



Morro Bay National Estuary Program

Morro Bay Eelgrass Report 2024 & 2025



Morro Bay National Estuary Program
601 Embarcadero, Suite 11
Morro Bay, CA 93442

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Contents

Introduction.....	3
Morro Bay Project Area.....	3
Morro Bay Estuary and Harbor.....	4
Eelgrass Distribution.....	5
Mapping Efforts.....	5
Eelgrass Acreage Data	7
Restoration Efforts	10
Monitoring Efforts.....	10
Permanent Transects.....	10
Bed Condition	18
Macroalgae Monitoring.....	22
Additional Activity	26
Dredging Operations	26
Embarcadero Projects	27
Partnerships.....	27
Research Efforts.....	27
Automated Eelgrass Classification using Drone Imagery	27
Water Quality Monitoring	28
Eelgrass Wasting Disease Research.....	29
Black Brant Population and Behavior Changes	30
Fish Biodiversity Research	31
Graduate Thesis Highlights.....	33
Upcoming Projects	34
Conclusions.....	34
References.....	35

Introduction

Seagrass beds are among the most valuable coastal habitats. They perform a wide range of important ecosystem services, including carbon sequestration, water purification, and sediment accretion and stabilization (Nordlund et al. 2017). Eelgrass (*Zostera marina*), like other seagrasses, is a critical foundational habitat. Eelgrass creates habitat that leads to increased abundance and diversity of many invertebrate and fish species, and it serves as a nursery for ecologically and commercially valuable species.

Eelgrass is a marine flowering plant with long, ribbon-like leaves that grow from an underground stem (rhizome). It is found worldwide in coastal waters. Eelgrass reproduces both sexually via flowers and seed production, and asexually via spreading rhizomes.

Unprecedented declines in seagrass distribution have been observed worldwide and are a growing cause for concern. The reasons for the decline are attributed to many natural and anthropogenic factors in coastal ecosystems. Natural impacts may come from changes in water depth, salinity, wave velocity, turbidity due to sediment or phytoplankton blooms, and herbivory pressure. Anthropogenic impacts may be either direct or indirect. Direct impacts include seagrass removal by dredging, propeller scarring, or shading caused by boat moorings or pier construction. Indirect impacts include the introduction of invasive species and non-point source loading of nutrients, herbicides, and sediment, which can negatively impact water clarity (Hauxwell et al. 2003). The indirect effects associated with sea level rise and climate change are not well understood but are widely expected to negatively impact seagrass distribution globally (Ralph et al. 2007).

Morro Bay has experienced fluctuations in eelgrass extent over the past two decades. From 2007 to 2016, more than 90% of Morro Bay's eelgrass disappeared, spurring many restoration, monitoring, and research efforts. Starting in 2016, eelgrass began to re-establish in areas where it had previously declined. Through restoration and natural recruitment, the past few years have been marked by significant growth. In 2023, eelgrass acreage reached its highest recorded extent since reliable estimates have been collected, which date as far back as the 1960s. The 2025 eelgrass mapping showed a 20% reduction in total coverage from the peak in 2023, but eelgrass remains abundant at 603 acres.

This report summarizes the eelgrass related efforts of the Morro Bay National Estuary Program (Estuary Program) and its partners in 2024 and 2025, including mapping efforts, detailed monitoring of eelgrass beds, and the latest research findings.

Morro Bay Project Area

Morro Bay is a shallow coastal lagoon located on California's Central Coast in San Luis Obispo County. Founded in 1870, the town of Morro Bay (population 10,861) is located in the northern extent of the estuary. The unincorporated community of Los Osos (population 14,503) is located on the southern shores of Morro Bay (Figure 1). Morro Bay was established as California's first State Estuary in 1994, paving the way for inclusion in the National Estuary Program in 1995. Today, Morro Bay is one of 28 recognized National Estuaries.

The Morro Bay watershed encompasses drainage from approximately 75 square miles. Freshwater inflows are delivered to the estuary via the Chorro Creek and Los Osos Creek sub-watersheds and through groundwater seepage in the Los Osos area. Non-urbanized lands in the Chorro Creek sub-watershed are used primarily as rangeland and public parks. Non-urbanized lands in the Los Osos sub-watershed are dominated by rangeland, row crop agriculture, and commercial greenhouse nurseries. There are a number of water quality impacts within

the Morro Bay watershed and estuary. For more information, refer to the Estuary Program’s Library at <http://www.mbnep.org/library>.

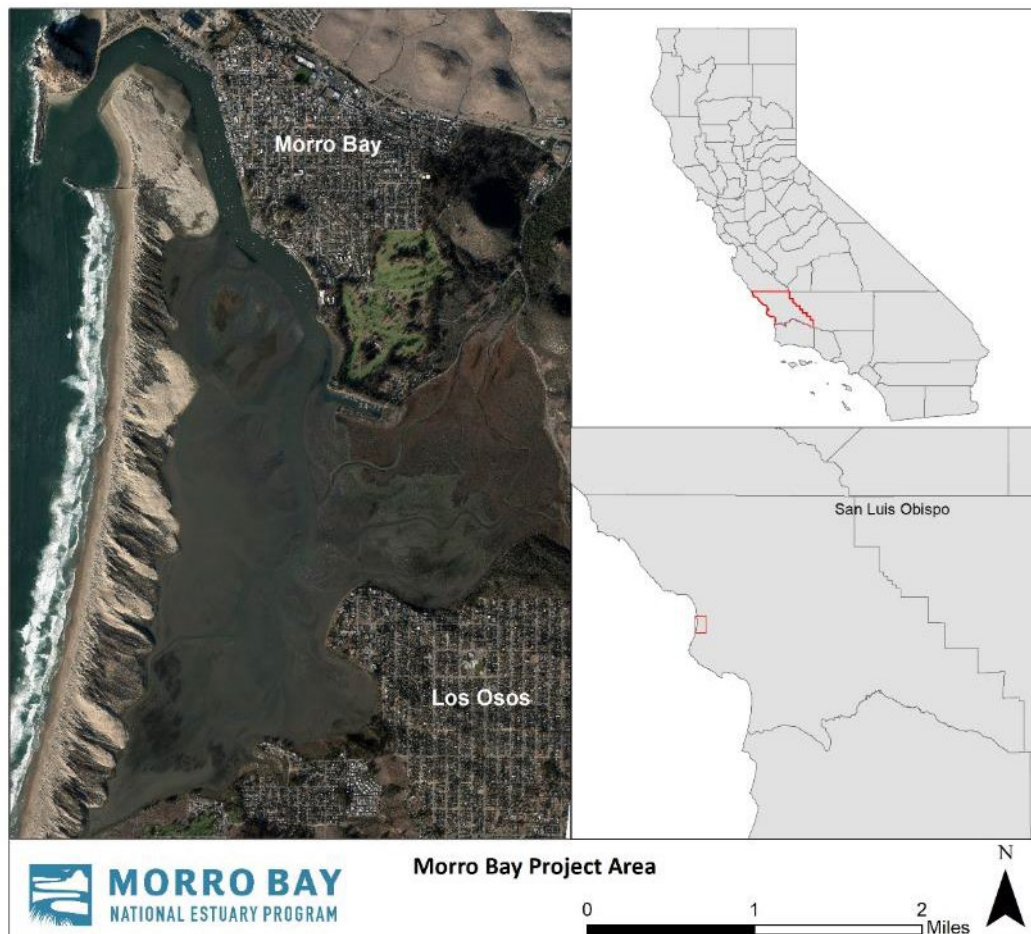


Figure 1. Morro Bay and location within San Luis Obispo County.

Morro Bay Estuary and Harbor

The Morro Bay estuary is comprised of approximately 2,300 acres of shallow, semi-enclosed intertidal and subtidal habitat. The estuary is bordered to the west by a four-mile vegetated natural sandspit that separates Morro Bay from the Pacific Ocean. Seagrass beds in Morro Bay are dominated by eelgrass (*Zostera marina*) with small patches of widgeon grass (*Ruppia maritima*) interspersed throughout the estuary. To date, Japanese eelgrass (*Zostera japonica*) has not been identified in Morro Bay.

Morro Bay is a popular destination for outdoor recreation and supports a commercial fishing port and aquaculture operations. Recreational activities in the bay include kayaking, sailing, fishing, wildlife observing, and waterfowl hunting. Two commercial aquaculture operations grow Pacific oysters (*Crassostrea gigas*) and operate in conditionally approved areas of the intertidal mudflats. The Morro Bay harbor is maintained by regular dredging events (see “Dredging Operations”).

Eelgrass Distribution

Mapping Efforts

Morro Bay's eelgrass population has been mapped for decades, but the method and time of year has varied. Many of the early eelgrass acreage estimates used subjective aerial photo interpretations, and discrepancies have not been fully quantified or reconciled for datasets generated prior to 2002. In 2002 and 2003, the Estuary Program contracted true color aerial flights, which were later re-analyzed using multispectral analysis to create a map of intertidal eelgrass similar to methods used in later years. Between 2004 and 2013, intertidal eelgrass was mapped with multispectral aerial images. Flights were typically completed during extreme low tides in November. In 2012, the flight had to be canceled due to weather conditions and was instead completed in May 2013. Merkel & Associates (M&A) surveyed the bay in July 2013 and July 2015 using sidescan sonar, a method that targets mostly subtidal eelgrass.

In 2017, a combination of sidescan sonar and unmanned aerial vehicle (UAV) imagery were seamed together to map intertidal and subtidal eelgrass bay-wide in the spring. Later that winter, Ocean Imaging (OI) collected multispectral aerial imagery to create a classification of intertidal submerged aquatic vegetation, which was groundtruthed by the Estuary Program. Multispectral imaging was again collected by OI in 2019 to identify eelgrass bay-wide and quantify acreage of other exposed and submerged vegetation and substrate types. Further details of this analysis can be found in the [Estuary Program's 2019 Eelgrass Report](#).

Since 2017, California Polytechnic State University, San Luis Obispo (Cal Poly) has surveyed eelgrass in Morro Bay annually using a UAV. This method of mapping is less expensive than multispectral imaging, allowing surveys to be conducted more frequently. For each survey, a UAV technician flies a drone over the bay at a standard height of 400 feet during a series of negative tide windows. Thousands of photos are stitched together and georeferenced to create a bay-wide image. Historically, the eelgrass was then quantified in ArcGIS, a Geographic Information System (GIS) software, by manually digitizing eelgrass beds into individual polygons. However, with the expansion of eelgrass acreage in recent years, the process of manual digitization has become prohibitively time-consuming, and the use of an image segmentation machine learning model has been developed to automate this task (see "Automated Eelgrass Classification Using Drone Imagery"). The Cal Poly team is currently optimizing the model to ensure accuracy, before sharing the calculated acreage for their winter 2023, 2024, and 2025 flights.

In 2023, M&A surveyed the estuary using a combination of UAV and sidescan sonar, stitching together intertidal and subtidal acreage. Eelgrass beds were identified from the UAV imagery using both automated spectral classification and manual digitization. Automated classification was essential for processing the large volume of eelgrass, considering the massive acreage expansion observed in 2023. Classifications were validated using 250 groundtruth points collected in the field by Estuary Program staff.

Winter 2024 and 2025 Mapping Efforts

Cal Poly continues to conduct annual UAV surveys. Their most recent flights spanned low tides in December 2023 to February 2024 and December 2024 to January 2025. Estuary Program staff and Cal Poly students have been working together on annotating the imagery by reviewing hundreds of points randomly distributed across the estuary. These annotations will be used to validate the results of their deep learning models and determine which iteration is the most accurate. Results are expected within the next year.

