Tracking Tidal Wetland Extent in San Francisco Bay:
A 2020 mapping update

SF ESTUARY
Wetlands Regional Monitoring Program

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Executive Summary

The tidal wetlands of San Francisco Bay (Bay) provide numerous benefits to the region, including carbon sequestration (Callaway et al. 2012), flood protection (Taylor-Burns et al. 2024), providing habitat for native and endangered species (Goals Project 2000), protecting shoreline communities and infrastructure from wave impact (Taylor-Burns et al. 2023), improving water quality (Mitsch and Gosselink 2015), and supporting a range of cultural and recreational uses. Our collective investment in conservation and restoration since the early 1990s has reversed the trend of wetland loss in the Bay, and has led to steady progress toward regional restoration goals.

The newly established Wetlands Regional Monitoring Program (WRMP) is overseeing regular mapping of baylands habitats as part of its regional-scale monitoring aimed at increasing the impact, utility, and application of permit-driven monitoring to inform science-based decision-making. Such mapping is crucial for understanding how tidal wetlands are changing over time and for tracking and informing management actions. The recently released Baylands Habitat Map (BHM) 2020 (WRMP 2024a), an early product of the WRMP, used cutting-edge automated mapping techniques paired with a standardized habitat classification scheme to map wetlands in the Bay. Using BHM 2020 data and restoration project information from EcoAtlas Project Tracker, the WRMP has calculated a new estimate of tidal wetlands in the Bay: 53,700 acres as of 2020.

This new 2020 estimate shows an increase in tidal wetland extent compared to previous estimates. The 2015 Baylands Ecosystem Habitat Goals Update estimated that there were 46,000 acres of tidal wetland as of 2009 (BEHGU; Goals Project 2015), and the State of the Estuary Report estimated there

Tidal Wetland at Point Isabel. Photo by Shira Bezalel, SFEI.

Aerial of Corte Madera Marsh. UAS imagery by Pete Kauhanen, SFEI.

were 52,800 acres of tidal wetland as of 2019 (SFEP 2019). Slight differences in mapping and calculation approaches between different reporting methods in the past complicate making direct comparisons among previous tidal wetland extent numbers. The WRMP will provide a standardized mapping approach and regular reporting moving forward, creating more consistent, repeatable and cost-effective tracking of tidal wetland extent.

The pace of restoration has accelerated since 1999, when the Bay Area wetland management community came together to set a conservation target of 100,000 acres of tidal marsh (Goals Project 1999). During this time period, while restoration efforts led to an increase in tidal wetland extent locally, the 2019 United States Fish and Wildlife Service (USFWS) National Wetlands Report documented a nationwide decline in tidal wetland extent (U.S. Fish and Wildlife Service 2024). Our regional success highlights the value of multiple government agencies, scientists, and environmental organizations setting a shared goal for tidal wetland restoration.

Tracking tidal wetlands will be increasingly important to understand the impacts of accelerating sea-level rise, shoreline development pressures, and sediment availability (Takekawa et al. 2013). Comparisons between BHM 2020 and future maps will show how the overall extent of wetlands is changing, capture expansion in vegetation establishment in newly restored wetlands and erosion along wetland edges, among other metrics, and assess how wetland project and management decisions made by individual project proponents or municipalities are influencing regional and ecosystem-scale conditions. The next WRMP Baylands Habitat Map, BHM 2025, will be released in 2026, and will include new restoration completed since 2020.

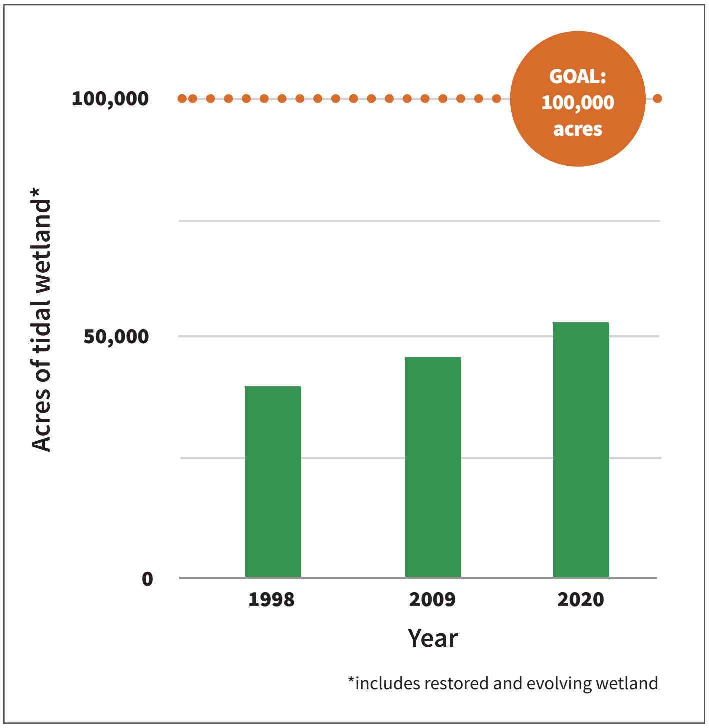

Figure ES-1. Change in tidal marsh over time. Comparing the new BHM 2020 tidal marsh estimates with previous Baylands Ecosystem Habitat Goals Update estimates from 1998 and 2009.

Aerial of Corte Madera Marsh. UAS imagery by Pete Kauhanen, SFEI.

Table of Contents

A PRODUCT OF

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WRMP is co-managed by SFEP and SFEI

SFEI San Francisco Estuary Institute

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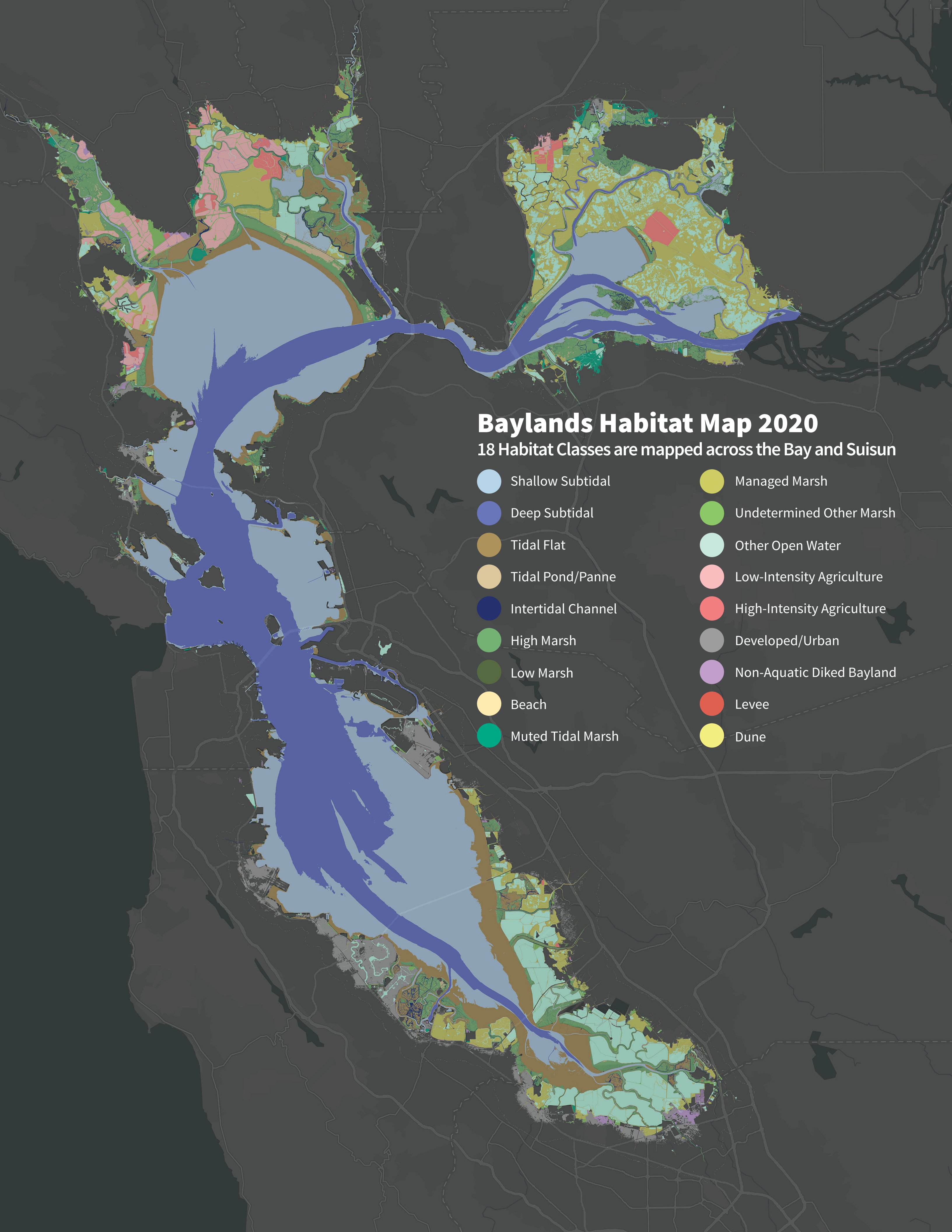

Baylands Habitat Map 2020
18 Habitat Classes are mapped across the Bay and Suisun
Shallow Subtidal
Deep Subtidal
Tidal Flat
Tidal Pond/Panne
Intertidal Channel
High Marsh
Low Marsh
Beach
Muted Tidal Marsh
Managed Marsh
Undetermined Other Marsh
Other Open Water
Low-Intensity Agriculture
High-Intensity Agriculture
Developed/Urban
Non-Aquatic Diked Bayland
Levee
Dune

1 Introduction

Tidal Wetlands of San Francisco Bay

San Francisco Bay (Bay) supports tens of thousands of acres of tidal wetlands (WRMP 2024a). These wetlands are important to the health of the Bay, providing benefits that include supporting endangered species, providing habitat for a variety of native fish and waterbirds, protecting the shoreline from erosion and flooding, improving water quality, and supporting a range of cultural and recreational uses. Although more than 80% of these wetlands were destroyed following Euro-American colonization (Goals Project 1999), our ongoing regional investment in conservation and restoration has reversed the trend of wetland loss in the Bay.

Bayland mapping efforts have been crucial for understanding tidal wetland changes over time. Knowing where wetlands are located, tracking their change, and identifying regional trends are essential for effective management. Through the newly established Wetlands Regional Monitoring Program (WRMP), co-managed by the San Francisco Estuary Institute (SFEI) and the San Francisco Estuary Partnership, a coordinated effort is in place to regularly and accurately monitor the Bay's tidal wetlands. The recently released Baylands Habitat Map (BHM) 2020, the Project Tracker Tidal Wetland Restoration Map (PTTWRM) 2020 (WRMP 2025), and the analysis detailed in this report are critical steps in this effort.

What is this report?

In this report, we share the latest tidal wetland acreage figures for the Bay and describe a standardized, repeatable Tidal Wetland Extent Protocol (Protocol) for determining them. We put this latest acreage in the context of previously calculated tidal wetland extent numbers, and explain some of the challenges and uncertainty associated with comparison to these earlier numbers.

53,700 acres of tidal wetlands*
in the Bay Area as of 2020

*Throughout this report we use the term "tidal wetlands" to refer to areas of established tidal marsh and areas of open water and tidal flats within restoration projects that are expected to become tidal marsh in the future. We retain the term "tidal marsh" for the 100,000-acre habitat goal established by the 1999 Baylands Goals Report (Goals Project 1999).

Whiteside tidal marsh in San Francisco Bay. Photo by Shira Bezalel, SFEI.

Benefits of San Francisco Bay's tidal marshes

Overall, the tidal wetlands in the Bay are vital for ecological health, environmental protection, and community resilience.

Shoreline Erosion Reduction Tidal wetlands act as a natural buffer against flooding and shoreline erosion by reducing wave energy (Taylor-Burns et al. 2023).

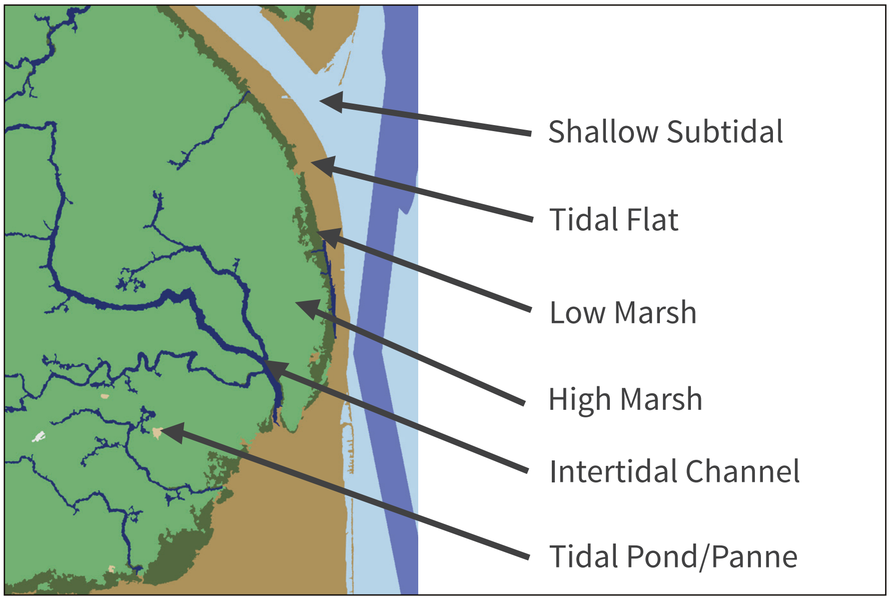
Biodiversity Tidal wetlands provide crucial habitat for a wide variety of species, including fish, birds, mammals, and invertebrates (Goals Project 2000). They also serve as nurseries for fish and stopovers for migratory birds.

Flood Protection Tidal wetlands act as natural sponges, absorbing excess water, reducing water flows, and reducing the risk of flooding in adjacent urban areas (Taylor-Burns et al. 2024).

