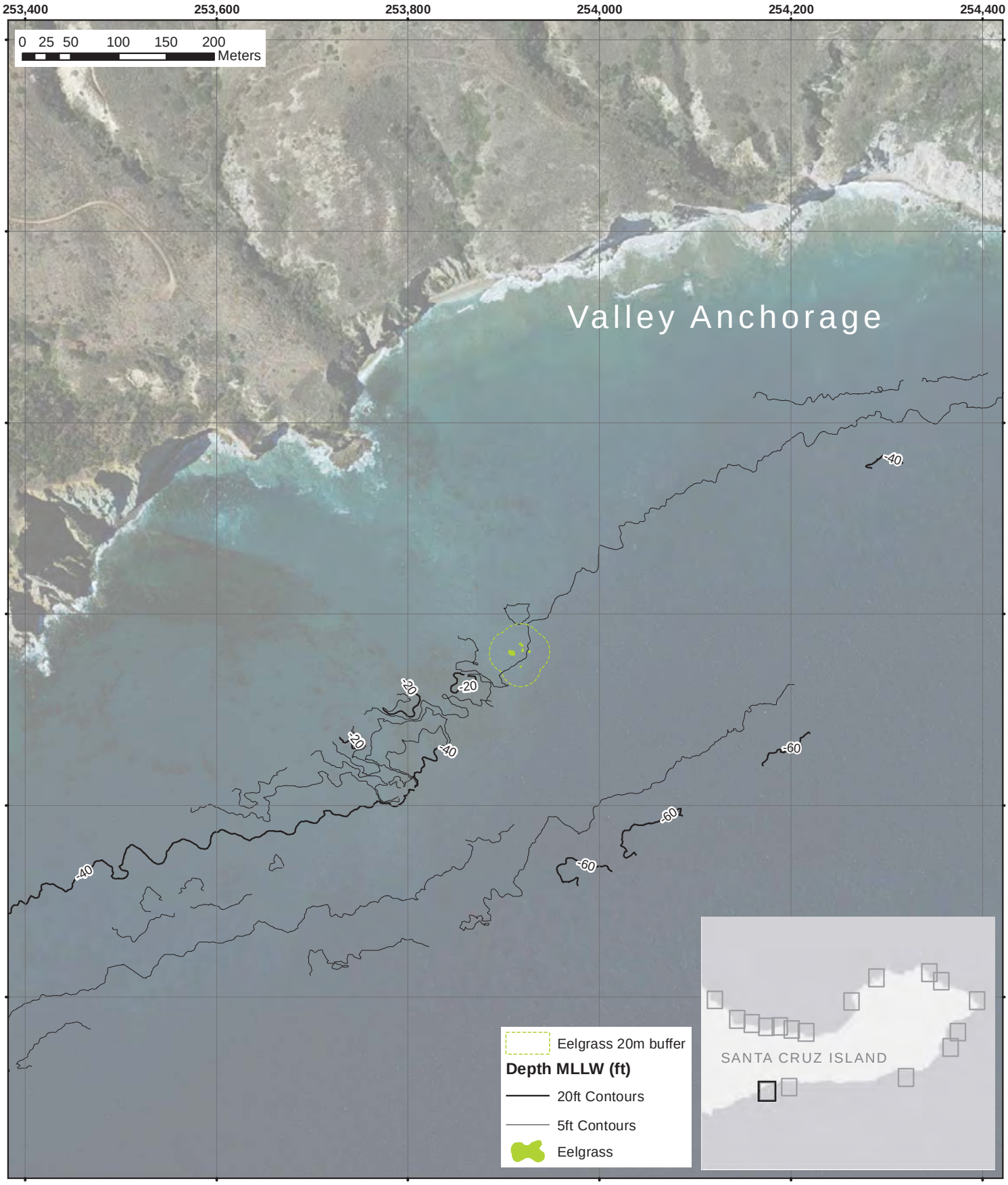
Appendix 1-O



Valley Anchorage East
Eelgrass Distribution - October 2015

Southern California Bight Regional Eelgrass Surveys

Appendix 1-P

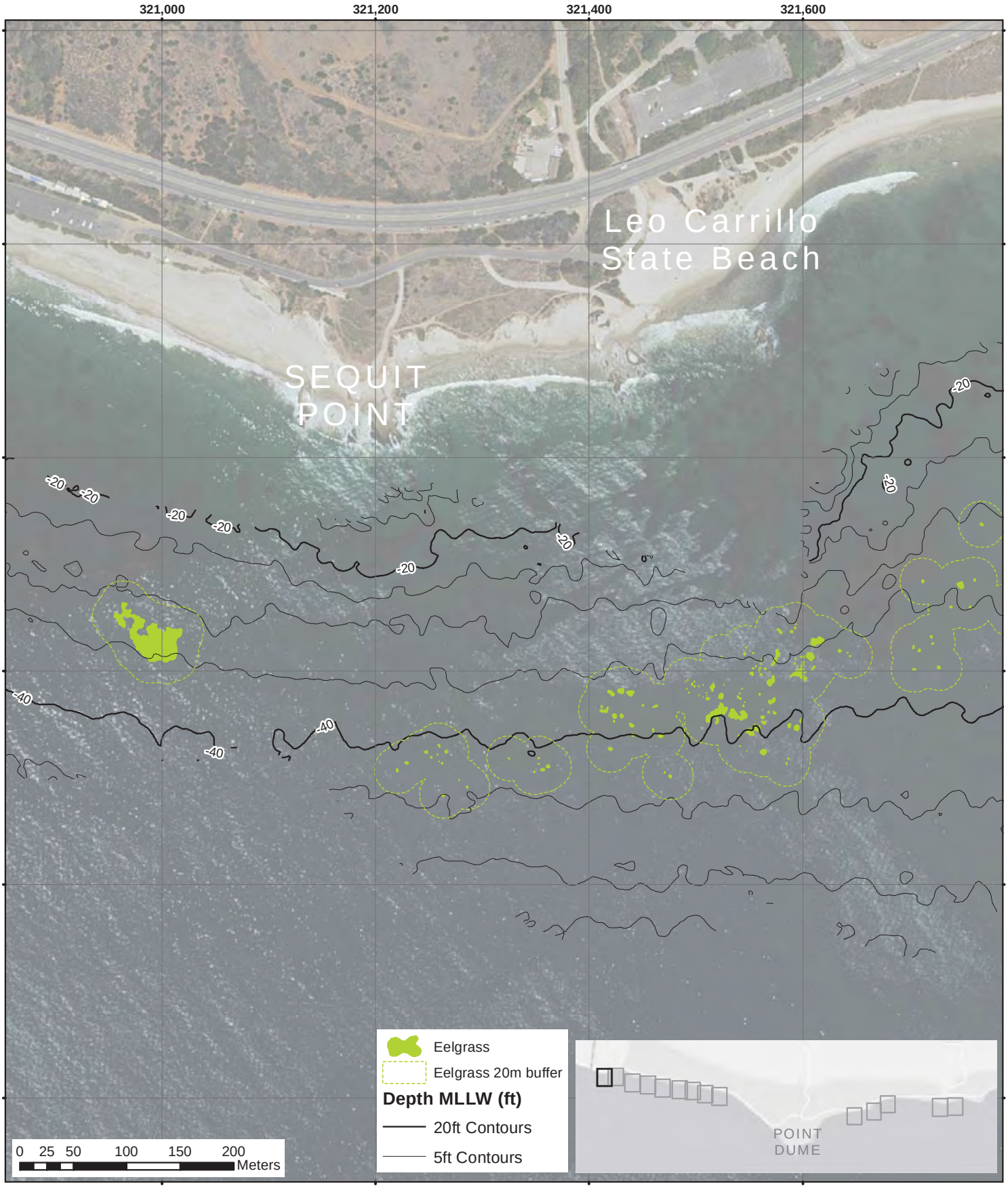


Valley Anchorage - Little Scorpion Anchorage
Eelgrass Distribution - October 2015

