Breeding Waterbird Ecology and Management for the South Bay Salt Pond Restoration Project

South Bay Salt Pond Restoration Project

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(September 9, 2025)

Outline

Informing Wetland Management for Nesting Waterbirds

1) Some waterbird populations are declining
2) Predatory gulls are increasing
3) Mercury threatens breeding birds
4) Management of nesting islands
5) Establishing new nesting colonies
6) Future distribution of waterbirds

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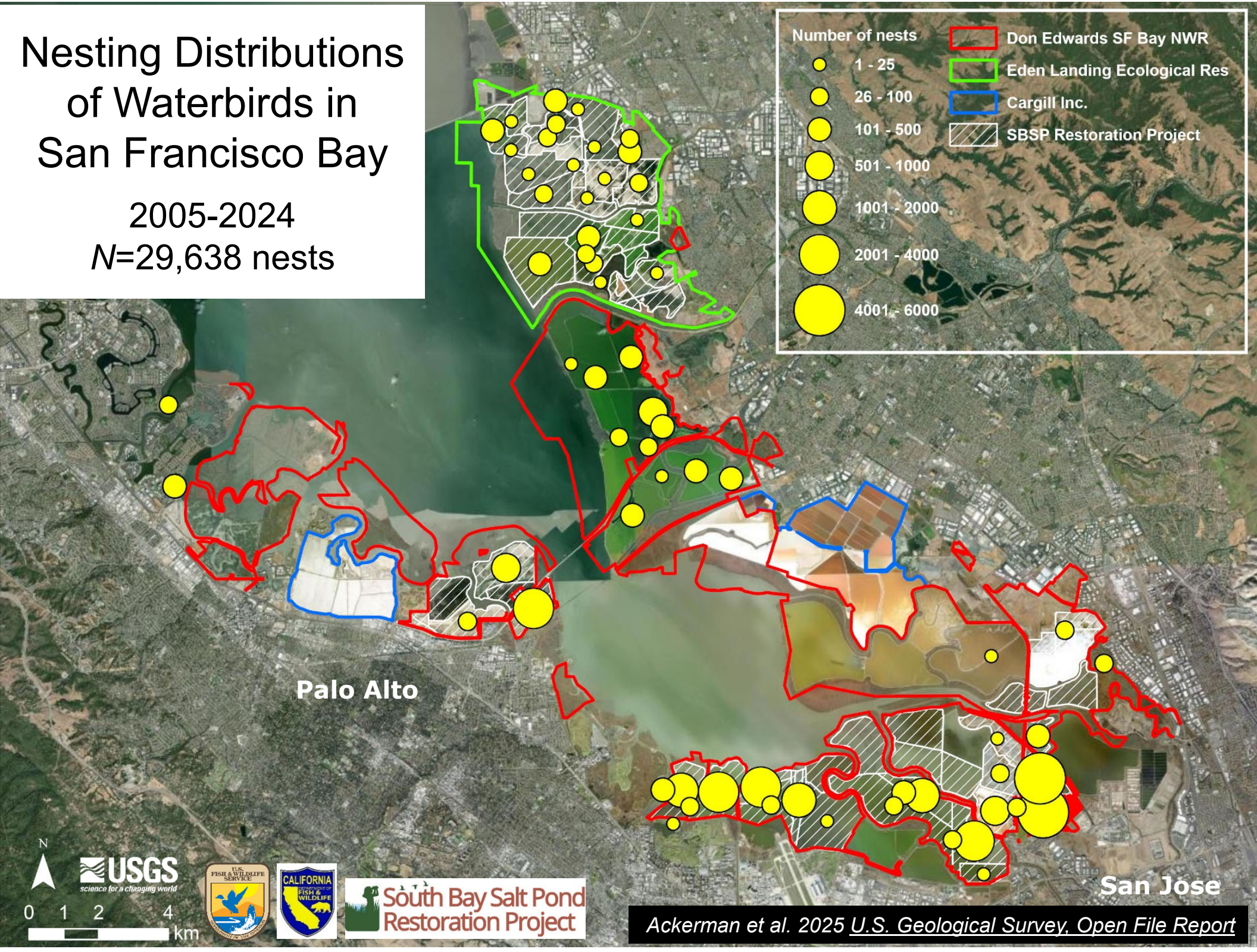
Nest Monitoring

2005 to 2024: 29,638 nests

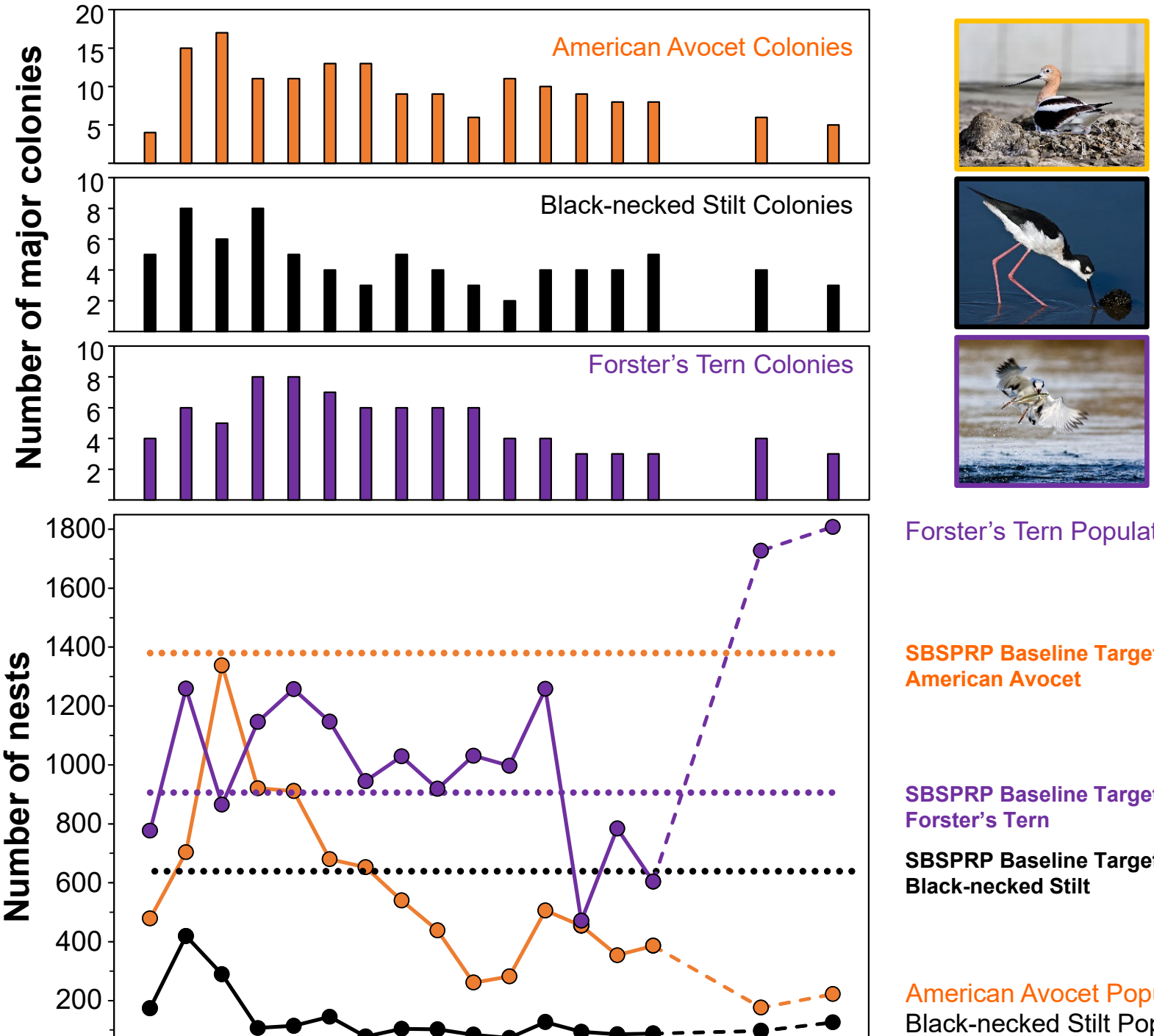
Nesting Distributions of Waterbirds in San Francisco Bay

2005-2024
N=29,638 nests



Ackerman et al. 2025 U.S. Geological Survey, Open File Report

Waterbird Nests Over Two Decades



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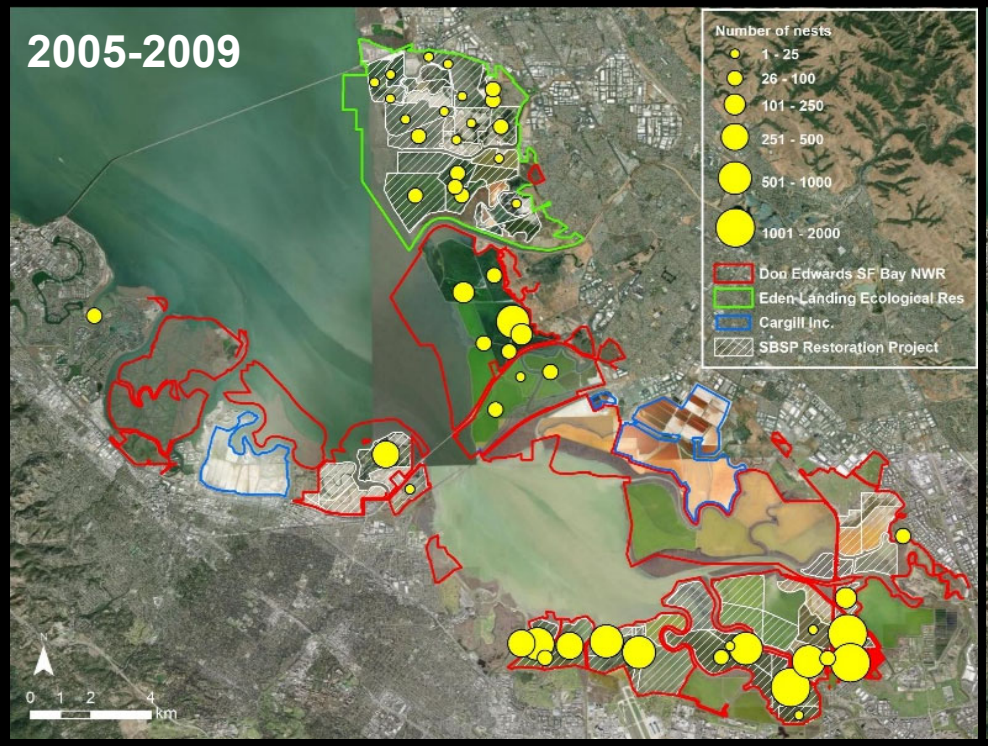
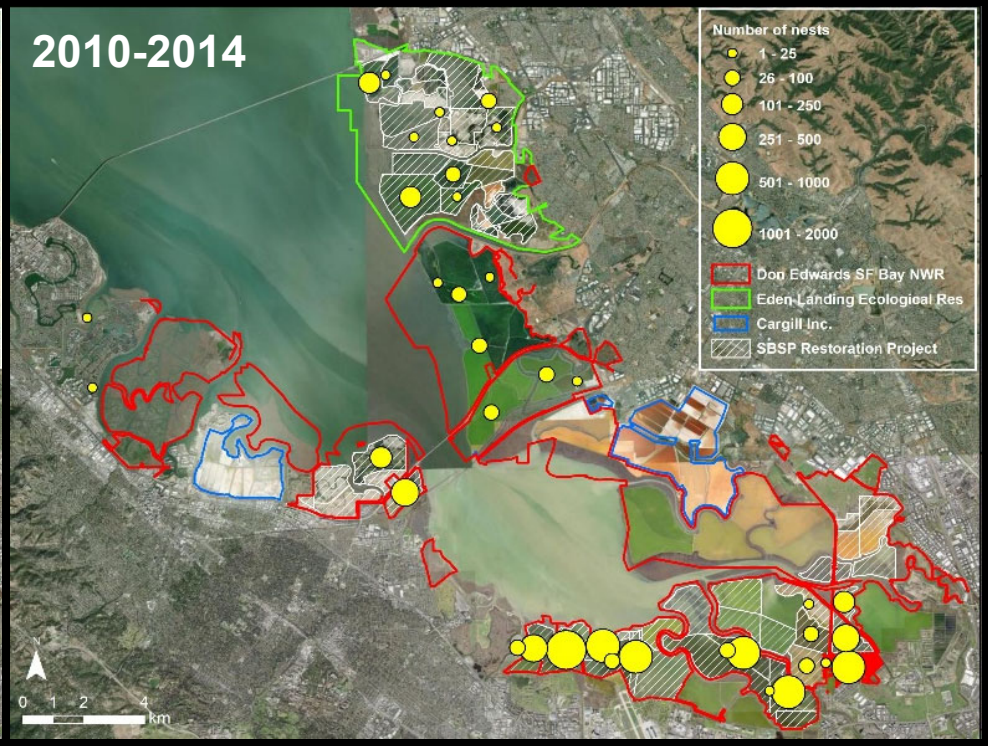
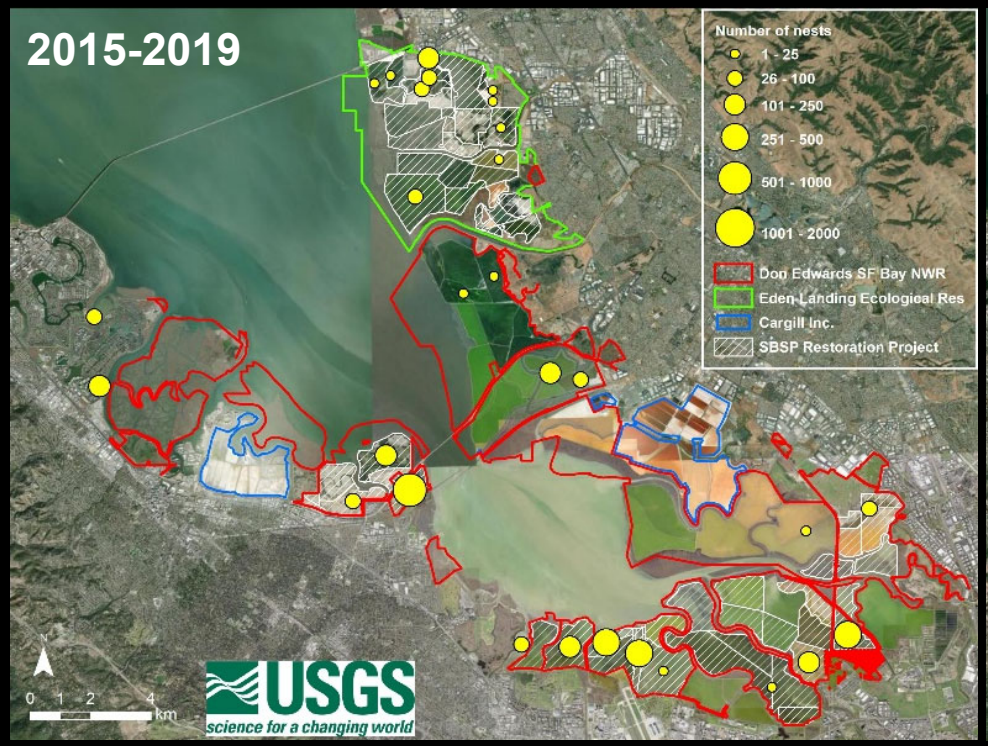
Ackerman et al. 2025 U.S. Geological Survey Open-File Report 2025

Hartman et al. 2021 San Francisco Estuary and Watershed Science 19:3:4

Fewer Nests in Fewer Places



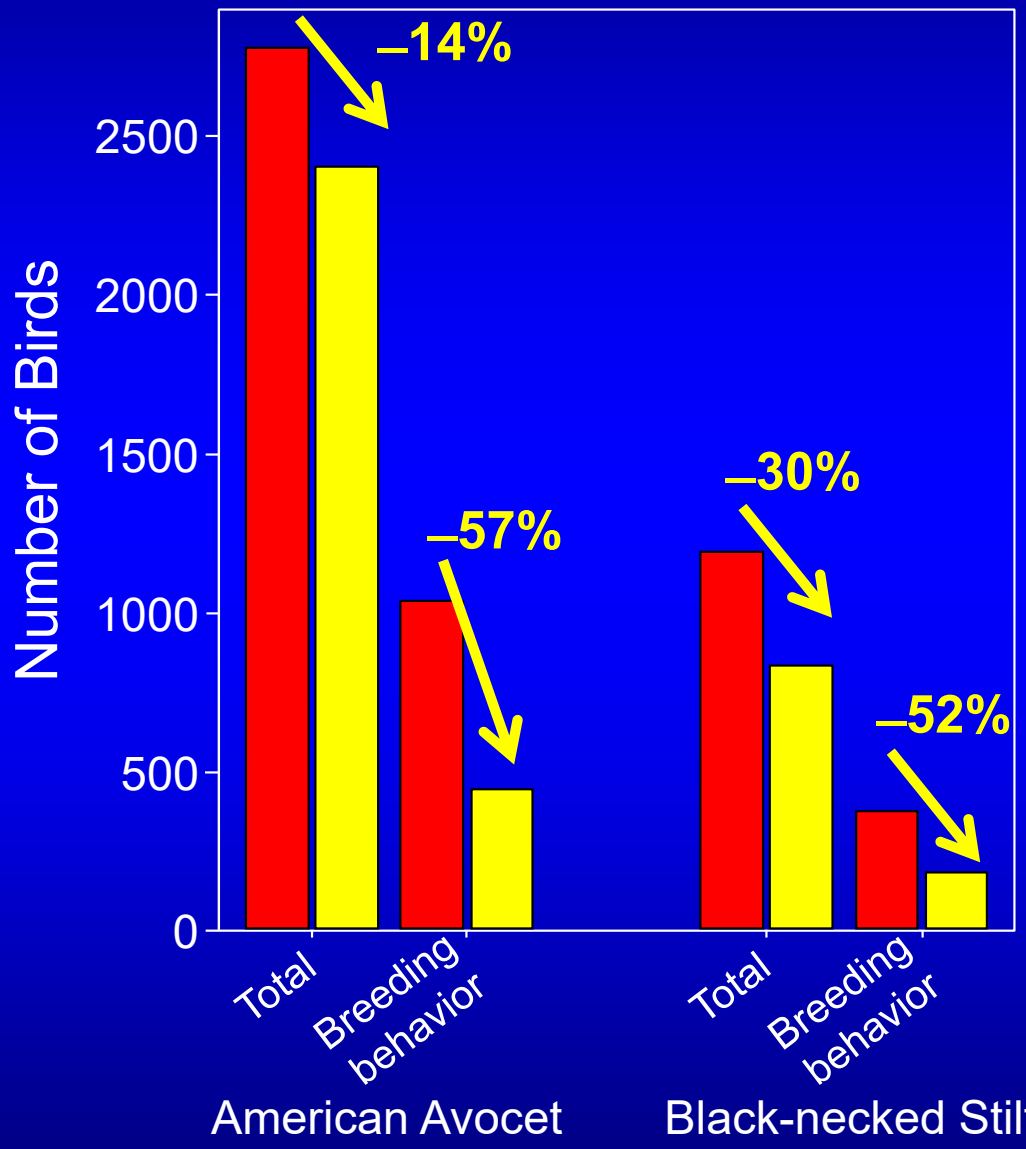




Ackerman et al. 2025 U.S. Geological Survey, Open File Report

Breeding Population Decline

(2001 vs 2019 South Bay Surveys)