Water Quality Improvement Tidal wetlands help filter runoff, trapping sediment, pollutants, and excess nutrients, which improves overall water quality and maintains healthy ecosystems (Callaway et al. 2012, Bear et al. 2017, Livingston 2020).

Carbon Sequestration Tidal wetlands are effective at capturing and storing carbon dioxide from the atmosphere in their sediments for centuries to thousands of years, which contributes to climate change mitigation (Callaway et al. 2012).

Cultural and Recreational Value Tidal wetlands provide opportunities for recreation, education, and tourism, enhancing the local economy, importance to and promoting appreciation for natural ecosystems (Bergstrom et al. 1990, Rutter et al. 2022).



Baylands Habitat Map tidal wetland classification. The BHM habitat types that are considered tidal wetlands as part of this Protocol include fully tidal low and high vegetated marsh, tidal ponds/pannes, and intertidal channels. Unvegetated tidal flats outside of restoration projects and large subtidal channels are not included in our acreage calculation of tidal wetland habitat. See Baylands Habitat Map 2020 Classification Key (WRMP 2024b) for habitat definitions.

Defining and documenting change in tidal wetlands

The Protocol introduced here combines BHM and Project Tracker data to track tidal wetland extent and restoration progress more consistently and in greater detail. This Protocol uses two newly created spatial data layers to identify areas of tidal wetlands: BHM 2020 version 1.1 (WRMP 2024a) and PTTWRM 2020 (WRMP 2025). Further background on BHM and Project Tracker is provided in the following sections.

The Protocol allows us to track wetland gain and loss through natural processes, conversion, and the tremendous progress in restoration while recognizing that wetland establishment can take decades, creating a lag time between investment and progress toward regional goals for wetland extent. Within restoration projects, we can monitor the extent of established vegetation, estimate the area expected to become vegetated in the future, and track in-progress restoration that has yet to be completed. These categories historically have been conflated, contributing to confusion about wetland extent and restoration progress. Planned restoration is a broad category that can be difficult to track, and we will develop protocols to better summarize these efforts in the future.

The 2015 Baylands Ecosystem Habitat Goals Update (2015 Baylands Goals Report) emphasized the concept of a "complete tidal wetland" system, highlighting the importance of considering connections between tidal wetlands and adjacent upland and subtidal habitats (Fig. 1.1; Goals Project 2015). While Project Tracker and BHM require clear boundaries for mapping tidal wetlands, natural systems have connections to adjacent habitats. The WRMP is developing separate metrics to assess these habitat connections using BHM.

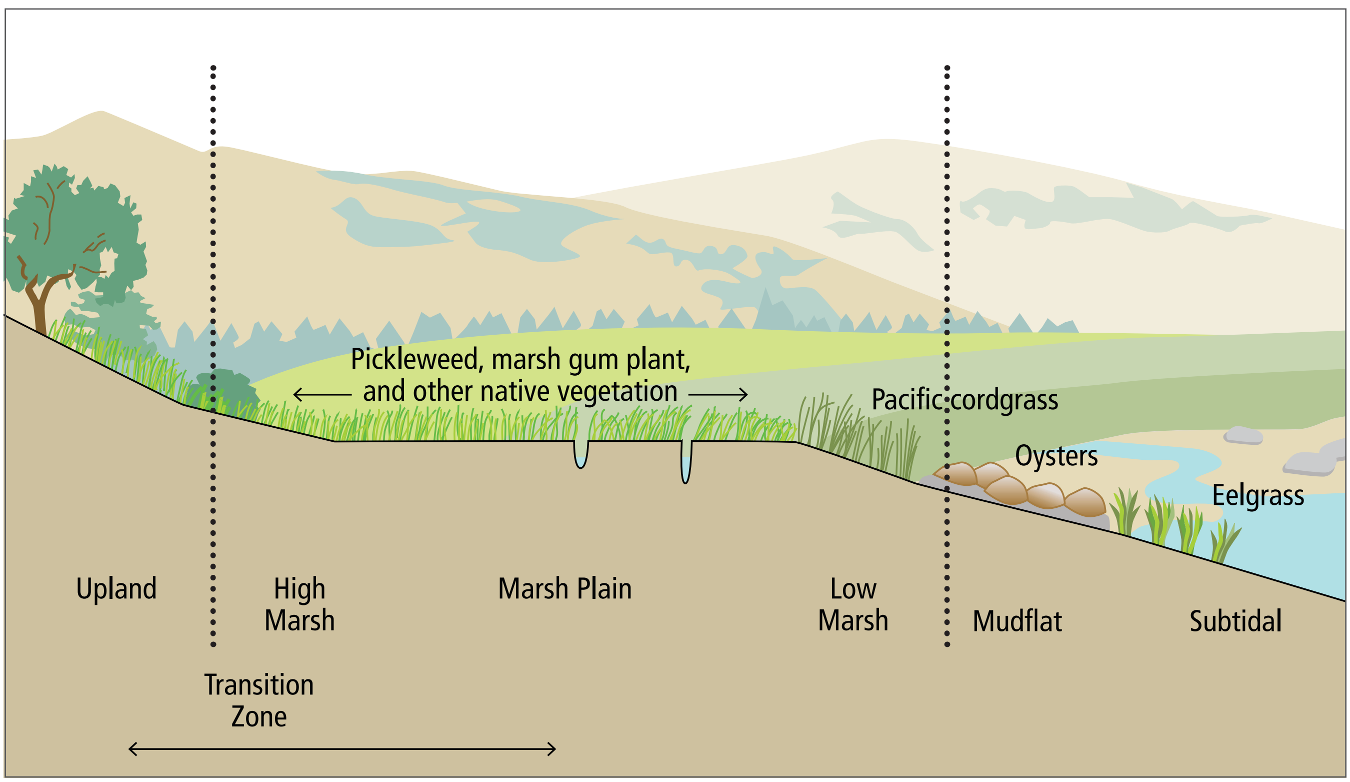


Figure 1.1 Example of a complete marsh. A complete wetland includes habitats from the subtidal to the upland transition. Clear boundaries need to be established to ensure accurate mapping. Therefore, the mapping approach described in this report does not include the upland-terrestrial transition zone (figure adapted from Goals Project 2015). Dotted lines mark the boundaries of high and low marsh.

2 The Baylands Habitat Map 2020

About BHM 2020: A new mapping approach

Past mapping efforts have been essential to understanding changes in the Bay. An early set of maps developed by SFEI compared wetland extents between the 1850s and 1998, which was key to illustrating the immense magnitude of tidal wetland loss due to environmental degradation (Goals Project 1999). The Bay Area Aquatic Resources Inventory 2009 (SFEI 2017; sfei.org/baari) was the next mapping effort. BHM 2020, co-created with the WRMP Geospatial Workgroup and funded by the U.S. Environmental Protection Agency, is the first complete map of Bay wetland habitats produced since 2009.

This current effort marks a major improvement in tracking wetland habitat change. By leveraging advancements in automated mapping and reducing reliance on hand digitization, paired with a standardized habitat classification scheme, the mapping team is laying the groundwork for consistent mapping and change detection. This mapping effort pairs high-resolution aerial imagery and tidal and elevation data (Fig. 2.1) with Object-Based Image Analysis (OBIA; Fig. 2.2; Blaschke 2010). BHM provides more uniform and efficient mapping than previous manual mapping efforts.

BHM 2020 is a critical update to past mapping efforts and is the basis for future, regular updates. BHM mapping will be updated for 2025 conditions and then every 4-6 years. Repeated mapping over time allows us to measure growth of vital wetland habitats due to restoration, track losses in these habitats due to sea-level rise (SLR), capture the regional benefits of multiple individual projects, inform restoration science, raise community awareness, and other factors. Additional metrics can be used to characterize wetland maturity,

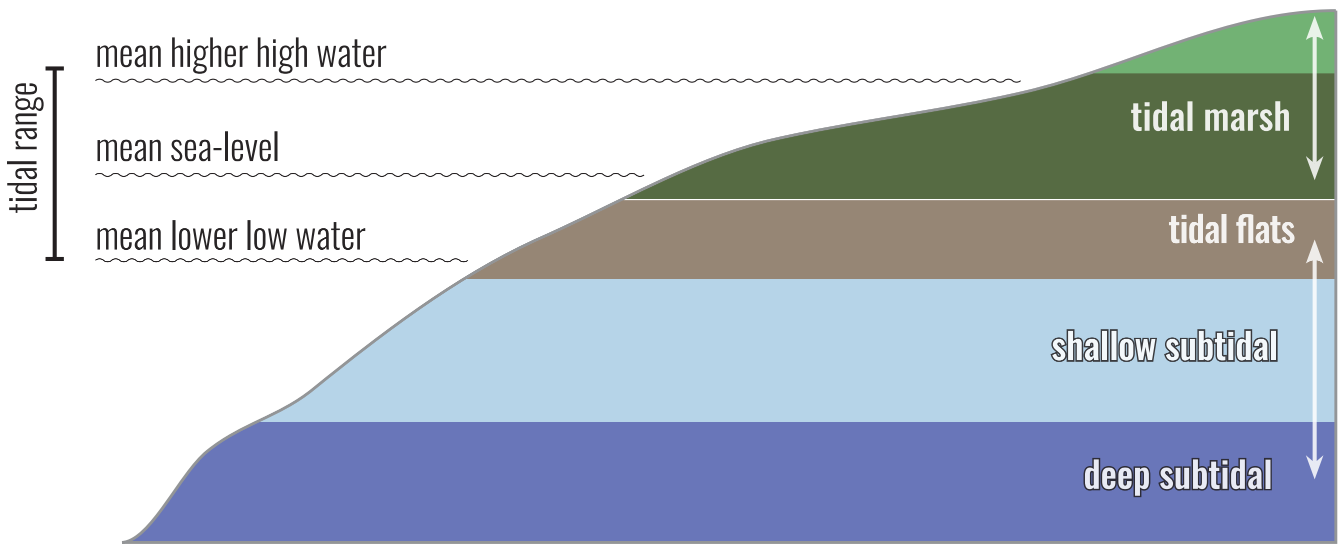


Figure 2.1 Mapping elevation model Schematic illustrating how different elevation ranges relative to the tide are suitable for different habitat types, and can be used to support mapping.

Figure adapted from: SFEI and SPUR. 2019.

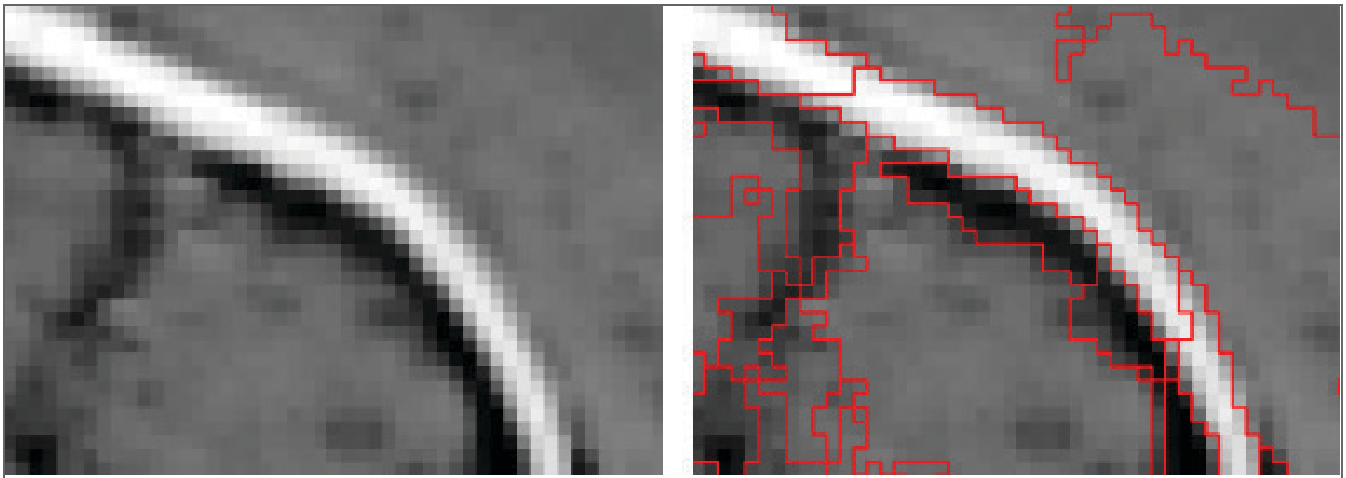


Figure 2.2 Baylands Habitat Map Methods. OBIA was used instead of hand digitizing to create BHM 2020. The initial image (left) was segmented into basic objects as mapping units (right) for subsequent classification into habitat. NAIP imagery, LiDAR, and other ancillary data were used as inputs to ensure consistent, objective, and repeatable mapping.

stability, and habitat value over time. Tracking these changes will be increasingly important in the future as SLR rates increase.

BHM 2020 lays the foundation for more automated and consistent habitat mapping in future updates. This regional effort will enable regular cost-effective updates and change detection analysis. Future mapping iterations will benefit from coordinated imagery and LiDAR collection by the WRMP, as well as ground validation from other WRMP monitoring efforts. With appropriate funding, the BHM can be effectively updated and used in the future as a critical tool to guide the Bay through changes from SLR.

Oro Loma Marsh. Photo by Shira Bezalel, SFEI.

