



Marsh Vegetation in the South Bay of San Francisco

Brian Fulfroost

Design, Community and Environment (DC&E)

6th Annual Bay-Delta Science Conference

PROJECT TEAM

GIS and Remote Sensing of vegetation

- ◆ **Brian Fulfrost** *Project Manager*
- ◆ **Charlie Loy** *GIS Analyst*

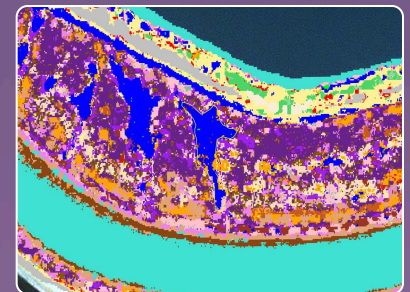
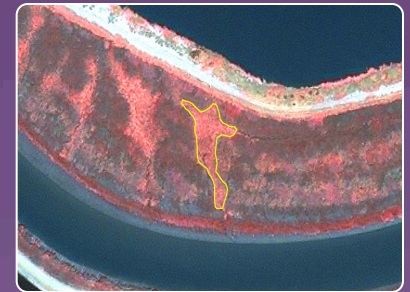
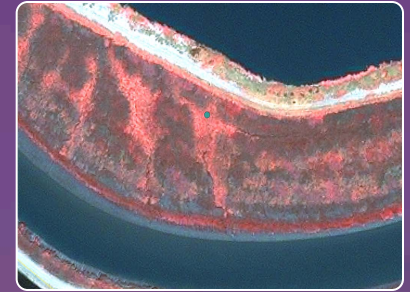
Marsh Ecology

- ◆ **David Thomson** *Lead Biologist*



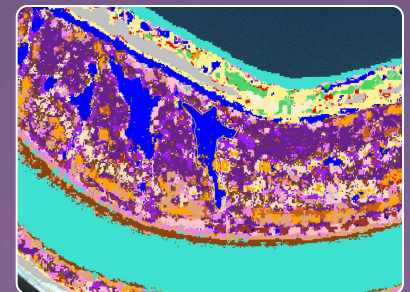
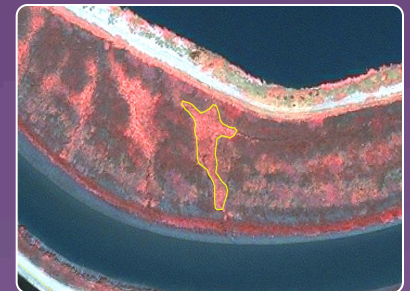
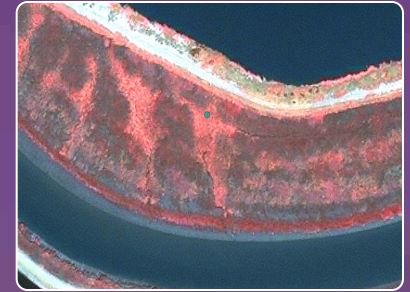
OVERVIEW - Goals

- ◆ 3 year pilot project (2009-2011) timed with Phase One breaches
 - Year One classification complete
 - Year Two in progress
- ◆ Goal was to build a semi-automated “model” to track evolution of marsh vegetation and sediment as part of adaptive restoration



OVERVIEW - Methods

- ◆ Habitat Classification - CNPS Rapid Assessment methodology to characterize spatial variability of dominant marsh vegetation
- ◆ Habitat Model - Satellite Image Interpretation and supervised classification of Ikonos 1 meter multispectral Imagery
- ◆ Habitat Ground Truthing (calibration and validation) using sub meter Trimble GPS



HABITATS TO BE MAPPED

HABITAT EVOLUTION PROJECT (HEP)-- HABITAT COMMUNITIES LIST 05/28/10

| # | CNDD Code | Vegetative Classification* | Marsh Community (Tidal) | Species | Mapped | Observed in Field | Number of Field Observations** |
|--|------------|-----------------------------------|-------------------------|--|--------|---|--------------------------------|
| Coastal and Valley Freshwater Marsh | | | | general type | | | |
| 1 | 52.101.00 | Bulrush | Low | <i>Scirpus</i> spp. | Yes | Yes | 2 |
| 2 | 52.102.01 | Bulrush - Cattail | Low | <i>Scirpus</i> spp. - <i>Typha</i> spp. | Yes | Yes | 5 (HTH) |
| 3 | 52.103.00 | Cattail Wetland | Low | <i>Typha</i> spp. | Yes | Yes | 3 |
| Coastal Brackish Marsh | | | | general type | | | |
| 5 | *52.112.00 | Alkali Bulrush | Low | <i>Scirpus maritimus</i> / <i>Scirpus robustus</i> (SCRO/SCMA) | Yes | Yes | 4 |
| 6 | | Alkali Bulrush / - Pepperweed | Ecotonal | (SCRO/SCMA)/ <i>Lepidium latifolium</i> | Yes | Yes | 2 |
| 7 | *52.112.01 | Alkali Bulrush / Fiddleneck | Ecotonal | (SCRO/SCMA)/ <i>Salicornia</i> spp. | Yes | Yes | 3 |
| 8 | 52.205.00 | Perennial Pepperweed | High | <i>Lepidium latifolium</i> | Yes | Yes | 2 |
| Salt - Alkali Marsh | | | | general type | | | |
| 9 | | Cordgrass | Low | <i>Spartina</i> spp. | Yes | Yes | 48 (ISP) |
| 10 | | Cordgrass - Annual Fiddleneck | Low | <i>Spartina</i> spp. - <i>Salicornia europaea</i> OR (spp.?) | Yes | Yes | 3 |
| 11 | *52.201.00 | Perennial Fiddleneck | Middle | <i>Salicornia virginica</i> | Yes | Yes | 17 |
| 12 | | Annual Fiddleneck | Low | <i>Salicornia europaea</i> | No | No | 0 |
| 13 | *52.201.03 | Perennial Fiddleneck / Saltgrass | Middle | <i>Salicornia</i> spp. / <i>Distichlis spicata</i> | Yes | Yes | 1 |
| 14 | 52.205.00 | Perennial Pepperweed | High | <i>Lepidium latifolium</i> | Yes | Yes | 7 |
| 15 | 52.205.01 | Pepperweed - Saltgrass | Ecotonal | <i>Lepidium latifolium</i> - <i>Distichlis spicata</i> | No | No | 0 |
| 16 | | Fiddleneck / - Pepperweed | Ecotonal | <i>Salicornia</i> spp. / <i>Lepidium latifolium</i> | Yes | Yes | 3 (HTH) |
| 17 | 52.206.00 | Gumplant | High | <i>Grindelia stricta stricta</i> | Yes | Yes | 5 |
| 18 | 52.211.00 | Sparscale | Middle | <i>Atriplex triangularis</i> | Yes | Yes | 1 |
| 19 | | Fiddleneck / Sparscale | Ecotonal | <i>Salicornia</i> spp. / <i>Atriplex triangularis</i> | Yes | Yes | 3 (HTH) |
| 20 | 52.500.00 | Alkali Heath Dwarf Scrub | Middle | <i>Frankenia salina</i> | Yes | Yes | 3 |
| 21 | | Fiddleneck / Alkali Heath | Middle | <i>Salicornia</i> spp. / <i>Frankenia salina</i> | Yes | Yes | 1,4 (HTH) |
| 22 | *52.201.02 | Perennial Fiddleneck / - Gumplant | Ecotonal | <i>Salicornia</i> spp. / <i>Grindelia stricta</i> | Yes | Yes | 1 |
| 23 | | Fiddleneck - Jaumea - Saltgrass | Ecotonal | <i>Salicornia</i> spp. - <i>Jaumea carnosa</i> - <i>Distichlis spicata</i> | No | No | 0 |
| 24 | | Salt Grass | High | <i>Distichlis spicata</i> | Yes | Yes | 1 |
| 25 | | | | <i>Jaumea carnosa</i> | No | No (dominant observations) | 0 |
| 26 | | | | <i>Salsola soda</i> | No | Yes | 1 |
| Levee Communities | | | | general type | | | |
| 27 | | Ice plant mats | High | <i>Carpobrotus chilensis</i> | No | | 0 |
| 28 | | | | <i>Mesembryanthemum nodiflorum</i> | Yes | Yes | 1 |
| 29 | | | | <i>Mesembryanthemum nodiflorum</i> /Tetragonia Te | No | Yes | 1 |
| 30 | | Fennel patches | High | <i>Foeniculum vulgare</i> | No | No | 0 |
| 31 | | Brassica nigra | High | <i>Brassica nigra</i> | Yes | Yes | 1 |
| 32 | | Bromus diandrus | High | <i>Bromus diandrus</i> | Yes | Yes | 1 |
| 33 | | Salt Grass flats | High | <i>Distichlis spicata</i> | Yes | | 0 |
| 34 | | Peripheral halophytes? | High | <i>Salicornia</i> /Frankenia/Sal Soda/MeNo | No | Yes | 1 |
| Upland Communities | | | | general type | | | |
| 35 | | Lolium multiflorum | High | <i>Lolium mul</i> | Yes | Yes | 1 |
| 36 | | | High | <i>Lomys/Disp</i> | Yes | Yes | 1 |
| 37 | | Baccharis pilularis | High | <i>Baccharis pilularis</i> | No | | 0 |
| Non-vegetative | | | | general type | | | |
| 38 | | mudflat | | unvegetated intertidal areas between veg and MLLW | Yes | no (visually identified on satellite image) | 0 |
| 39 | | wrack (includes dead veg) | | deposited materials | Yes | no (visually identified on satellite image) | 0 |
| 40 | | bare earth | | dirt/soil/salty soil | Yes | no (visually identified on satellite image) | 0 |
| Water | | | | | | | |
| 41 | | panne | | unvegetated intertidal areas w/in veg | Yes | Yes | 2 |
| 42 | | water (sloughs) | | intertidal waterway w/out riverine input | Yes | no (visually identified on satellite image) | 0 |
| 43 | | estuary | | intertidal riverine area (fresh water input) | No | no (visually identified on satellite image) | 0 |

* / =subdominant -- = co-dominant

** Data collected by Habitat Evolution Project (HEP) team members except where noted. HTH = Data collected by HT Harvey in 2008 for The City of San Jose. ISP = Data collected by Invasive Spartina Project 2009