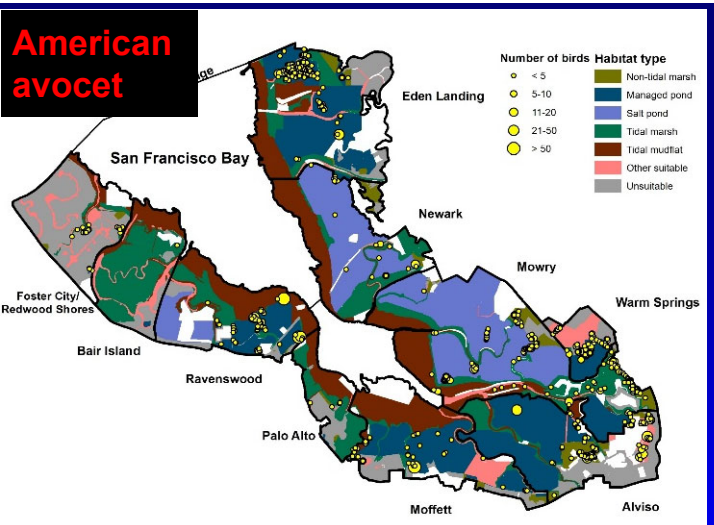


Hartman et al. 2021 San Francisco Estuary and Watershed Science 19:3:4

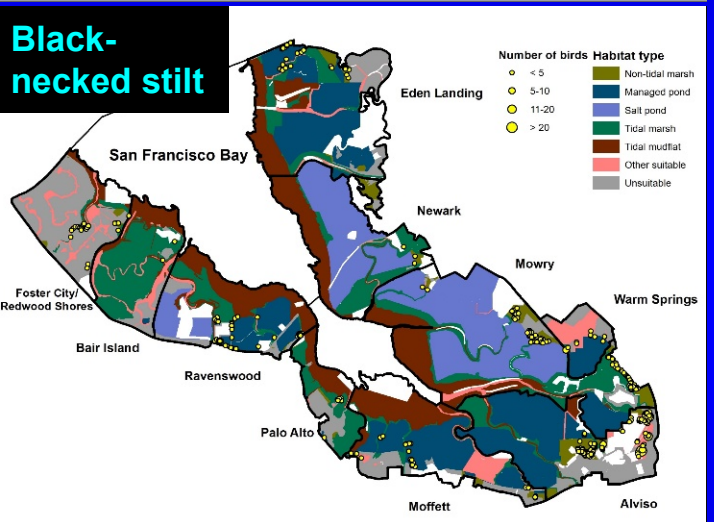
Habitat Use vs Availability

(2019 South Bay Survey)

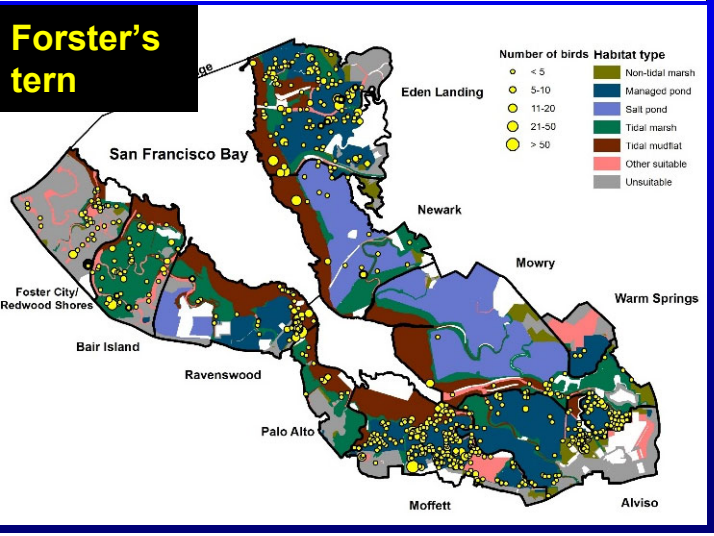
American avocet

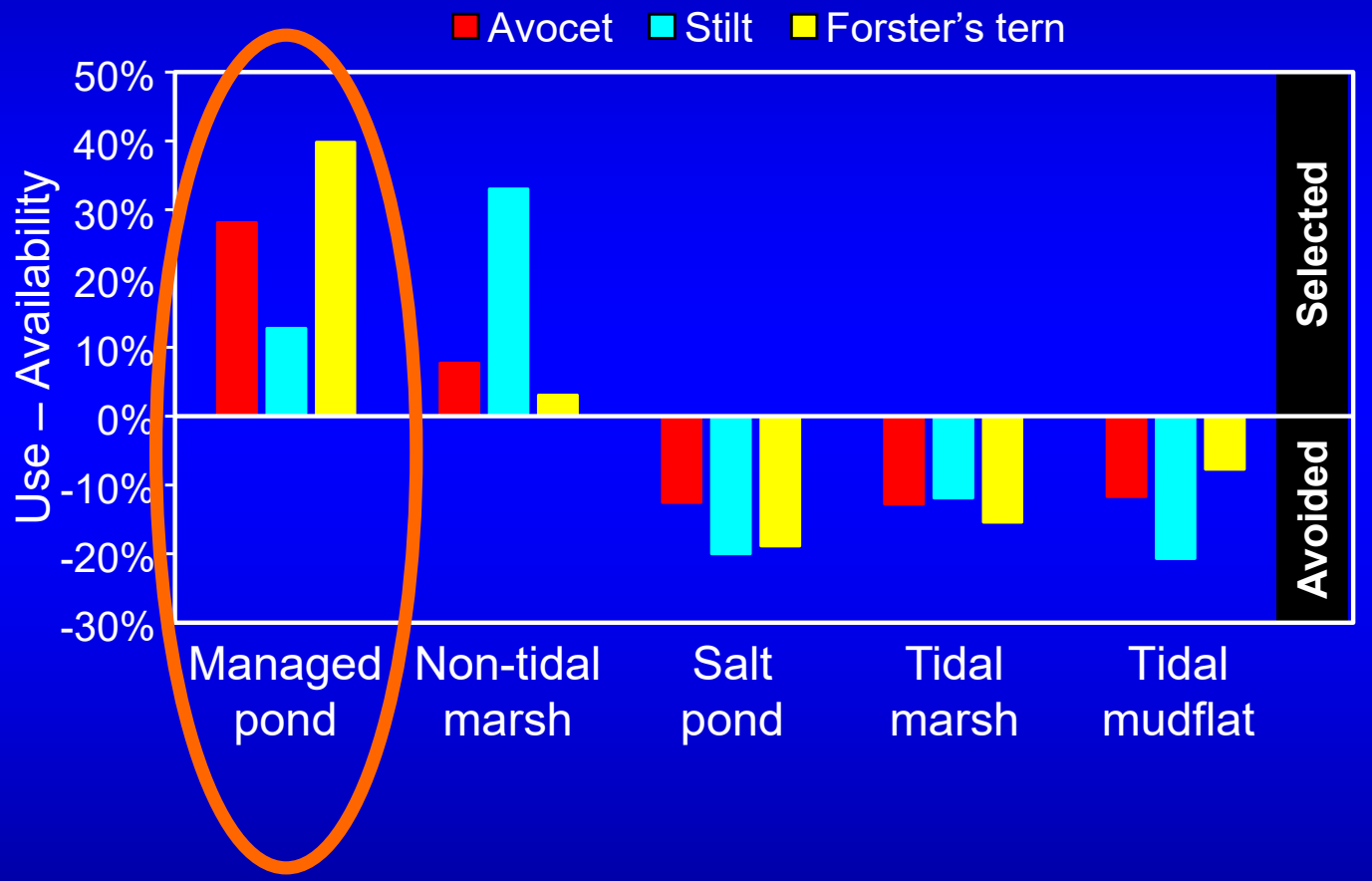


Black-necked stilt



Forster's tern





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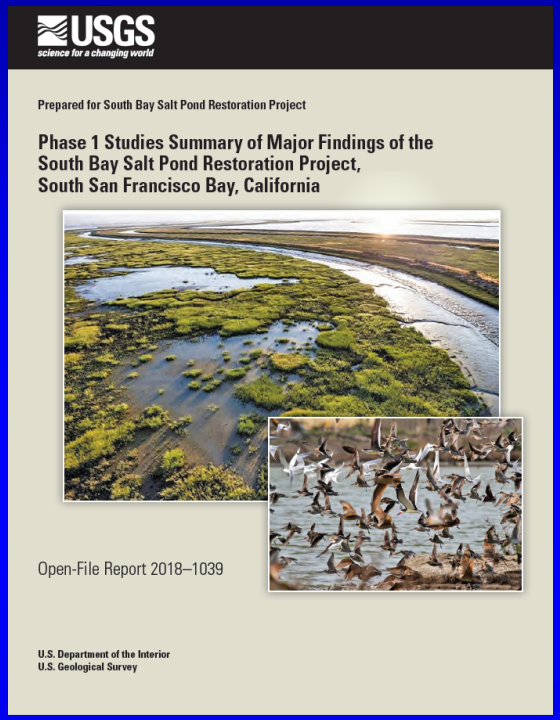
Hartman et al. 2021 San Francisco Estuary and Watershed Science 19:3:4

Restoration Project's Phase 1 Assessment



	Key Uncertainties: *Can the existing number and diversity of migratory and breeding shorebirds and waterfowl in the Project area be supported with reductions in salt pond acreage?*	**Score**
1	Is the number of **diving ducks** maintained?	
2	Is the number of **ruddy ducks** maintained?	
3	Will managed ponds provide foraging and roosting habitat for **migratory shorebirds**?	
4	Will managed ponds provide breeding habitat to support sustainable densities of **snowy plovers**?	
5	To what extent will the creation of large isolated pond **islands** maintain numbers and reproductive success of **terns, avocet, and stilts**?	
6	Will reconfigured and managed ponds significantly increase the prey base for, and pond use by, **waterfowl, shorebirds, and phalaropes/grebes**?	
7	Is the number of **California least terns** in the Project area maintained?	

Meets/exceeds expectations | Uncertain, trending positive | Uncertain | Uncertain, trending negative | Not meeting expectations

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Valoppi 2018 U.S. Geological Survey, Open File Report 2018-1039

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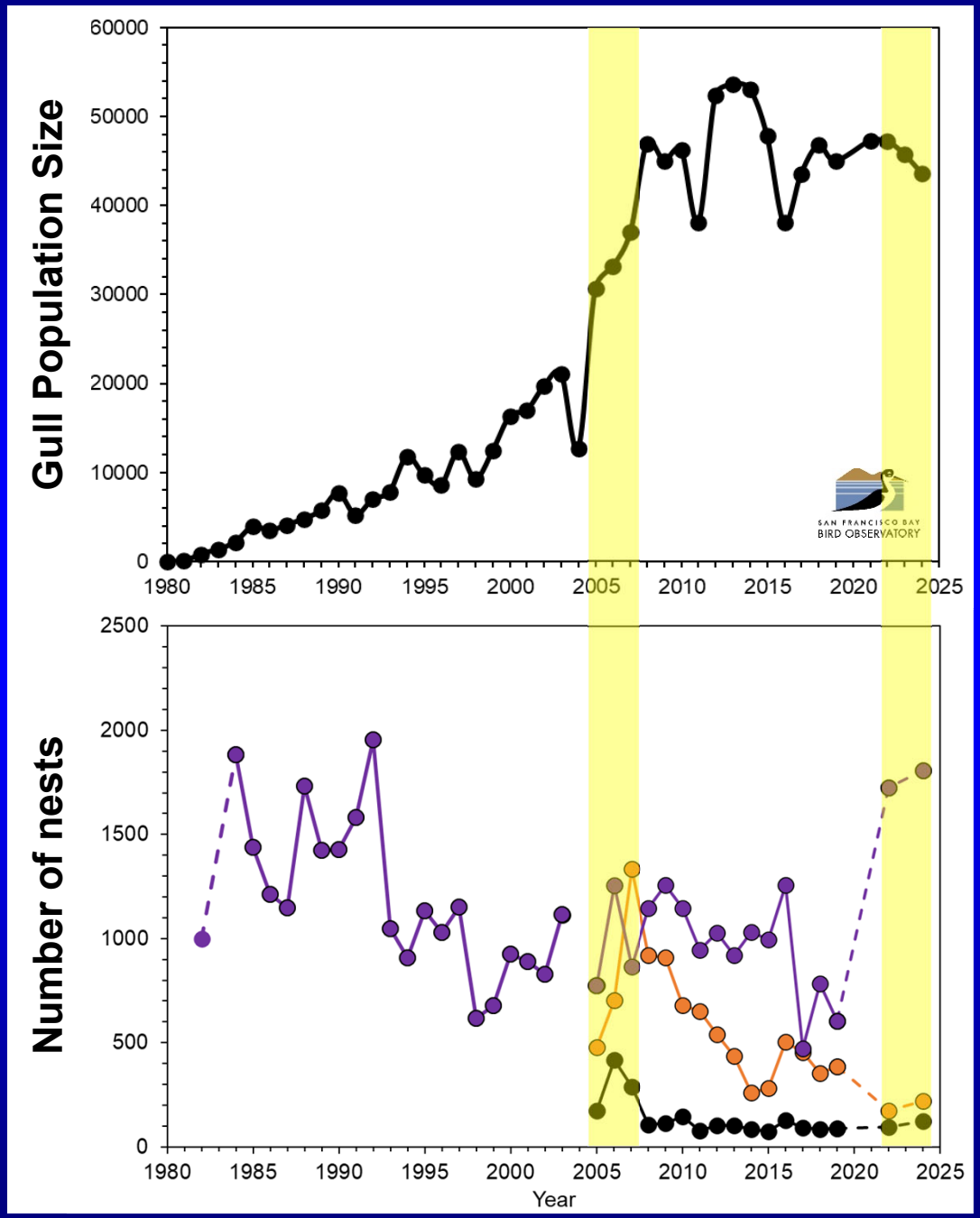
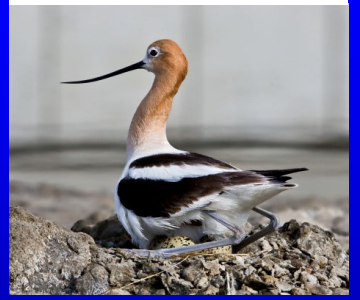
Breeding Populations in San Francisco Bay



