Habitat Evolution Mapping Project 2.0

Final Results (2019 & 2021) &

Change Analysis (2009-11 & 2019/21)

Brian Fulfrost, Lead Geospatial

Noah Young, Image Analyst

David Thomson, Lead Biologist

Matt Hinshaw, Lead Fied Crew

South Bay Salt Pond Restoration Project

SAN FRANCISCO BAY RESTORATION AUTHORITY

State of California Coastal Conservancy

CAL IPC

40 years SAN FRANCISCO BAY BIRD OBSERVATORY

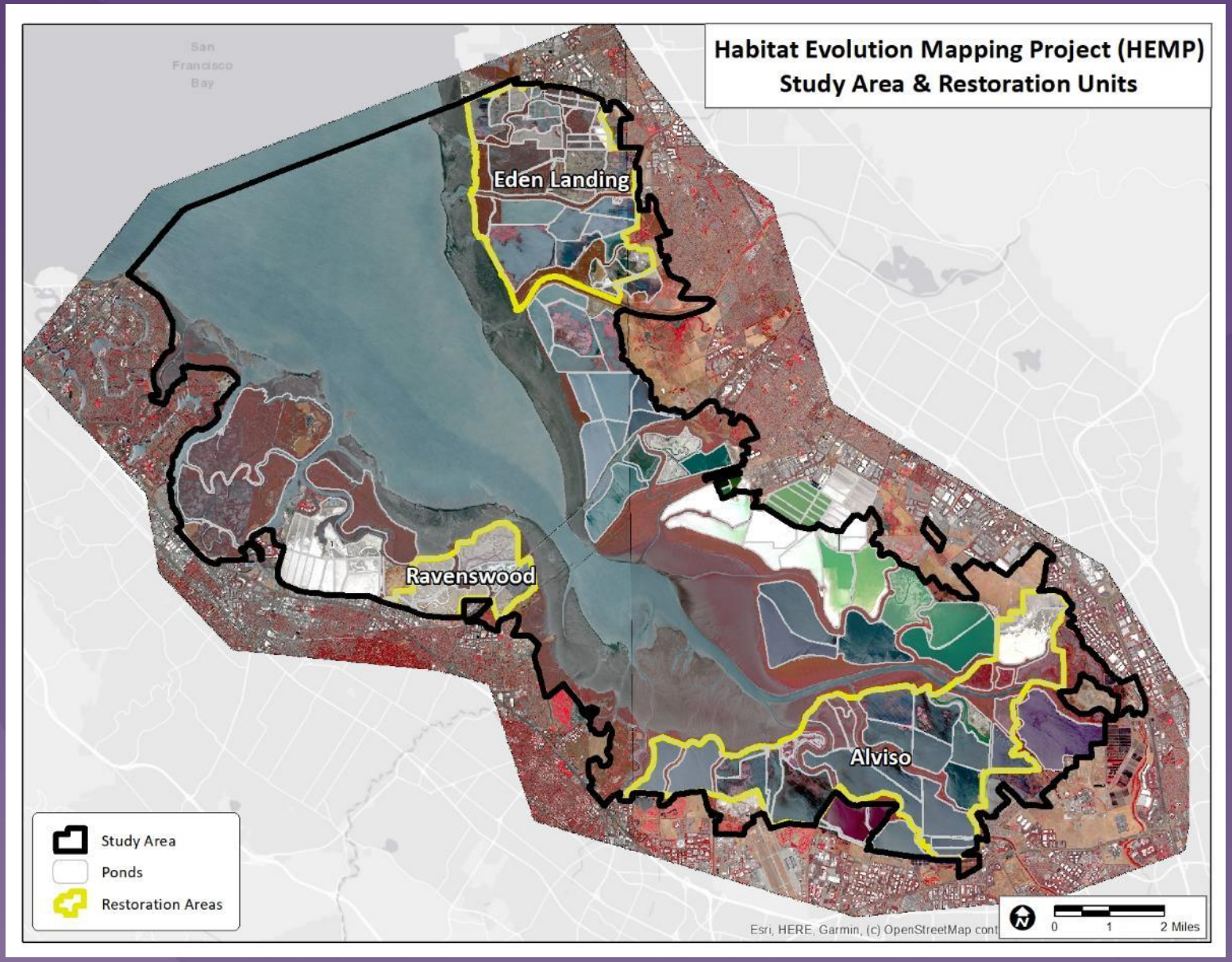
CALIFORNIA DEPARTMENT OF FISH & WILDLIFE

U.S. FISH & WILDLIFE SERVICE DEPARTMENT OF THE INTERIOR

California Wildlife Foundation

BRIAN FULFROST & ASSOCIATES

Habitat Evolution Mapping Project 2.0 (2019 & 2021)



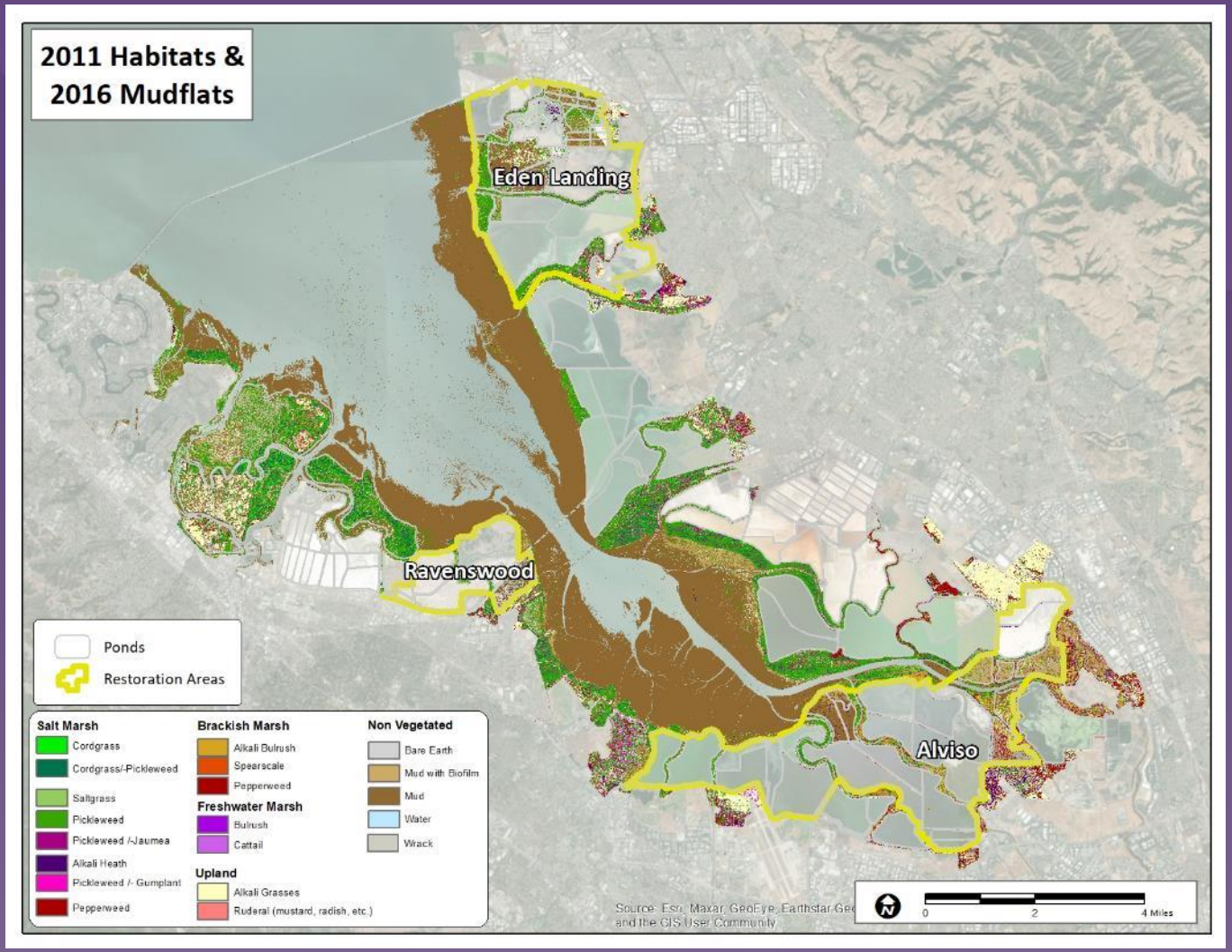
Habitat Evolution Mapping Project 1.0 (2009-2011)

2009-2011

~15,000 acres of tidal salt, brackish, and freshwater marsh vegetation mapped

2016

~18,000 acres of tidal mudflats mapped



Habitat Evolution Mapping Project (1.0 and 2.0) - Project Goals

Track evolution of tidal marsh habitats (vegetation and mudflats)

Tidal Marsh

- Salt, Brackish and Freshwater Marsh Habitats
- Habitats mapped as vegetation Alliance/Association
- Map floral colonization of restored ponds

Mudflats

- Map extent and distribution of mudflats
- Map presence of and distribution of biofilm

Other

- Map abiotic and upland habitats (including Pepperweed)
- Use ISP data to distinguish invasive and native Cordgrass

Habitat Evolution Mapping Project (1.0 and 2.0) - Methods

- Based on analysis of **high resolution multispectral satellite imagery**
- Extensive **ground truthing** of **habitat classifications**

Step 1. Develop Vegetation Classification (Habitat Types)

Step 2. Satellite Imagery acquisition
- time satellite flyover (~12pm) with Mean Lower Low Water (MLLW)
- Worldview-2 (2019 & 2021) - 8 band, ~0.5 meter
- Ikonos (2009-2011) - 4 band, ~1 meter

Step 3. Habitat Model (w/ ground truthing)
- supervised classification of image into habitat classes

Step 4: Mudflat Model (w/ ground truhing) – HEMP 2.0 only
- mix of methods designed to optimize tidal variability

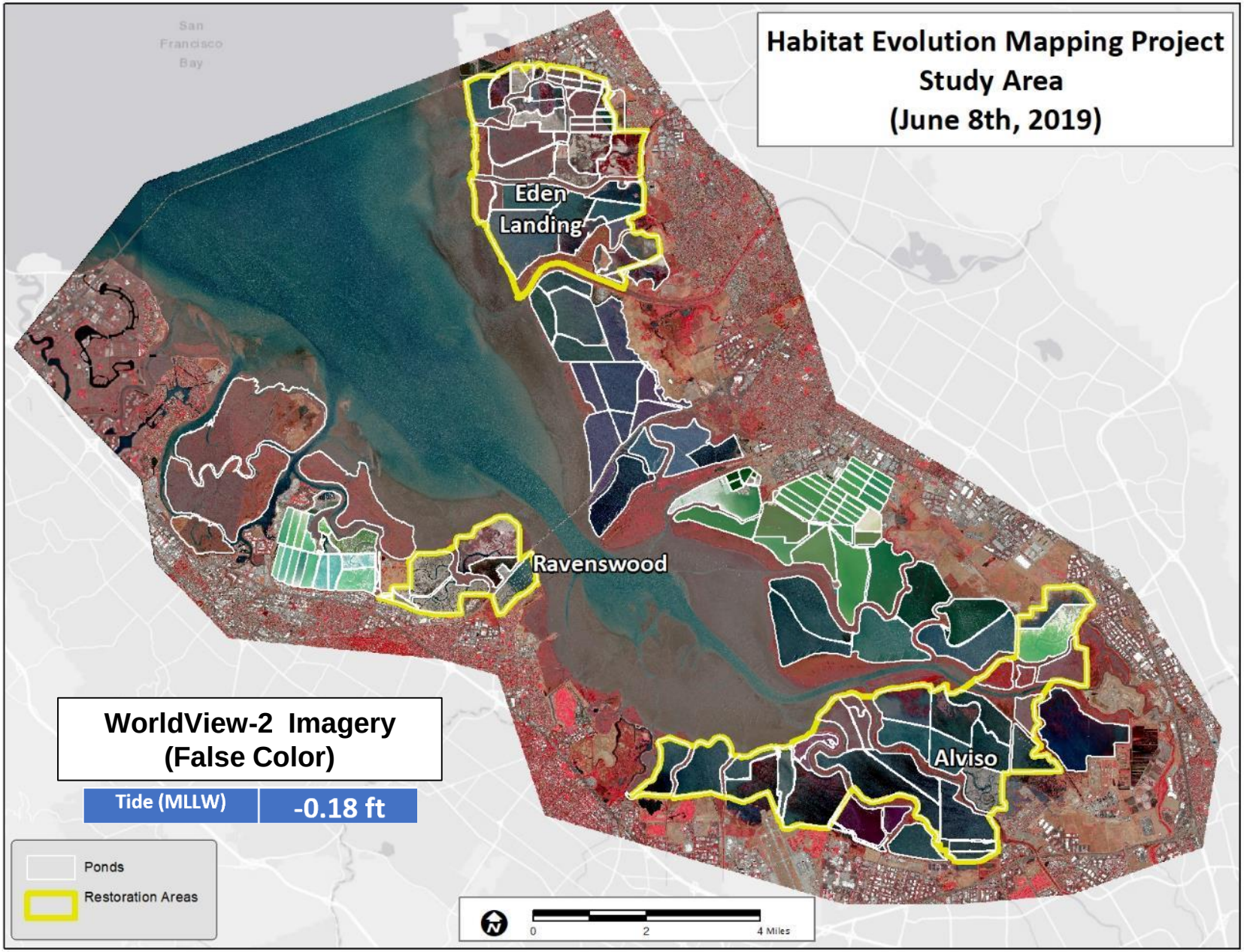
Step 5. Final Model Validation (w/ ground truhing)

