# Adaptive Management in Action: The South San Francisco Bay Salt Pond Restoration Project.


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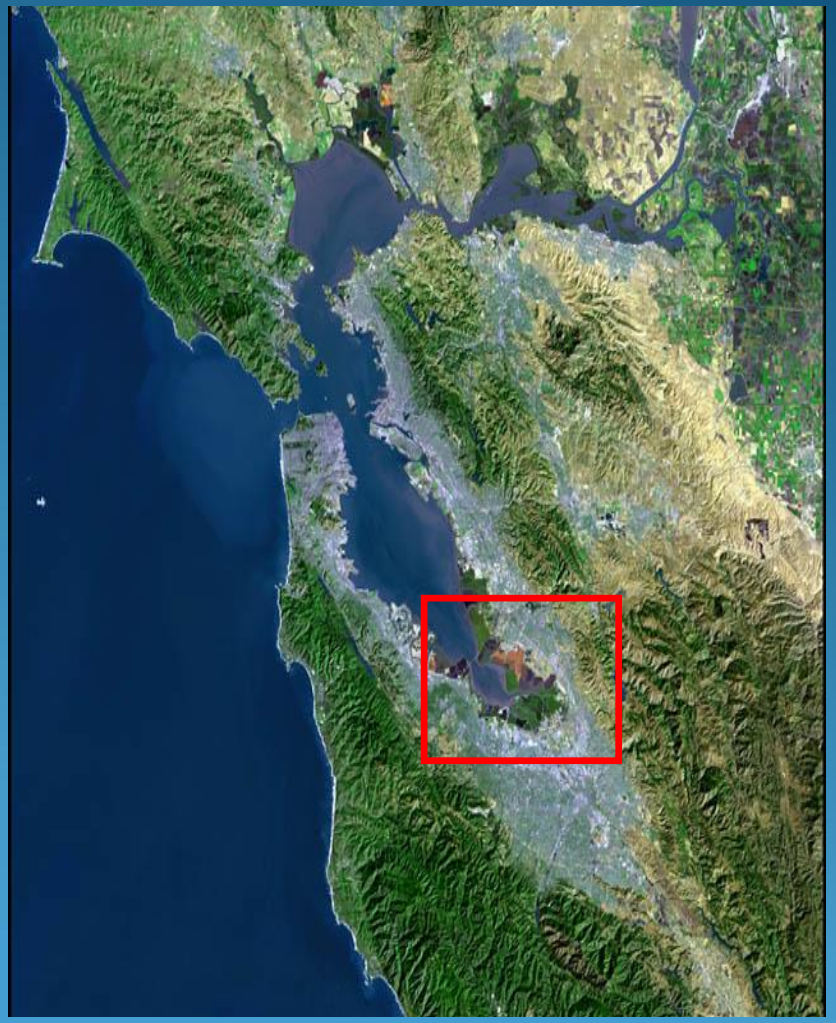
*Lead Scientist , South SF Bay Salt Pond Restoration Project*

USGS science for a changing world

# San Francisco Bay

- Restoring the wildlife habitat
- Recreation access for 4+ million people
- Flood Protection for Silicon Valley



SFEI AQUATIC SCIENCE CENTER
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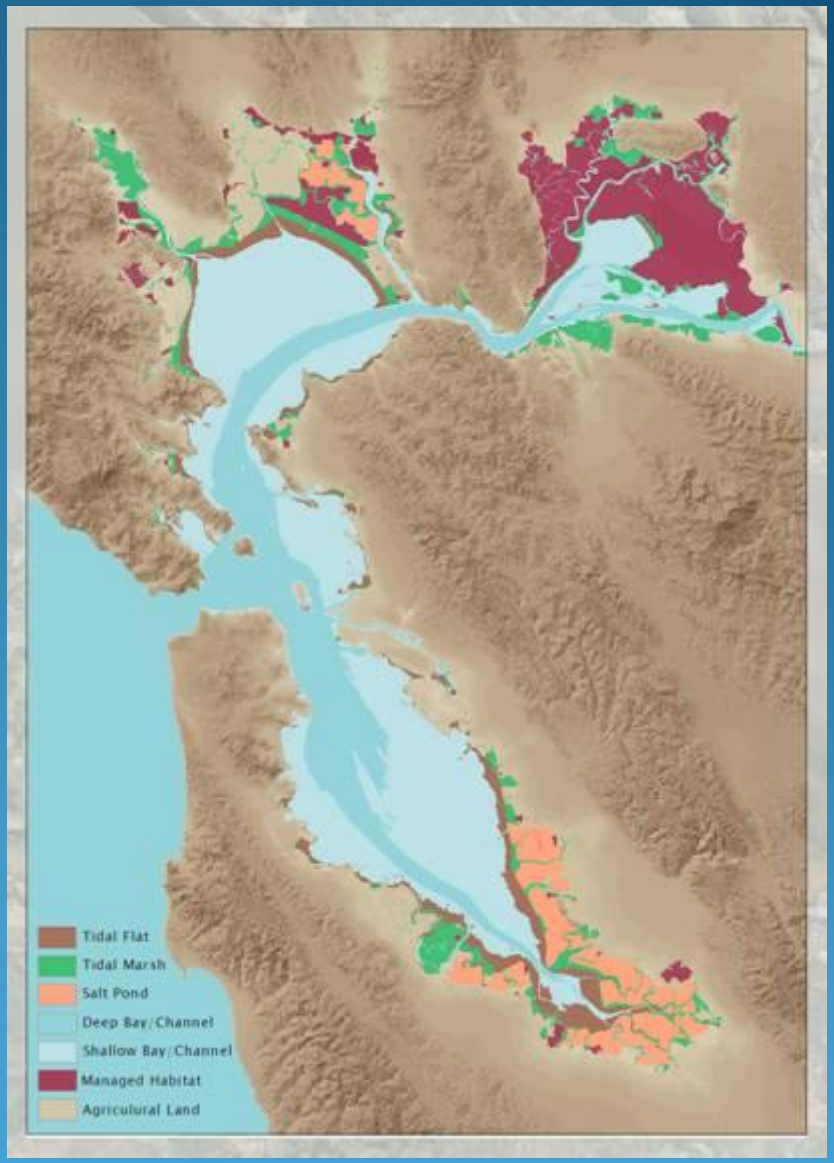
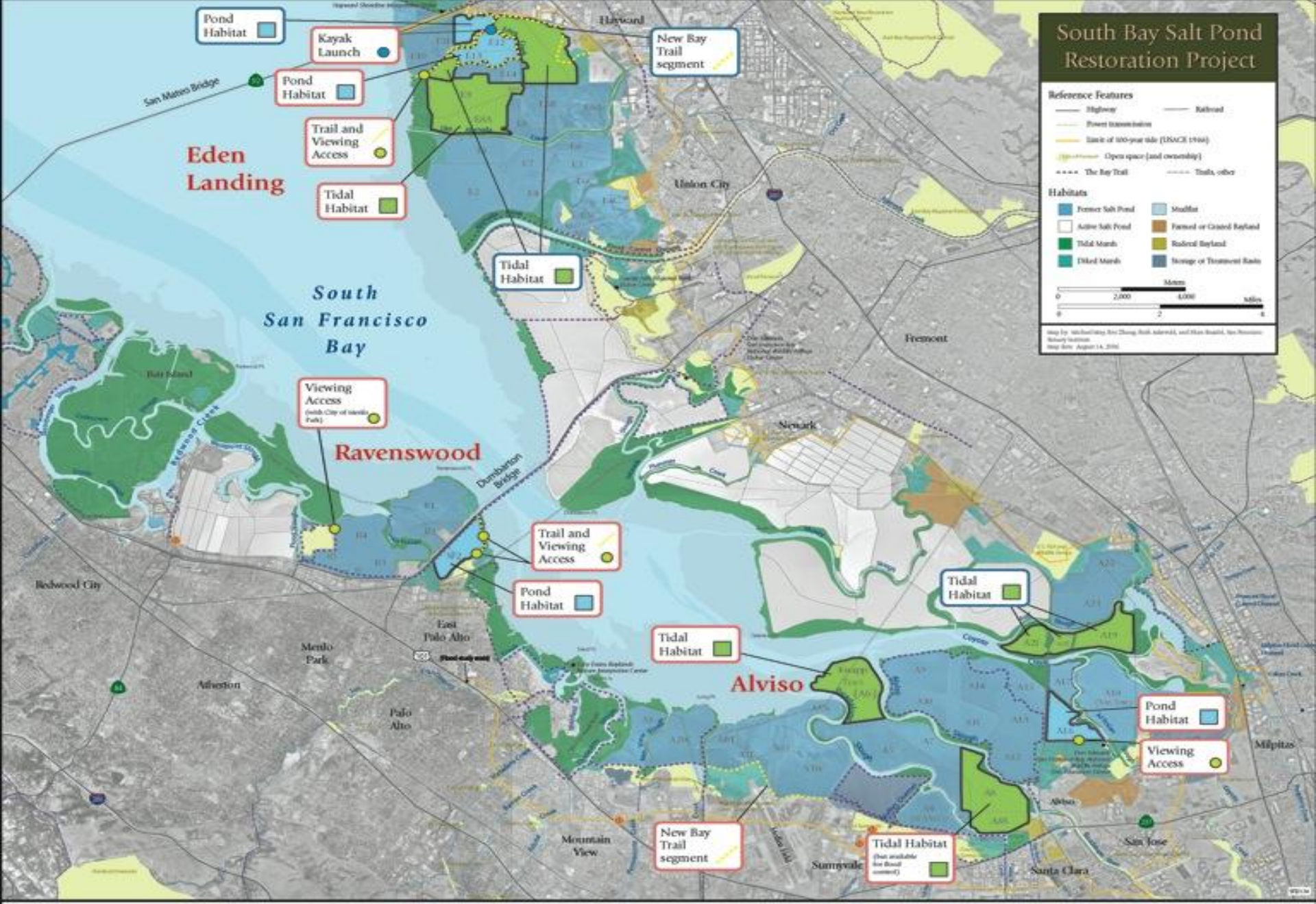
Past (~1850)

Present (~2000)






# Initial Restoration Actions

South Bay Salt Pond Restoration Project

2006 - 07

proposed 2008

# Acquisition in 2003: A Public/Private Partnership


- 16,500 total acres
  - 15,100 in South Bay
  - 1,400 along Napa River
- $100 million cost
  - $72M from State of California
  - $8M from United States Government
  - $20M from Packard, Goldman, Hewlett, and Moore Foundations





US Army Corps of Engineers®





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The Bay Institute

SANTA CLARA BASIN






# Why restore tidal marsh?

- 90% of historic SFB tidal marshes have been lost to development
- Many tidal marsh species are now threatened or endangered
- Conversion of salt ponds to marsh is critical for the recovery of these species

**Some Tidal Marsh Species:**

***Ridgway's Rail***

***Salt Marsh Harvest Mouse***

***Song Sparrows***

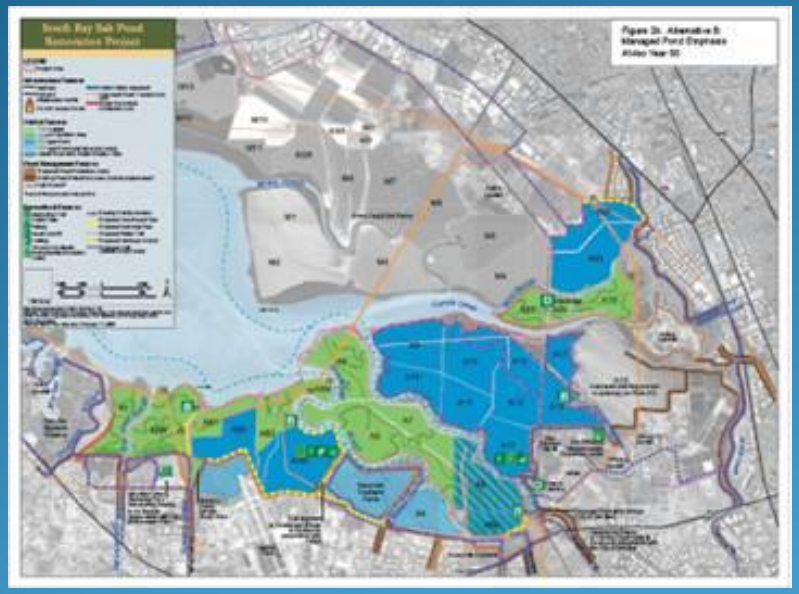
***California Black Rail***

# Why manage ponds?

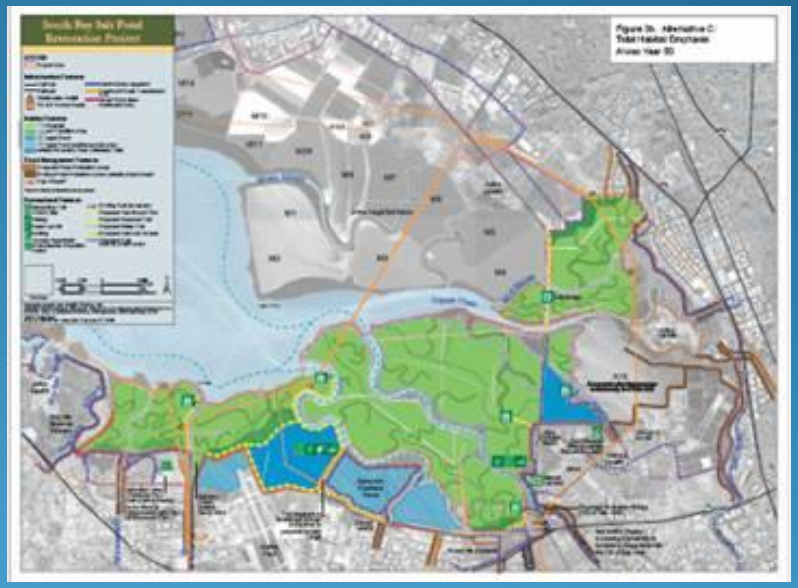
- Key habitats for dense migratory bird populations in migration and winter
- Pacific Flyway Migration and Wintering Area for water birds
- Western Hemispheric Shorebird Reserve Network
- These species don't use mature vegetated tidal marsh