Southern California Bight Regional Eelgrass Surveys

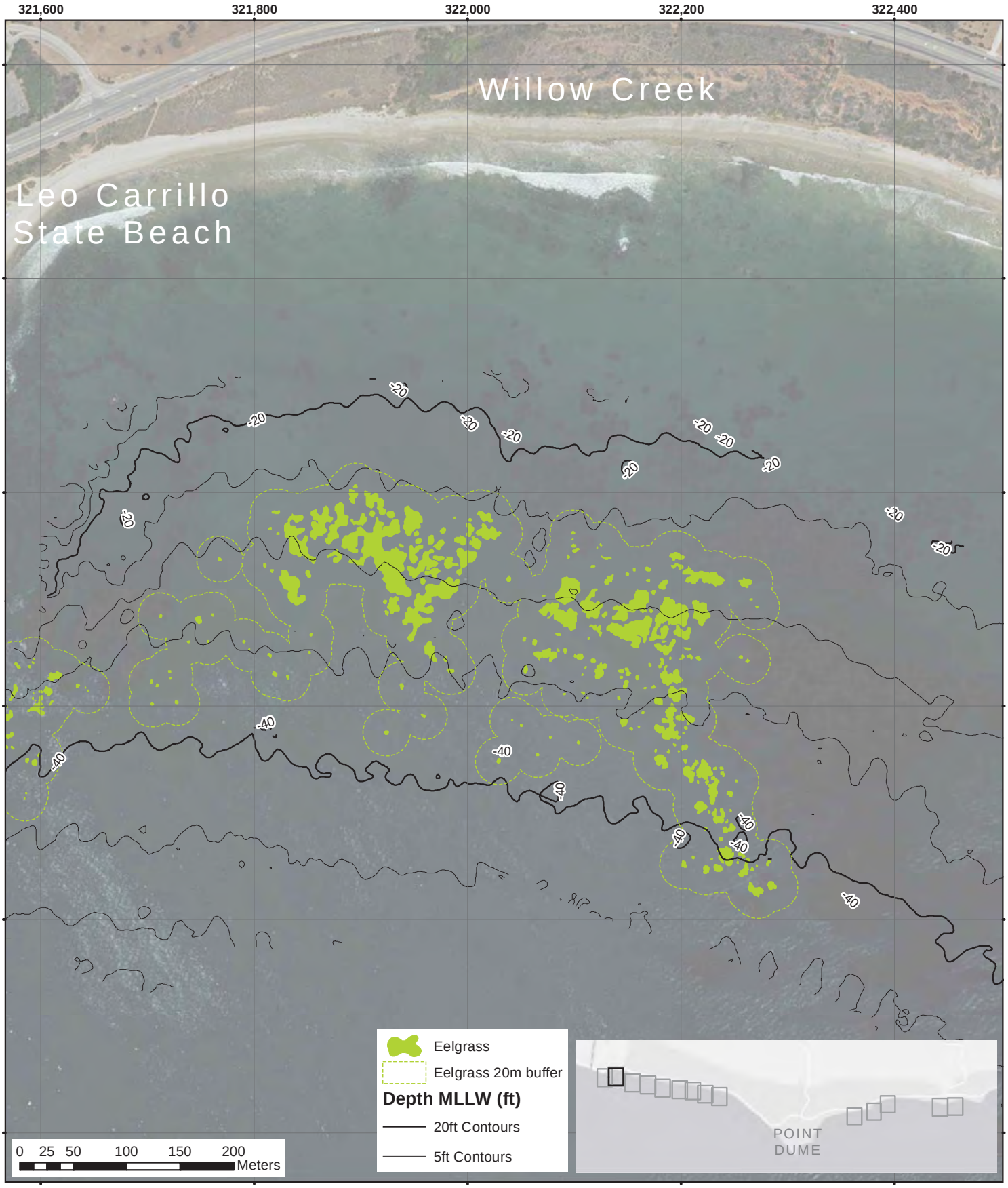
Appendix 1-Q

Appendix 2. Ventura/Los Angeles County Line to Marina Del Rey Eelgrass Beds – October 2015



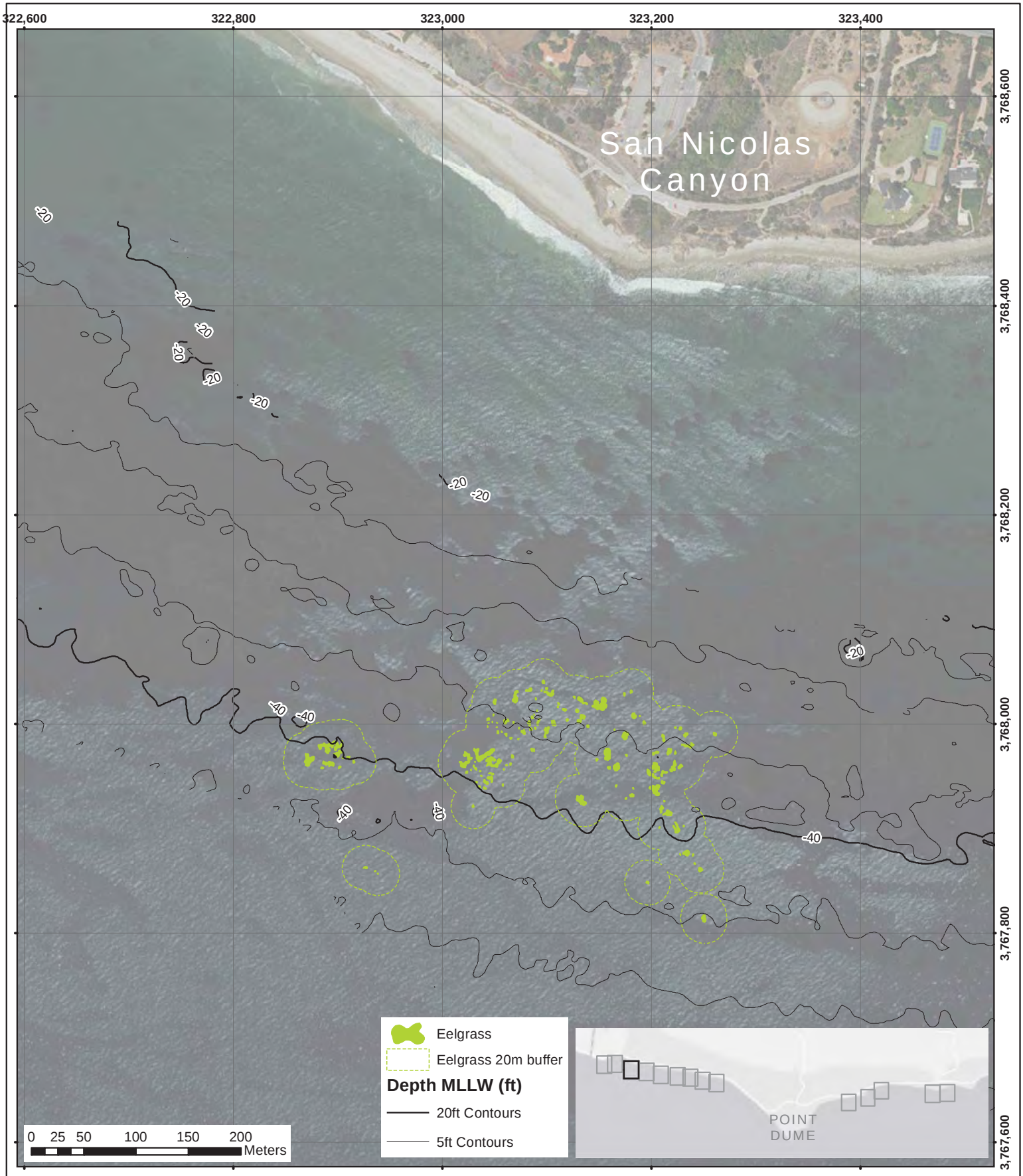
Sequit Point - Leo Carrillo State Beach
Eelgrass Distribution - October 2015
Southern California Bight Regional Eelgrass Surveys