HABITATS TO BE MAPPED

Examples of Key Vegetative Alliances



Pickleweed



Gumplant



Pepperweed
Invading Alkali
Bulrush



Alkali Heath



Cordgrass



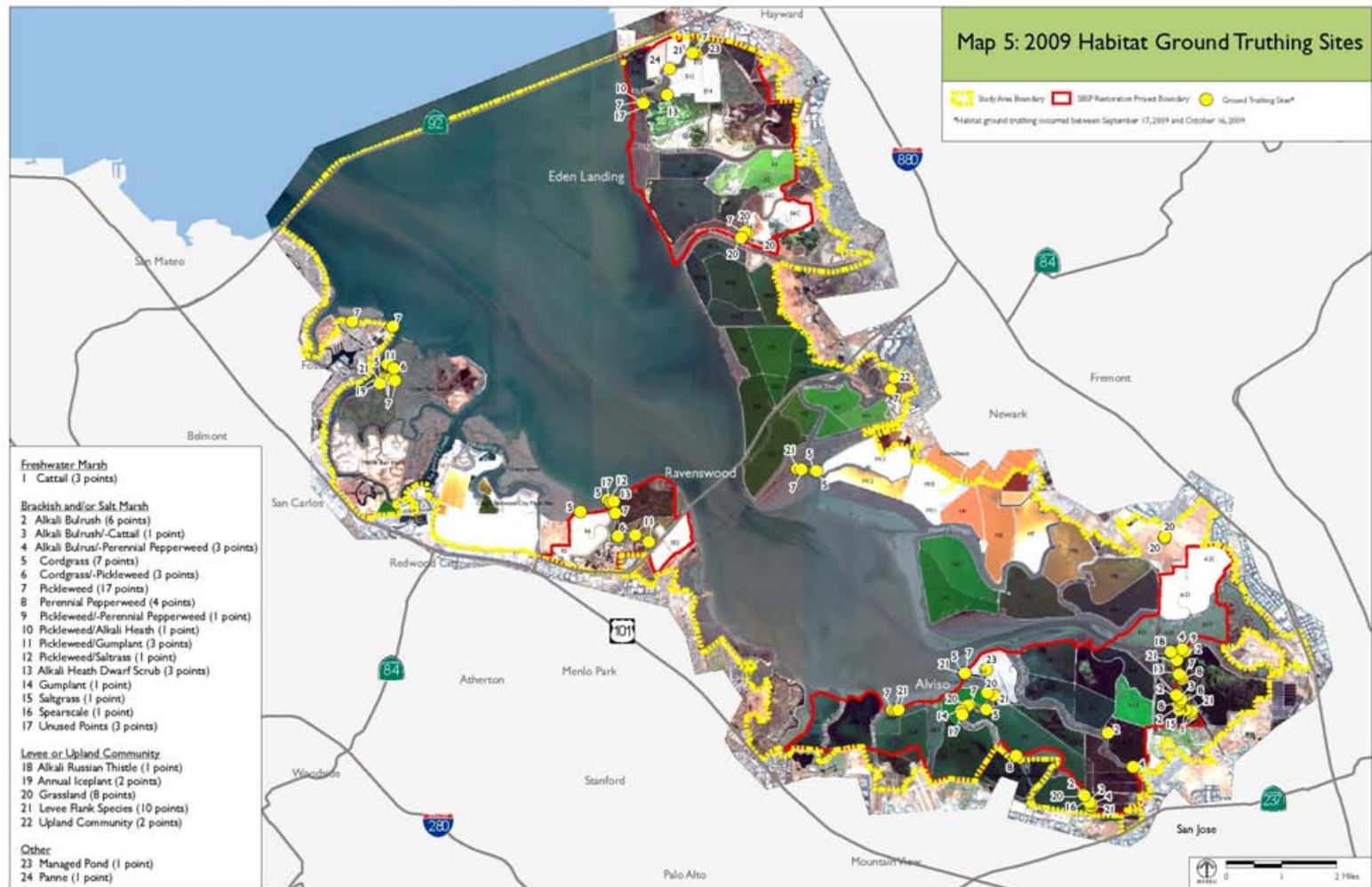
Annual
Pickleweed

HABITAT CLASSIFICATION - GPS BASED GROUND TRUTHING

- ♦ Characterize common and rare plant associations based on simple rules of dominance
- ♦ Digital surveys with Trimble Terrasync

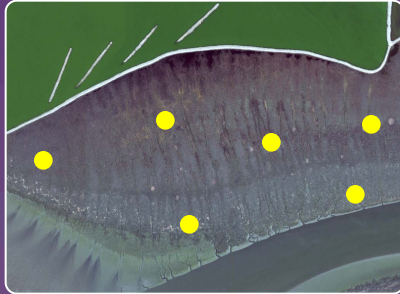
A screenshot of the TerraSync software interface. The main window displays a form for data collection. The form includes fields for 'Location/Environment', 'Polygon/Stand #', 'Date/Time' (set to 7/15/2010), 'Surveyor(s)' (set to David Thomson), 'Is GPS within Stand?', 'If No, Distance?', 'If No, Bearing?', 'All Features', 'Common Veg Features', 'Common Species', '% Cover', 'Pattern', 'Shape', 'Strata/Height Class', 'Phenology', and 'Common Species'. The 'Common Species' dropdown is open, showing a list of species: Sal virginica, Sal soda, Sal acutus, Sal californicus, Sal robust/maritim, and Sal spp. The right side of the interface shows a 'Skyplot' window with a circular plot and a scale bar. Below the Skyplot, there is a status bar indicating 'GPS is disconnected' and a 'Productivity Precision' scale.

YEAR 1 HABITAT GROUND TRUTHING

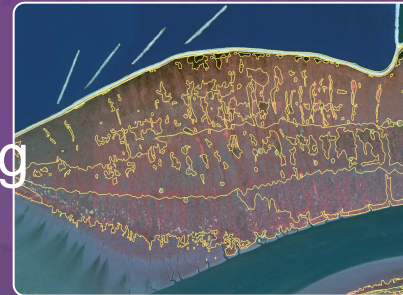


Map prepared by DCAE on May 28, 2010.

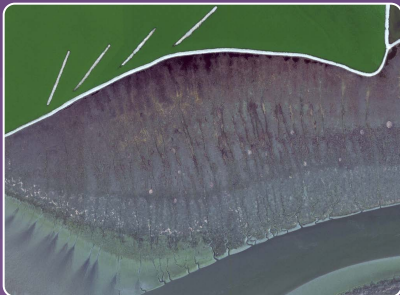
CALIBRATE WITH A RANGE OF DATASETS



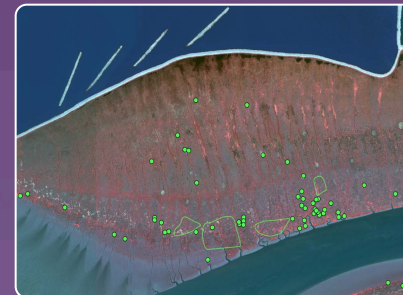
Habitat
Ground Truthing



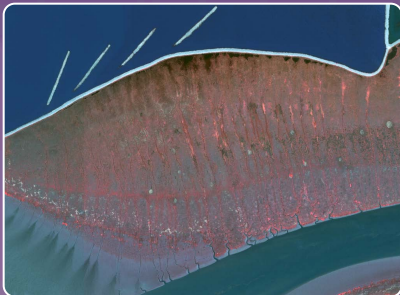
City of San Jose
'08



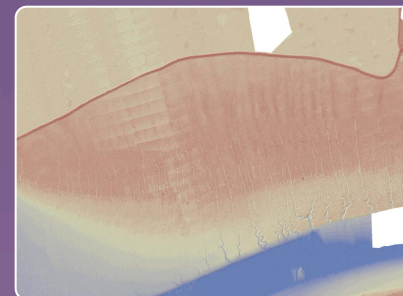
IKONOS True



Invasive Spartina
Project



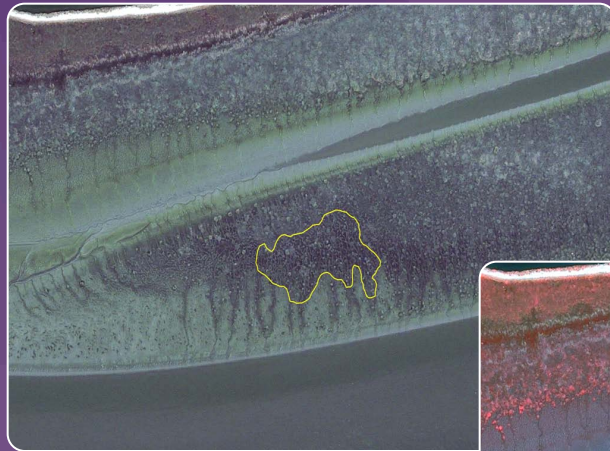
IKONOS False



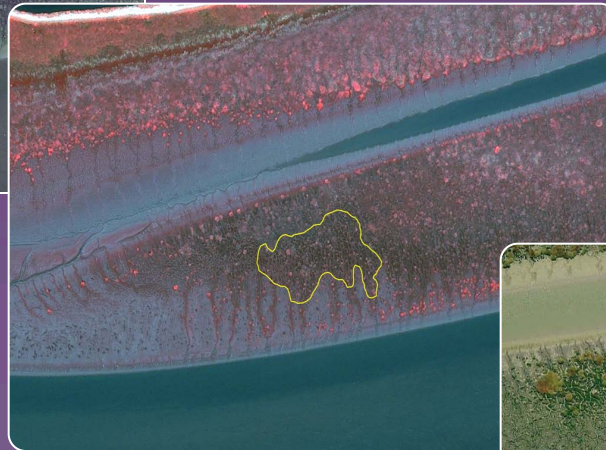
LIDAR (USGS)