# South Bay Salt Pond Restoration

## Proposed Alternatives

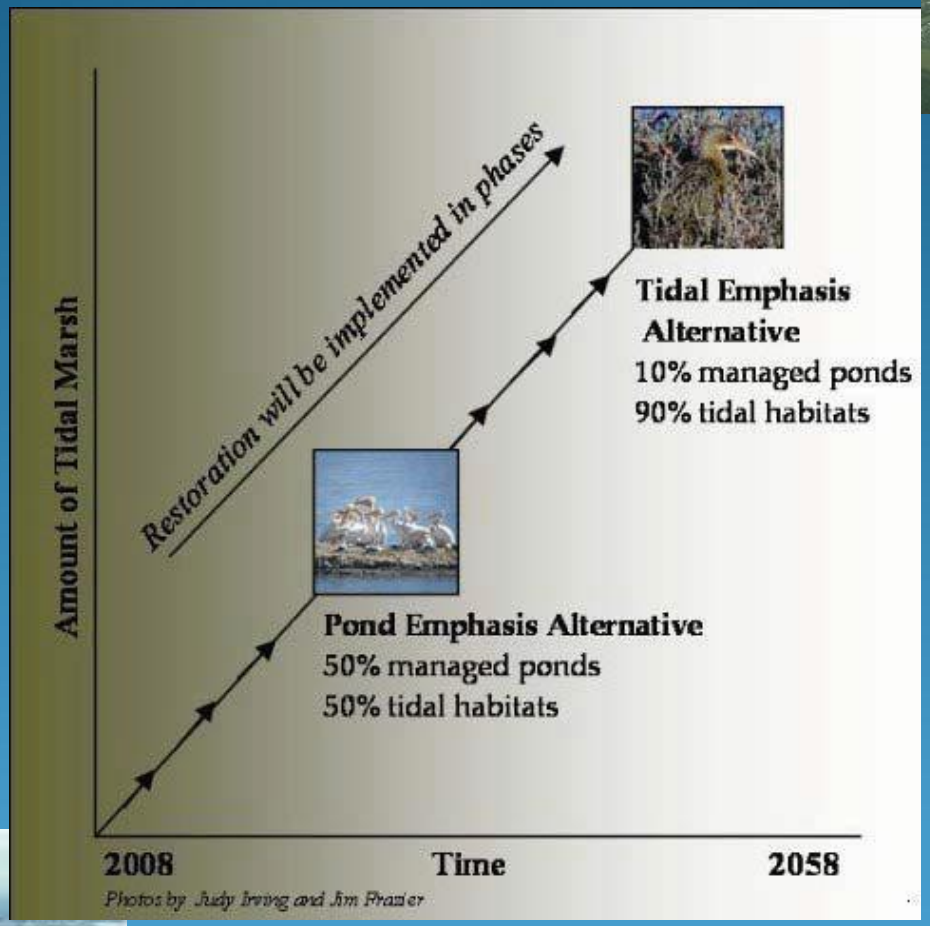


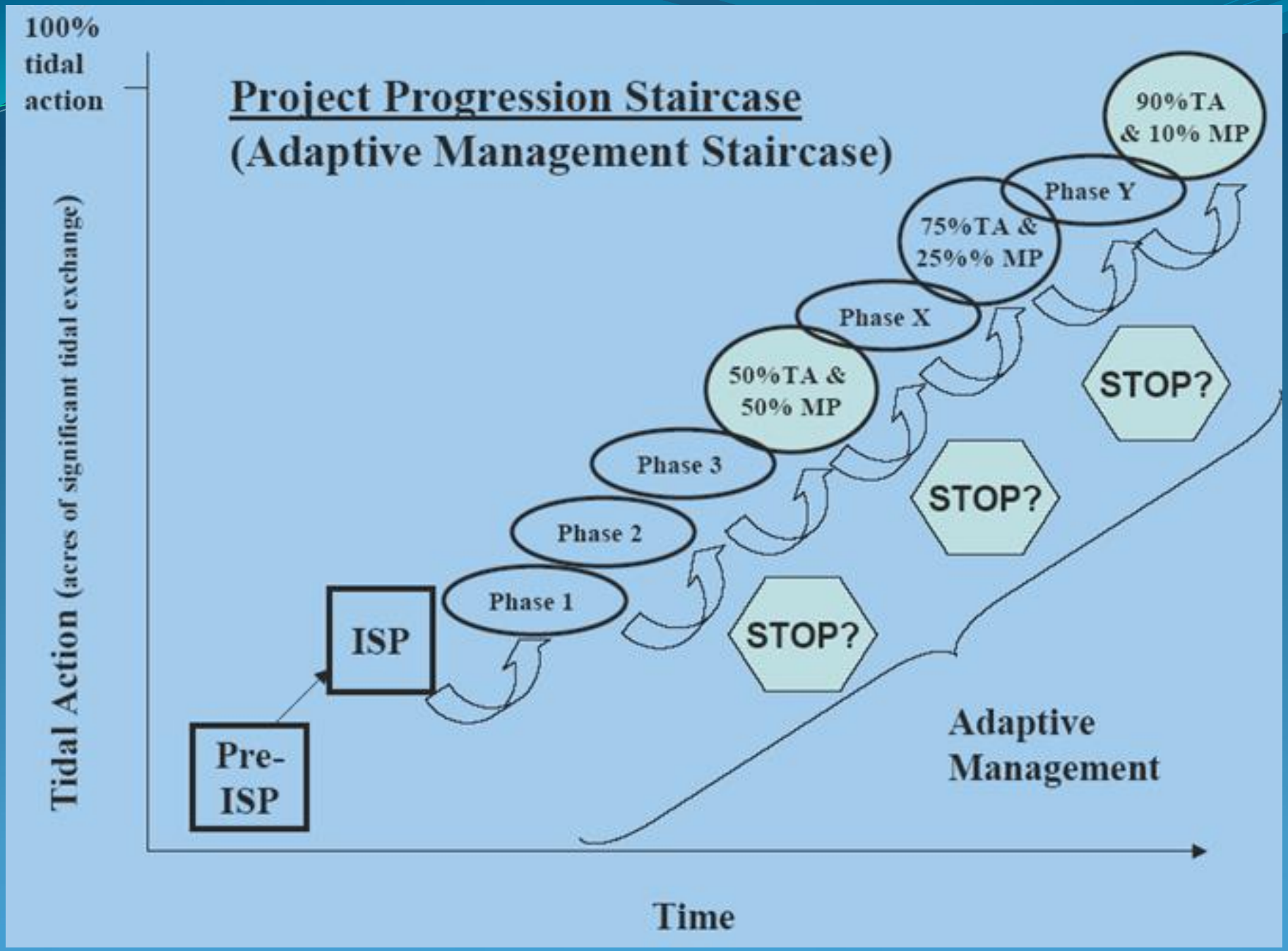
Managed Pond Emphasis



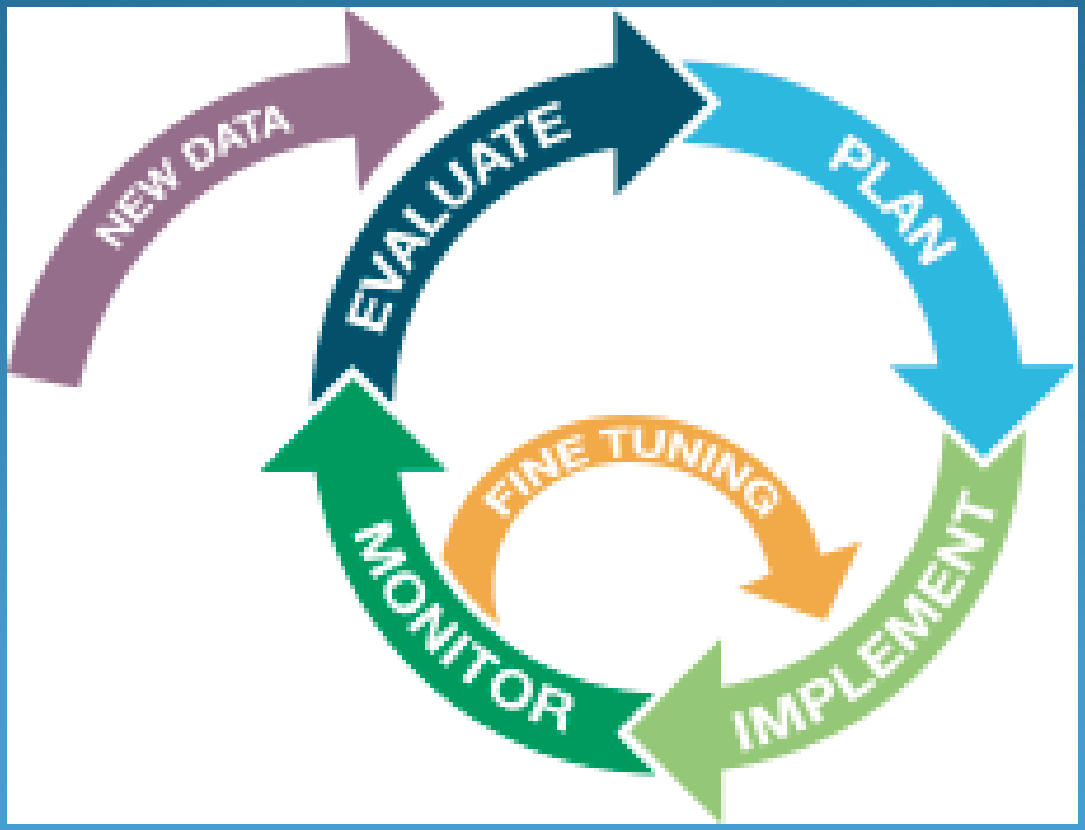
Tidal Marsh Emphasis

# Managed Pond versus Salt Marsh





100% tidal action
Project Progression Staircase
(Adaptive Management Staircase)
90%TA & 10% MP
Phase Y
75%TA & 25%% MP
Phase X
50%TA & 50% MP
Phase 3
Phase 2
Phase 1
ISP
Pre-ISP
STOP?
STOP?
STOP?
Adaptive Management
Tidal Action (acres of significant tidal exchange)
Time

# What is an Adaptive Management



*Beginning of a large restoration experiment…*

- Adaptive management will only be possible with targeted science support to track changes
- Strong science and applied research will be critical for success of the restoration
- Science support provided by USGS, academic, non-profit and consultants

# Key Uncertainties

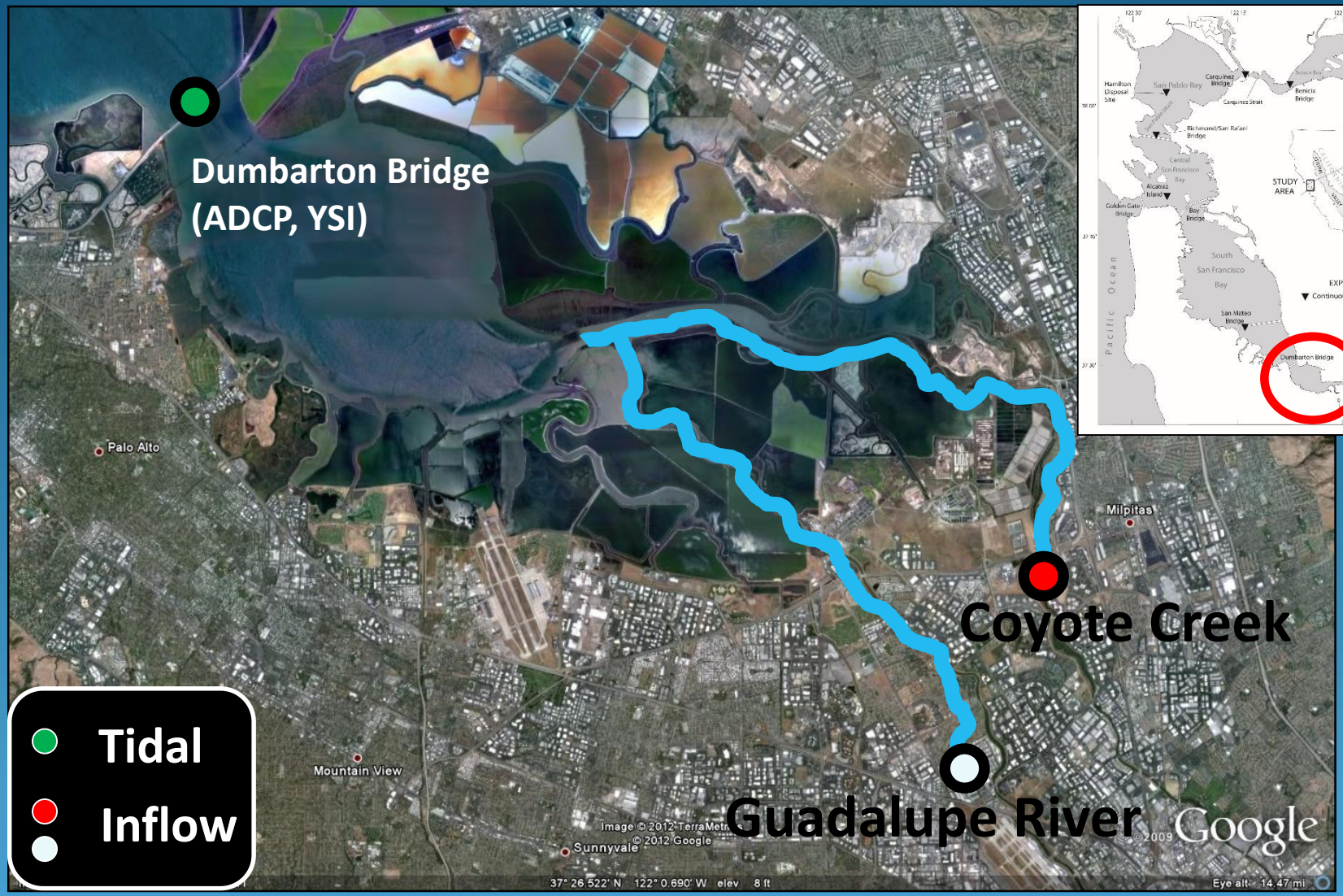
- Will there be enough sediment to fill ponds?
- How will restoration affect mudflat habitat?
- How will restoration affect birds, fish?
- How will nuisance species affect restoration?
- Will legacy mercury be a problem?
- How will trail use affect wildlife?
- How to manage pond water quality?
- How will climate change and SLR affect restoration?

