Baylands Habitat Map 2020

WRMP Webinar Series

October 15, 2024



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United States Environmental Protection Agency



Photo: Ellen Plane, SFEI

Baylands Habitat Map

Objectives:

- Detect landscape change over time
 WRMP Indicator 1
- Consistent and Repeatable
 Avoid Heads-Up Digitizing
 - Limit Interpretation Error
- Track/Assess Restoration Goals







WRMF Monitoring Program

Baylands Habitat Map 2020

- 18+ Classes
- Sub-Meter Resolution
- Aim to Re-Map every 3-5 years
- Built via Computer Algorithm
- Extent is Possible Tidal Influence





Subtidal

Intertidal, Full Tidal Connection





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A few challenges to mapping bayland habitats

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Difference in Image Analysis Techniques

- Object Based Image Analysis (OBIA)
 - Workflow
 - Segmentation
 - Classification
 - Iterate/Grow/Merge



Image from Government of British Columbia (<u>www2.gov.bc.ca</u>)

Trimble eCognition Developer





Example Workflow



Multi-Resolution Segmentation: R, G, B, NIR

Scale: 25 Shape: 0.1 Compactness: 0.9



Assign Class: Water: NDWI > 0.2

 $\mathrm{NDWI} = \frac{\mathrm{Green} - \mathrm{NIR}}{\mathrm{Green} + \mathrm{NIR}}$

Underprediction



Assign Class: Water: NDWI > 0.1

Overprediction



Assign Class: Water: NDWI > 0.15

Alright, but need to do better!

What is relative tidal elevation? A Modeled Functional Extent



Relative Tidal Elevation Examples



Relative Tidal Elevation Examples



Relative Tidal Elevation Examples



Why Relative?



Let's See the Map!















Level of Detail





Baylands Habitat Map 2020

Data Access

- SFEI Data Center (Download)
- EcoAtlas (Web Viewing)
- Habitat Key
 - Detailed descriptions for each classification
- Methods Documentation
 - Accuracy Assessment

Shallow Subtidal Deep Subtidal Tidal Flat Tidal Pond/Panne **Tidal Channel** 🔲 High Marsh Low Marsh Muted Marsh Beach Dune Levee Other Open Water Managed Marsh 🔲 Other Marsh Developed/Urban Low-Intensity Agriculture High-Intensity Agriculture Non-Aquatic Diked Bayland

Baylands Habitat Map 2020



^{SF ESTUARY} Wetlands Regional Monitoring Program



Dotted pattern indicates unnatural type Estuarine and Marine Deep Subtidal Shallow Subtidal Tidal Flat Tidal Pond/Panne Intertidal Channel Tidal Marsh - High Marsh Tidal Marsh - Low Marsh Beach Other Marsh - Muted Tidal Marsh Other Marsh - Managed Marsh Other Marsh - Undetermined Other Marsh

Dune

Other Open Water - Muted

Other Open Water - Managed

Other Open Water - Undetermined





Dotted pattern indicates unnatural type Estuarine and Marine Deep Subtidal Shallow Subtidal Tidal Flat Tidal Pond/Panne Intertidal Channel Tidal Marsh - High Marsh Tidal Marsh - Low Marsh Beach Other Marsh - Muted Tidal Marsh Other Marsh - Managed Marsh Other Marsh - Undetermined Other Marsh Dune Other Open Water - Muted Other Open Water - Managed Other Open Water - Undetermined



Habitat Key

- Discussion of WRMP Habitat Type Classification System development
- Detailed descriptions of each classification
 - Illustrative photos (on the ground and remote sensing)
- Critical for change over time and repeat mapping efforts



Wetlands Regional Monitoring Program

Baylands Habitat Map 2020 Classification Key



April 2024 Version 1.0



Baylands Habitat Map 2024

- Regional LiDAR
 - Summer 2025
 - Additional Products
 - Vegetation Height
 - Intensity
 - Collaborative Cost-Sharing
- Future Improvements
 - Restored Areas
 - Elevation Data
 - Biofilm
 - Tidal Ponds/Pannes





Relationship to WRMP

- Expert input from WRMP TAC and Geospatial Workgroup
- Foundational Dataset for WRMP Indicators & Other Metrics
- Ongoing iterative process: two-way data exchange
 - Tide Gauges Relative Tidal Elevation
 - Vegetation Surveys Ground Truthing



What this means for the region !?!

