Marine and Estuarine Invasions in California's Nearshore Habitats

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Marine Invasions Research Lab
Smithsonian Environmental Research Center &
Romberg Tiburon Center, San Francisco State University

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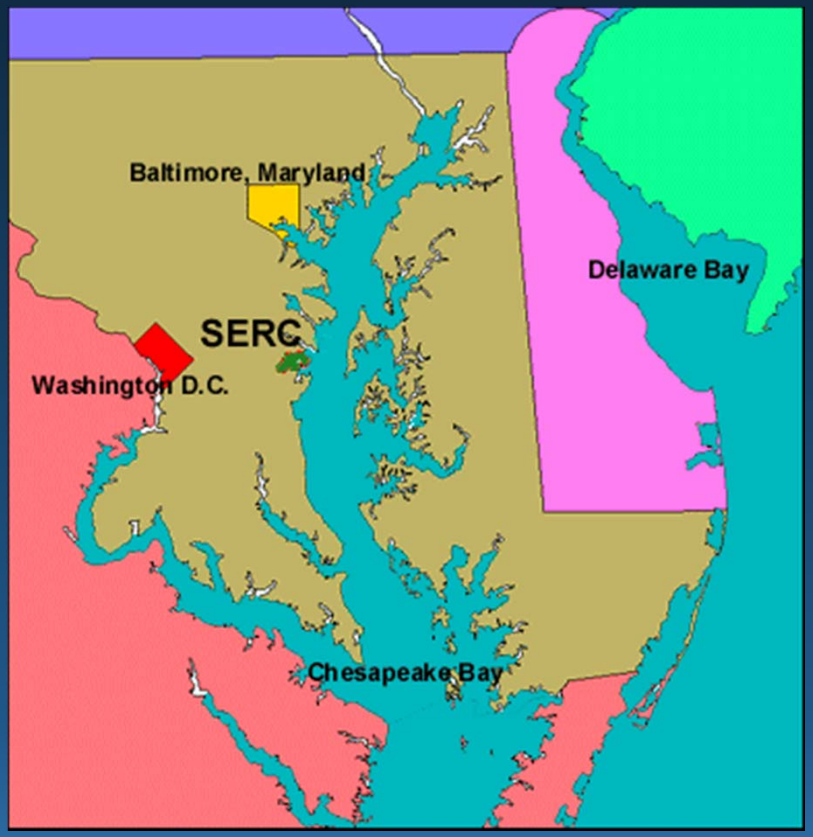
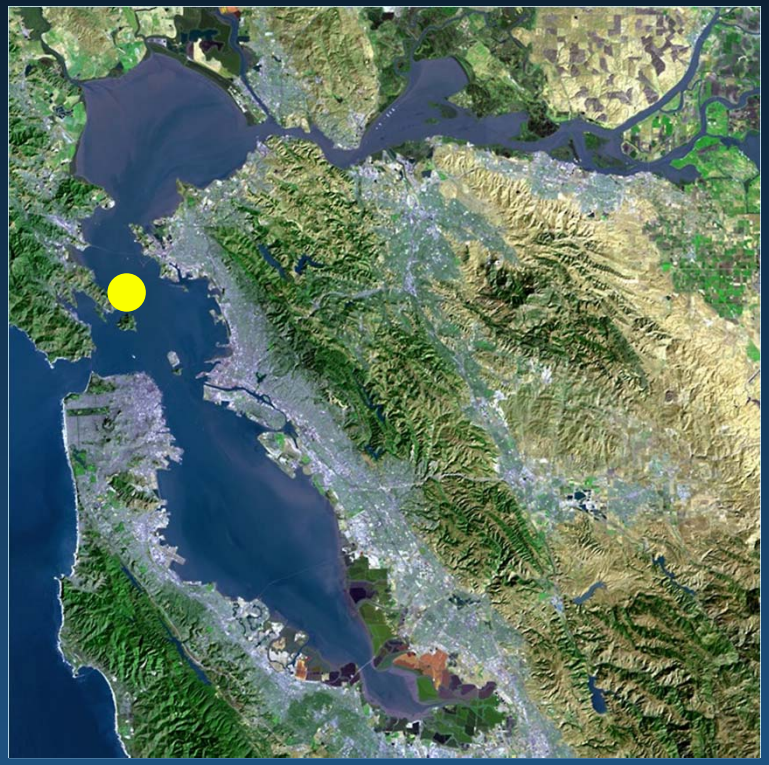
Marine Invasions Lab



Main lab: Edgewater, MD (Chesapeake Bay)

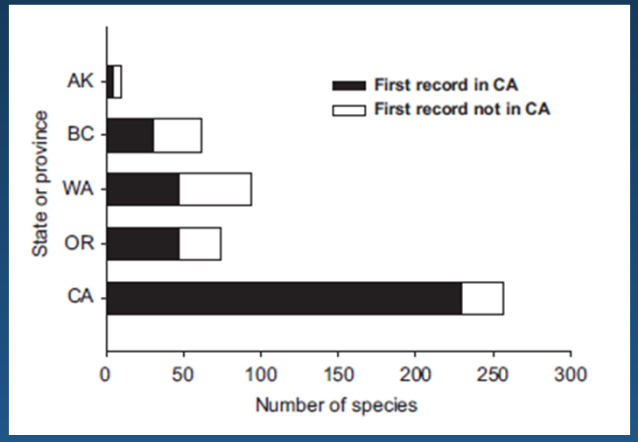


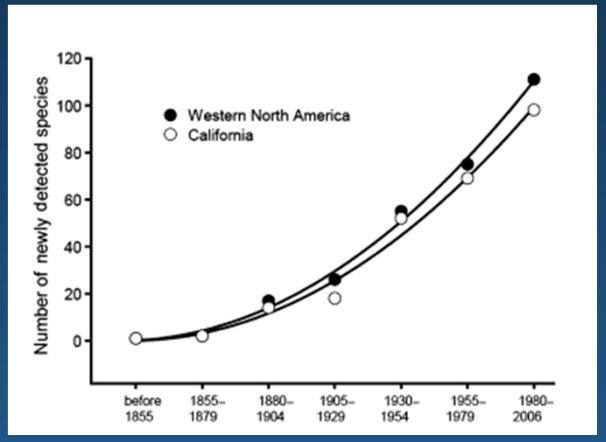
San Francisco Bay unit (Tiburon, CA)

Based at Romberg Tiburon Center (SFSU) since 2000

Marine invasions in California

Over 257 non-native marine species established in California (Ruiz et al., 2011)





Spatial and temporal analysis of marine invasions in California

Office of Oil Spill Prevention and Response (OSPR)

Surveys, analysis and reporting of marine and estuarine non-indigenous species (NIS) in California

- 5-year project (2012-2017)
- Different habitats and fauna (hard-substrate, soft-sediment, plankton, outer coast)

Some Guiding Questions

What are the patterns of diversity and abundance of non-native marine species (in California waters)?

What controls these patterns of diversity and abundance?

How do invasions affect the workings of the recipient ecosystem?

What vectors are most responsible for moving non-native species around?

Five P's

Phenomenon

Pattern

Process

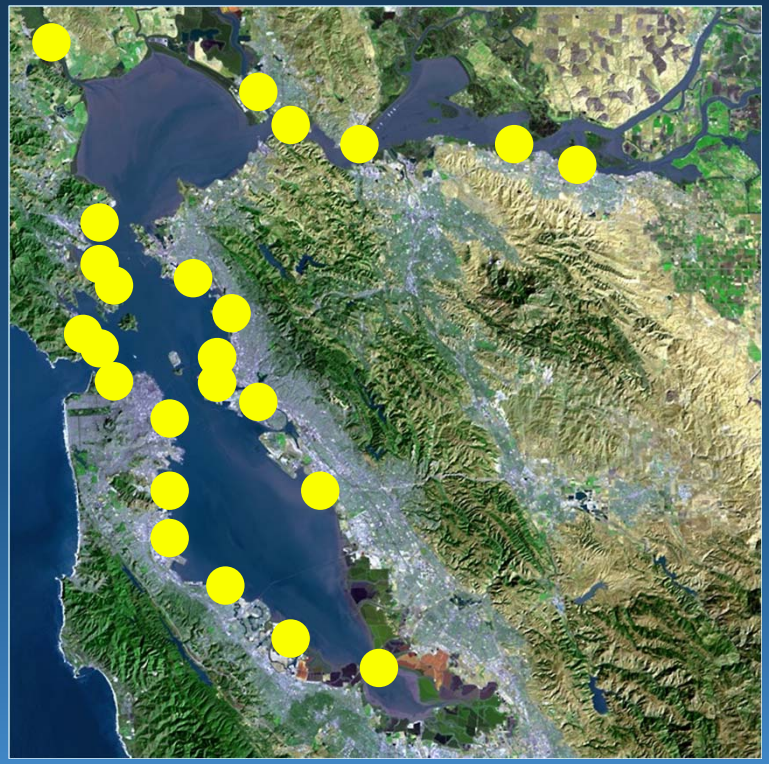
Prediction

(Policy)