HABITAT INTERPRETATION GUIDE OF MARSHES

EX: Pickleweed /-Cordgrass



◆ True color satellite image



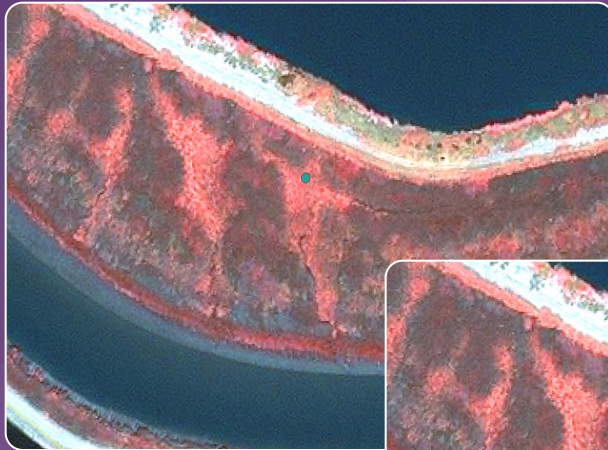
◆ False color satellite image

◆ As seen on Bing Maps

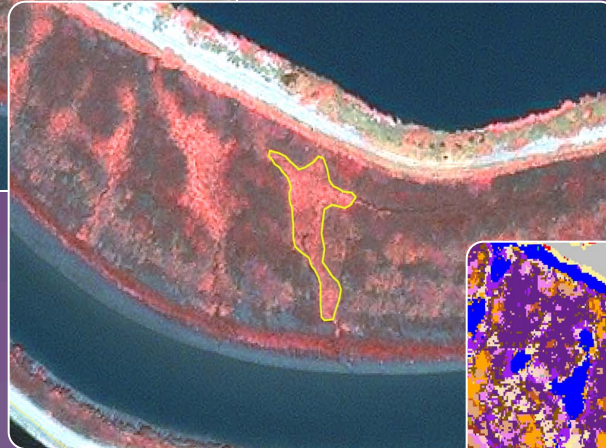


CREATE TRAINING SITES FOR CLASSIFICATION

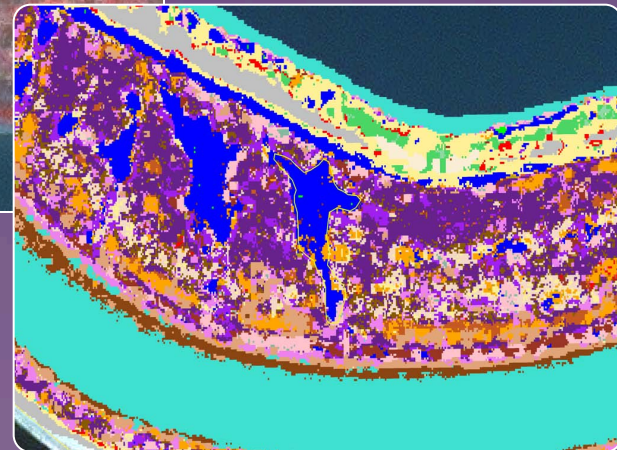
- ◆ Point taken in field with GPS



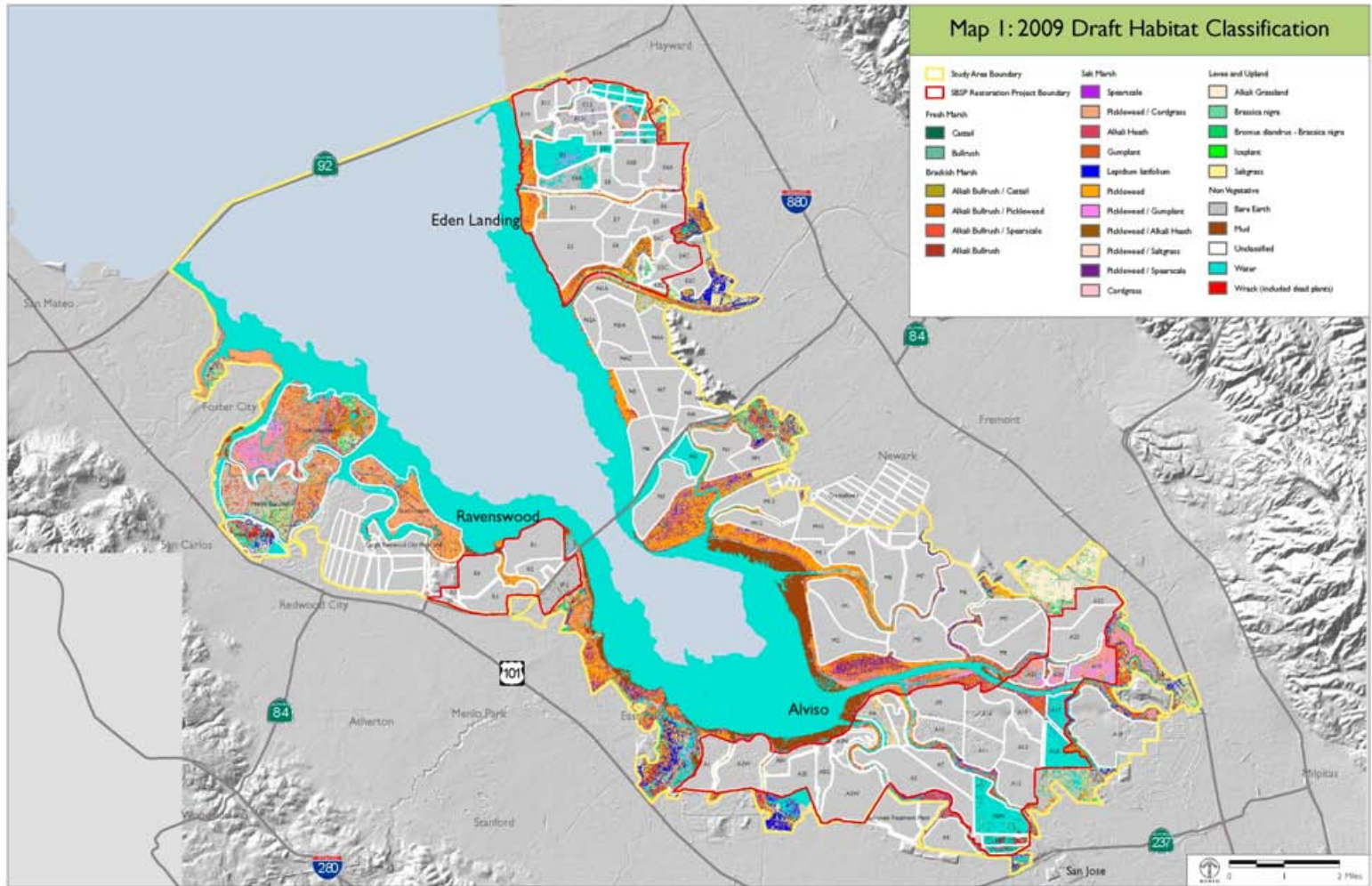
- ◆ Digitized at Computer to create training site



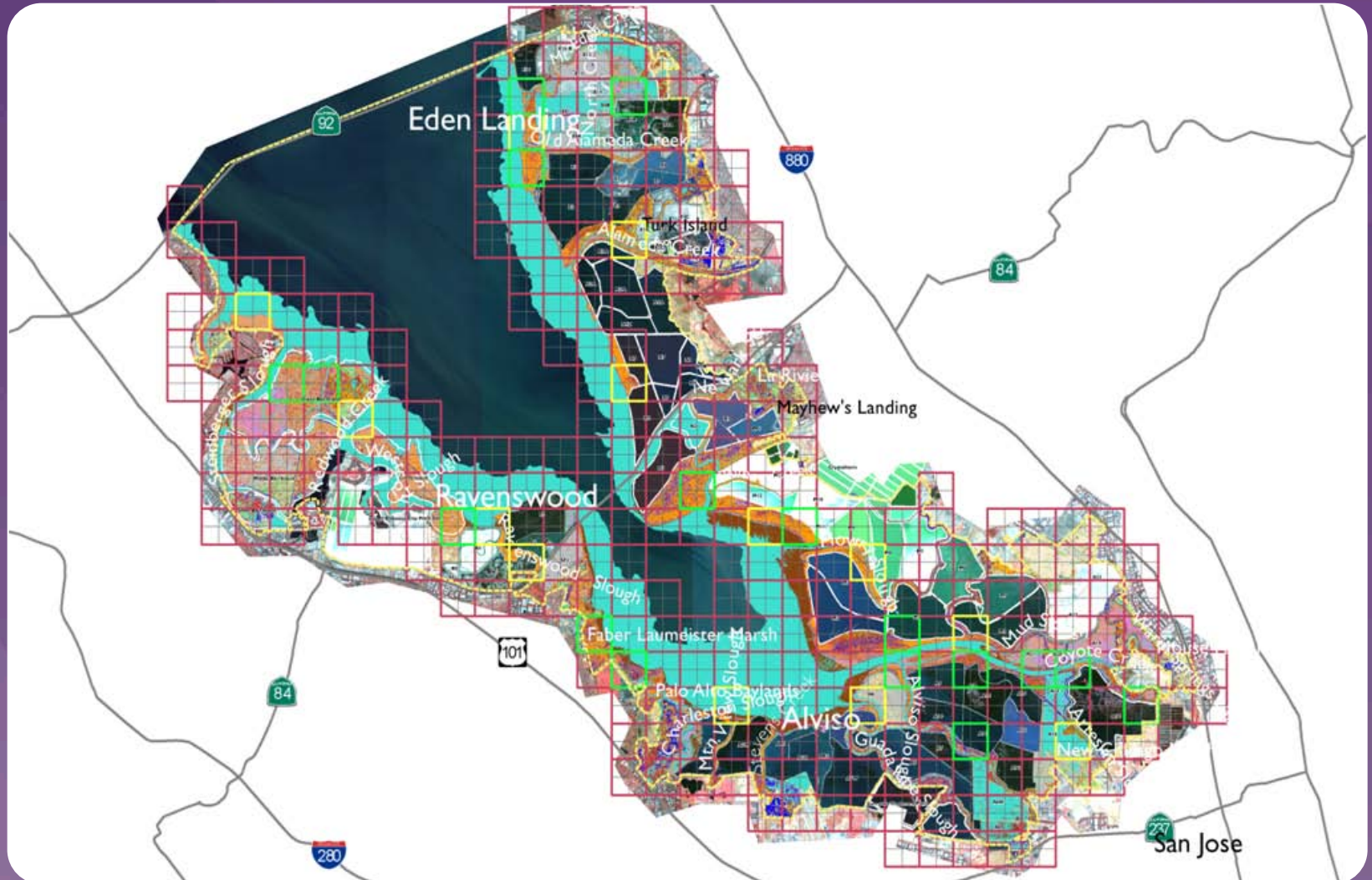
- ◆ Training sites used to identify habitat classification (ERDAS IMAGINE)