Spring 2025 Mapping Effort

The most recent eelgrass acreage map was assembled from a composite of low-altitude, true color aerial imagery collected by UAV and vessel-mounted interferometric sidescan sonar (ISS) conducted by M&A, which

was the same approach used in 2023. UAV imagery was collected at extreme low tides from April to June to capture intertidal and shallow subtidal acreage. ISS surveys were conducted during the same timeframe within deeper subtidal channels.

Upon completion of the surveys, M&A utilized a combination of spectral classification and manual digitization of the drone imagery orthomosaic and direct interpretation of hydroacoustic data to map the total eelgrass extent. All eelgrass cover was buffered by 0.5 meters in accordance with the California Eelgrass Mitigation Policy (2014) recommendations before calculating the final acreage. It should be noted that the inclusion of this buffer began in 2023 and had not been used in prior surveys. It is also worth noting that this survey's timing differs from most of our earlier mapping efforts, which typically take place in late fall or winter. Seasonality can impact eelgrass morphology and the appearance of beds, as was observed in 2023. However, M&A accounts for this variability in appearance when classifying eelgrass and Estuary Program staff review all imagery and draft acreage maps before they are finalized.

At the conclusion of their analysis, M&A reported 603 acres of eelgrass within the estuary in spring 2025. This represents a reduction from the all-time high of 750 acres mapped in 2023 but is still significantly above restoration targets and pre-decline conditions. Approximately 572 acres were designated as intertidal, and 31 acres were designated as subtidal eelgrass, as delineated by the height of the lowest tide in 2023 (-1.7 feet Mean Lower Low Water (MLLW)). M&A conducted a depth analysis using the digital elevation model (DEM) from a 2019 topo bathymetric LiDAR survey and compared it with the 2025 eelgrass inventory. They found that eelgrass ranges between +4 feet to -17 feet relative to MLLW. The bulk of eelgrass is present in the lower intertidal at +1 foot MLLW, with nearly 55% of all acreage falling between 0.5 - 1.5 feet MLLW.



Figure 2. Demonstration of the image resolution captured with M&A's UAV drone during spring of 2025. High resolution imagery allows for the differentiation between eelgrass beds and algae mats, which are otherwise difficult to classify visually. Eelgrass beds (top half of image) are typically dark green and exhibit a wavy, hairlike texture due to the long, slender blades. Algae mats (bottom half) are generally light green and appear in a more random, strewn-about fashion.

The 2025 data were ground-truthed using a combination of underwater drop video camera, low-tide surveys conducted by both M&A and the Estuary Program, and extremely low-altitude UAV imagery to get a closer look at eelgrass morphological characteristics. Over 1,000 ground-truth points were collected, half of which were used for guiding classifications and half for assessing the accuracy of the final map. Comparing the ground-truthing results with the final acreage resulted in an accuracy assessment of 98.5%.

Eelgrass Acreage Data

The following table and figure present Morro Bay's eelgrass acreage over time and the method of data collection. It is important when comparing these data to keep in mind that the mapping methodology has changed over time. Between differences in mapping techniques (e.g., drone mapping, sonar) and differences in estuary conditions during mapping events (e.g., water clarity, tide height), the extent of eelgrass coverage captured can vary. Previous versions of this report are available at <http://www.mbnep.org/library> and include additional historical information and sources.

Table 1. Eelgrass acreages and mapping methods, 1960 to 2025.

Year	Time of Year	Eelgrass Acreage	Method
1960	Unknown	335	Field surveys (Haydock)
1970	Unknown	452	Aerial photos (CA Fish & Game)
1988	Unknown	404	Aerial photos (Josselyn), reinterpreted (Chesnut)
1994	Late Sept to early Nov	435	Quadrat sampling (Chesnut)
1995	Late Sept to early Nov	260	Quadrat sampling (Chesnut)
1996	Late Sept to early Nov	165	Quadrat sampling (Chesnut)
1997	Late Sept to early Nov	98	Quadrat sampling (Chesnut)
1998	Unknown	125	Aerial photos (Tetra Tech)
2002	November 25, 2002	149	True color aerial images, reanalyzed (Estuary Program with Golden State Aerial and Ocean Imaging)
2003	November 21, 2003	167	True color aerial images, reanalyzed (Estuary Program with Golden State Aerial and Ocean Imaging)
2004	November 24, 2004	267	Multispectral aerial images (Estuary Program with Ocean Imaging)
2006	November 6, 2006	287	Multispectral aerial images (Estuary Program with Ocean Imaging)
2007	November 24, 2007	344	Multispectral aerial images (Estuary Program with Ocean Imaging)
2009	November 13, 2009	240	Multispectral aerial images (Estuary Program with Ocean Imaging)
2010	November 4, 2010	176	Multispectral aerial images (Estuary Program with Ocean Imaging)
2013	May 28, 2013 for multi-spectral imagery, July 2013 for sonar	15	Multispectral aerial images (Estuary Program with Ocean Imaging) and sonar (M&A)
2015	July 2015	13	Sonar (M&A)
2017	April 2017	14	Sonar and UAV (M&A)
2017	December 3, 2017	13	Multispectral aerial images (Estuary Program with Ocean Imaging)
2017	December 1 to 4, 2017	9	UAV (Cal Poly, Sea Grant)*
2018	December 6, to 8, 20 and 21, 2018	16	UAV (Cal Poly, Sea Grant)*
2019	November 26, December 11 to 13, 23 and 24, 2019, January 8, 2020	37	UAV (Cal Poly)*
2019	November 24, 2019	42	Multispectral aerial images (Estuary Program with Ocean Imaging)
2020	November 14 to 16, December 14 and 15, 2020	146	UAV (Cal Poly)*
2021	December 2, 3, and 4, 2021 January 1, 2022	500	UAV (Cal Poly)*
2023	April 14 to 18, May 9 to 11, and June 16 to 17, 2023	750	Sonar and UAV (M&A)
2025	April 18 to 20, May 2 to 7, and June 10 to 15, 2025	603	Sonar and UAV (M&A)

**Note that the Cal Poly UAV imagery and manual digitization process has an approximate error of 10% associated with it.*

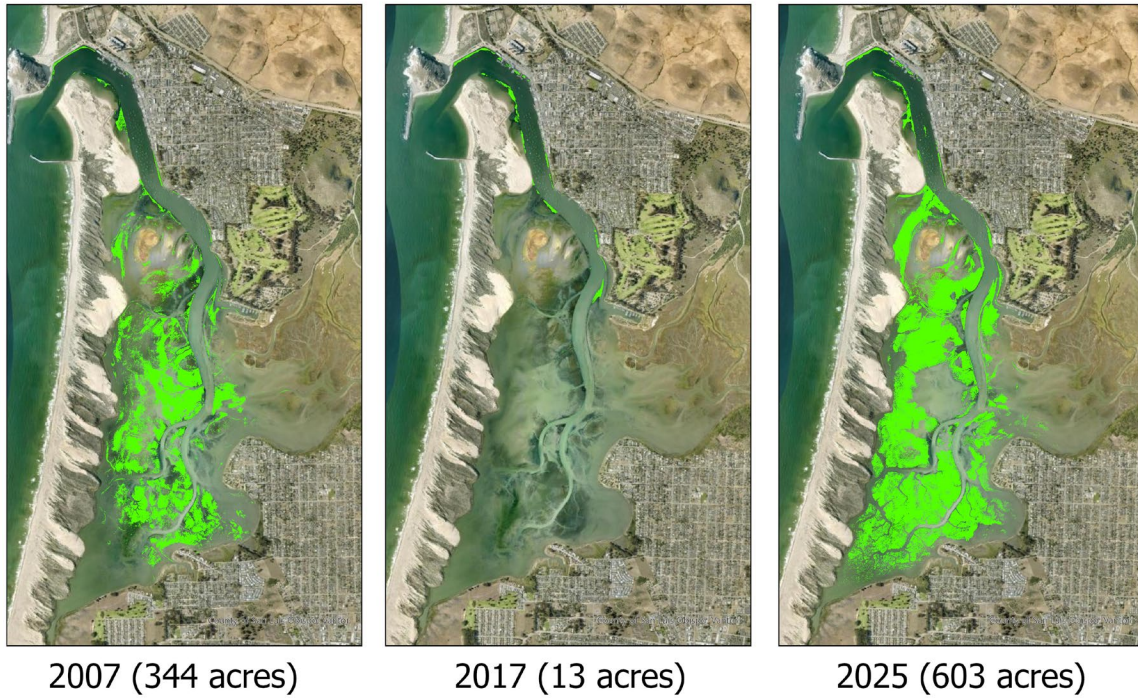


Figure 3. Changes in eelgrass acreage in Morro Bay from 2007 to 2025. Note that the intertidal eelgrass extent from 2007 and 2017 was analyzed with multispectral imagery (Ocean Imaging) and both the intertidal and subtidal extent from 2023 was analyzed using a combination of drone imagery and sidescan sonar (M&A).¹

Although eelgrass acreage in 2025 was lower than in 2023, eelgrass remains well-recovered from the 2007 to 2017 decline, as eelgrass cover is roughly 67 times the 2017 low of 9 acres mapped during a late fall drone survey (Table 1). Some reduction was anticipated following the 2023 survey, as eelgrass may have been approaching, or had already exceeded, the bay's carrying capacity. We are encouraged to see that the majority of eelgrass coverage has been retained over the past two years, despite a loss of 147 acres. Most of the lost acreage occurred along the margins of beds that had rapidly expanded, except for an approximately 60-acre patch that has transitioned to mudflat with scattered mats of *Gracilaria* algae. This bare patch likely formed due to the combination of a higher elevation area that created shallow conditions and a high eelgrass density that contributed to poor circulation and a culmination of environmental stressors, but this does not appear to be indicative of a broader transition within the bay (Koch et al. 2007). Continued monitoring will be essential for tracking acreage fluctuations and enacting restorative measures in a timely manner if needed.

[†] Because of differences in eelgrass mapping methodology over time, acreages of eelgrass cannot be directly compared from year-to-year.