3 Project Tracker Tidal Wetland Restoration Maps

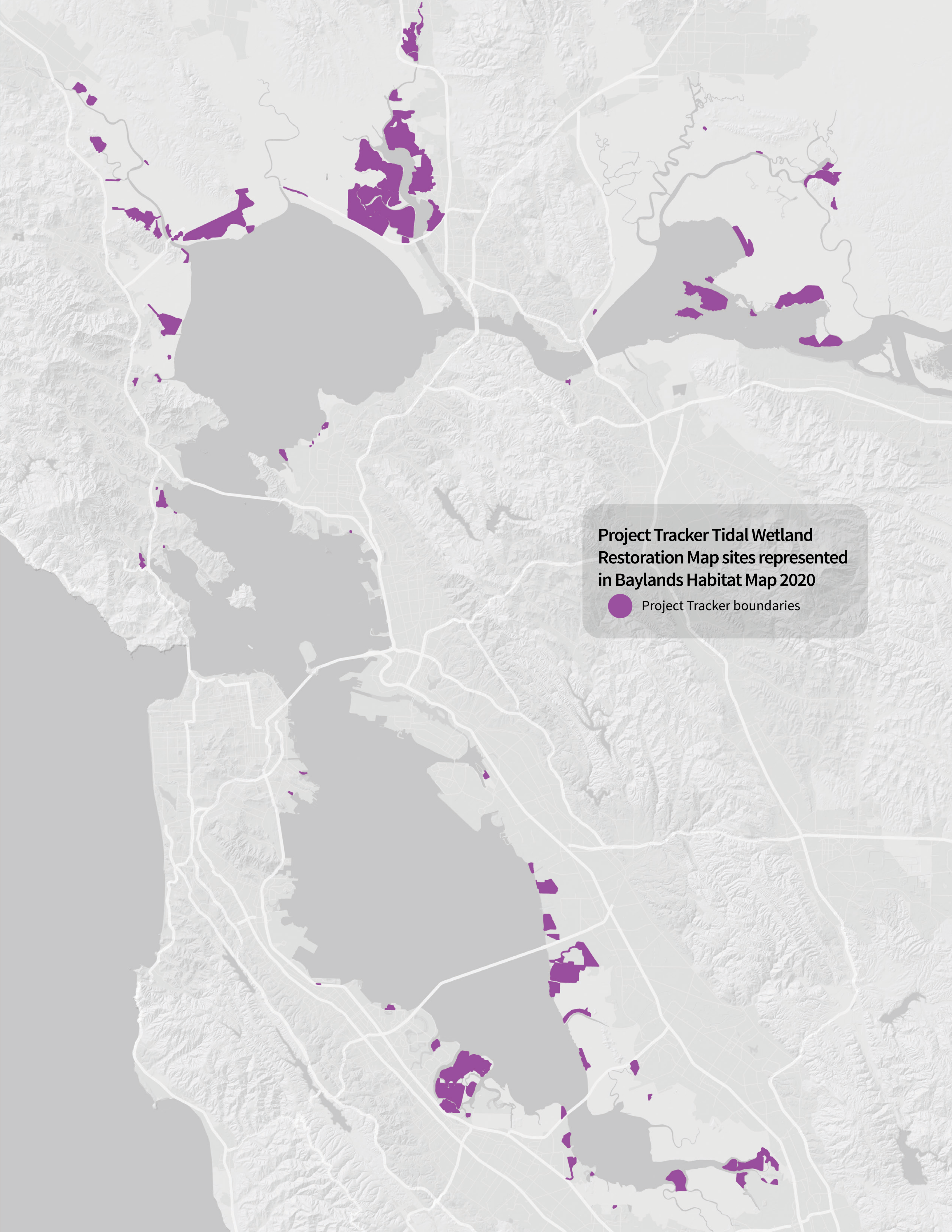
Tracking tidal wetland restoration

EcoAtlas Project Tracker (ptrack.ecoatlas.org) is a statewide online data entry tool used across the Bay region and beyond to track information on wetland restoration, mitigation, and habitat conservation projects. Habitat restoration projects entered into Project Tracker can be viewed and downloaded, along with other projects and data layers, through EcoAtlas (ecoatlas.org). Project Tracker provides standardized information on the activities involved in restoring habitats including habitat types, dates, acres, and any relevant events and contacts. The tool is used by agency staff, scientists, and resource managers and is a critical component of the California Wetland and Riparian Area Monitoring Plan's (WRAMP) three-tiered approach to monitoring and assessment.

Project Tracker is the most complete database of California restoration projects and a valuable tool for planners and managers. However, several known issues limit Project Tracker's ability to comprehensively track wetland restoration acreage. First, reliance on individual project managers and proponents to enter and maintain data means project information is not consistently updated as project plans and statuses change. Second, Project Tracker was designed with a high degree of flexibility to accommodate diverse user needs, and this comes with the tradeoff that attributes of restoration projects are not always consistently applied across users.

The WRMP has created new data products that represent the current state of tidal wetland restoration from Project Tracker, starting with PTTWRM 2020. This product addresses existing issues by systematically reviewing and updating all Project Tracker records in the Bay. By creating this standalone dataset, we hope to package information from Project Tracker into a resource for the region's restoration community that can be reviewed and updated annually, and cited to allow for more clarity on how restoration estimates are being calculated and used for additional analyses to evaluate restoration progress and performance (see Appendix 2).

PTTWRM 2020 includes all tidal wetland restoration projects in the Bay completed by the end of 2020. For the calculation of Baywide tidal wetland acres in this report, only restoration sites completed by January 1, 2020, were used to ensure that sites were accurately mapped based on conditions when the imagery was collected (see opposite page). This excludes approximately 865 acres of restoration completed in 2020. Completed projects included intentionally and unintentionally breached projects that were permanently opened to tidal action. Projects classified as "in progress" (where groundwork had begun) and those in any phase of planning ("planned") were not included in the data layer. PTTWRM 2024 has also been generated and yearly updates will be released at the end of each calendar year.


Project Tracker Tidal Wetland Restoration Map sites represented in Baylands Habitat Map 2020
Project Tracker boundaries

4 Tracking Restoration Progress

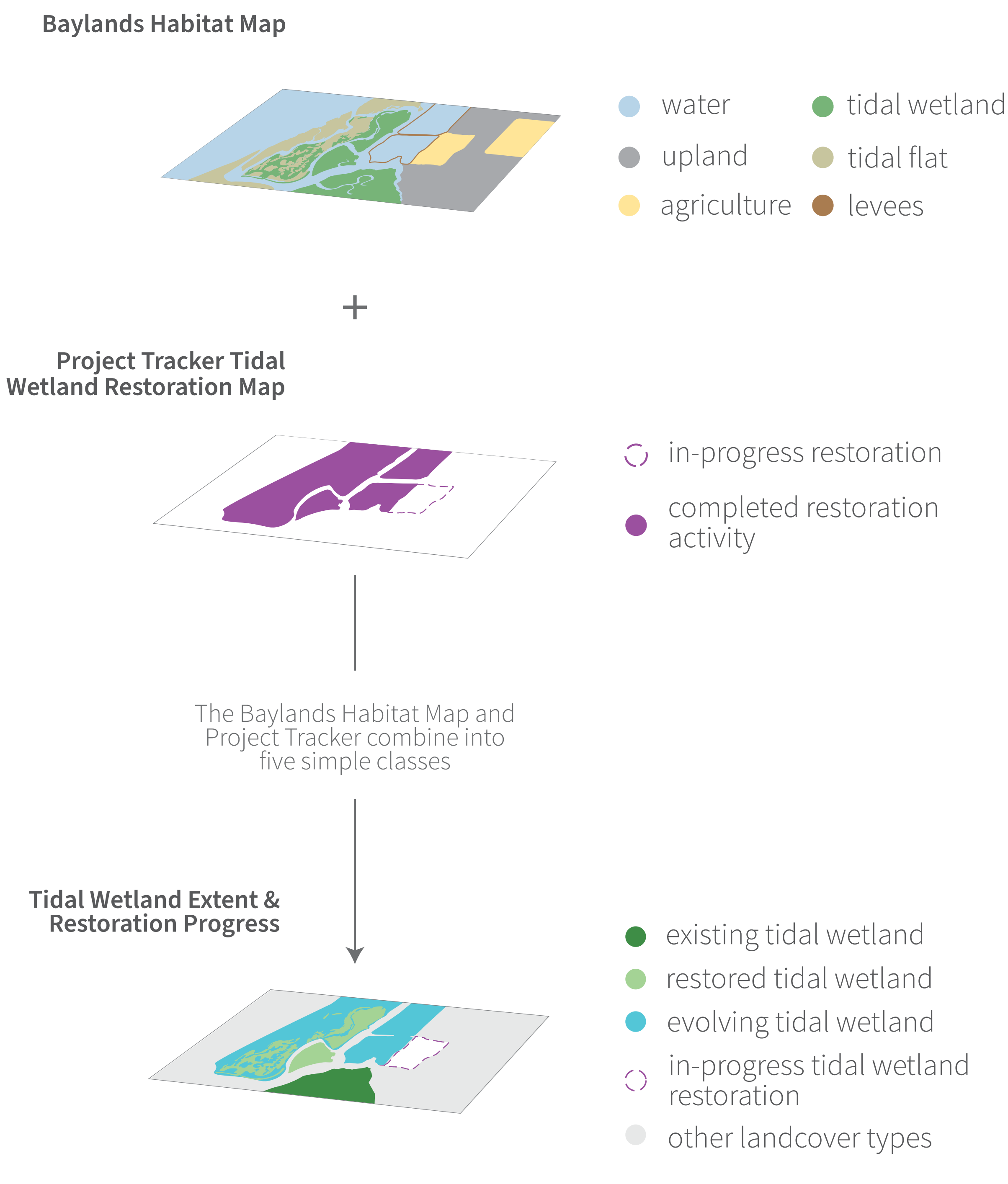
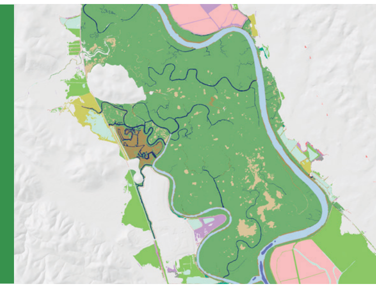


Figure 3.1 Combining PTTWRM data with BHM data provides a more complete view of the Bay's tidal wetlands by tracking existing, restored, and evolving wetlands. In-progress restoration, while available in Project Tracker, is not reported here.

New mapping tracks tidal wetland establishment

Completed Tidal Wetland

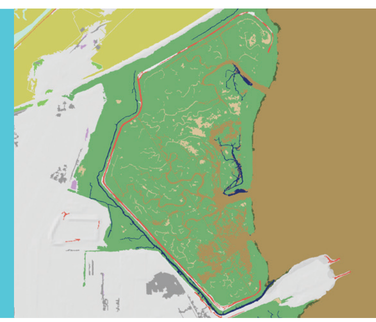
Existing Tidal Wetland
Ancient or centennial tidal wetland occurring outside of restoration projects. Petaluma Marsh is an example of a non-restored ancient wetland that has existed in the Bay for thousands of years.



Restored Tidal Wetland
Tidal wetland that has been restored to tidal flow and now supports wetland vegetation and well-defined channels. Sites may include small areas of undifferentiated open water and tidal flat that were classified as "evolving tidal wetland." Carl's Marsh is a restored wetland.

Future Tidal Wetland

Evolving Tidal Wetland
Tidal wetland that has resulted from recent or ongoing restoration activities but has not yet developed wetland vegetation and well-defined channels. Sites are often lower in elevation. Cooley Landing, restored in 2000, is an evolving site.



In-Progress Tidal Wetland Restoration
Former tidal wetland sites that are currently disconnected from tidal waters may require groundwork or the addition of dredged material to raise elevations of subsided land before being restored to tidal action. Bel Marin Keys Unit V is an active project, with levee realignment completed in 2020 and ongoing sediment placement before future breaching.

Habitat Classes

- Shallow Subtidal
- Levee
- Tidal Flat
- Intertidal Channel
- High Marsh
- Low Marsh
- Other Open Water
- Low-Intensity Agriculture
- High-Intensity Agriculture
- Non-Aquatic Diked Bayland
- Tidal Pond/Panne
- Managed Marsh

5 Tidal Wetland Change Over Time

The last tidal wetland map of the Bay documented conditions in 2009 (BAARI 2009). In the ensuing 21 years since that map, significant progress has been made in restoring tidal flow to former wetlands, primarily through the expansive restoration of salt ponds to tidal wetlands in the South Bay Salt Pond and Napa-Sonoma Salt Pond Restoration Projects, along with many other restorations throughout the Bay. This substantial increase in restored tidal wetland area since 2009 had not been captured in mapping efforts until BHM 2020. The passing of Measure AA in 2016, as part of multibenefit funding for flood protection and shoreline public access, established a dedicated funding stream for environmental protection of the Bay, further accelerating restoration efforts (San Francisco Bay Restoration Authority 2016). The San Francisco Bay Restoration Authority oversees Measure AA funds, ensuring their equitable distribution across the Bay.