James T. Carlton

Hard substrate, soft sediment, and plankton surveys

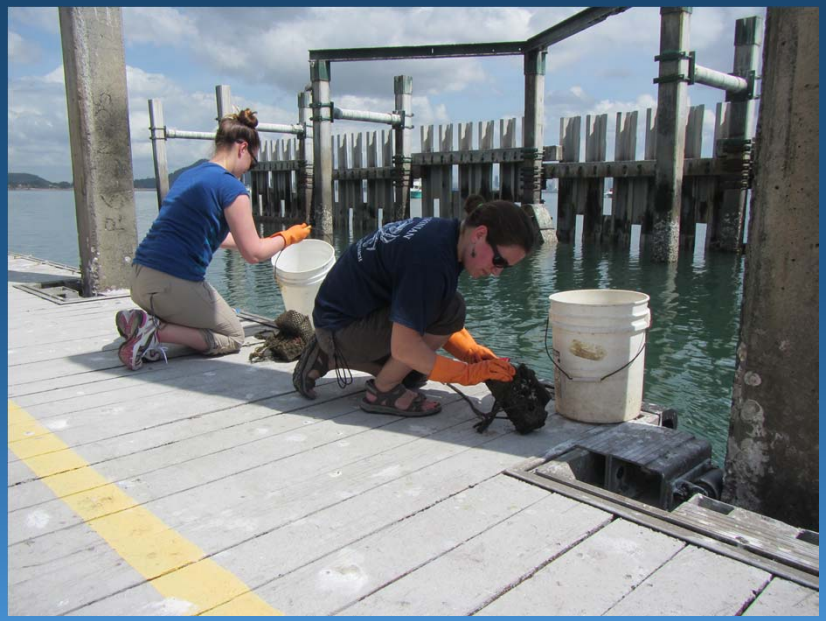
0.1m^2 Van Veen Grab

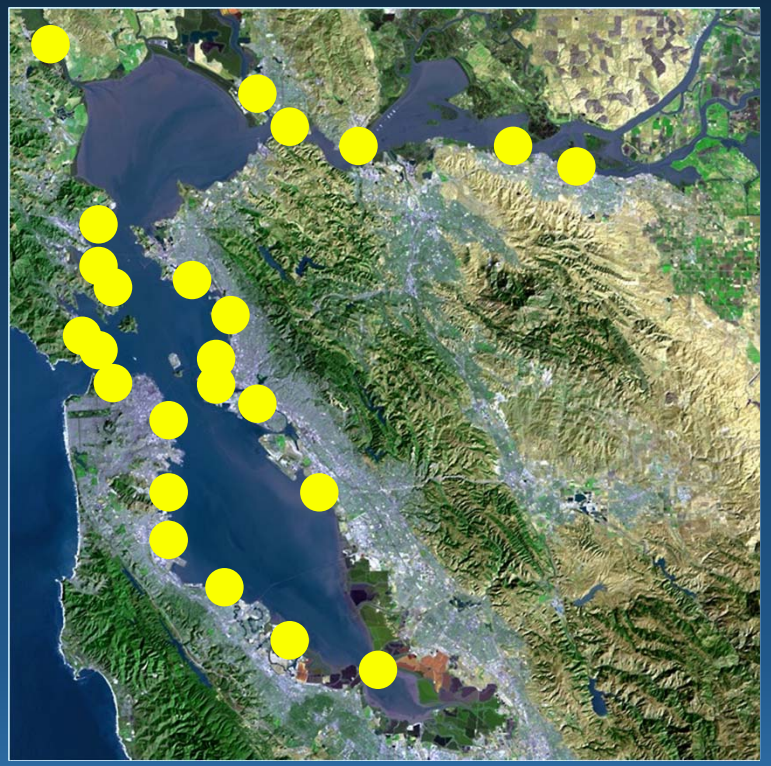


Today: focus on hard substrate, mostly SF Bay

Most marine invasions are on hard substrates:

Docks, rocks, pier pilings, seawalls, rocky bottoms…





Sample processing workflow

Morphological taxonomy

Final identifications

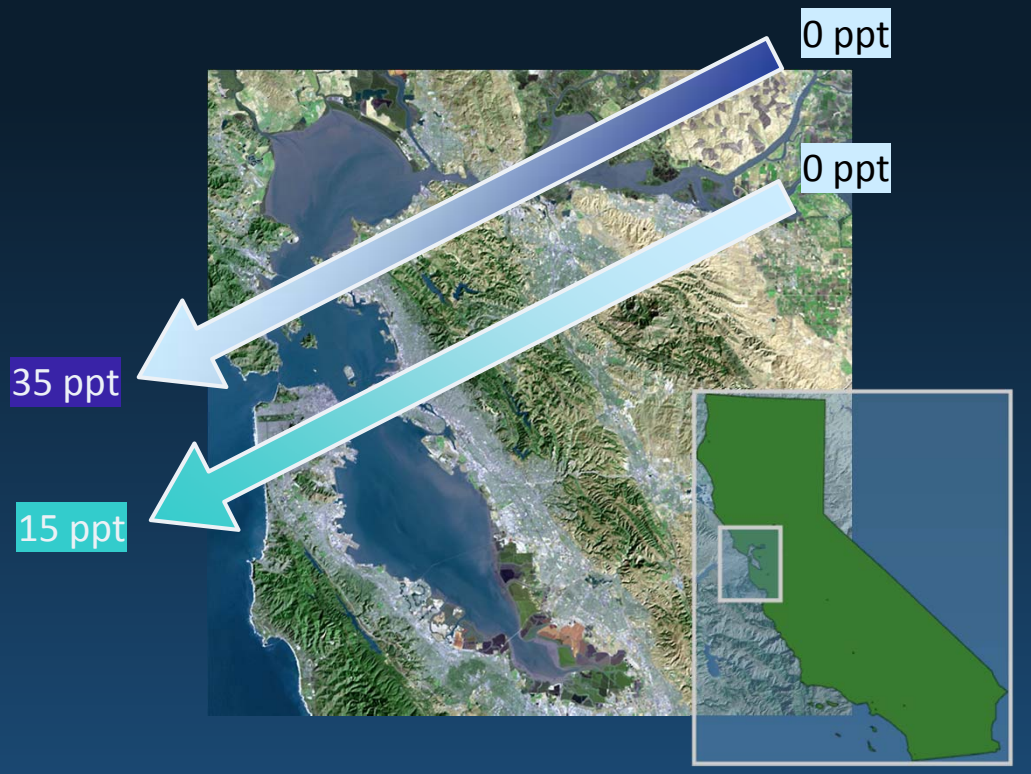
Genetic analyses

Geller Lab, Moss Landing Marine Labs

Environmental variation in estuaries

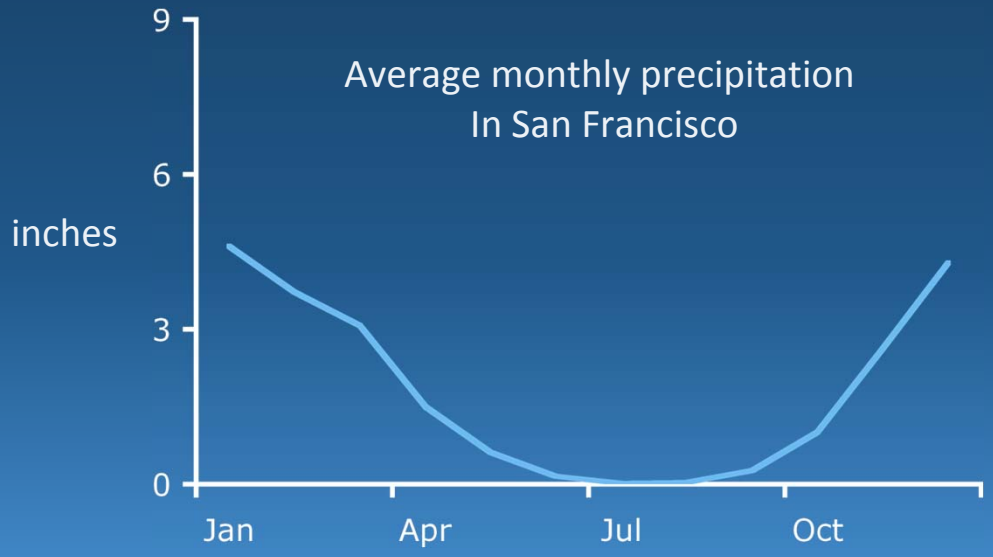
Salinity is a key estuarine variable

Changes to freshwater inflow significantly change salinity in estuaries and nearshore ocean



San Francisco Estuary:

- Drains 163,000 km^2 = 40% of California
- Nearly all precipitation falls during November - March
- Large interannual variation