# Sediment

Subsided areas require sediment for marsh to develop

- Sediment supply coming into South Bay
- Sediment accumulation in breached ponds
- Restoration impacts on scour and mudflats
- Restoration impacts on remobilization of mercury

# Sediment Supply - Study Locations




Shellenbarger, Wright and Schoellhamer

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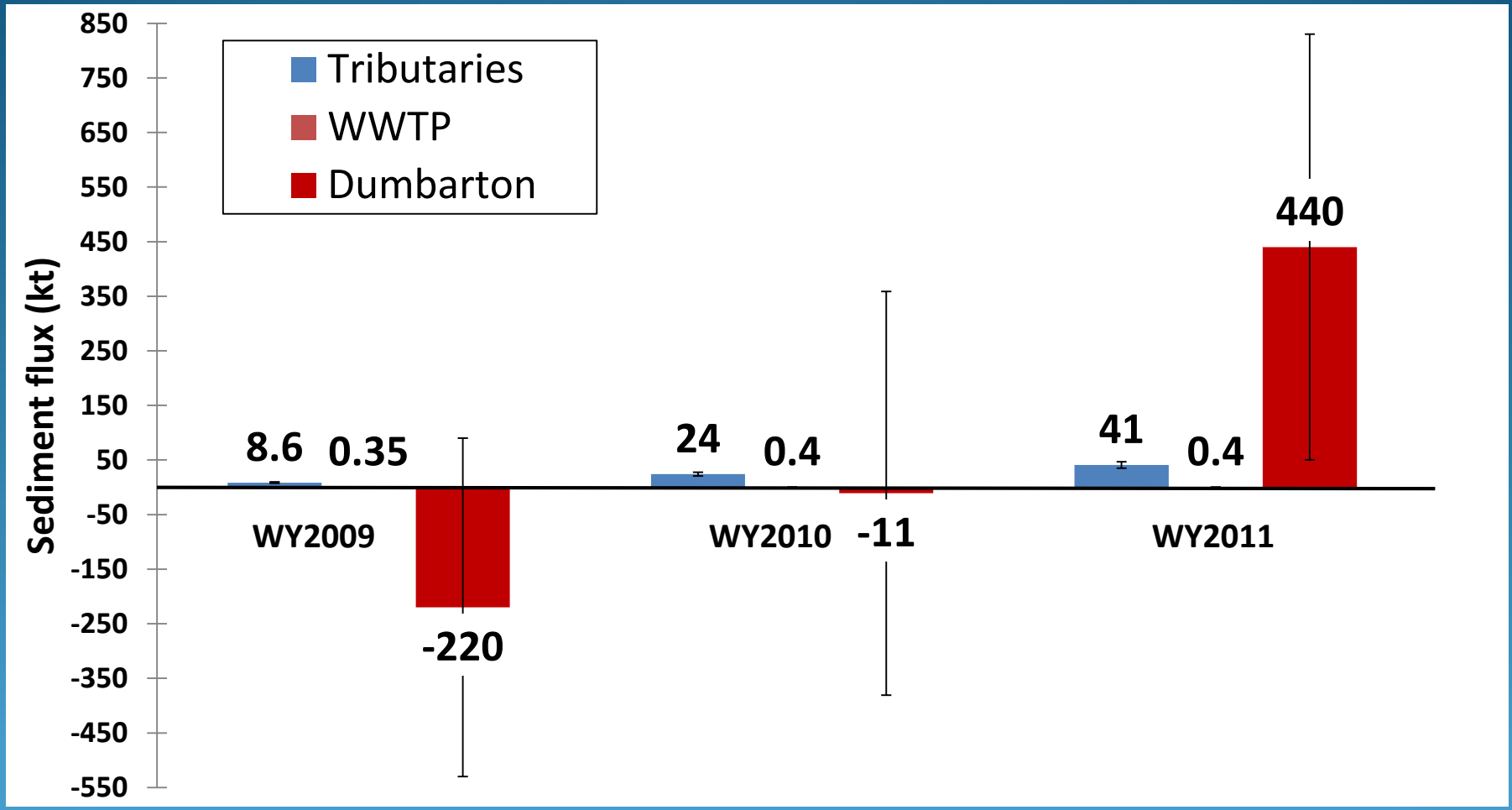
# Sediment Supply
## tidal versus freshwater inflows

Positive values are seaward

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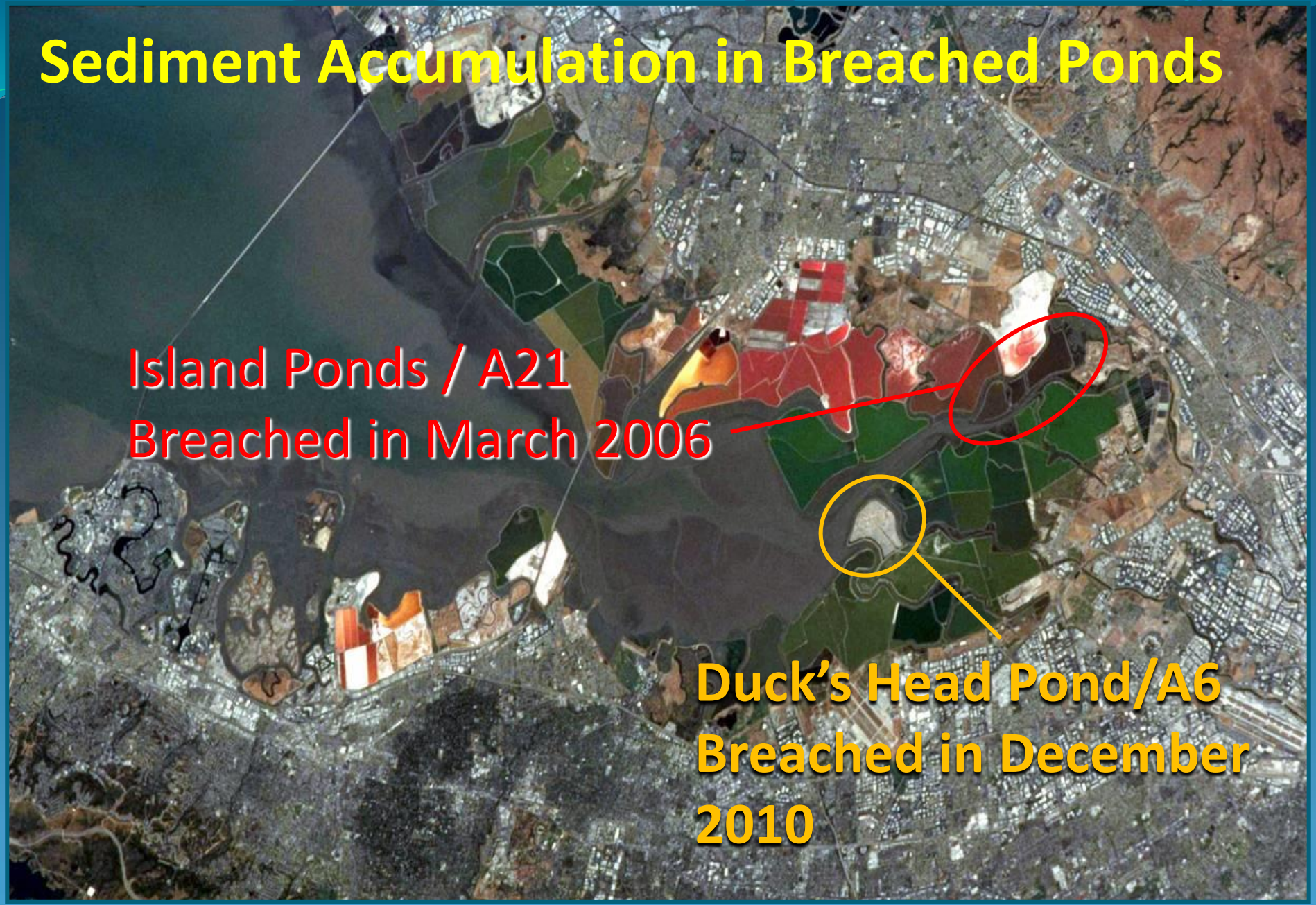
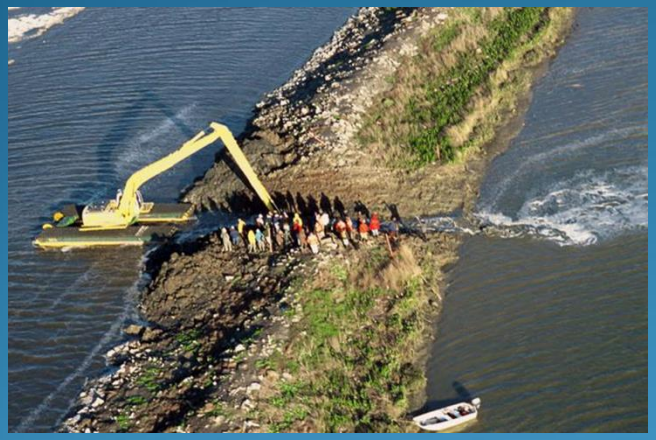
# Sediment Accumulation in Breached Ponds



# How are the ponds restored to marsh?



# Wetland Sediment Dynamics at the Island Ponds

Ponds breached in Spring 2006


- Ponds accumulate sediment at a rapid rate: > 20 cm in 2-3 years in some areas
- Plant recruitment is occurring at higher elevations within Pond A21

USF Callaway

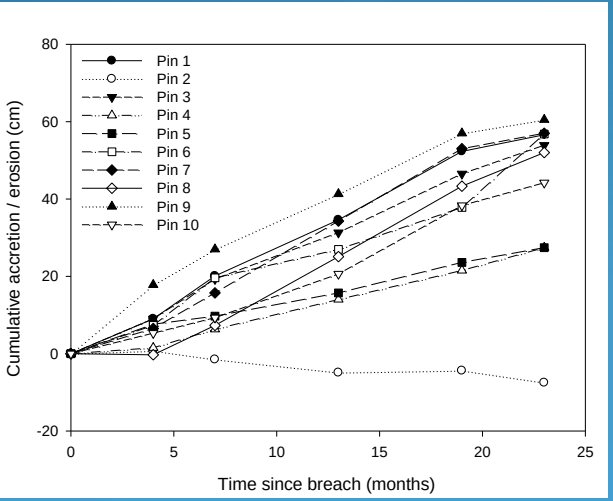
H.T. HARVEY & ASSOCIATES ECOLOGICAL CONSULTANTS Ball


Cris Benton

# The “Ducks Head” Pond A6 sediment accumulation studies

Average deposition across all ten locations was 42.8 cm over 23 months.

Average rate of 22.2 cm/year





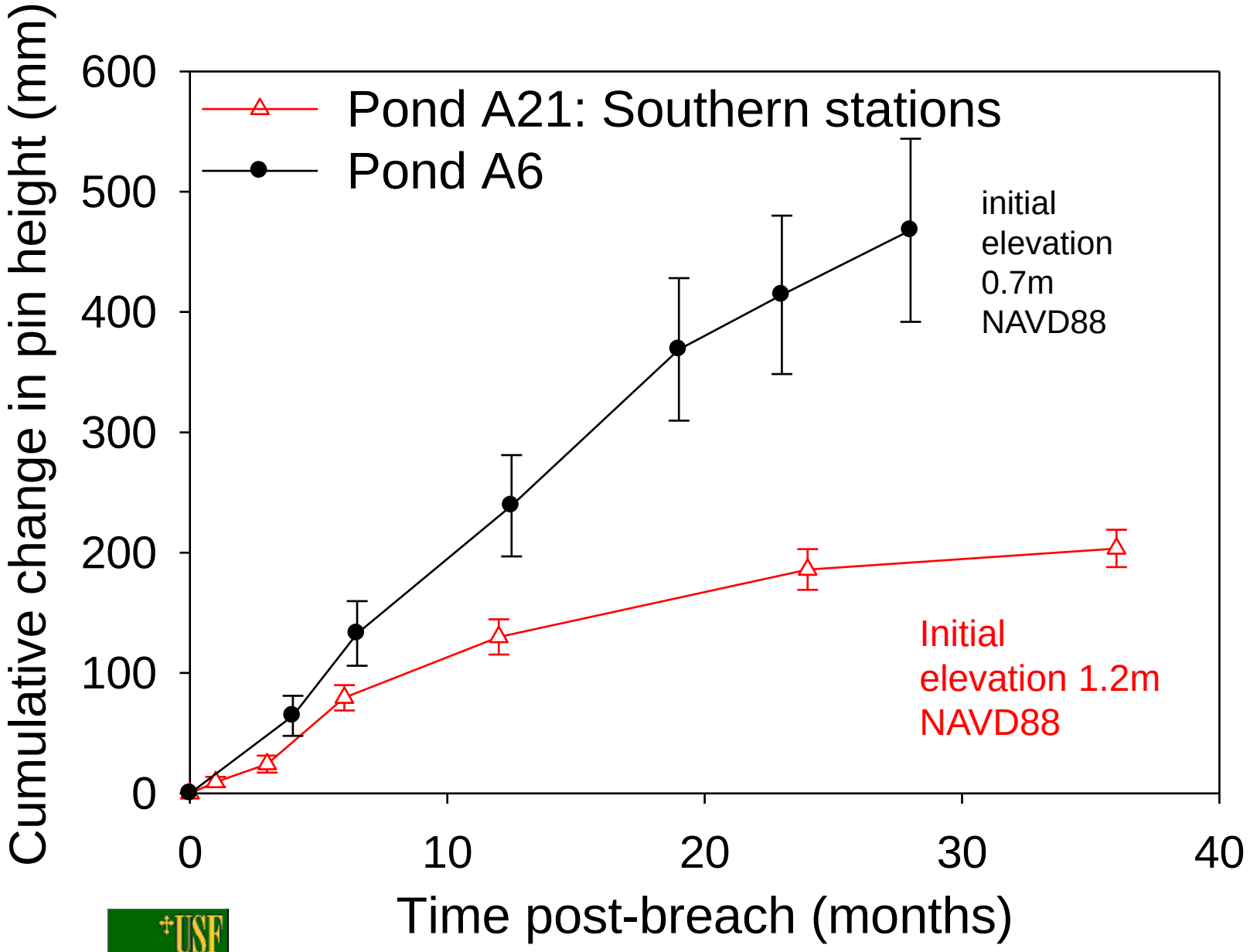
Callaway

H.T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS

Ball

**Breached Dec 2010**

# Sediment Accumulation in Breached Ponds






USF UNIVERSITY of SAN FRANCISCO

# Duck's Head Pond A6

July 2015, 56 months

August 2011, 8 months

# How will restoration affect mudflat habitat?

- ~ 2000 acres of mudflat habitat
- Traditional satellite imagery problematic
- Pilot Study using World View 2 or 3 with Coastal Blue Band
- Ground-truth