Habitat Evolution Mapping Project (1.0 and 2.0) – Habitat Classifications (19)

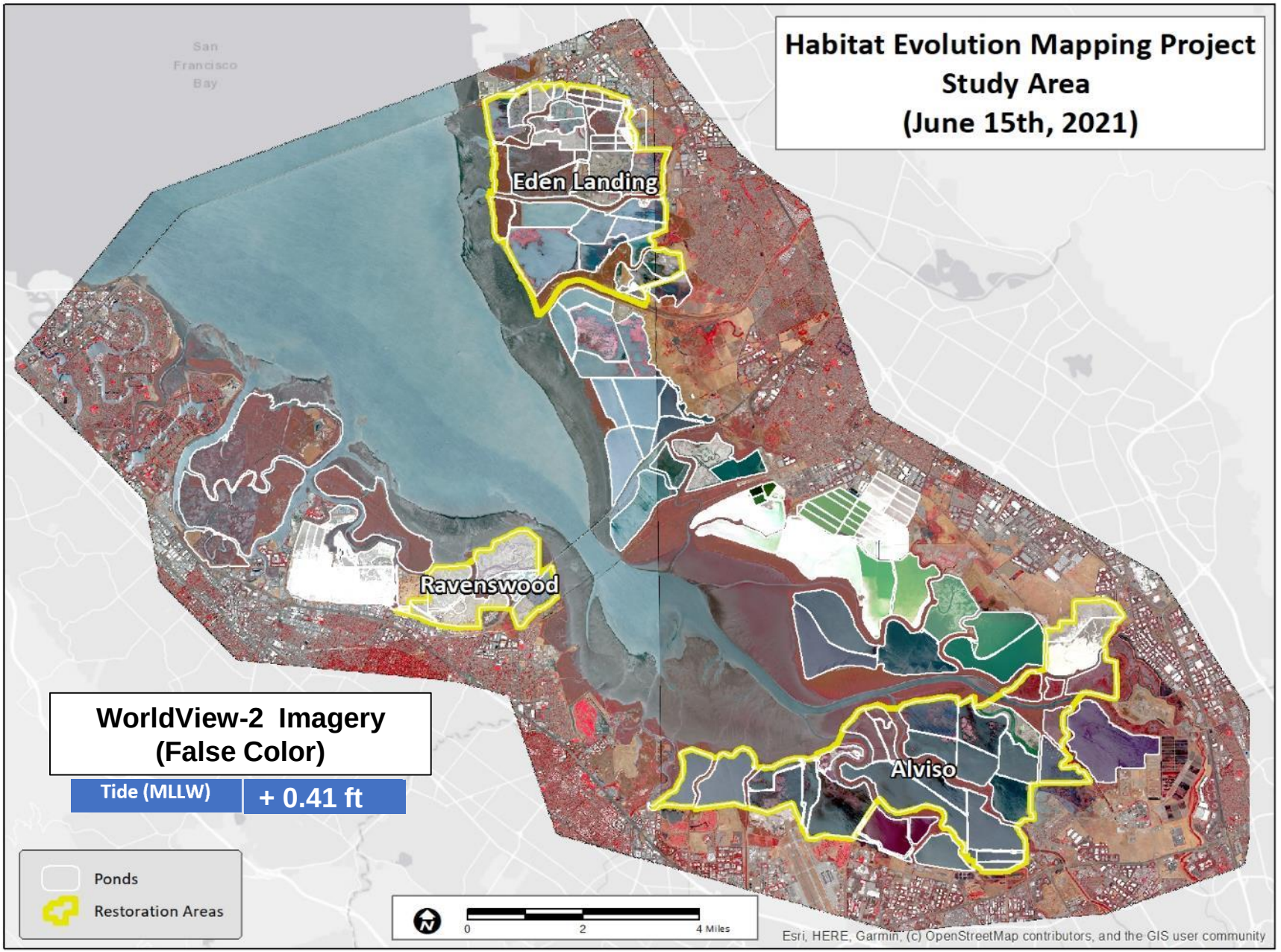
Habitat Type		Mapped Habitats (19) (Alliances and Associations)
Salt Marsh (7)	Salt Marsh – low (MTL-MHW)	Cordgrass
		Cordgrass /- Pickleweed
	Salt Marsh – "mid" (MHW-MHHW)	Pickleweed
		Saltgrass
		Pickleweed /- Jaumea
	Salt Marsh – high (MHHW)	Alkali Heath
		Pickleweed /- Gumplant
Brackish Marsh (2)		Alkali Bulrush
		Spearscale
		Pepperweed*
Freshwater Marsh (2)		Freshwater Bulrush
		Cattails
Upland (3)		Alkali Grasses
		Ruderal
Non-Vegetated (5)		Mudflat
		Mudflat with Biofilm
		Wrack
		Bare Earth
		Water

*Pepperweed was not included in the 'Brackish Marsh' habitat category when acreages were calculated.

Habitat Evolution Mapping Project 2.0 (2019) – Imagery and Ground Truthing



Habitat Evolution Mapping Project 2.0 (2021) – Imagery and Ground Truthing



HEMP 2.0 Final Results – Accuracy Assessment

Overall Accuracy (dominant habitat alliance)

2021: 84% (*Kappa 0.79*)

2019: 85% (*Kappa 0.82*)

2011: 76%
2010: 70%
2009: 70%

Overall Accuracy (sub-dominance habitat association)

2021: 82% (*Kappa 0.78*)

2019: 80% (*Kappa 0.76*)

2011: 61 %
2010: 67 %
2009: 56 %

HEMP 2.0 – Final Results Overview

- Acreages of salt, brackish, and freshwater habitats have almost all increased significantly within Restoration Units and Restored Ponds although a few have fluctuated but not decreased below 2009 levels

- Rate of floral colonization between 2019 and 2021 > between 2011 and 2019 in many restored ponds (e.g. North Creek Marsh, A6, Outer Bair).

- Although bay exposed mudflats decreased by 4% between 2016 and 2019 (14,413, to 13,773 acres), they have a very similar extent and distribution, and appear to be accreting more than eroding when compared to 2005 MLLW line.

- Direction (+/-) and size of change in habitat acreages varies at different geographic (e.g. study area, restoration unit, or restored ponds) and temporal (2 vs 10 years) scales.

HEMP 2.0 - Final Results Overview (Study Area)

Changes between 2009 (HEMP1) and 2021 (HEMP2)

- **3% increase** (8,796 to 9,078 acres) in Salt Marsh species (low, mid, and high marsh)
- **Doubling of Cordgrass** and Cordgrass /- Pickleweed (444 to 904 acres)
- **Pickleweed acreages are nearly identical** (7,335 to 7,315 acres)
  - **35% increase** in Alviso
  - **32% increase** in Eden
- **Gumplant & Alkali Heath combined +10% (2019) and -10% (2021)**
  - Mixed results for Gumplant (acreages have fluctuated)
  - Results look best in 2021
- **20% increase in acres of Alkali Bulrush** (473 to 568 acres)
  - Acreages of Alklai Bulrush appear cyclical

HEMP 2.0 - Final Results Overview (Study Area)

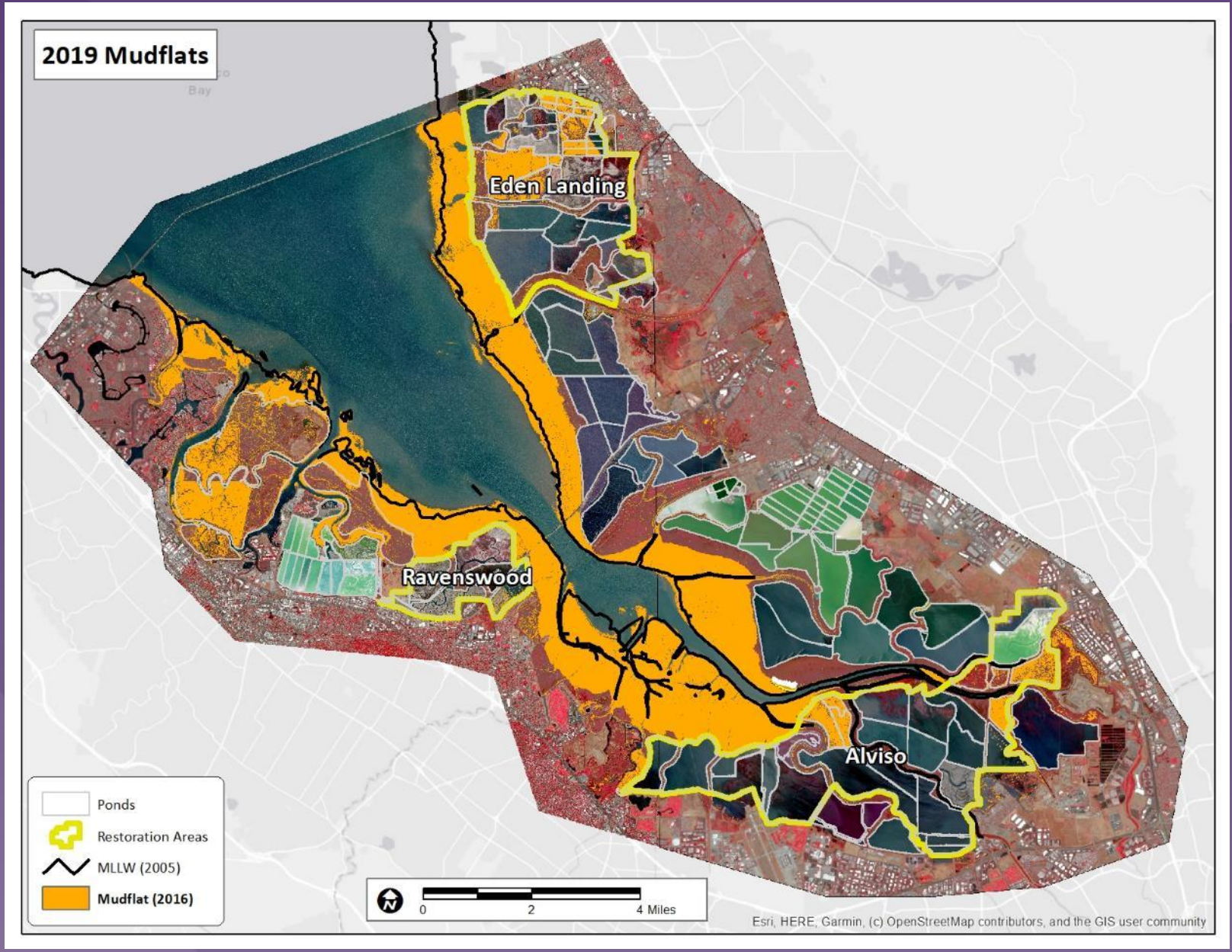
Changes between 2009 (HEMP1) and 2021 (HEMP2)