Data from NWS

Hard substrate (fouling) communities from fresh to saltwater

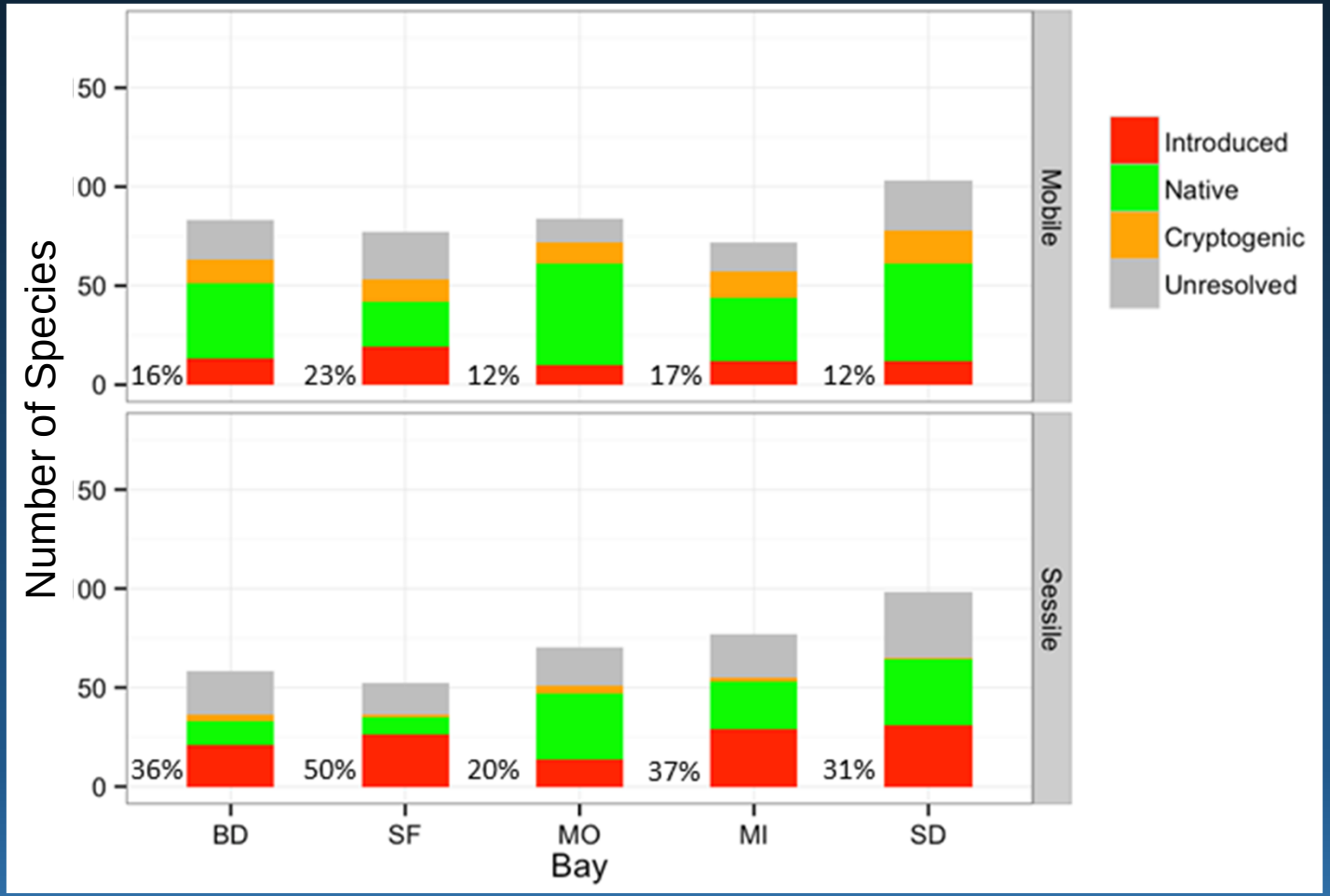
How many species?

San Francisco Bay had highest absolute # NIS and highest % NIS

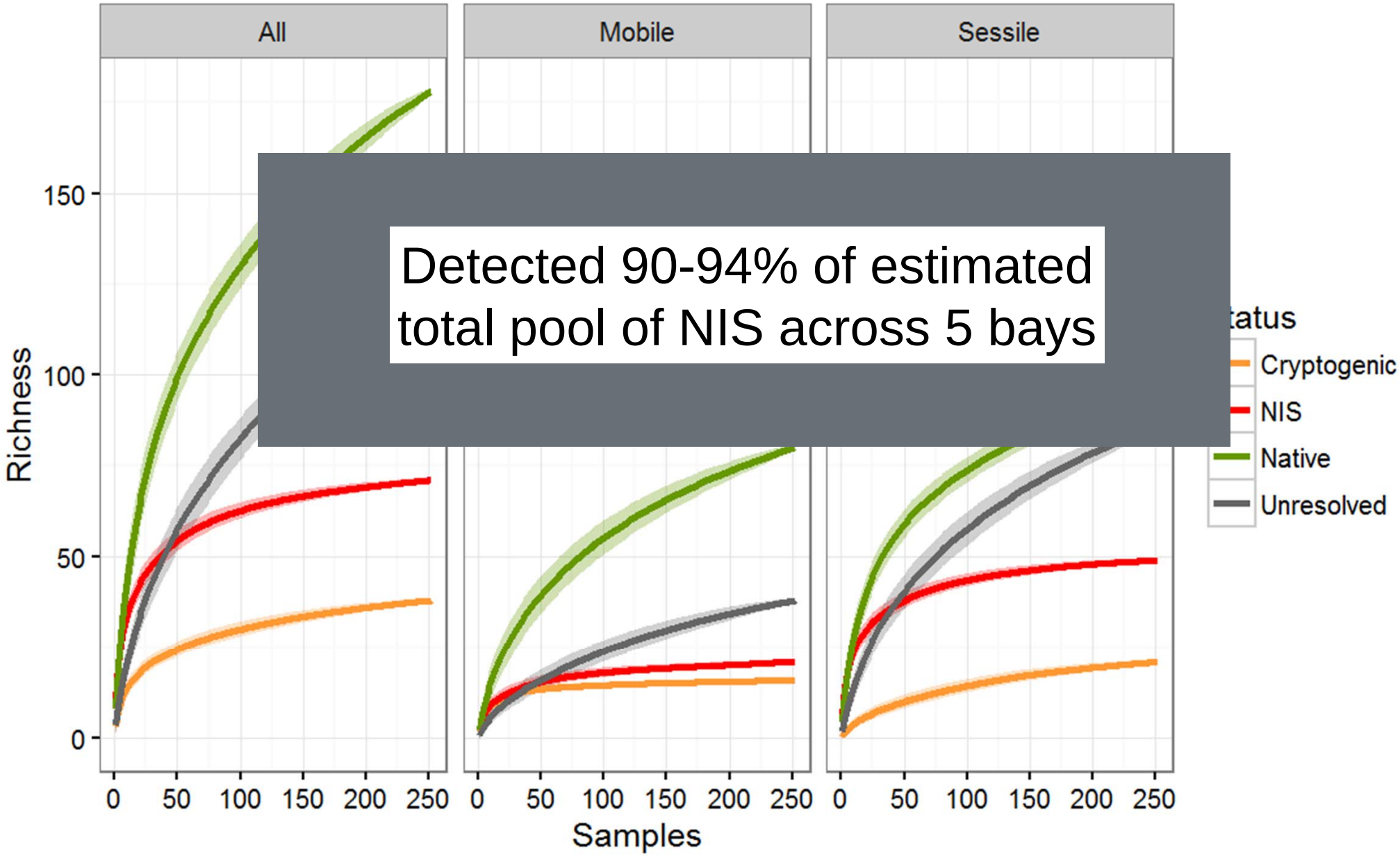
Increasing sessile diversity further south (expected latitudinal gradient)