Appendix 2-A



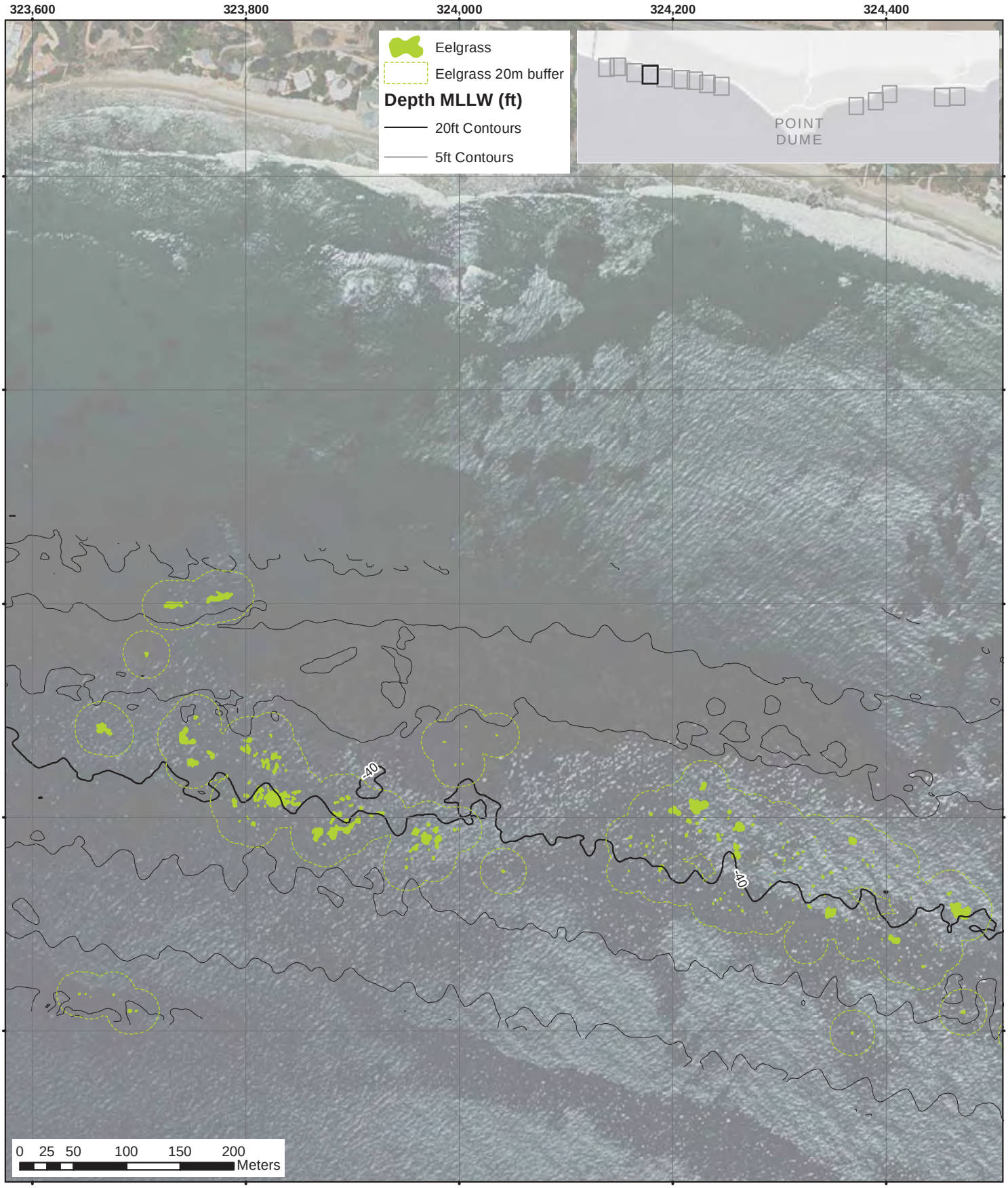
Leo Carrillo State Beach - Willow Creek
Eelgrass Distribution - October 2015
Southern California Bight Regional Eelgrass Surveys

Appendix 2-B



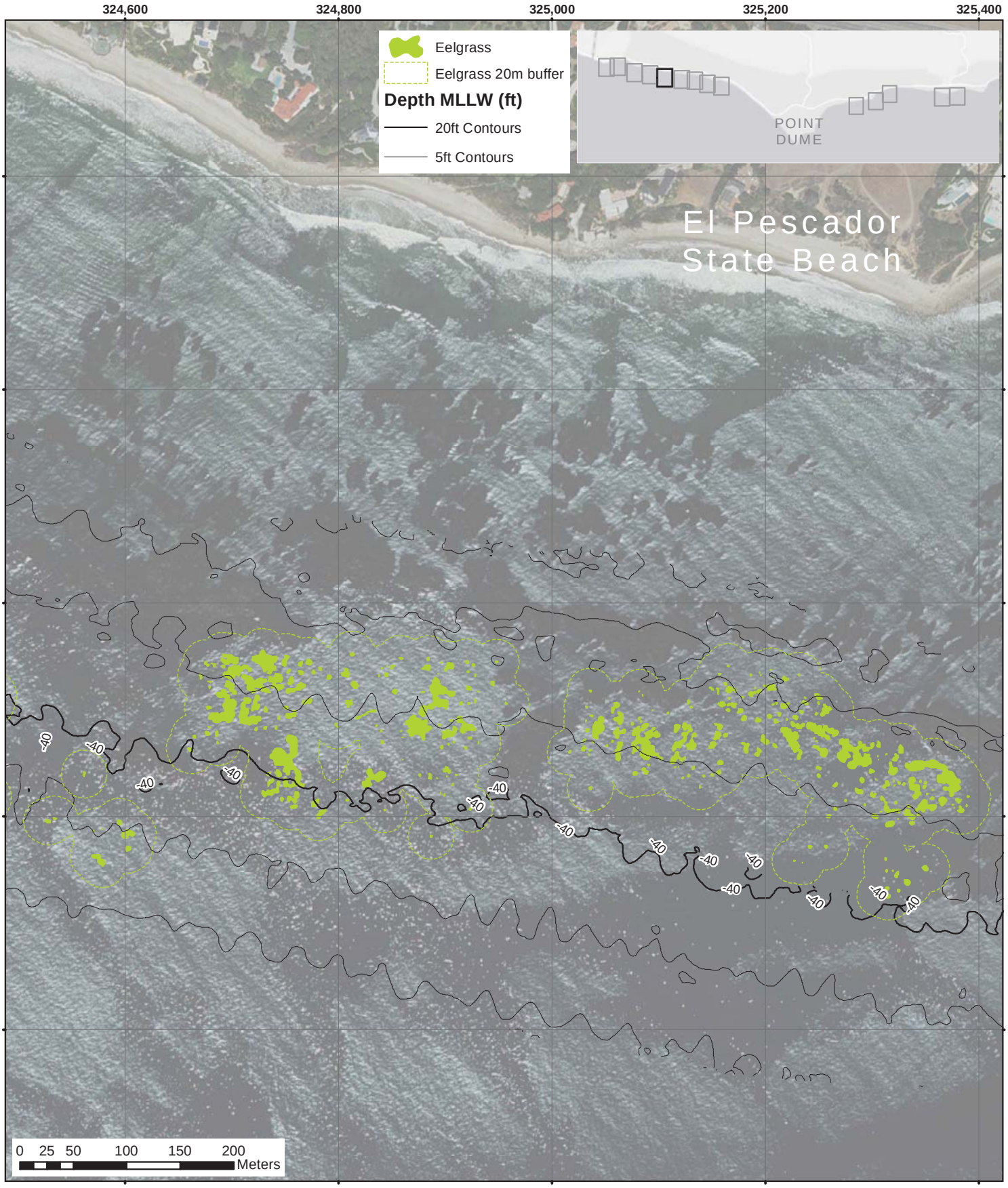
San Nicolas Canyon
Eelgrass Distribution - October 2015
Southern California Bight Regional Eelgrass Surveys

