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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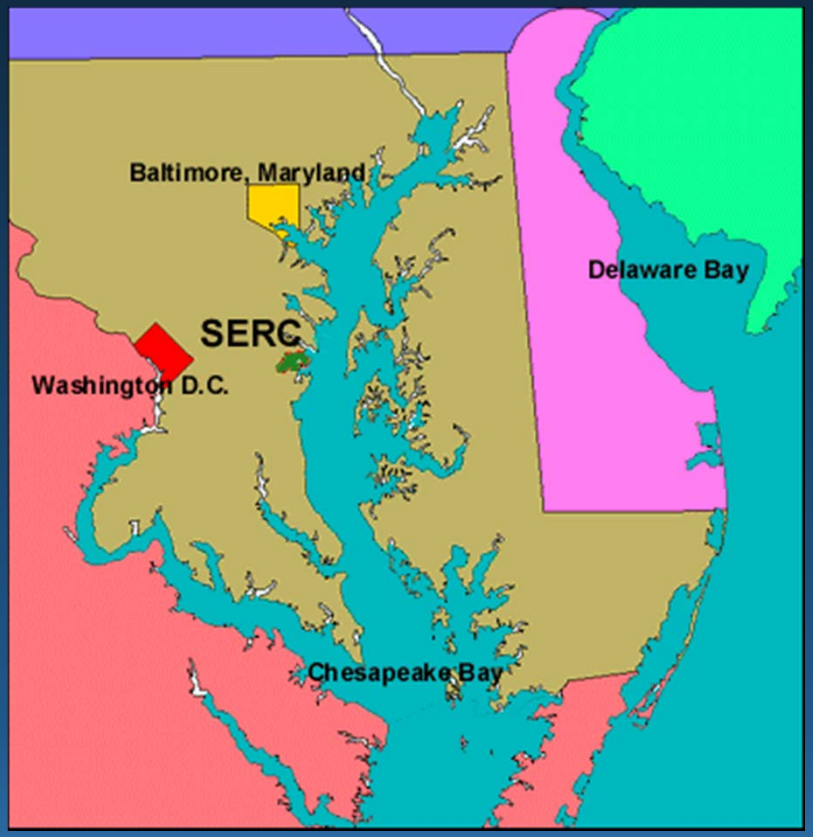


Main lab: Edgewater, MD (Chesapeake Bay)

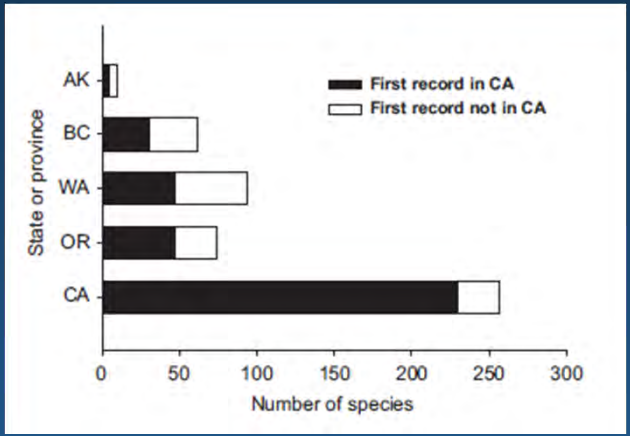
Marine Invasions Lab

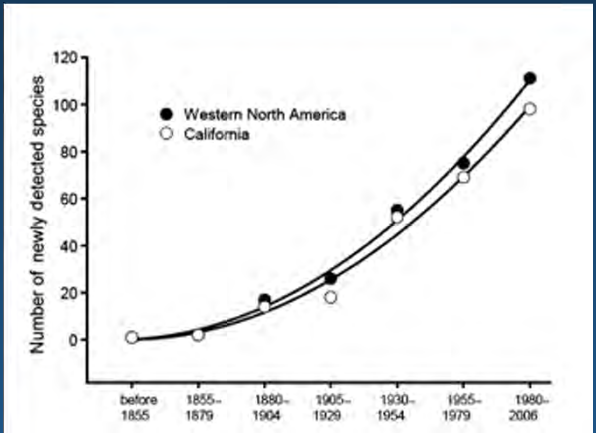
San Francisco Bay unit (Tiburon, CA)