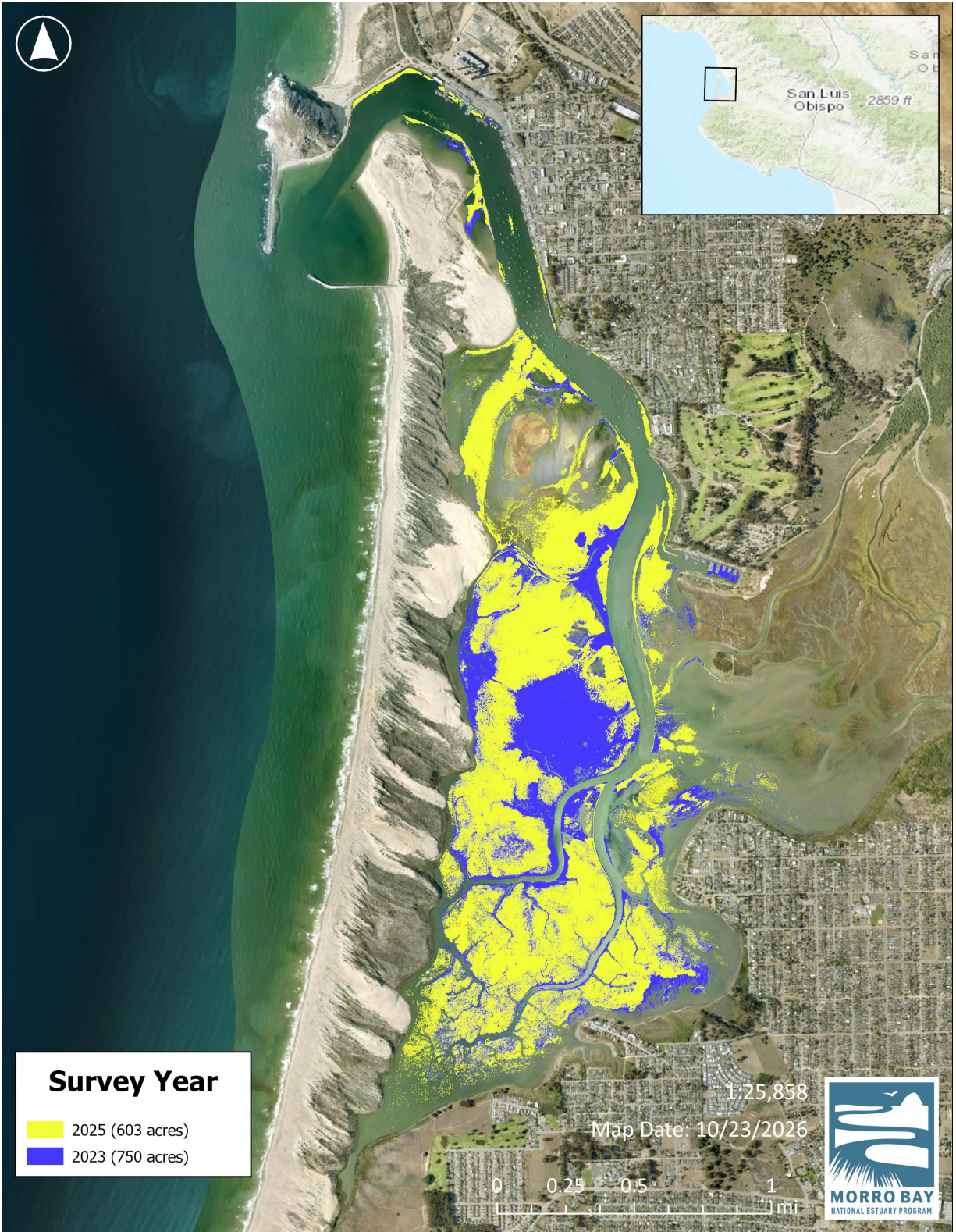


Figure 4. Eelgrass distribution throughout the estuary in spring 2023 (blue) and spring 2025 (yellow). Regions where the blue color is exposed represent areas where eelgrass coverage has contracted over the past two years.

Restoration Efforts

Eelgrass restoration was initiated in 2017 as a response to the precipitous decline in acreage that began in 2007 and had reached alarmingly low levels by 2013. A variety of different restoration methods were attempted, with the most successful stemming from transplanting. Since 2022 and the recovery of eelgrass to pre-decline acreage, restoration efforts have been halted. While the rebound of eelgrass acreage cannot be fully attributed to restoration, the effort likely had an important impact by reintroducing eelgrass to areas where it had been lost and contributing to seed dispersal throughout the estuary.

For more information on historic eelgrass restoration efforts, please refer to past [eelgrass reports on the Estuary Program website](#).

Monitoring Efforts

The Estuary Program has implemented several supplementary monitoring efforts to track eelgrass changes throughout the bay. Permanent monitoring transects were established in 2005 to measure average shoot density at sites spanning the length of the bay. To further assess eelgrass bed condition, California Sea Grant and Cal Poly established a monitoring effort in late 2015 to measure average density, blade length, evidence of necrosis, and competition with algae and other organisms. Macroalgae monitoring began in 2023 following a notable uptick in the percent coverage of *Ulva*, in order to track how eelgrass responds to changes in macroalgae abundance and biomass.

Permanent Transects

History

Permanent transects were established to track changes in eelgrass shoot density throughout Morro Bay starting in 2005. There are six transects currently monitored in the bay (Figure 5). Four transects (Coleman, Reference, Chorro, Pasadena) were monitored annually from 2006 to 2010. No data were collected in 2011 due to staffing logistics. In November 2012, a fifth transect was established near the State Park Marina. From 2012 to 2016, some sites were not surveyed due to poor weather or tide conditions. In December 2017, a new transect was established on the eastern side of the channel at Tidelands Park, called “Embarcadero.” The transect now called “Reference” was originally named “Tidelands” but has since been renamed to avoid confusion.



Figure 5. The six current permanent transect monitoring locations: Coleman, Embarcadero, Reference (previously named Tidelands), Marina, Chorro, and Pasadena.

Methods

Monitoring was conducted during extreme low tides (-0.4 feet and below) during the late fall, as this period provides the best tide windows for accessing intertidal monitoring sites. At each site, a high-accuracy GPS unit was used to identify the transect location (most sites have few or no permanent markings), and a meter tape was set out along a 50-meter transect. A 0.5-meter by 0.5-meter quadrat was used to take measurements at points along the transect tape. Percent coverage of eelgrass, macroalgae (predominantly *Gracilaria* and *Ulva*), and bare substrate were measured. If eelgrass was present, shoots were counted to determine density.

While there are six permanent transect locations, some sites have more than one transect. If an eelgrass bed was fairly wide, additional transects were established running parallel to each other to measure eelgrass at various depths. Note that for analysis, all data from a site in a particular year were combined to represent eelgrass at that general location.

Initially the effort included an eelgrass biomass measurement. From 2005 to 2012, eelgrass samples were collected adjacent to each transect. However as eelgrass declined, it became too damaging to collect samples, and the biomass study was halted.

Results

Average shoot density for each site is summarized in Figures 6 and 7.

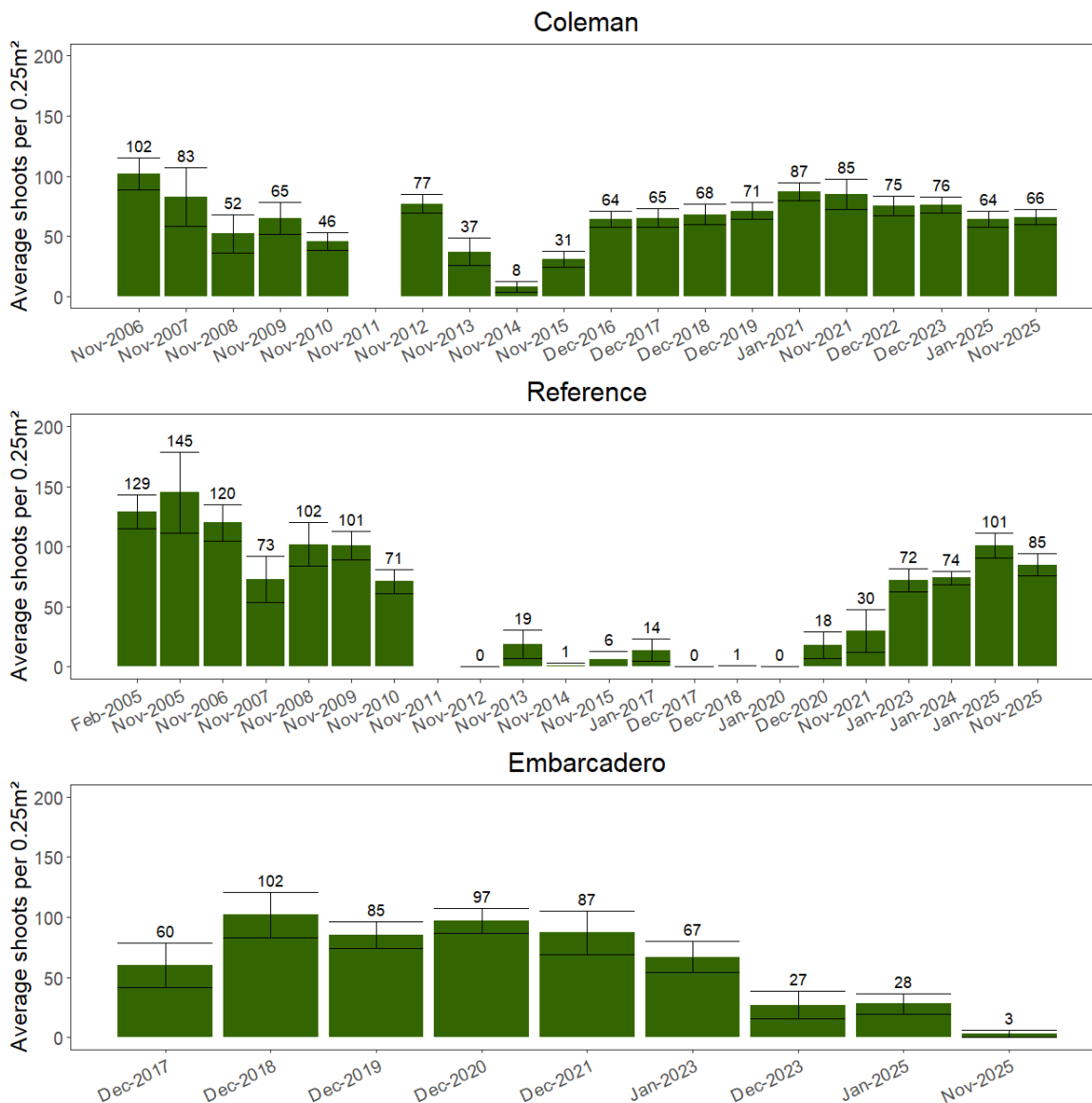


Figure 6. Average shoot density counts per year at the three northern sites, closest to the mouth of the estuary. Shoots were counted within a 0.5 m x 0.5 m quadrat. Error bars represent a 95% confidence interval. Years with no bars or data labels represent years when no survey was conducted.

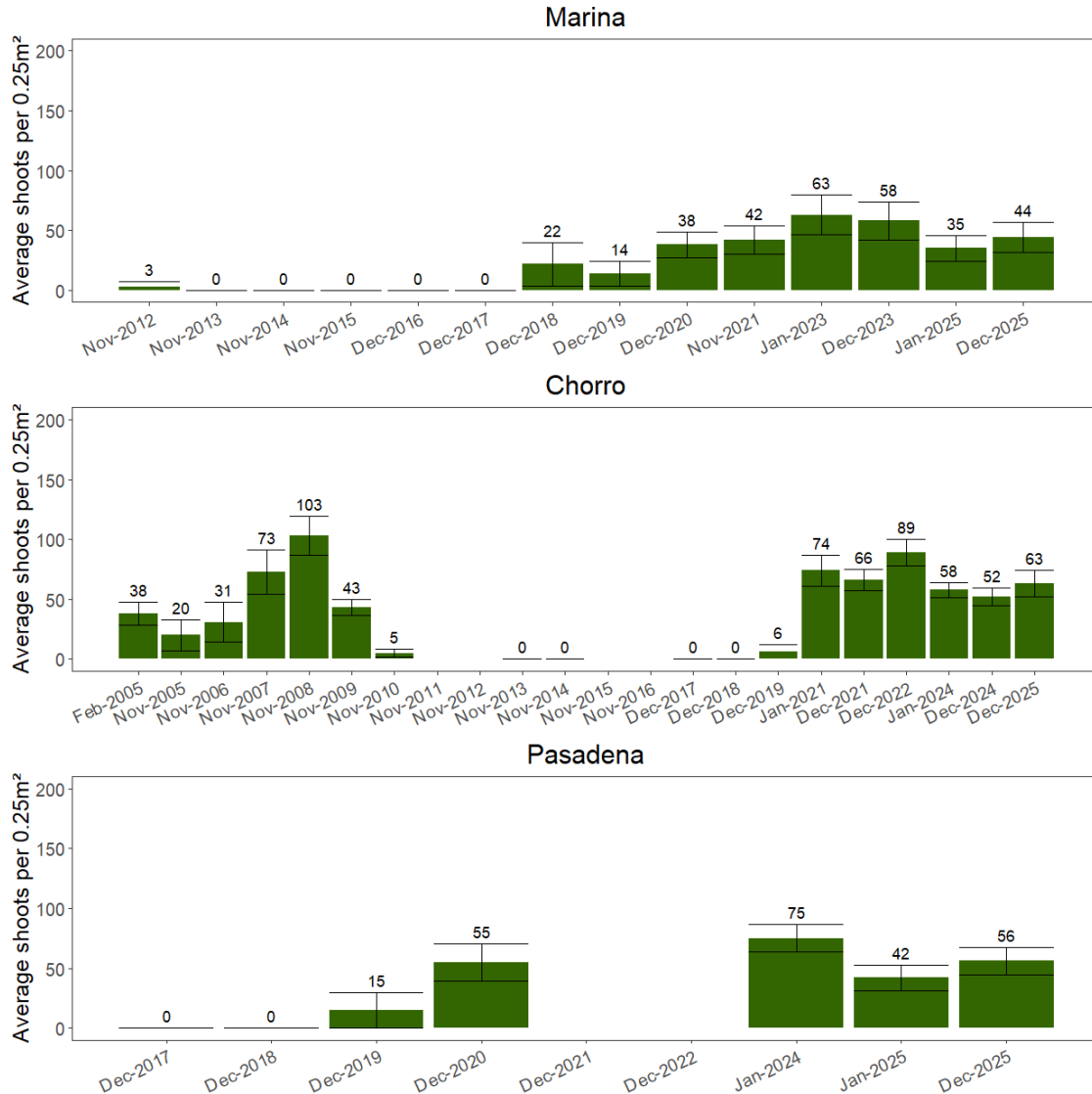


Figure 7. Average shoot density counts per year at the three southern sites, further from the mouth of the estuary. Shoots were counted within a 0.5 m x 0.5 m quadrat. Error bars represent a 95% confidence interval. Years with no bars or data labels represent years when no survey was conducted.