Appendix 2-C



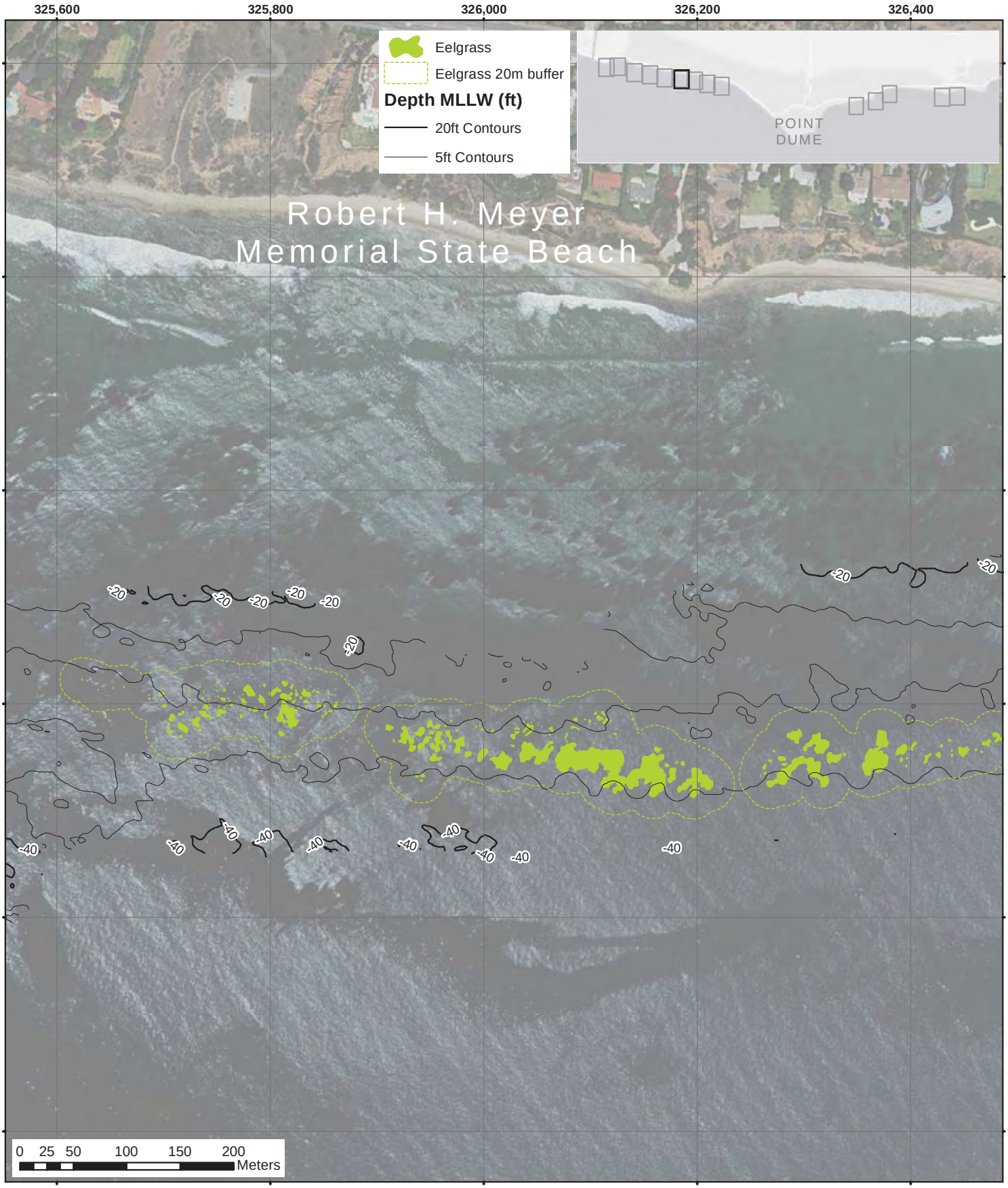
San Nicolas Canyon East
Eelgrass Distribution - October 2015
Southern California Bight Regional Eelgrass Surveys

Appendix 2-D



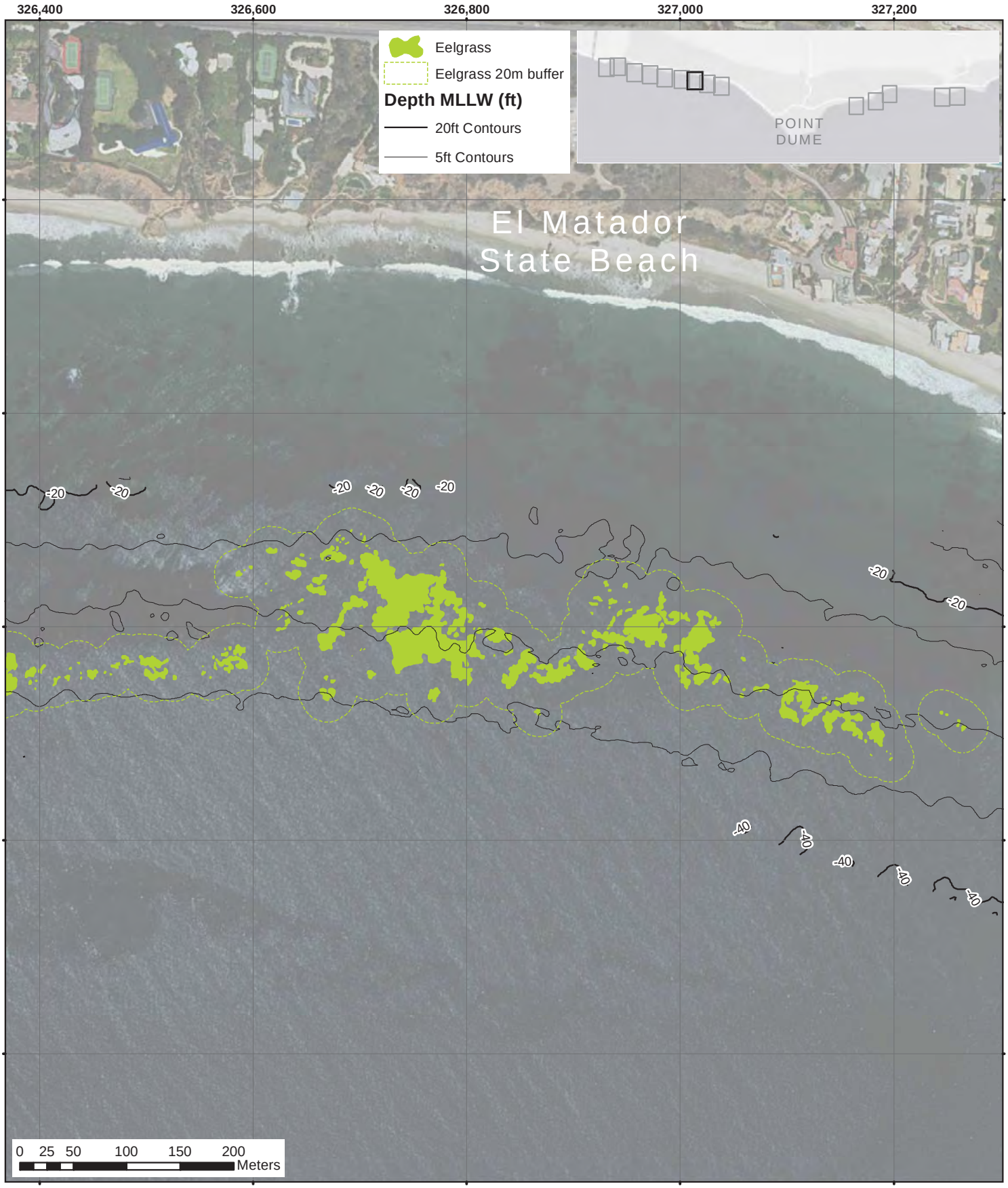
El Pescador State Beach
Eelgrass Distribution - October 2015
Southern California Bight Regional Eelgrass Surveys