Metrics & Indicators

Assess Progress Toward Bay Restoration Goals

Resilience Planning

Identify Opportunities & Priority Areas

Jurisdictional & Regulatory Needs

How the Map can be Used

- Understand how Bay tidal marshes are doing
 - Progress toward restoration goals
 - Support for specific functions and processes
 - Change over time
- Identify where actions can have the most impact
- Support field-based monitoring and research



How are Bay tidal marshes doing?



How much tidal marsh is there in the Bay?



How much tidal marsh is there in the Bay?

Tidal Marsh (non-restored)

Restored Tidal Marsh - (breached)

Evolving into Tidal Marsh - (breached)

"In-progress" Restoration (planning phase)



How are Bay marshes are doing?

How are sites changing over time?





Pond A6

How are Bay tidal marshes doing?

Additional Map-based Metrics

- Marsh elevation
- Percent vegetated
- Wildlife support metrics
- Flood attenuation
- Shoreline change
- ... and more

Example: Marsh Connectivity for Wildlife Movement





Map-based Metrics Analyzed at Multiple Scales (WRMP)





Map-based Metrics Analyzed at Multiple Scales (WRMP)



Track Change Over Time

- Repeat mapping every 3 5 years
- Maps and metrics will change over time due to restoration and SLR





Metrics as Restoration Performance Measures (SFBRA)

Restoration contributes to the size, shape, and connectivity of tidal marsh patches

Ravenswood



Larger Tidal Marsh Patch



Planning: Where can actions have the greatest impact?



- Baylands Resilience Framework is an early application of the 2020 BHM
- Designed to measure the resilience of baylands ecosystem services to sea-level rise
- Metrics inform adaptation and restoration actions (e.g. beneficial use of dredged sediment through USACE's Regional Dredged Material Management Plan)



Marsh elevation

Baylands Resilience Metrics







Distance to shallow water placement location

Baylands Resilience Metrics





Planning: Coordinate Regional Actions

BCDC's Regional Shoreline Adaptation Plan (RSAP) Mapping Platform uses the 2020 BHM map for coordinated regional adaptation planning





Support Monitoring and Research: CRAM example

New mapping will help with:



"Sample draw" to determine survey locations



Orienting and navigating in the field



Assessing metrics of wetland condition



Summary

- Mapping approach uses advanced automated techniques to make the mapping more repeatable
- Updated mapping is a valuable resource for restoration planning, management and monitoring
- BHM 2020 is available for viewing and download
 - Download from Project Webpage: <u>https://www.sfei.org/projects/baylands-change-basemap</u>
 - View on EcoAtlas: http://sfei.li/ecoatlas-bhm
 - BHM 2020 Factsheet: <u>https://www.sfei.org/documents/baylands-habitat-map-2020-m</u> <u>apping-progress-towards-habitat-restoration-goals</u>



THANKS!



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- Todd Hallenbeck, BCDC



QUESTIONS?



Alex Braud, SFEI alexb@sfei.org

April Robinson, SFEI april@sfei.org

Cristina Grosso, SFEI <u>cristina@sfei.org</u>



The Baylands Habitat Map 2020

Mapping progress towards habitat restoration goals

The Baylands Habitat Map 2020 (BHM 2020) was cocreated by the **Wetland Regional Monitoring Program's** (WRMP) Geospatial Workgroup and San Francisco Estuary Institute (SFEI), and funded by the **USEPA Water Quality Improvement Fund.**

BHM 2020 is the first complete map of San Francisco Bay wetland and aquatic habitats produced since 2009 (BAARI 2009; sfei.org/baari). It provides updated mapping of tidal habitats and diked baylands, expanding our understanding of the full impact of recent habitat change and restoration.