- **85% decrease (1,100 to 153 acres) in Pepperweed**
- **4X increase in Spearscale (57 to 221 acres)**

Changes between 2019 and 2021

- **617 acres of direct floral colonization of mudflats (~90% within ponds and marshes)**
- **7% increase in Pickleweed**
  - **5% increase** in Alviso
  - **21% increase** in Eden
- **20% decrease in Alkali Bulrush**

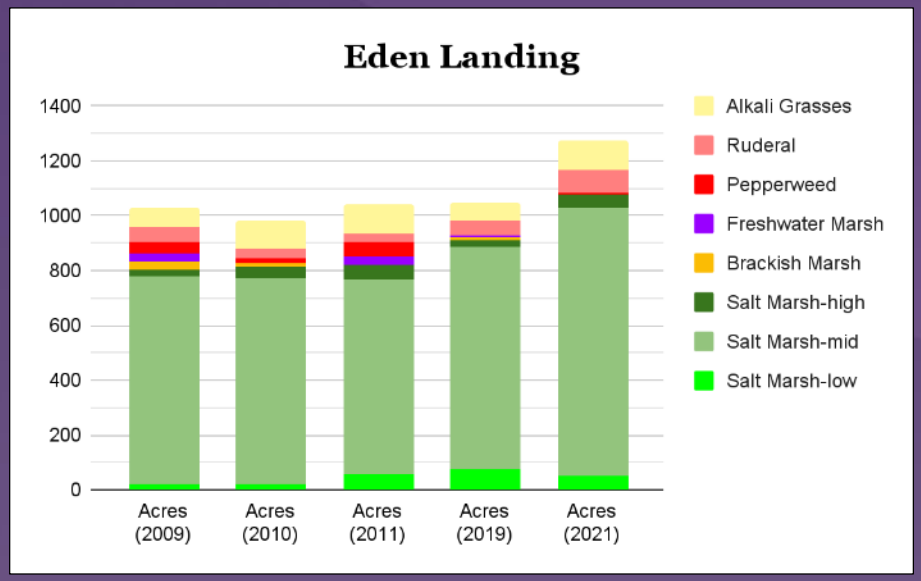
HEMP 2.0 - Final Results – Mudflats (2019 & 2016)

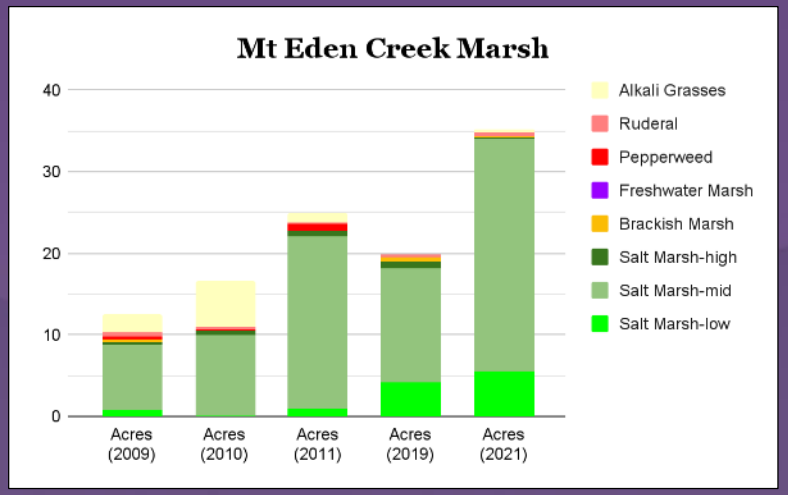


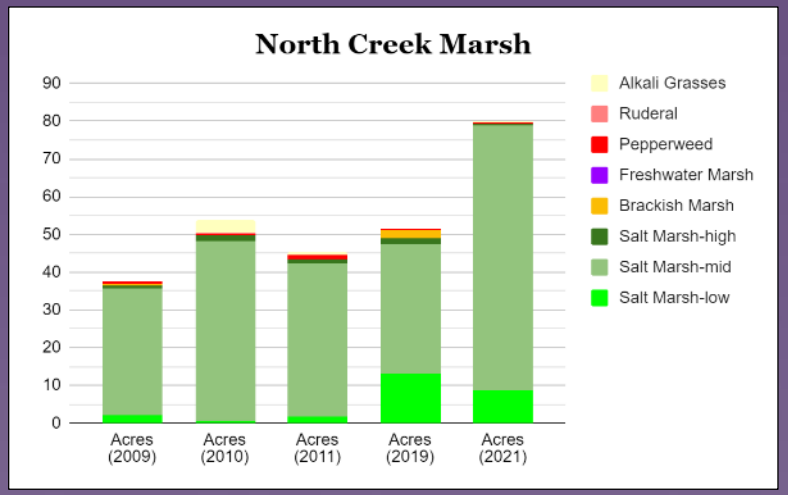
HEMP 2.0 - Final Results – Mudflats (2019 & 2016)

	2016 (acres)*	2019 (acres)	2021 (acres)**
bay/slough	14,413	13,773	11,989
pond/wetland	4,022	3,769	4,024
Total	18,435	17,542	16,014

HEMP 2.0 - Final Results (Eden Landing)