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

0.1m² 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

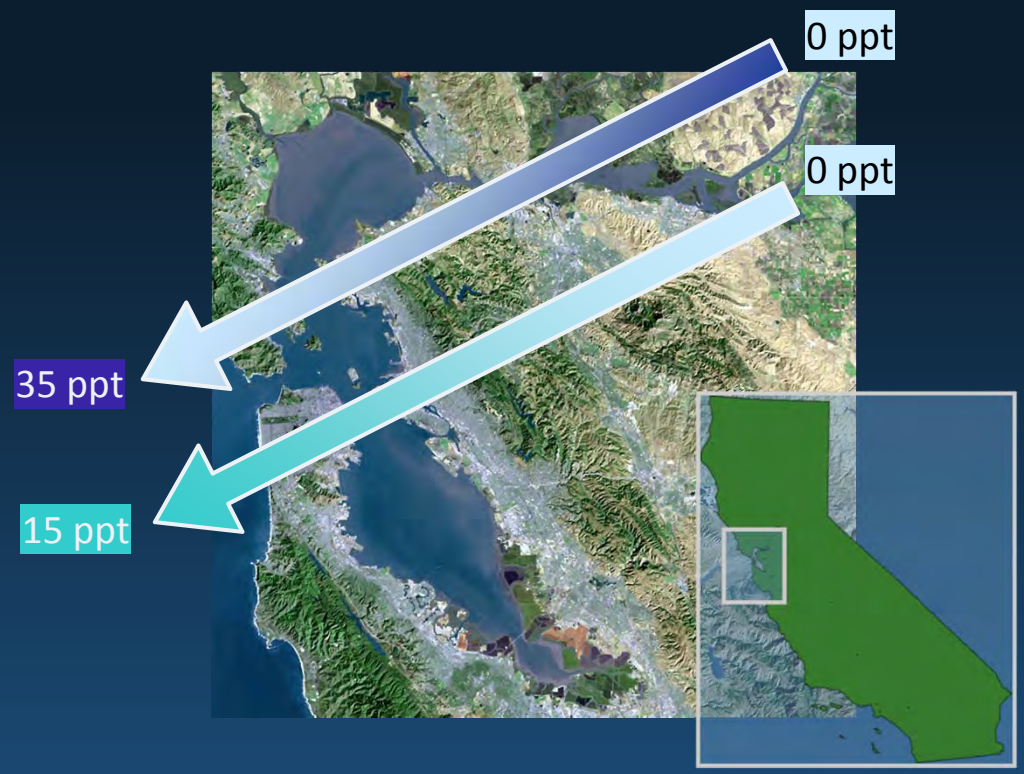
Genetic analyses

Geller Lab, Moss Landing Marine Labs

Environmental variation in estuaries

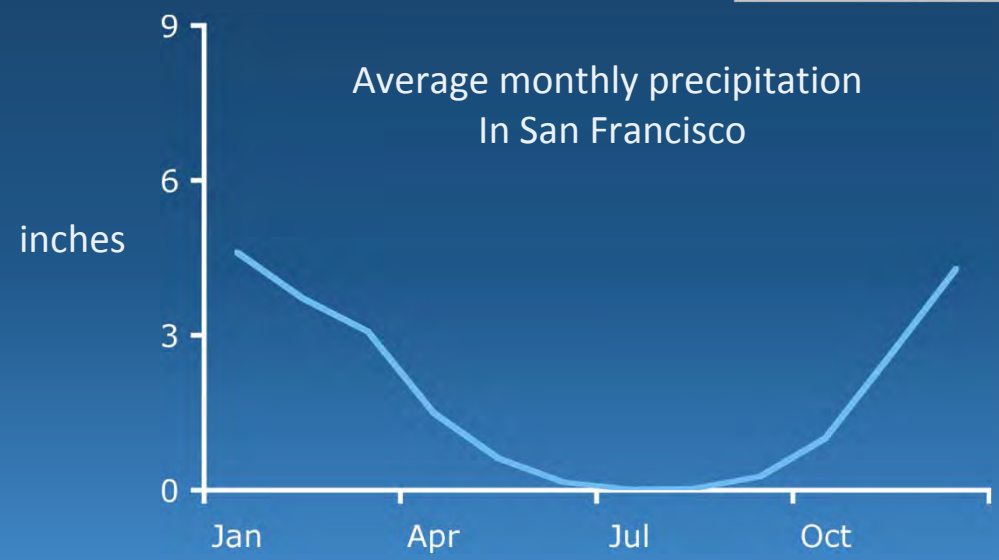
Salinity is a key estuarine variable

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



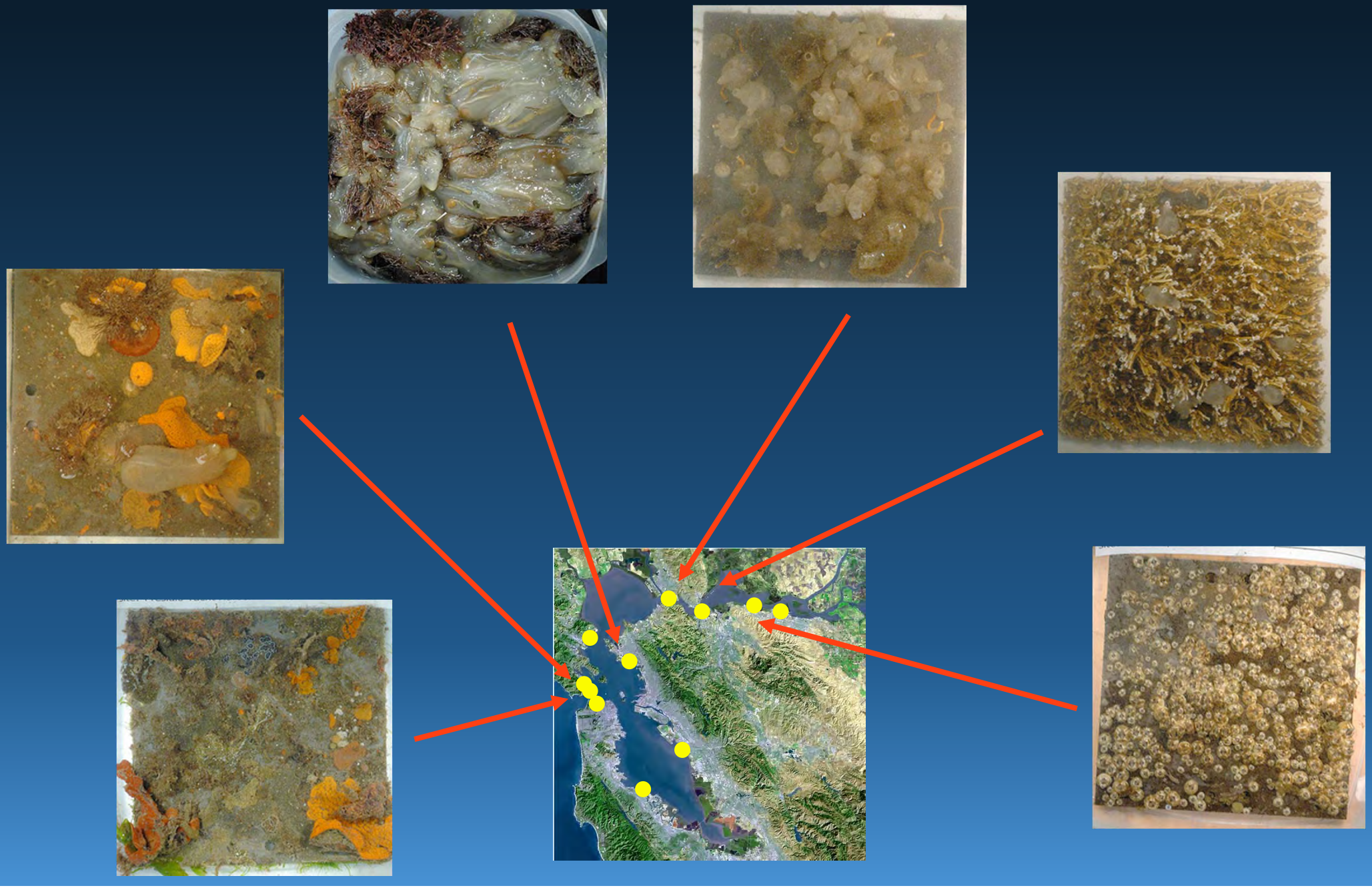
San Francisco Estuary:

