State of the Estuary Report 2015

Summary

HABITAT – Eelgrass

Summary

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SotER –Habitat Indicator

Subtidal - Eelgrass (*Zostera marina)*

1. Brief description of indicator and benchmark

Attribute	Indicator	Benchmarks
HABITAT		
Subtidal	• Eelgrass coverage (acres)	The benchmarks of 8,000 and 4,000 acres are based on the 2010 *San Francisco Bay Subtidal Habitat Goals Report* which established a goal of increasing native eelgrass populations in SF Bay within 8,000 acres of suitable subtidal/intertidal area of a 50-year time frame using a phased approach.

2. Indicator status and trend measurements

	STATUS	TREND	DETAILS
Eelgrass	Poor	Mostly Improving	Monitoring of eelgrass acreage since 2003 has shown a general expansion trend. However, current eelgrass acreage is significantly less than the estimated maximum potential coverage, based on a habitat suitability model. In addition, there has been a recent decline in eelgrass bed coverage that is a significant departure from the expansion trend.

3. Brief write-up of scientific interpretation

The indicator for health of the subtidal habitat of the San Francisco Bay is acreage of eelgrass beds. In San Francisco Bay, eelgrass is the most extensive type of submerged aquatic vegetation, or underwater flowering plants. Eelgrass performs a wide variety of functions in the Bay. Eelgrass beds provide shelter and food to small fishes of a variety of species, such a pipefish, kelpfish, staghorn sculpin, and multiple other species that are either bay resident, or which transit through the bay during portions of their life history. Eelgrass provides food for

various species of birds both directly and indirectly. Eelgrass is also used as a preferred substrate for spawning by Pacific herring. Eelgrass beds mute wave energy, slow currents and trap sediment, reducing turbidity and shoreline erosion. Inventories of eelgrass bed coverage in the San Francisco Bay have been undertaken since 2003 under a comprehensive monitoring program, allowing the tracking of eelgrass trends over time.

The *San Francisco Bay Subtidal Habitat Goals Report* (Subtidal Goals Report) produced in 2010 contains restoration goals for native eelgrass in San Francisco Bay. The goals were based on a comparison of the current coverage of eelgrass (about 1% of the Bay) compared to the maximum potential coverage of eelgrass (about 9% of the Bay), determined by a habitat suitability model. The Subtidal Goals Report determined that the restricted extent of eelgrass beds may be limiting their support of valued ecosystem services and, furthermore, that restoration of eelgrass beds has been demonstrated and is feasible. The benchmark for eelgrass is based on the restoration goal in the Subtidal Habitat Goals report of increasing eelgrass populations in the Bay within 8,000 acres of suitable subtidal/intertidal area over a 50-year time frame using a phased approach under a program of adaptive management. The benchmarks under the phased approach are to increase eelgrass coverage by 25 acres within 5 years, 100 acres within 10 years, and up to 8,000 acres within 50 years.

The overall trend for eelgrass bed coverage since 2003 has been expansion. The 2009 baseline used for the Subtidal Goals report was 3,700 acres, and by 2011 acreage increased to just under 4,000 acres, thus meeting the initial 5 and 10 year goals of expansion of coverage by 25 and 100 acres. However, more recent monitoring data from 2013 and 2014 shows a significant decline of eelgrass bed coverage to 3,300 acres and approximately 2,790 acres, respectively. This is well below the 2009 baseline used in the Subtidal Goals Report. This recent decline is a significant departure from the expansion trend observed in the bay since 2003, leading to concerns about the possible end or even reversal of this trend. However, eelgrass beds are a dynamic habitat and can experience tremendous variability in coverage from year-to-year. In many instances, significant declines and increases, and even baywide distribution patterns may be attributed to specific environmental conditions or unique events. For instance, substantial declines in eelgrass, that were detected in October 2016, principally resulted from December 2005-January 2006 storms and subsequent flooding from the local watersheds and the Delta. This event depressed salinities throughout the north Bay for periods of over a month and loaded the Bay with considerable resuspendable sediment that exacerbated turbidity levels for an extended period of time. During the recent drought years, eelgrass has expended towards the Delta and even slightly into Suisun Bay, however some of the largest beds that have historically been more stable, have concurrently suffered some significant declines. In some cases, these declines are likely to be related to desiccation stress within intertidal areas, while in other areas, declines at the shallow margins of these extensive beds may be related to