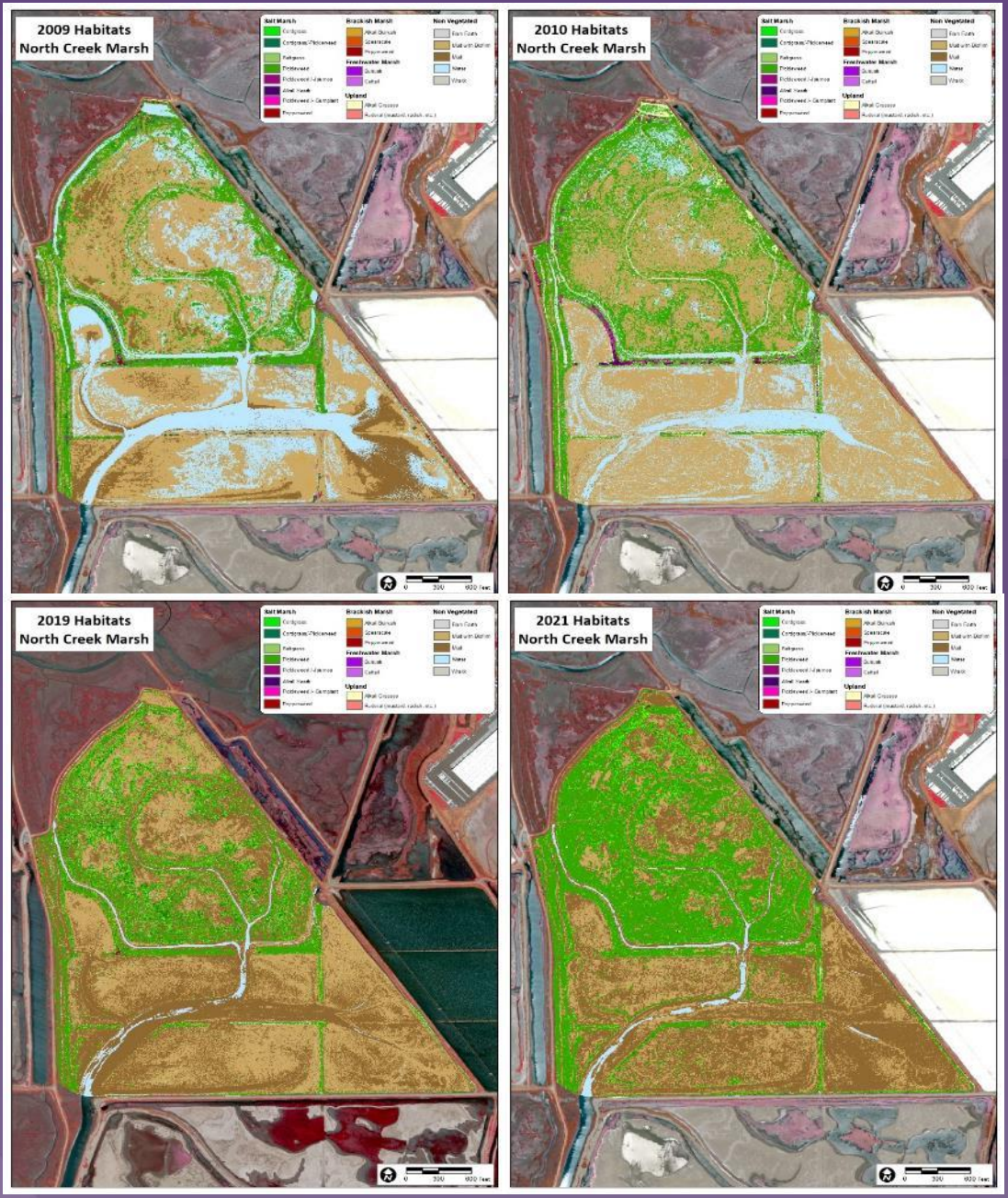




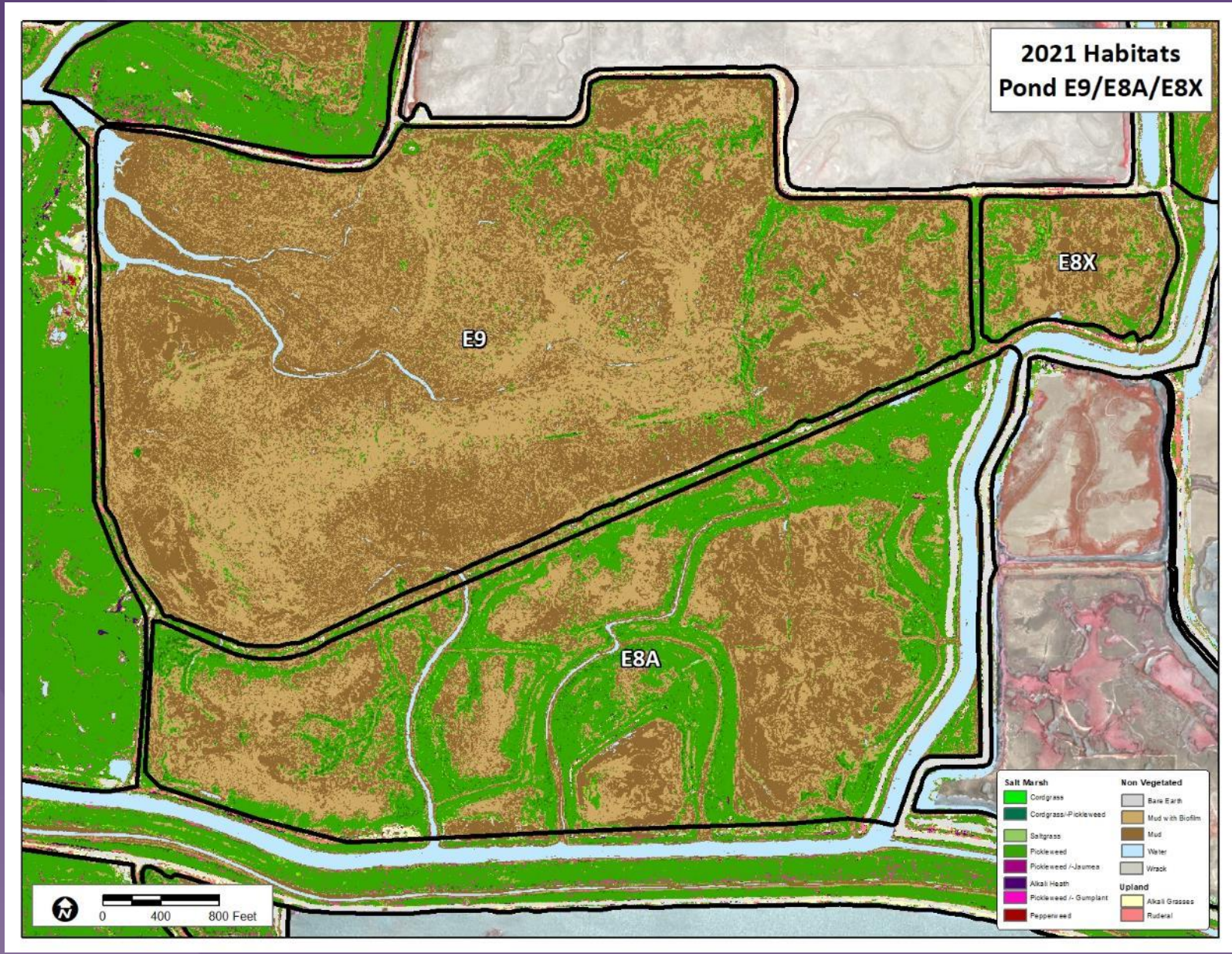


- 23% increase in all biotic habitats
- 2X + increase in low salt marsh (23 to 54 acres)
- 29% increase in mid salt marsh (755 to 976 acres)
- 2X increase in high salt marsh (23 to 45 acres)

Habitat Evolution Mapping Project 2.0 – Final Results (North Creek Marsh)

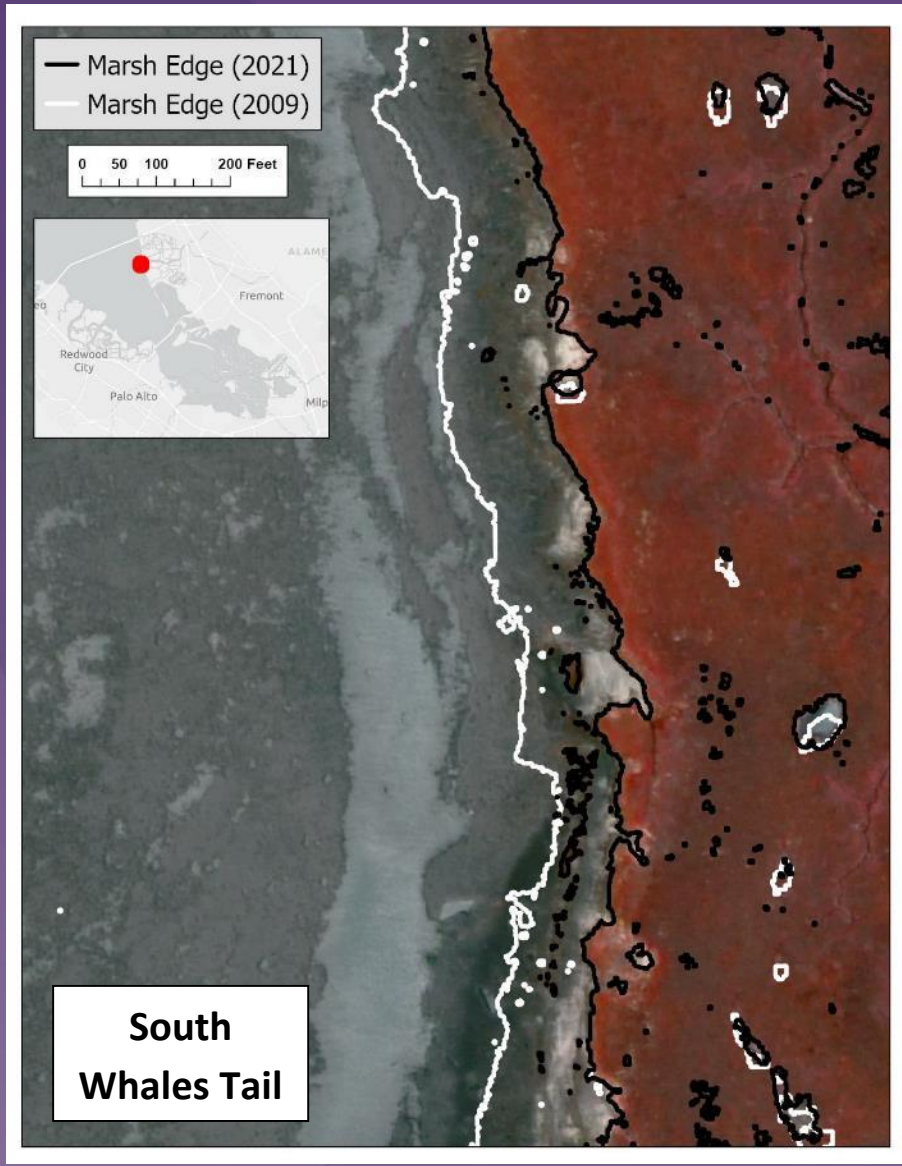


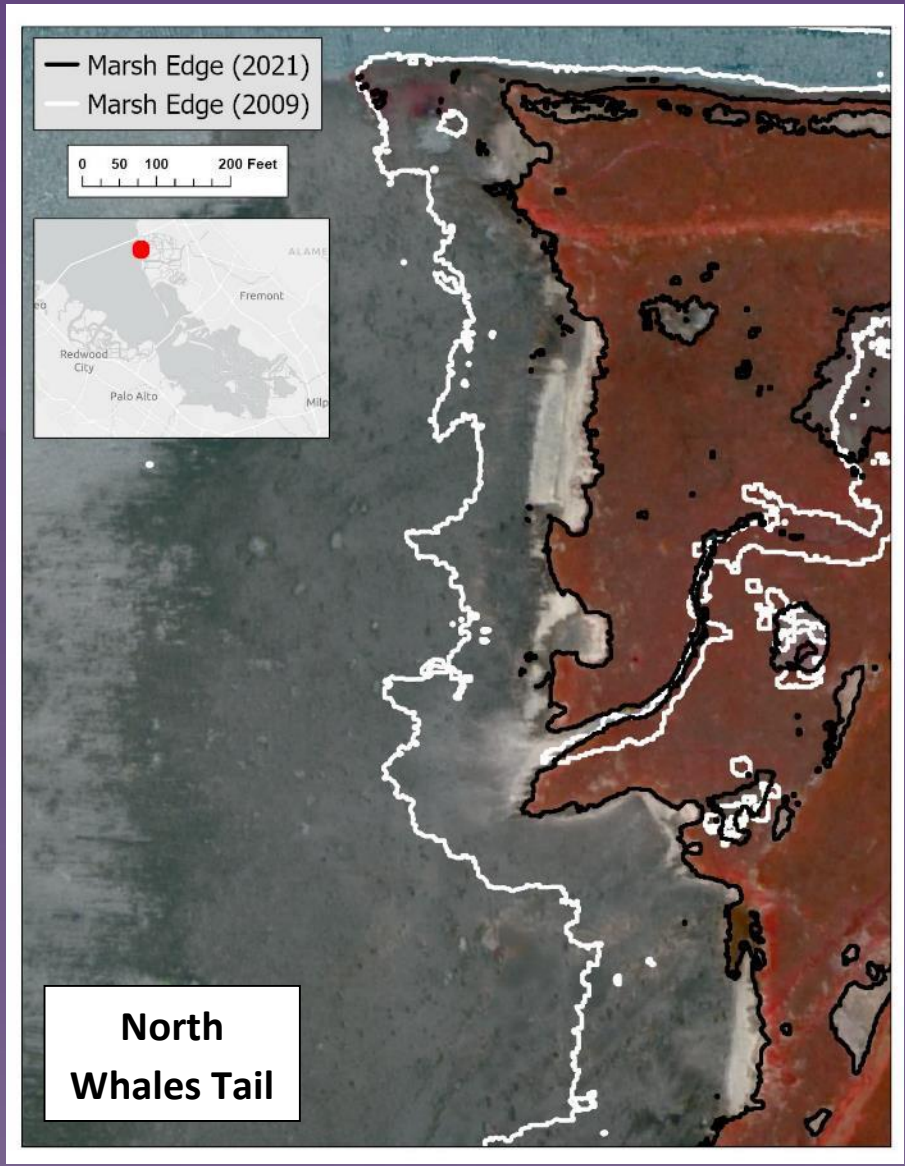
Habitat Evolution Mapping Project 2 – Final Results (E9/E8A)



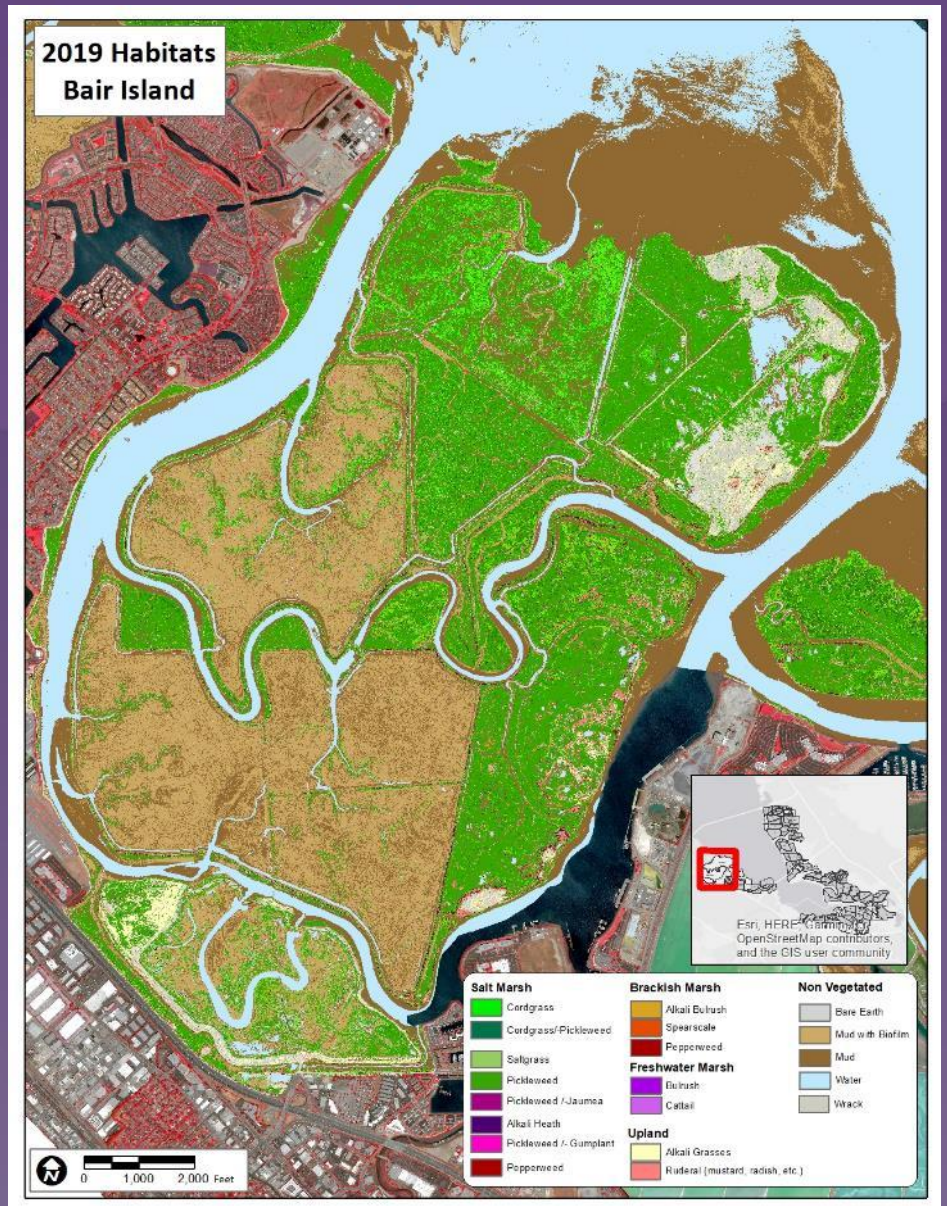
Habitat Evolution Mapping Project 2 – Final Results (E9/E8A)