- 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



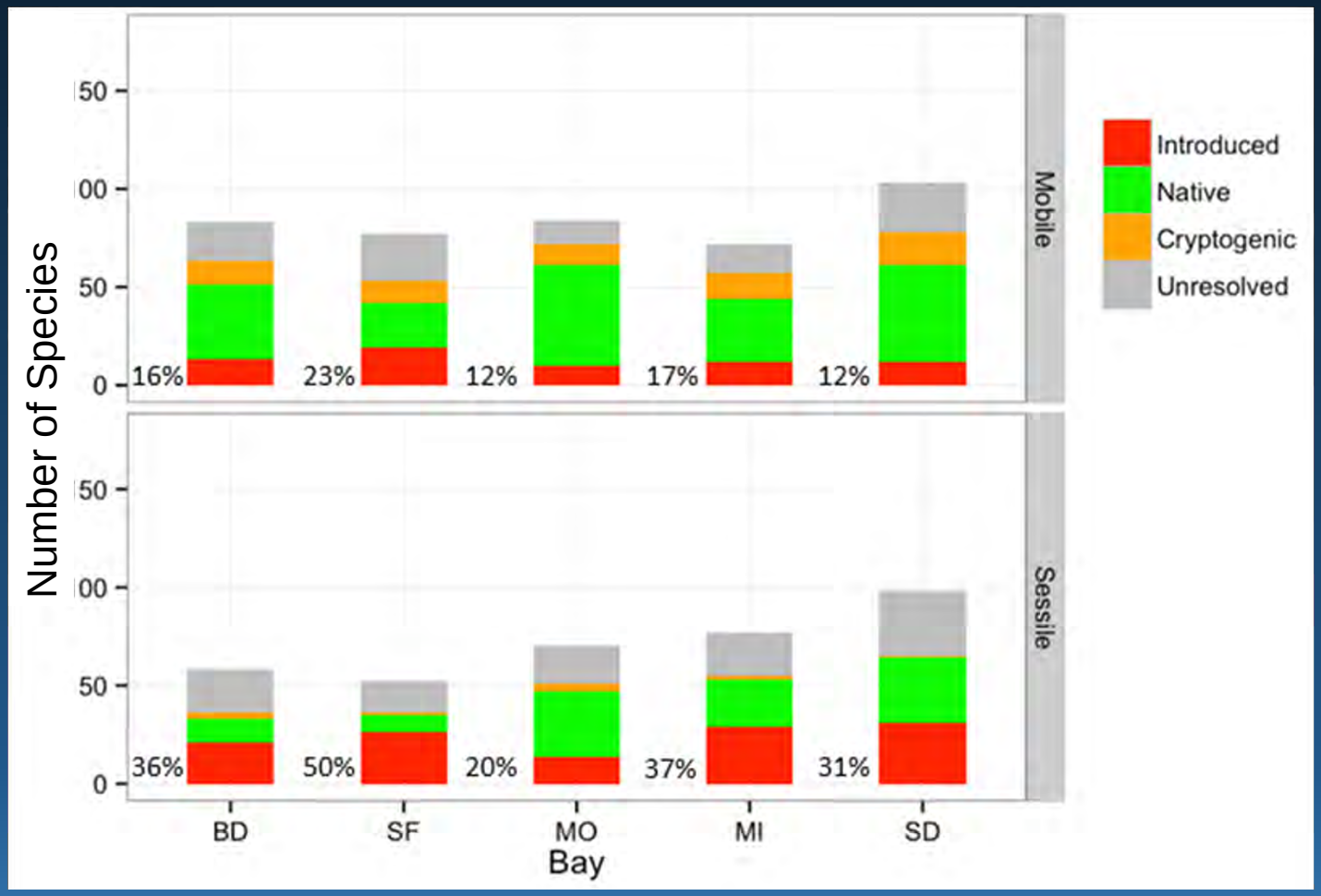
How many species?

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

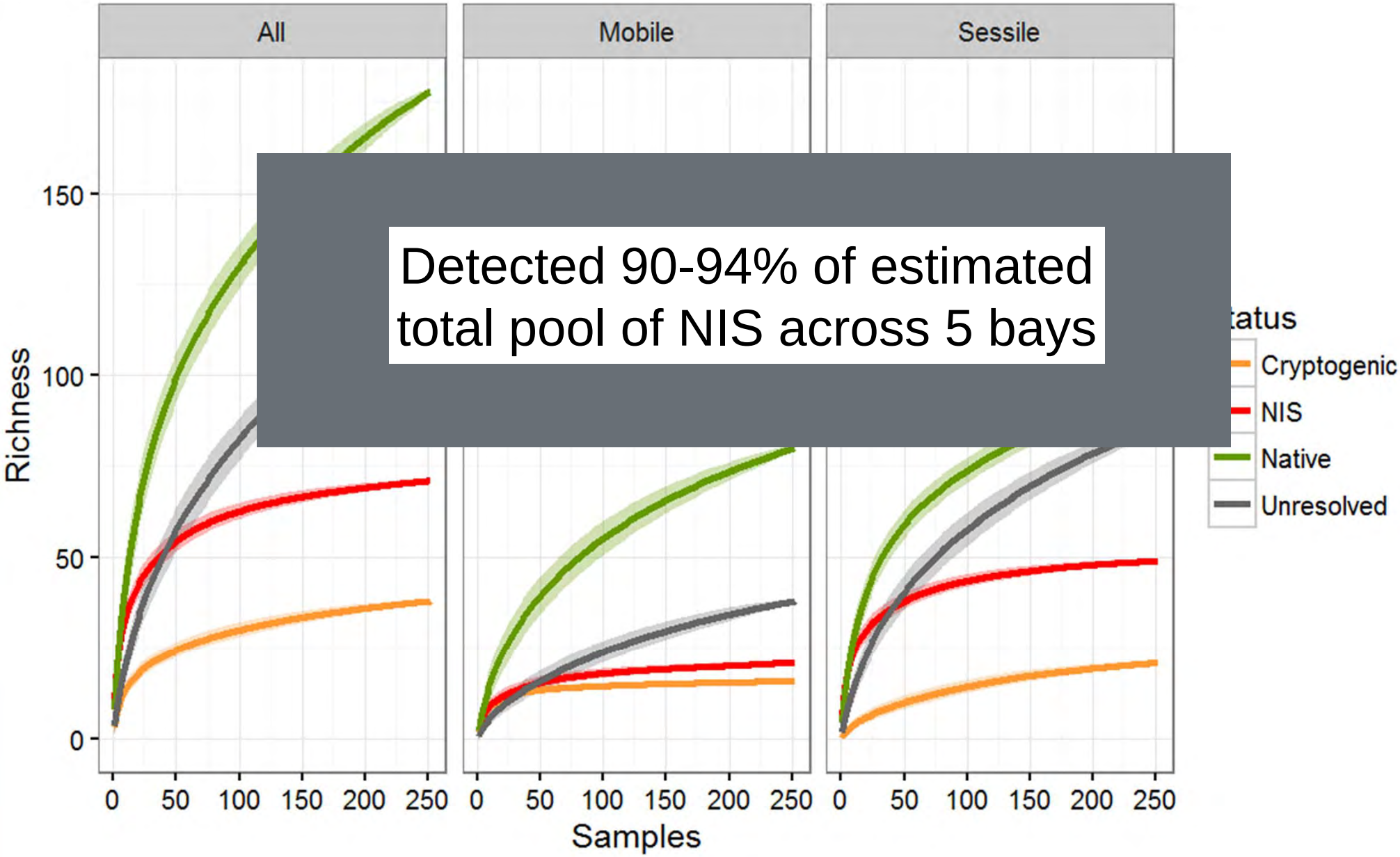
Increasing sessile diversity further south (expected latitudinal gradient)