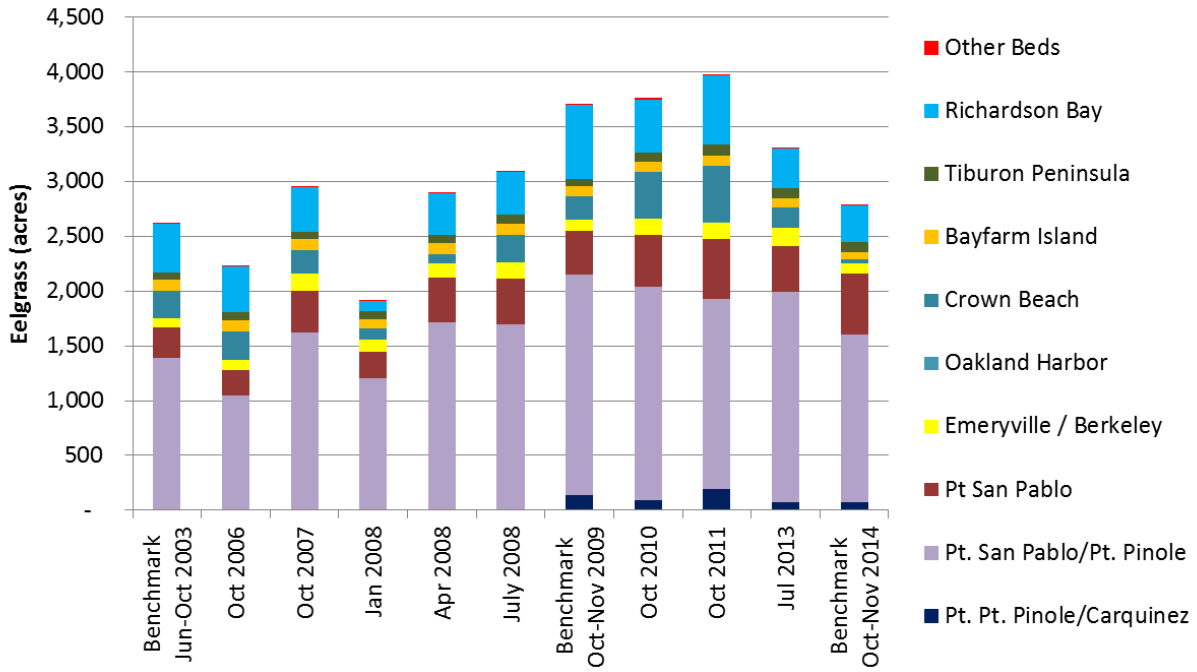
thermal stress from high residence time warm water. There may also be loss from disease, although no direct evidence of expansive bed damage has yet been noted in San Francisco Bay. Additional monitoring will better determine the current trend of eelgrass in the Bay and provide greater insights into both the natural and anthropogenic factors controlling the extent and distribution of eelgrass.

Eelgrass beds are subject to many threats over short and long time scales. In the Bay, eelgrass beds are strongly limited in maximum depth by allowable light penetration associated with turbidity of the water. In the Bay, turbidity of the water is related to both large-scale factors such as sediment supply from tributaries, as well as local effects such as increased turbidity from dredging and shipping activities. In addition, hardened shorelines reflect waves and increase their effects, which can break up eelgrass beds. The most recent decline in eelgrass bed coverage in the Bay raises concerns about the large-scale, long-term stability of eelgrass in the Bay, and the resulting potential loss of functions and services provided by eelgrass beds. In recent years, wasting disease has also become a significant factor affecting the area and distribution patterns of eelgrass within California bays and estuaries. The earliest evidence of wasting disease declines were noted in southern California in about 2006 with disease having now been noted in most California bays and estuaries, including San Francisco Bay. In Morro Bay, the system hardest hit by wasting disease, there has been a 97 percent decrease in eelgrass extent since 2007 likely a result of a combination of factors (e.g., disease, water quality, sedimentation) and efforts are now underway to foster recovery. The full ramifications of disease on eelgrass distribution and trajectory are not yet known, but are a factor of major concern with respect to achieving restoration goal.