14-21 mobile NIS detected per estuary

23-35 sessile NIS detected per estuary



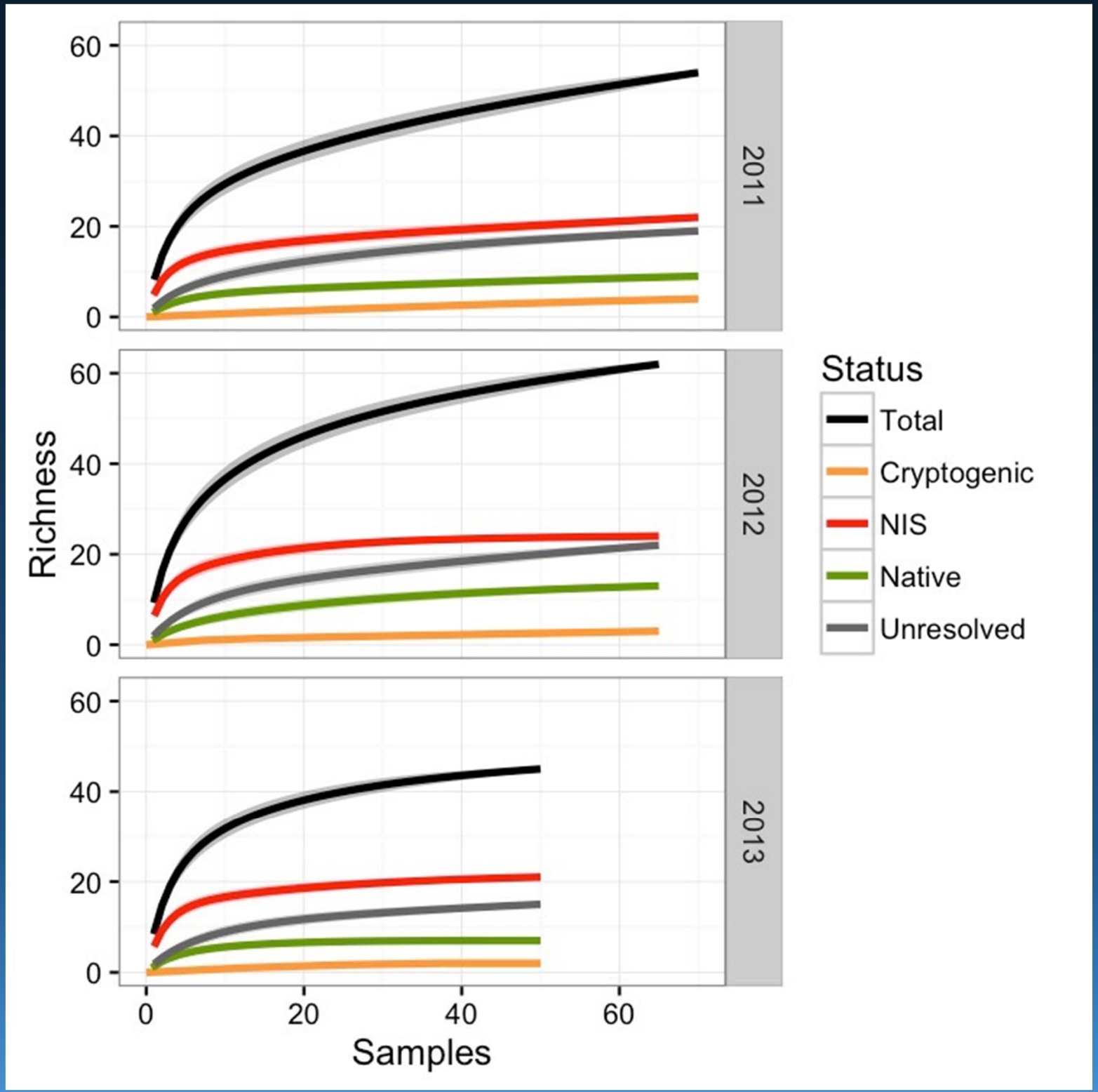
Species accumulation

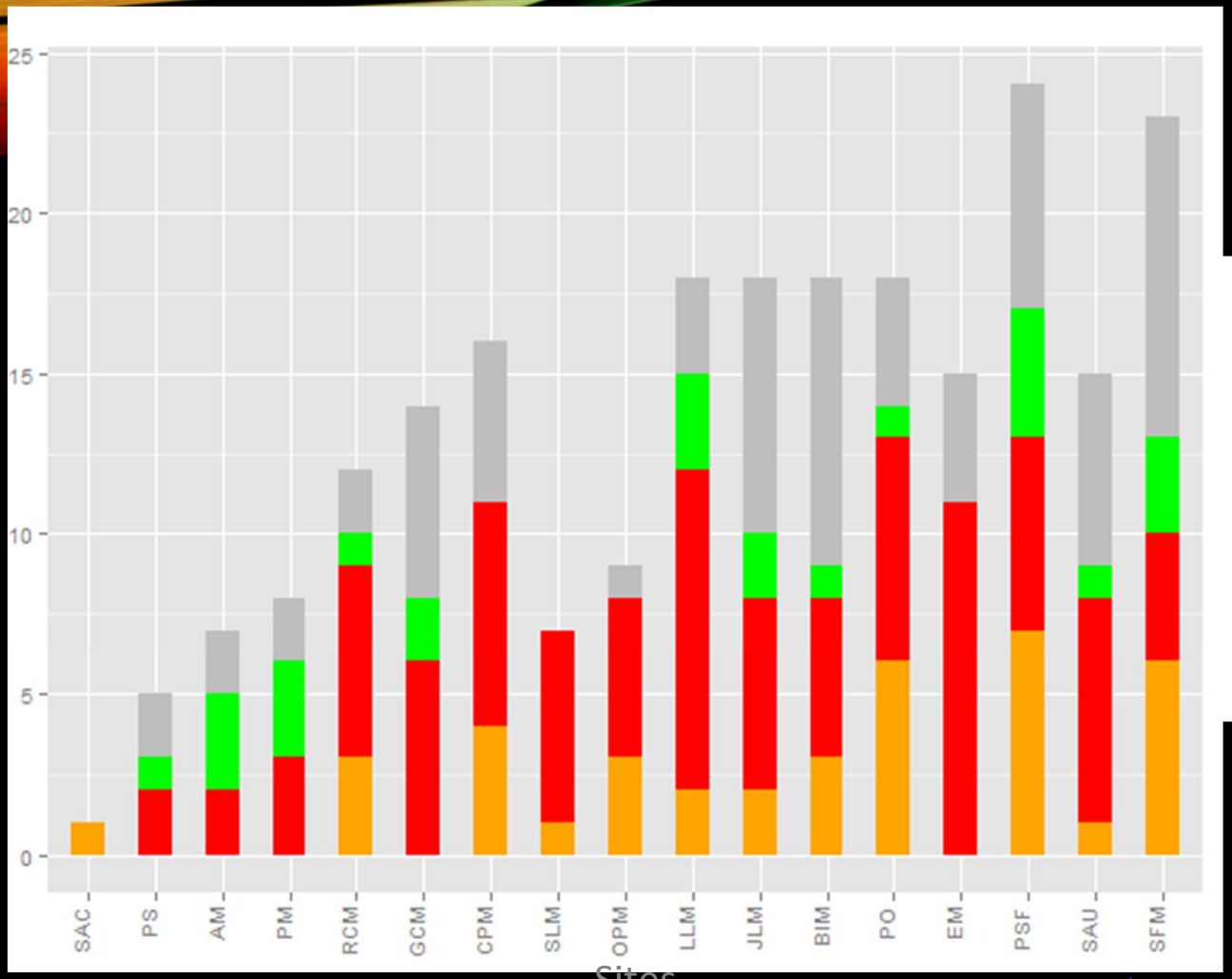


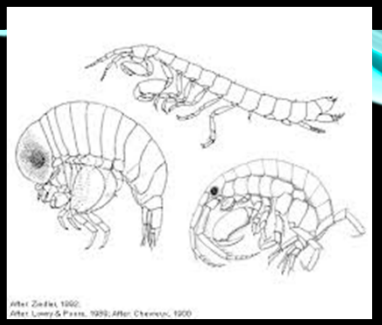
Detected 90-94% of estimated total pool of NIS across 5 bays

San Francisco Bay

Essentially complete sampling of NIS in most years







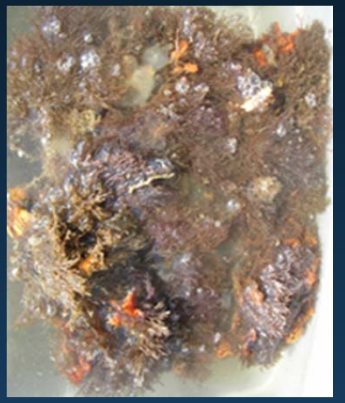
Status
Cryptogenic
Introduced
Native
Unresolved

Delta → GGB

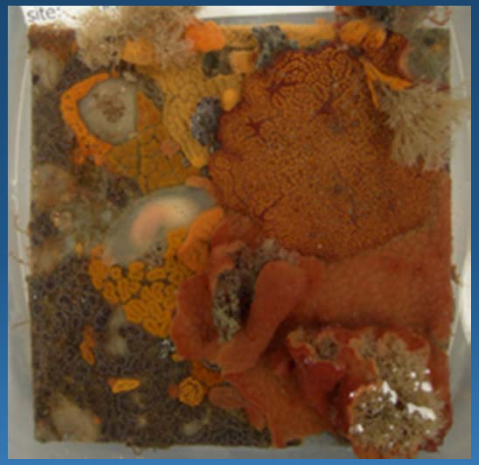
Detecting non-native species — change across years
Summer fouling communities in Richmond, CA

2001, 2002

2003, 2004



2005



2006

2007, 2008

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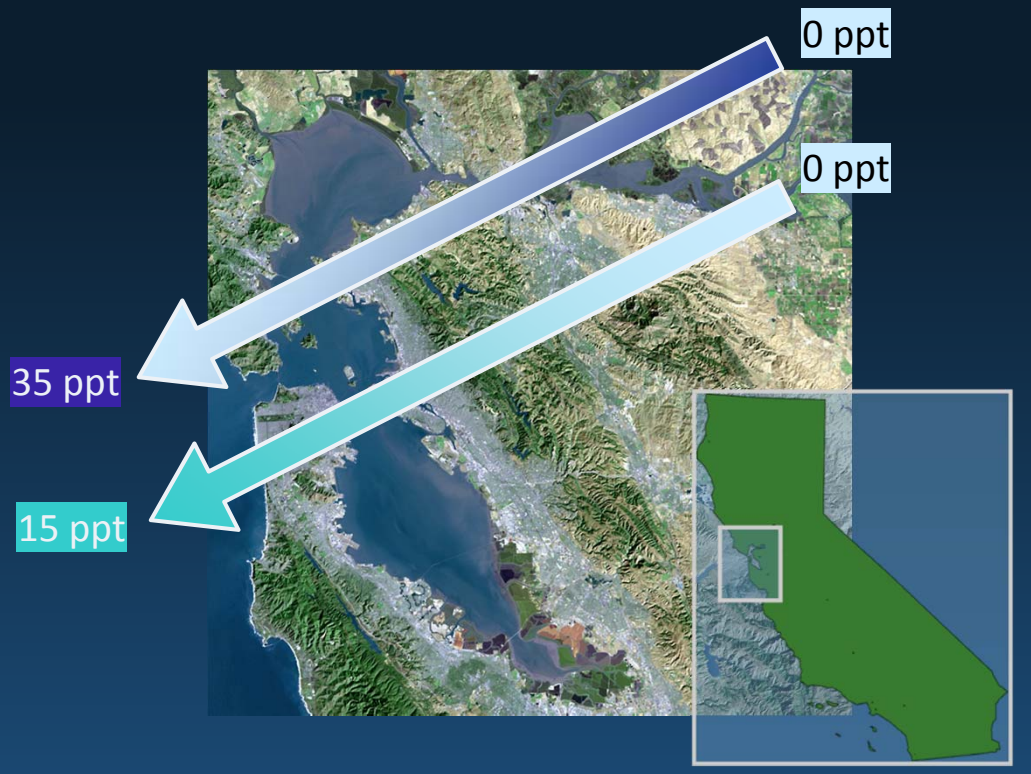
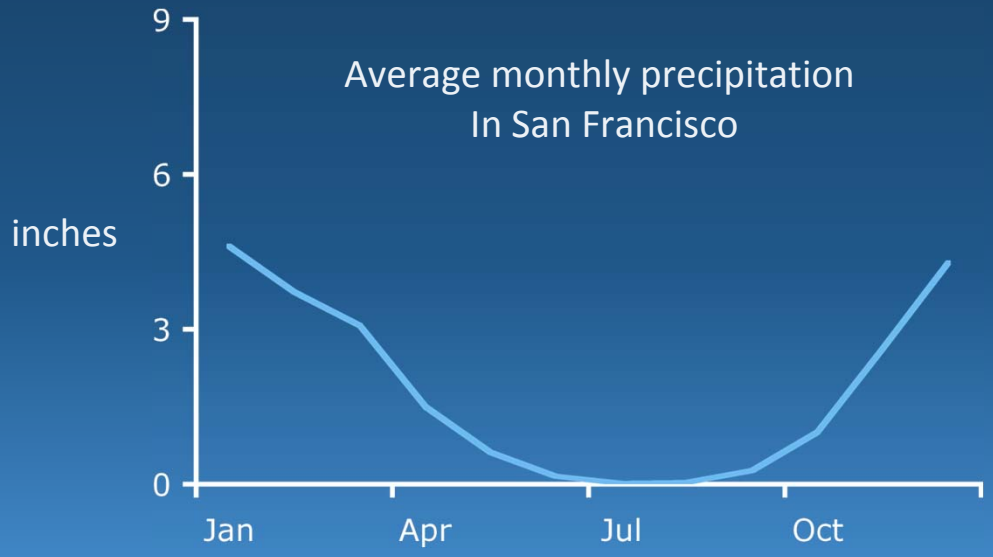