The 1999 Baylands Ecosystem Habitat Goals set an ambitious target of 100,000 acres of tidal marsh habitat for the Bay (Goals Project 1999). This goal, once achieved, would restore just over half of the 190,000 acres of the historical extent. The pace of restoration in San Francisco Bay has greatly accelerated since 1999. Between the 1998 and 2009 maps, approximately 9,000 acres of tidal wetlands were restored, and an additional 23,000 acres were planned for restoration (Goals Project 2015). Between 2009 and 2020, 7,400 acres

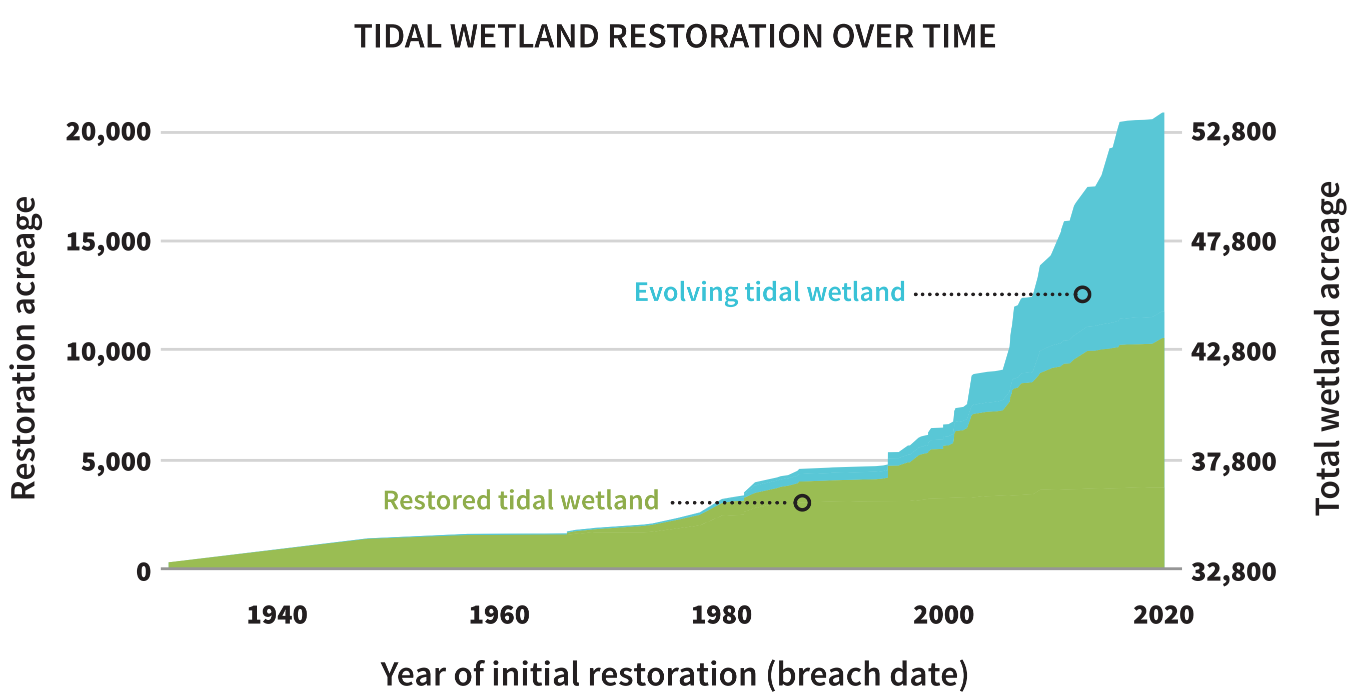


Figure 5.1 Restored and evolving tidal wetlands within restoration projects, by year of initial restoration (breach date). The pace of restoration increased following the 1999 Bayland Goals effort. Most of the older restoration projects now support restored tidal wetland with established wetland vegetation and well-defined channels, while younger restoration projects support more evolving tidal wetland, with more undifferentiated tidal flats and open water.

of wetland had tidal flow restored (WRMP 2025), contributing to the 53,700 acres of tidal wetland reported here (Figs. 5.1 and 5.2; full page maps on pages 12-15). Notably, this total does not include approximately 1,080 acres of tidal wetlands at Brown's and Winter Island along the eastern edge of the Bay, which were not included in BHM 2020 but will be included in BHM 2025. In recent years, several reports have presented different values for tidal wetland extents (see Appendix 4 for details).

During this period, while restoration and tidal wetland extent were increasing locally, the 2019 USFWS National Wetlands Report showed a national decrease in tidal wetland extent. Our regional success highlights the value of multiple government agencies, scientists, and environmental organizations setting a shared goal and pace for tidal wetland restoration. This collective effort communicates its need and sets the pace of restoration.

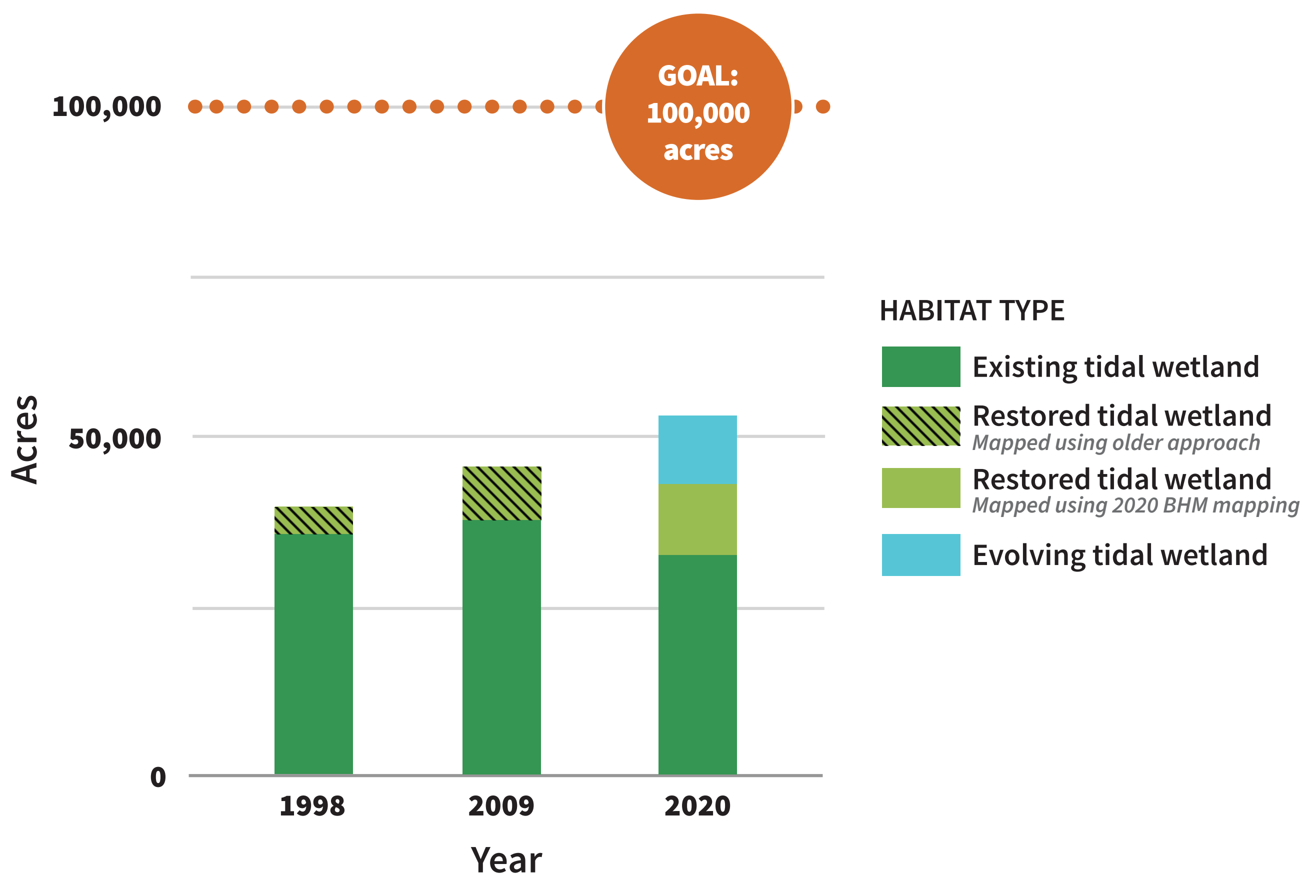


Figure 5.2 Change in wetland area over time. Numbers from 1998 and 2009 are taken from the 2015 Baylands Habitat Goals Update Report (Goals Project 2015). The 2020 estimate of tidal wetland extent was calculated using the Protocol laid out in this report. The Protocol treats restoration differently than previous estimates in two major ways. First, the Protocol distinguishes between areas within restoration sites that have features of well-established tidal wetlands, such as vegetation and clearly defined channels (**restored tidal wetland**), and areas that will eventually become mature tidal wetlands but currently have the features of early restoration such as undifferentiated open water and tidal flat (**evolving tidal wetland**). Secondly, the Protocol uses PTTWRM data that classify sites with unintentional breaches as restoration. **This new classification may give the impression that there is now less existing tidal wetland than during previous assessments, but this is largely an artifact of methodology, not an indication of wetland loss (Appendices 1 and 3).**

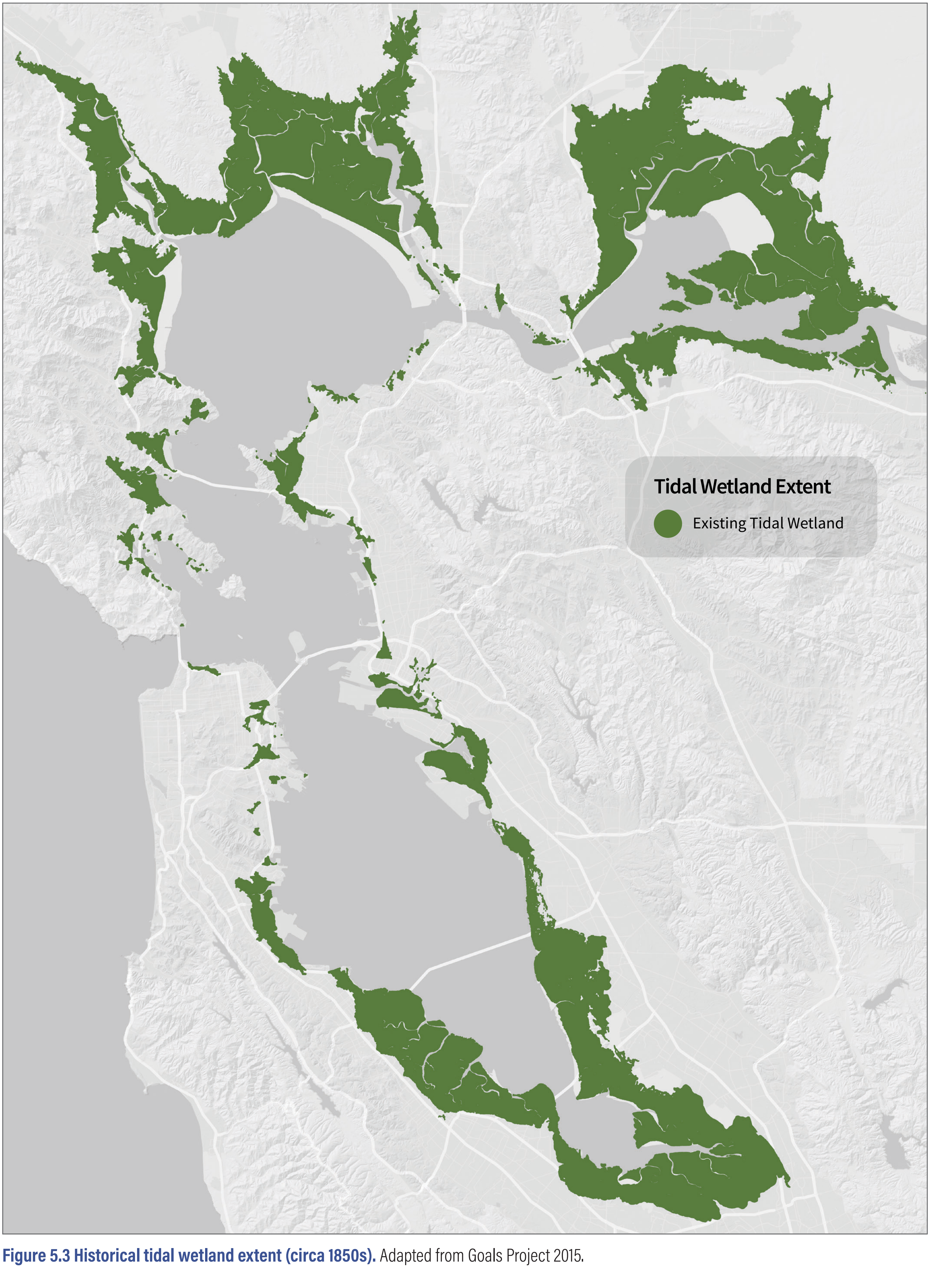


Figure 5.3 Historical tidal wetland extent (circa 1850s). Adapted from Goals Project 2015.

Figure 5.4 1998 tidal wetland extent. Adapted from Goals Project 2015.

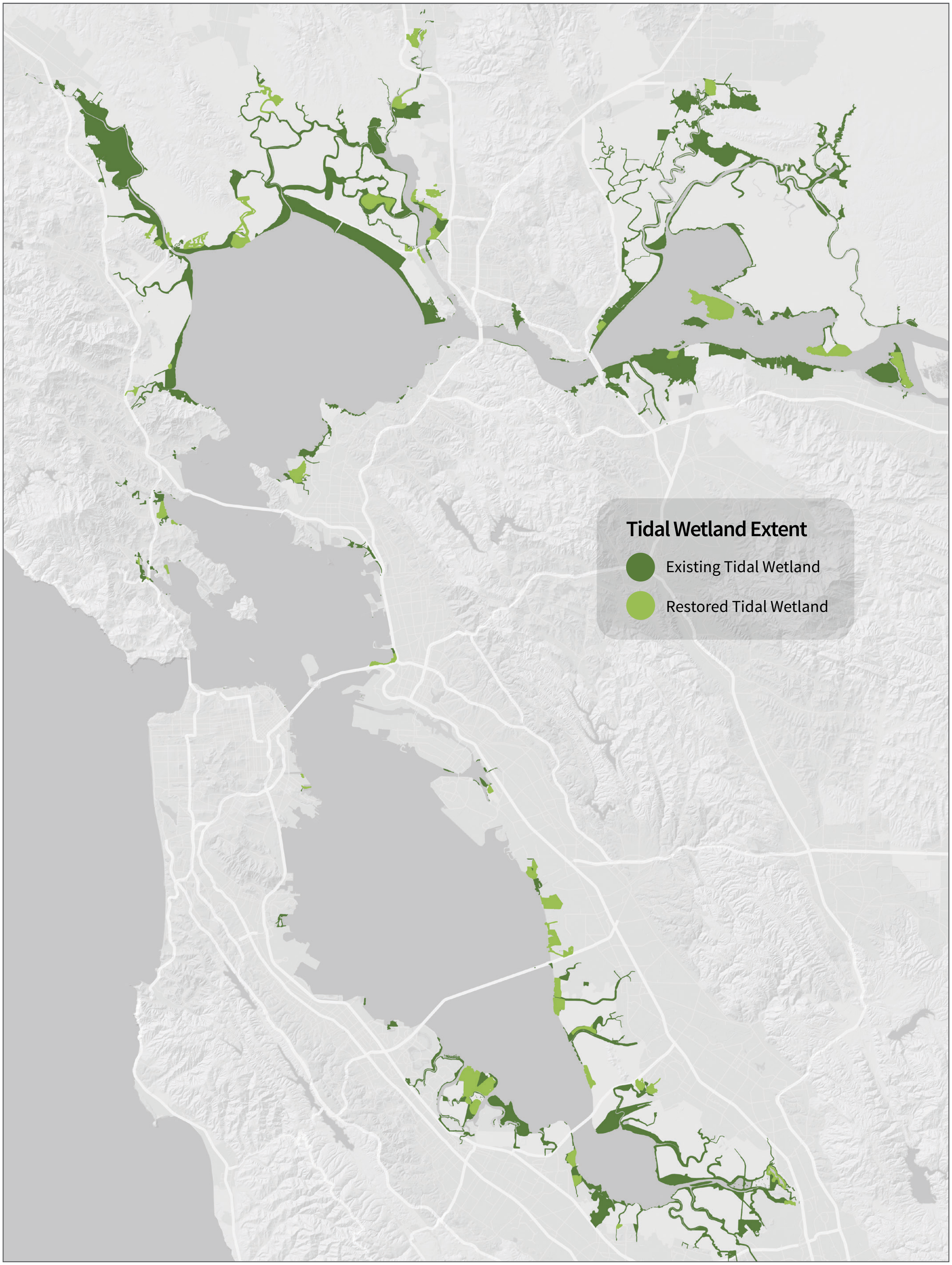


Figure 5.5 2009 tidal wetland extent. Adapted from Goals Project 2015.