4. Related figures

5.

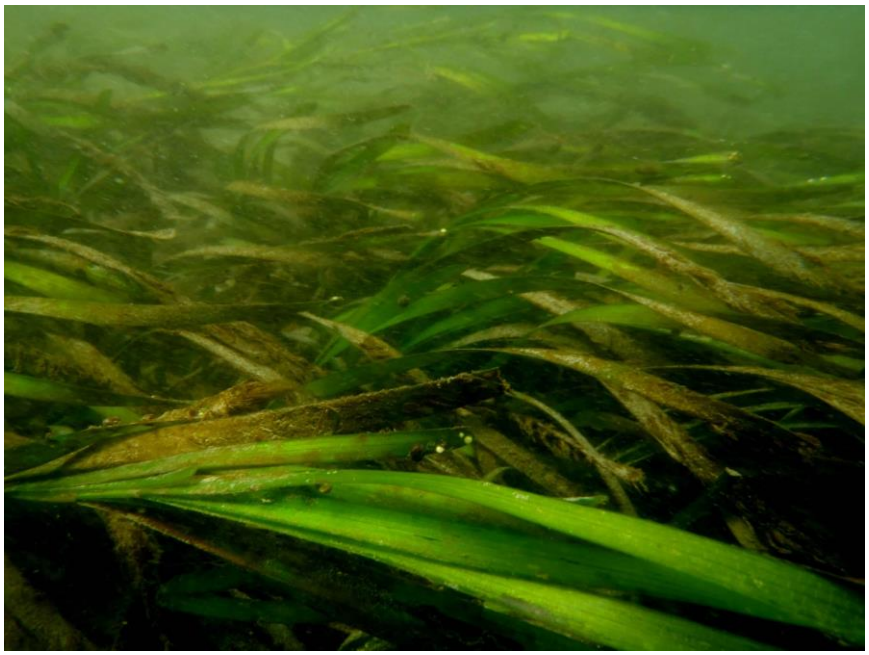
a. Eelgrass extent and distribution from 2014 Regional Eelgrass Monitoring Report (Merkel & Associates 2015).



b. Table from Report with numbers - Eelgrass Occurrence by Survey/Monitoring Period and Bay Region

REGION	Benchmark Jun-Oct 2003 (ac.)	Oct 2006 (ac.)	Oct 2007 (ac.)	Jan 2008 (ac.)	Apr 2008 (ac.)	July 2008 (ac.)	Benchmark Oct-Nov 2009 (ac.)	Oct 2010 (ac.)	Oct 2011 (ac.)	Jul 2013 (ac.)	Benchmark Oct-Nov 2014 (ac.)
Pt. Pt. Pinole/Carquinez							136	93	190	68	77
Pt. San Pablo/Pt. Pinole	1,389	1,045	1,620	1,202	1,710	1,693	2,017	1,944	1,740	1,923	1530
Pt San Pablo	282	232	377	246	409	417	401	474	542	418	552
Emeryville / Berkeley	80	96	159	107	130	154	95	149	154	167	92
Oakland Harbor	0						-	1	2	2	0
Crown Beach	251	254	220	100	86	246	219	423	518	188	36
Bayfarm Island	102	110	96	90	104	107	88	93	93	81	70
Tiburon Peninsula	63	72	62	67	77	78	66	85	100	95	91
Richardson Bay	449	417	414	94	379	390	675	487	629	354	335
Other Beds	5	4	5	3	5	5	10	11	12	9	8
TOTAL	**2,623**	**2,231**	**2,955**	**1,910**	**2,901**	**3,089**	**3,707**	**3,760**	**3,982**	**3,306**	**2,790**

c. Photo of eelgrass



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Technical Appendix

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Eelgrass (*Zostera marina*) Indicator – Technical Appendix