San Francisco Estuary:

Drains 163,000 km^2 = 40% of California

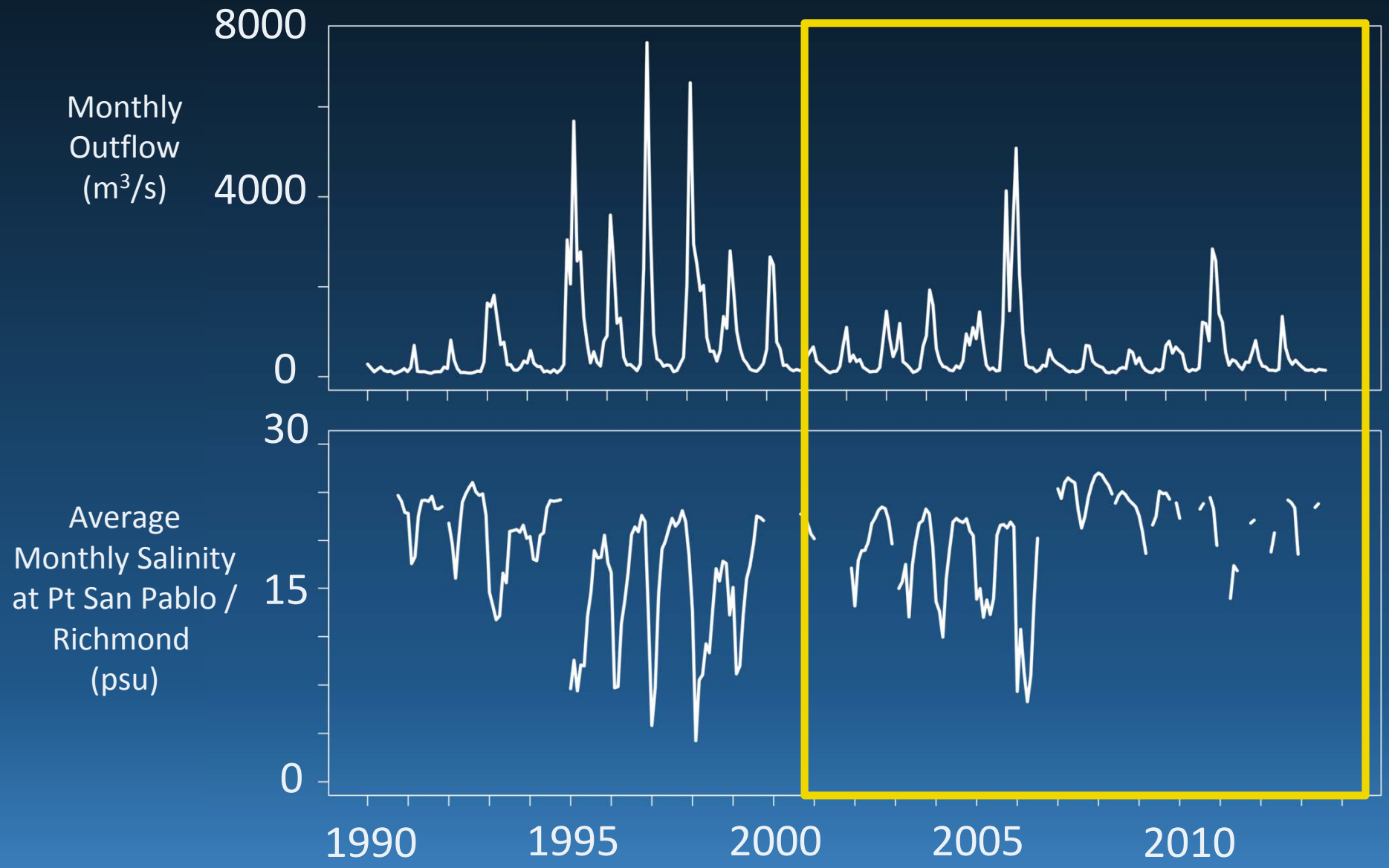
Nearly all precipitation falls during November - March