BRIAN FULFROST & ASSOCIATES

SAN FRANCISCO BAY BIRD OBSERVATORY

Thomson

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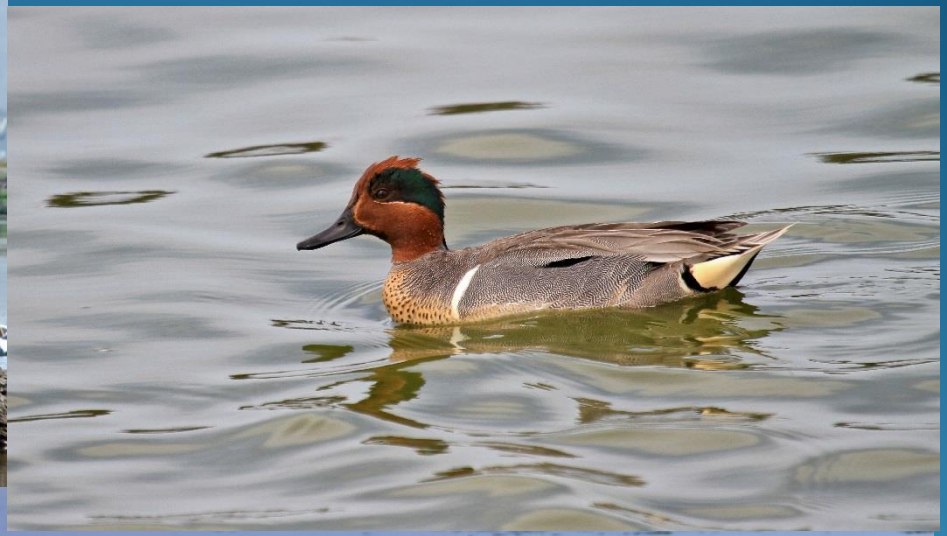
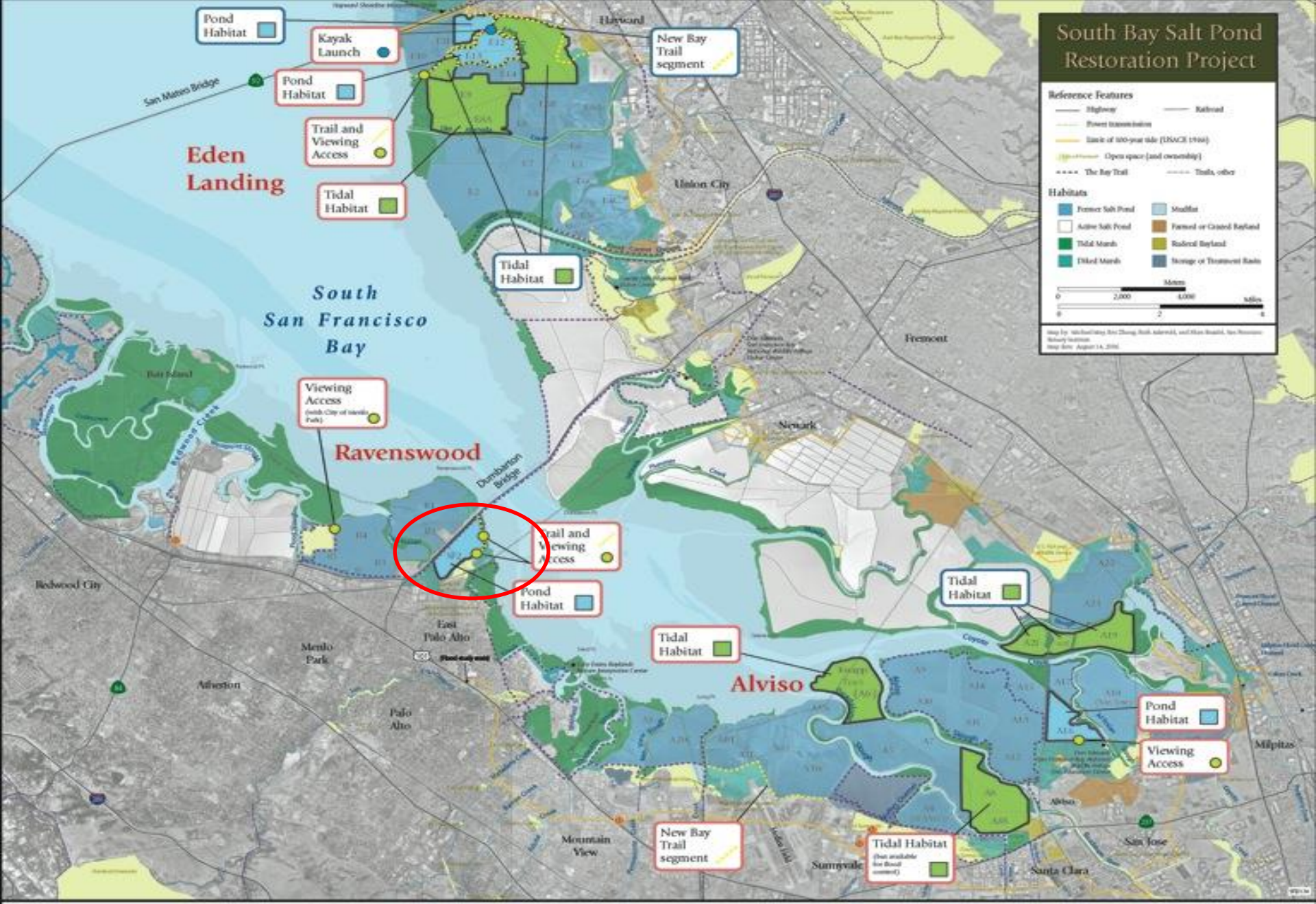
Byrd, De La Cruz, Foxgrover, Valoppi

# How can we enhance habitat for birds?

> 40 species of birds




# Initial Restoration Actions

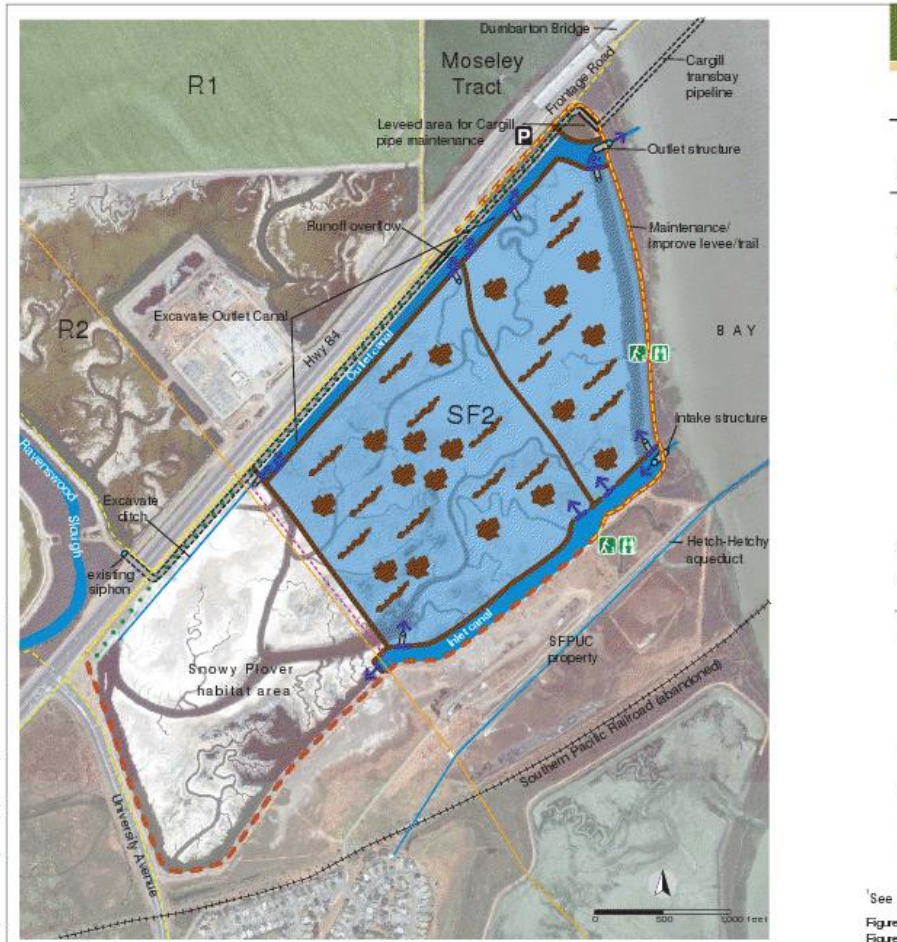
South Bay Salt Pond Restoration Project

2006 - 07

proposed 2008

# Bird Island Experiment – SF2

- Enhance pond reconfiguration with nesting islands, controlled tidal flow
- Opened September 2010



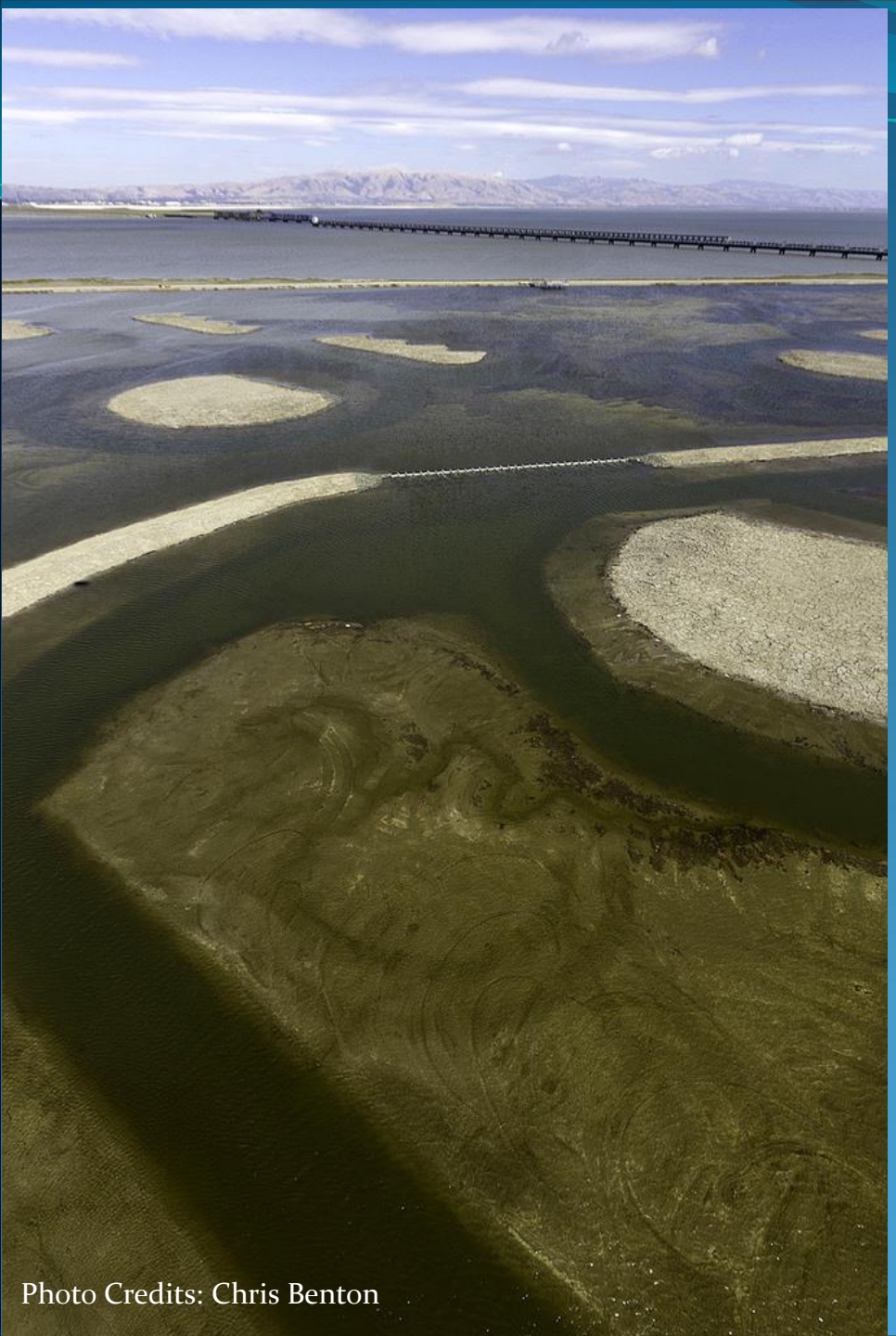


Photo Credits: Chris Benton

# Bird Nesting on Islands

2011
193 nests
28 of 30 islands used
80% of nests on islands
6% of nests on levees
14% of nests in cell 3 panne