Appendix 2-E



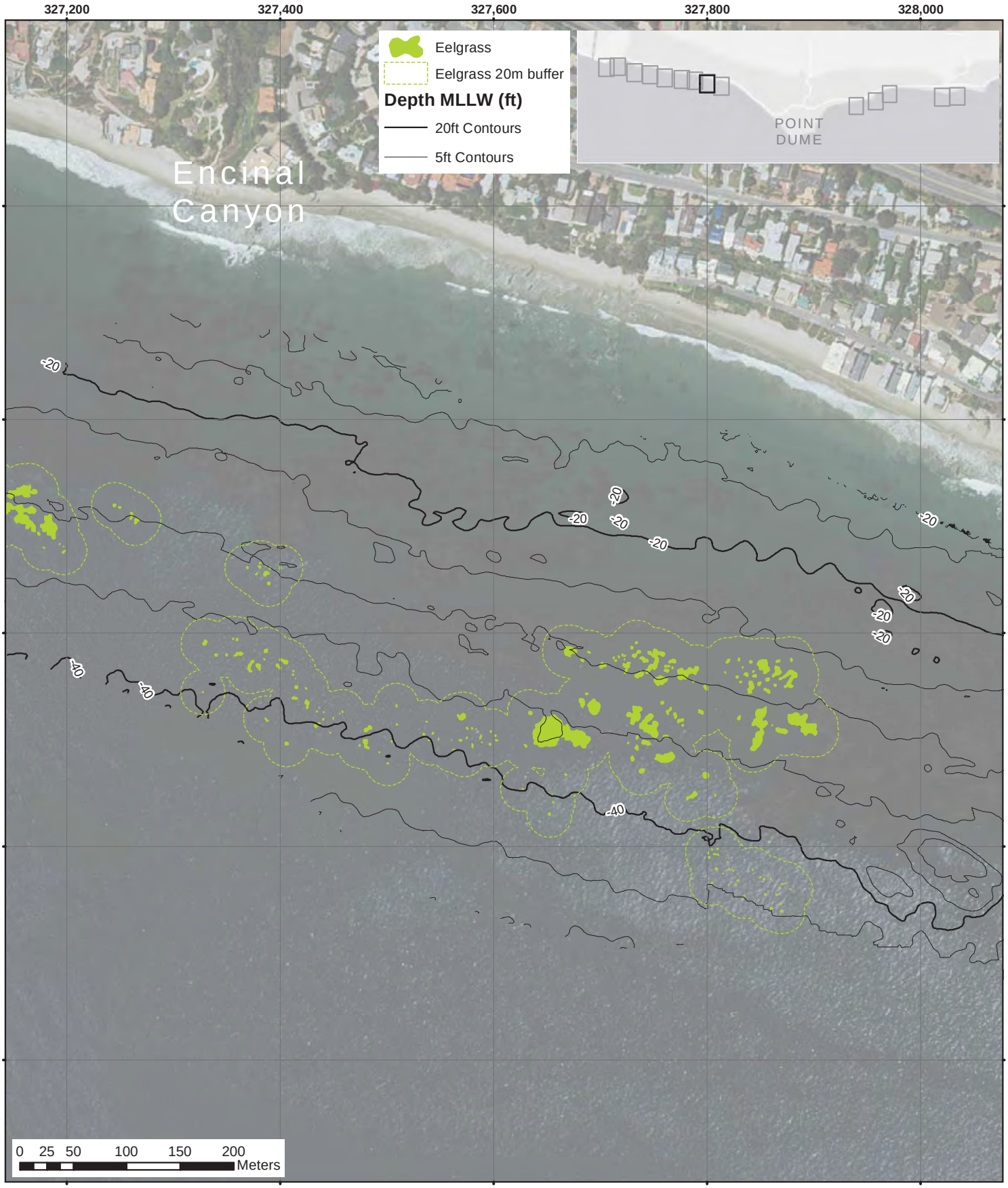
Robert H. Meyer Memorial State Beach
Eelgrass Distribution - October 2015
Southern California Bight Regional Eelgrass Surveys

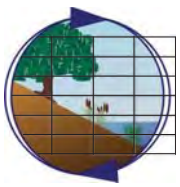
Appendix 2-F



El Matador State Beach
Eelgrass Distribution - October 2015
Southern California Bight Regional Eelgrass Surveys