Large interannual variation



Data from NWS

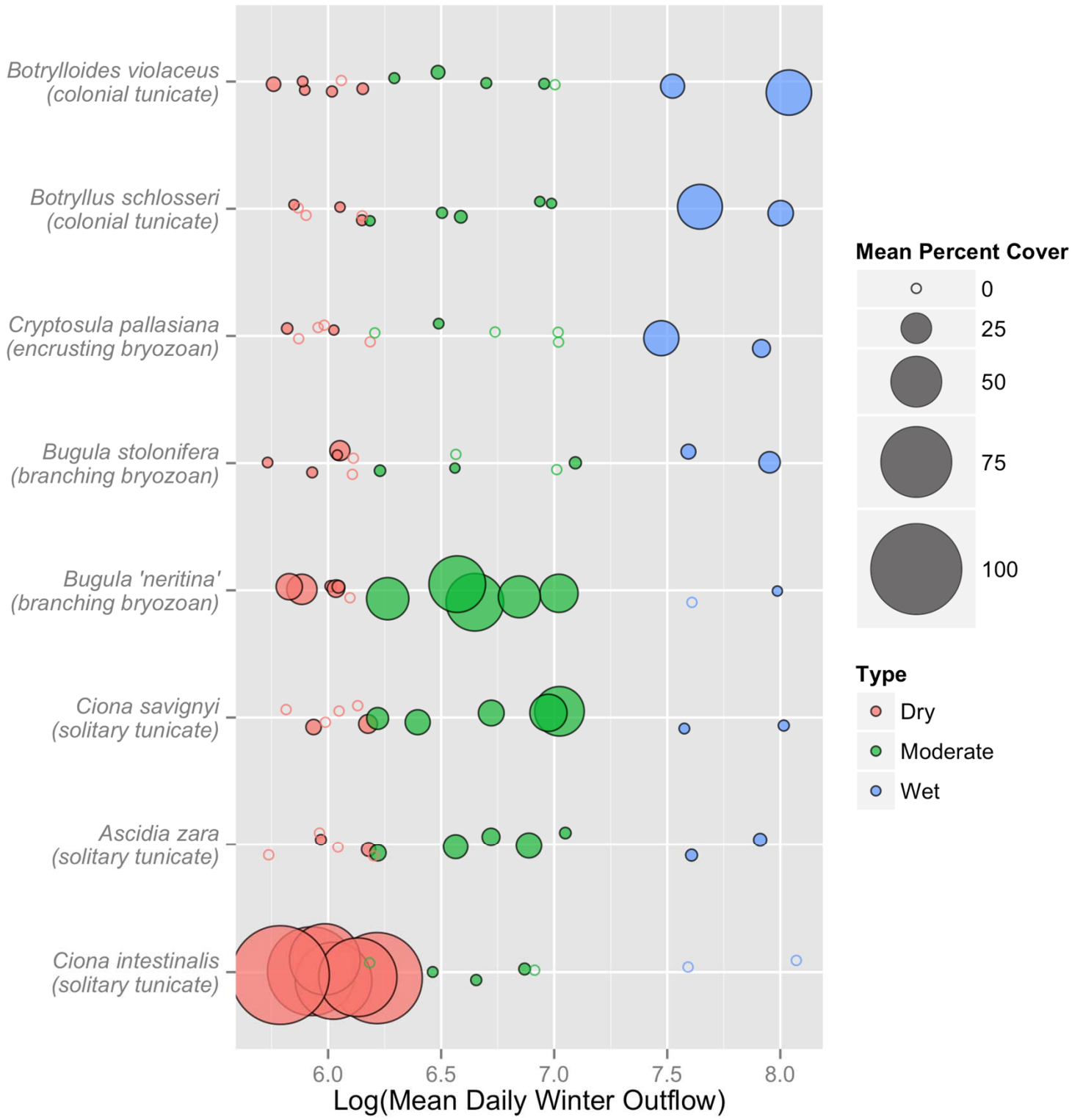
Focal Period: 2001 – 2013



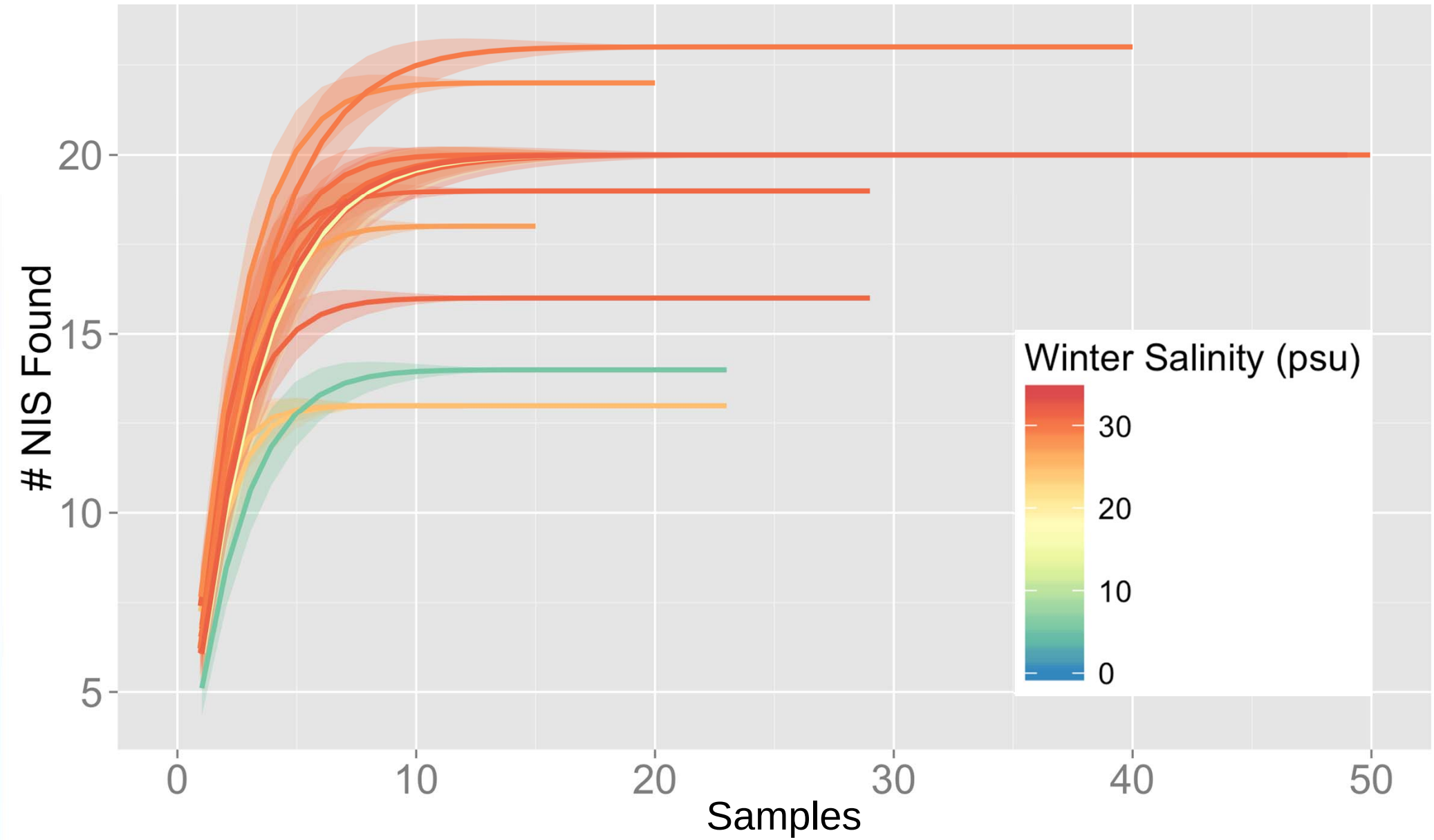
Environmental conditions make a big difference at the same site across years:

Summer species abundances vary as a function of the *previous winter's* outflow (salinity)

Chang et al. (in review)



Species accumulation: how consistently do we find NIS across different environmental conditions?



Are non-native species confined to bays?

Wasson et al. (2005) Biological Invasions

Biological Invasions (2005) 7: 935–948
DOI 10.1007/s10530-004-2995-2

Habitat differences in marine invasions of central California

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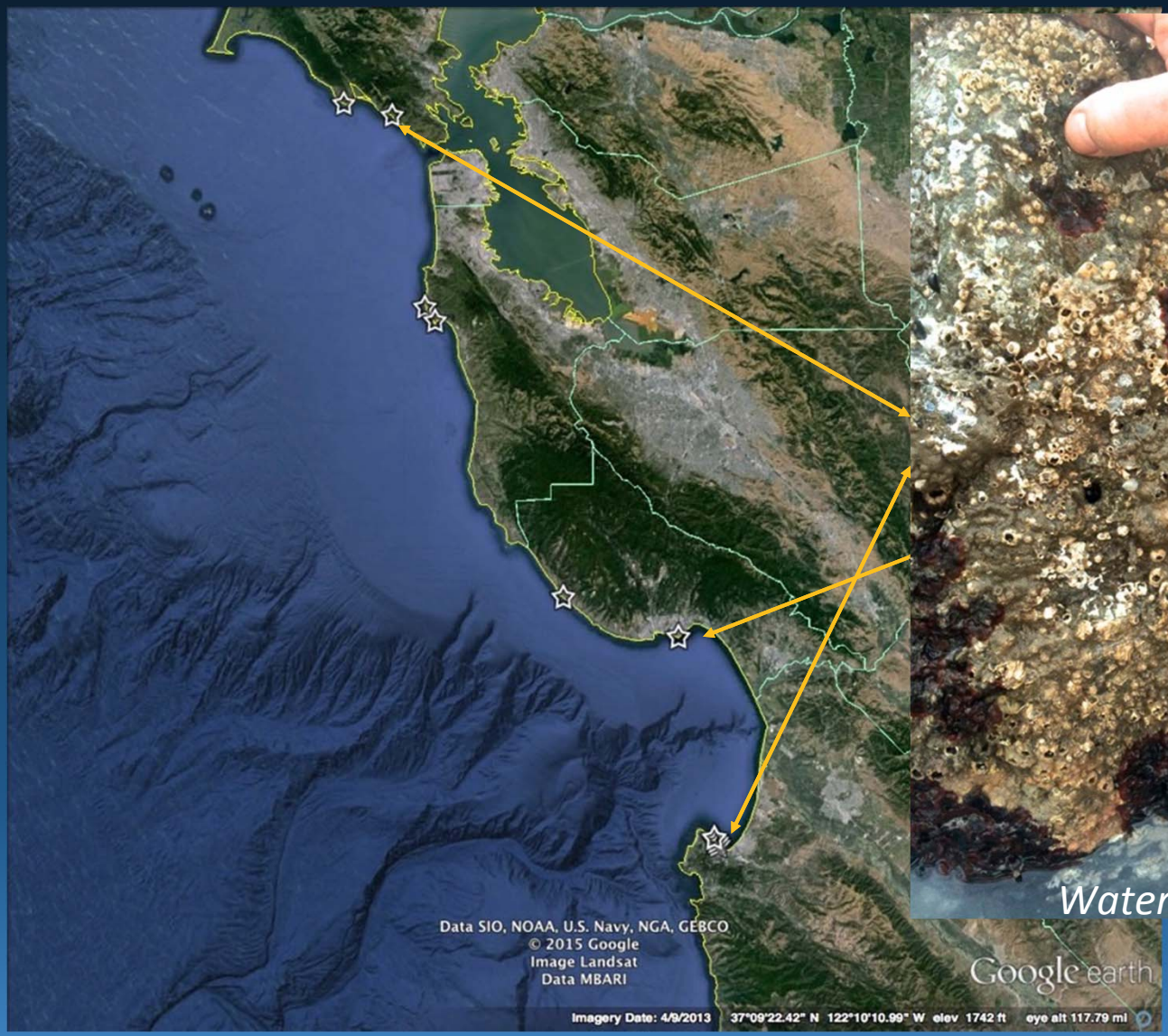
Received 16 May 2003; accepted in revised form 10 March 2004

Key words: estuary, habitat, intertidal, invasion, invertebrate

Many fewer invasions outside bays – low *propagule pressure*

But if bays are hotspots / sources of invasions, we need to watch the outer coast