Ackerman

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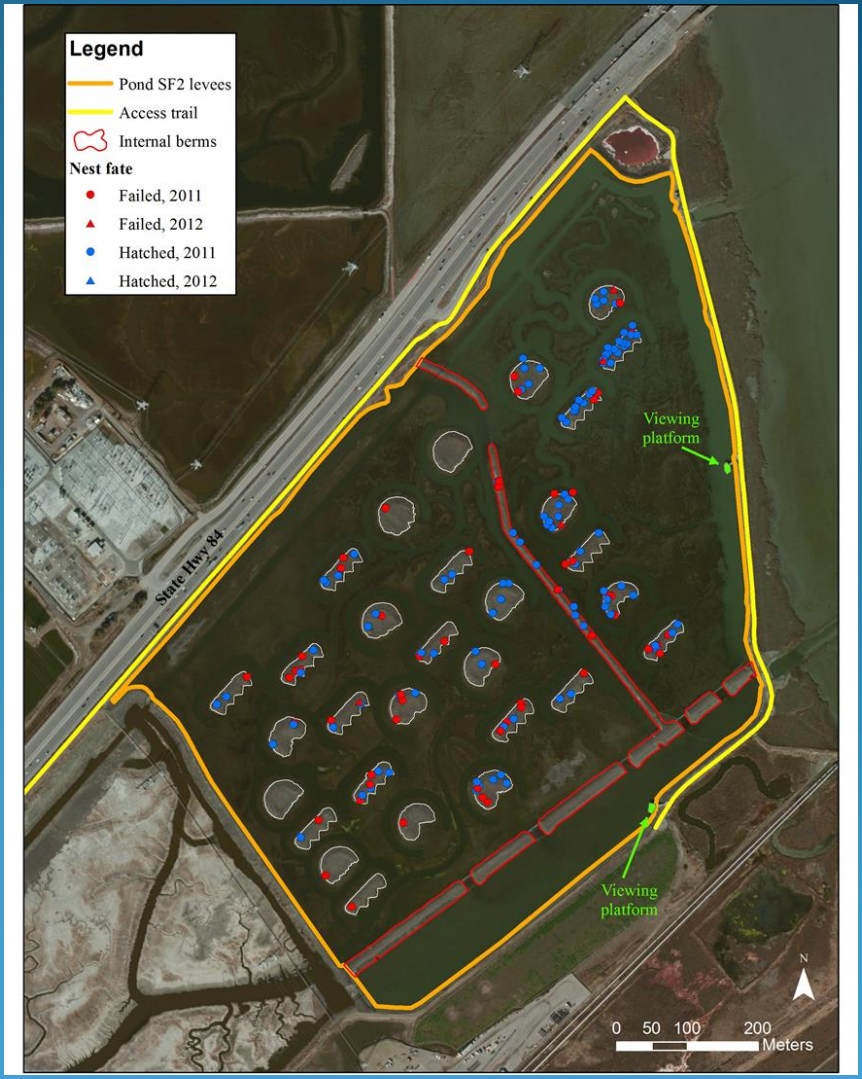
# Results from SF2 nesting study

- 2012
- 68 nests
- 2 of 30 islands used
- 6% of nests on islands
- 0% of nests on levees
- 94% of nests in cell 3 panne

- 2011- 160 Avocet nests, 64% nest success
- 2012 – 4 Avocet nests, 0% nest success

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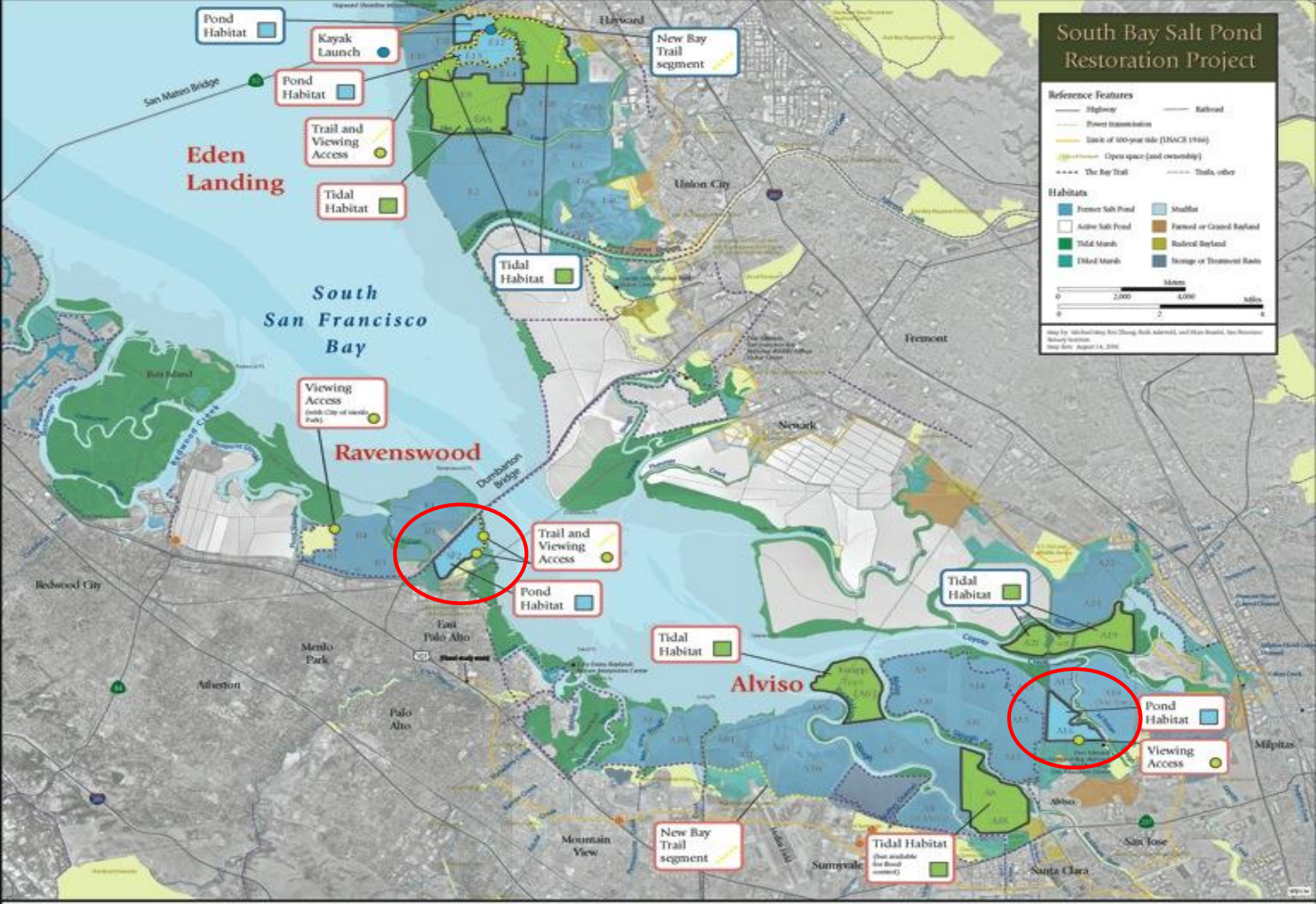
# Island Recipe for Nesting birds

- < 1 km from bay
- 100 – 200 m from levee
- Linear, 0.05-0.10 ha in size
- 0.5-1.5 m above the water surface
- Fewer islands per pond (3-5)




# Initial Restoration Actions

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# Social Attraction

What is it?

- Singles Bar for Birds

Why are we doing it?

- To attract nesting birds to specific areas

# Social Attraction

## Bird Island Pond,SF2

- 3 islands for CATE + calls
- 1 island for plovers + calls
- 1 island for FOTE


## Bird Island Pond, A16

- 2 islands for CATE + calls
- 1 island for plovers + calls

# Social Attraction

What are the results?

(Preliminary data for Caspian Tern, CATE)

- **SF2 islands:** 147 nests, ~120 tern chicks fledged;
- **A16 islands:** 73 nests, ~54 tern chicks fledged;
- **Total – 220-247 breeding terns, 174 chicks;**

  **Breeding success is 0.79 chicks fledged/breeding pair**

Ackerman USGS science for a changing world Strong U.S. FISH & WILDLIFE SERVICE Trachtenbarg US Army Corps of Engineers

# Island Effect for Wintering Birds

Isolated islands at high tide were used most

Use of shallow mounds by shorebirds

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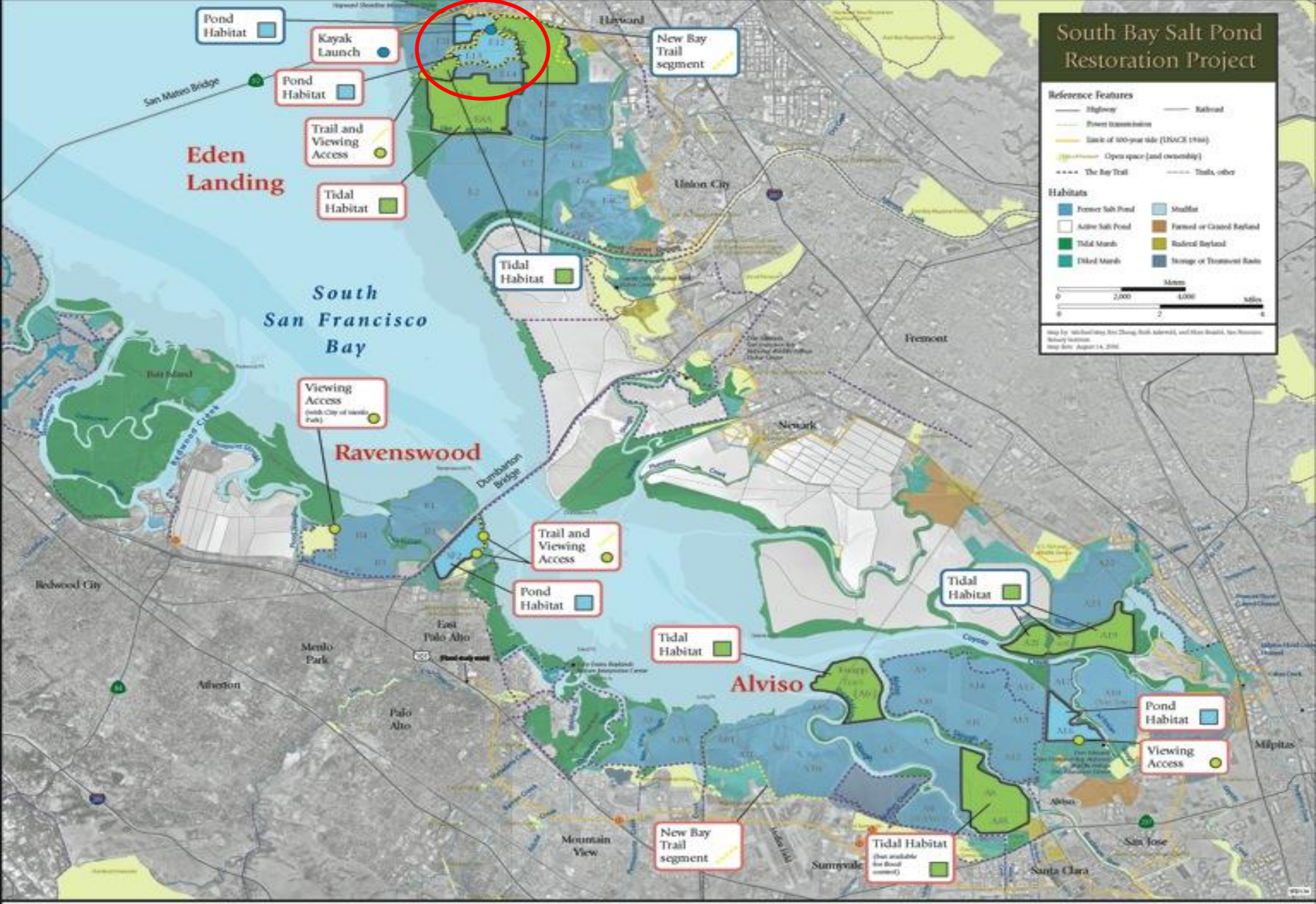
De La Cruz

Photos by Pelican Media




# Initial Restoration Actions

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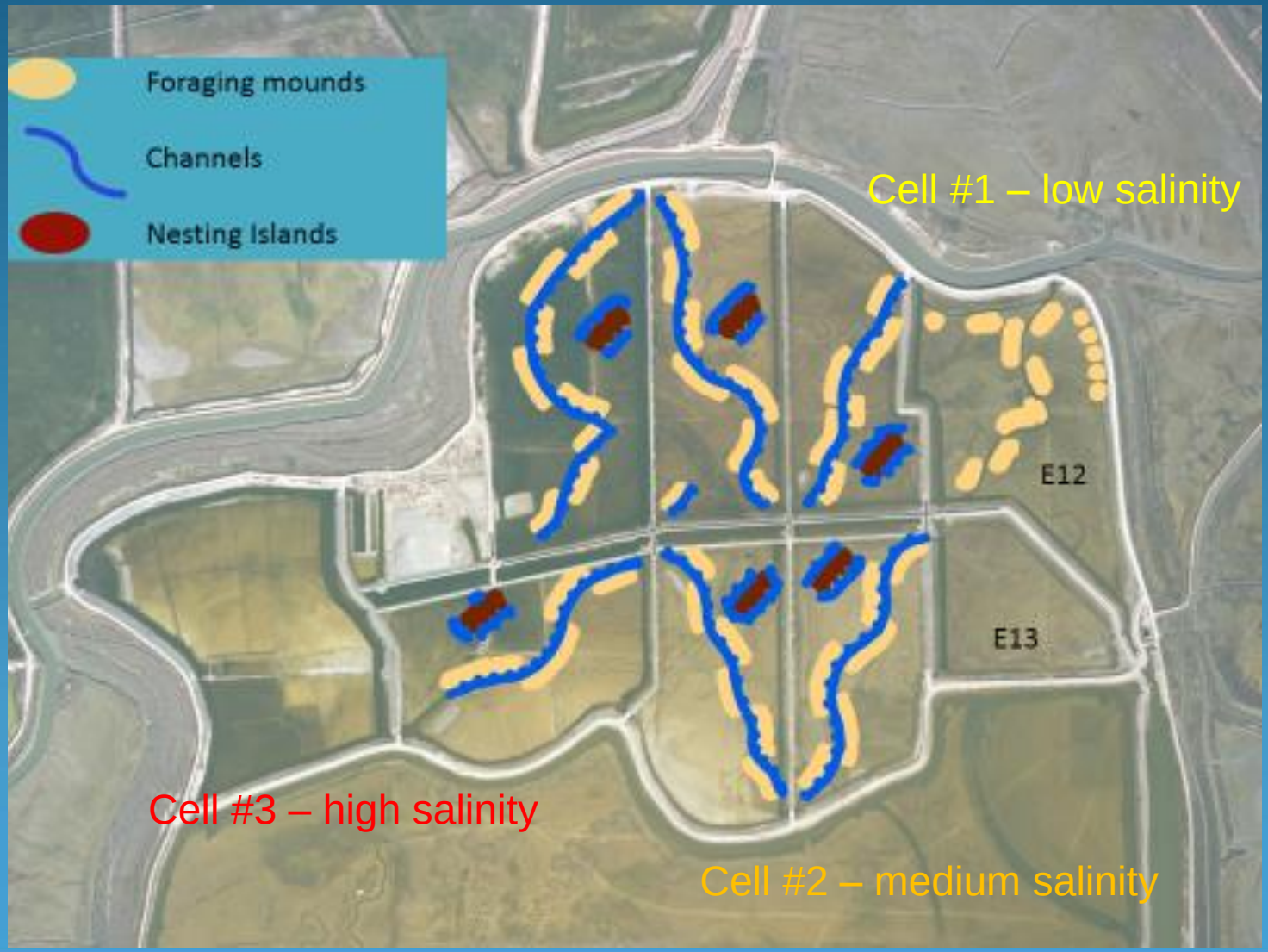
# Pond E12/E13 Redesign for Wintering Birds