Appendix 2-G

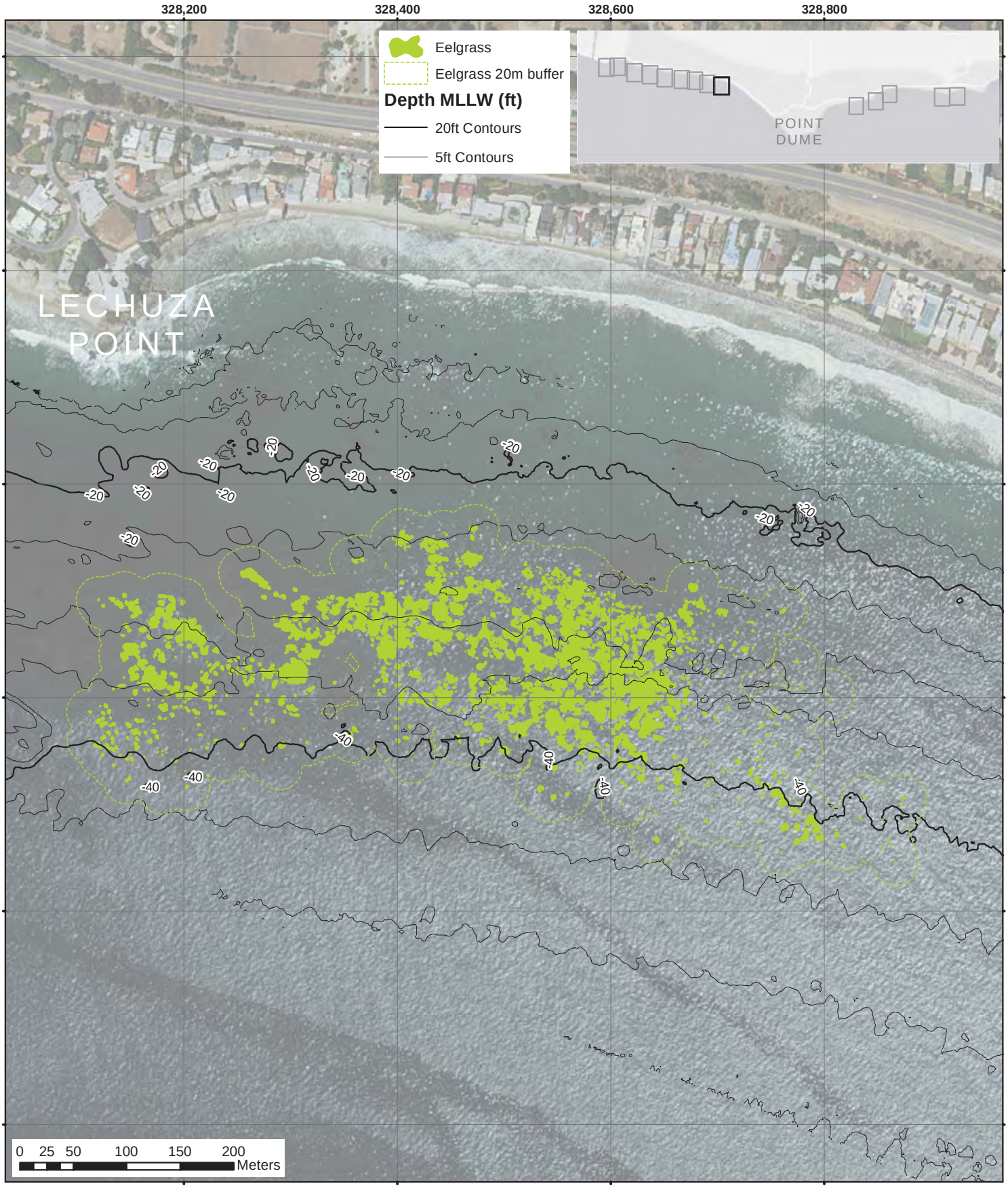




Encinal Canyon
Eelgrass Distribution - October 2015
Southern California Bight Regional Eelgrass Surveys

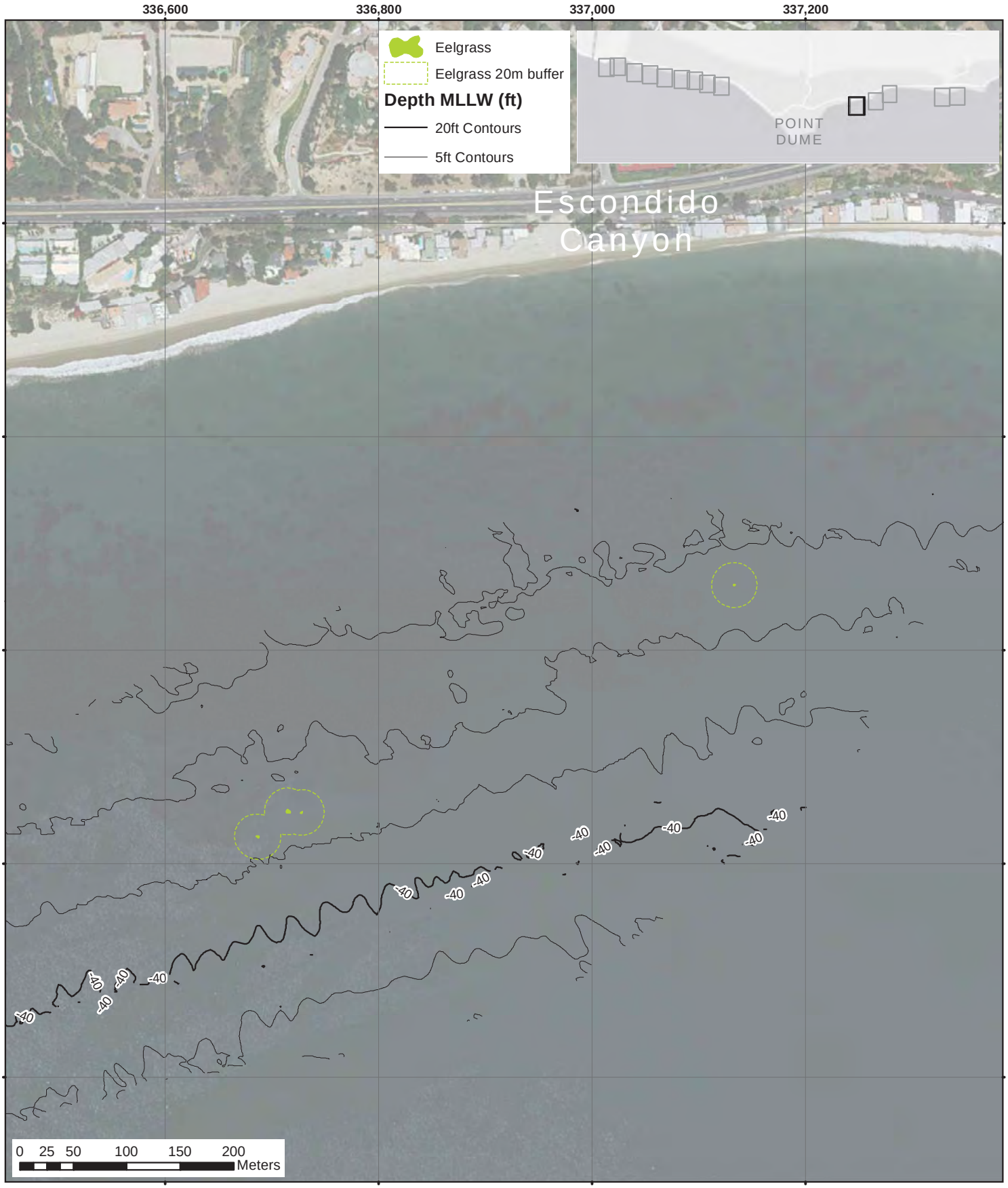
Appendix 2-H

Merkel & Associates, Inc.