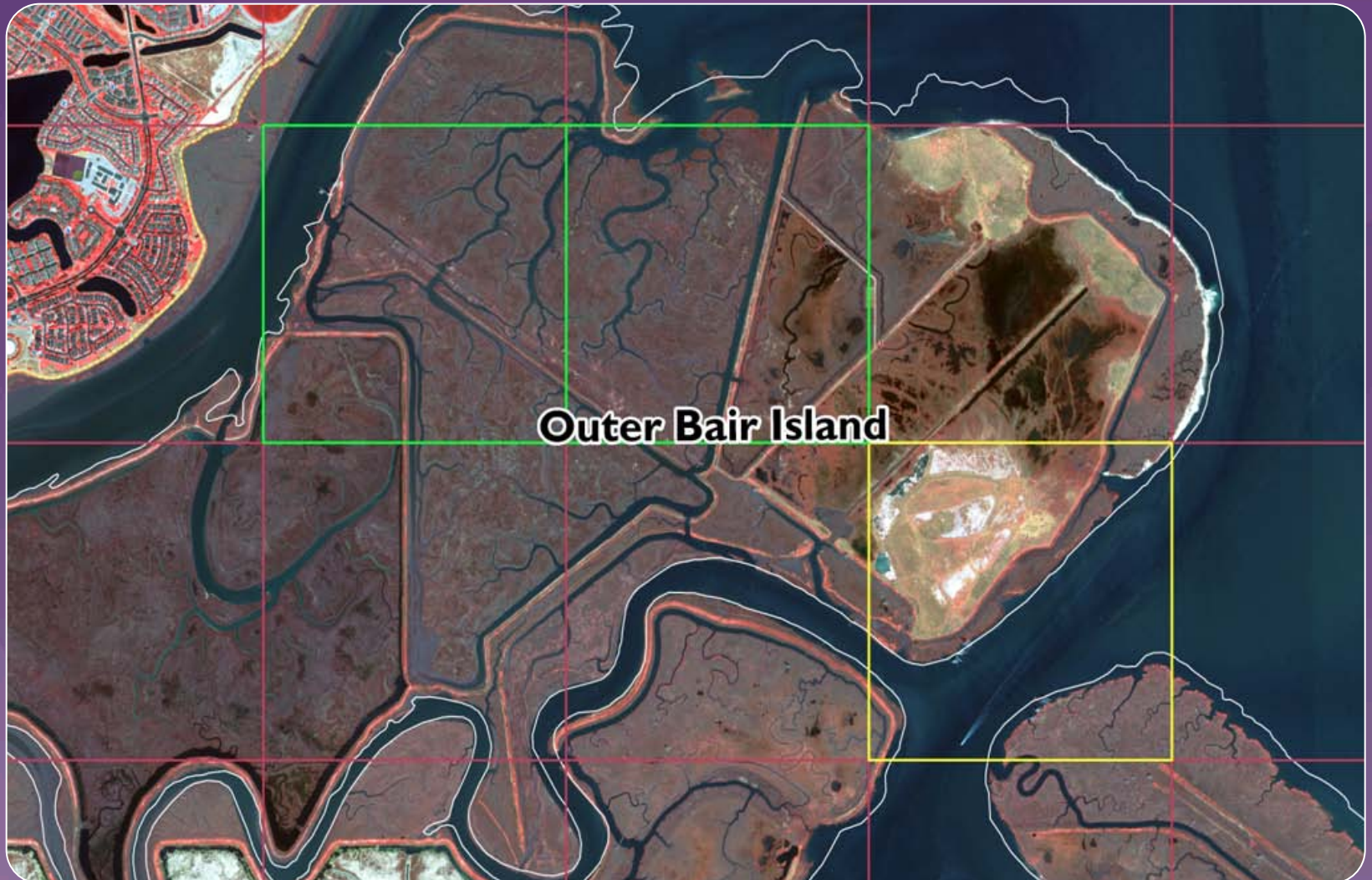
YEAR I DRAFT HABITAT CLASSIFICATION



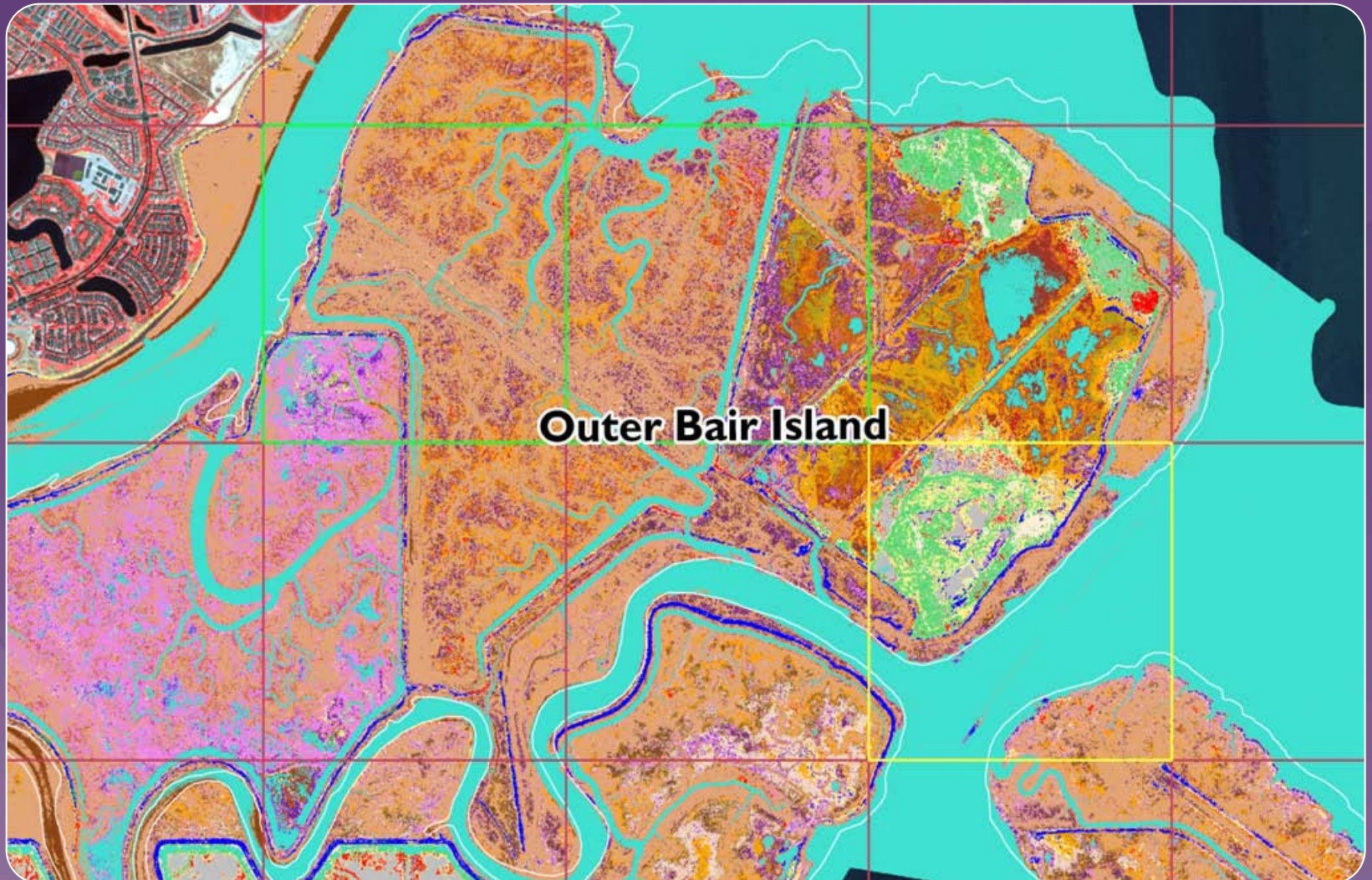
HABITAT CLASSIFICATION ASSIGNMENT REVIEW