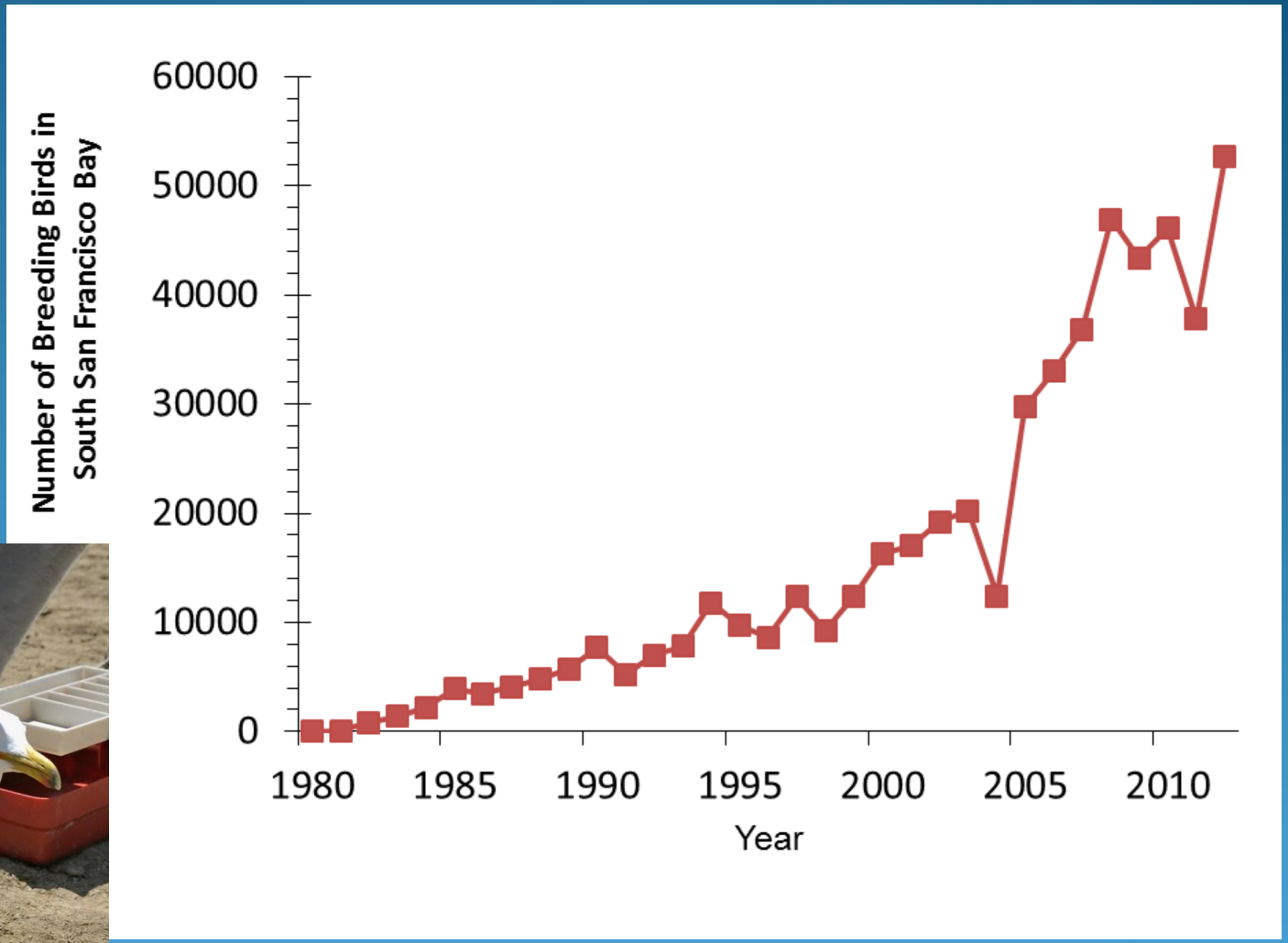

Pelican Media

- High, Medium, Low salinity
- Mimic the terrain favored by the shorebirds
  - A series of shallow channels snake through the ponds
  - Alongside low sausage-shaped dirt mounds for roosting and foraging
- Creates varying levels of water depth and salinity to optimize bird use – habitat diversity

# Salinity Experiment – Ponds E12/E13



# How will the presence of nuisance species affect waterbirds?

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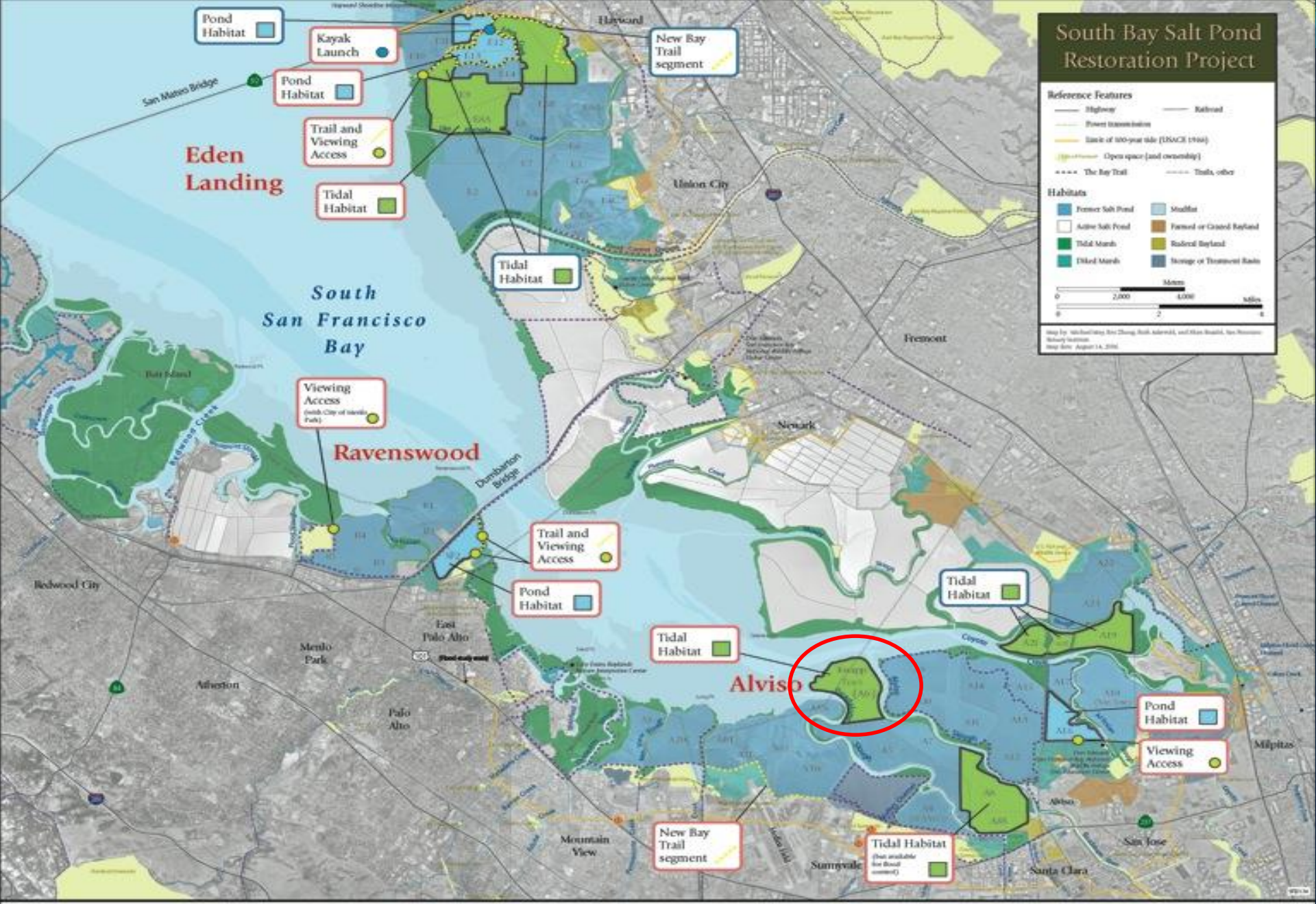


# Initial Restoration Actions

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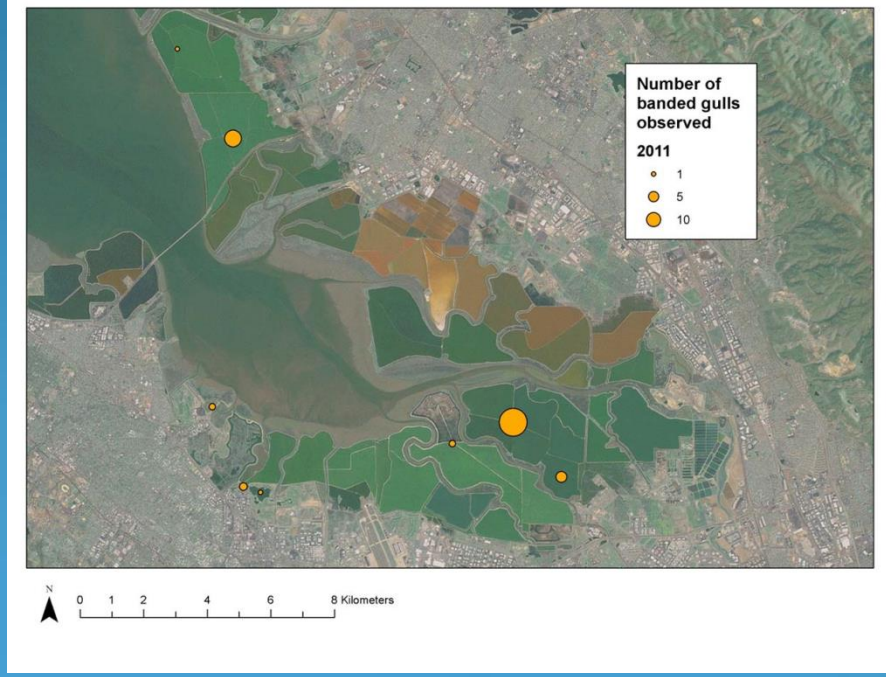
# California Gull – nuisance species

December 6, 2010
Pond A6 “Ducks Head”
Tidal Marsh (360 acres)


J. Irving

# Gull studies

- In 2010, 569 gull chicks were banded, and resightings done in 2011
- The majority of gulls moved to the pond levees on the other side of Alviso Slough
- Overall CA gull populations decreased 17% from 2010 to 2011, then increased 28% from 2011 – 2012 (52,704 birds).
- 2013, 2014 ~ 53,000 birds

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SAN FRANCISCO BAY BIRD OBSERVATORY

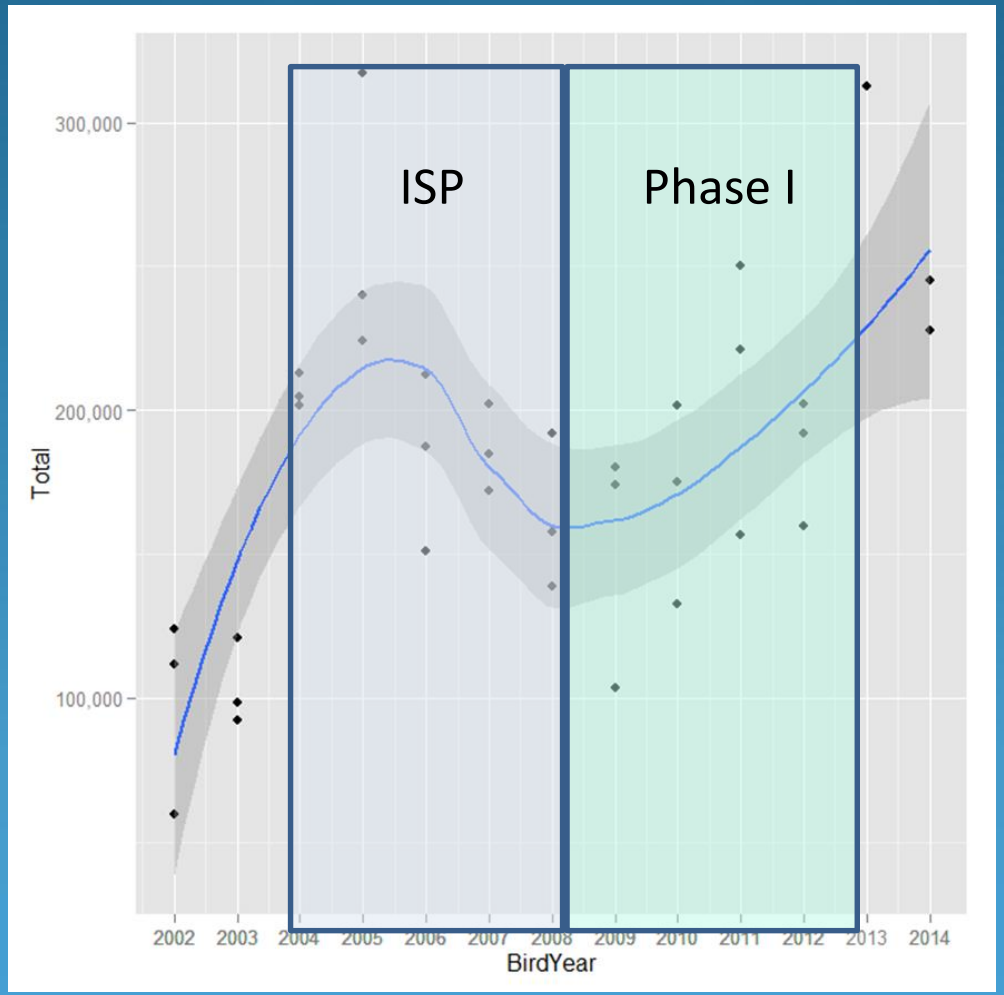
Bluso-Demers, Robinson-Nilsen

# What was the impact on nesting birds?


- Forster's Tern chick fledging success
  - 4% in 2010
  - 40% in 2011

So having fewer gulls and gulls further away from tern nesting colonies benefited tern nest success, even if CAGU populations remain elevated