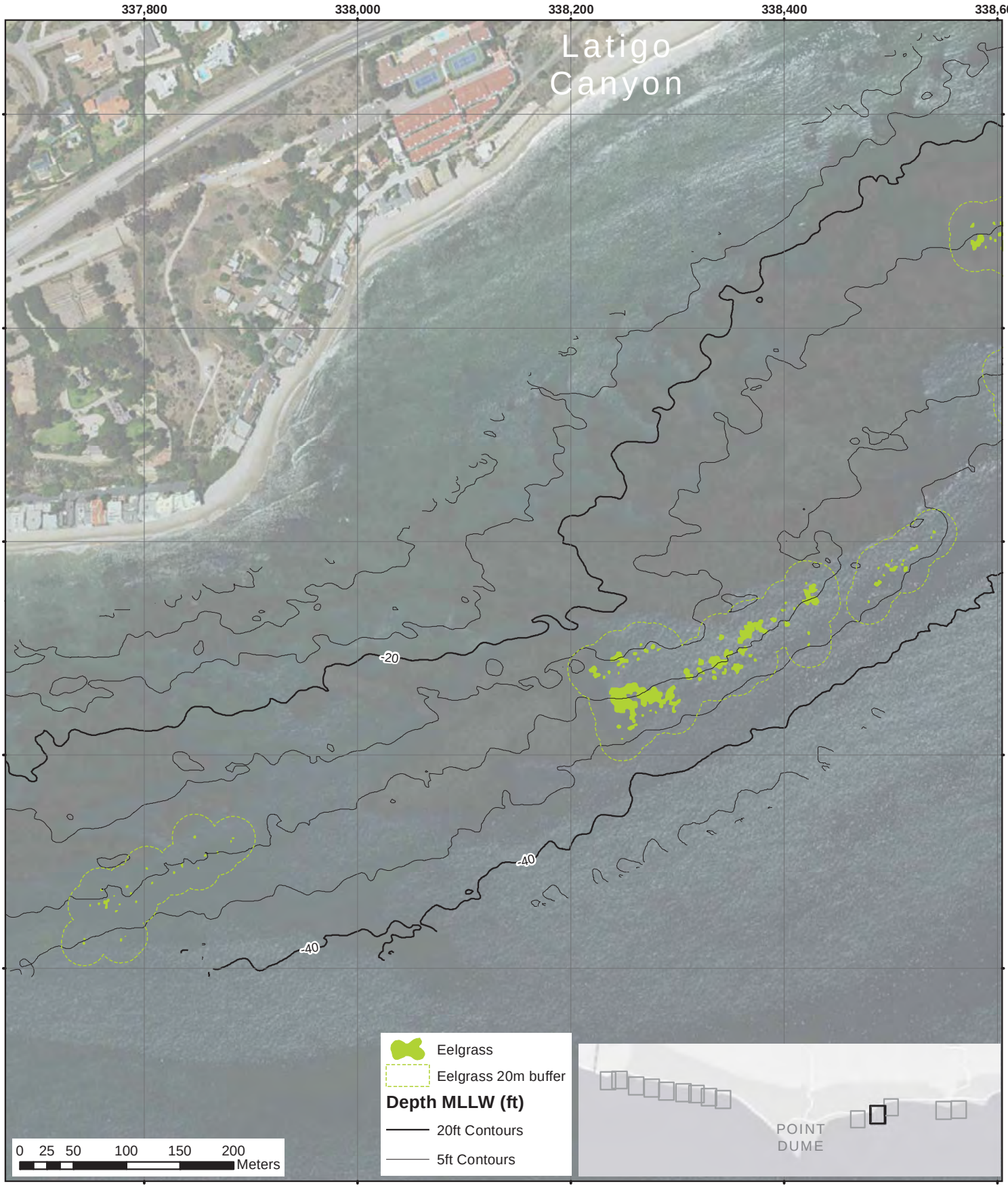
Lechuza Point
Eelgrass Distribution - October 2015
Southern California Bight Regional Eelgrass Surveys

Appendix 2-I



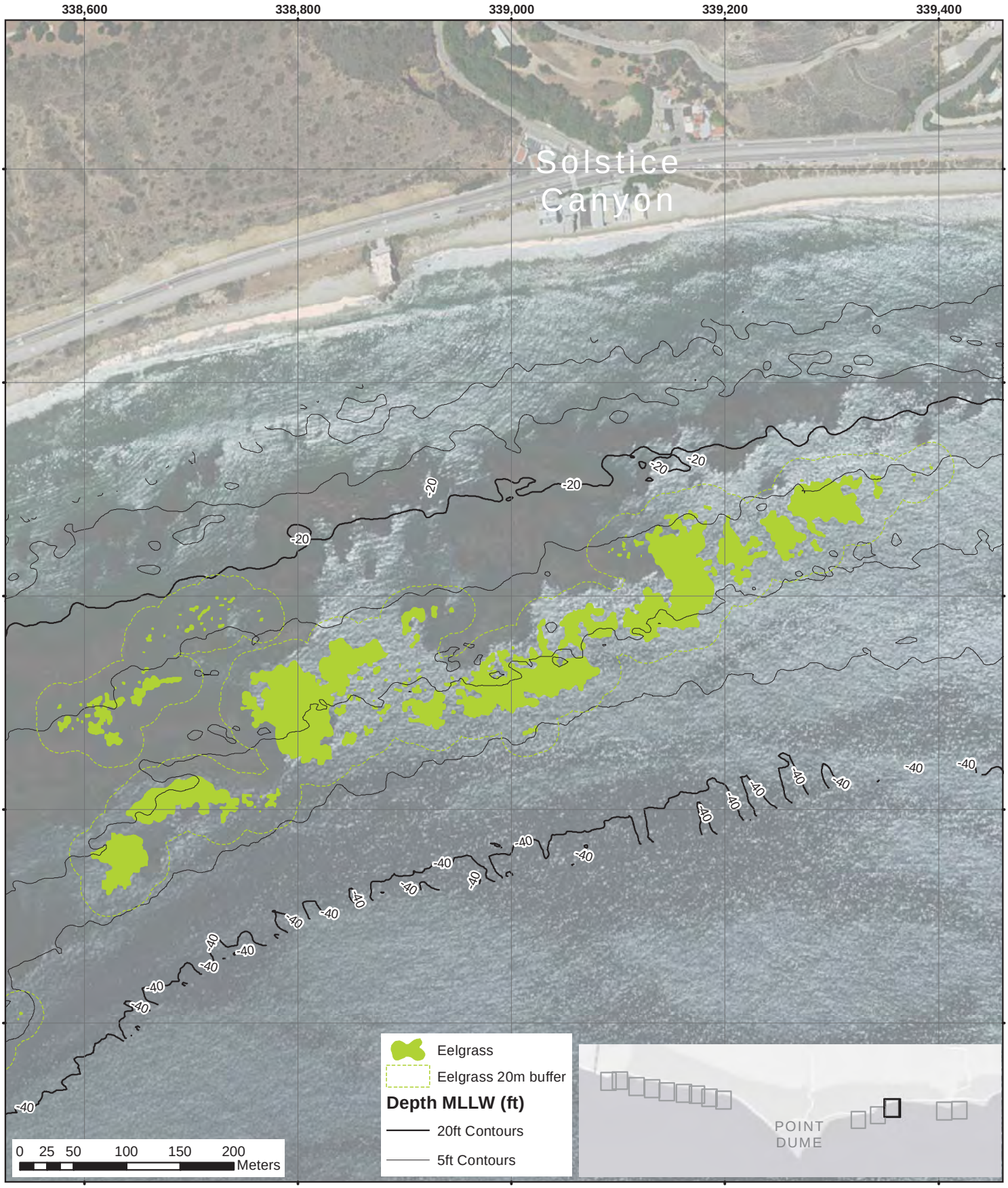
Escondido Canyon
Eelgrass Distribution - October 2015
Southern California Bight Regional Eelgrass Surveys

Appendix 2-J



Latigo Canyon
Eelgrass Distribution - October 2015
Southern California Bight Regional Eelgrass Surveys

Appendix 2-K



Solstice Canyon
Eelgrass Distribution - October 2015
Southern California Bight Regional Eelgrass Surveys