14-21 mobile NIS detected per estuary

23-35 sessile NIS detected per estuary



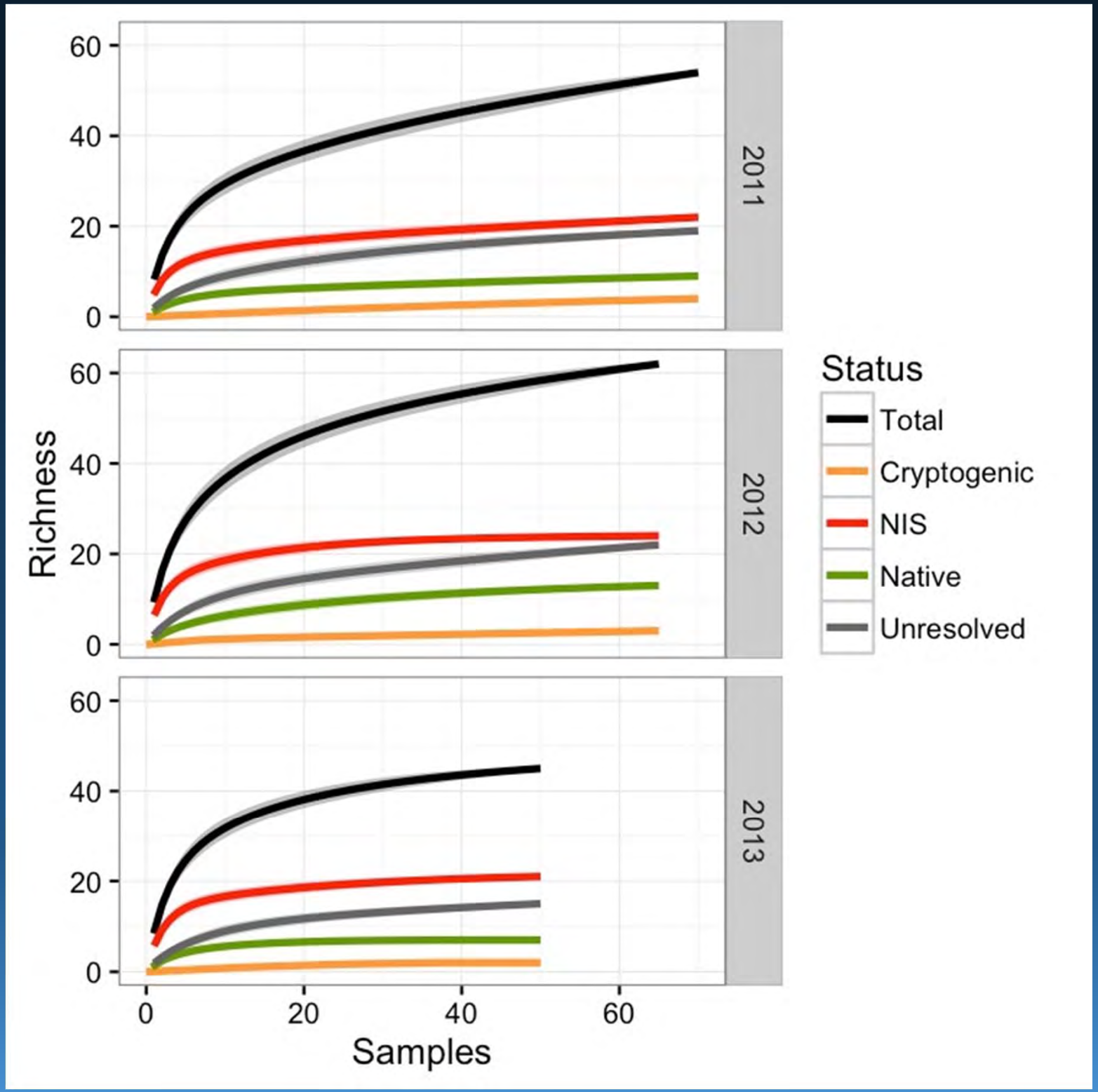
Species accumulation

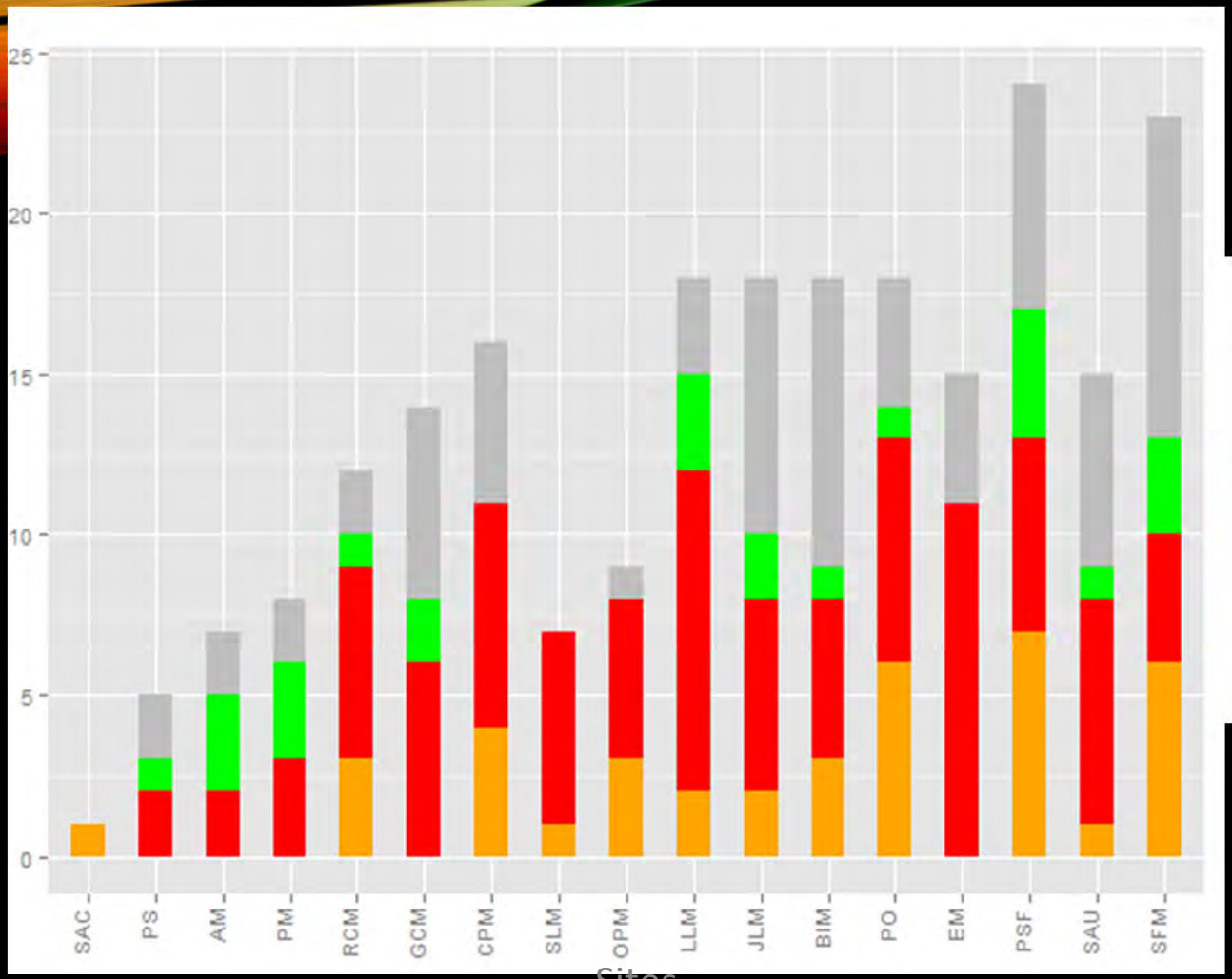


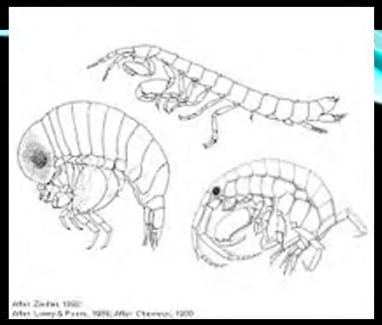
Detected 90-94% of estimated total pool of NIS across 5 bays