Habitat Evolution Mapping Project 2.0 – Marsh Erosion: 2009-2021 (Whales Tail)

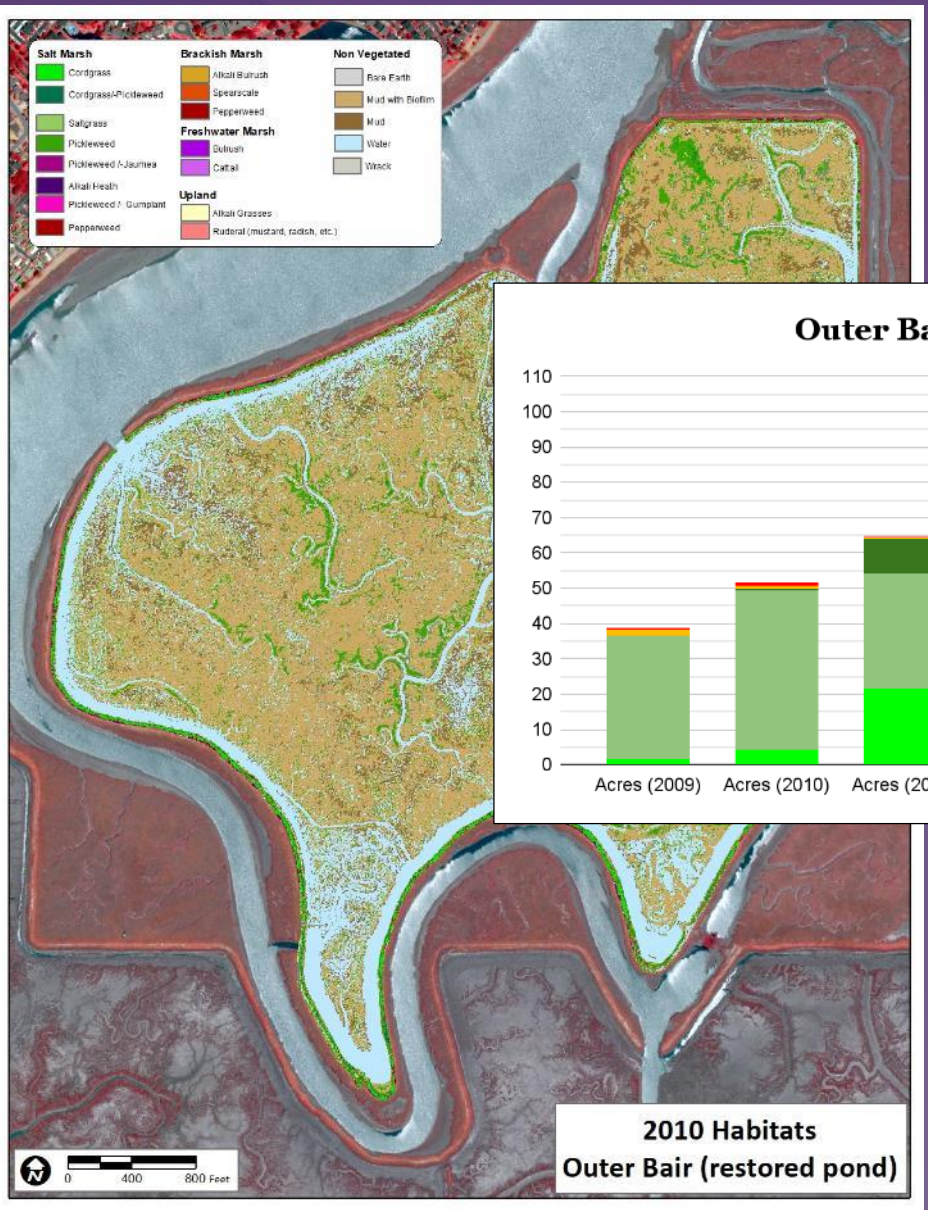


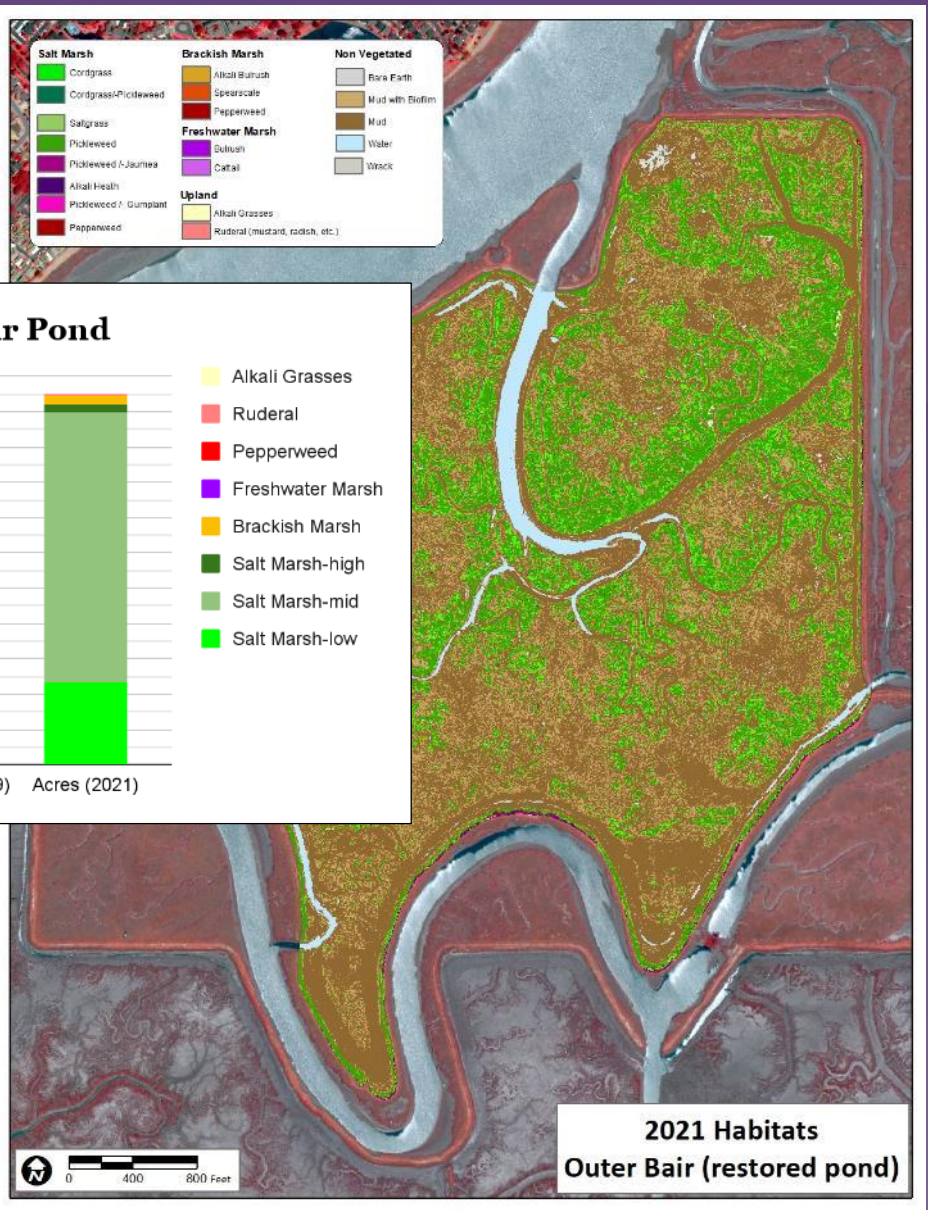


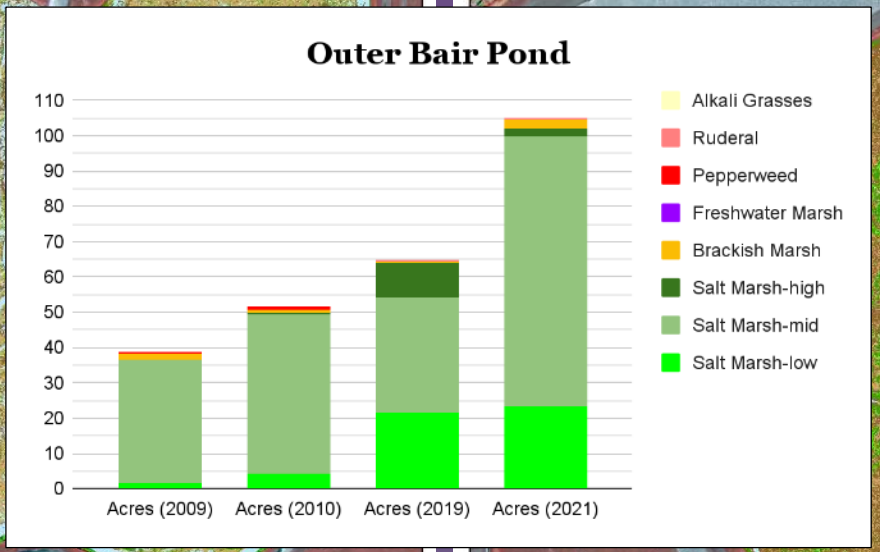
Habitat Evolution Mapping Project 2.0 – Final Results (Bair Island)