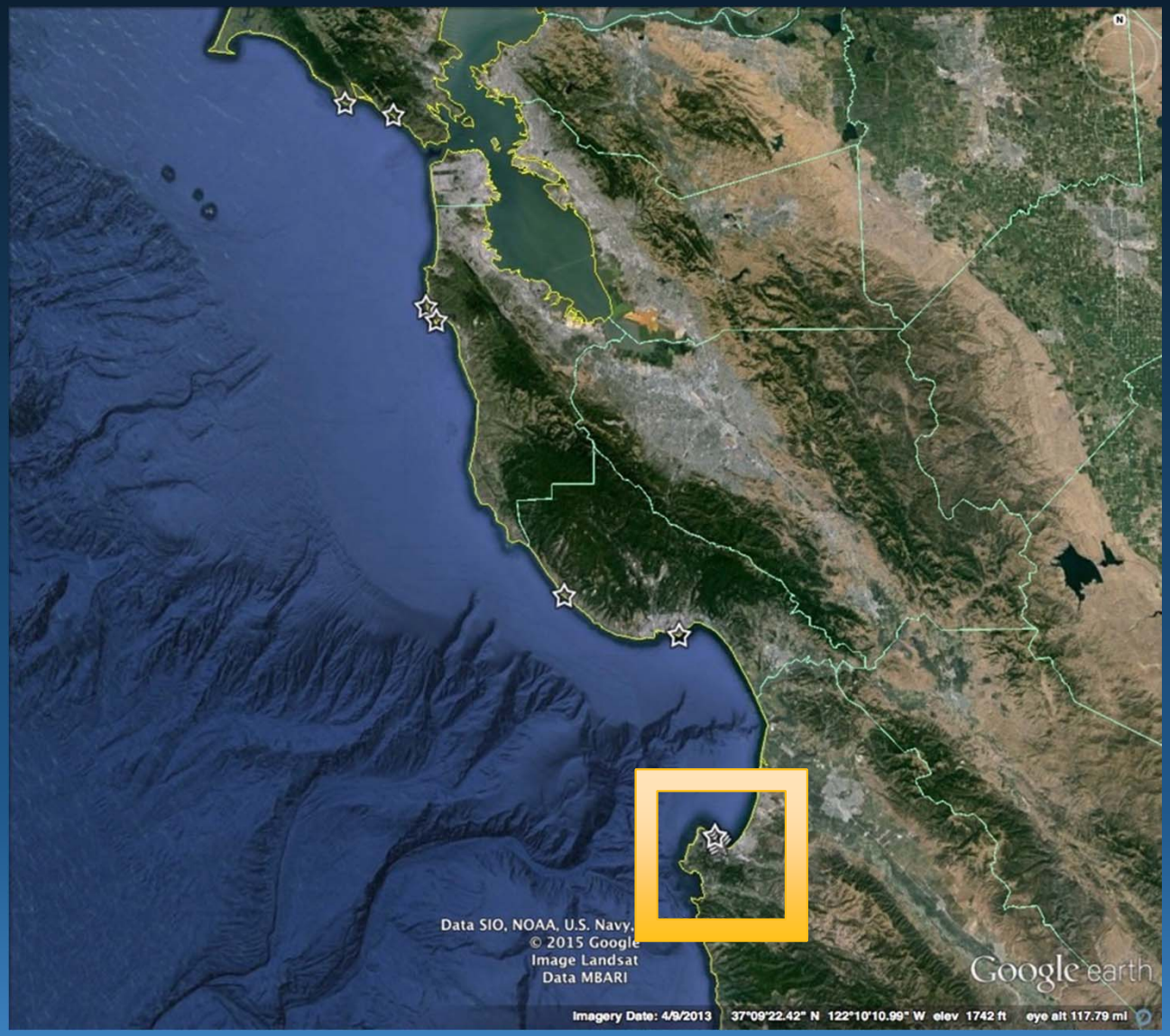
Outer coast surveys: intertidal



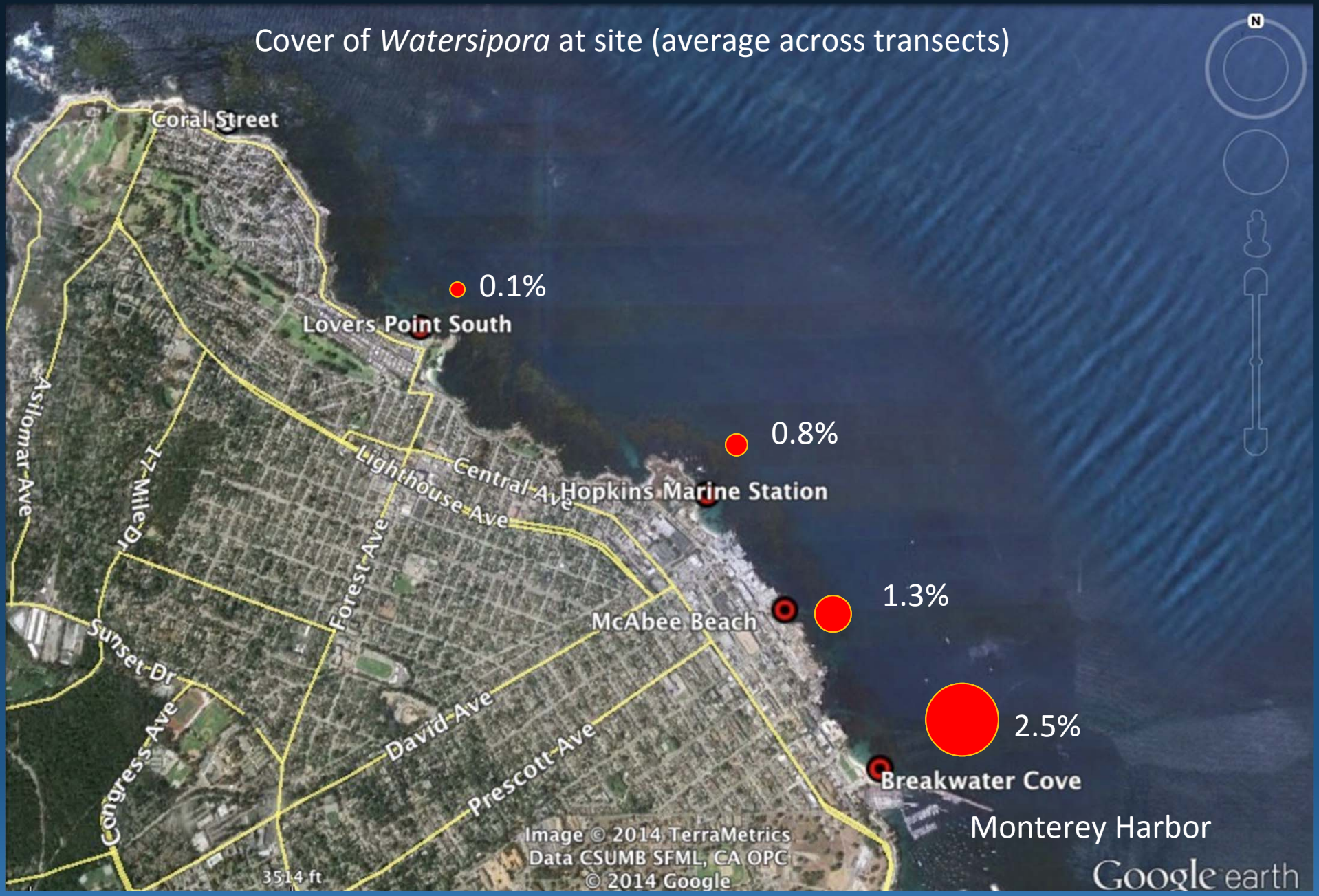
Watersipora subtorquata

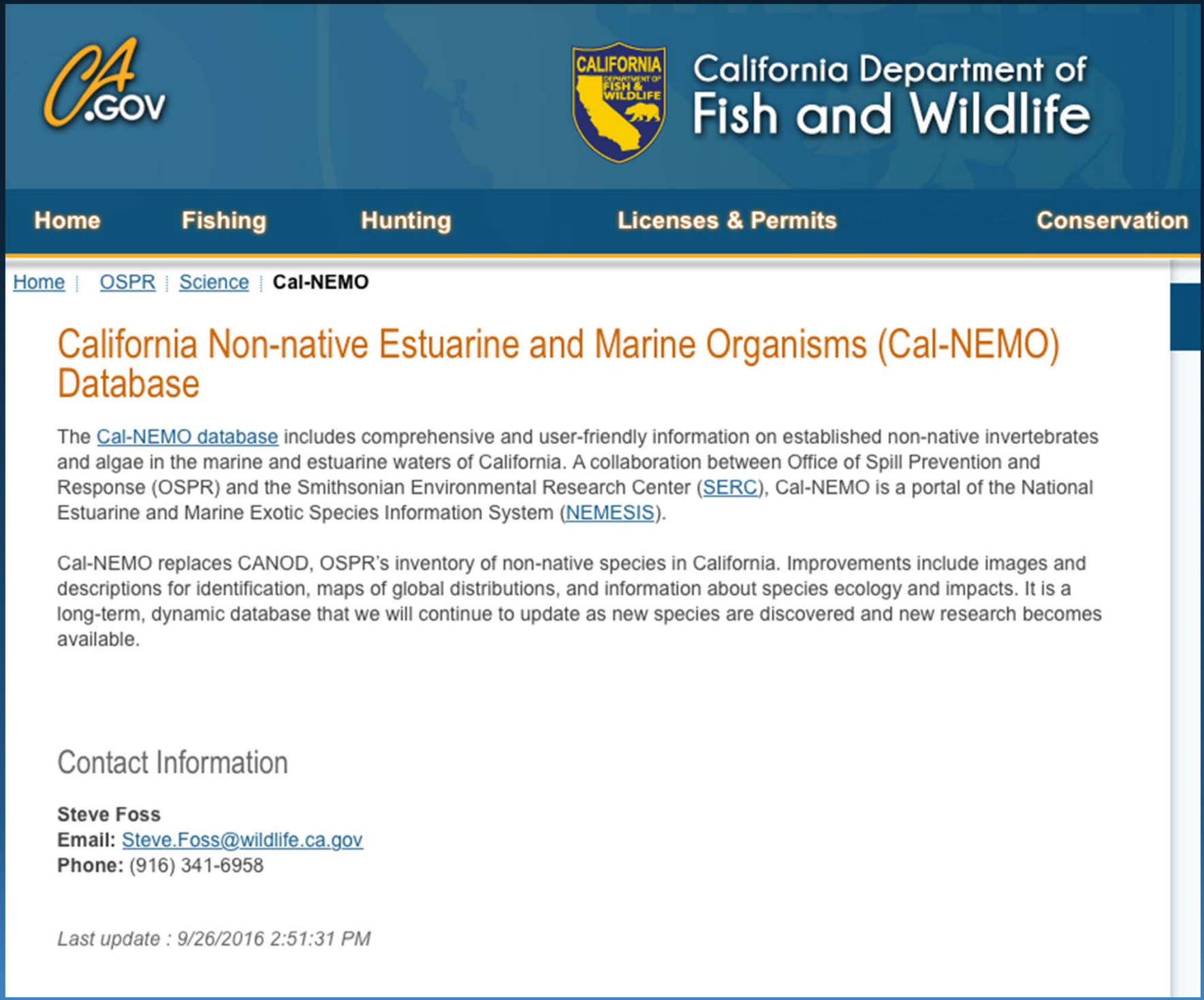
IS

Outer coast surveys: subtidal




Watersipora found
No *Watersipora* found
Coral Street
Lovers Point South
Hopkins Marine Station
McAbee Beach
Breakwater Cove
218
1
Salinas Hwy
Copper Roof House
Monastery Beach
Pt. Lobos
Data CSUMB SFML, CA OPC
Data MBARI
© 2014 Google
3.48 mi
Google earth
Imagery Date: 8/25/2013 36°34'29.54" N 121°56'05.72" W elev 316 ft eye alt 13.86 mi