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

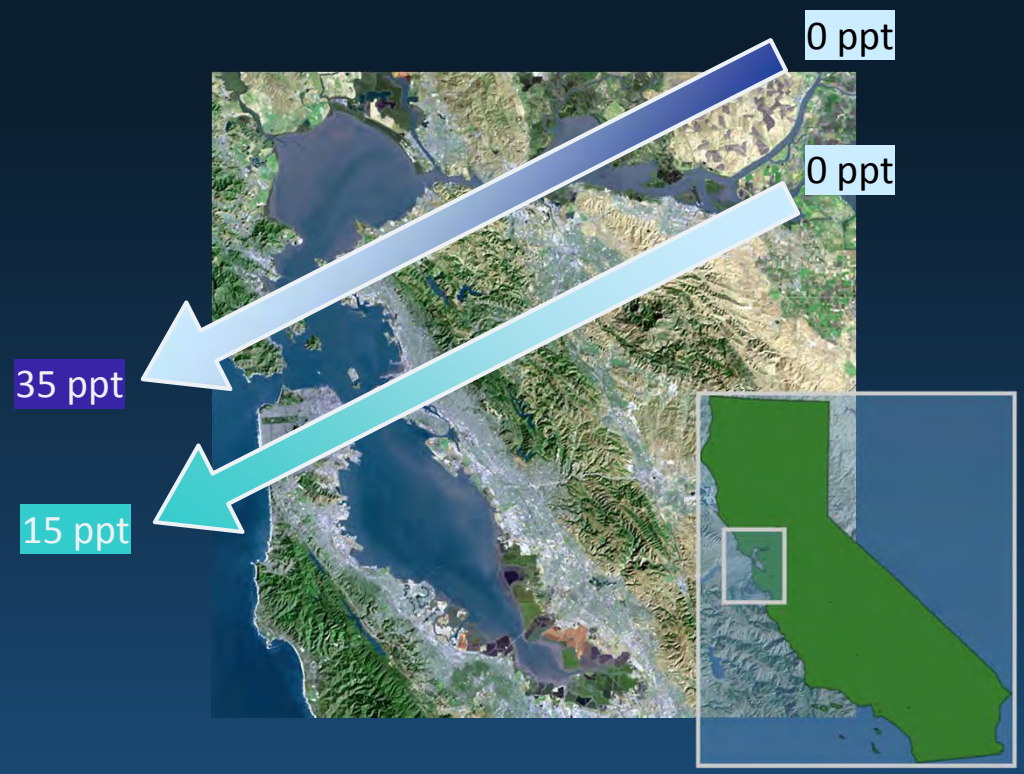
2006

2007, 2008

Environmental variation in estuaries

Salinity is a key estuarine variable

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

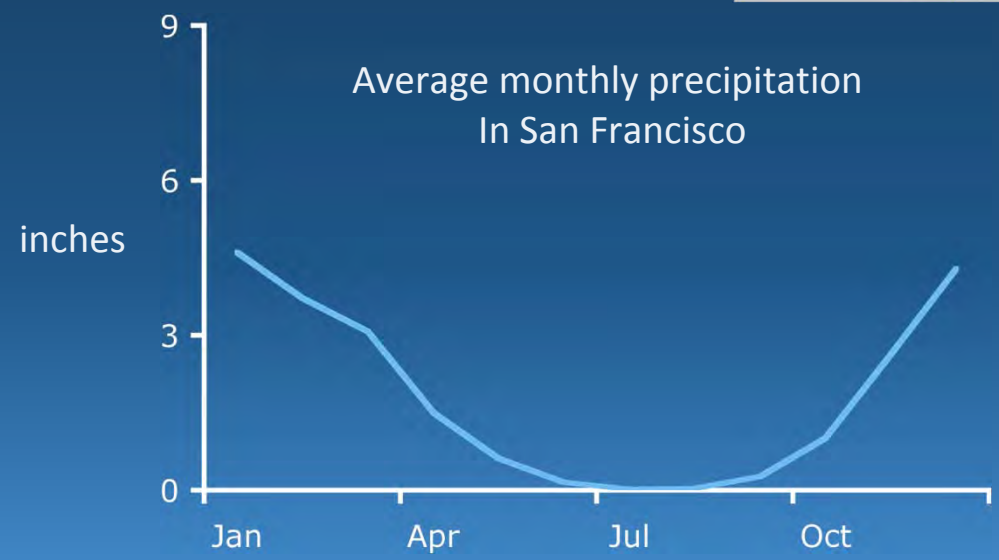


San Francisco Estuary:

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

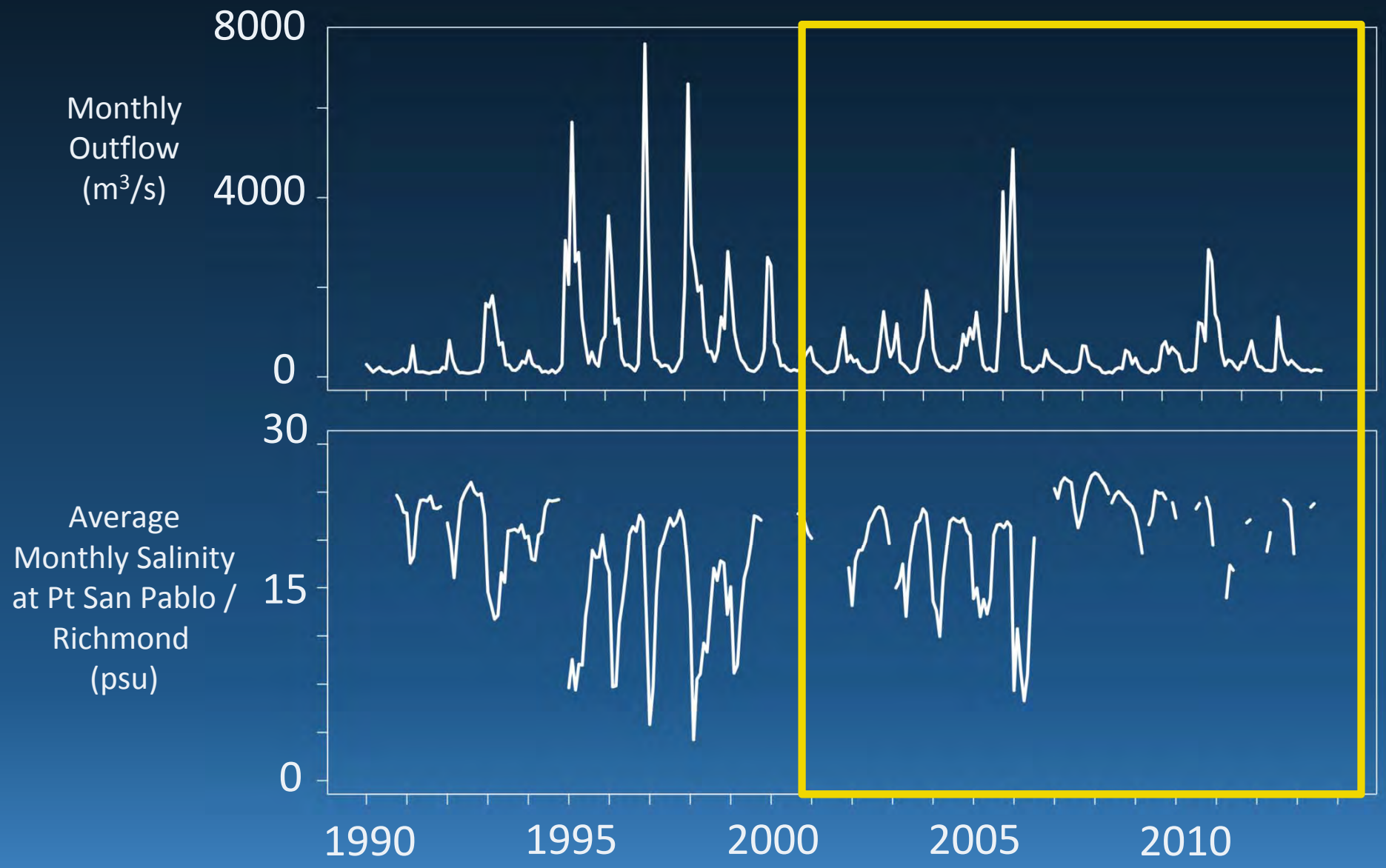
Nearly all precipitation falls during November - March