Background and Rationale

Discuss how the indicator relates to the ecological health of the estuary

The indicator for health of the subtidal habitat of the San Francisco Bay is acreage of native eelgrass (*Zostera marina*) beds. In San Francisco Bay, eelgrass is the most extensive type of submerged aquatic vegetation, or underwater flowering plants. Eelgrass performs a wide variety of functions in the Bay. Eelgrass beds provide shelter and food to small fishes of a variety of species, such a pipefish, kelpfish, staghorn sculpin, and many other Bay resident species and fish that pass through the Bay during various periods in their life history. Eelgrass provides food for many species of birds both directly and indirectly. Eelgrass is also used as a preferred substrate for spawning by Pacific herring. Eelgrass beds also dampens wave energy and slow currents in a manner that results in trapping sediment, reducing turbidity, and protecting shoreline area from erosion. Inventories of eelgrass bed coverage in the San Francisco Bay have been undertaken since 2003 under a comprehensive monitoring program, allowing the tracking of eelgrass trends over time.

Include historical information about the indicator and any current programs to evaluate it.

The earliest known studies of eelgrass in the Bay were conducted in the 1920s. Though those studies were not intended to document the area of eelgrass distribution, they do indicate eelgrass beds in at least Marin County at the time, and there is anecdotal evidence that eelgrass may have been present elsewhere in the Bay (Boyer and Wyllie-Echeverria 2010).

The earliest Baywide survey for eelgrass in San Francisco Bay was conducted in 1987 using visual inspection and depth-sounding from small boats. (Wyllie-Echeverria and Rutten 1989). That survey reported 316 acres of eelgrass, located throughout the Bay.

In 2003, a Baywide Eelgrass Inventory and Resource Management Research Program was developed and jointly managed by the California Department of Transportation and NOAA's National Marine Fisheries Service (NMFS). The program has been the most comprehensive effort to inventory eelgrass in the San Francisco Bay over time. The program resulted in comprehensive baywide eelgrass inventories conducted by Merkel & Associates in 2003 and 2009 using sidescan and single beam sonar along with aerial surveys, and annual fixed position belt-transect surveys using sidescan sonar in years 2006, 2007, 2008, 2010, 2011 and 2013. The transects provide spatial and density information on a shoreline segment-by-segment basis that is scaled against the comprehensive mapping results of the "benchmark year" to evaluate changes in bed coverage, areal extent and regional distribution (Merkel 2013).

NMFS continues to support inventories of eelgrass in San Francisco Bay, including a 2014 survey, which was completed using interferometric sidescan sonar, allowing for the integration of bathymetric data collection, concurrent with eelgrass distribution mapping.

The overall trend for eelgrass bed coverage since 2003 has been expansion. By 2011, monitoring reported a Baywide acreage of just under 4,000 acres. However, the latest monitoring data from 2013 and 2014 shows decline of eelgrass bed coverage to 3,300 acres and 2,790 acres, respectively. These recent surveys show a significant departure from the expansion trend. However, eelgrass beds are a dynamic habitat and can experience tremendous variability in coverage from year-to-year and in

response to large-scale climatic conditions. Additional monitoring will better determine the current trend of eelgrass in the Bay and facilitate understanding of the variability of eelgrass resources in the bay and the response to various stressors.

Explain why this indicator and this calculation approach were chosen.

This indicator was chosen because of the importance of eelgrass directly as a valuable ecological resource and as an indicator of health for the San Francisco Bay. Further, it was selected because of the long-term inventory and monitoring program which has a proven track record of being robust over time. Data on eelgrass bed coverage in the Bay have been collected using the same methodology and by the same entity since 2003, creating a long-term comparable dataset for eelgrass bed coverage.

Benchmark

Describe the benchmark and why it was chosen.
Discuss any limitations of the benchmark and how it might be improved in the future.