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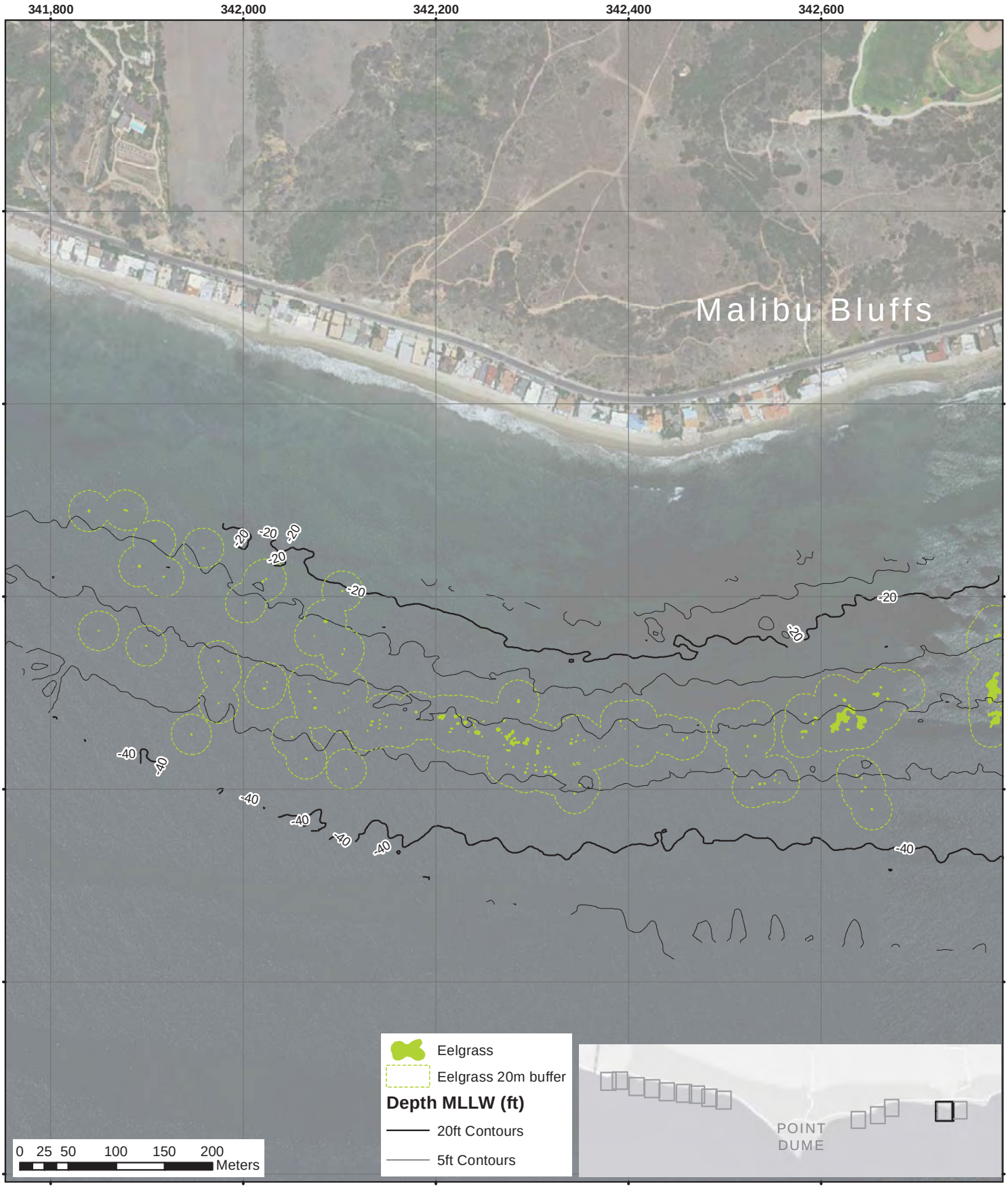
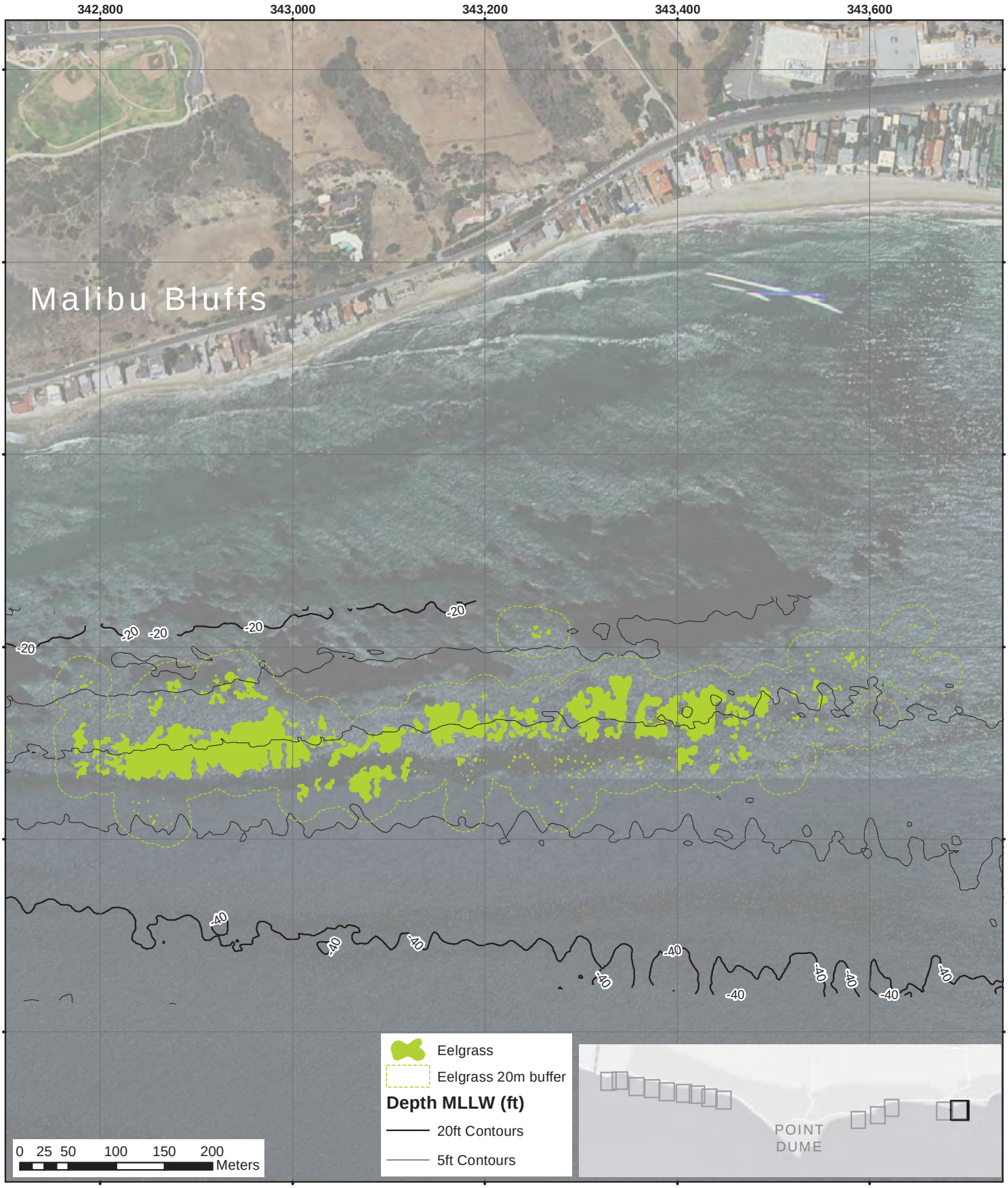


Malibu Bluffs West
Eelgrass Distribution - October 2015
Southern California Bight Regional Eelgrass Surveys

Appendix 2-M



Malibu Bluffs East
Eelgrass Distribution - October 2015
Southern California Bight Regional Eelgrass Surveys

Appendix 2-N