# South Bay Wintering Bird Abundance

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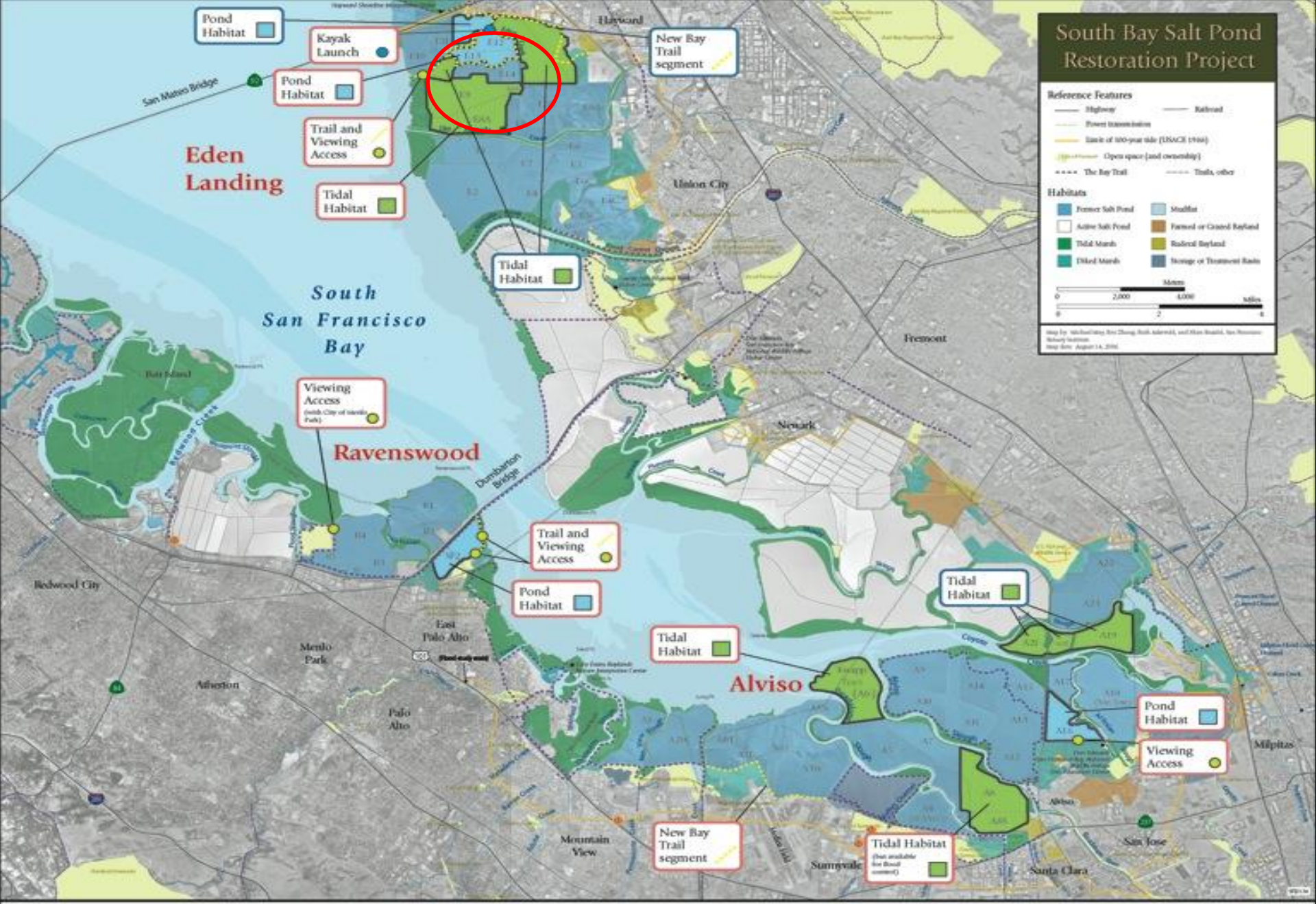
Takekawa, De La Cruz


M. Kern


Callie Bowdish

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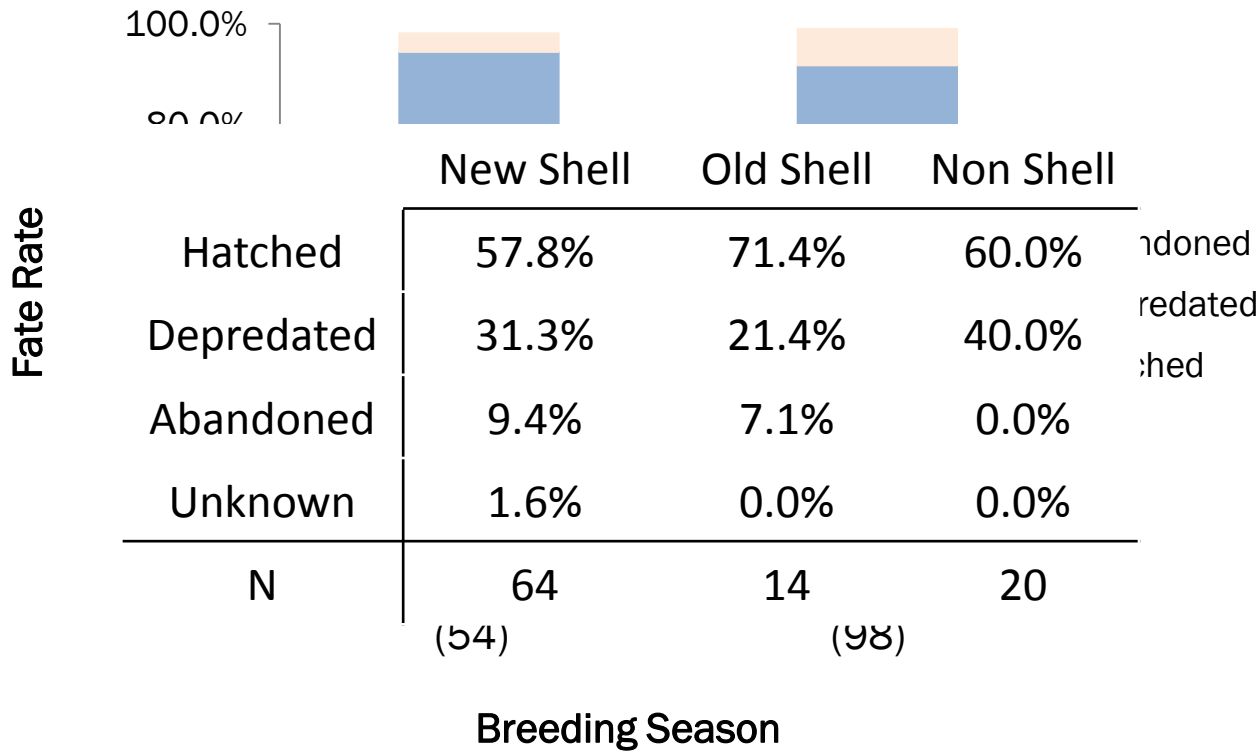
# Snowy Plover Habitat Enhancement

# Preliminary Results of Plover Habitat Enhancement




Tokatlian

# How will legacy mercury affect wildlife?

- How much mercury will be mobilized due to the scour of Alviso Slough as a result of the tidal restoration at Ponds A5, A6, A7, and A8?
- Where will the mobilized mercury move to?
- What effect will the increased tidal action in these Ponds and surrounding sloughs have on mercury methylation and bioaccumulation processes?

Slotton

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Ackerman, Marvin-DiPasquale, Jaffe, Shellenbarger

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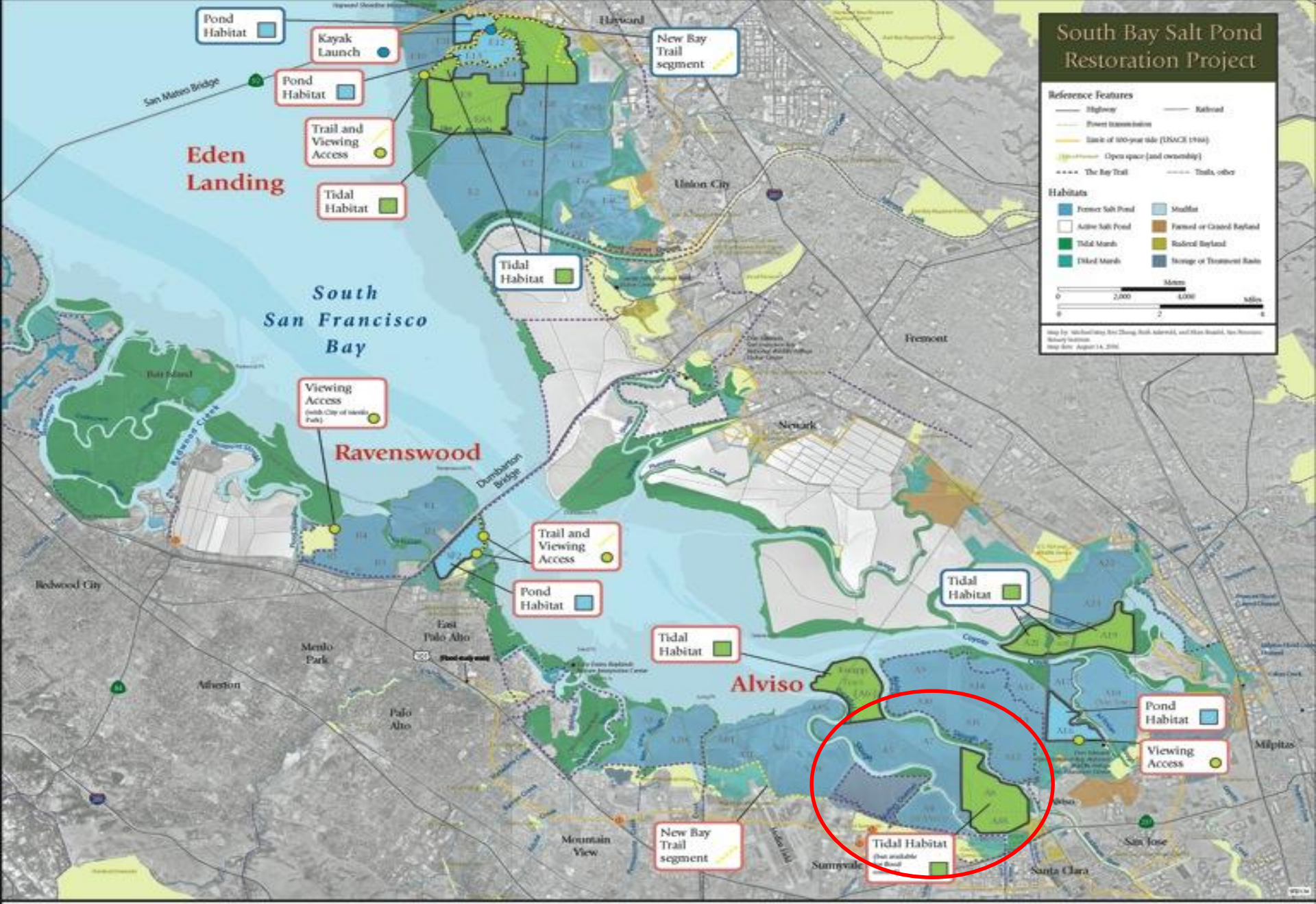