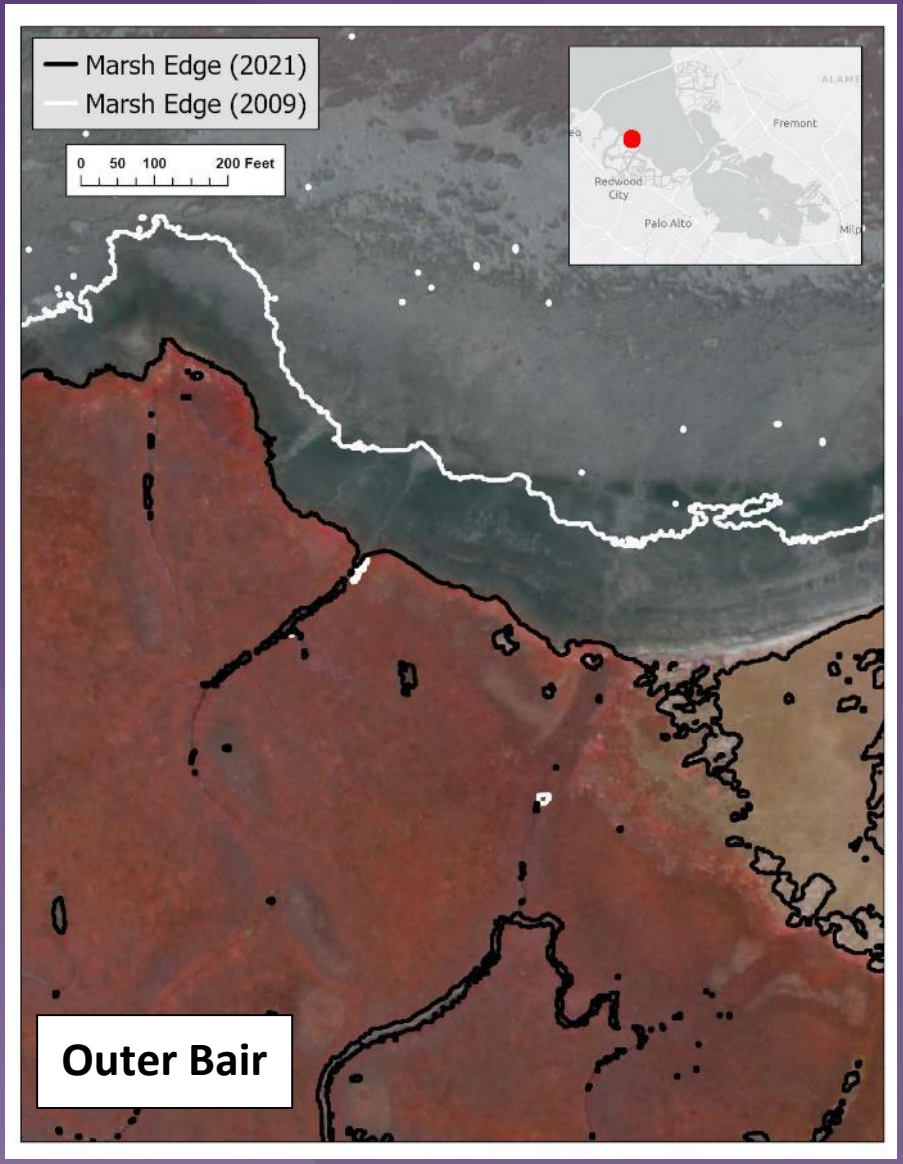
Habitat Evolution Mapping Project 2.0 – Final Results (Outer Bair Island)

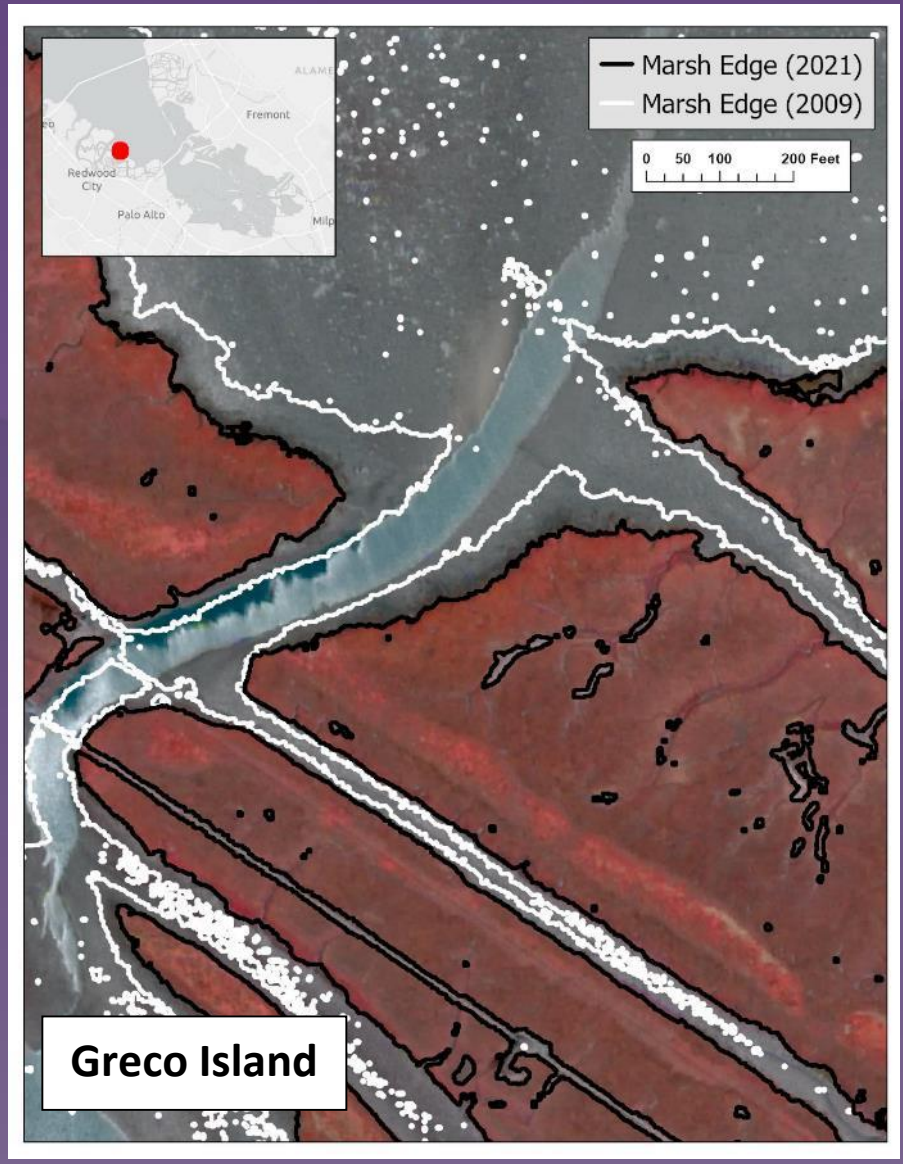




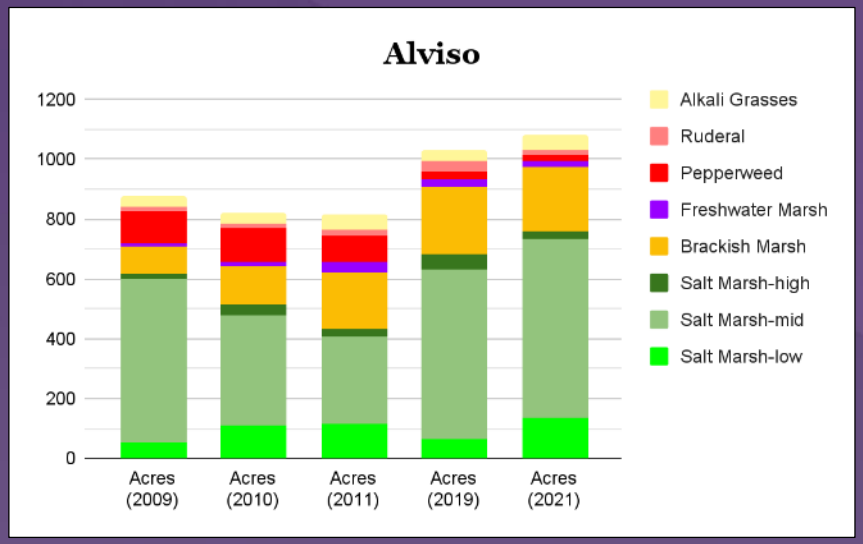


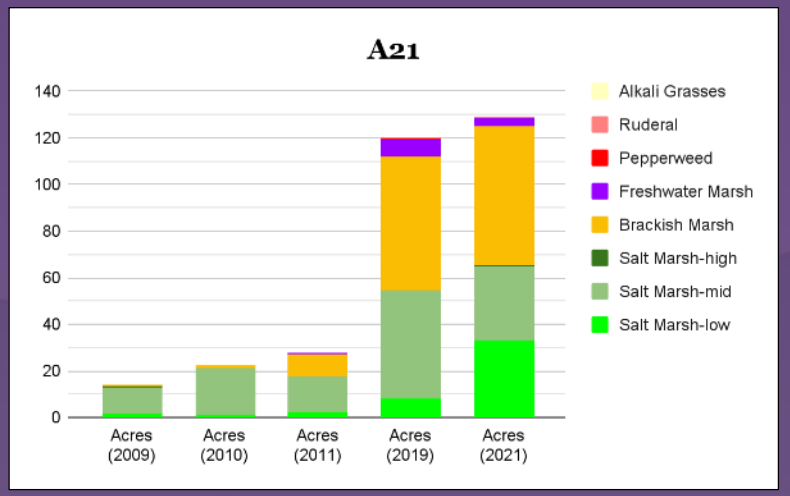
Habitat Evolution Mapping Project 2.0 – Marsh Erosion: 2009-2021

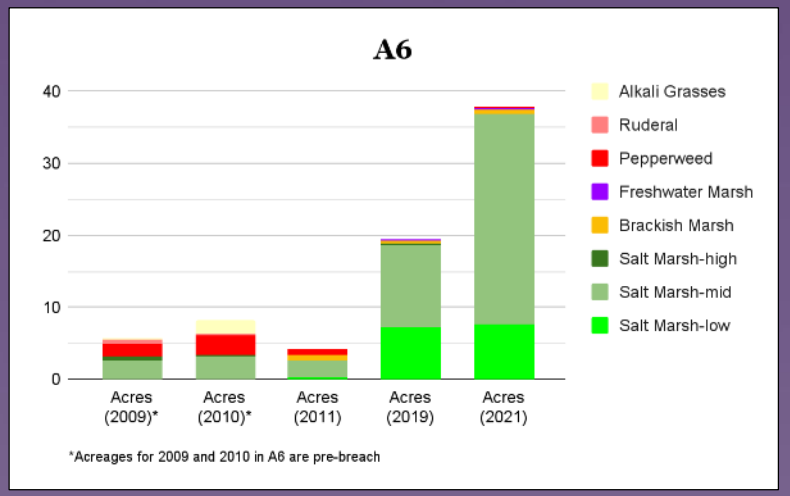




Habitat Evolution Mapping Project 2.0 - Final Results (Alviso)