Eelgrass density has rebounded to pre-decline levels at Coleman, Reference, and Chorro, the three sites where surveys were conducted before 2017. Most sites have exhibited relatively stable density for the past three years, except for the Embarcadero Transect, which dropped from 97 shoots per 0.25m² in 2020 to 3 shoots per 0.25m² in 2025. This decline appears to reflect a downslope shift of the bed toward a deeper, more subtidal elevation, likely driven by a combination of macroalgae abundance and active erosion occurring at the site.

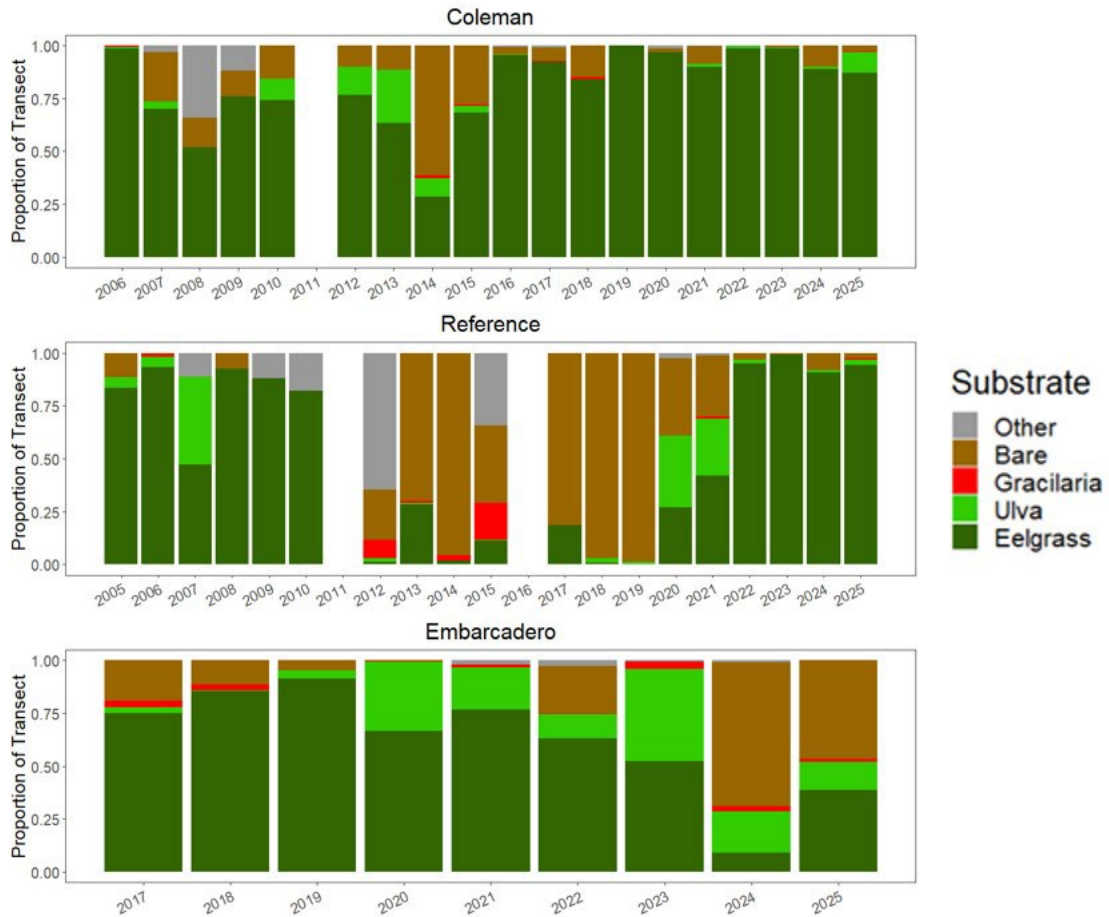


Figure 8. Proportional composition of the primary recorded percent coverage types at the three northern sites, averaged over all quadrats for a given year. Each vertical bar represents one year's sampling efforts.

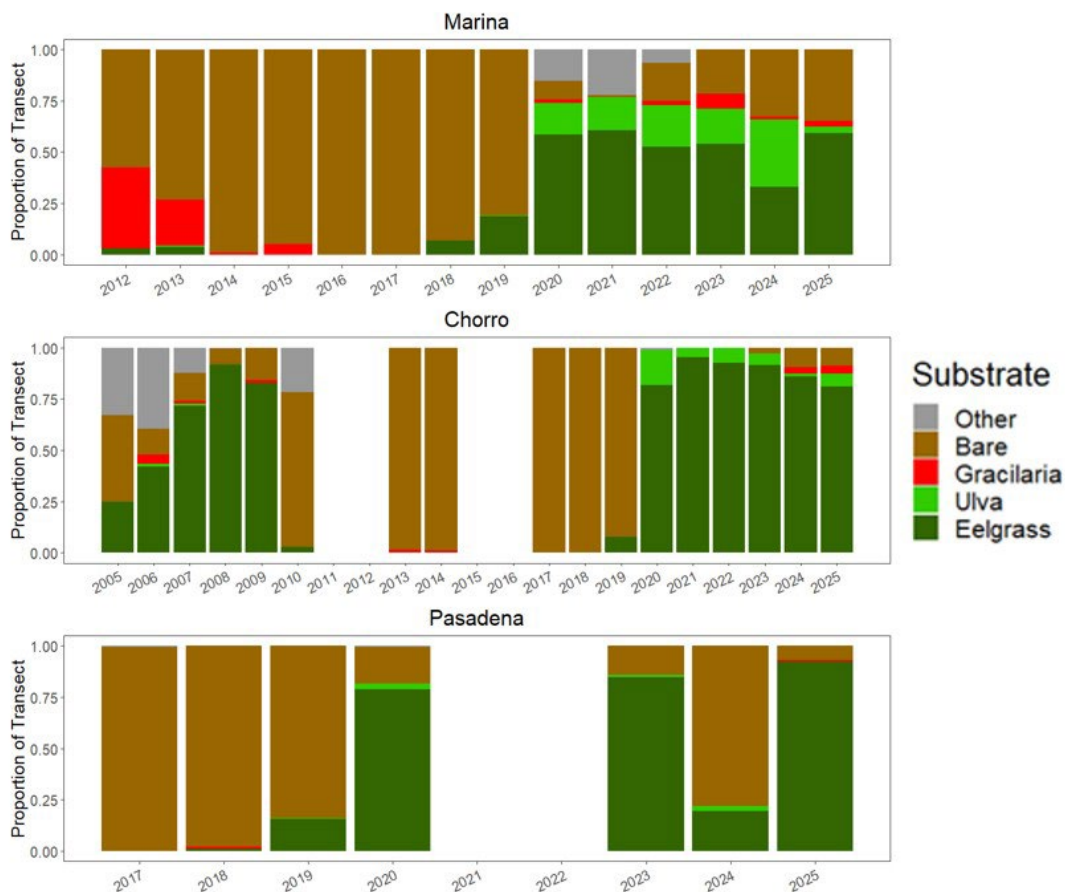


Figure 9. Proportional composition of the primary recorded percent coverage types at the three southern sites, averaged over all quadrats for a given year. Each vertical bar represents one year's sampling efforts.

Proportional compositions are summarized in Figures 8 and 9. The percent cover of eelgrass (dark green bars) observed at all sites closely follows the fluctuations in density seen in Figures 6 and 7. However, these plots show how additional macroalgae taxa fluctuated in abundance as well. The percent cover of *Ulva* (light green bars) across many of the sites has notably increased starting in 2020. The presence of *Ulva* does not seem to be suppressing eelgrass growth at most sites, although the particularly high coverage of algae at Embarcadero did precede the decline in density observed at this site.

Photo and Observations

Photo monitoring documents site conditions by providing a visual record of changes across the permanent transect locations. Time series have been selected from several survey sites to demonstrate trends observed over the past several years.



Figure 10. Permanent Transect monitoring at Reference Transect, 2017 to 2024. As was the case for many sites across the estuary, Reference was a mudflat in 2017 that has since expanded to a fully continuous eelgrass bed spanning as far as the eye can see. At this site in particular, recovery was patchy at first, starting out as eelgrass “islands” that retained sediment while the area around it eroded. These islands have since grown together into one large eelgrass bed that had the highest density of all survey sites in both 2024 and 2025.



Figure 11. Permanent Transect monitoring at Embarcadero Transect, 2017 to 2024. This site has been an anomaly in recent years, experiencing a significant decline in eelgrass density while other sites have been stable or increasing. Starting in 2020, green algae made up a quarter of visible canopy at this site, which is notably higher than the rest of our monitoring locations. Algae coverage reached nearly 50% in 2023, after which eelgrass density fell considerably.



Figure 12. Permanent Transect monitoring at Pasadena Transect, 2018 and 2025. Pasadena serves as a representation of the Back Bay eelgrass recovery post-2017. The warmer and shallower Back Bay experienced the highest acreage declines from 2007 to 2017, but have since become covered in dense, continuous beds.

Permanent transects were initially established to track eelgrass density from sites throughout the bay. Although the data effectively describes eelgrass density at a particular location over time, it is limited as an indicator of overall eelgrass health. Eelgrass growing within a few meters of a permanent transect location may not be captured by these surveys, and the dataset is further limited by seasonality and other factors that may affect bed health like necrosis, epiphyte cover, or presence of epifauna. Because of these limitations, a complementary method of monitoring was needed to better characterize the condition of existing eelgrass. Permanent transect monitoring has continued, as it is the longest running eelgrass dataset for Morro Bay and provides a record of conditions before and after the 2007 to 2017 eelgrass decline.

Bed Condition

History

Bed condition monitoring was established in 2015 as a joint effort between the Estuary Program, Dr. Jennifer O'Leary of California Sea Grant, and Cal Poly. This method measures eelgrass conditions in terms of density, blade length, evidence of necrotic tissue, and competition with algae and other organisms. Monitoring is conducted at five significant beds in Morro Bay along a 150-meter, seven-quadrat survey. Historically, both intertidal and subtidal eelgrass beds were surveyed, and monitoring occurred twice per year, once in late fall and again in the spring. Since 2019, only the spring intertidal sampling has been conducted due to limited capacity and lack of optimal tides.