Large interannual variation



Data from NWS

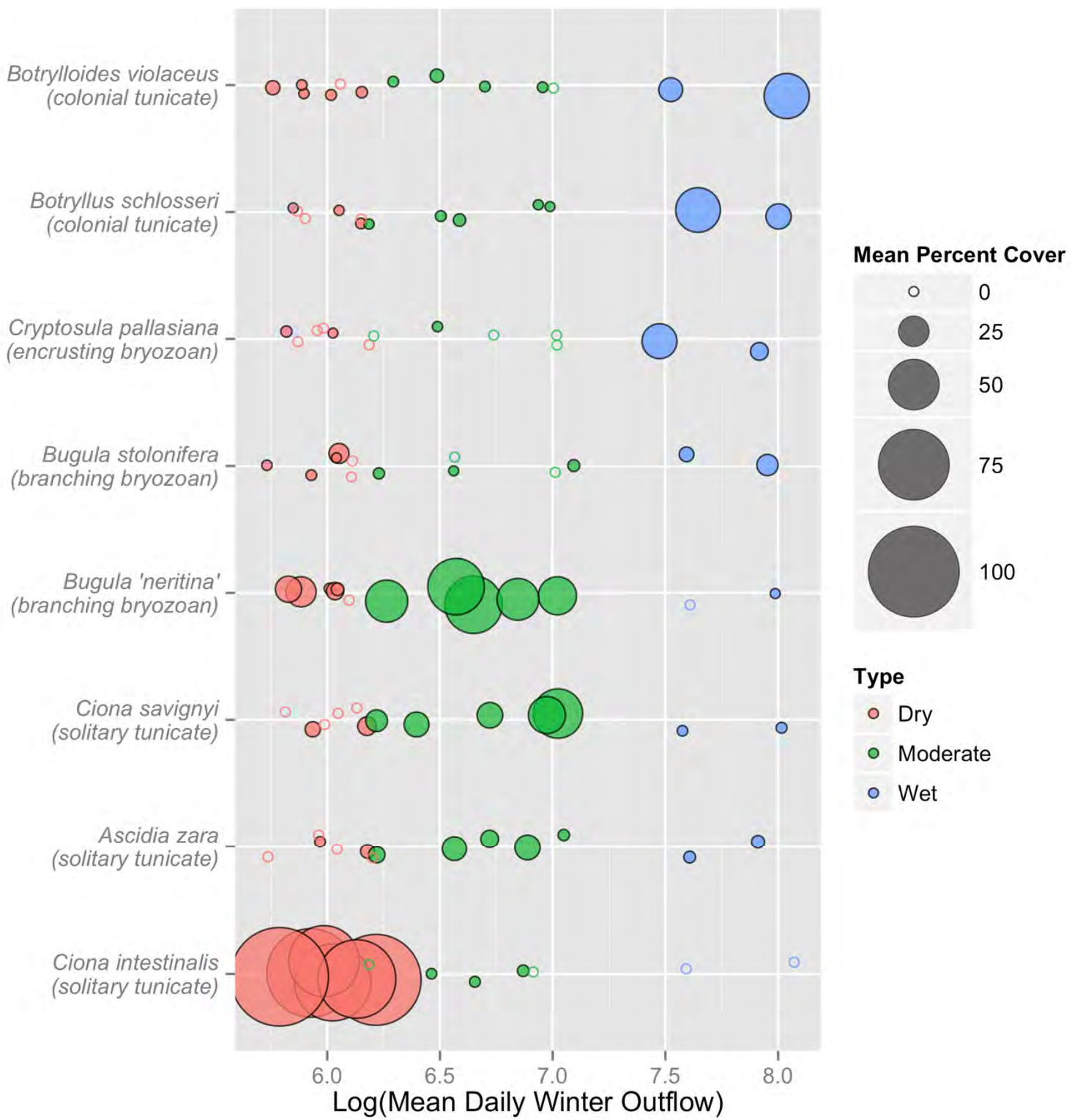
Focal Period: 2001 – 2013



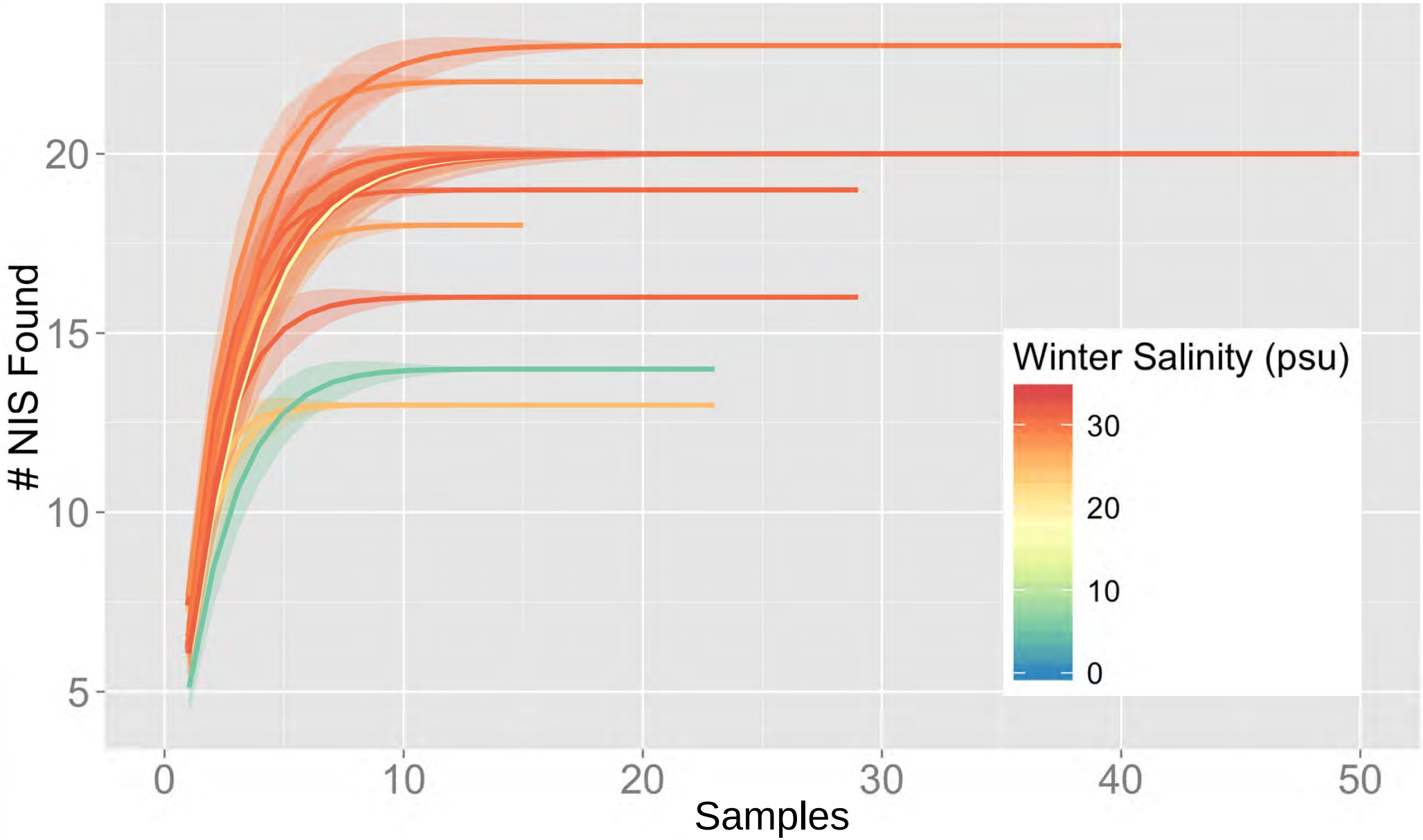
Environmental conditions make a big difference at the same site across years:

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

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Habitat differences in marine invasions of central California

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

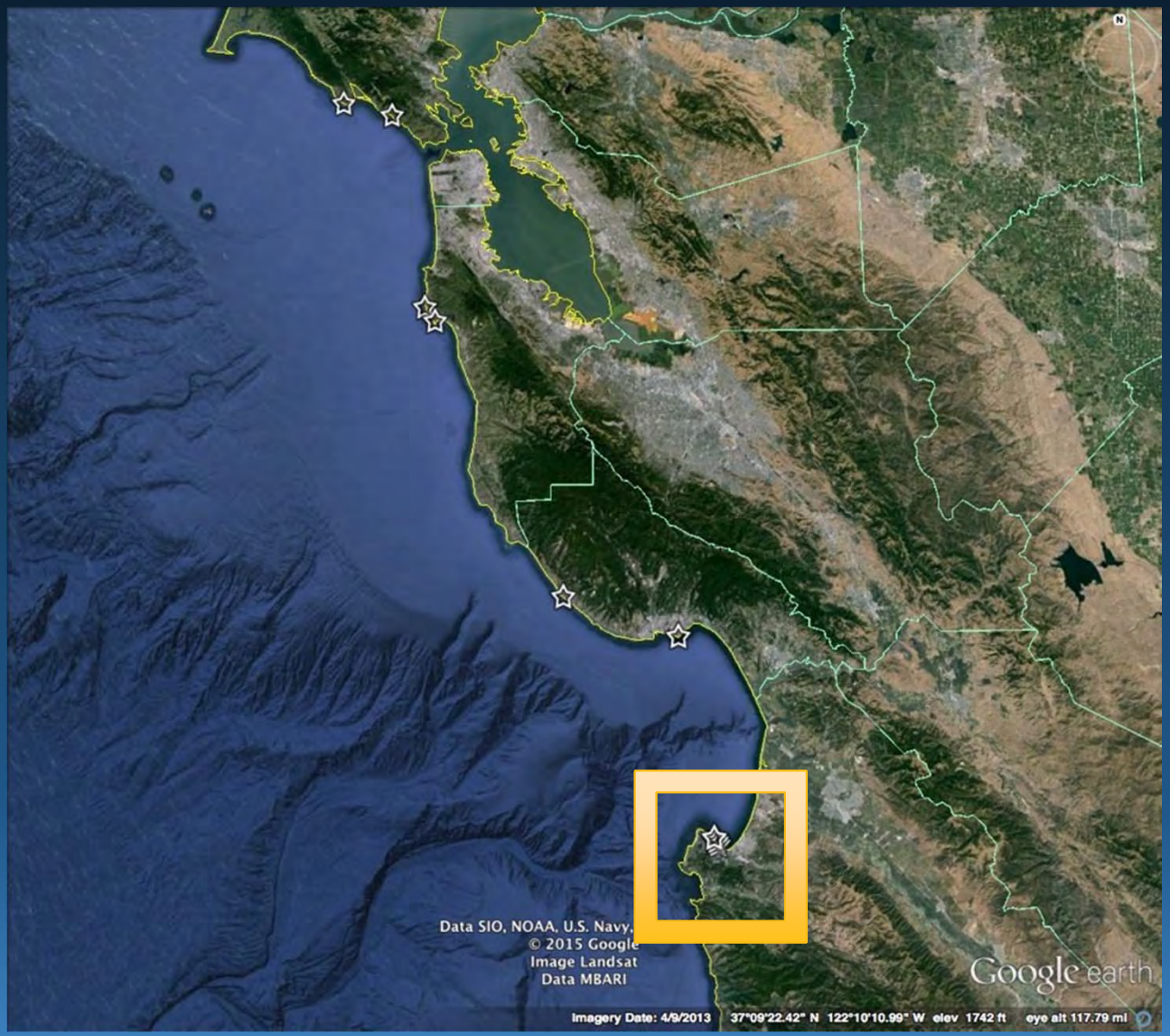
Many fewer invasions outside bays – low *propagule pressure*