HABITAT CLASSIFICATION ASSIGNMENT REVIEW



HABITAT CLASSIFICATION ASSIGNMENT REVIEW



MISASSIGNMENT—ALGAE/BIOFILM INFLUENCE

Recently Breached Pond A21

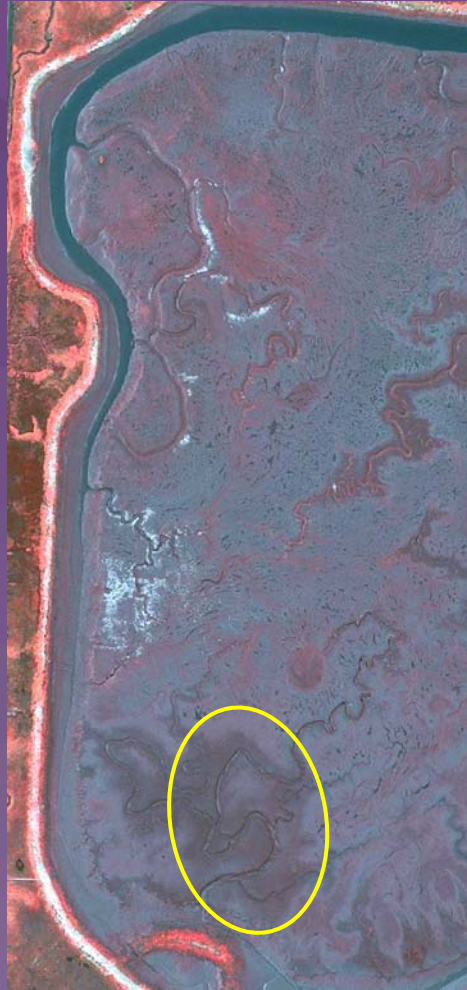
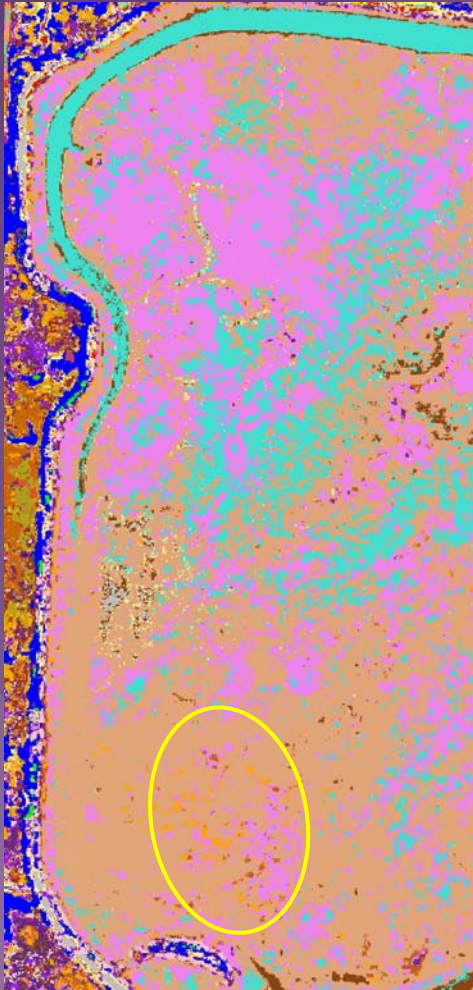
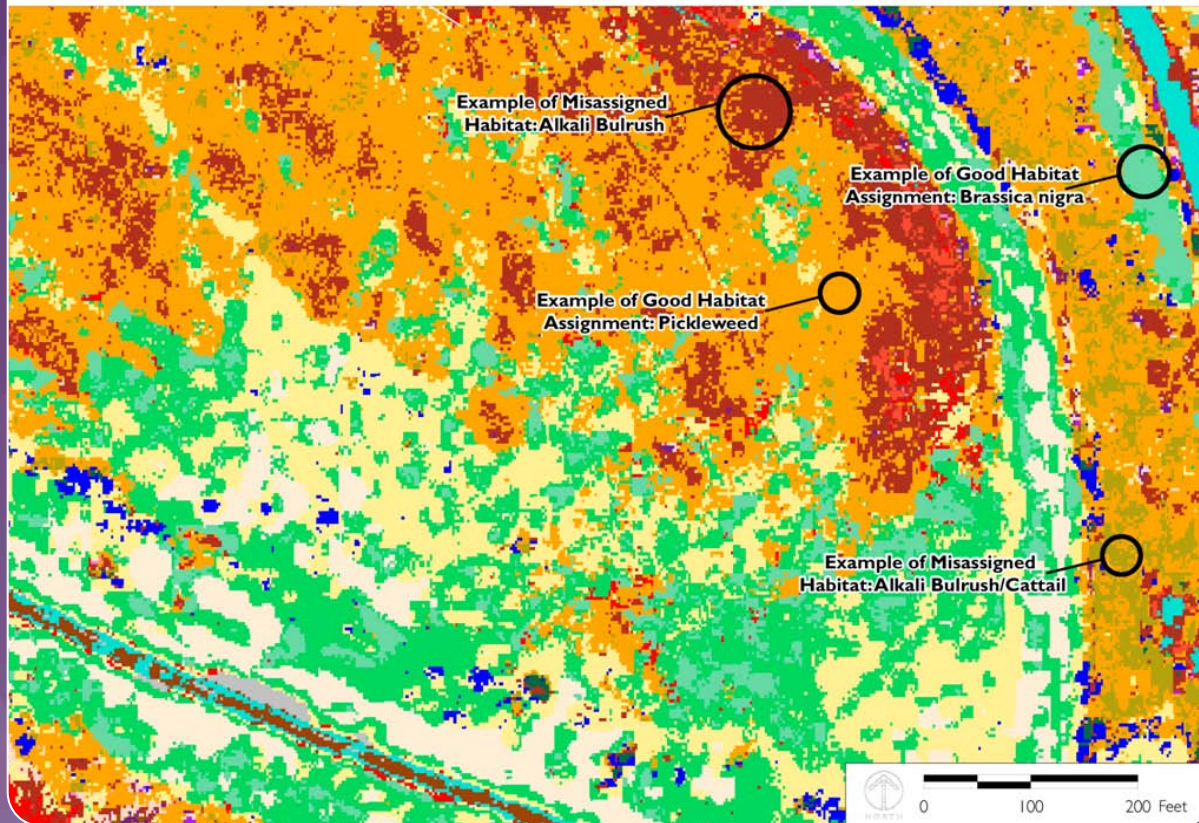


Photo Credit: KAP cris' (www.flickr.com/photos/kap_cris)

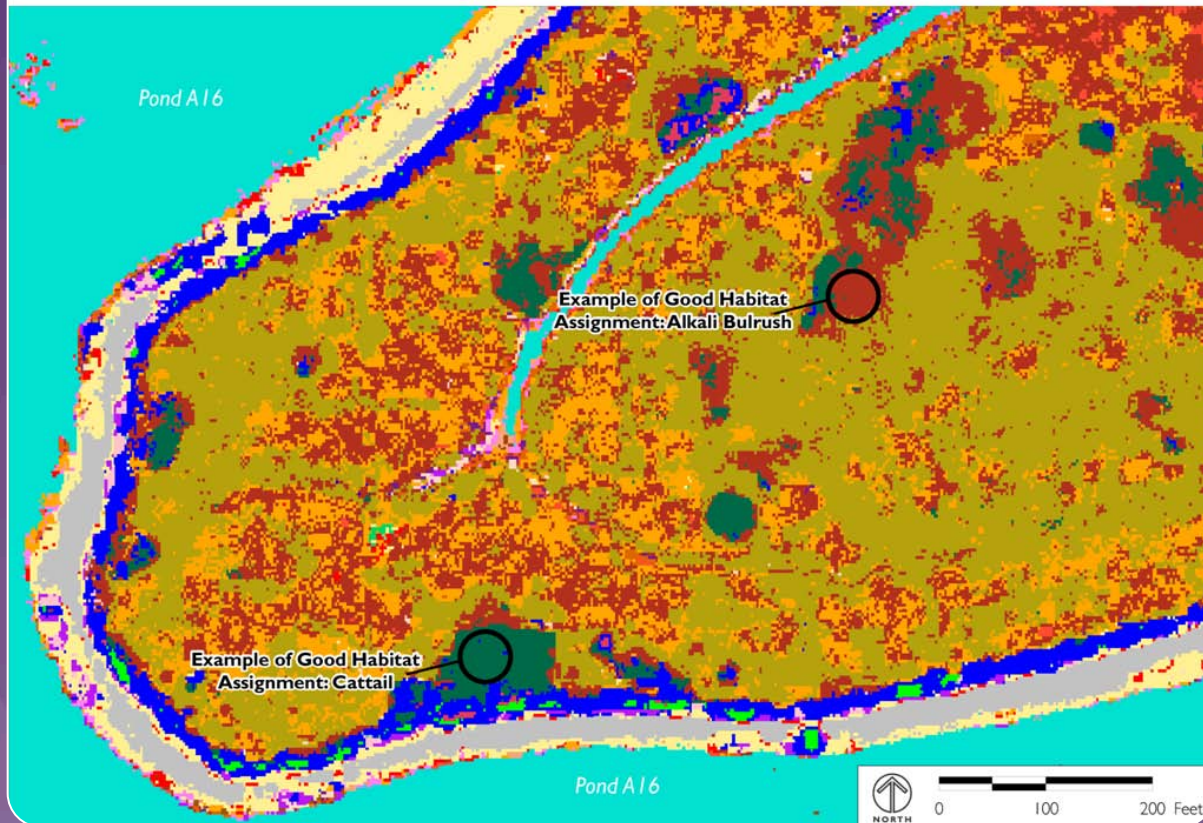
HABITAT CLASSIFICATION EXAMPLES

#1 - Eden Landing: Grassland and Pickleweed Habitats



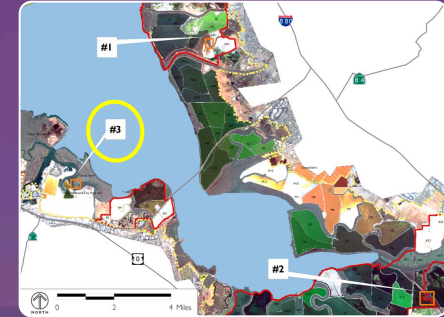
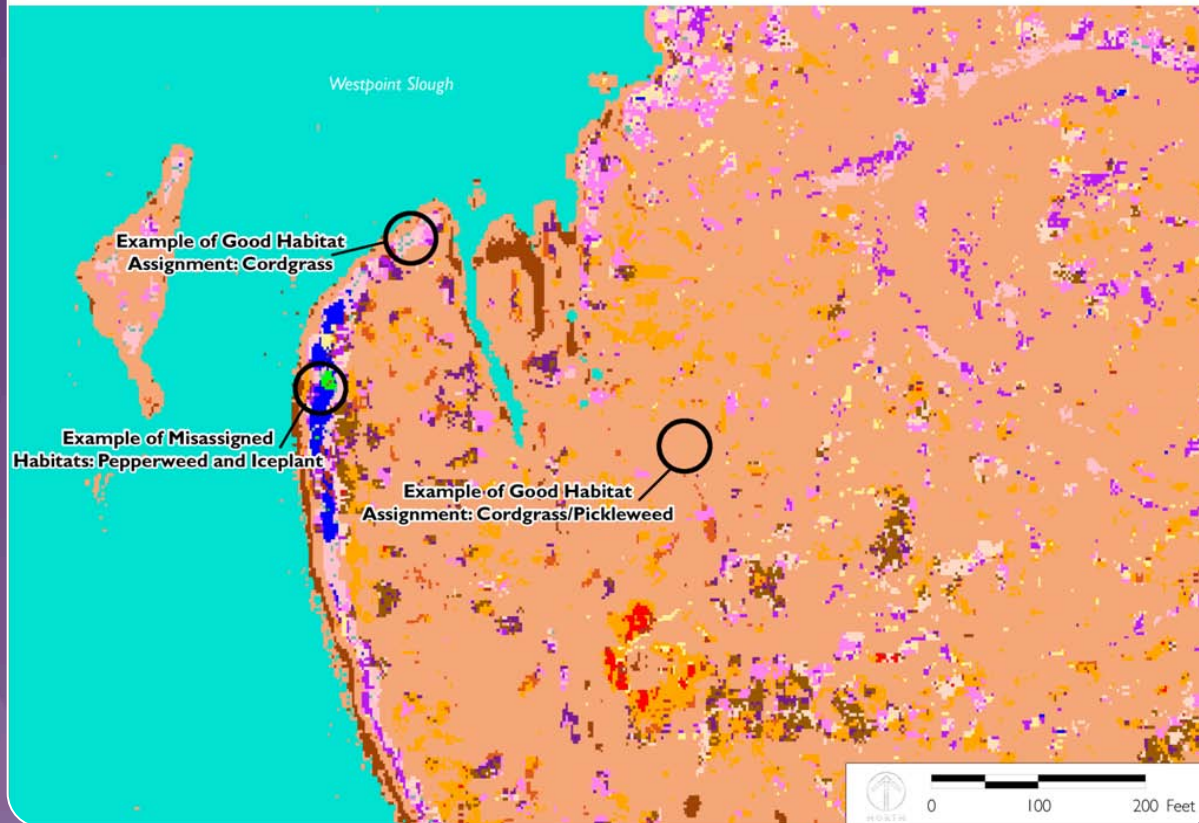
HABITAT CLASSIFICATION EXAMPLES