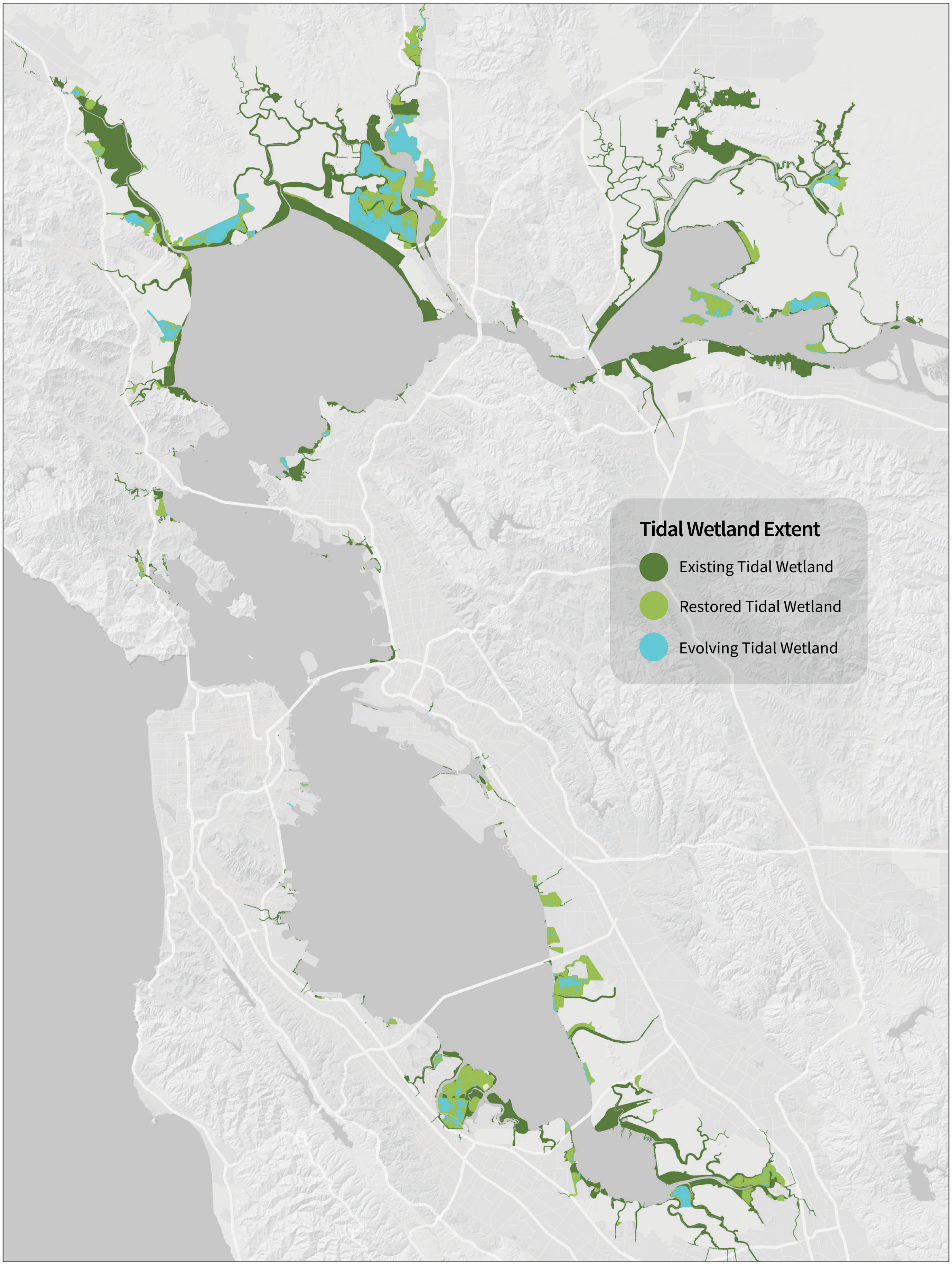
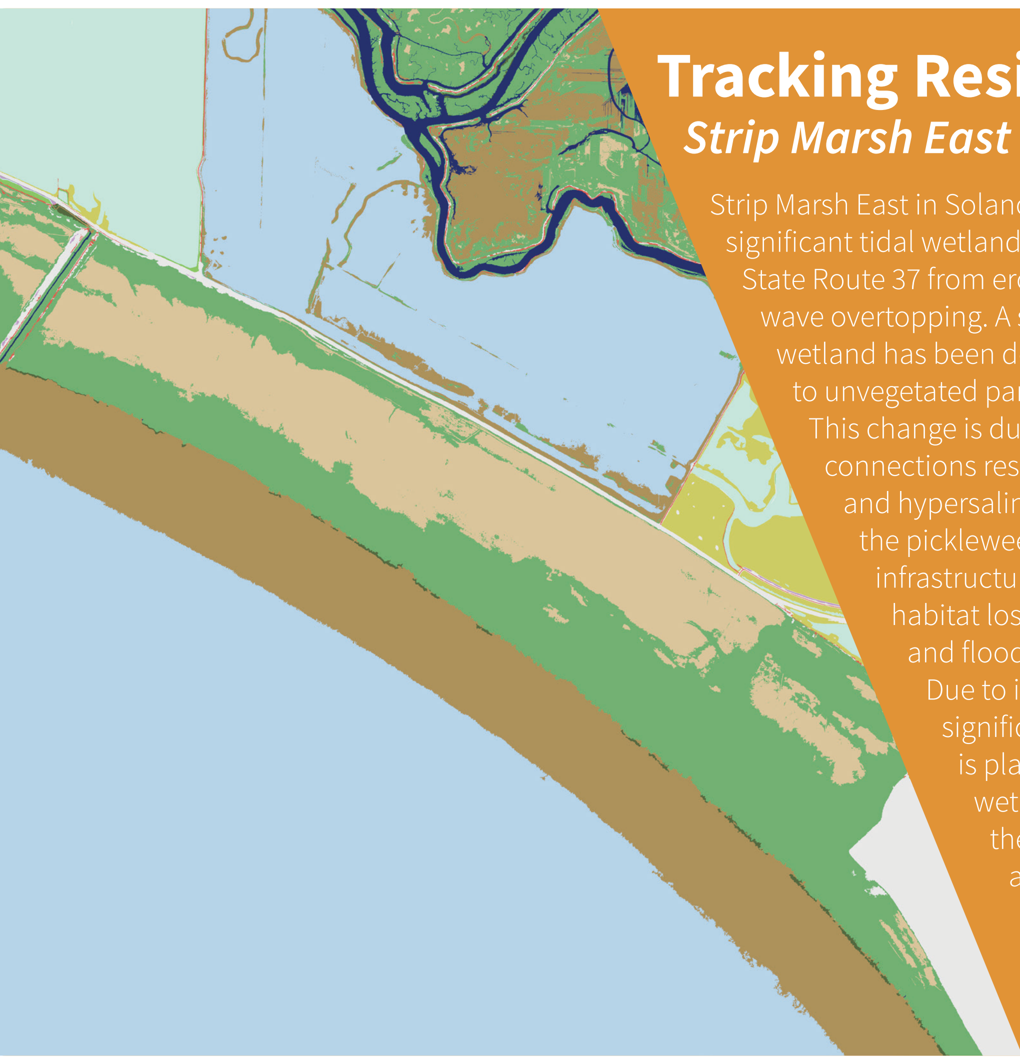


Figure 5.6 2020 tidal wetland extent. Adapted from BHM 2020.

6 The Importance of Continued Monitoring

In this section, we highlight four wetlands that showcase why continued monitoring is essential to understanding tidal wetland conditions in the Bay. The monitoring is important for **Tracking Resilience**, **Understanding Wetland Response to Sea-Level Rise**, **Restoration and Adaptive Management**, and **Measuring Wetland Progradation**. Monitoring these changes provides managers with important information to select successful restoration methods, identify threats to infrastructure, target priority future restoration sites, and anticipate bayland tidal wetlands' adaptive capacity. Ongoing monitoring is vital to assessing tidal wetland extent and performance into the future. The BHM methods will allow for more frequent, cost-effective, and consistent mapping to track important changes to wetland location, size, and health.



Tracking Resiliency

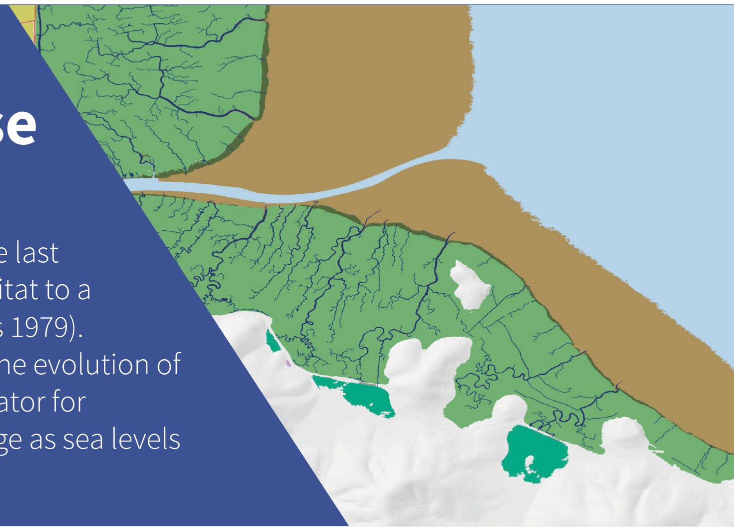
Strip Marsh East

Strip Marsh East in Solano County is an ecologically significant tidal wetland that protects four miles of State Route 37 from erosion and flooding due to wave overtopping. A significant portion of the wetland has been degraded from healthy habitat to unvegetated pannes due to poor drainage. This change is due to alterations in hydrologic connections resulting in reduced tidal flow and hypersaline conditions that caused the pickleweed to die back and impact infrastructure (Toms et al. 2022). This habitat loss has increased erosion and flood risks along State Route 37. Due to its ecological and economic significance, an enhancement project is planned to restore drainage to the wetland. Continued monitoring of the wetland will be necessary to assess threats to habitat and infrastructure, its adaptation to SLR, and the success of future restoration interventions.

Understanding Wetland Response to Sea-Level Rise

China Camp State Park

China Camp State Park in Marin County contains one of the last remnants of ancient tidal wetland in the Bay providing habitat to a variety of species (Atwater et al. 1979, California State Parks 1979). Continued monitoring of China Camp is key to measuring the evolution of Bay wetlands. The wetland will serve as an important indicator for understanding how natural wetlands react to climate change as sea levels continue to rise.



Restoration and Adaptive Management

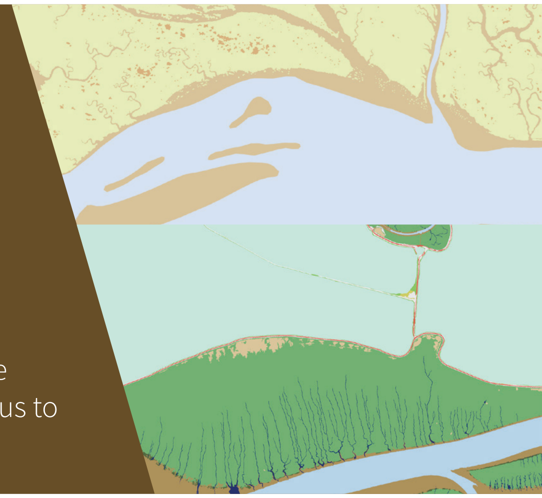
Sonoma Baylands

The Sonoma Creek baylands have had a series of restorations and enhancements since the 1990s, including 1999 Tolay Creek Restoration Project, the 2002 Tubbs Setback Restoration, and the 2015 Sonoma Creek Enhancement and Sears Point Restoration Projects (Sonoma Land Trust and Partners 2020). Mapping the progress of these restorations, including wetland habitat extent, helps measure restoration success and performance. Continued tracking will allow us to understand how restored tidal wetlands evolve over time in the context of changes in climate and SLR, and measure habitat growth and ecosystem services. This information has informed the 2020 Sonoma Creek Baylands Strategy, which is a comprehensive high-level plan for landscape-scale restoration, flood protection, and public access; the planning for the adaptation of State Route 37 to SLR; and the restoration design of over 6,000 acres of tidal habitat by the Sonoma Creek Baylands Restoration project.