Methods

Eelgrass health is assessed using a combination of methods. Within each quadrat, shoot counts are collected to determine eelgrass density, a subset of random blades are measured, and plant and algae material are identified using the point-intercept method at 25 points. To estimate patchiness, eelgrass presence/absence is recorded along every meter of the transect.

An integral component of the Bed Condition protocol involves closely examining eelgrass blades to assess their condition. Determining eelgrass blade condition involves a detailed assessment of health metrics on five shoots at each quadrat. For each shoot, the presence or absence of necrotic tissue, epiphytes, and epifauna on each blade are recorded. During the first several years of the project, photos were taken in the field and manually processed to estimate their percent cover. However, due to the subjective and time-consuming nature of manual imagery analysis, the Estuary Program is currently exploring ways to automate this process. Inspired by efforts from researchers at Cornell, who developed the Eelgrass Lesion Image Segmentation Application (EeLISA), work is underway to develop an in-house computer vision model from a series of scanned and annotated eelgrass blades ([Rappazzo et al. 2021](#)).



Figure 13. Bed condition monitoring sites at Coleman Beach, North Sandspit, Reference Bed, Reference West, Windy Cove, and Oyster Bed.

Results

The Estuary Program conducted spring 2024 and 2025 bed condition monitoring at Coleman Beach, North Sandspit, Reference Bed, Windy Cove, and Oyster Bed sites (Figure 13). North Sandspit and Reference Bed were both established at the beginning of the project but have had gaps between sampling years due to a lack of available tides. The Reference Bed site was modified to include an additional transect (Reference West) running perpendicular to the historic transect, which has experienced significant erosion and now contains only a few dwindling patches of eelgrass. The Oyster Bed transect was established and monitored for the first time in 2023. This site was originally a Permanent Plot monitoring site, but after this project was discontinued in 2022, the site was modified into a 150-meter transect to fit the protocol of the Bed Condition project. The figures below display results from preliminary data analysis using only the spring intertidal data from 2016 to 2025.

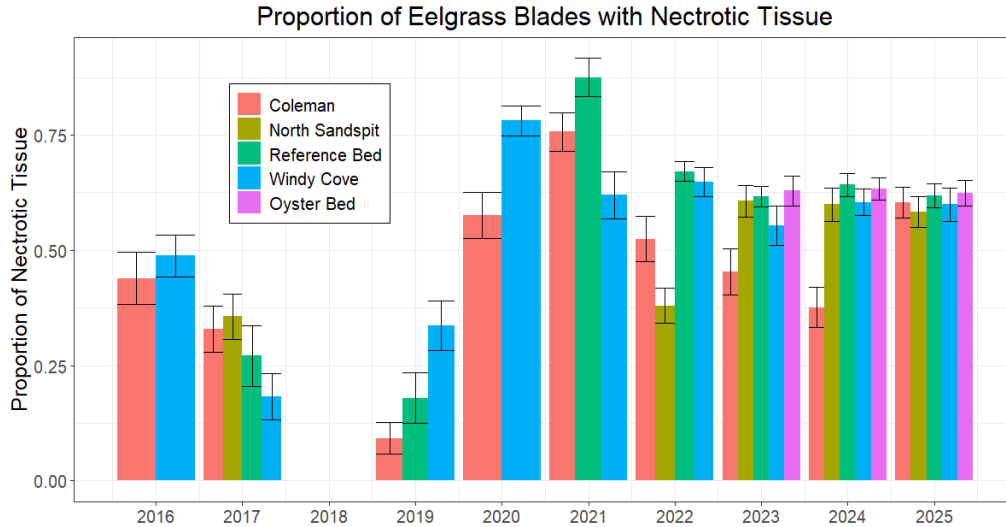


Figure 14. Proportion of eelgrass blades with necrotic tissue during spring intertidal sampling events. No sampling was conducted in 2018. Reference Bed is represented as the combination of results from the historic transect and the new Reference West transect. Sites were not sampled in years where their respective color bar is absent. Error bars represent the standard error.

Of the metrics collected during Bed Condition monitoring, the presence of necrotic tissue is the most direct indicator of eelgrass health. Other metrics such as blade length and epiphyte coverage may vary spatially, limiting their usefulness in determining bed health. The proportion of eelgrass blades containing necrotic tissue is determined by dividing the number of blades that have patches of decaying tissue by the total number of blades assessed at that site. At Coleman and Windy Cove, the two sites monitored most consistently, results show that the average proportion of blades containing necrotic tissue was lowest in 2019 (0.21) and peaked in 2021 (0.69). Since then, the prevalence of necrotic tissue has remained relatively stable, fluctuating between 50-60% of blades. Most sites have been consistent over the past several years, however, Coleman exhibited a significant increase in 2025, reversing what had been a decreasing trend.

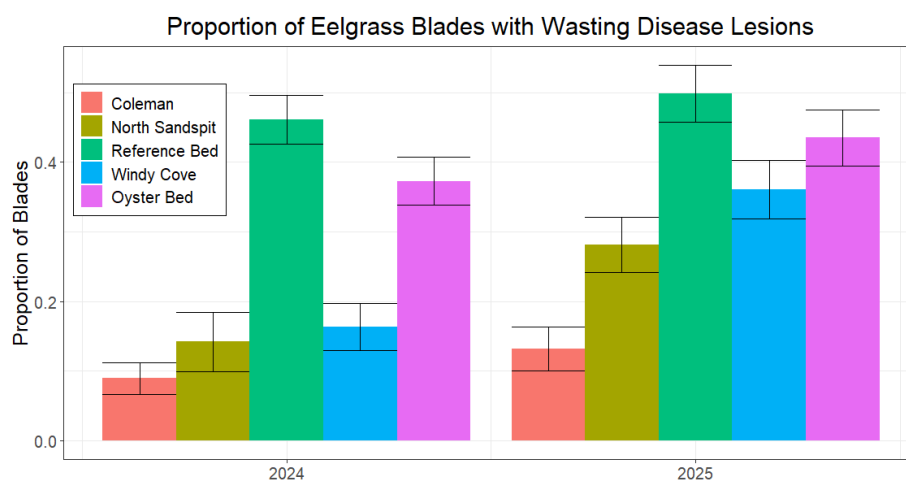


Figure 15. Proportion of eelgrass blades with eelgrass wasting disease lesions during spring intertidal sampling events. Error bars represent the standard error.

In 2024, the Estuary Program began distinguishing wasting disease (EWD) lesions from the generic “necrotic tissue” definition used previously. While necrotic tissue encompasses all states of natural decay, EWD lesions are specifically characterized by black spots or dead tissue rimmed by a black outline. EWD prevalence in the bay generally increases with distance from the mouth of the estuary, consistent with studies that have linked EWD to warmer conditions along the West Coast (Aoki et al. 2022). The Reference Bed site is the only site that does not fit this pattern, consistently displaying the highest EWD proportion despite its relative proximity to the mouth. While current data allow us to compare EWD prevalence among the monitoring sites (proportion of blades infected), they do not describe EWD severity (extent of the lesions on the infected blades). Because both metrics are important for determining the overall impact of EWD, the Estuary Program is currently exploring methods to analyze scanned eelgrass blades to understand EWD severity patterns within the bay (Figure 16). EWD prevalence was higher at all sites in 2025 than in 2024, which may be related to comparatively warmer water temperatures in spring 2025.



Figure 16. Eelgrass blades from Oyster Bed during the spring 2025 Bed Condition survey. These blades were collected under a California Department Fish and Wildlife (CDFW) Scientific Collection Permit and scanned to analyze the severity of eelgrass wasting disease. Scans from 2024 and 2025 are being manually annotated to train a computer vision model. Scans from 2026 will be used to test the accuracy of the model.

The production of flowering shoots also hinges on water temperature signals. While specific temperature thresholds vary across different geographic regions, seed production is typically initiated as water temperature reaches 15°C (Phillips et al. 1983). In 2025, the estuary experienced notably warmer conditions in the period leading up to survey efforts than in 2024 (Figure 17), which could have contributed to the higher abundance of flowering shoots across all survey sites. This was especially evident at the North Sandspit (NSS) and Reference Bed (REF) sites, where flowering shoot abundance more than doubled despite overall shoot density decreasing at both sites. The reason for this pronounced difference appears to be survey timing. North Sandspit and Reference Bed were surveyed almost a month later than the other sites due to tidal constraints, giving the process of seed production and flowering more time to progress. For this reason, it is important to note that the abundance of flowering shoots is likely impacted by survey timing, therefore sites monitored a month apart cannot be directly compared.

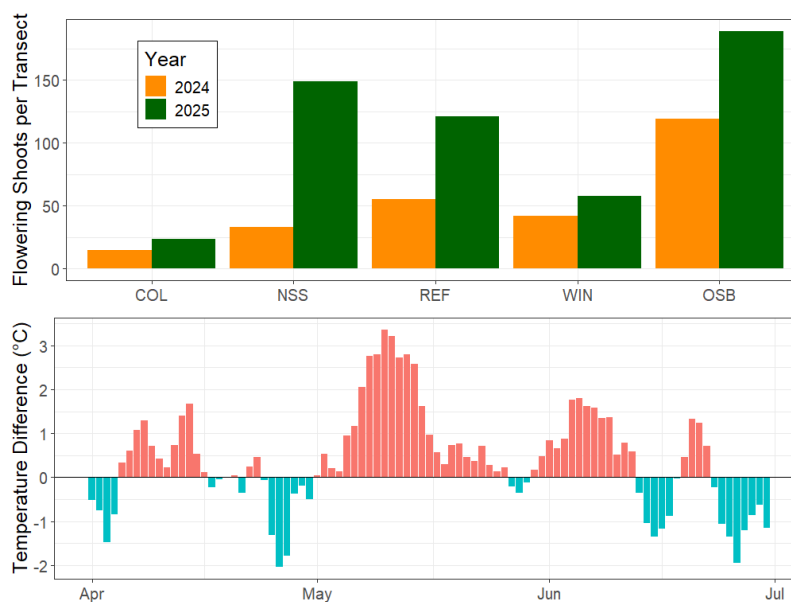


Figure 17. Total flowering shoots counted along each 150-meter transect in 2024 and 2025 (top). Difference in daily average temperature between 2024 and 2025 (bottom). Positive values (red bars) represent days when 2025 was warmer and negative values (blue bars) represent when 2025 was cooler. The time period immediately preceding the 2025 surveys (May 7 to May 14) was characterized by water temperature over 2°C warmer than in 2024, and exceeding the 15°C threshold associated with eelgrass flowering.

Macroalgae Monitoring

History

The Estuary Program began monitoring macroalgae abundance and biomass in May 2023, after a notable increase in algae abundance observed during field surveys between 2020 and 2023. The Macroalgae Monitoring project was developed to track changes in macroalgae cover and biomass both spatially and temporally. Sites were established to examine variations in macroalgae cover and biomass throughout the estuary as well as across differing elevations. In addition, co-location with eelgrass monitoring sites will aid in developing a better understanding of how the density of macroalgae affects eelgrass beds. For the first two years of the project, surveys were conducted three times per year to determine algae seasonality (spring, summer, winter). Moving

forward, surveys will be conducted once per year in the summer, which is when algae biomass reaches its annual peak.



Figure 18. Macroalgae monitoring site locations.

Methods

Since May 2023, seven surveys have been conducted for this project during low tides that fall below -0.5ft MLLW. To account for the changes in abundance of drifting algae over short time scales, monitoring takes place within a single low tide series over several consecutive days. Estuary Program staff and contractors support the fieldwork component of the project, which involves quadrat monitoring along three transects at each site. Each transect has been established at a specified elevation relative to the MLLW tide datum using LiDAR results from a 2022 survey. Transect elevations are set at -0.5ft MLLW (Low), 0ft MLLW (Center), and 0.5ft MLLW (High). These elevations were chosen because they encompass the range of elevations where eelgrass and algae exhibited the highest degree of interaction during preliminary site scouting. Elevation change between transects was verified *in situ* using an auto level in July 2023.