California Gull: +36%

Forster's Tern: +83%

American Avocet: -76%



Black-necked Stilt: -62%

Strong et al. 2004 Waterbirds 27:411-423

Burns et al. 2018 Studies of Western Birds 3:180-189

Hartman et al. 2021 San Francisco Estuary and Watershed Science 19:3:4

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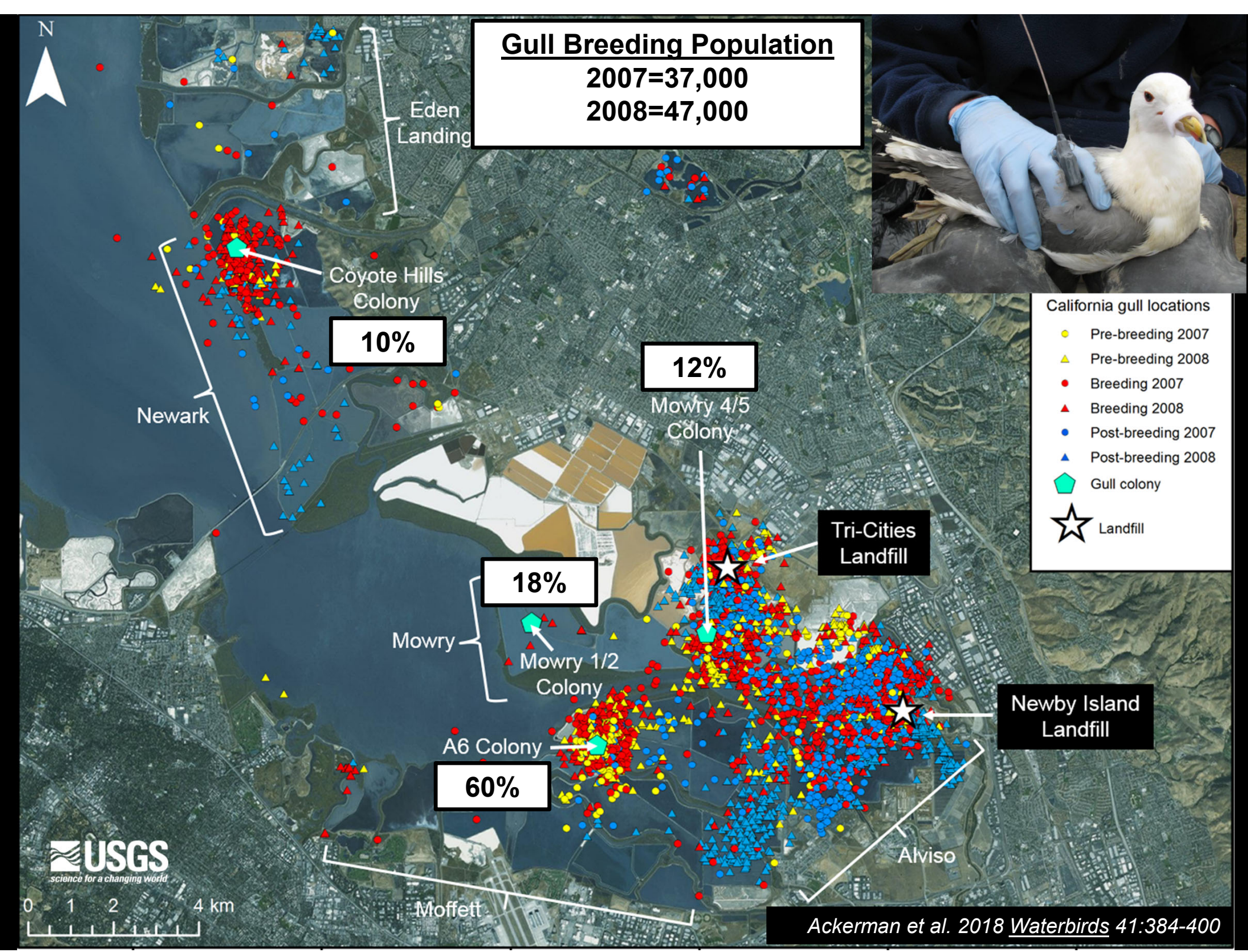
Gull Breeding Population
2007=37,000
2008=47,000
N
Eden Landing
Coyote Hills Colony
10%
Newark
12%
Mowry 4/5 Colony
Tri-Cities Landfill
18%
Mowry
Mowry 1/2 Colony
Newby Island Landfill
A6 Colony
60%
Alviso
Moffett
California gull locations
Pre-breeding 2007
Pre-breeding 2008
Breeding 2007
Breeding 2008
Post-breeding 2007
Post-breeding 2008
Gull colony
Landfill
USGS
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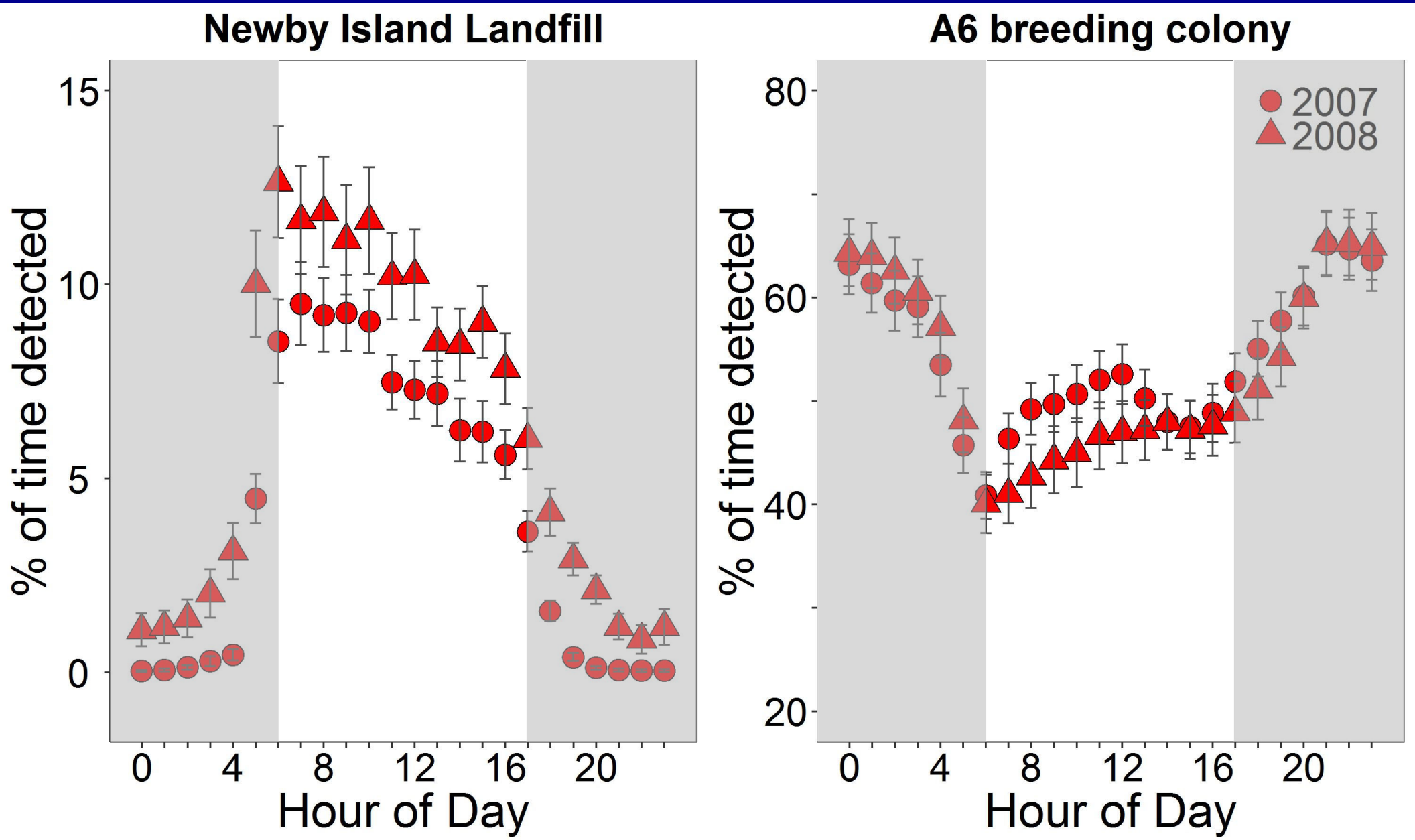
0 1 2 4 km
Ackerman et al. 2018 Waterbirds 41:384-400

Gulls Use Landfills During Day Operations & Colonies at Night



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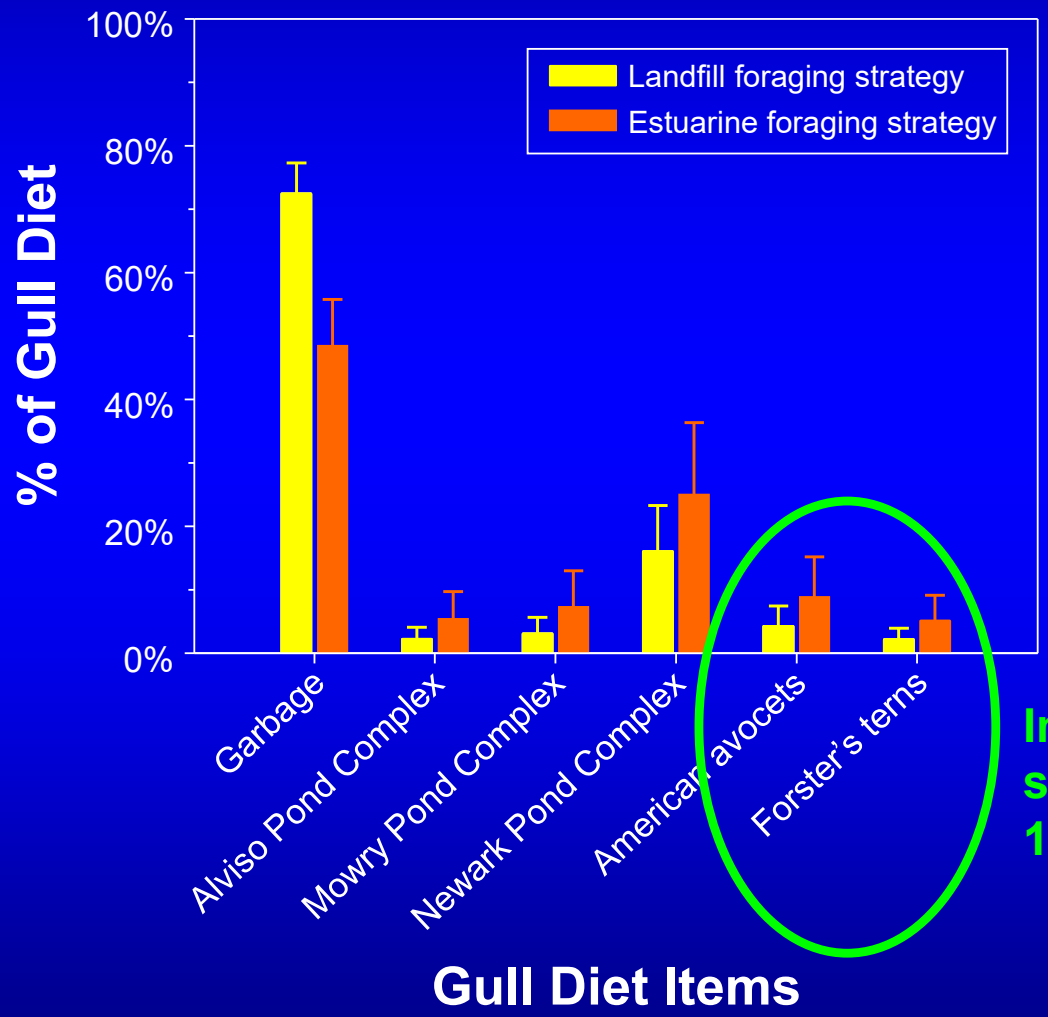
Ackerman et al. 2018 Waterbirds 41:384-400

Gull Diet in San Francisco Bay

(based on stable isotope analysis)



Individual gulls will specialize on prey; 1 gull killed ≥11 tern chicks

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Peterson et al. 2017 Ecological Indicators 74:205-215

Gull Predation on Waterbird Eggs and Chicks

Eggs

11% of depredation on avocet & stilt

Chicks

55% of avocet, 15% of stilt, 54% of tern chick deaths

Ackerman et al. 2014 Journal of Wildlife Management 78:818-829

Ackerman et al. 2014 Journal of Avian Biology 45:609-623

Herring et al. 2011 Southwestern Naturalist 56:35-43

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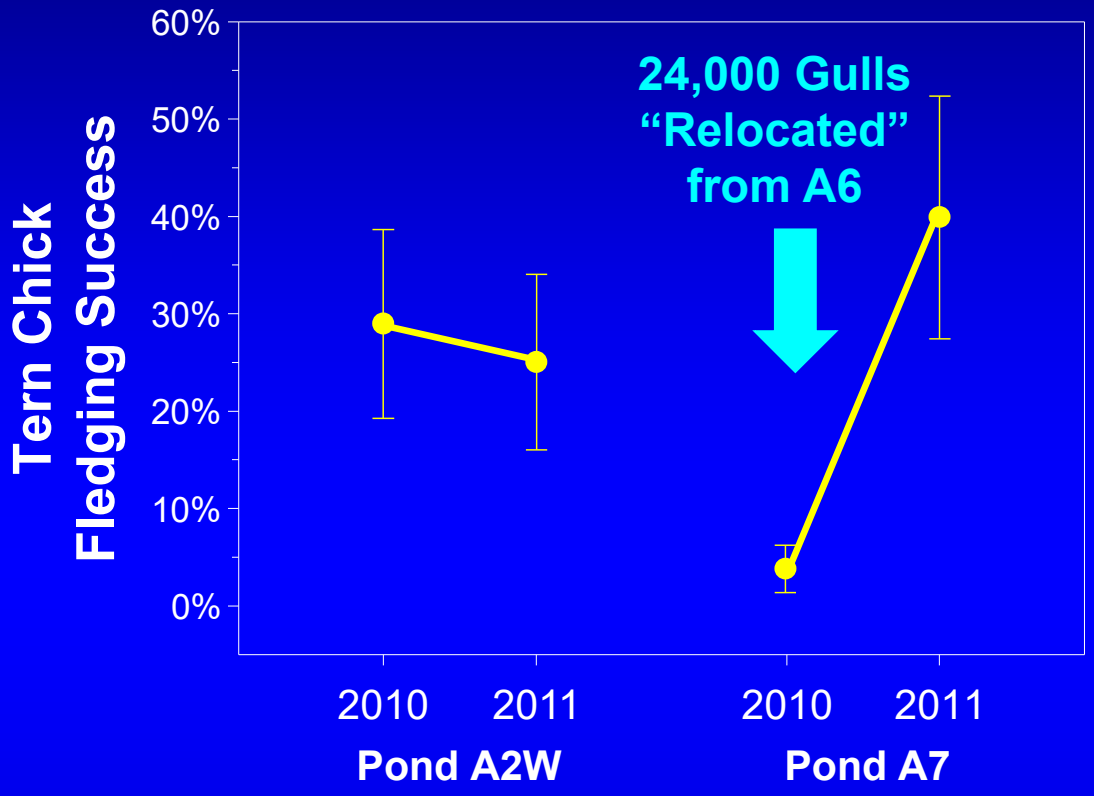
900% Increase in Tern Chick Survival After Gull Colony Relocation



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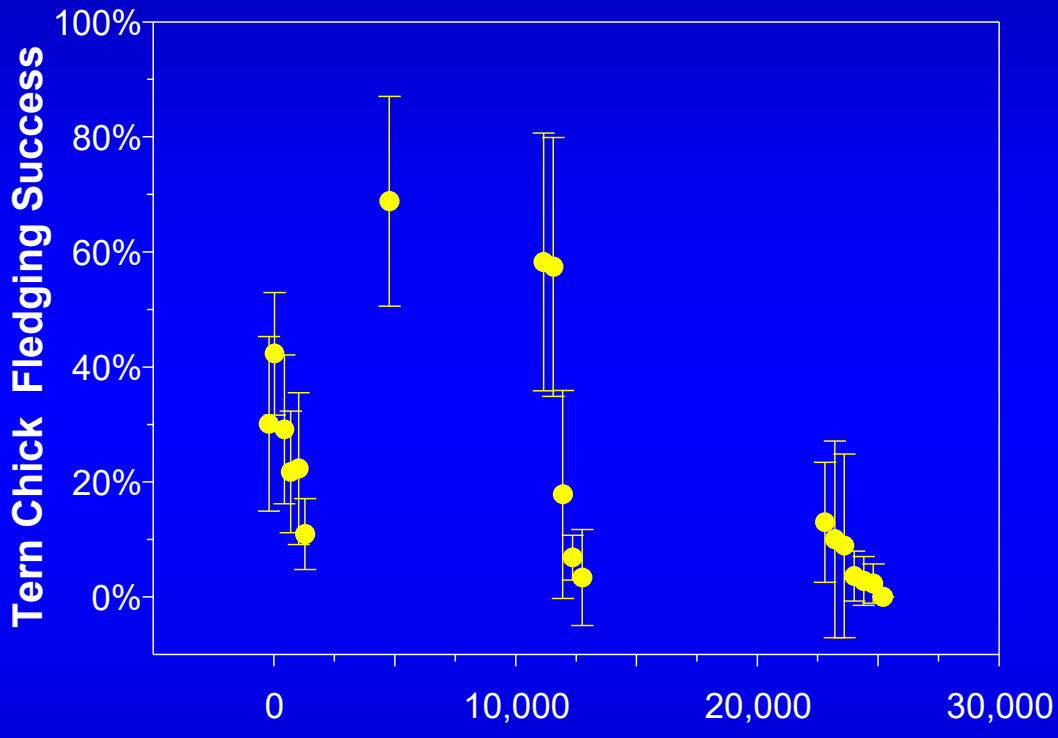
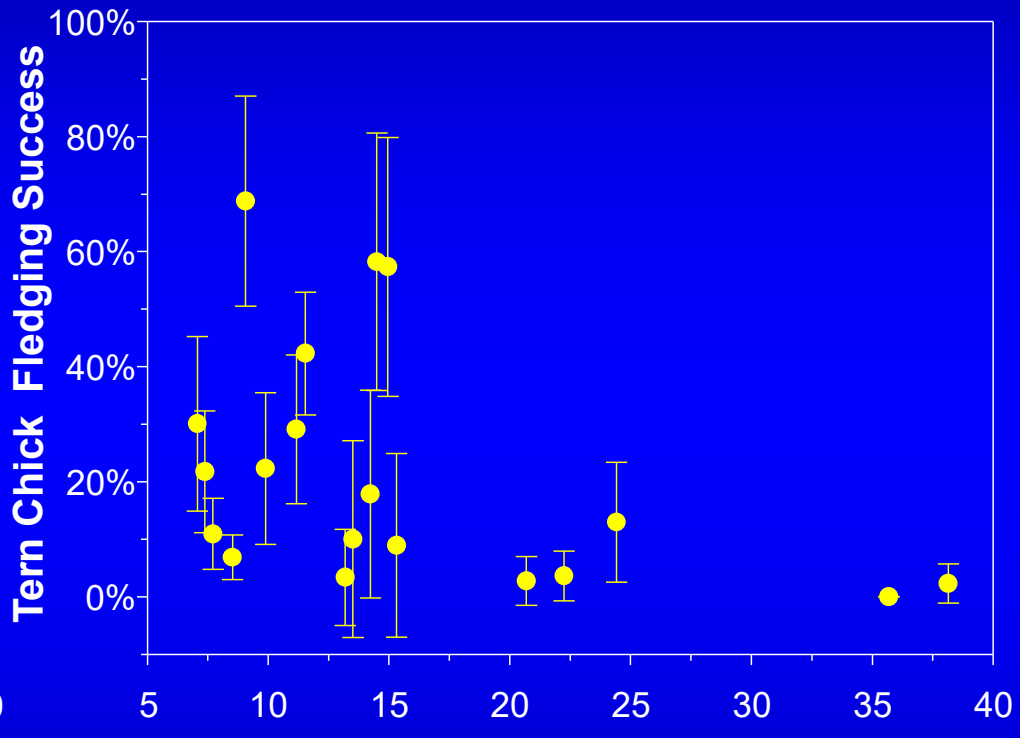
Ackerman et al. 2014 Journal of Wildlife Management 78:818-829