#2 - Alviso: Bulrush, Cattail, and Cordgrass Habitats

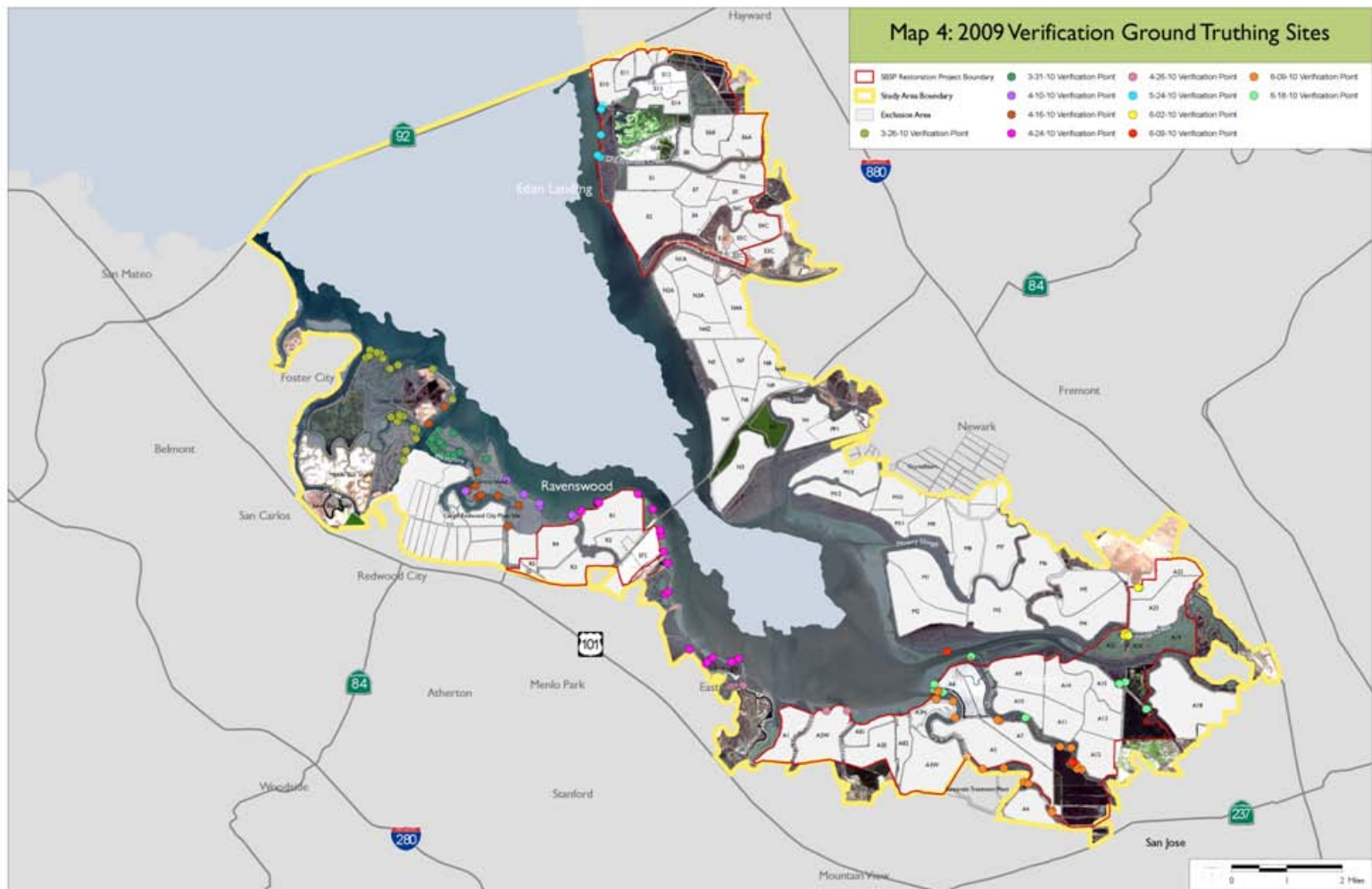


HABITAT CLASSIFICATION EXAMPLES

#3 - Greco Island: Pickleweed/Cordgrass Habitat



YEAR I VERIFICATION GROUND TRUTHING



VERIFICATION IN THE FIELD



INVASIVE PEPPERWEED EXAMPLE – GOOD ASSIGNMENT

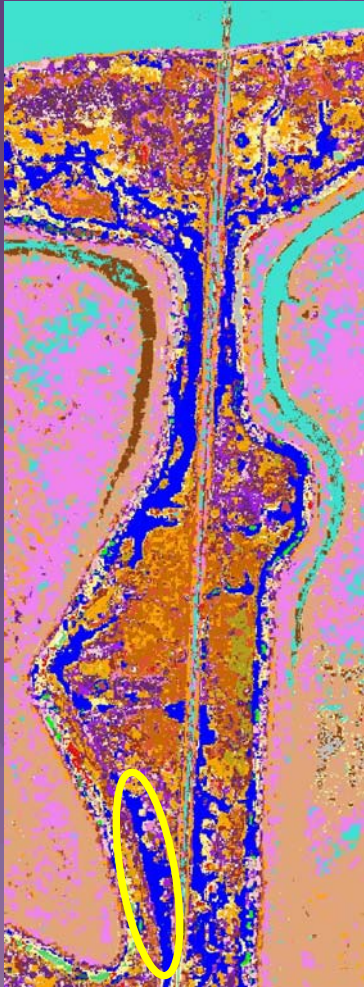


Photo Credit: KAP cris' (www.flickr.com/photos/kap_cris/)

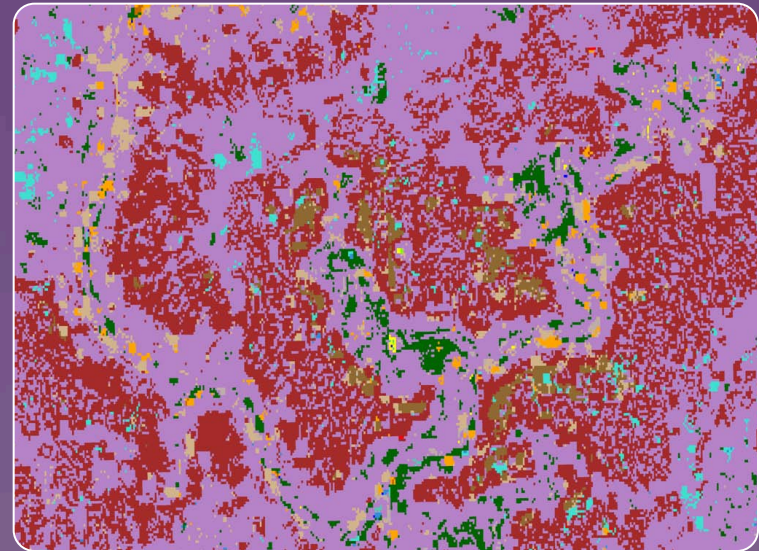
YEAR ONE - GOOD VEGETATION ASSIGNMENTS

- ♦ Island Ponds – Pickleweed and Spartina new growth.

2009 – False Aerial



Vegetation Assignment



NATIVE PERENNIAL PICKLEWEED – GOOD ASSIGNMENT

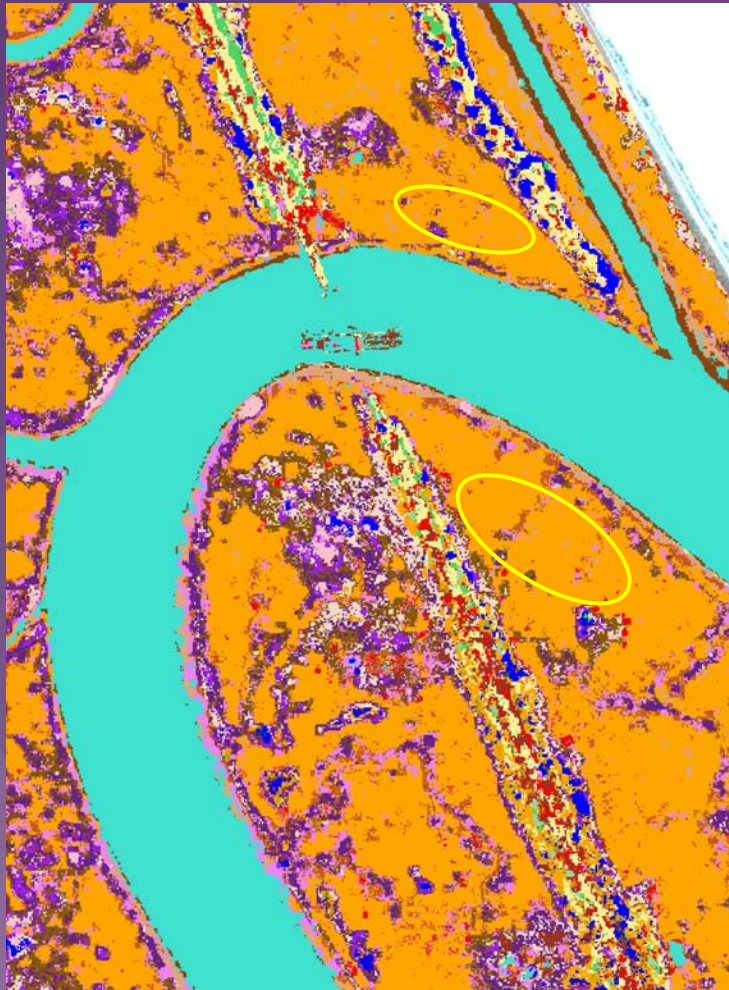
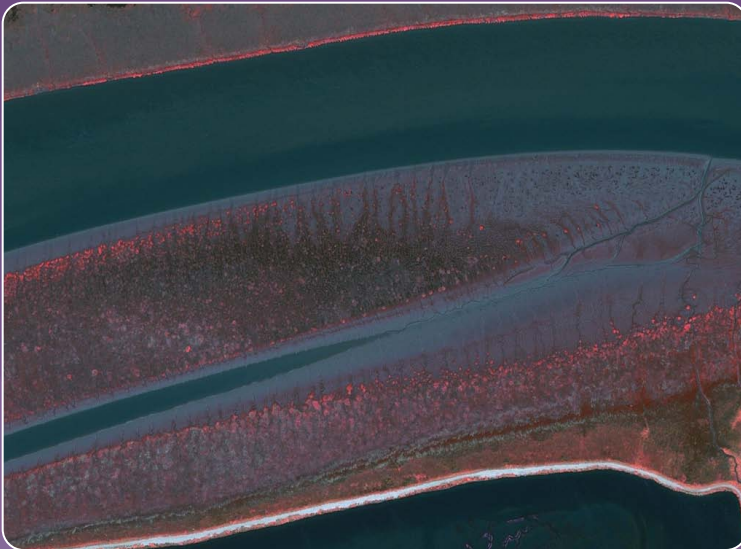