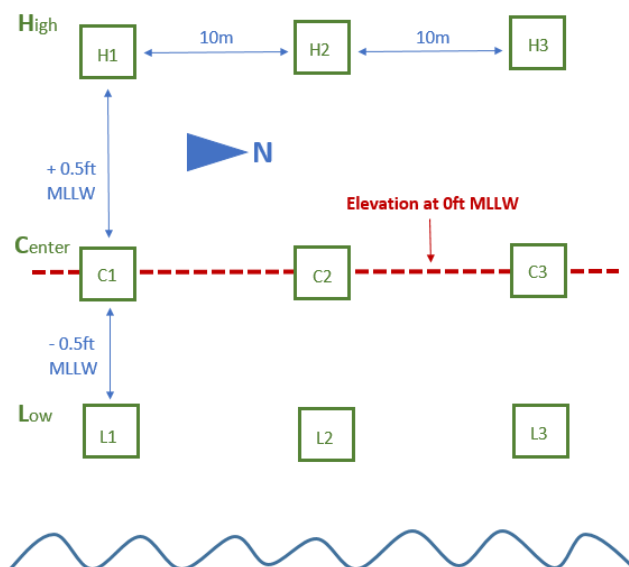


Figure 19. Schematic displaying quadrat placement for the macroalgae monitoring sites. The center transect is established at 0ft MLLW, with a high and low transect spaced at elevations 0.5ft above and below MLLW respectively. Three quadrats are monitored on each transect, spaced ten meters apart, resulting in a three quadrat by three quadrat grid for the study area. Eelgrass health metrics are observed within the area of all three transects.

Quadrat sampling consists of two methods for estimating the percent cover of different vegetation types: visual estimation (to the nearest 5%) and point-intercept (using a grid of 25 intersection points). An algae sample is then collected from the inner 0.25m² of the quadrat, which is transported back to the lab where it is refrigerated until further processing. Eelgrass health metrics such as the patchiness of the bed, presence of epiphytes, and incidence of decaying tissue throughout the survey area are collected as well.



Figure 20. Algae biomass samples are collected from the four center squares of a one-meter by one-meter quadrat, as indicated by the blue dashed line in the photo above. The *Ulva* mat has been cut away and collected for dry weight processing, revealing shoots of eelgrass hidden underneath the algal mat.

After the completion of fieldwork, Estuary Program staff dry and weigh algae samples in the lab. Before drying, algae samples are thoroughly rinsed to remove mud and invertebrates. They are then placed in an oven at 80°C

and are reweighed until drying is complete. The resulting dry weights are then standardized to grams of algal biomass per square meter.

Results

Macroalgae monitoring was conducted in May and August 2023; February, May, and July 2024; and February and July 2025. Due to inclement weather making site access difficult, the Pasadena site was not monitored in February 2024.

The percent cover and biomass methods were designed to represent differing impacts of algae abundance. Percent cover represents the two-dimensional extent of algal coverage that serves as a canopy, potentially covering eelgrass and preventing its ability to effectively photosynthesize. The biomass metric is derived from dry weights of algal material and represents the bulk three-dimensional extent of the algal mat. This is of interest as higher algal abundance may contribute to soil conditions that are anoxic and high in sulfides, conditions which are detrimental to eelgrass growth ([Gustafsson & Bostrom 2014](#)). Algae belonging to the genus *Ulva*, commonly referred to as “sea lettuces,” were the most abundant throughout all seasons, making up 91% of the total algae biomass collected during surveys.

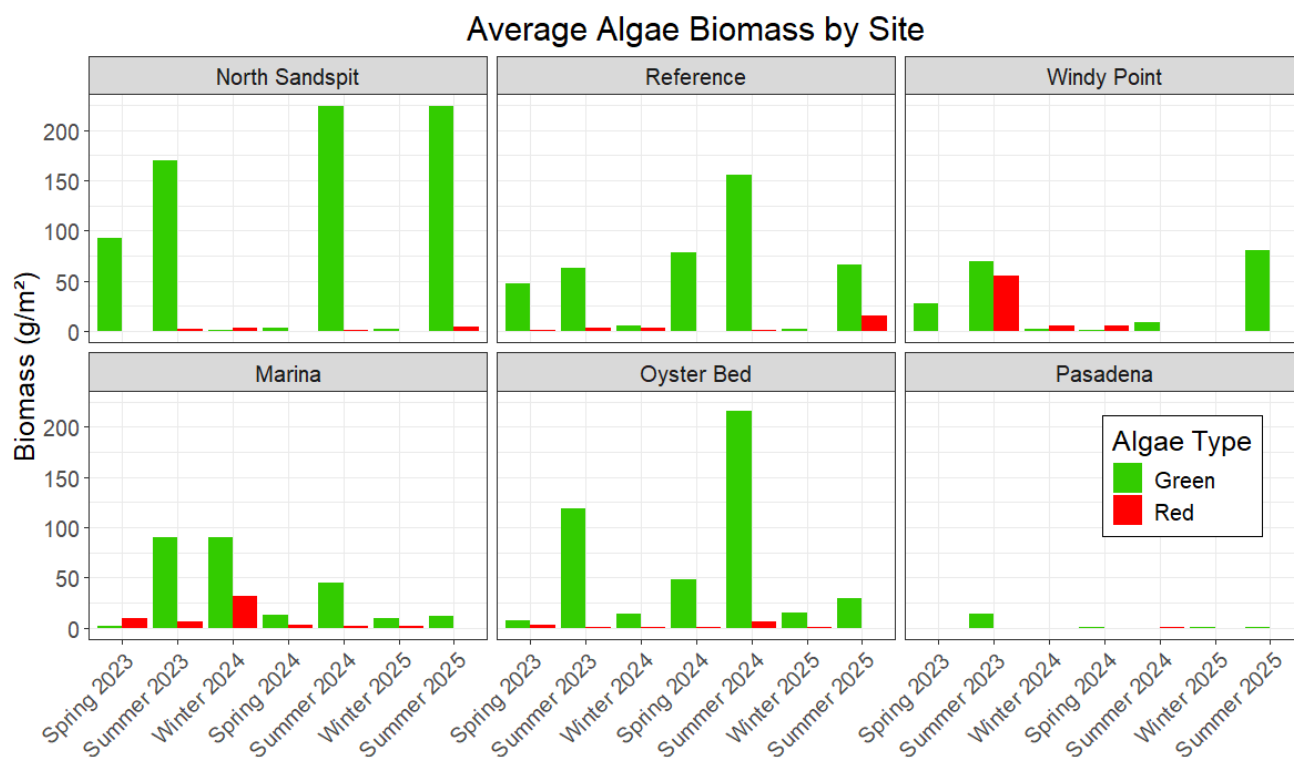


Figure 21. Average macroalgae biomass (g/m²) by site and survey season. Survey sites are arranged from top left to bottom right by increasing distance from the mouth of the bay. The PAS transect was not sampled during the winter surveys in February 2024.

A Kruskal-Wallis test found a significant difference in green algae biomass between the seasons ($H = 9.90$, $p = 0.007$) and a follow-up pairwise Dunn’s test confirmed that green algae biomass is significantly higher in the summer than in the winter ($z = 2.95$, $p = 0.009$). Summer biomass was not significantly higher than spring biomass, but the results were fairly close to being statistically significant ($z = 2.15$, $p = 0.063$). Biomass in the spring and winter were also not significantly different from each other ($z = 0.79$, $p = 0.433$). Non-parametric statistical tests were used instead of standard ANOVA because the biomass dataset was heavily skewed, contained valid outliers, and groups did not exhibit equal variance.

The highest macroalgae abundance was observed during the summer surveys and average macroalgae biomass within Morro Bay was positively correlated with average water temperature ($R^2 = 0.77$, $p = 0.006$). *Ulva lactuca*, the species that made up the bulk of the biomass samples, has been documented to reach optimal growth between 16 to 19°C, which is within the range of typical summer conditions in Morro Bay ([Steffensen 1976](#)). Spring generally had the second highest abundance, which is likely due to the arrival of *Ulva* in the spring through the process of upwelling. Upwelling occurs when surface water masses are driven offshore, which pulls deeper water masses to the surface along the coast. These upwelled water masses are rich in nitrates that can initiate blooms of drift algae like *Ulva*. While algae biomass begins to increase along with nutrient concentrations in the spring, the rising water temperature and light availability contributes to algal growth over the next few months leading into summer (Figure 22). Winter consistently had the lowest algal abundance, likely due to a combination of cold water, light limitation, and low nitrate concentrations.

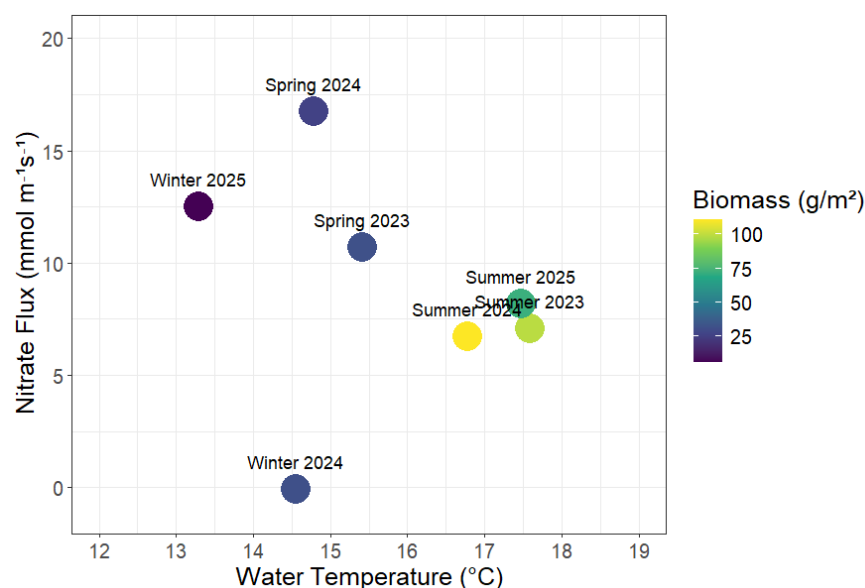


Figure 22. Average algae biomass (g/m²) by monthly average water temperature (°C) and nitrate flux (mmol m⁻¹s⁻¹). The average of algae biomass was taken across all sites to obtain a representative average for the estuary during each survey period. Nitrate flux is a metric of upwelling intensity calculated using the BEUTI index for the US west coast at 35N latitude ([Jacox et al. 2018](#)). Water temperature was recorded by the CeNCOOS back bay sensor station within Morro Bay.

Because summer represents the peak of macroalgae abundance, spring and winter surveys have been discontinued and annual summer sampling will be conducted to determine interannual variability. The interannual trends will aid in determining the driving factors for algae abundance in Morro Bay and its impacts on eelgrass beds. So far, macroalgae abundance does not seem to be negatively impacting eelgrass in a measurable way. On the contrary, the recent expansion of eelgrass acreage may actually promote more algal retention as drift algae is caught by the blades, as observed in similar studies ([Bell & Hall 1997](#)). Further monitoring is needed to uncover the long-term impacts of the increase in macroalgae biomass on eelgrass beds in the Morro Bay estuary.

Additional Activity

Dredging Operations

The Morro Bay harbor is a designated Harbor of Safe Refuge and is the only safe harbor between Santa Barbara and Monterey. Maintenance of this important harbor requires frequent dredging operations. The harbor mouth

is dredged annually by the Army Corps of Engineers (ACOE) to maintain a channel depth of approximately 40 feet.