Tern Chick Fledging Success Declines with Gull Colony Size & Location



Number of Gulls at Nearest Gull Colony



Gull Predation Pressure Index 1
(each tern colony in relation to all gull colonies' distance and size)

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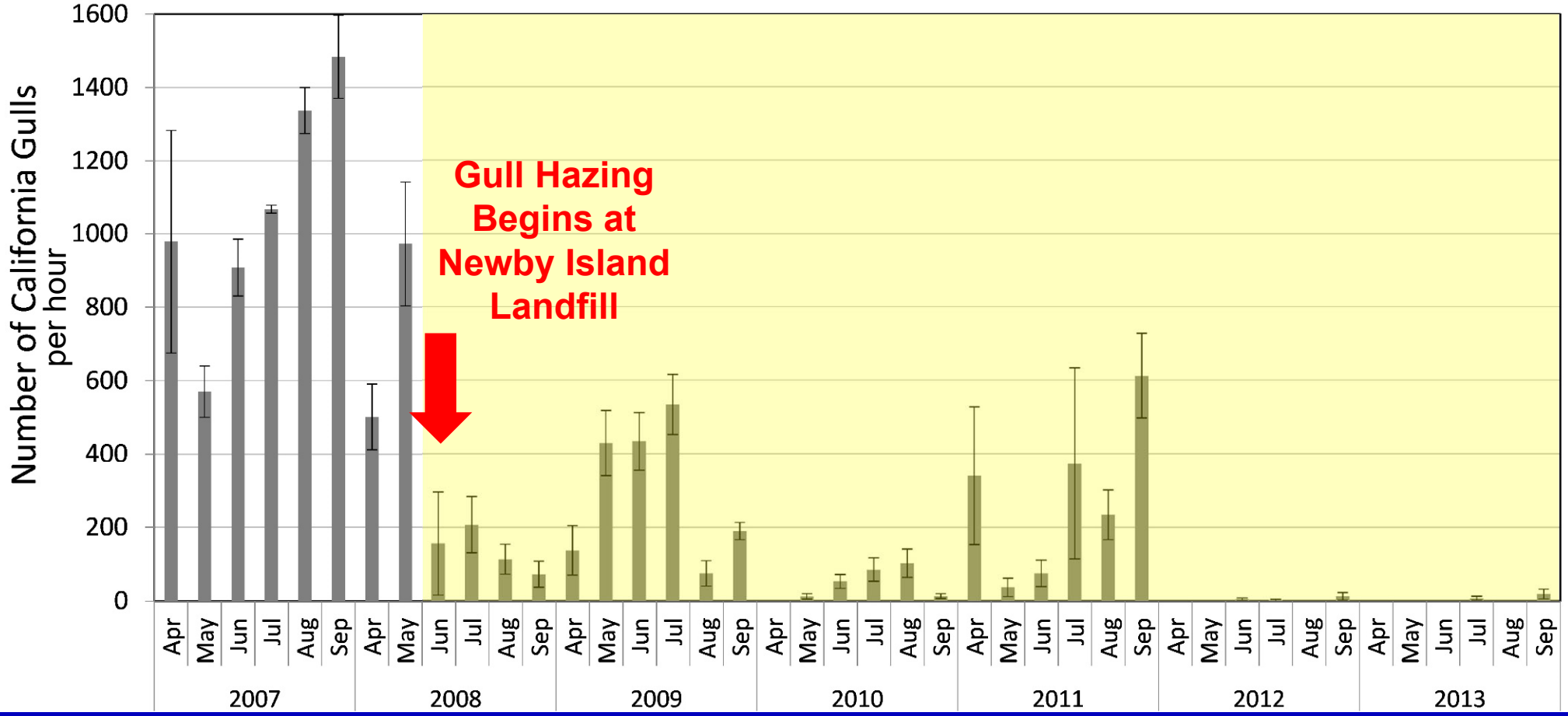
Ackerman et al. 2014 Journal of Wildlife Management 78:818-829

Hazing Gulls at Landfills Works, But…



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SAN FRANCISCO BAY BIRD OBSERVATORY

Burns et al. 2018. Studies of Western Birds 3:180-189

Hazing Gulls at Landfills Works, But…Now Gulls Just Travel to Further Landfills

Vasco Road Landfill

Altamont Landfill

Recology Composting

Coyote Hills Gull Nesting Colony

Newby Island Landfill

Alviso Gull Nesting Colony

Regional Wastewater Facility

Max Distance from Nest=64km

- Gull Nesting Colony
- Don Edwards Refuge
- Eden Landing Ecological Reserve

N

0 10 20 km

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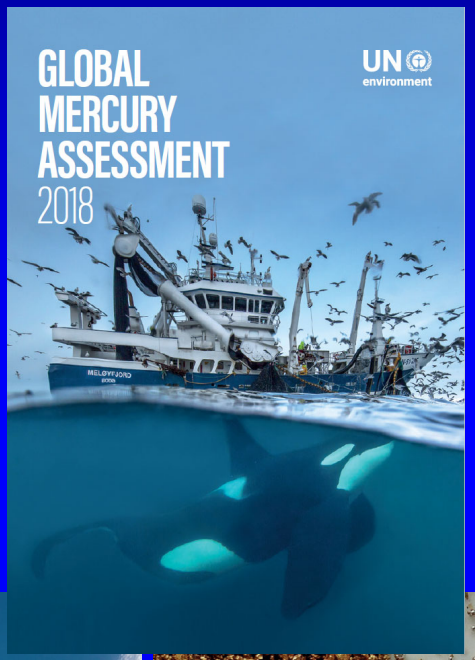
Another Threat to Birds: Mercury Toxicity

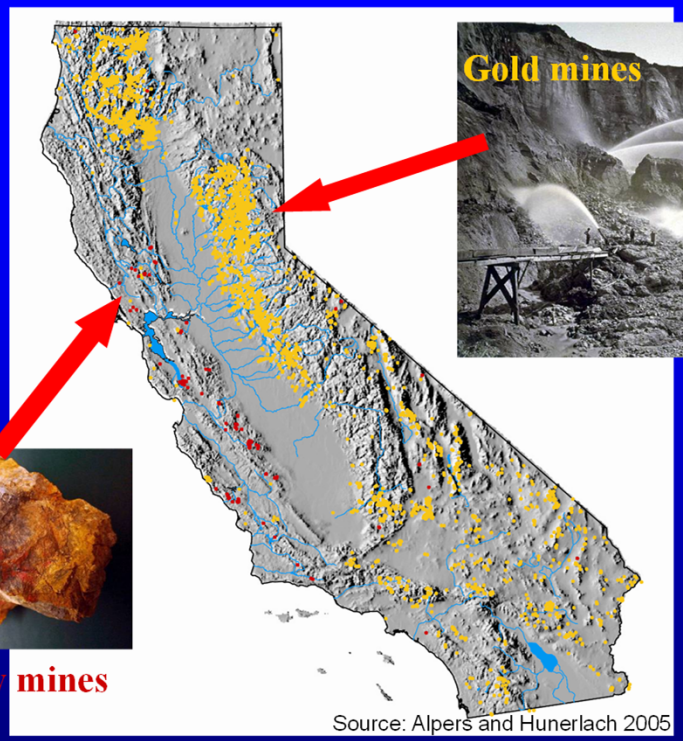
Effects on Human and Animal Health, Especially Impaired Reproduction

UN environment programme

MINAMATA CONVENTION ON MERCURY



Mercury mines



Source: Alpers and Hunerlach 2005

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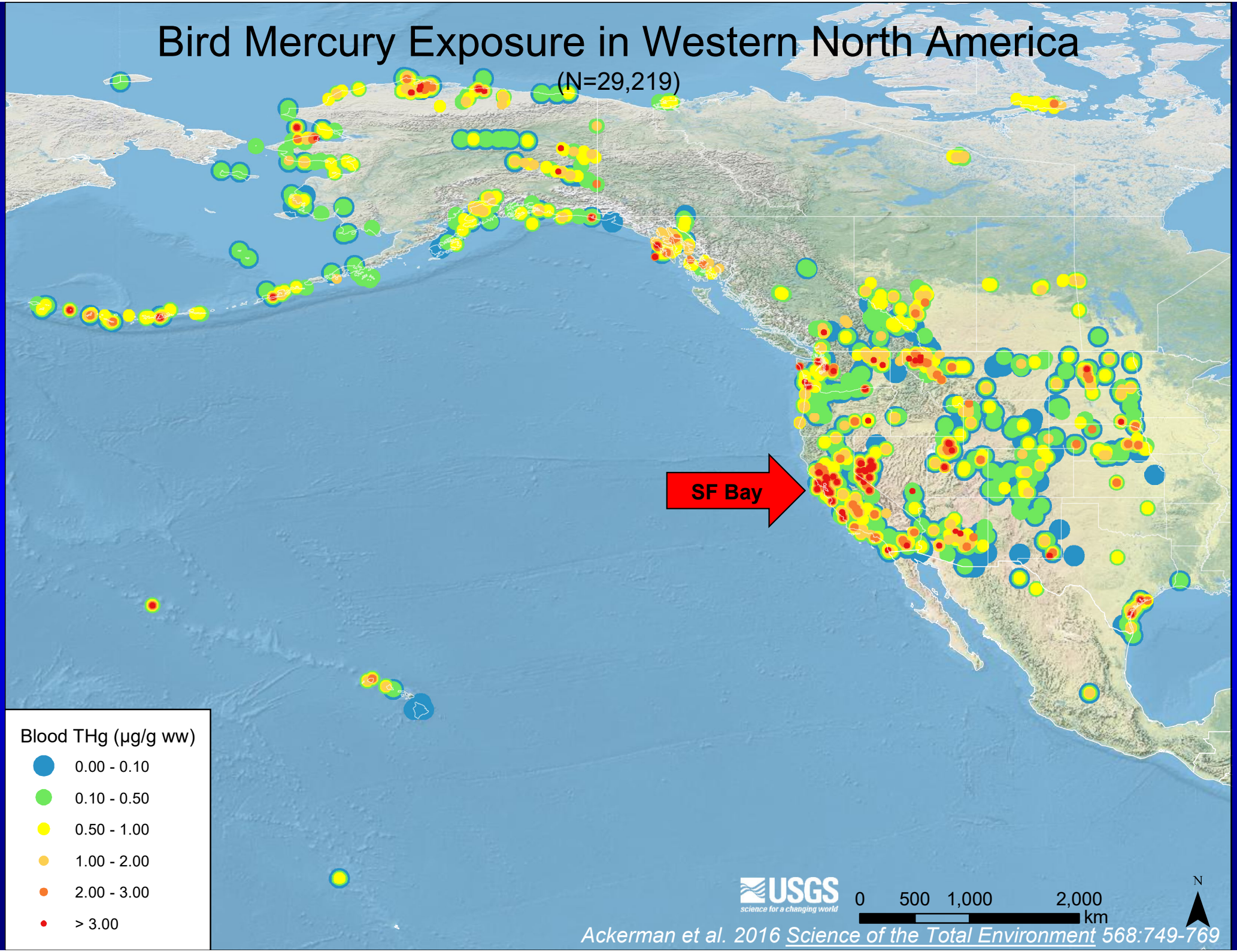
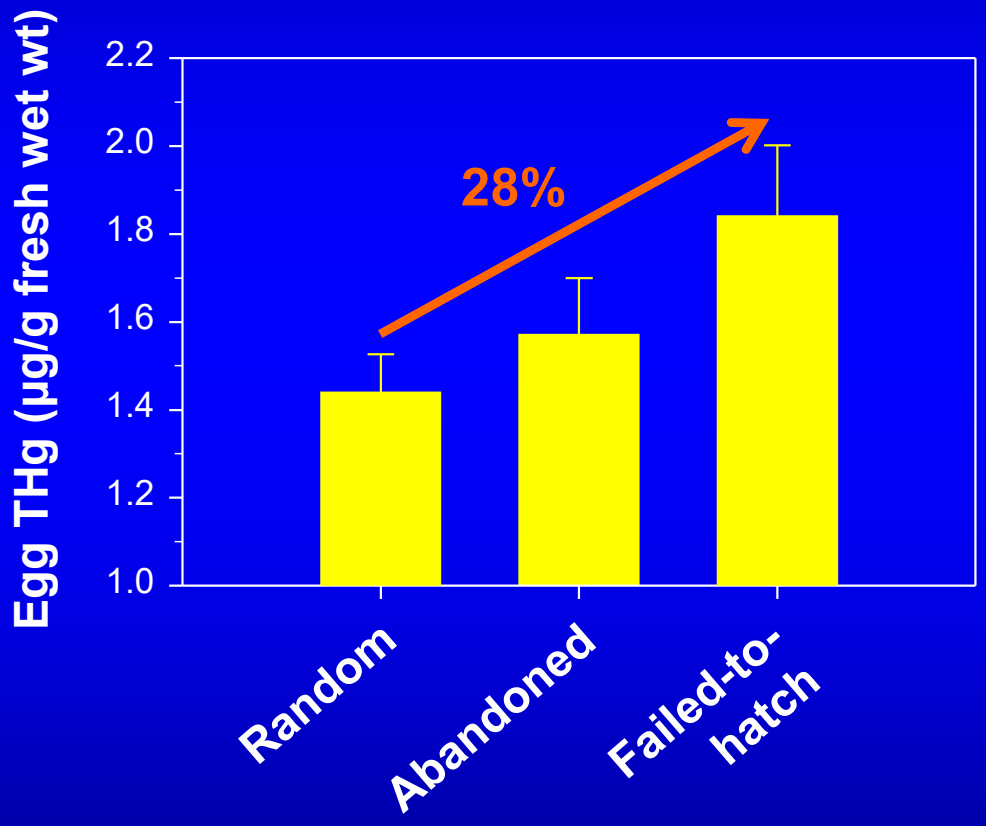
Bird Mercury Exposure in Western North America

(N=29,219)



Ackerman et al. 2016 Science of the Total Environment 568:749-769

Mercury Highest in Failed-to-Hatch Tern Eggs



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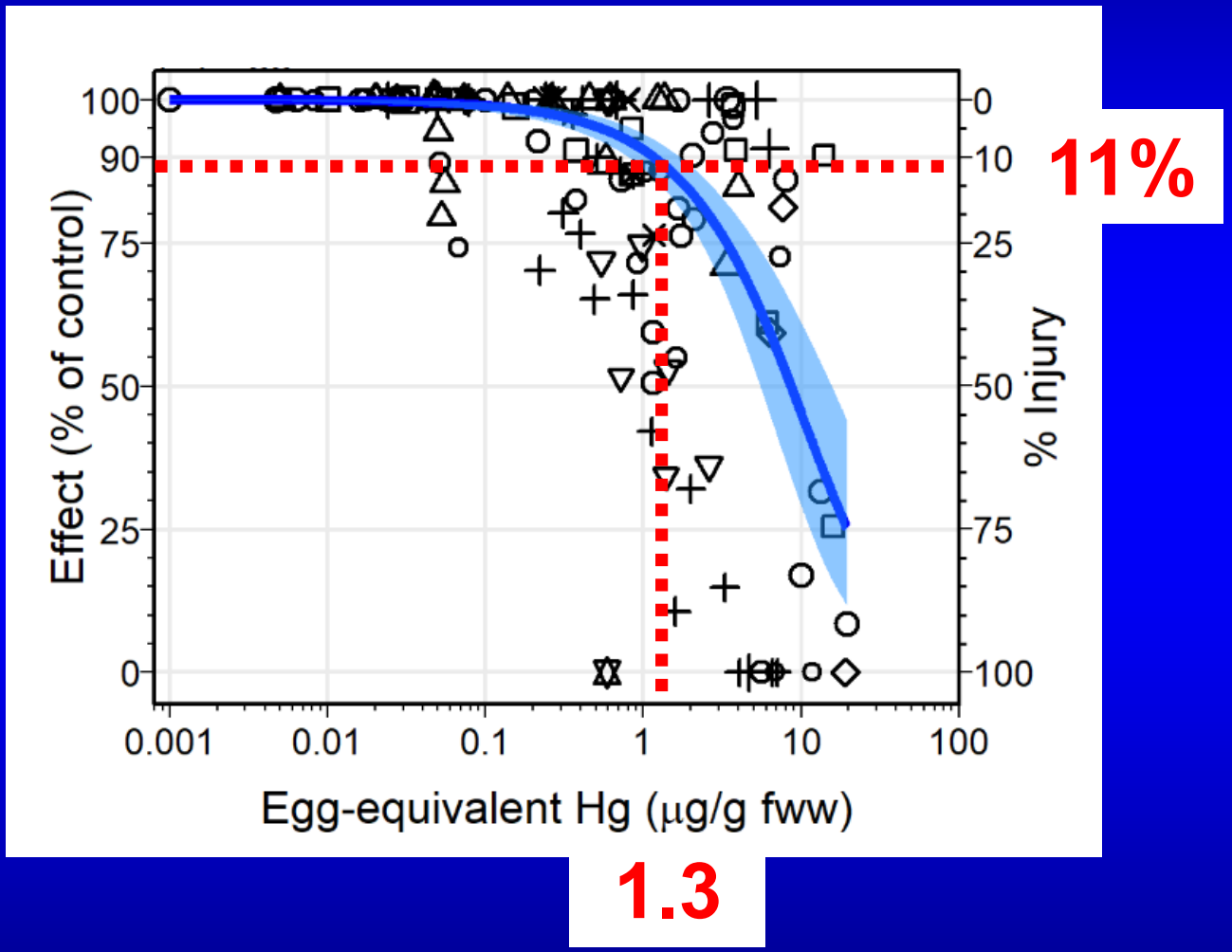
Ackerman et al. 2014 U.S. Geological Survey Open File Report 2014-1251