Cover of *Watersipora* at site (average across transects)
Coral Street
0.1%
Lovers Point South
0.8%
Hopkins Marine Station
Asilomar Ave
17-Mile Dr
Lighthouse Ave
Central Ave
Forest Ave
1.3%
McAbee Beach
Sunset Dr
Congress Ave
David Ave
Prescott Ave
2.5%
Breakwater Cove
Monterey Harbor
Image © 2014 TerraMetrics
Data CSUMB SFML, CA OPC
© 2014 Google
3514 ft
Google earth



https://www.wildlife.ca.gov/OSPR/Science/Cal-NEMO

Take-Home Messages

Bays are highly invaded; San Francisco Bay is most invaded

Spillover onto hard substrate outside marinas, and outside bays needs to be examined further

Repeated, standardized surveys allow us to track changes in invasions across a wide range of environmental conditions

Help predict invasion consequences of management actions and responses to climate change

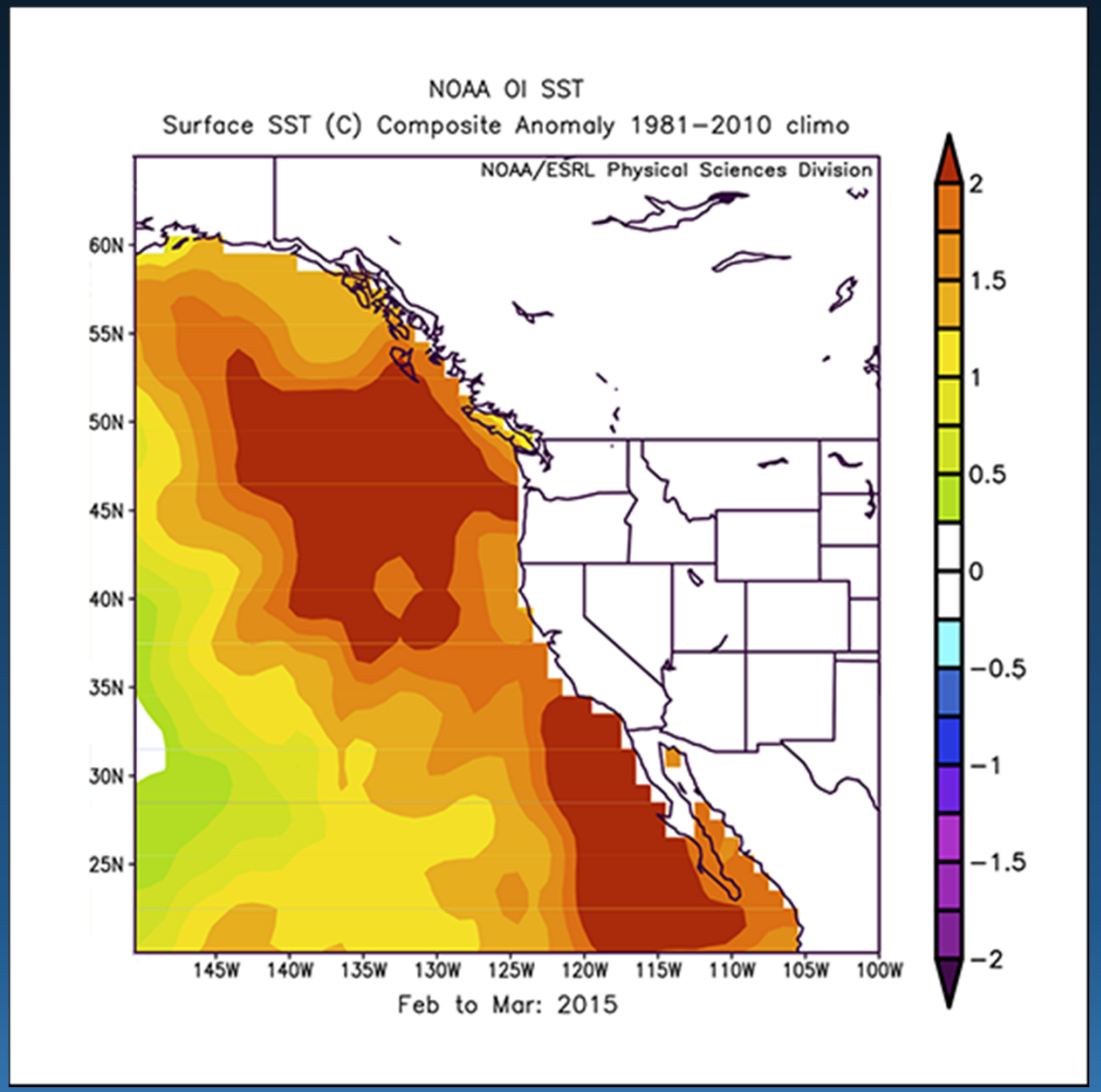
Smithsonian Environmental Research Center

Looking Ahead

How are management actions affecting invasions?

How will our changing climate influence invasions?

Are we prepared for the changing risk landscape posed by droughts and wet years, the “Blob”, and other challenges?



Thank you!

Funding:

CDFW

US Coast Guard

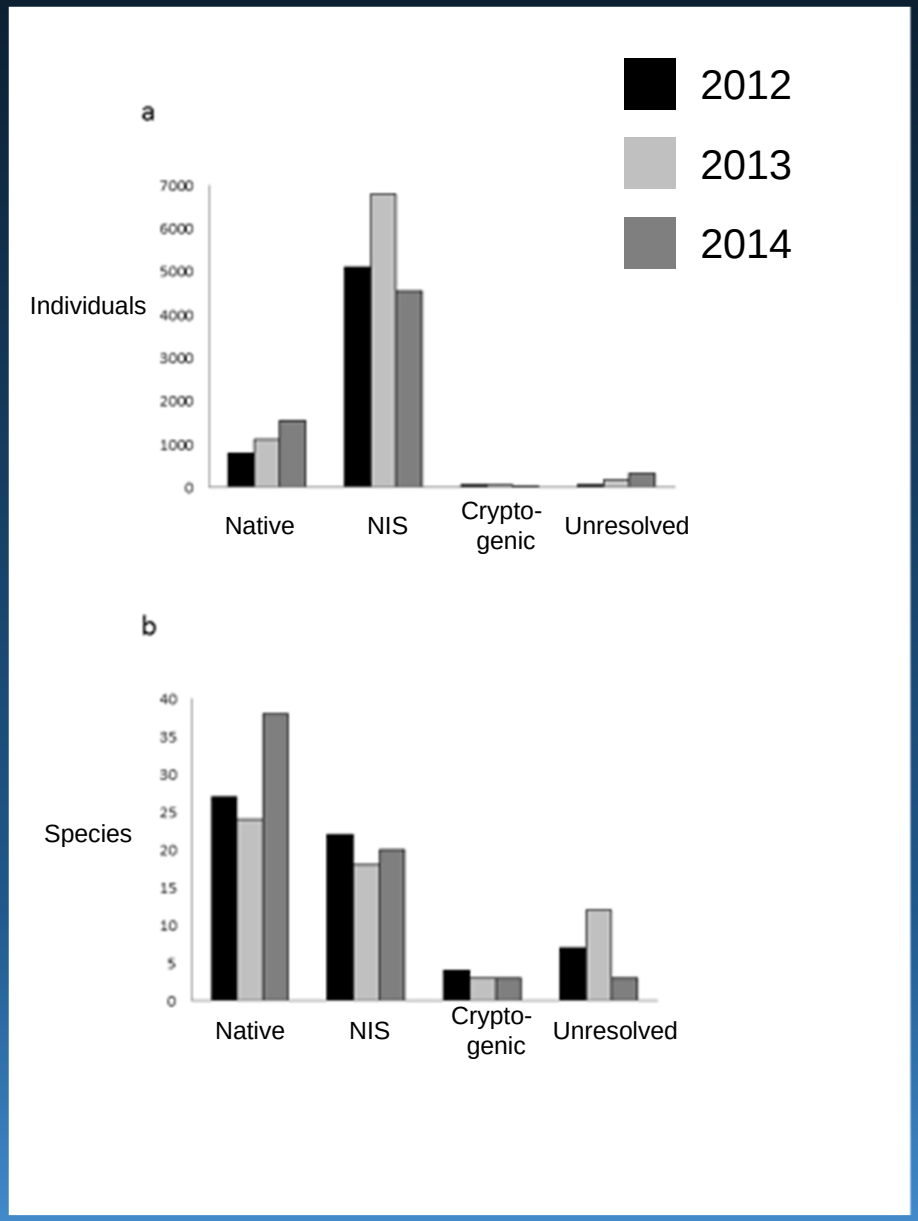
Romberg Tiburon Center for Environmental Studies

SF State

Smithsonian Environmental Research Center

Soft sediment

Abundance and richness similar across years



Species accumulation