Photo Credit: KAP cris' (www.flickr.com/photos/kap_cris/)

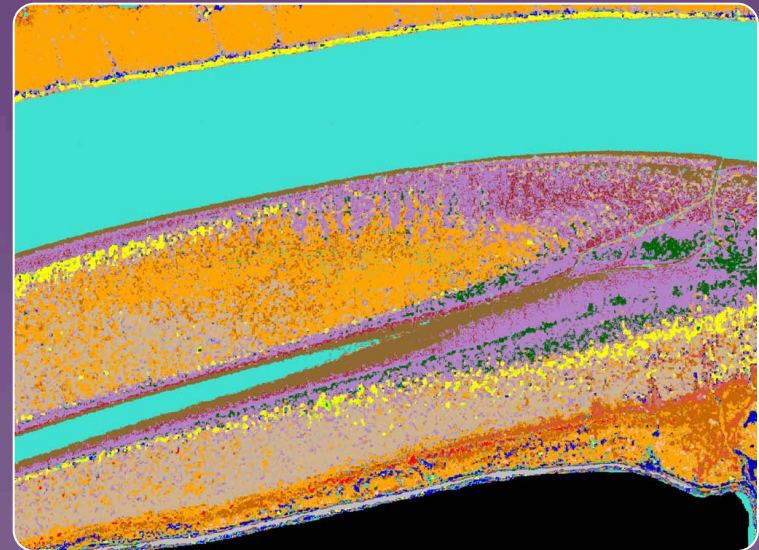
YEAR ONE - GOOD VEGETATION ASSIGNMENT

- ◆ Coyote Creek

2009 – False Aerial



Vegetation Assignment



INVASIVE PEPPERWEED EXAMPLE – GOOD ASSIGNMENT

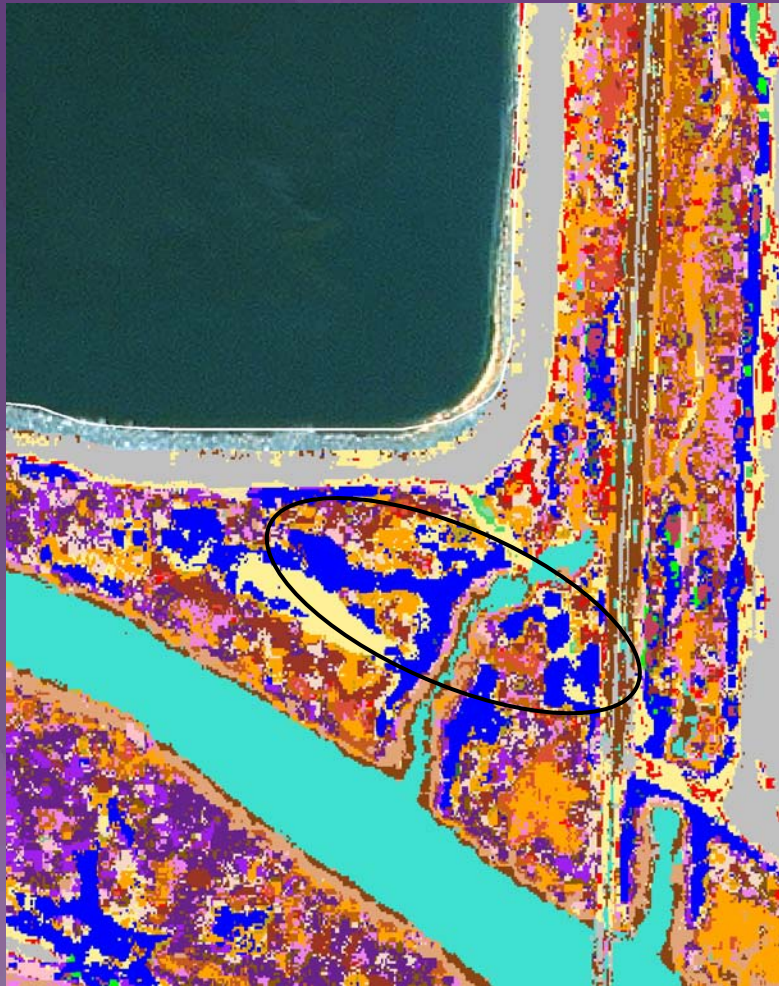
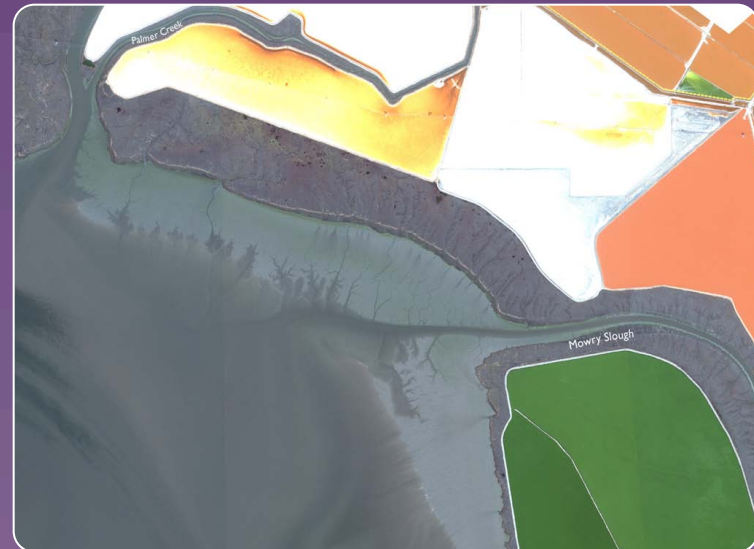
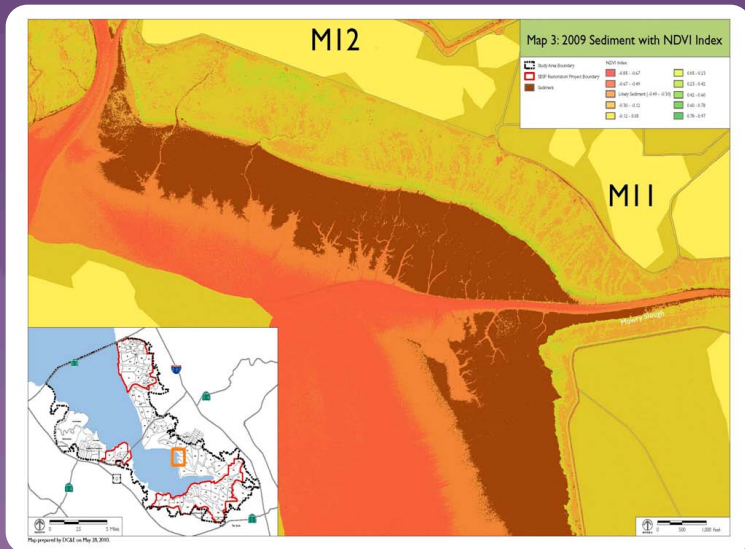


Photo Credit: KAP cris' (www.flickr.com/photos/kap_cris/)

SEDIMENT MAPPING ISSUES WITH SATELLITE IMAGE

- ♦ Optimal Satellite Acquisition at low tide (MLLW)
- ♦ Low tide NDVI index image captures mud instead of water with suspended solids



HABITAT AND METHOD ISSUES

1. Complex Levee Communities
2. Minimum Mapping Unit
3. ^(MMU)Spectral Mixing



New Zealand
Spinach



Slender-
leaf
Iceplant



Mustard
and Radish



Saltwort

YEAR TWO PROGRESS UPDATE

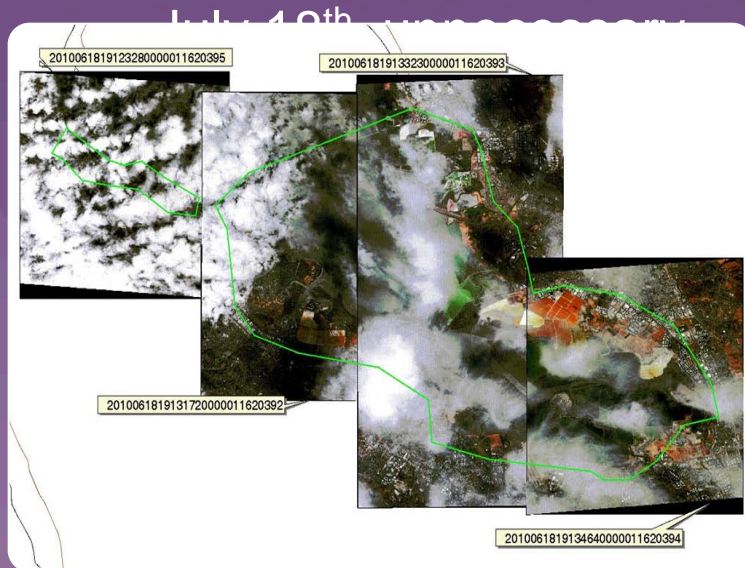
- ◆ Data Acquisition
 - IKONOS imagery year 2
 - New vegetative growth in breached ponds
- ◆ Refining habitat training sites
- ◆ Refining habitat classification
- ◆ Supplemental Rapid Assessments