Egg Survival Declines with Mercury Contamination



Natural Resource Damage Assessment and Restoration Program
Restoration Program

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Ackerman et al. 2024 Environmental Toxicology and Chemistry 43:1195-1241

Ackerman et al. 2024 U.S. Geological Survey Software Release, https://doi.org/10.5066/P9MSD8X0

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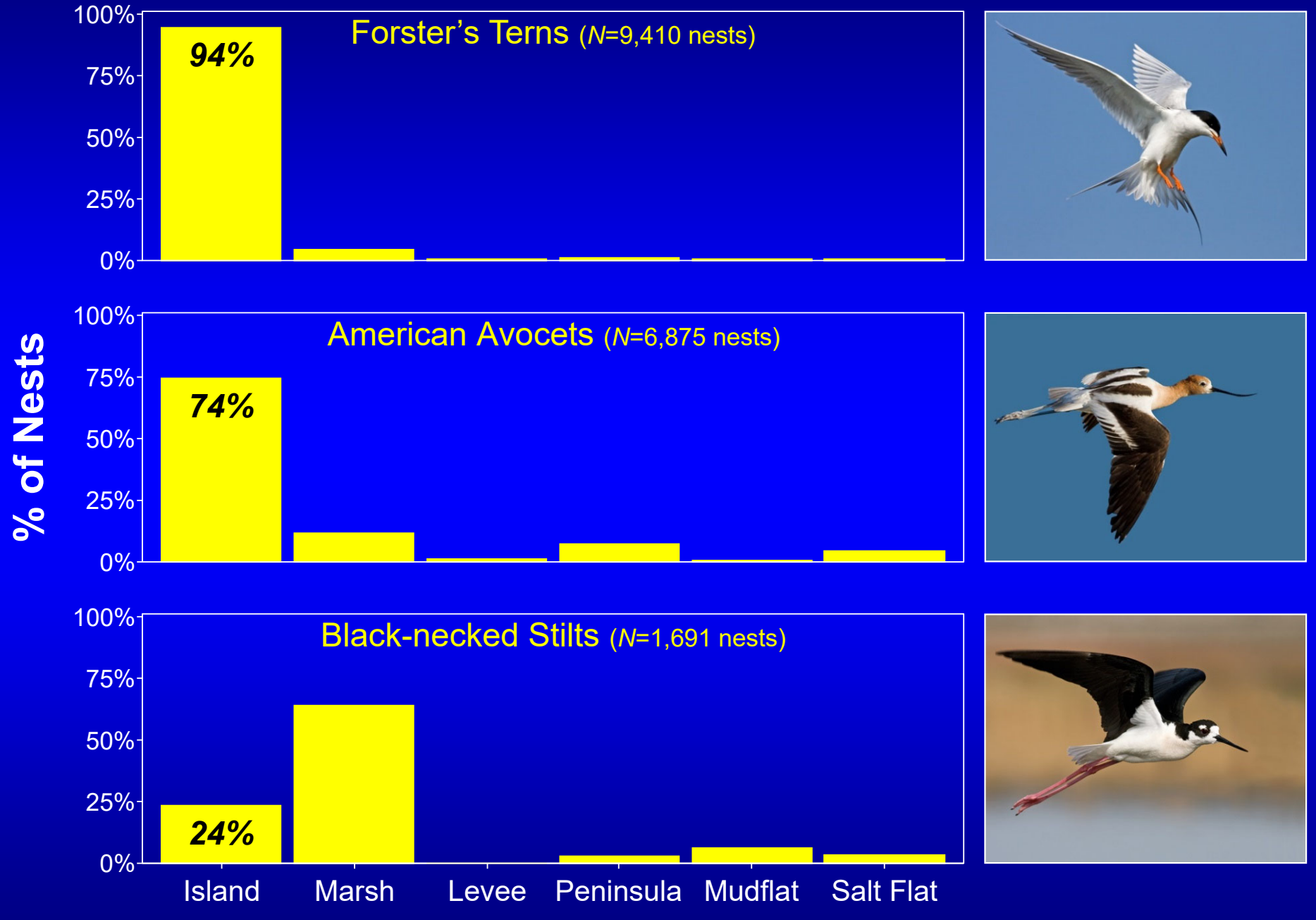
Nests Are On Islands In Managed Ponds



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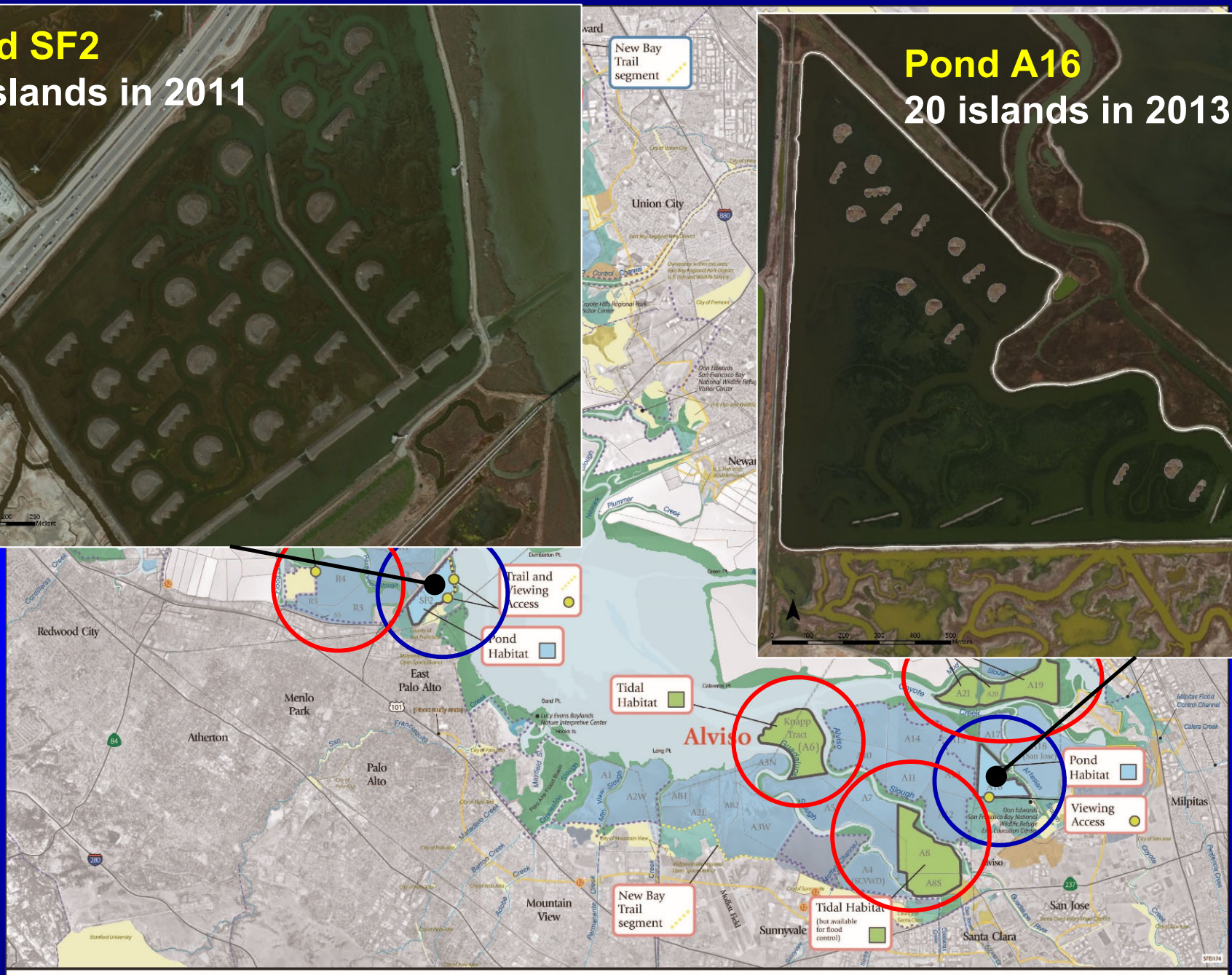
Ackerman et al. 2014 U.S. Geological Survey, open File Report 2014-1263

South Bay Salt Pond Restoration Project



Initial Restoration Actions

South Bay Salt Pond Restoration Project

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Constructing Island Nesting Habitat

1) How many islands to put in a wetland?
2) Location of island within wetland?
3) Size and shape of island?
4) Topography of island?

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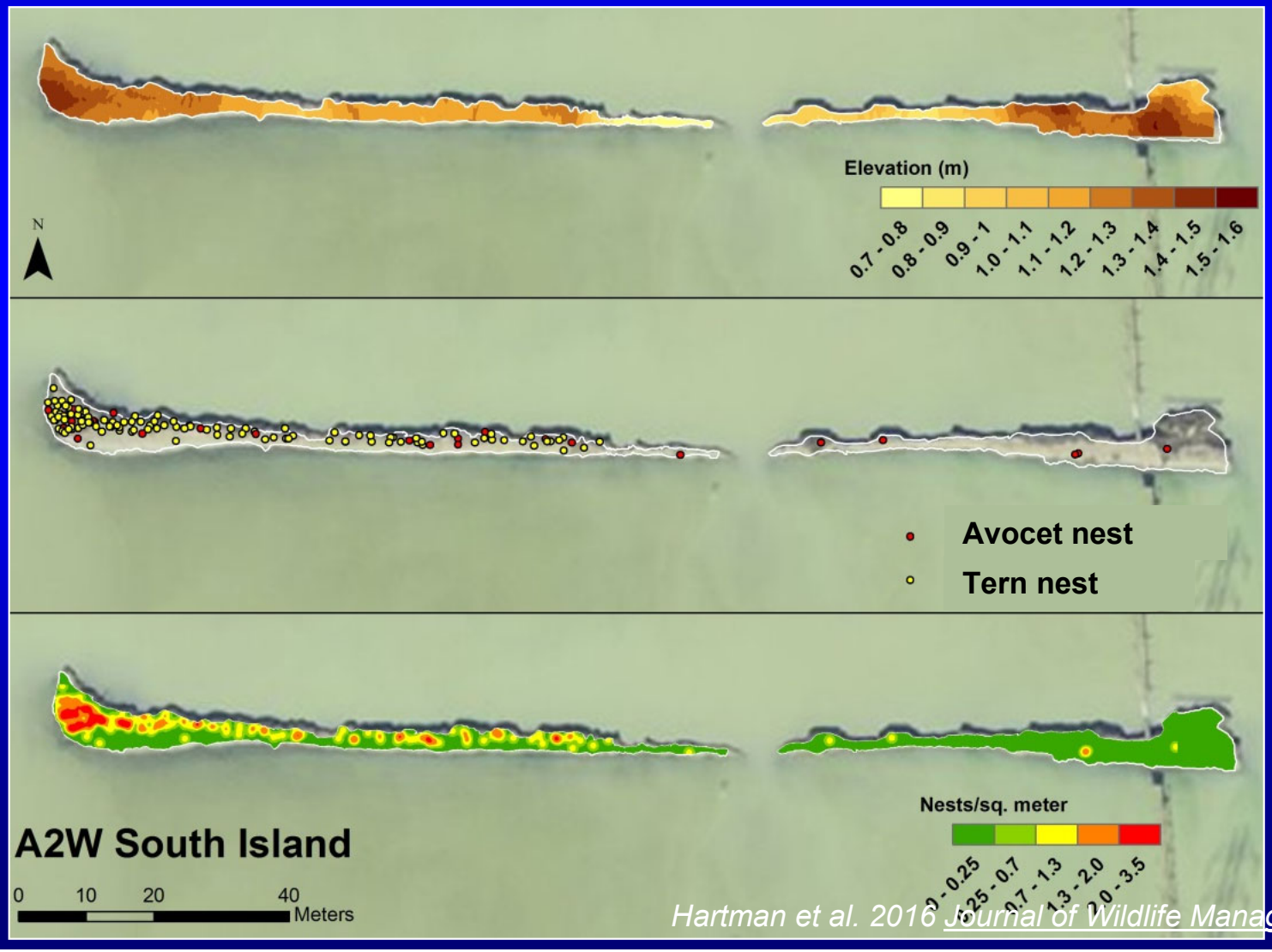
Island Topography & Nest Site Selection

Real-time kinetics (RTK) GPS (1cm accuracy)