This effort marks a major advancement for tracking habitat change in the Bay. The mapping team used cutting-edge automated approaches—laying the groundwork for consistent mapping and change detection for years to come.

18 Habitat Classes are mapped across the Bay and Suisun



tal Protection

Wetlands

Regional

Program

Monitoring



SFEI AUTHORS: Alex Braud - Pete Kauhanen - Cristina Grosso WRMP Geospatial Workgroup DESIGN: Cate Jaffe - Ruth Askevold - Alex Braud SFEI Publication #1186 - April 2024 Other map credits: Basemap by ESRI

Sonoma Baylands -Updated mapping shows

the evolution of older tidal marsh restoration projects.

These projects may take many years to evolve

into mature marshes. At

evolution from previously unvegetated tidal flat into semi-vegetated tidal

the Sonoma Baylands,

the BHM shows this

marsh.

EVOLVING MARSHES

20

chana

What can we learn? MARSH LOSS FROM SLR

Corte Madera Marsh • The BHM shows where marsh is being lost due to erosion and SLR. At Marta's Marsh in Corte Madera, areas of Idal marsh are shrinking due to levee breakage and subsequent erosion. As rates of sea level rise accelerate, being able to track these areas of marsh loss will become increasingly important.



Pond A6 • The BHM captures new tidal marsh restoration projects that had not been completed at the time of the last Baywide mapping (BAARI 2009). Pond A6 is on the state breached in 2 ap update shows and tidal marsh vegetation established at this site.

Why is the 2020 Baylands Habitat Map so important to wetland management?

Wetland management and restoration require accurate habitat maps that can demonstrate and quantify changes around the Bay.

Past mapping efforts have been essential to understanding changes in the Baylands. An early set of maps developed by SFEI compared marsh extents between the 1850's and 1998, and was key to illustrating the immense magnitude of tidal marsh loss due to environmental degradation.

Repeated mapping over time allows us to **measure growth of vital** wetland habitats due to restoration, and track losses in these habitats due to sea level rise (SLR) and other factors. Tracking these chanes will be increasingly important over time as rates of SLR increase. BHM 2020 is a critical and timely update to past mapping, providing the newest snapshot of the Baylands since the last complete mapping effort in 2009 (BAARI 2009).

TIDAL MARSH LOSS OVER TIME



MAPPING IMPROVED WITH AUTOMATED TECHNIQUES

The mapping team utilized advanced automated techniques and best available data to ensure comprehensive coverage and accuracy.

Datasets such as NAIP imagery, LIDAR, and others were analyzed using scripted Object-Based Image Analysis (OBIA) techniques calibrated for Bay conditions. The team's scripted techniques and **meticulous ruleset process** support consistent, objective, and repeatable mappings. Mappers used a detailed habitat type key with clear definitions to guide the classification process, **ensuring consistency in future mapping efforts** to support change analysis.

Future mapping iterations will benefit from more coordinated imagery and LiDAR collection by the WRMP, as well as ground-truthing that will leverage other WRMP products.

Schematic illustrating how different relative elevation ranges are suitable for different habitat types, and can be used to support mapping.



Figure adapted from: 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, C.A.

By leveraging advancements in automated mapping, this effort enables regular costeffective updates and change detection analysis..."



FOR MORE

https://www.sfei.org/projects/ baylands-change-basemap

> CONTACT: cristina@sfei.org or alexb@sfei.org

BHM 2020 SETS THE STAGE FOR FUTURE UPDATES

By leveraging advancements in automated mapping, this effort has enabled regular cost-effective updates and change detection analysis, significantly increasing the value of this approach and its application to map updates. With appropriate funding, the Baylands Habitat Map can be quickly updated and used into the future as a critical tool to quide the Bay through changes from sea level rise.



SFEI Publication #1186 • April 2024





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