Measuring Wetland Progradation

Calaveras Point

While many Bay wetlands may lose area due to SLR, certain wetlands may naturally grow, or “prograde,” because of local-scale natural and anthropogenic factors. Unlike most Bay wetlands, Calaveras Point Marsh in southern Alameda County has experienced seaward growth in recent years due to sediment deposition. Various local factors including channel adjustments and the movement of the mouth of the Guadalupe Slough have led to the wetland’s growth (Watson 2008). Tracking wetland extent enables us to understand how these local factors support wetland growth.



7 Conclusions and Next Steps

As of the beginning of 2020, restoration efforts across the Bay have achieved 53% of the 100,000-acre target for tidal wetland habitat (WRMP 2024a). Understanding where we are along this trajectory would not have been accomplished without this new mapping effort developed through the WRMP. The next WRMP BHM, representing conditions in 2025, will capture thousands of acres of new restoration completed since 2020. The consistent, repeatable, and objective Tidal Wetland Extent Protocol facilitates faster, more rigorous decision-making for wetland conservation and restoration. This will enable timely tracking of wetland drowning in the face of climate change and SLR so that actions can be taken.

Tracking tidal wetland extent will become even more important in the coming decades, as the risk of tidal wetland loss increases due to accelerating SLR and variable sediment availability. Future maps made using BHM methodology will enable a robust assessment of change over time, revealing changes in the overall wetland extent, vegetation establishment in newly restored wetlands, and erosion along wetland edges. By highlighting regional variations in wetland establishment, future versions of BHM will inform management decisions. Also of increasing importance for wetland restoration mapping is ensuring the equitable distribution of tidal wetland restoration across the Bay, so that all can benefit from these important ecosystems, as we continue to make progress toward our regional goals.

Managed wetland in Suisun Marsh. Photo by Shira Bezalel

Salt marsh harvest mouse in McInnis Marsh. Photo by Aviva Rossi, SFEI.

Importance of Regional Monitoring

The Bay restoration community is working rapidly to protect and restore wetlands. To meet our regional wetland extent target of 100,000 acres, close coordination and consistent monitoring are needed between land managers, scientists, and regulators. The newly implemented WRMP, which funded and houses BHM 2020 and PTTWRM 2020, will improve wetland restoration project success by putting in place regional-scale monitoring, increasing the impact, utility, and application of permit-driven monitoring to inform science-based decision-making. As the WRMP continues to grow, it will become a robust, science-driven, collaborative regional monitoring program that includes: a monitoring site network, an open data-sharing platform, and a comprehensive science framework. We can only robustly learn lessons from monitoring if it allows comparing a large and representative number of sites in a consistent manner, which is what WRMP aims to provide.

In addition to BHM 2020 and future updates, the WRMP is developing other BHM-based metrics related to ecosystem function, and defining bayland management units—smaller, relatable wetland areas that will also be evaluated over time. The WRMP is working to align wetland metrics across other Bay programs and reports (SFEI 2024) and link its methods and metrics to the Baylands Resilience Framework (SFEI 2023), which uses spatial information to map opportunities and create tangible tools for restoration planning and measuring wetland functionality. Together, these efforts support a coordinated and consistent approach to better understanding and restoring our important wetland ecosystems. §

8 Bibliography

Atwater, B., S. Conard, J. Dowden, C. Hedel, R. MacDonald, and W. Savage. 1979. History, Landforms, and Vegetation of the Estuary's Tidal Marshes. San Francisco Bay: the Urbanized Estuary. American Association for the Advancement of Science.

Bear, S. E., M. T. Nguyen, J. T. Jasper, S. Nygren, K. L. Nelson, and D. L. Sedlak. 2017. Removal of nutrients, trace organic contaminants, and bacterial indicator organisms in a demonstration-scale unit process open-water treatment wetland. Ecological Engineering 109:76–83.

Bergstrom, J. C., J. R. Stoll, J. P. Titre, and V. L. Wright. 1990. Economic value of wetlands-based recreation. Ecological economics 2:129–147.

Blaschke, T. 2010. Object based image analysis for remote sensing. ISPRS journal of photogrammetry and remote sensing 65:2–16.

California State Parks. 1979. China Camp State Park General Plan. Natural Resources Agency, Department of Parks and Recreation, Sacramento, CA.

Callaway, J. C., E. L. Borgnis, R. E. Turner, and C. S. Milan. 2012. Carbon Sequestration and Sediment Accretion in San Francisco Bay Tidal Wetlands. Estuaries and Coasts 35:1163–1181.

Dusterhoff, S., K. McKnight, L. Grenier, and N. Kauffman. 2021. Sediment for Survival: A Strategy for the Resilience of Bay Wetlands in the Lower San Francisco Estuary. San Francisco Estuary Institute, Richmond, CA.

Goals Project. 1999. Baylands Ecosystem Habitat Goals. U.S. Environmental Protection Agency and S.F. Bay Regional Water Quality Control Board, San Francisco and Oakland, CA.

Goals Project. 2000. Baylands Ecosystem Species and Community Profiles: Life histories and environmental requirements of key plants, fish and wildlife. Prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project. San Francisco Bay Regional Water Quality Control Board, Oakland, CA.

Goals Project. 2015. The Baylands and Climate Change: What We Can Do. Baylands Ecosystem Habitat Goals Science Update 2015, prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project. California State Coastal Conservancy, Oakland, CA.

Livingston, E. H. 2020. Use of wetlands for urban stormwater management. Constructed wetlands for wastewater treatment:253–262.

Mitsch, W. J., and J. G. Gosselink. 2015. Wetlands. Fifth edition. Wiley, Hoboken, New Jersey.

Rutter, J. D., A. A. Dayer, and A. H. Raedeke. 2022. Ecological Awareness, Connection to Wetlands, and Wildlife Recreation as Drivers of Wetland Conservation Involvement. Wetlands 42:18.

San Francisco Bay Joint Venture. 2022. Restoring the Estuary to Benefit Wildlife and People. Richmond, CA.

San Francisco Bay Restoration Authority. 2016. Measure AA Clean and Healthy Bay Parcel Tax.

SFEI. 2017. Bay Area Aquatic Resources Inventory (BAARI). San Francisco Estuary Institute, Richmond, CA.

SFEI. 2024. Aligning Planned Indicators of the Wetland Regional Monitoring Program with Other San Francisco Estuary Efforts Phase 2 Version. SFEI, Richmond, CA.

SFEI. 2023. Baylands Resilience Framework for San Francisco Bay: Wildlife Support. San Francisco Estuary Institute, Richmond, CA.

SFEI and SPUR. 2019. San Francisco Bay Shoreline Adaptation Atlas: Working with Nature to Plan for Sea Level Rise Using Operational Landscape Units. Publication #915, San Francisco Estuary Institute, Richmond, CA

SFEP. 2019. State of the Estuary Report 2019 Update: Status and trends of indicators of ecosystem health. San Francisco Estuary Partnership.

Sonoma Land Trust and partners. 2020. Sonoma Creek Baylands Strategy. Prepared by Sonoma Land Trust, San Francisco Estuary Institute, Point Blue Conservation Science, Environmental Science Associates, Ducks Unlimited, U.S. Fish and Wildlife Service.

Takekawa, J. Y., K. M. Thorne, K. J. Buffington, K. A. Spragens, K. M. Swanson, J. Z. Drexler, D. H. Schoellhamer, C. T. Overton, and M. L. Casazza. 2013. Final report for sea-level rise response modeling for San Francisco Bay estuary tidal marshes. USGS Numbered Series, U.S. Geological Survey, Reston, VA.

Taylor-Burns, R., C. Lowrie, B. Tehranirad, J. Lowe, L. Erikson, P. L. Barnard, B. G. Reguero, and M. W. Beck. 2024. The value of marsh restoration for flood risk reduction in an urban estuary. Scientific Reports 14:6856.

Taylor-Burns, R., K. Nederhoff, J. R. Lacy, and P. L. Barnard. 2023. The influence of vegetated marshes on wave transformation in sheltered estuaries. Coastal Engineering 184:104346.

Toms, C., P. Baye, S. Siegel, D. Gillenwater, and J. Lowe. 2022. Highway 37 Strip Marsh East Near-Term Enhancement Actions Primer.

U.S. Fish and Wildlife Service. 2024. Status and Trends of Wetlands in the Conterminous United States 2009 to 2019.

Watson, E. B. 2008. Marsh expansion at Calaveras Point Marsh, South San Francisco Bay, California. Estuarine, Coastal and Shelf Science 78:593–602.

WRMP. 2025. Project Tracker Tidal Wetlands Restoration Map (PTTWRM) 2020. San Francisco Estuary Institute.

WRMP. 2022. Wetlands Regional Monitoring Program: Standard Operating Procedures for Indicators 1 and 3. San Francisco Estuary Institute, Richmond, CA.

WRMP. 2024a. Baylands Habitat Map 2020. San Francisco Estuary Institute, Richmond, CA.

WRMP. 2024b. Baylands Habitat Map 2020 Classification Key. San Francisco Estuary Institute, Richmond, CA.

9 Appendices

This Appendix provides additional detail on the approach and datasets used to calculate the 2020 tidal wetland extent estimate shared in this report. It also provides more detail on the previously reported tidal wetland extent estimates that this 2020 estimate is being compared to. Additionally, it explains how the differences in mapping methods account for the variations between older estimates and the updated approach.
Specific topics addressed are:

- Appendix 1 - Comparing Baylands Habitat Map (BHM) 2020 and 2009 Bay Area Aquatic Resources Inventory (BAARI) mapping
- Appendix 2 - Accounting for restoration in tidal wetland estimates
- Appendix 3 - Step-by-step approach for calculating the 2020 tidal wetland extent
- Appendix 4 - Comparing current and previous tidal wetland extent estimates

Appendix 1. Comparing BHM and BAARI mapping

Prior to BHM 2020, BAARI 2009 (SFEI 2017) was the most current complete map of bayland habitats. Most recent estimates of tidal wetland extent before this report relied on BAARI data, either directly or indirectly, including the 2015 Bayland Ecosystem Habitat Goals Update (BEHGU; Goals Project 2015), the 2019 State of the Estuary Reports (SFEP 2019), and reporting by the San Francisco Bay Restoration Authority and Save the Bay (see Appendix 4).

Beyond representing different time periods, BAARI and the current BHM map differ in several key ways. BAARI used 'heads-up digitizing', relying on the individual judgment of trained technicians to delineate and classify wetlands. In contrast, BHM used Object-Based Image Analysis (OBIA) techniques, applying algorithms, defined rulesets, and automated techniques to enhance classification standardization (Blaschke 2010). This standardization should improve comparability of mapping efforts moving forward. Additionally, the mapped extent of BAARI covered the open coast, which is not included in the BHM extent.

There are differences in the geographic extents of the BAARI and BHM mapping. BAARI includes tidal wetlands along the coast, including Bolinas and Tomales Bay, and extends further east toward the Delta to include Brown's Island and Winter Island. Future versions of BHM will extend east to Winter Island, fully encompassing the tidal extent of the San Francisco Bay Regional Water Board boundary. More information about the specific methodologies used can be found here:

BAARI Methods: https://www.sfei.org/baari/methods
BHM Methods: https://www.sfei.org/data/baylands-habitat-map-2020-gis-data.

During the early development of BHM 2020, preliminary maps were compared to BAARI to refine BHM methodology and correct areas that appeared misclassified. We compared the final version of BHM 2020 map to BAARI where their geographic extents overlapped to better understand differences between the two mapping approaches. There were 43,468 acres of mapped tidal wetland in BHM and 44,139 acres of mapped tidal wetland in BAARI within the overlapping area. We believe the apparent reduction in tidal wetlands in BHM 2020 as compared to the 2009 BAARI data reflects differences in mapping methodology and classifications, rather than a real-world loss of wetlands. Our investigations showed differences between the two data sets could be explained by the following factors:

- **Difference in Minimum Mapping Unit:** The BHM's object-oriented approach captures features at finer scales than BAARI, leading to mapping differences. BAARI classified small patches (under 200 acres total, scattered across the entire Bay) as tidal wetland, while the BHM distinguishes these as finer-scale features including levees, dunes, and beaches.
- **Misclassifications (true errors) in BAARI:** This mapping error occurs when features are inaccurately represented on the map compared to on-the-ground conditions, often due to incorrect interpretation by mapping technicians. In BAARI, a primary contributor to misclassifications is the misidentification of tidal wetlands that are actually "Managed Wetlands".
- **Misclassification (true errors) in BHM:** While this dataset is as accurate as possible, future revisions are expected. The understanding of wetland water regimes still largely depends on input from ground managers; therefore, some misclassification regarding hydrologic connectivity remains. We anticipate further refinements as managers and the broader wetland restoration community provide feedback on the 2020 BHM.
- **Methodological Differences in Classification:** Differences in the rulesets for classification between BAARI and BHM led to discrepancies in reported tidal wetland area.
    - For example, areas mapped as "Shallow Bay" in BAARI now include regions classified as "Intertidal Channel" in BHM (which is a subclass of tidal wetland). Similarly, areas classified as "Shallow Subtidal" in BHM were classified as tidal wetlands in BAARI. These differences stem from the underlying ruleset used to define BHM classification and the interpretation of available data by trained technicians when digitizing BAARI.
    - BAARI did not distinguish between muted tidal and fully tidal wetlands, whereas this distinction is now made in BHM. See *Muted Wetlands* below for additional information.
- **True Gains:** These refer to real gains in tidal wetlands, such as restoration progress.
- **True Losses:** These represent actual losses of tidal wetlands, such as from shoreline erosion.

The Figure A1 below shows habitat changes between mapping efforts for areas that were classified as tidal wetland in either BAARI or BHM but not both. It is not entirely possible, however, to distinguish from this comparison which changes are a result of classification differences versus on-the-ground changes in wetland extent. In the future, with more standardized BHM mapping and without the complication of classification differences, it will be easier to detect true wetland losses and gains. Definitions for BHM habitat classes can be found within the Baylands Habitat Map 2020 Classification Key (WRMP 2024b).