- Topography of 30 nesting islands
- Locations of >1,600 nests on islands



Island Elevation

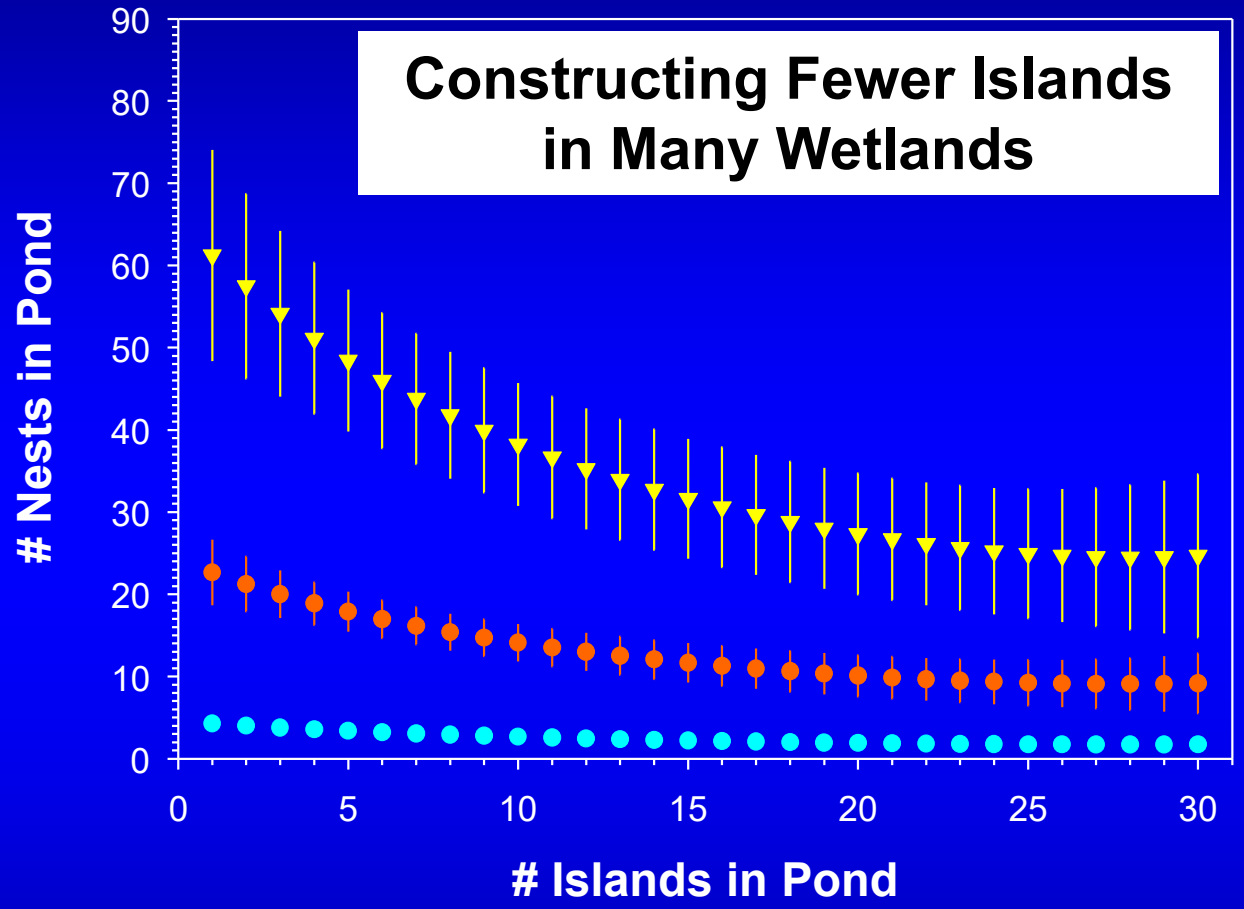
Nest Locations

Nest Densities

USGS science for a changing world

Hartman et al. 2016 Journal of Wildlife Management 80:1177-1188

Number of Nesting Islands Within Wetlands



Forster's Terns
Avocets
Stilts

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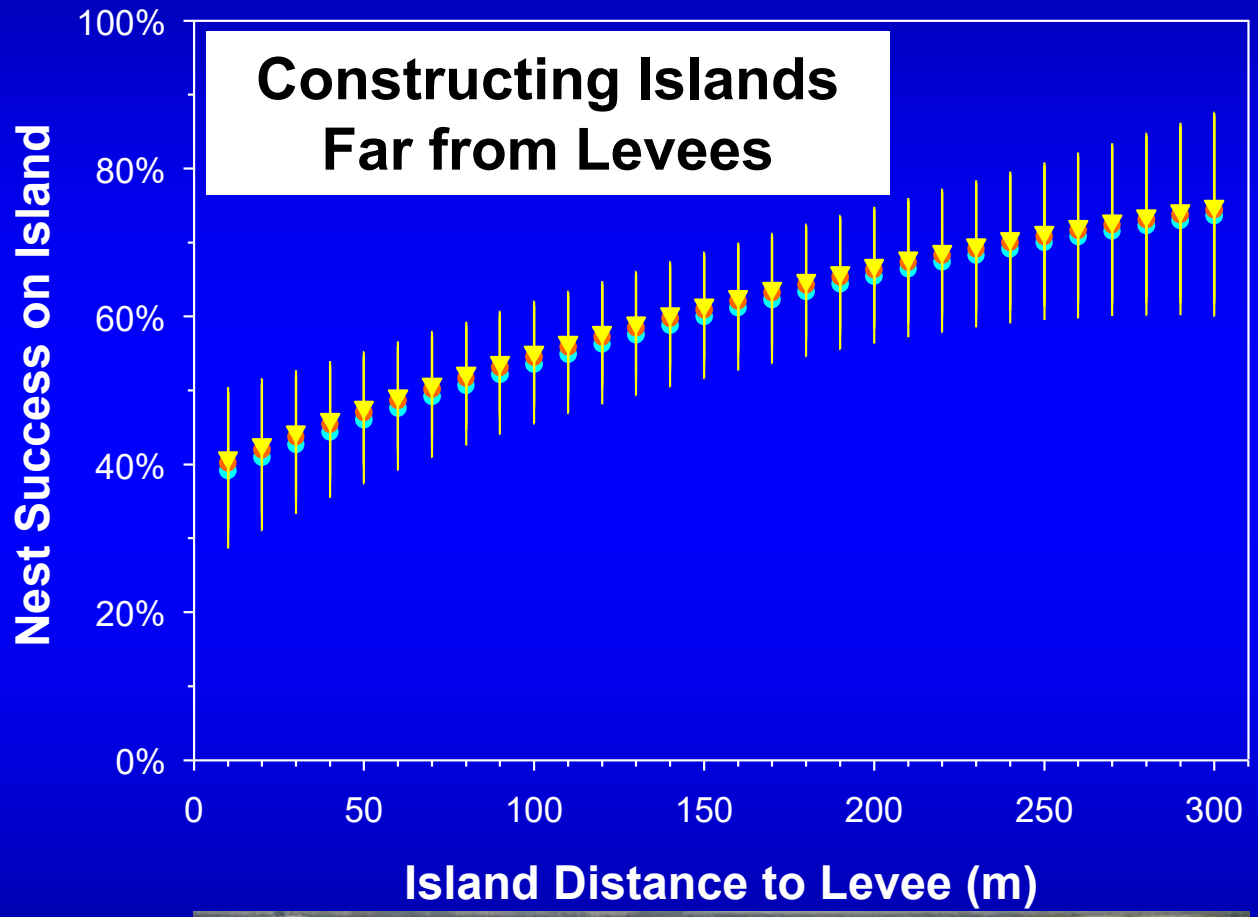
Hartman et al. 2016 Journal of Wildlife Management 80:1177-1188

Nesting Island Location Within Wetlands



Forster's Terns
Avocets
Stilts

Hartman et al. 2016 Journal of Wildlife Management 80:1177-1188

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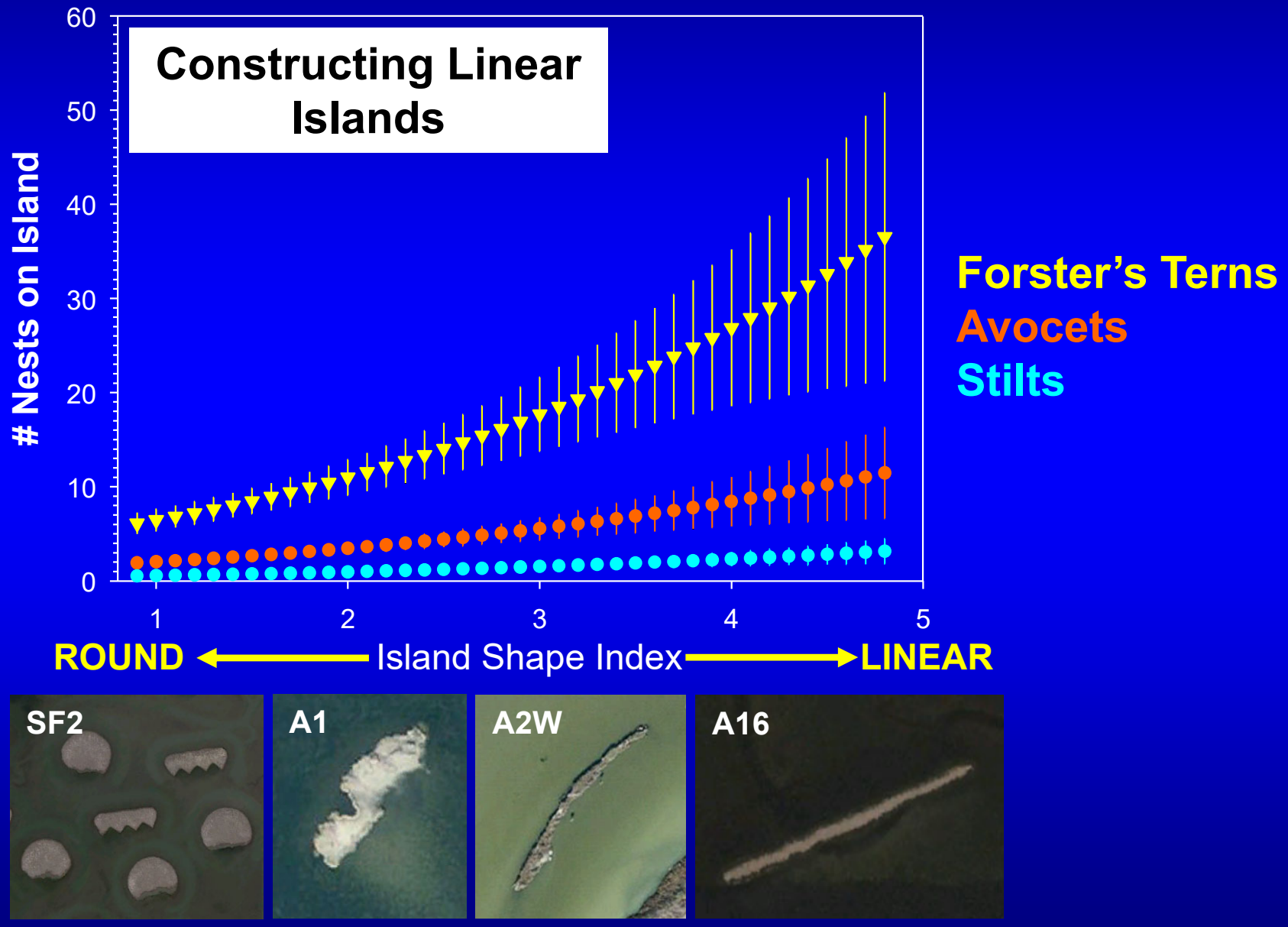
Nesting Island Shape



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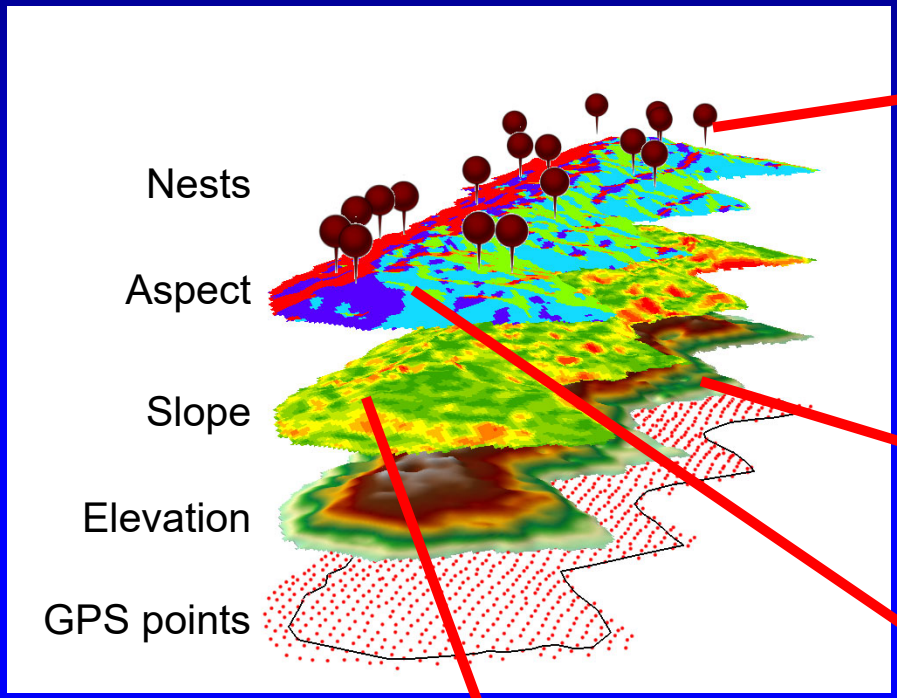
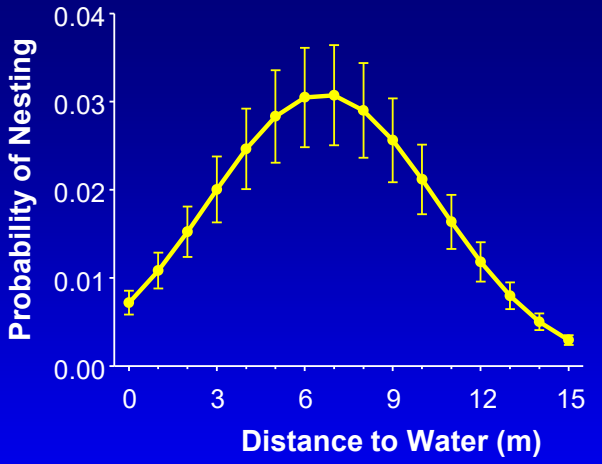
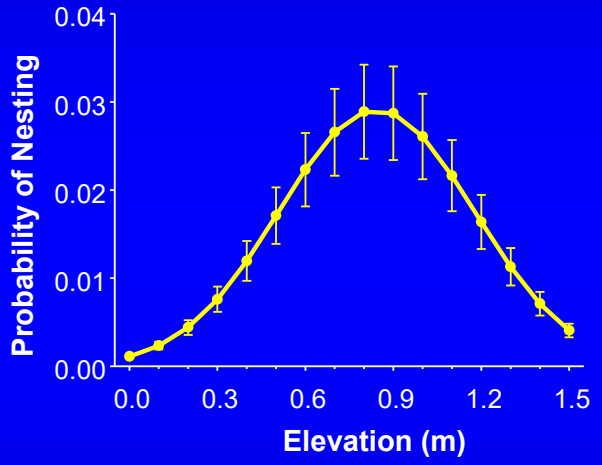
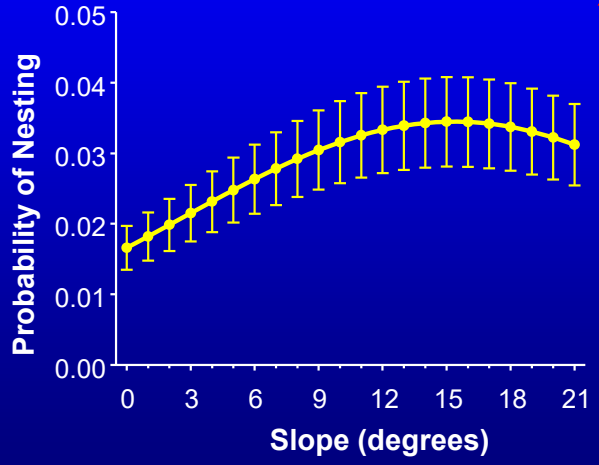
Hartman et al. 2016 Journal of Wildlife Management 80:1177-1188

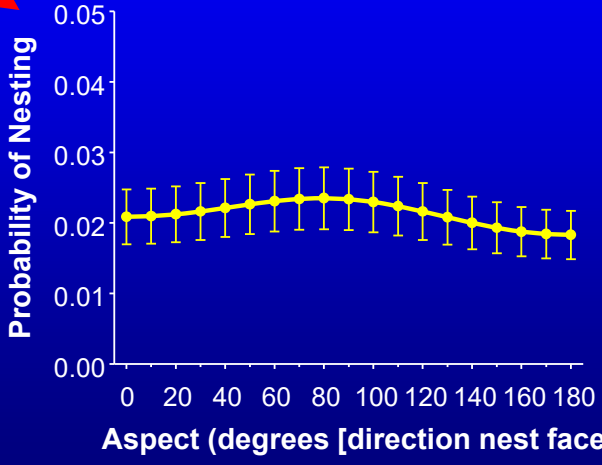
Nest Site Location on Islands











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Hartman et al. 2016 Journal of Wildlife Management 80:1267-1279

Recipe for Constructing Island Nesting Habitat

Where should nesting islands be built?

- Near (<1km) SF Bay
- >100m from pond levees

How many islands should be built in a wetland?

- 3-5 islands within many different wetlands

How big and what shape should islands be?

- Small (0.05-0.10 ha)
- Linear (e.g., 50m×10m or 100m×10m)

Island topography?

- Elevation: 0.5–1.5m above the water surface
- Distance to water: ≤10m of the water's edge
- Slope: Both steep (avocets) and flat (terns)
- Aspect: South-facing, East-West linear islands

Vegetation?

- Include patches of 1) dense and short vegetation and 2) bare ground

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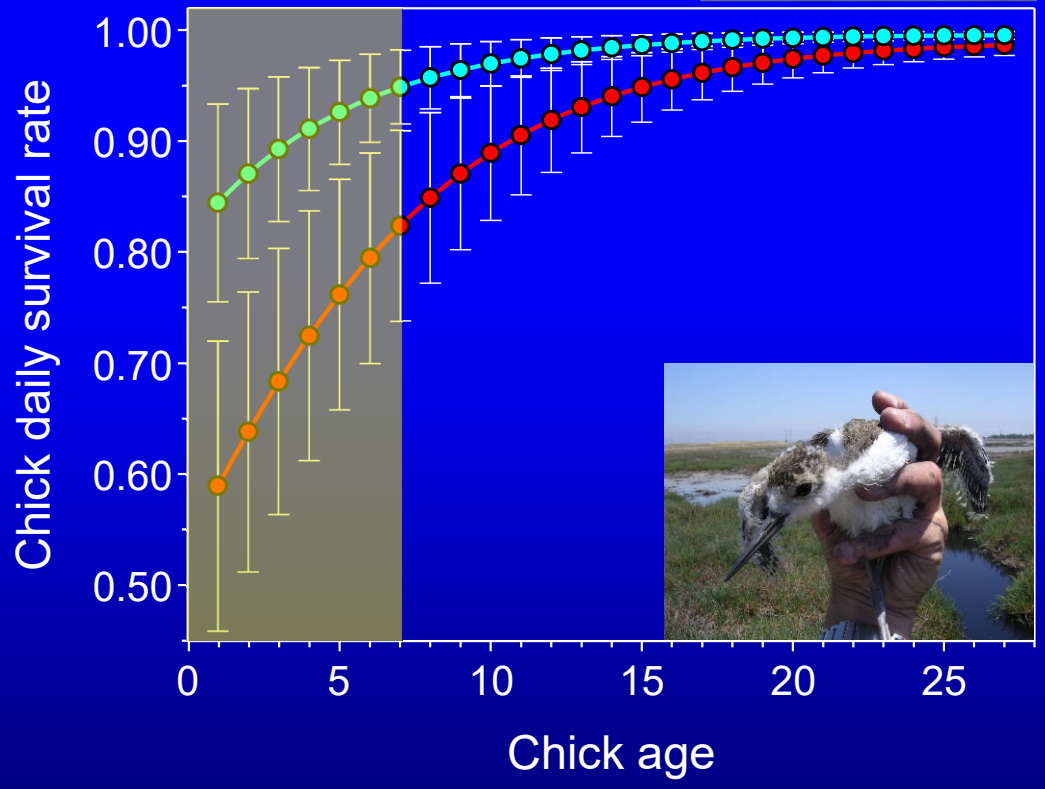
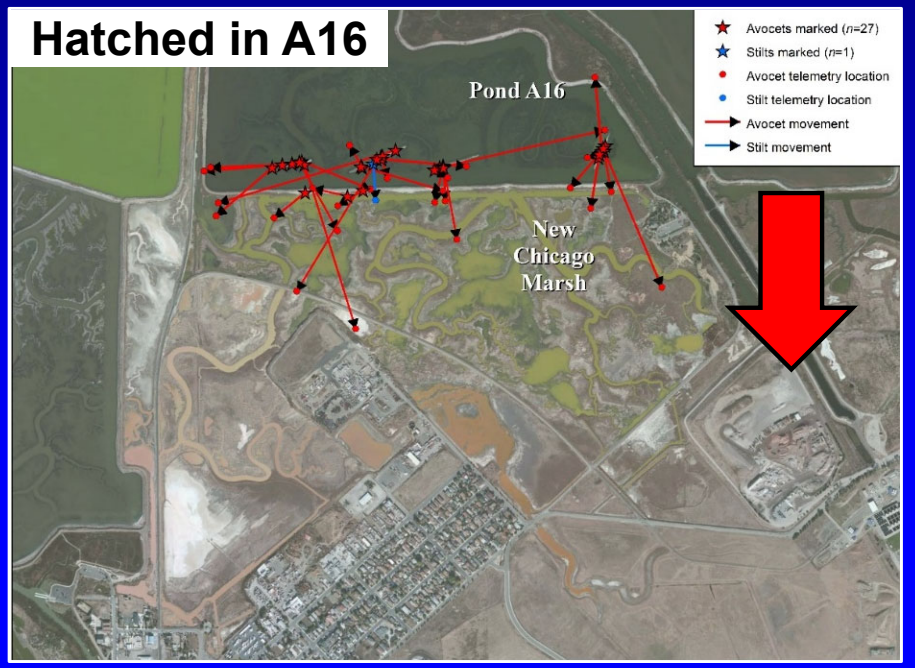
Ackerman et al. 2014 U.S. Geological Survey, open File Report 2014-1263