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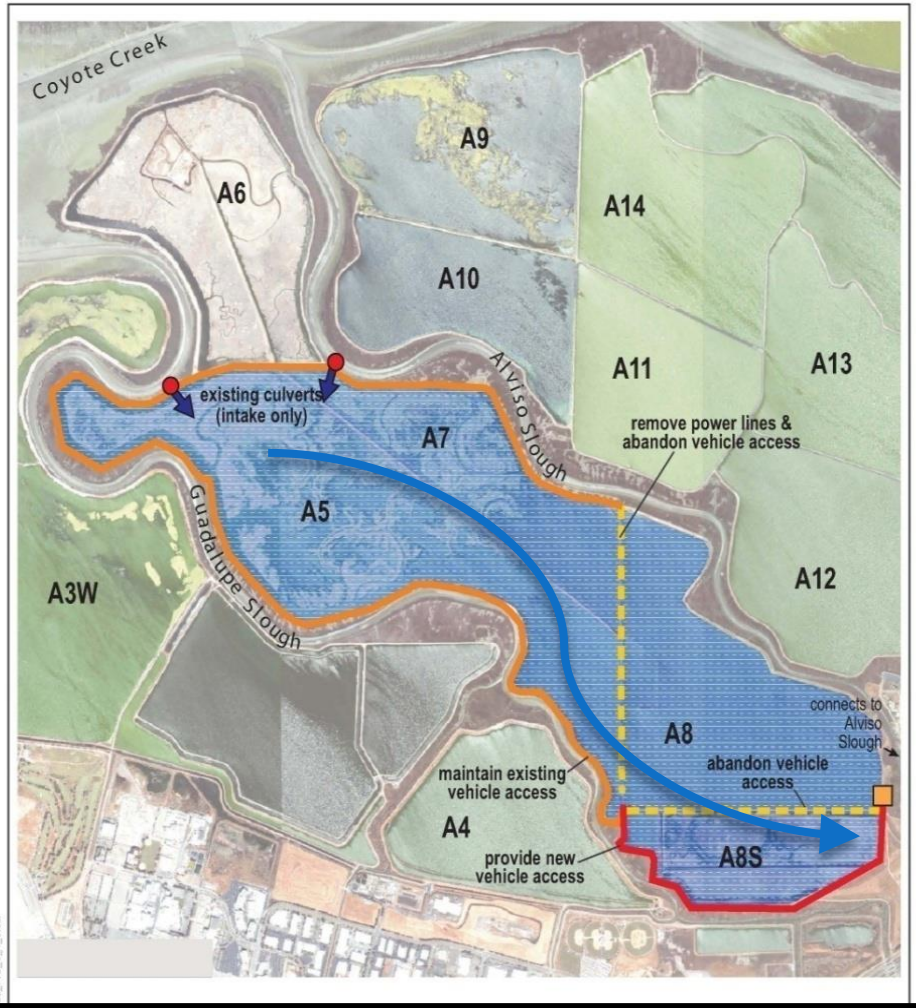
# Mercury Accumulation and Remobilization

# Mercury

Inflow/outflow gates

Armored Notch –
40 feet, 8 gates

Opened 1 out of 8 gates (5’/40’)
June 1, 2011




**Ponds A8, A5, A7: Muted Tidal (1400 acres)**

# What is the Hg doing?

- In the ponds ? Hg birds and pond fish
- In water? Hg water samples collocated with fish
- In Alviso Slough ? Hg in slough fish
- In Alviso Slough ? Hg remobilization from sediment scour

avocet

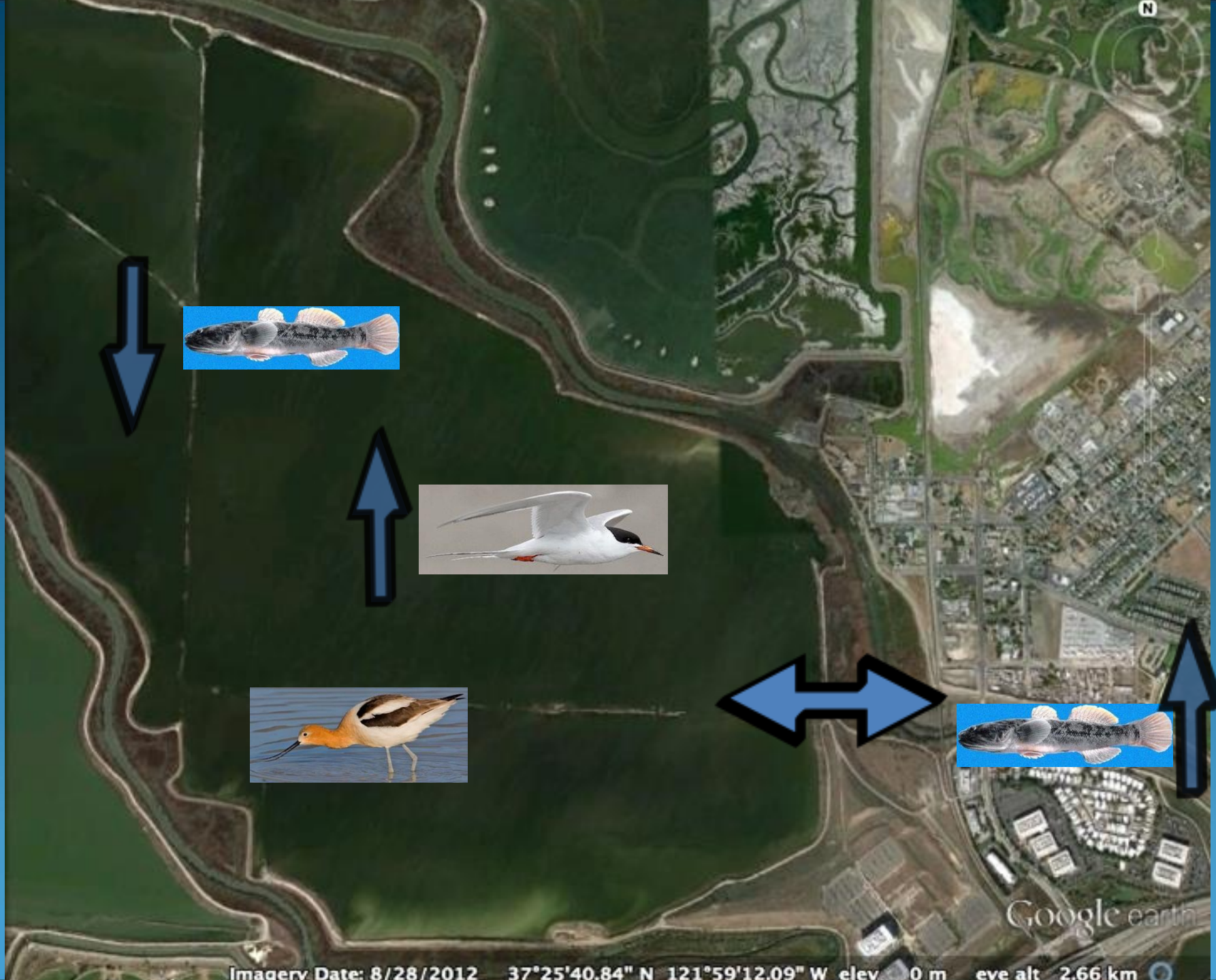
Forster's tern

stickleback


mudsucker

silverside


Google earth
Imagery Date: 8/28/2012 37°25'40.84" N 121°59'12.09" W elev 0 m eye alt 2.66 km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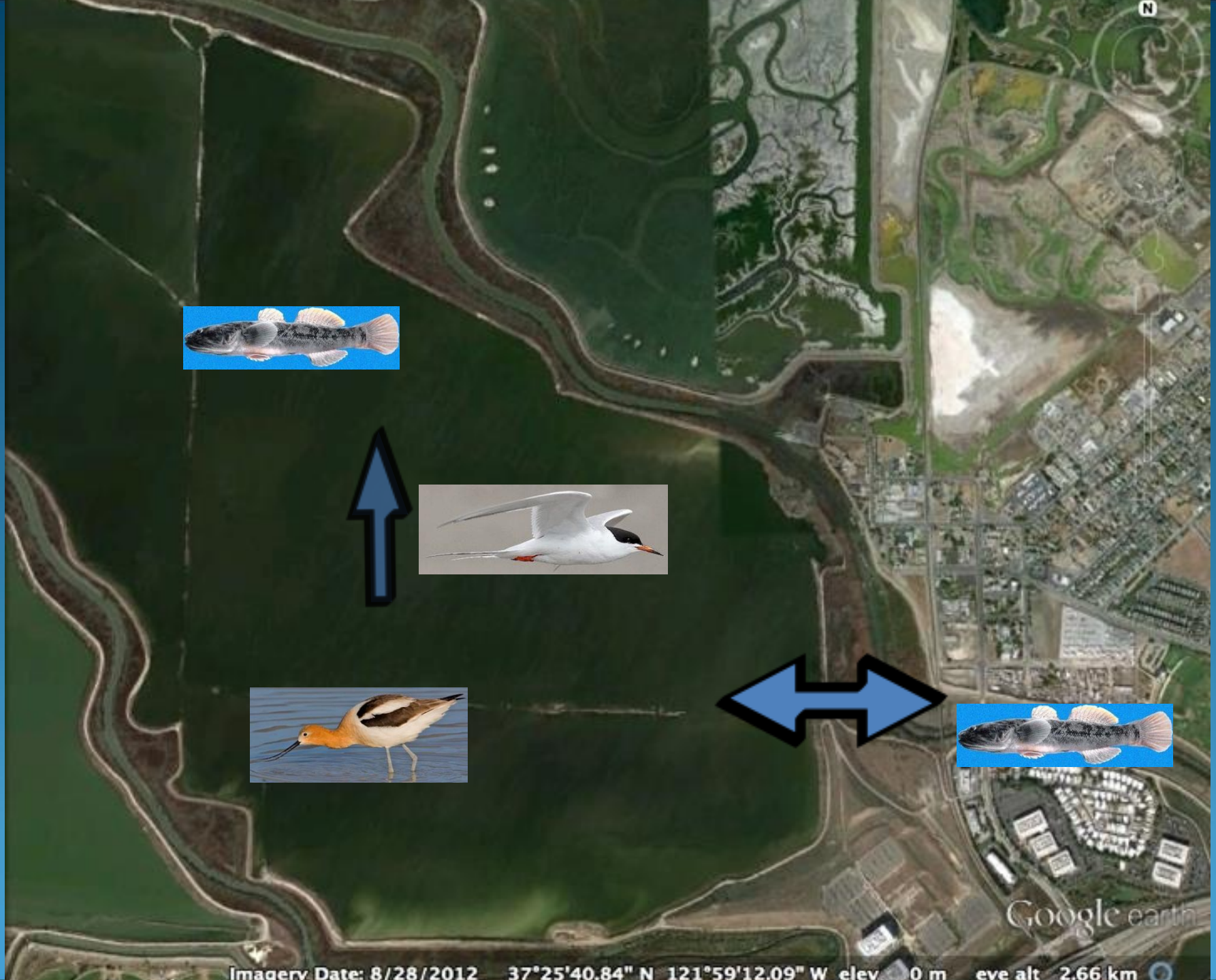
Google earth
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# How will trails affect Wildlife?

- Breeding behavior
- Nest success
- Foraging
- Roosting

- What is safe distance from trail to habitat?

# Results of Trail Studies

- For Western Snowy Plover nesting birds disturbed by walkers on avg 164 m away, 146 m tangentially

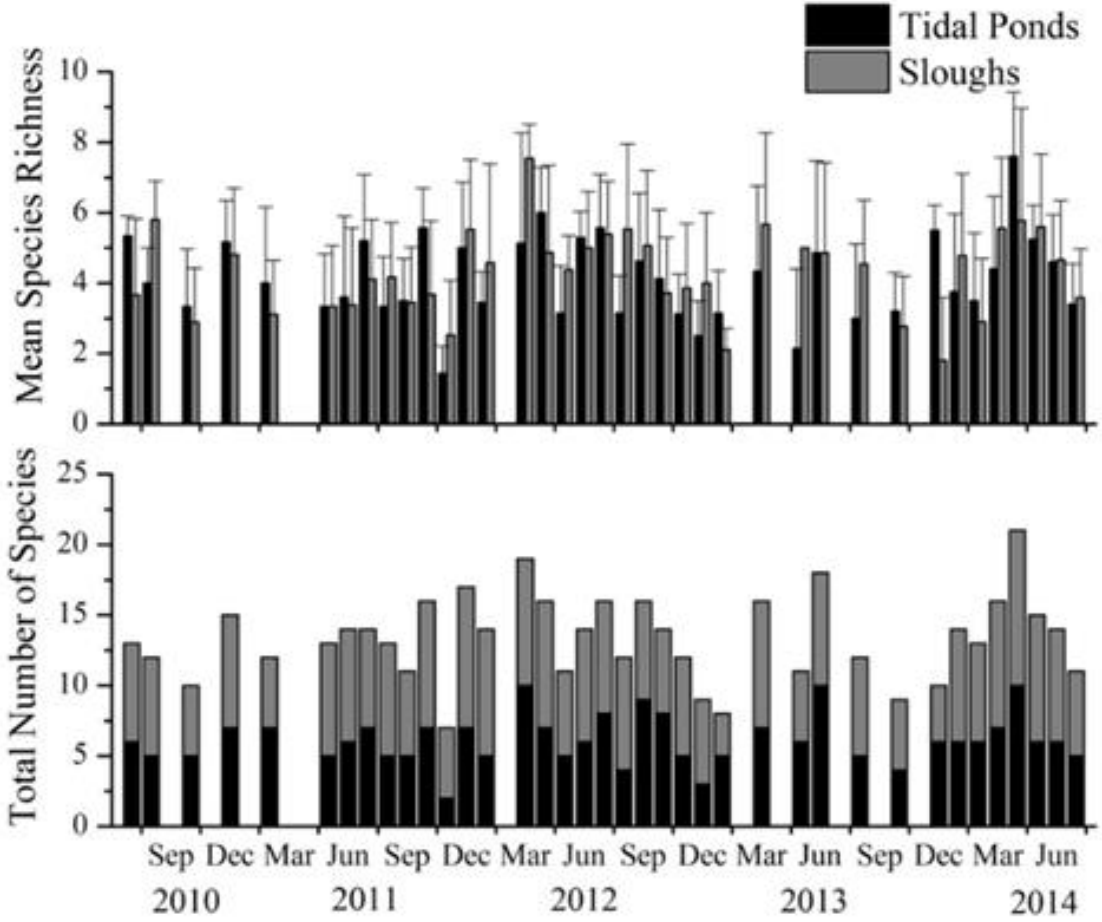
- Waterfowl (wintering/migr) safe buffer from trail = 120 m
- Shorebirds (wintering/migr) safe buffer from trail = 50 m

San José State University

Trulio

# How will restoration affect water quality and fish?

40 species of fish – 90% native




Longfin Smelt – CA threatened species

Hobbs

UCDAVIS
UNIVERSITY OF CALIFORNIA

# Climate change and SLR - Why bother to restore?

- What effect with CC and SLR have on biology and habitats of SF Bay?
- What effect will SLR have on salt pond restoration?
- How should the restoration adaptively manage?

# Management Response – Adaptation Strategies

- Restore wetlands early rather than latter
- Use of upland fill to increase elevation
- Use of dredge material for pond enhancements is being evaluated
- Creating high tide refugia - marshmounds

# Interdisciplinary Science in Action











www.southbayrestoration.org