The benchmarks chosen for eelgrass in San Francisco Bay come from the 2010 San Francisco Bay Subtidal Habitat Goals Report (Subtidal Goals Report). The goals for eelgrass in the Subtidal Goals Report are based on a comparison of the 2009 coverage of eelgrass (3,700 acres or about 1% of the Bay), compared to the maximum potential coverage of eelgrass (23,440 acres or about 9% of the Bay). The maximum potential coverage of eelgrass was determined by a spatial-numeric habitat suitability model developed by Merkel & Associates (Merkel 2005). The model is based on bathymetry, current speed, exposure to wind waves, residence time, and the locations of extant eelgrass beds. Habitat characterized by the model as suitable for the establishment of eelgrass beds occurs at depths less than about 2 m in broad swaths along the shores of San Pablo, Central, and South Bays. About half of the maximum potential coverage of eelgrass was classified as moderately suitable to highly suitable. The Subtidal Goals Report developed restoration goals for eelgrass over a 50-year period based on the acreage of nearshore areas of moderate to high habitat suitability as predicted by the model. The benchmark of 8,000 acres within 50 years would increase eelgrass distribution within 50% of identified potential habitat. In addition, a phased adaptive management approach to eelgrass restoration was suggested in an effort to increase knowledge, and thus success, over time. The phased goals are to increase eelgrass coverage by 25 acres within 5 years, 100 acres within 10 years, and 8,000 acres within 50 years. The benchmark of 8,000 acres therefore represents the scoring break between “fair” and “good” for eelgrass health in the Bay. A second benchmark of 4,000 acres was chosen as the scoring break between “poor” and “fair” for eelgrass health. Of the years monitored, only one year (2011) comes close to meeting the “fair” benchmark, which is consistent with what the modeling shows for potential eelgrass habitat and consistent with how restoration efforts over time may be able increase eelgrass acreage in the Bay. It is important to note, however, that eelgrass beds are dynamic and acreages will vary from year to year. Trends for eelgrass are best evaluated over time using not only overall geographic extent, but also the stability of populations and the establishment of new beds.

The benchmark as developed by the Subtidal Goals Report may be refined in the future based on additional information on eelgrass restoration methods (including site selection). The benchmark may also be improved based on refinement of the habitat suitability model with additional data on Bay conditions and responses of eelgrass beds to the environment. Of high benefit to the suitability modelling would be enhancement of shallow bathymetric data within the Bay and potentially the integration of stochastic flood and sediment loading events.

Peer Review

Describe how the indicator was vetted with other experts in the community as per the SOTER Peer Input Guidelines.

The indicator and benchmark rely heavily on the information contained in the 2010 Subtidal Goals Project, a collaboration among the San Francisco Bay Conservation and Development Commission, the California Ocean Protection Council, the California State Coastal Conservancy, the National Oceanic and Atmospheric Administration, and the San Francisco Estuary Partnership. The Subtidal Goals Project underwent significant peer review. Contributors included multiple staff of the participating agencies, as well as additional experts from academia, non-profit organizations, and consulting firms who served on steering committees and provided input and review. The monitoring program for assessing the eelgrass distribution indicator was developed and tested over a three year period between 2006 and 2009. The monitoring program accuracy was verified by evaluating the transect-based estimates of eelgrass occurrence in the Bay against the measured distribution of eelgrass from the 2003 and 2009 benchmark comprehensive eelgrass surveys to determine the difference between calculated and measured eelgrass extent. The error checking process indicates that the monitoring program yields and overall error rate of approximately 1.5 percent for estimating baywide eelgrass extent. The monitoring program development was reviewed as draft and final documents by multiple agency reviewers at National Marine Fisheries Service and the California Department of Transportation during the program development.

In addition, the indicator as developed for the State of the Estuary Report was vetted with the following experts in the community: Marilyn Latta, State Coastal Conservancy; Korie Schaeffer, NOAA National Marine Fisheries Service, Natalie Consentino-Manning, NOAA NMFS Restoration Center; and Keith Merkel, Merkel & Associates. Ms. Latta, Ms. Schaeffer, and Ms. Consentino-Manning were three of the leads on the Subtidal Goals Project.

Literature Cited

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