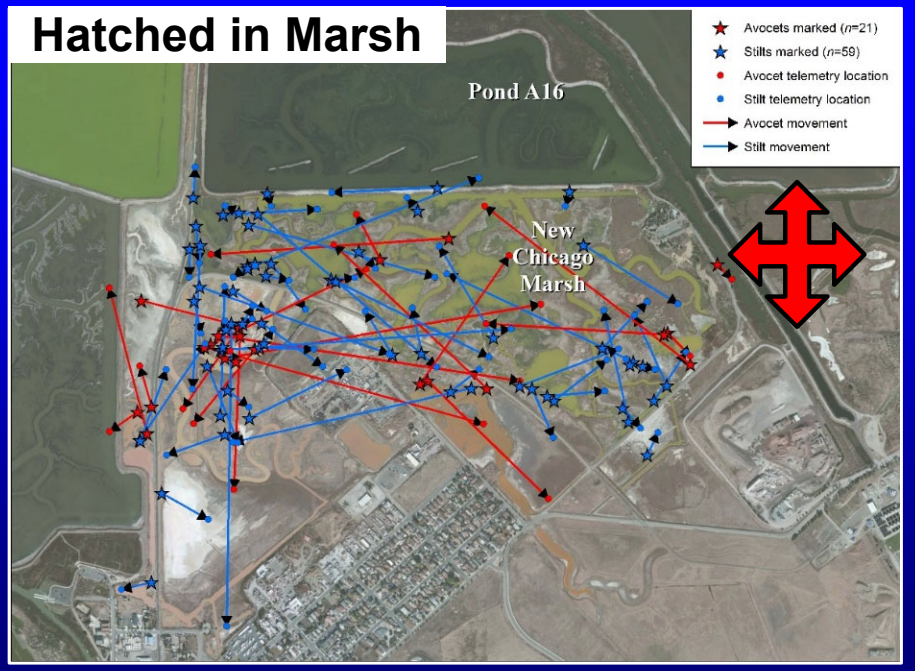
Chick Survival is Influenced by Habitat

Predation by Gulls
Stilt=15%
Avocet=55%

Survival to Fledging
Stilt=40%
Avocet=6%







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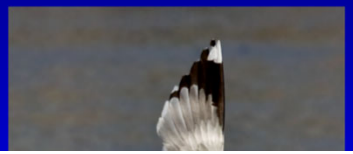
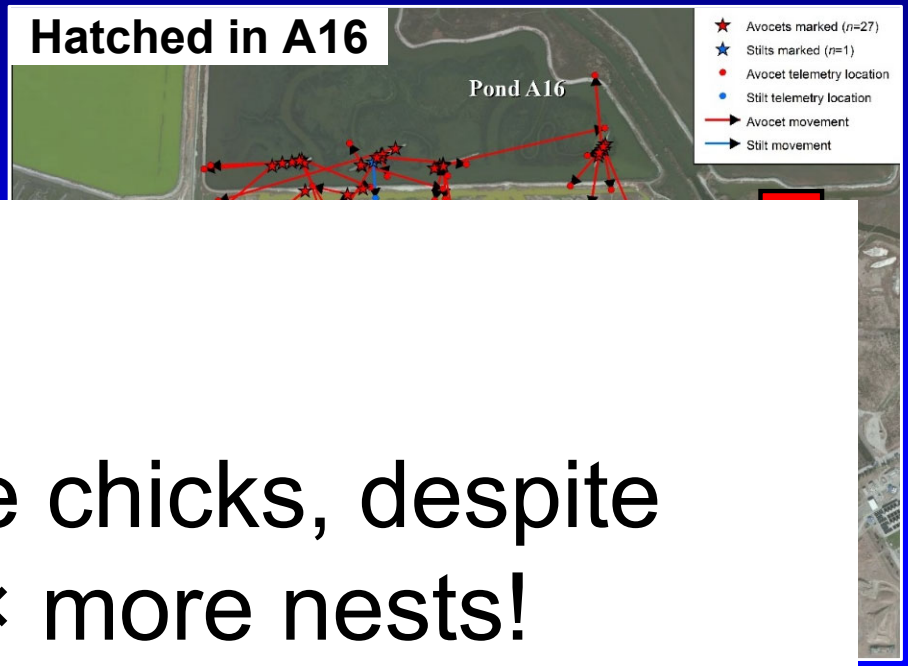
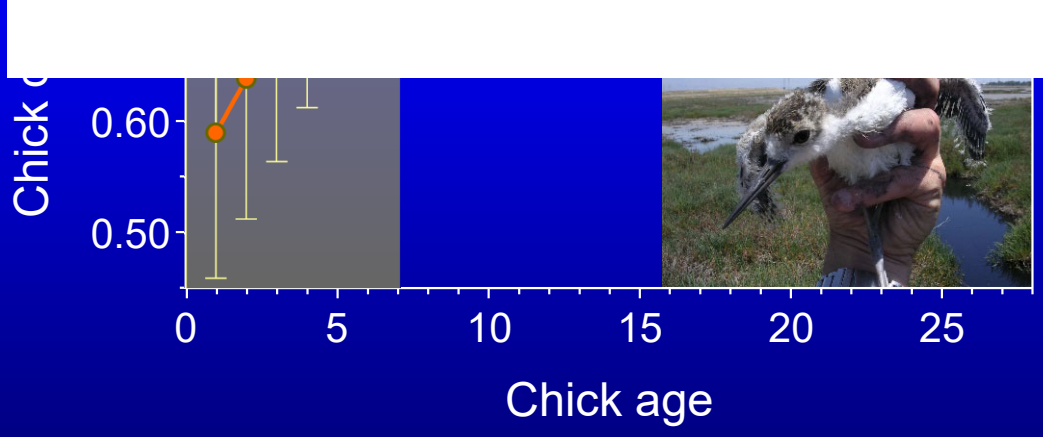
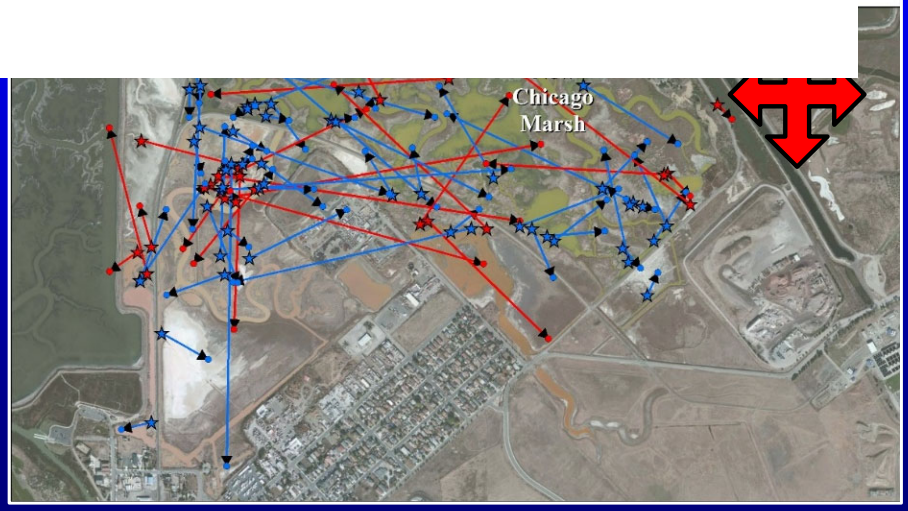




Stilts fledged 3.3× more chicks, despite Avocets producing 1.8× more nests!





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Ackerman et al. 2014 Journal of Avian Biology 45:609-623

Outline

Informing Wetland Management for Nesting Waterbirds

1) Some waterbird populations are declining
2) Predatory gulls are increasing
3) Mercury threatens breeding birds
4) Management of nesting islands
5) Establishing new nesting colonies
6) Future distribution of waterbirds

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Establishing New Bird Colonies Using Social Attraction

Decoys and electronic broadcasting of bird calls

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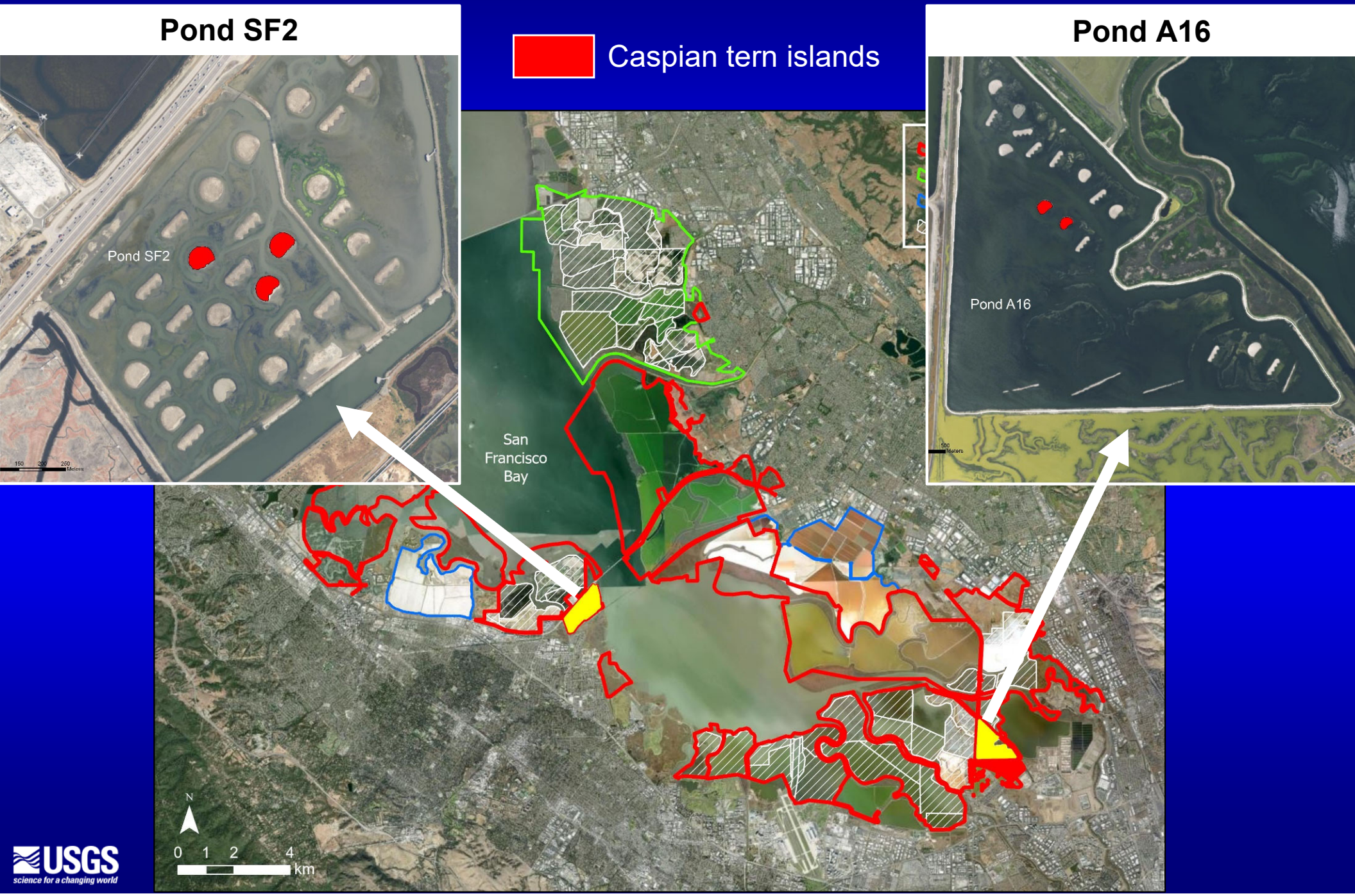
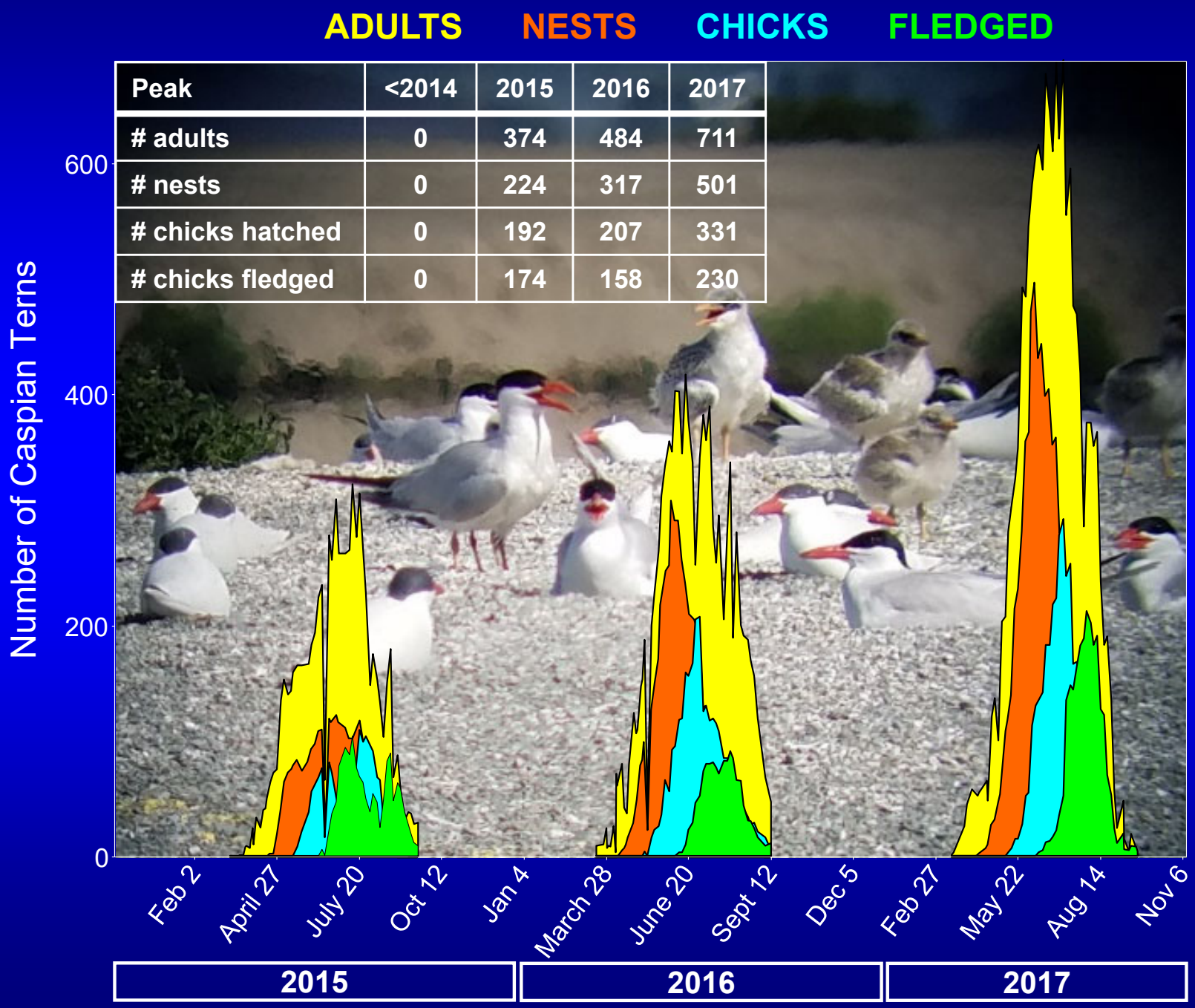
Caspian Tern Social Attraction Islands