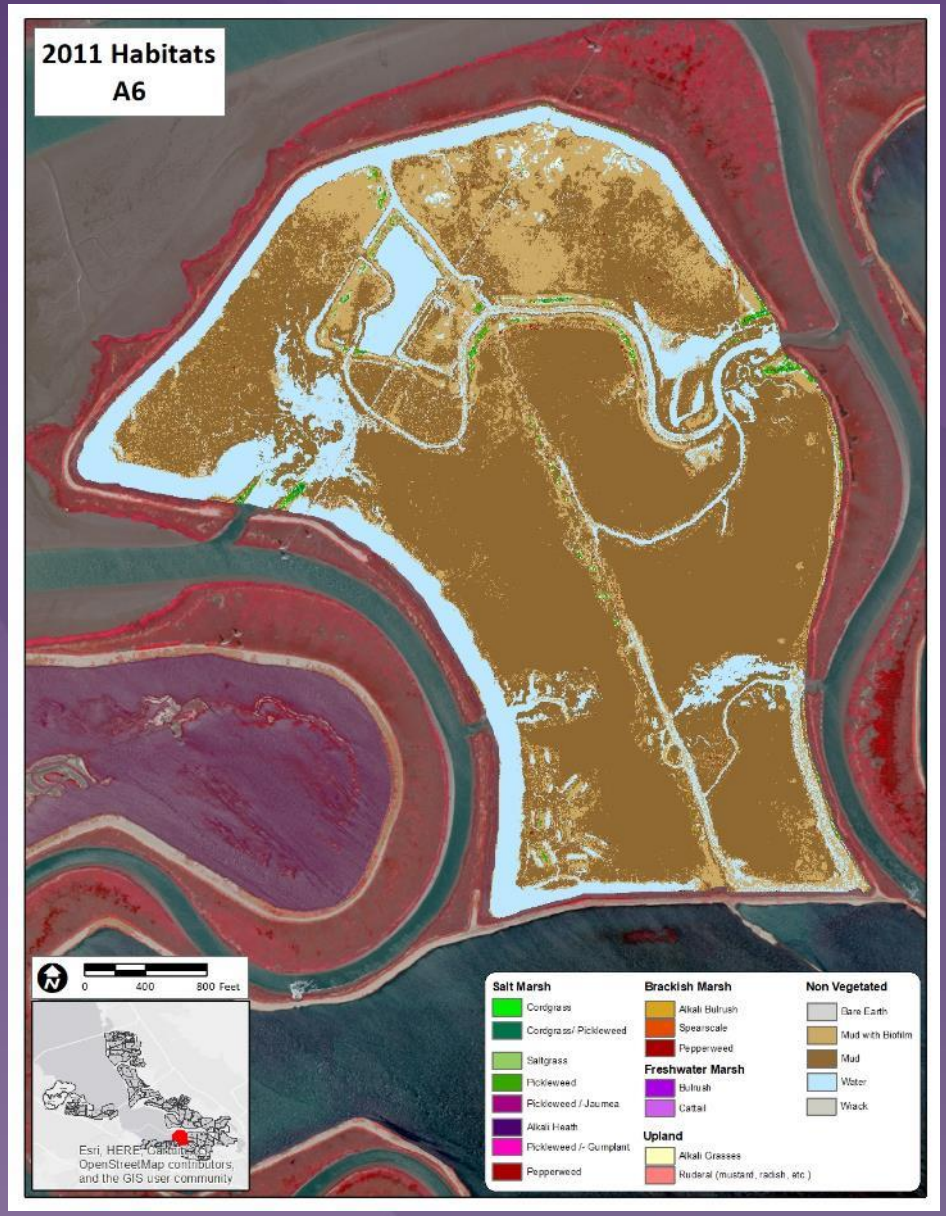


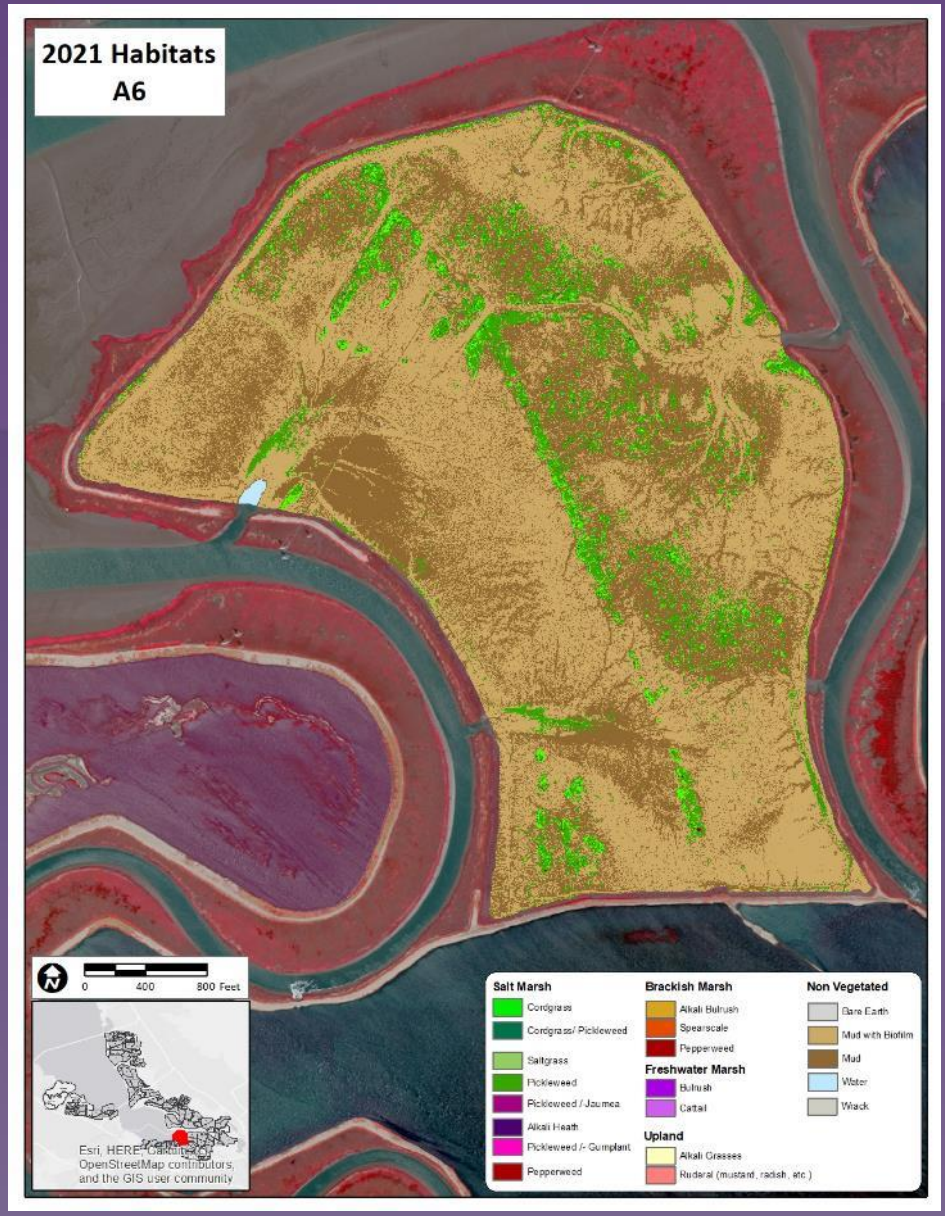


- 2.5X increase in Cordgrass (54 to 135 acres)
- 35% increase in Pickleweed (435 to 586 acres)
- 70% increase in Gumplant
  (large fluctuations-> mixed results)

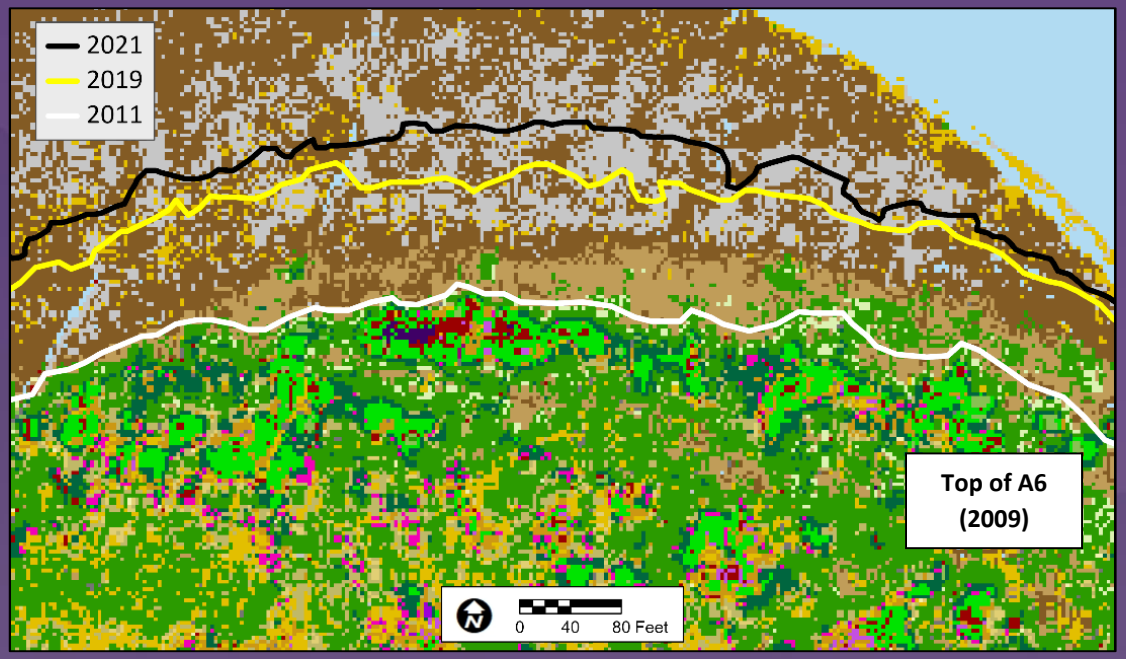
- 2.5X increase in Alkali Bulrush (72 to 178 acres)
- 2X increase in Freshwater Marsh (12 to 21 acres)

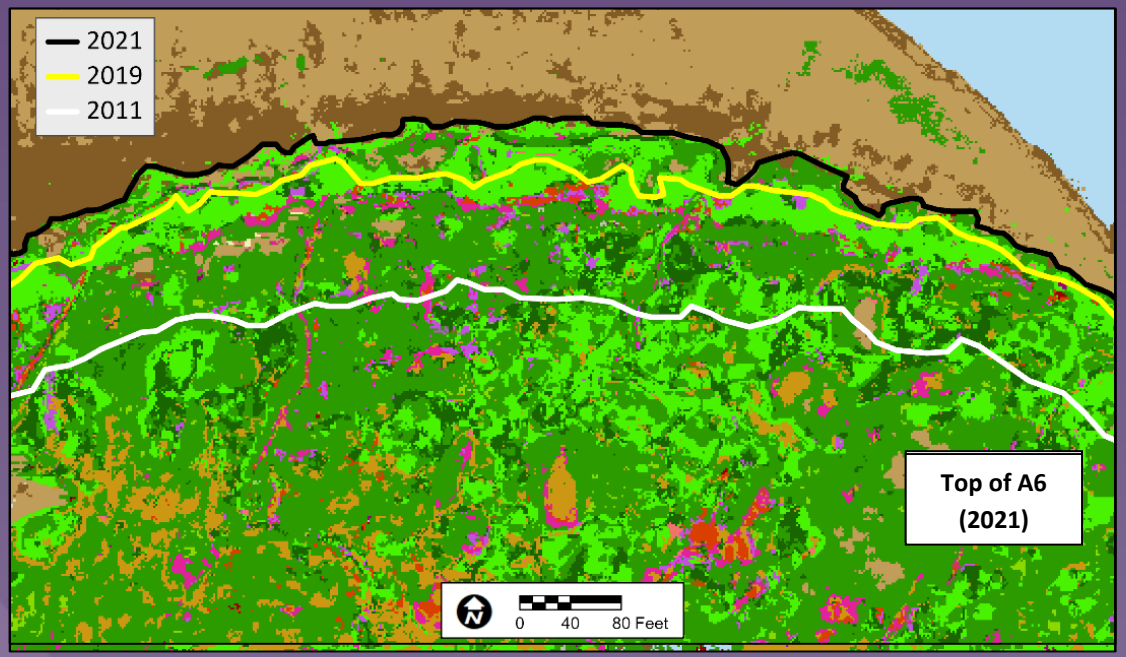
Habitat Evolution Mapping Project 2.0 – Final Results (A6)