As of May 2023, ACOE filed their Final Environmental Assessment to continue annual operation and maintenance (O&M) dredging through September 2028 ([US Army Corps of Engineers, 2023](#)). This assessment was completed in compliance with the National Environmental Policy Act (NEPA) and culminated in a Finding of No Significant Impact (FONSI). This means that the dredging project is not expected to have a significant impact on the environment. The report is exceptionally thorough, detailing how there are no expected adverse effects on federally threatened species like the Western snowy plover, steelhead, and southern sea otter. There are also no expected adverse effects on Essential Fish Habitat (EFH), and established eelgrass beds are strictly off-limits for dredging and dredge material placement.

Embarcadero Projects

Eelgrass grows intermittently along the Morro Bay Embarcadero, and impacts to eelgrass must be considered before any construction may occur. Surveys to monitor eelgrass changes have typically been completed by consulting firms like Tenera Environmental and Padre Associates using scuba divers and/or sonar before, during, and after construction projects. However, no pre or post construction surveys were conducted in 2024 and 2025.

Partnerships

The Estuary Program is continuing their partnership with Cal Poly and Cuesta College to support eelgrass research efforts. The effort also involves CA Department of Fish and Wildlife (CDFW), National Oceanic and Atmospheric Administration (NOAA), and U.S. Fish and Wildlife Service (USFWS) partners. These partnerships promote sharing of data and expert opinions to help guide eelgrass activity.

Research Efforts

Various research efforts are underway related to Morro Bay eelgrass. They are briefly summarized, including an estimate of when results will be available if the study hasn't been completed yet.

Automated Eelgrass Classification Using Drone Imagery

A machine learning model for the classification of eelgrass has been under development, utilizing drone imagery from Morro Bay. This project started as a collaborative effort between researchers at Stanford and Cal Poly, which resulted in a publication describing the model's successful quantification of eelgrass acreage in 2019 ([Tallam et al 2023](#)). The researchers used a state-of-the-art image segmentation machine learning technique to delineate eelgrass beds by assigning each pixel in the orthomosaic of drone imagery a classification of "eelgrass" or "non-eelgrass." The final deliverable is a map of eelgrass acreage, which can be used to calculate the total acreage and display its distribution throughout the estuary.

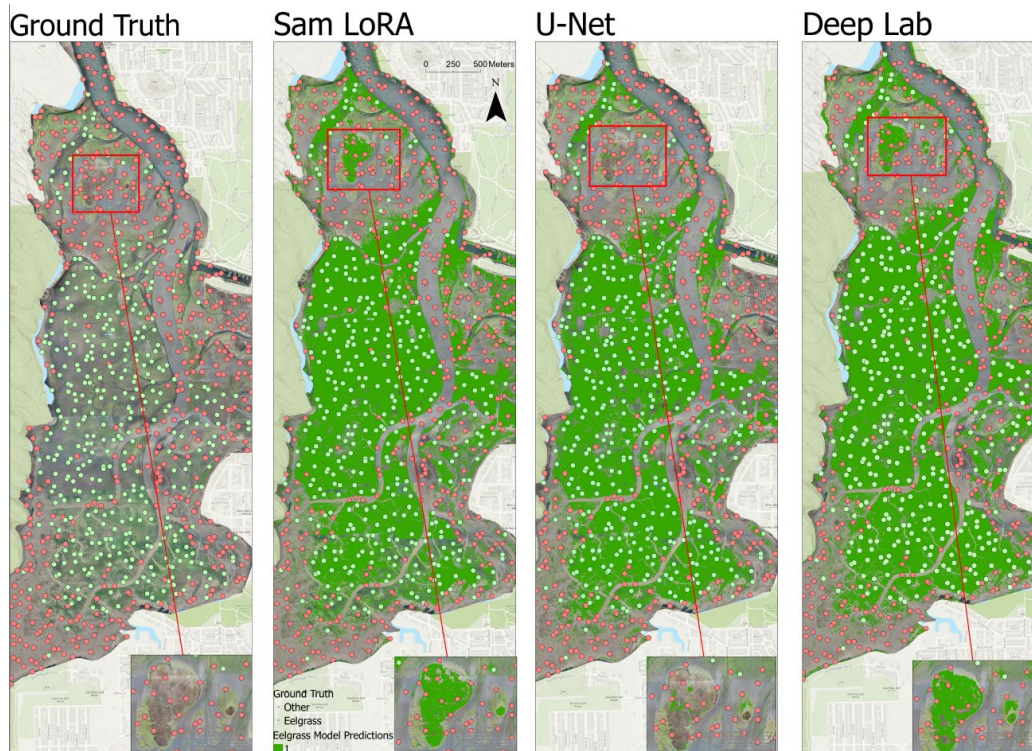


Figure 23. Drone imagery from 2022 underlying acreage maps generated by different machine learning algorithms. From left to right: imagery only, Sam LoRA (Segment Anything Model, Low-Rank Adaption), U-Net (a convolutional neural network), and Deep Lab (a residual neural network). The points represent manually annotated “ground truth” points to validate model performance, which have been colored to represent eelgrass (red) and non-eelgrass (pink). The zoomed-in portion highlights Wednesday Island, which is not composed of eelgrass.

The Cal Poly lab is currently working on a follow-up to the 2023 publication focused on training a new machine learning model with four years of drone imagery (2018 to 2021) and several different machine learning algorithms. Machine learning models typically perform better with more training data, so this model is expected to outperform the current version (which was trained on a single year of drone imagery). In addition, using imagery from multiple years is anticipated to improve eelgrass classification across a wider range of conditions, including situations that were previously challenging, such as partially submerged eelgrass beds. They will also compare model performance with varying amounts of training data (1 year, 2 years, 3 years, 4 years), to determine if multiyear models are optimal or if there are diminishing returns with more data. As the model improves, the lab has plans to apply it to systems beyond Morro Bay, testing its ability to track eelgrass beds and other seagrasses on both the East and West Coast.

Water Quality Monitoring

Dr. Ryan Walter from Cal Poly's Physics Department continues to maintain water quality instrument packages at the front bay and the back bay, as well as a weather station in the back bay. Funding for these stations are provided by the Central and Northern California Ocean Observing System (CeNCOOS) and the Estuary Program. A real-time data stream is available here: <https://www.cencoos.org/observations/sensor-platforms/shore-stations/>. Additionally, Dr. Walter maintains temperature sensors at the mouth of the bay and back of the bay.



Figure 24. Senior research scientist Ian Robbins checks on the instruments at the back bay sensor station (left). The top of the station houses meteorological instruments for measuring weather parameters and a solar panel to power all the sensors. Dr. Bockmon and her students collect water from Pasadena Park using a Niskin sampler (right). Photos courtesy of Ian Robbins and Dr. Emily Bockmon.

Dr. Emily Bockmon of Cal Poly's Chemistry Department oversaw numerous ocean acidification monitoring and carbonate chemistry sampling efforts. Data from two autonomous pH sensors are automatically uploaded from the sensor to the web and can be viewed here: <https://data.cencoos.org/#metadata/100050/station>. Data calibration, processing, and sensor maintenance are ongoing. Dr. Bockmon and her students also conduct monthly carbonate chemistry sampling at three shore locations.

Eelgrass Wasting Disease Research

Students and faculty from Cuesta College have been studying the occurrence of the slime mold *Labyrinthula* spp. on eelgrass in Morro Bay since 2018. This project, led by Drs. Laurie McConnico and Silvio Favoreto, is focused on the distribution of *Labyrinthula* spp. throughout the estuary and understanding its role in eelgrass wasting disease. Eelgrass blade sampling is conducted annually in Morro Bay by Cuesta College faculty and students. Approximately 24 individual blades are collected (12 healthy and 12 necrotic) from the mouth, mid-bay, and back bay. Students process fragments of each blade to examine the severity of wasting disease lesions and extract the DNA of microorganisms living on the blades. So far, the results indicate that *Labyrinthula* spp. behaves as an opportunistic organism in the Morro Bay estuary rather than a primary pathogen. Opportunistic microbes take advantage of a weakened state to promote disease but are unable to establish infection in healthy hosts.



Figure 25. Eelgrass blade segments are placed in petri dishes and incubated at room temperature to promote the growth of *Labyrinthula* spp. for whole-genome sequencing. Photo courtesy of Dr. Silvio Favoreto.

In late 2025, two sets of DNA samples were sent out for genetic analysis. The first was a batch of 160 samples for 16S rRNA sequencing, which is a method for analyzing the bacterial microbiome. Much like how a human's gut microbiome is essential for their health, the microbiome present on eelgrass blades can reveal similar insights for its health. By pairing the microbiome results with the severity of wasting disease on the eelgrass blades, the Cuesta lab can better understand how *Labyrinthula* spp. interacts with the microbiome and how that impacts eelgrass health. The second batch of samples consisted of eight cultured *Labyrinthula* spp. extractions that will have their entire genome sequenced. Preliminary work with Random Amplified Polymorphic DNA (RAPD) has shown that *Labyrinthula* spp. in Morro Bay exhibits a surprisingly high level of genetic diversity. Whole Genome Sequencing (WGS) will identify potential virulence markers, providing a critical insight into the pathogenic capabilities of this slime mold within Morro Bay. Results from these experiments are expected in 2026.

Black Brant Population and Behavior Changes

The black brant (*Branta bernicla nigricans*) is a small goose that feeds primarily on eelgrass. Morro Bay is an important stop on its annual migration between summer nesting sites in Alaska and wintering sites in Baja California. The brant populations in Morro Bay have historically been associated with eelgrass availability and were likely impacted by the eelgrass decline. However, the recent increase in eelgrass acreage has not yet resulted in a brant increase of similar magnitude.

John Roser, a local biologist, has been counting brant in Morro Bay for almost thirty years. To estimate the presence of brant in the bay, mid-winter counts are conducted each January and can be compared to historic counts as far back as 1931. Counts from the 1930s through the 1960s averaged between 6,000 to 7,000 brant, with some counts reaching as high as 13,000 brant, as was recorded in 1951. The more recent counts, displayed in Figure 26, are all below these historic averages. Brant numbers in Morro Bay experienced a significant decline from the early 2000s until 2015 but have started a modest recovery.

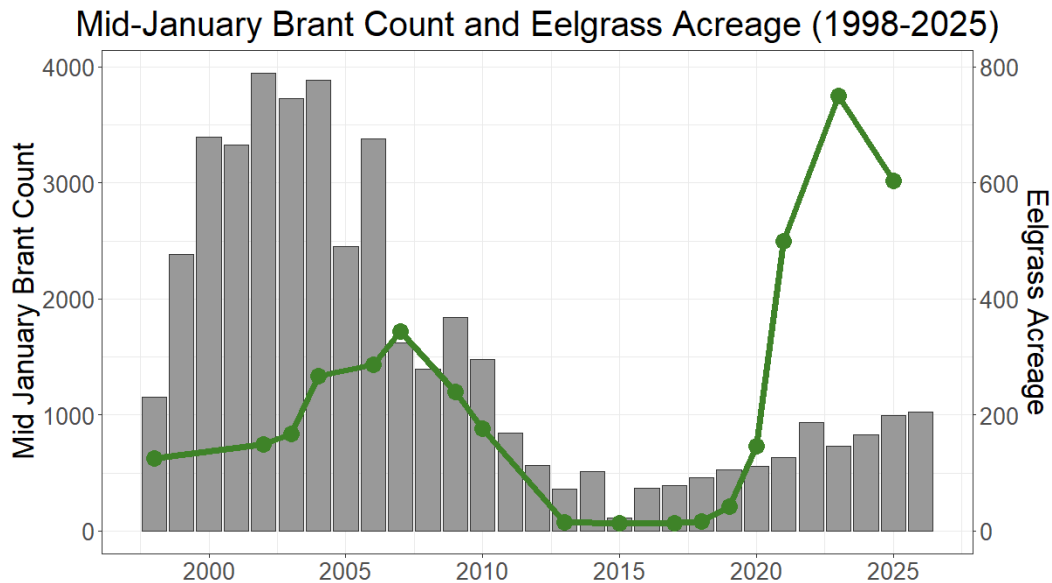


Figure 26. Results of the Mid-January Brant count from 1998 to 2025 compared with eelgrass acreage. Brant counts are available through January 2026 and the latest eelgrass acreage data comes from drone flights in spring 2025.