New Caspian Tern Colonies Established on Refuge



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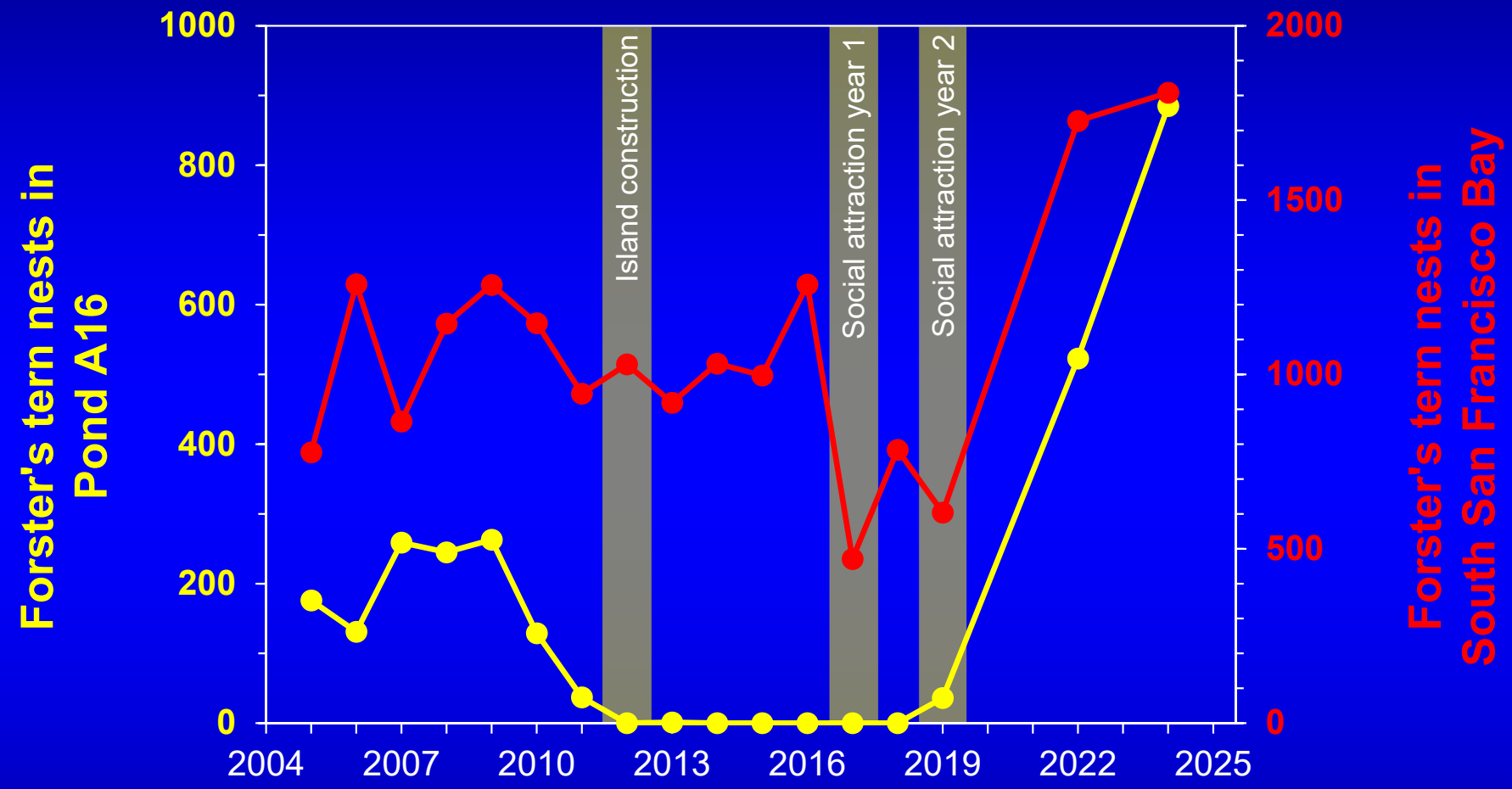
Hartman et al. 2019. Global Ecology and Conservation 20:e00757

Forster's Tern Social Attraction in Pond A16



Hartman et al. 2020. U.S. Geological Survey, Open File Report 2020-1081

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Valley Water

SAN FRANCISCO BAY BIRD OBSERVATORY

Outline

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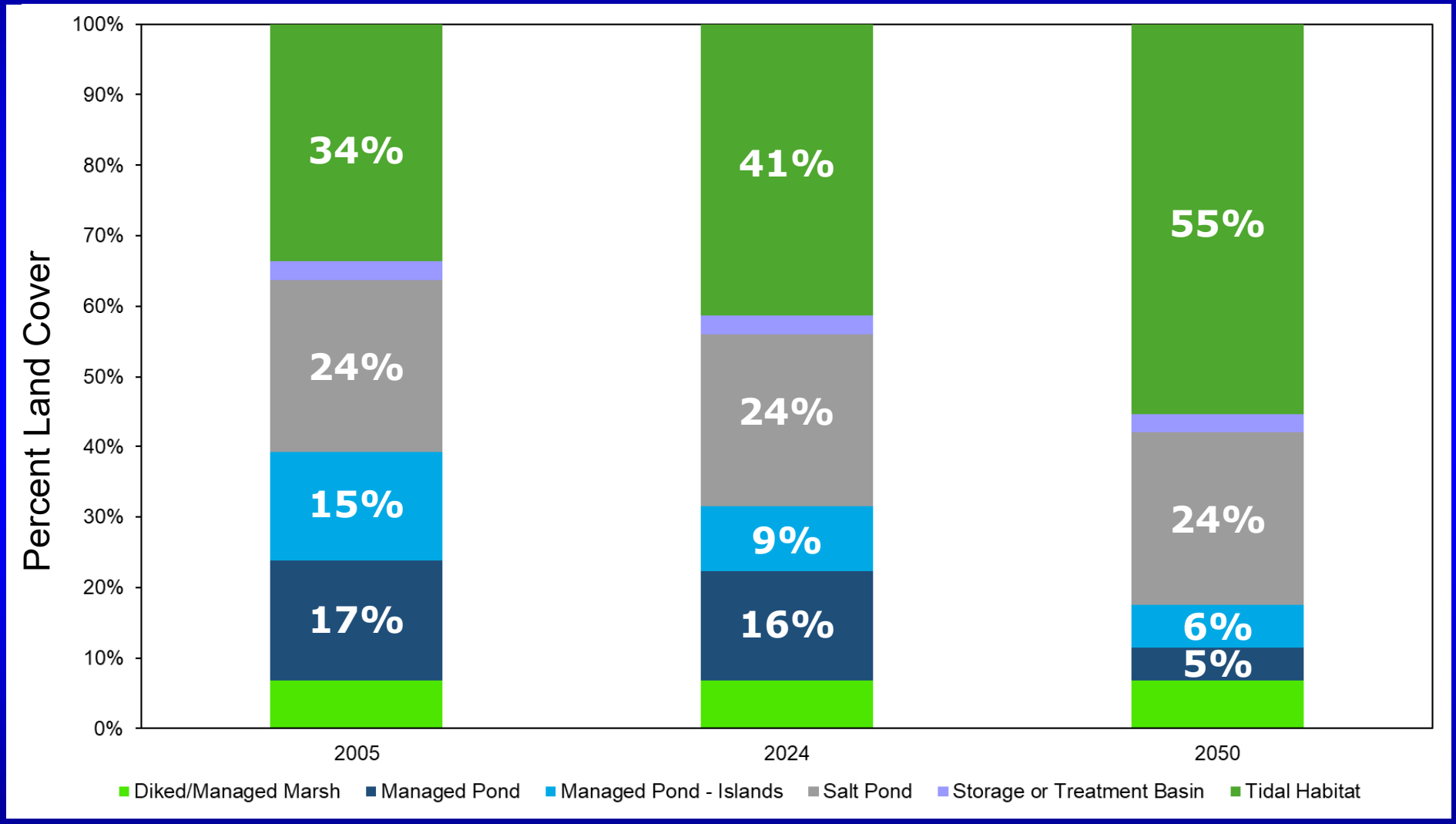
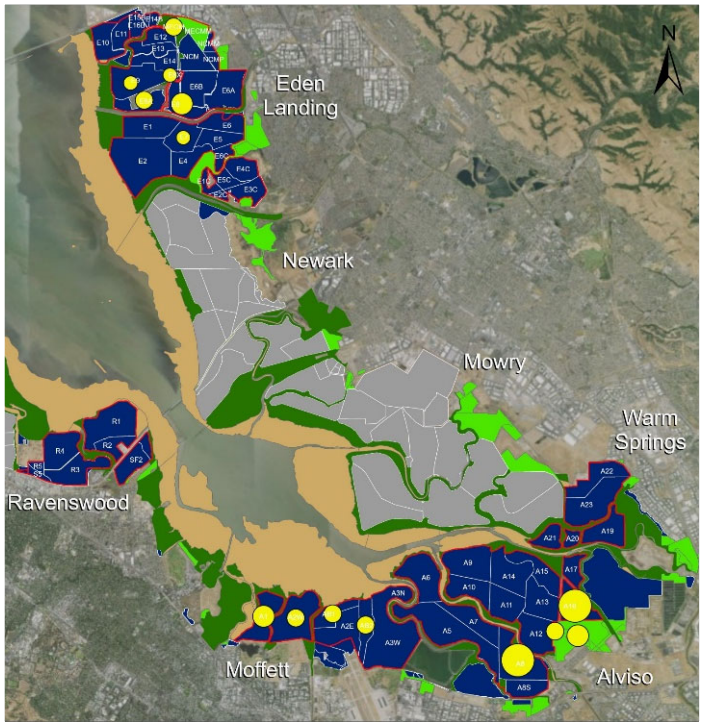
Habitat Change in South San Francisco Bay

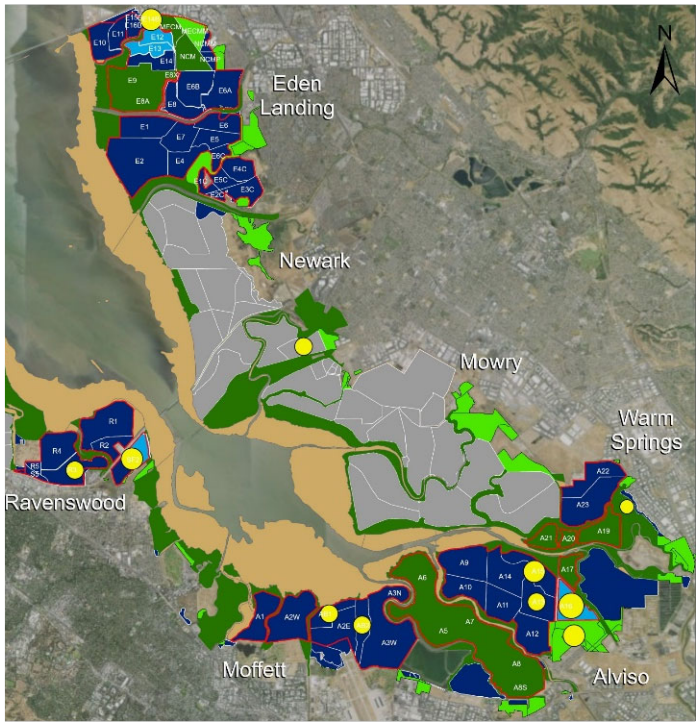


Habitat Changes & Avocet Population Trends

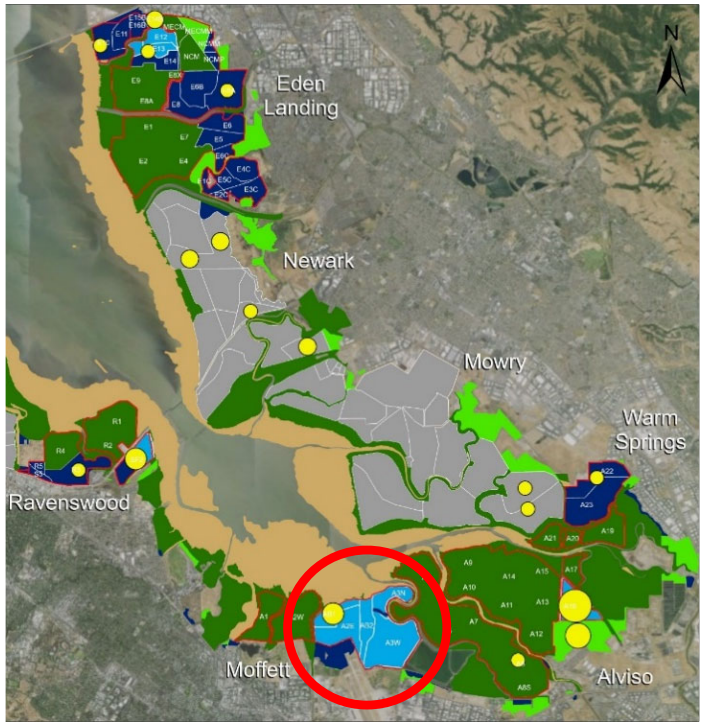
2005
479 nests



2024
222 nests



2050
517 nests?



- Nest Location & Abundance
- Restoration Project Boundary
- Managed Pond
- Enhanced Managed Pond with Islands
- Tidal Marsh
- Tidal Mudflat
- Non-tidal Marsh
- Salt Pond

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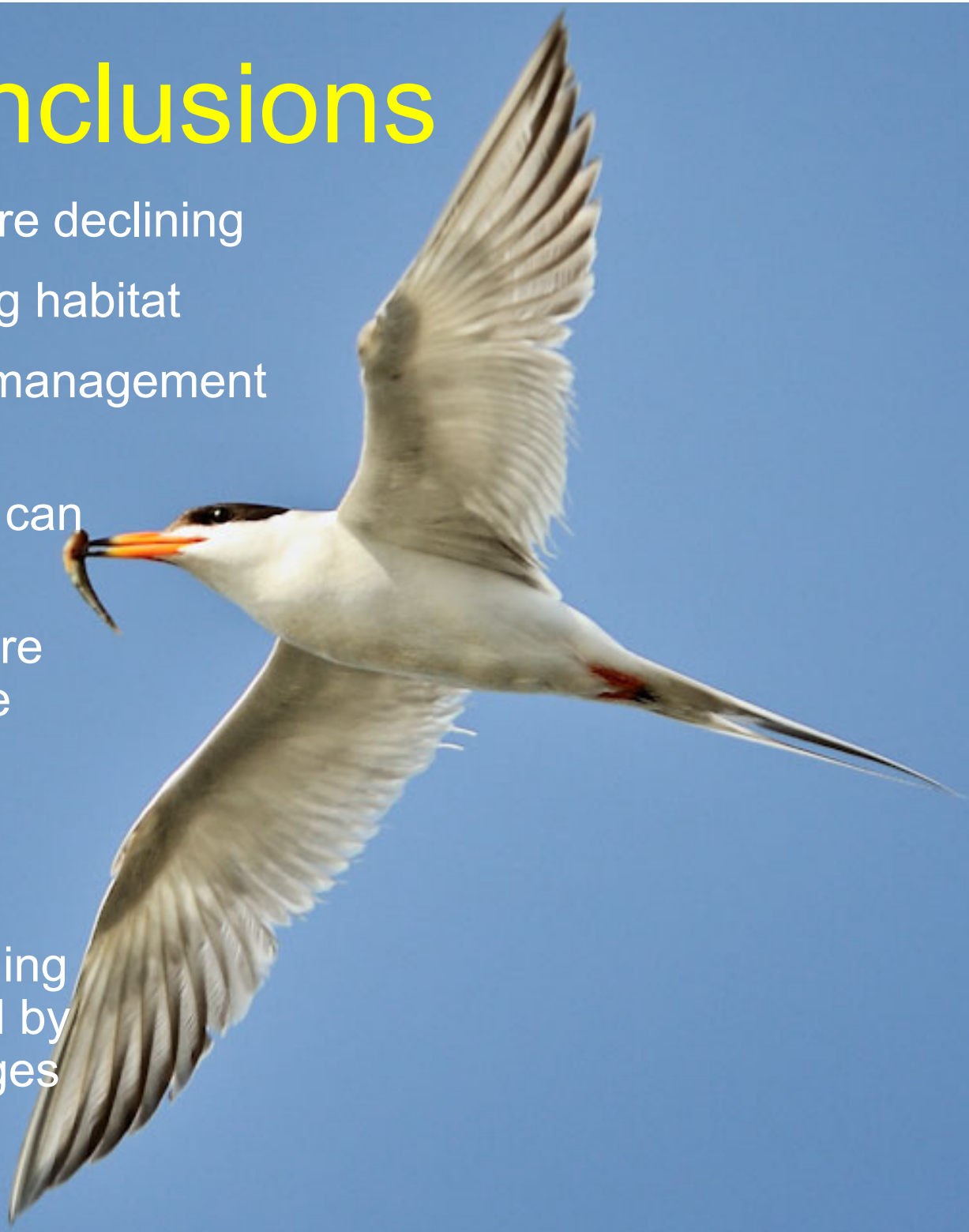
This is information is preliminary and is subject to revision. It is being provided to meet the need for timely best science. The information is provided on the condition that neither the U.S. Geological Survey nor the U.S. Government may be held liable for any damages resulting from the authorized or unauthorized use of the information.

Conclusions

- Some nesting populations are declining
- Islands are important nesting habitat
- Informing construction and management of island nesting habitat
- Social attraction techniques can establish nesting colonies
- Predatory gull populations are increasing & gulls depredate waterbird eggs and chicks
- Mercury toxicity causing reproductive impairment
- Future distributions of breeding waterbirds will be influenced by these management challenges and opportunities



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Thank You Partners!

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Photos by: USGS Staff, Ken Phenicie, & Michael Kern

South Bay Salt Pond Restoration Project

California Wildlife Foundation

U.S. Fish & Wildlife Service

California Department of Fish & Wildlife

Coastal Conservancy

Valley Water

US Army Corps of Engineers®