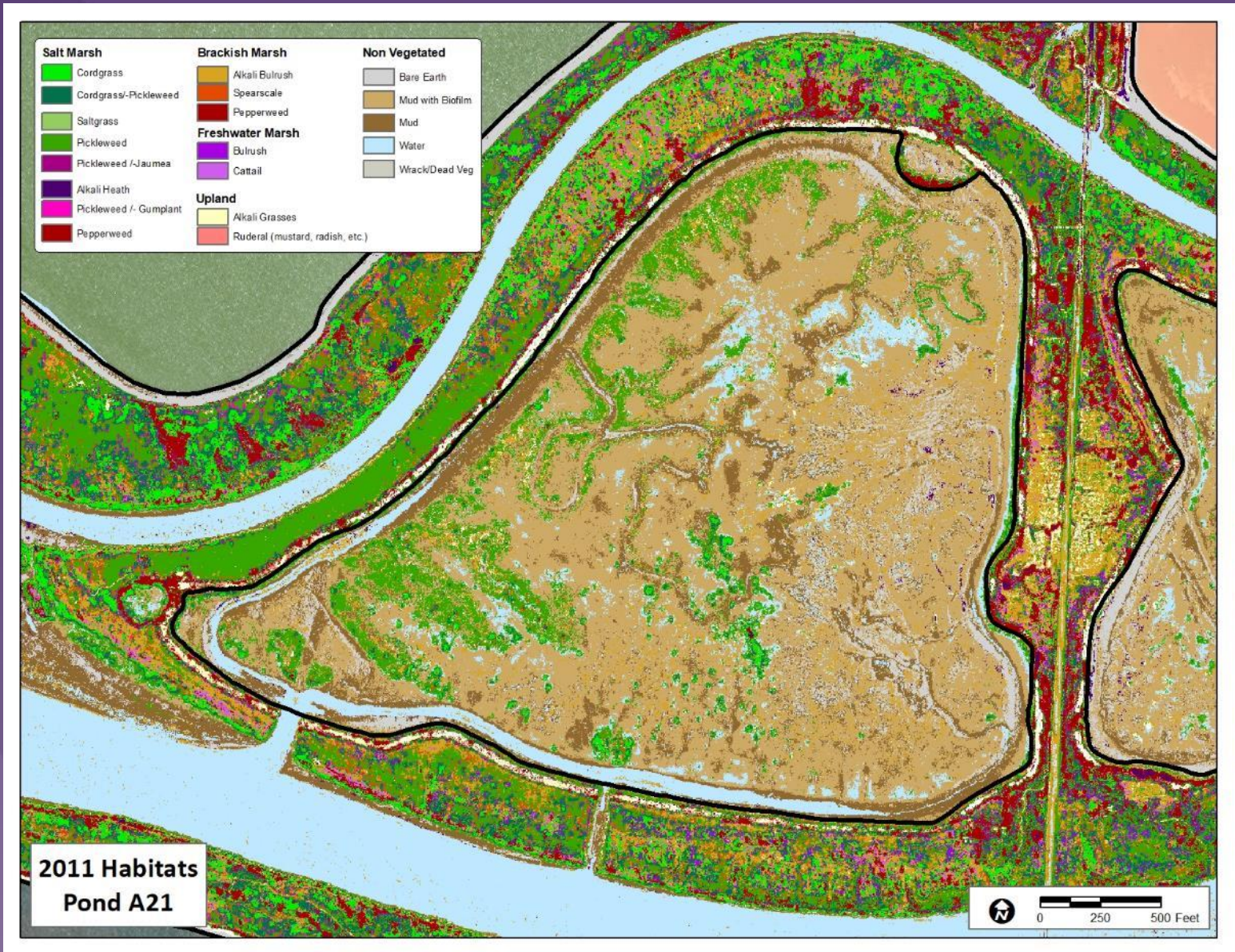


Habitat Evolution Mapping Project 2.0 – Final Results (Top of A6)

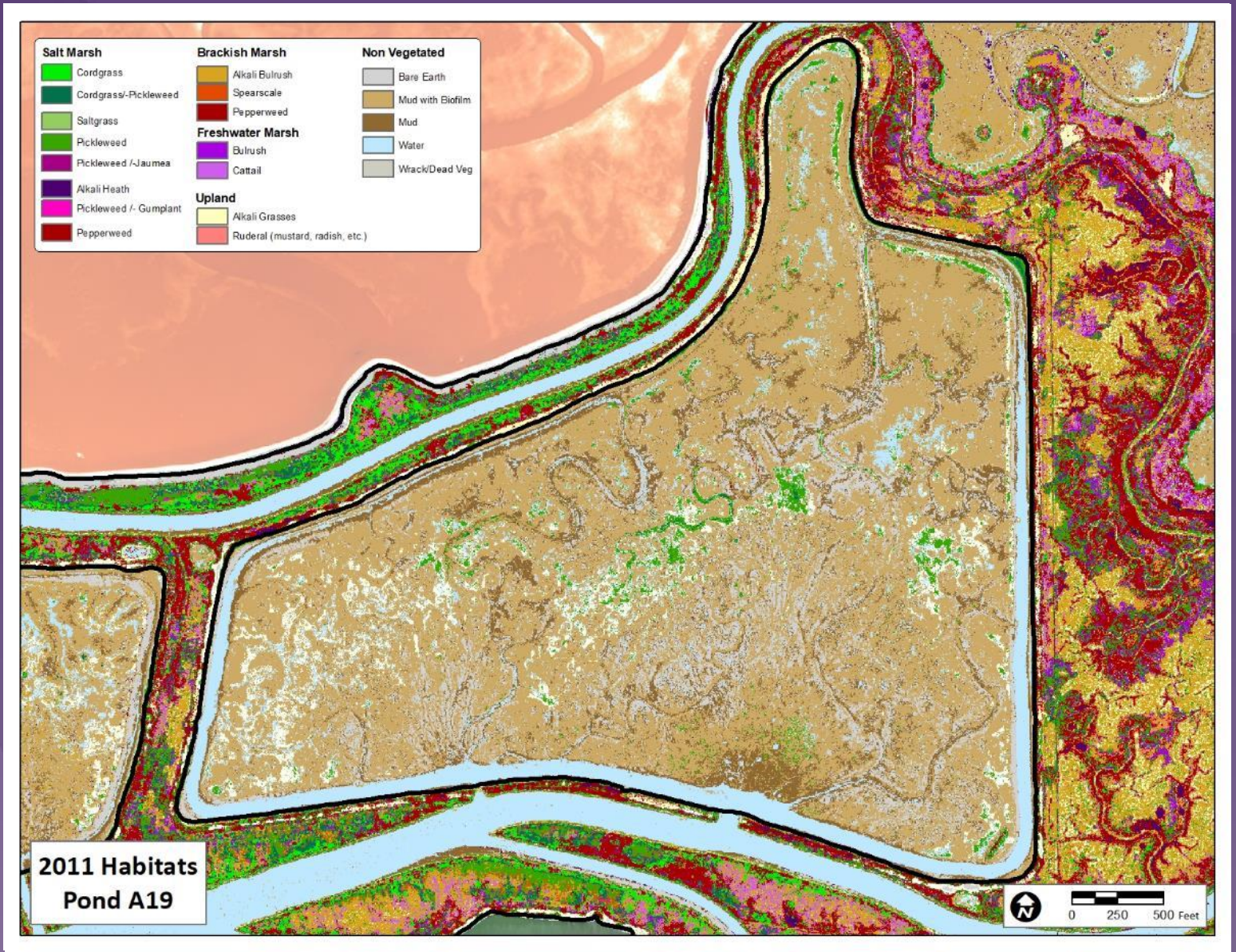




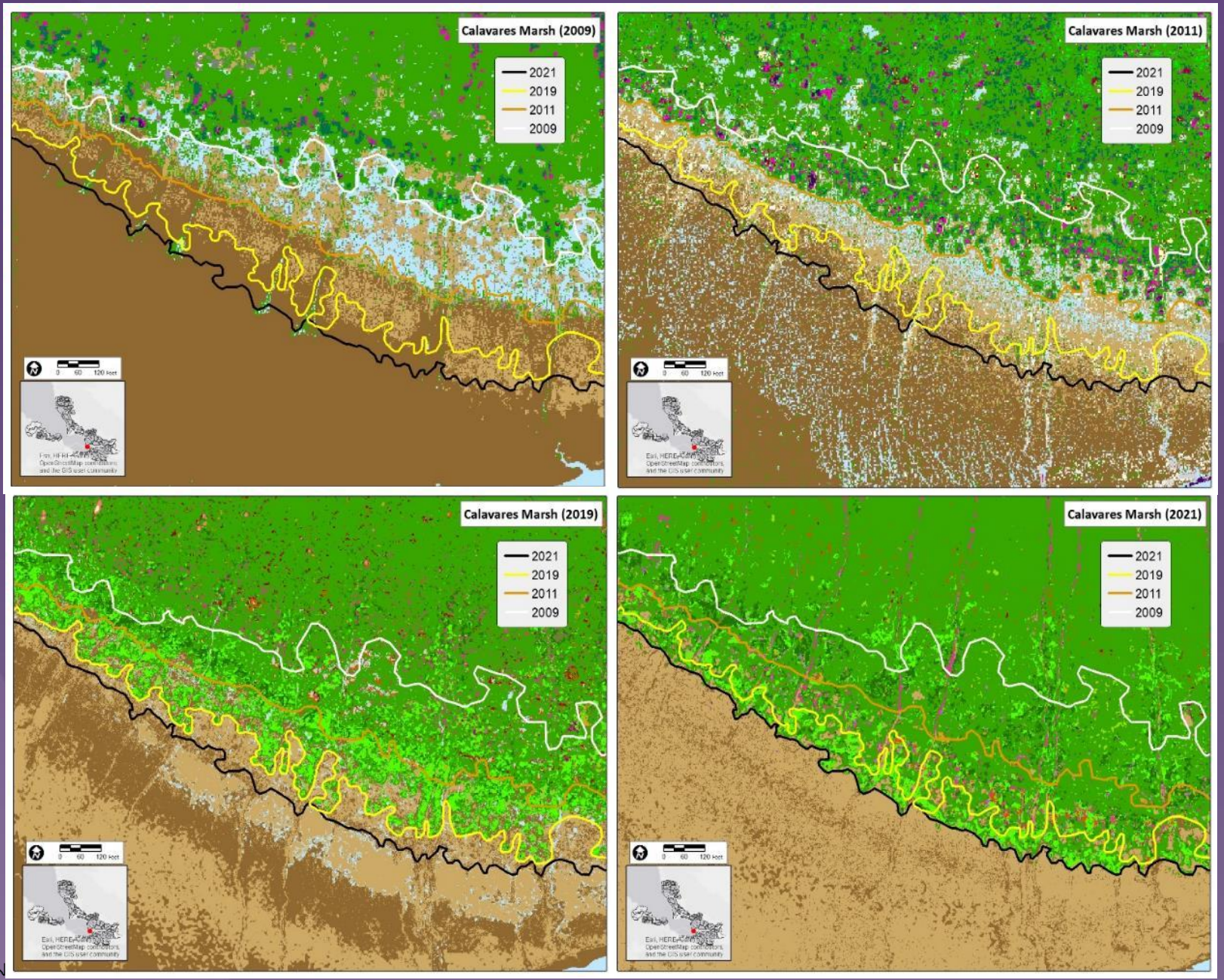
Habitat Evolution Mapping Project 2.0 – Final Results (A21)



Habitat Evolution Mapping Project 2.0 – Final Results (A19)



Habitat Evolution Mapping Project 2.0 – Final Results (Calavares Marsh)



Habitat Evolution Mapping Project 2.0 – Final Results (Ogilvie Island)

Final Deliverables
(Hemp2_deliverables_list.doc)

(1) HEMP 2.0 - Final Report

- Executive Summary
- HEMP2 Results (2019 and 2021) & HEMP1 (2009-2011) Change Analysis
- Summarized at 3 Scales: Study Area, Restoration Unit, and Restored Pond
- Methods (Habitats and Mudflats) and Appendices
- https://www.southbayrestoration.org/document/habitat-evolution-mapping-project-decadal-update-2019-2021-final-report

(2) HEMP 2.0 - Final Data

- 2019 Habitats - https://bfa.egnyte.com/dl/BC3SHXVCCc
- 2021 Habitats - https://bfa.egnyte.com/dl/HoMJHp4NOq
- Updated Hemp1 Habitats - https://bfa.egnyte.com/dl/HdGCoXJNdl

(3) HEMP 2.0 - Presentation & Webinar

Additional Research

(1) Quantify Marsh Erosion and other wetland dyanmics outside of Restoration Units

(2) Differentiate Native and Invasive Cordgrass with Invasive Spartina Project (ISP)

(3) Create Vegetation and Channel *polygons*


Questions?
bfaconsult@gmail.com