The hope is to see brant return in larger numbers if eelgrass continues to thrive, however the changing climate has altered the number of brant that choose to migrate from Alaska. Warmer temperatures in Alaska allow for adequate food availability throughout the year, causing proportionally fewer brant to make the 3,000-mile migration. While the number of brant stopping by Morro Bay is fairly low, it is worth noting that their overall population numbers across the Pacific Flyway are stable.

Fish Composition Study

In 2006 and 2007, Dr. John Stephens of Occidental College conducted a multi-method study to assess fish populations in Morro Bay. Dr. Jennifer O’Leary repeated the work in 2016 and 2017, when eelgrass acreage was at historic lows. O’Leary documented changes in fish species composition throughout the estuary due to eelgrass loss ([O’Leary et al. 2021](#)). The Estuary Program wanted to understand how fish communities had responded to the increase of eelgrass. The Estuary Program contracted with Stillwater Sciences to conduct fish surveys in fall 2023 and spring 2024 to evaluate fish community composition, assess how fish varied between habitat types, and compare results to prior survey efforts.

Shallow shoreline locations were monitored using a beach seine, the intertidal flats were surveyed with benthic beam trawls, and the deep open channel was surveyed with midwater otter trawls. These methods were consistent with the previous efforts and were conducted under an approved CDFW Scientific Collection Permit. In addition to historic and traditional methods, environmental DNA (eDNA) was collected at each monitoring site. The eDNA samples were sent to Jonah Ventures LLC for sequencing and resulted in the detection of 62 unique fish taxa, providing a broader picture of fish composition.



Figure 27. Species assessed during the 2023 and 2024 fish study in Morro Bay.

During the 2023 and 2024 surveys, the most abundant species were bay pipefish (*Syngnathus leptorhynchus*), making up 42% of overall catch and 74% of catch within intertidal flat habitat (shown in yellow in Figure 28). Bay pipefish are a habitat specialist species that are uniquely adapted to life within eelgrass beds. The second most abundant species were arrow goby (*Clevelandia ios*), a burrowing fish that benefits from eelgrass beds stabilizing sediment along the shoreline (shown in orange in Figure 28). In comparison to historic data, both species reached their highest relative abundance when eelgrass abundance was highest (post-recovery). The tidal flat and shoreline habitats experienced major compositional shifts along with changing eelgrass conditions, whereas the open channel remained dominated by speckled sanddabs (*Citharichthys stigmaeus*) regardless of eelgrass abundance (shown in purple, Figure 28). This is likely because the Morro Bay estuary contains very little subtidal eelgrass acreage, so the loss and recovery of eelgrass had a relatively small impact on the open channel fish population.

For information on this study, please find the [final report produced by Stillwater Sciences on the Estuary Program website](#).

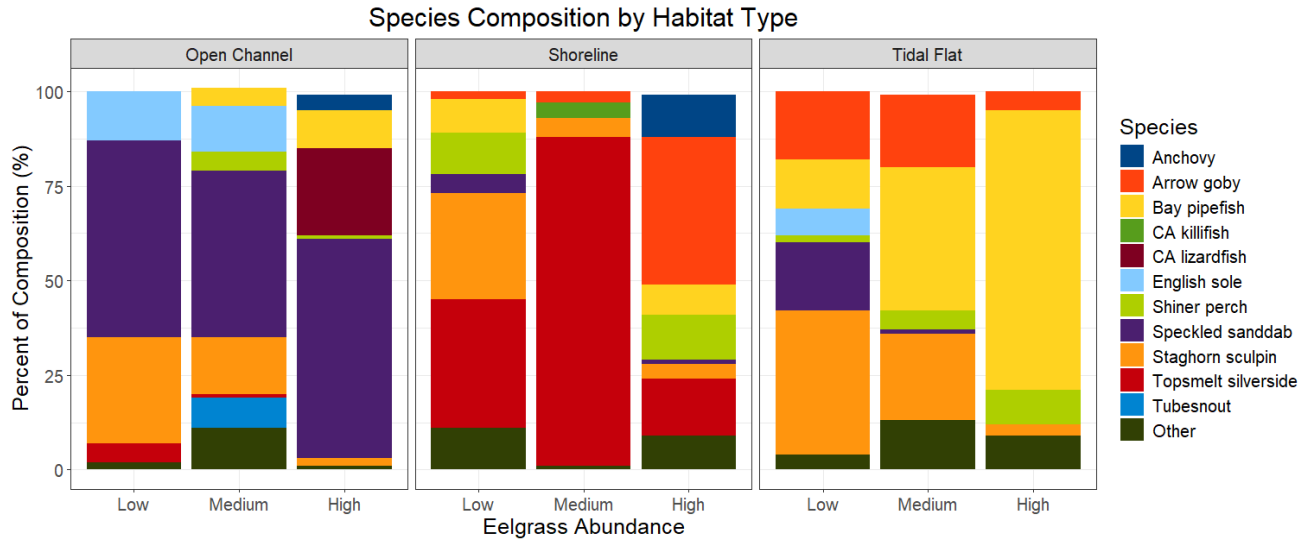


Figure 28. Fish species composition at each habitat type, including the open channel (left), shoreline (center), and tidal flat (right). Within each sub-plot, eelgrass abundance is arranged from low (2016-2017 surveys), medium (2006-2007 surveys), and high (2023-2024 surveys) as opposed to chronological order.

Graduate Thesis Highlights

Morro Bay's eelgrass beds not only support fish populations; they have also been a valuable resource for graduate students in numerous fields of study. The dramatic story of decline and recovery over the past two decades has made Morro Bay an ideal study system for those looking to explain complex environmental systems.

- **Kaden Caliendo, Civil and Environmental Engineering (Cal Poly SLO), December 2023:** [*The Tidal Prism, Viable Eelgrass Habitat, and the Effects of Sea Level Rise in Morro Bay*](#)
 - This study involved deploying inexpensive tidal gauges around Morro Bay and using digital elevation models (DEM) of the estuary to calculate the tidal prism (the volume of water that moves in and out of the estuary during a complete tidal cycle). Taking things a step further and factoring sea level rise into the equation, Caliendo projected that the tidal prism could increase 40% by 2100. This is predicted to result in a short-term expansion of viable eelgrass habitat up to 1,938 acres, assuming there are no major changes to estuarine bathymetry from erosion or sediment accretion. However, as the sea level continues to rise, viable eelgrass habitat would decrease by up to 59% between 2022 and 2100.
- **Dakota Osborne, Biological Sciences (Cal Poly SLO), August 2024:** [*Of Geese and Grass: Investigating Impacts of Brant Grazing on Eelgrass*](#)
 - This study investigated the top-down effects of brant grazing on eelgrass, following up on a study from Humboldt that indicated grazing may be an important factor in maintaining eelgrass health. Osborne established several plots in the 2018-2019 brant season, four of which were open to grazing and four of which were enclosed to prevent grazing. There were no significant differences in eelgrass growth, condition, or epiphyte load between the open and enclosed plots, contradicting the Humboldt study and suggesting that brant grazing does not have a significant effect on Morro Bay eelgrass.

- **Gwenyth Greco, Geographic Information Science (CSU Northridge), December 2024:** [*Measuring the Impact of Sea Otter Presence and Activity on Eelgrass System Health in Morro Bay, CA: The Creation of a Novel Otter-Eelgrass Index*](#)
 - This study combined sea otter surveys, iNaturalist observations, eelgrass monitoring, and satellite data to characterize the potential relationship between sea otters and eelgrass health. Greco used these data to construct the experimental Sea Otter Presence Impact on Eelgrass (SOPIE) index, which quantifies the otter-eelgrass relationship. The SOPIE index varied across monitoring sites, with Coleman Beach receiving the highest score, indicating that there is a correlation between otter activity and eelgrass health at this location.
- **Dillon Murphy, Statistics (Cal Poly SLO), March 2026:** [*Using Ensemble Disagreement to Stabilize Conformal Prediction Under Distribution Shift*](#)
 - This study built upon the eelgrass acreage classification efforts described earlier in this report, to improve model reliability when conditions change between years. Conformal prediction allows the model to quantify its level of uncertainty when assigning classifications, but this technique can be overconfident. Murphy added a difficulty adjustment to this prediction process, using the level of disagreement between multiple models to quantify the difficulty of a specific area and make the model more cautious when classifying those challenging areas. The end goal is to create eelgrass mapping models that are more trustworthy across variable, real-world conditions.

Upcoming Projects

- **Eelgrass Acreage Mapping:** The Estuary Program will partner with Cal Poly for a bay-wide UAV drone survey during winter 2026. The imagery will be processed using their machine learning model to provide an acreage map of eelgrass extent. This effort will be accompanied by an extensive ground-truthing effort that utilizes both field surveys and manual review of the imagery to ensure model accuracy.
- **Continuation of Monitoring Projects:** In 2026, the Estuary Program plans to conduct monitoring of permanent transects, bed condition locations, and macroalgae sites. The computer vision model to identify eelgrass wasting disease lesions from blade scans is actively under development and preliminary results are expected in the coming year. Despite having surpassed recovery targets, the continuation of eelgrass monitoring is essential for ensuring timely restoration efforts in the event of a large decline.
- **Additional Research Activity:** Dr. Ryan Walter of Cal Poly will continue to maintain the water quality instrument package at the mouth of the bay and in the back bay throughout 2026. Dr. Bockmon of Cal Poly will also continue to oversee the operation of the autonomous pH sensors at the mouth and back bay locations and monthly shoreline sampling. Dr. Laurie McConnico and Dr. Silvio Favoreto of Cuesta College will continue their annual data collection to further our understanding of Eelgrass Wasting Disease in the bay.

Conclusions

Eelgrass plays a vital role in the health of the Morro Bay ecosystem. While the acreage of eelgrass in Morro Bay has fluctuated in the past, the last decade has included the most precipitous decline and subsequent recovery on record. While we have not yet determined the exact explanation for the recovery, it is likely the result of a combination of shifts in elevation, water quality, natural recruitment, and restoration efforts. The Estuary Program plans to continue monitoring eelgrass health and acreage to further develop our understanding of eelgrass bay-wide and to assess how specific eelgrass beds are faring over time.

The past several years have marked a major transitional period in Morro Bay's eelgrass beds, and the Estuary Program is in the process of investigating the impacts of this transition. Eelgrass coverage climbed to record highs in 2023 before contracting to a lower, yet potentially more sustainable extent of 603 acres in 2025. Amidst these eelgrass fluctuations, broader changes in climate will continue to modify conditions within the estuary. Data indicates that migratory patterns are changing, sedimentation and erosion continue to modify estuarine bathymetry, and macroalgae abundance has significantly increased during the spring and summer. Consistent monitoring will be key in adapting to and addressing future changes.

In 2026 and beyond, we will build upon our existing knowledge of eelgrass and its complex relationships with macroalgae proliferation, sedimentation, wasting disease, and more. We will continue to stay up to date on restoration strategies so we can respond quickly and efficiently in case of a rapid decline or die-off. The Estuary Program and its many partners will continue to work towards a better understanding of the estuary as a whole and apply that understanding to supporting a sustainable eelgrass population in Morro Bay.

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