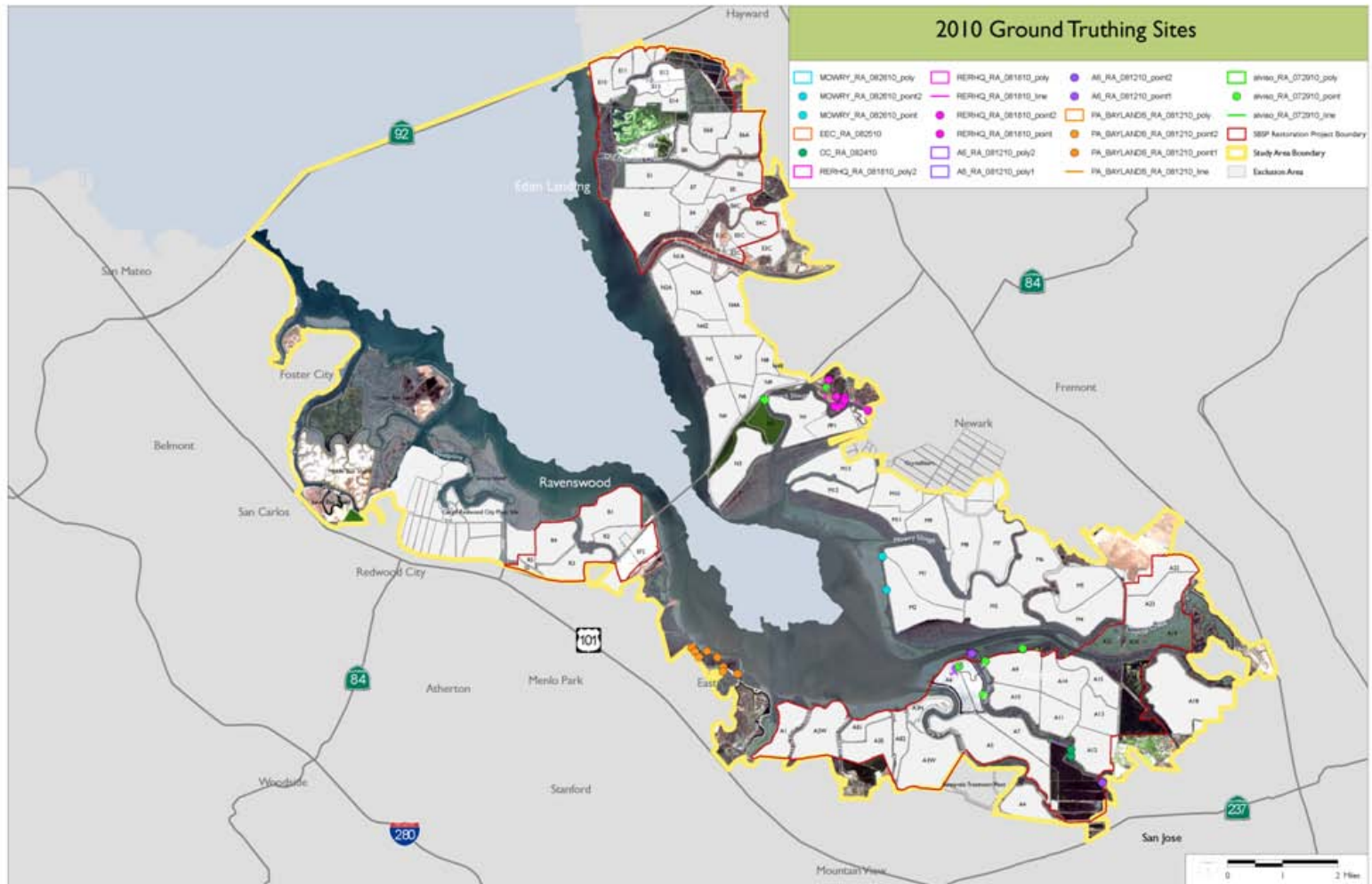
Island Ponds Establishing New Vegetation Post Levee Breach
Photo Credit: KAP cris' (www.flickr.com/photos/kap_cris/)

SATELLITE AQUISITION ISSUES FOR YEAR 2

- ◆ Only 3 attempts at low tide (MLLW) with noon lighting
 - June 18th, optimal tide (Failed—too much cloud cover—EX below)
 - July 4th, good tide (Success—see EX below)



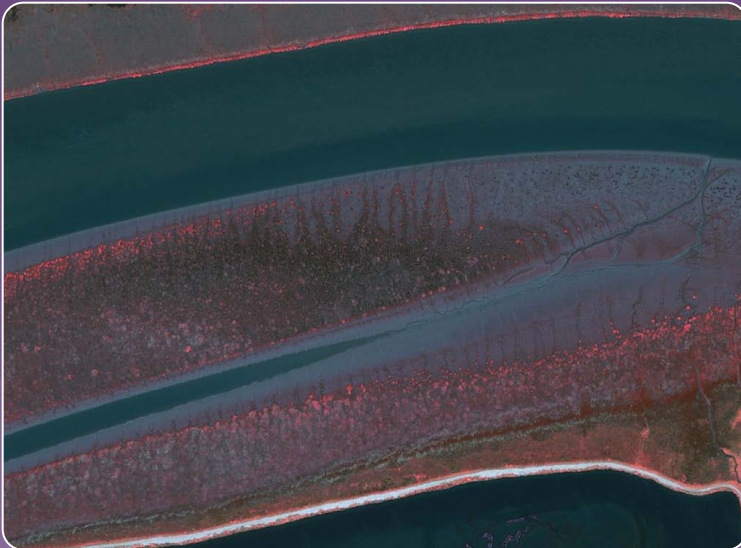
YEAR 2 HABITAT GROUND TRUTHING



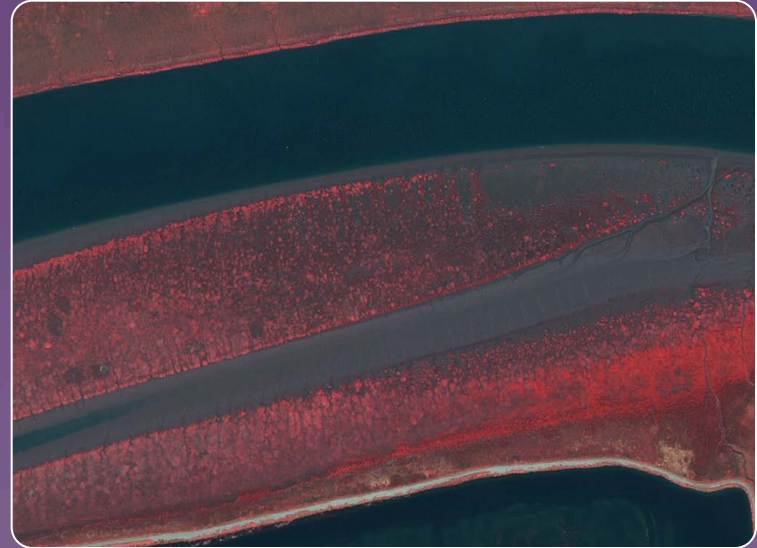
YEAR TWO - VEGETATION GROWTH FROM 2009-2010

◆ Coyote Creek

2009



2010



YEAR TWO - VEGETATION GROWTH FROM 2009-2010

◆ Island Ponds

2009



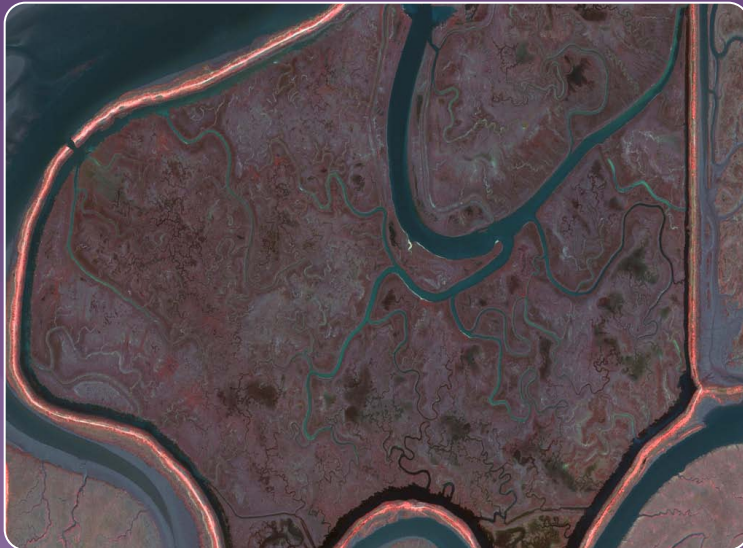
2010



YEAR TWO - VEGETATION GROWTH FROM 2009-2010

◆ Bair Island

2009



2010



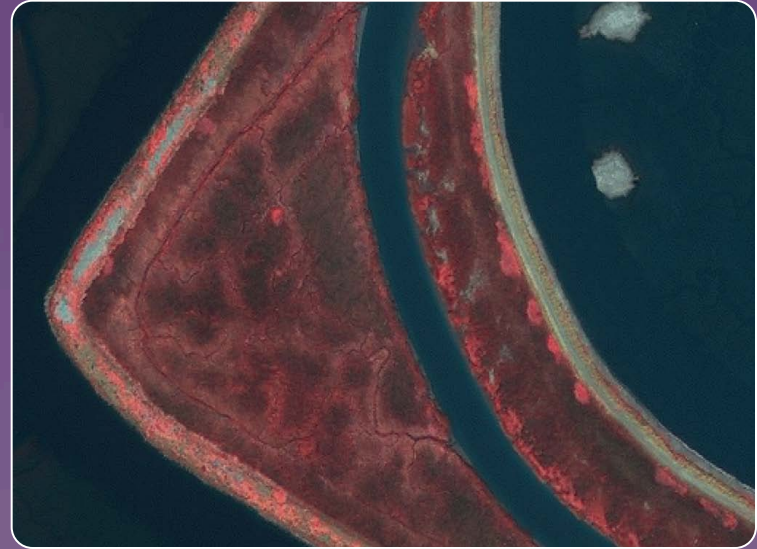
YEAR TWO - VEGETATION GROWTH FROM 2009-2010

♦ Alviso Slough

2009



2010



2010 – Phase One breaches and adaptive management

- ◆ SF2

2009



2010



ACKNOWLEDGEMENTS

- ◆ **Funding provided by:**

**California State Coastal Conservancy
and the US EPA, San Francisco Bay
Water Quality Improvement Fund in
partnership with the San Francisco
Estuary Partnership (SFEP)
/Association of Bay Area
Governments (ABAG)**

SOUTH BAY SALT POND RESTORATION PROJECT



Questions?

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