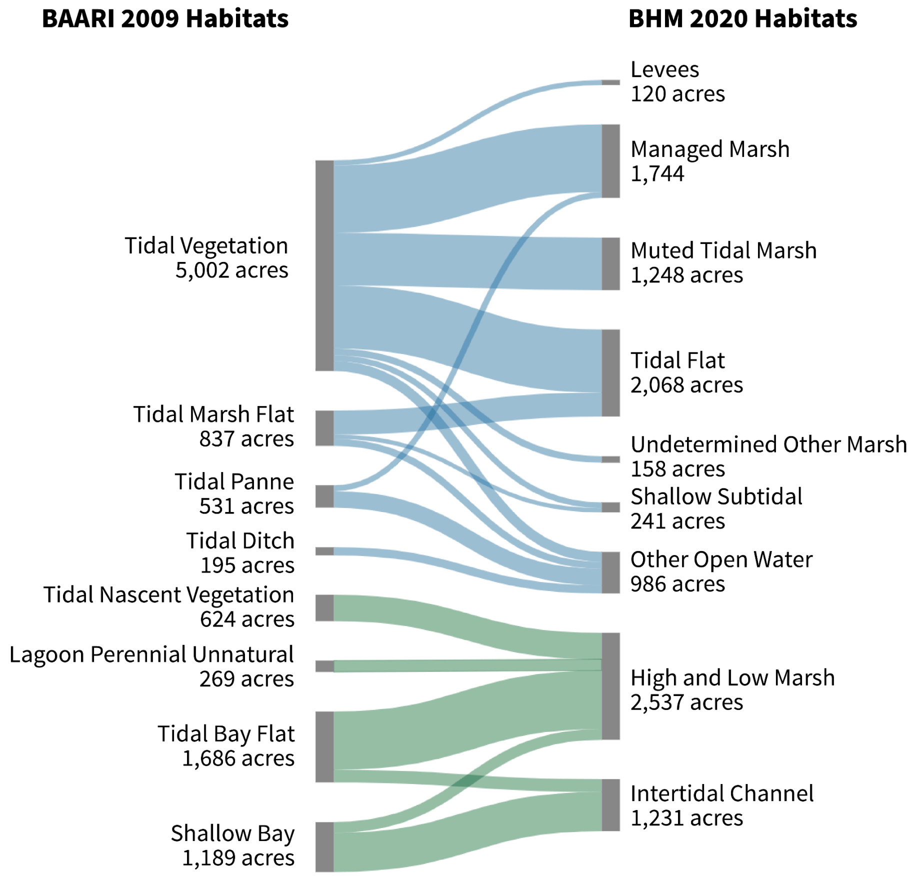


Figure A.1 Sankey diagram showing habitat changes in acres that were classified as tidal wetland in either BAARI or BHM, but not both. Habitat types on the left represent BAARI classifications. Categories of the BAARI that are considered to constitute tidal wetlands include tidal vegetation, tidal marsh flat (primarily small channels within wetlands, excluding tidal flats), tidal pannes, and tidal ditches. Habitat types on the right represent BHM classifications, where tidal wetlands include tidal marsh (includes low and high marsh), tidal ponds/pannes, and intertidal channels. Blue represents classes that were classified as tidal wetland in BARRI but not tidal wetland classes in BHM, while green represents classes that were not tidal wetland in BAARI but tidal wetland classes in BHM. Habitat category changes of less than 250 acres were not included in this figure.

Mapping Muted Tidal Wetlands

Muted tidal wetlands are mapped within the BHM but are not included within the calculation of tidal wetland extent. The Baylands Habitat Map 2020 Classification Key defines muted wetlands in the following way: “A muted tidal marsh is an area of tidal bayland supporting at least 30% cover of tidal marsh vegetation, and a monthly or more frequent nexus with a muted tide, meaning that the depth or spatial extent of tidal inundation of the muted tidal marsh is lessened by artificial water control structures, such as constructed levees, seas walls, berms, tide gates, culverts, weirs, etc. The muted tide tends to attain a lesser height than the closest source of unmuted tide. 30% vegetated cover is used due to the high spatial resolution of the four-band imagery (60 cm) and is consistent with the cutoff used by U.S. Fish &

Wildlife Service for National Wetland Inventory mapping when determining which vegetation type is dominant and determines class type."

Muted wetlands present unique challenges for tidal wetland mapping because they occur along a gradient of tidal impairment. It is often difficult to define a precise and consistent threshold at which a wetland should be considered muted instead of tidal.
To address this, the BHM mapping team worked closely with the WRMP Geospatial Working Group (see (WRMP 2022) for list of members), using expert judgment to refine classifications of potentially muted areas. This is an area where we hope to introduce more standardization and automation in future mapping iterations. BHM 2020 includes approximately 2,500 acres of muted wetlands that are not included in the 53,700-acre tidal wetland estimate.

To account for differences in tidal versus muted influence in areas of "evolving wetland" (i.e., restoration sites in the process of developing into vegetated tidal wetland) we manually reviewed the sites where water regime classifications differed between BHM and Project Tracker. In cases where BHM classification seemed more accurate, we updated Project Tracker information to match BHM. In cases where the Project Tracker classification was a better fit, we used the Project Tracker classification. This was the case for Ponds 6 and 6A of the Napa Salt Pond Restoration Project, originally classified as tidal in BHM, that were reclassified as muted upon closer review and excluded from the 53,700-acre tidal wetland estimate. Additionally, portions or all of seven sites initially classified as managed, muted, or upland by BHM were determined to be fully tidal and were added to the 53,700-acre estimate. The classifications for Ponds 6 and 6A, part of the Napa River Salt Marsh Restoration Project, will be updated in future versions of BHM, including BHM 2020 version 1.2.

Appendix 2. Accounting for Restoration

In addition to mapping differences, one of the major sources of variability between previous estimates of tidal wetland extent is how tidal wetland restoration is counted. Mature tidal wetlands can take a long time to establish within restoration sites. These restoration sites can support large areas of tidal flat and open water, with only sparse vegetation, for years or even decades. These early restoration sites often do not get classified as tidal wetland in BHM and BAARI, and therefore they need to be accounted for in another way.

Project Tracker Data

As described earlier in this report, we used PTTWRM 2020 data (Fig. A.2), derived from Project Tracker, to identify tidal wetland restoration sites to include in our estimate. While SFEI is responsible for managing the data and web tool within its Regional Data Center, there are several statewide and regional groups that guide the development of the tool's functionality and review the accuracy and completeness of the information. For the production of the PTTWRM data sets, SFEI systematically reviewed Project Tracker records based on specific activity and habitat criteria. In collaboration with regional experts, SFEI refined inclusion decisions, updated record attributes using key sources, corrected spatial boundaries, and reclassified 'unspecified' entries to improve data quality. Missing sites were incorporated by cross-referencing existing datasets and stakeholder input. For a complete description of the data product process, see see the Project Tracker Tidal Wetlands Restoration Map (PTTWRM) 2020 metadata (Wetlands Regional Monitoring Program 2025).

We defined the PTTWRM 2020 dataset as a subset of Project Tracker using the following parameters:

- **ActivityType**
    - Restoration/re-establishment refers to restoring habitat that was once present but is no longer present. Re-establishment results in a net increase in habitat area and function.
    - For the PTTWRM dataset, we focused on restored tidal wetlands. These are features where tidal action has been restored either through breaching (e.g., the conversion of a diked wetland to a tidal wetland), through the construction of tidal channels, or the cessation of dredging.
    - Rehabilitation and enhancement projects that increase habitat function and quality but do not increase tidal wetland acreage were not included for this query.
    - Final dataset included: "Restoration/Re-establishment", "Creation/Establishment"
- **ActivityStatus**
    - Definition: The progress stage the activity is in. Our initial query included both completed and in-progress restoration, however only completed projects were included in the estimate of tidal wetland acreage.
    - Final dataset included: "Completed", "Construction completed", and "Implementation completed"

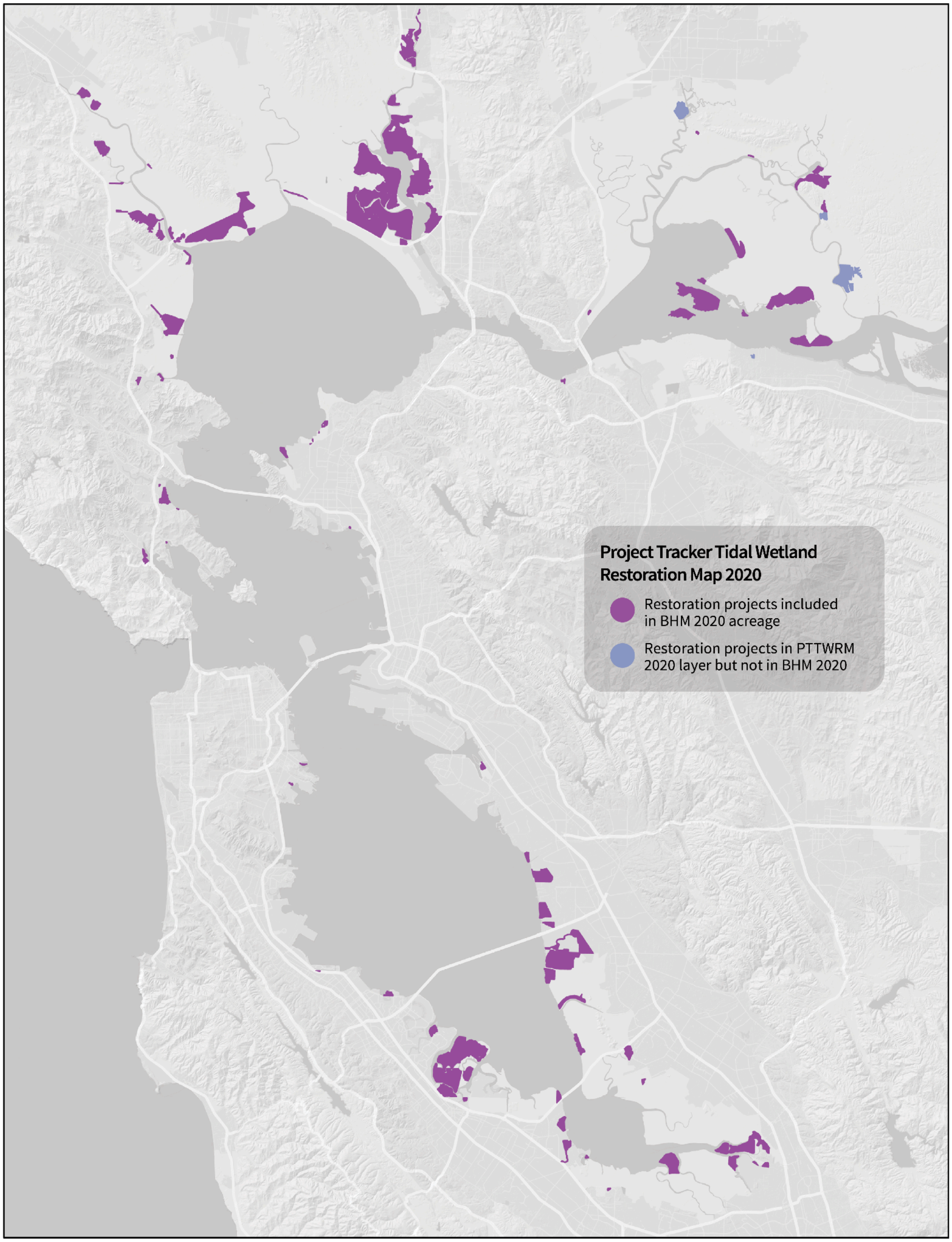


Figure A.2 Project Tracker Tidal Wetland Restoration Map 2020 highlights which restoration sites were included in the 2020 tidal wetland extent acreage and which were not mapped as restored within BHM 2020.

- **Habitat**
  - **Classification table available on the Project Tracker website**
  - **Final dataset: "Estuarine Wetland"**
- **Subhabitat**
  - Classification table available on the Project Tracker website
  - Final dataset: "Marsh"
- **Water Regime**
  - Classification table available on the Project Tracker website
  - Final dataset: "Fully Tidal"
- **SiteEvents**
  - Final dataset: Sites with Levee Breach events
  - Subtypes include: "Levee breach planned", "Levee breach unplanned", and "Dredging end"

Accounting for "evolving" wetlands

For the WRMP estimates, all restoration areas actively evolving into tidal wetlands were included in the final acreage estimate. To maintain transparency when comparing to previous numbers, we categorized evolving wetlands separately. In contrast, for BEHGU, some evolving restoration sites were counted as tidal wetland and some were not, depending on what the dominant habitats were at the time (Fig. A3).

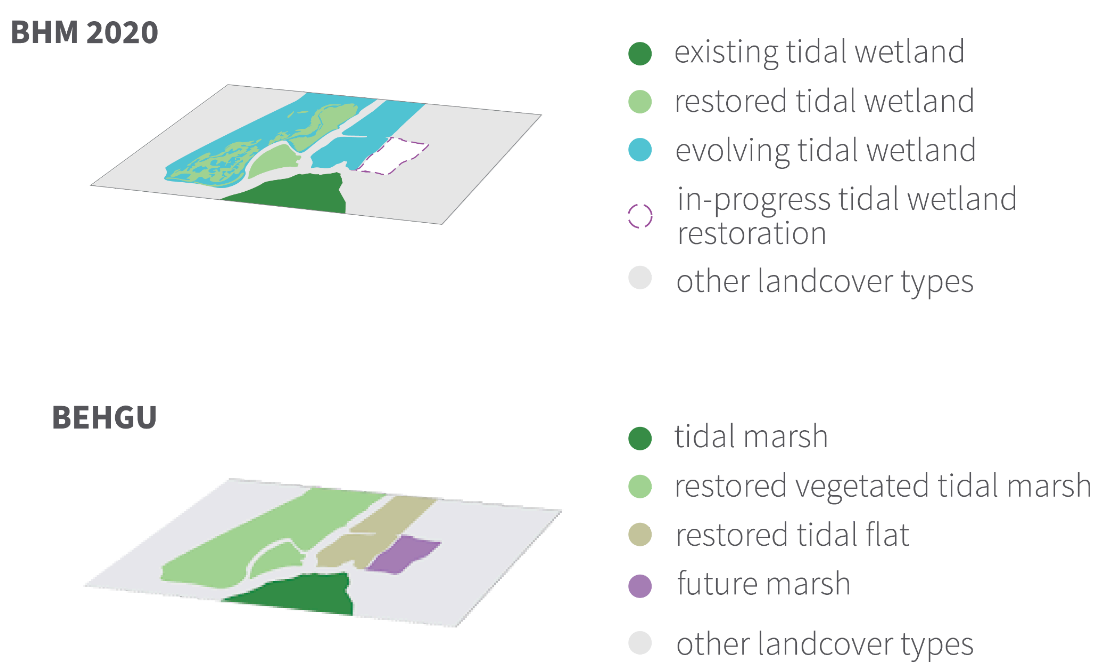


Figure A.3 Comparison of how restoration was accounted for in the WRMP's BHM 2020 versus BEHGU 2015. For the WRMP estimates, all restoration areas actively evolving into tidal wetland were included. For BEHGU, some restoration sites were counted as tidal wetland and some were not, depending on what the dominant habitats were at the time.

Intentional restoration vs unintentional breaches

In this effort, we used an inclusive definition of restoration that includes unintentional breaches of levees or berms that were never repaired and subsequently led to the establishment of tidal wetland (Figs. A4 and A5). These areas function similarly to intentional restoration, noting that some of these restoration activities involved interventions such as sediment placement. Many of the sites breached before the mid-1990s were unintentional breaches.

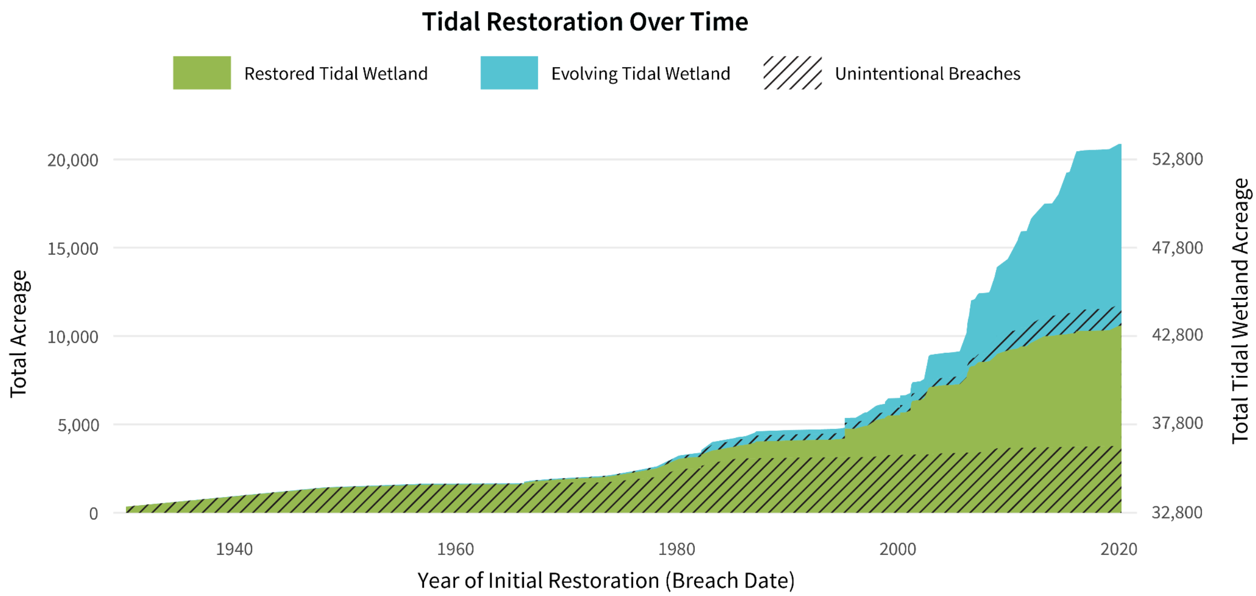


Figure A.4 Tidal wetland restoration over time including sites that were intentionally and unintentionally breached.

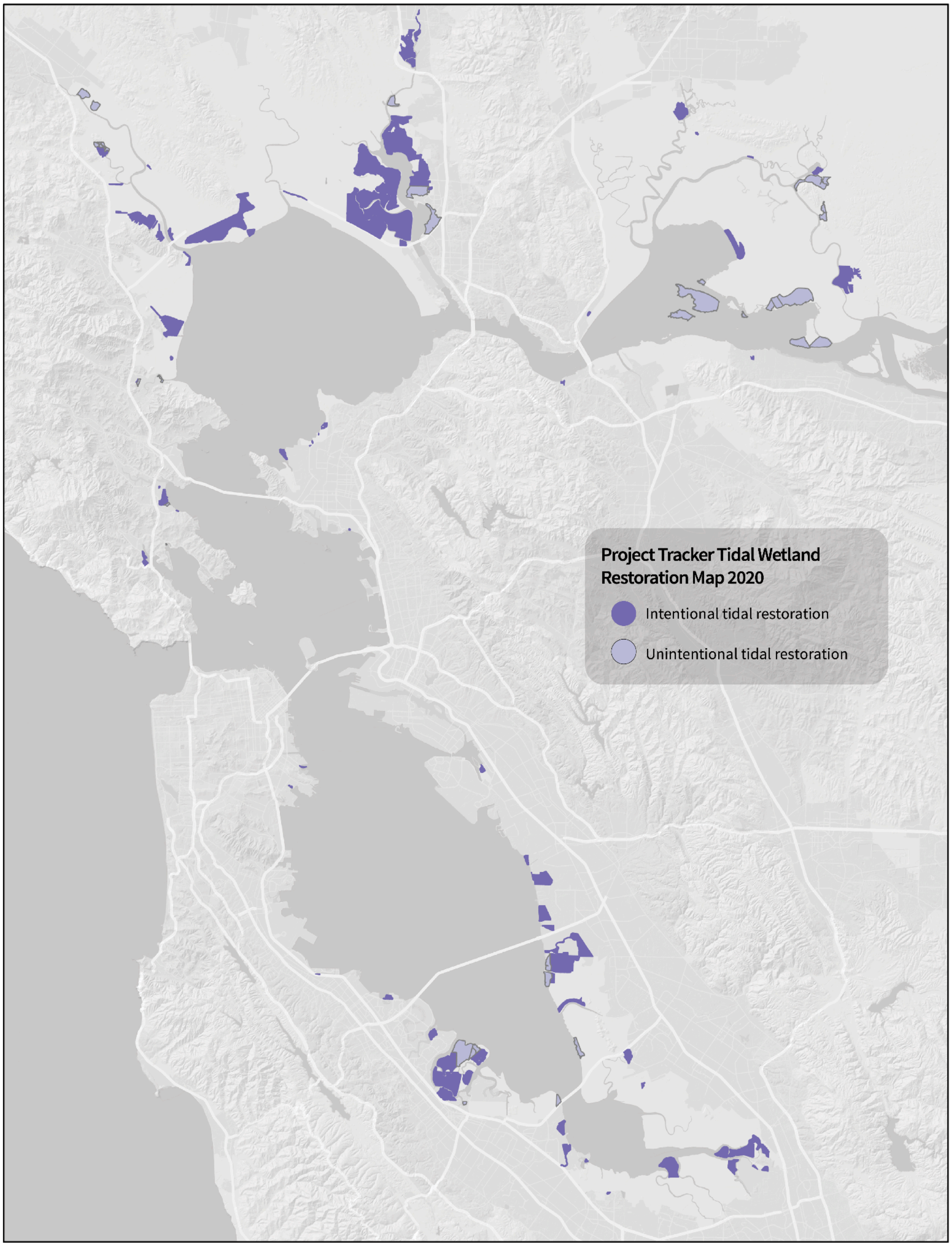


Figure A.5 Project Tracker Tidal Wetland Restoration Map 2020, highlighting locations of sites that were intentionally and unintentionally breached.

Appendix 3. Step-by-Step Approach for Calculating Tidal Wetland Extent

1. Spatial Analysis

- In R, PTTWRM restoration site polygons were intersected with BHM polygons to assign habitat categories and calculate the area of intersected regions.
- Sites that did not intersect any BHM polygon were flagged as "upland."

2. Temporal Analysis

- PTTWRM breach date was used to define project states and group areas by year of completion, allowing evaluation of restoration trends.

3. Aggregations

- Habitat areas were aggregated into summary totals:
  - Existing and Restored Tidal Wetland: High Marsh, Low Marsh, Intertidal Channel, Tidal Pond/Panne.
  - Evolving Tidal Wetland: Tidal Flat and Shallow Subtidal BHM categories that occurred inside restoration site polygons were reclassified as Evolving Tidal Wetlands.

Appendix 4. Comparing the 2020 Estimate to Previous Estimates

Over the past ten years, multiple reports have assessed the status of tidal wetlands in the Bay, providing data on their extent and key ecological metrics. These reports help gauge ecosystem health and highlight the benefits of restoration efforts. Key questions regularly asked by restoration practitioners, managers, and researchers are what was the historical extent of tidal wetlands, how many acres are currently present within the Bay, and how is this area increasing with restoration efforts? Beginning with the Baylands Ecosystem Habitat Report (Goals Project 1999) published in 1999, historical (circa 1800) and current (1998) tidal wetland extents were presented. These values helped to frame restoration targets and identify potential areas for restoration. In 2009, the BAARI (SFEI 2017) was released and represented the most recent extent of the Bay's habitats. BHM 2020 is the first update since BAARI to map habitat extents within the Bay.

Reports regarding Bay tidal wetland status and health that included estimates of tidal wetland extents between 1999 and the present have relied on values from the BAARI dataset to estimate tidal wetland extents. Depending on publication date, some reports also included more recent restoration efforts in their estimates. A review was conducted across these reports to identify tidal wetland extents reported, the underlying dataset used to generate the extent estimation, the wetland types included, and the sources for restoration extents. This review considered whether internal wetland channels, tidal flats, or non-tidal areas of restoration sites were included, along with the overall estuary extent, specifically where the eastern edge of the lower estuary was delineated.

Table A1 references the key recent publications that cite tidal wetland extent, the year published, year(s) of reported wetland area, and data source(s). Estimates vary depending on the date of the report; however, reports published within a few years of each other still present areas ranging from 40,000 to 45,000 acres for existing tidal wetlands and 6,000-14,000 acres for restored wetlands. Full page maps on report pages 12-15 highlight the distribution of tidal wetlands for each mapping effort: historic, 1998, 2009, and 2020. While the data sources were included for all reports, the details on what areas specifically were included were not provided. Many reports cite Project Tracker (https://ptrack.ecoatlas.org/) as a source for recently restored tidal wetlands; however, a list of projects, sites, or any other supporting documents was not included, nor were compilation methods that made it possible for others to replicate the process. Additionally, restoration site areas that were not available publicly at the time of reporting were sometimes included in area calculations but were not referenced due to sensitivity around site identification. All areas reported were rounded to the nearest thousand. The rationale for reporting at this scale is unclear but could relate to the inherent errors or uncertainty in mapping efforts, or the uncertainty in the areas reported in Project Tracker.

Suggested improvements for reporting tidal wetland extents moving forward include:

1. Publicly available tables, metadata, and spatial files that document which sites were included under each tidal wetland category (e.g., existing, restored), along with the corresponding source for the classification.
2. Greater specificity in the reporting of wetland areas. Currently, all wetland area values are reported to the nearest thousand acre. More precise reporting would better capture small-scale restoration within the Bay, particularly in more developed areas, and more accurately track progress toward the goal of achieving 100,000 acres of tidal wetlands in the Bay (Goals Project 2015).
3. Consistent mapping extents. Future versions of the BHM will align with the San Francisco Bay Regional Water Board boundary. In BHM 2020, two large tidal wetlands at the eastern edge of the boundary were not mapped - Browns Island and Winter Island - because a different boundary extent corresponding to Operational Landscape Units was used (SFEI and SPUR 2018).

Table A.1 Summary of recent published / reported tidal wetland area estimates.

Report / Website	Year Published	Year(s) of reported tidal wetland area	Tidal wetland area (acres)	Source
Baylands Ecosystem Habitat Goals Update	2015	2009	38,000 existing 8,000 restored	BAARI 2009, Project Tracker[1]
State of the Estuary Report	2019	2019	52,800	BAARI 2009, Project Tracker[2]
Save the Bay	2025 website	not reported	53,000	not reported[3]
San Francisco Bay Restoration Authority	2025 website	not reported	40,000 existing 13,000 restored	Save the Bay[4]
Sediment for Survival: A Strategy for the Resilience of Bay Wetlands in the Lower San Francisco Estuary	2021	2009, 2015, 2016	45,000 existing 6,000 restored	Modern Baylands extent from BAARI 2009; current & planned restoration from BEHGU 2015 with 2019 updates from USFWS personal communication[5]
San Francisco Bay Joint Venture's Restoring the Estuary to Benefit Wildlife and People (2022 Implementation Strategy)	2022	1999	40,000 existing 13,000- 14,000 restored	1999 Baylands Habitat Goals Project; State of the Estuary Report 2019; SFBJV Accomplishments Analyses 2021; SFBJV internal document[6]

[1] Goals Project 2015, [2] SFEP 2019, [3] www.savesfbay.org, [4] www.sfbayrestore.org/, [5] Dusterhoff et al. 2021, [6] San Francisco Bay Joint Venture 2022