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

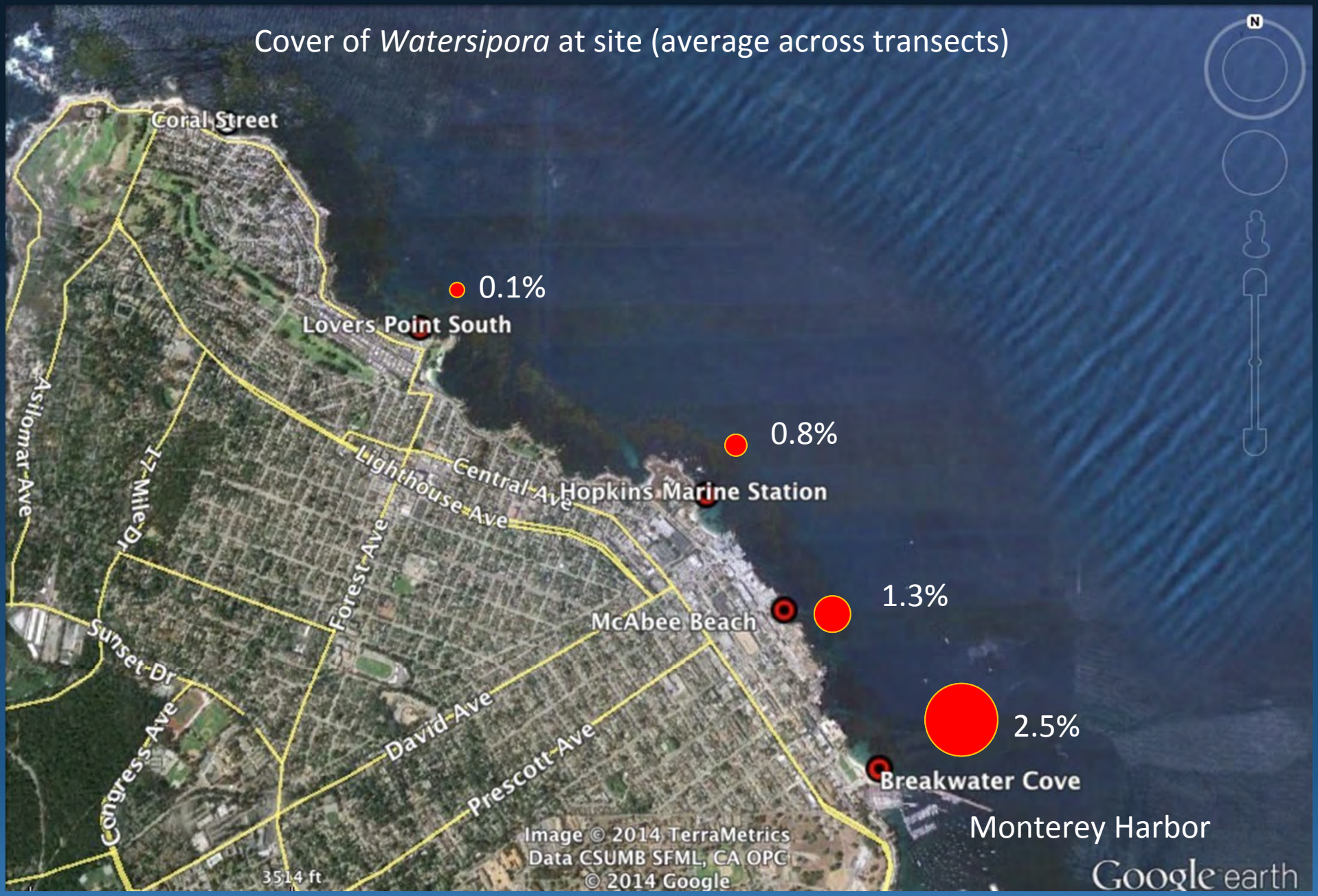
Outer coast surveys: intertidal

Watersipora subtorquata

Outer coast surveys: subtidal



Watersipora found
No *Watersipora* found
Coral Street
Lovers Point South
Hopkins Marine Station
McAbee Beach
Breakwater Cove
218
Salinas Hwy
1
Copper Roof House
Monastery Beach
Data CSUMB SFML, CA OPC
Data MBARI
© 2014 Google
Pt. Lobos
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
Central Ave
Lighthouse Ave
Asilomar Ave
17-Mile Dr
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

California Department of Fish and Wildlife

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California Non-native Estuarine and Marine Organisms (Cal-NEMO) Database

The Cal-NEMO database includes comprehensive and user-friendly information on established non-native invertebrates and algae in the marine and estuarine waters of California. A collaboration between Office of Spill Prevention and Response (OSPR) and the Smithsonian Environmental Research Center (SERC), Cal-NEMO is a portal of the National Estuarine and Marine Exotic Species Information System (NEMESIS).

Cal-NEMO replaces CANOD, OSPR's inventory of non-native species in California. Improvements include images and descriptions for identification, maps of global distributions, and information about species ecology and impacts. It is a long-term, dynamic database that we will continue to update as new species are discovered and new research becomes available.

Contact Information

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Phone: (916) 341-6958

Last update : 9/26/2016 2:51:31 PM

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

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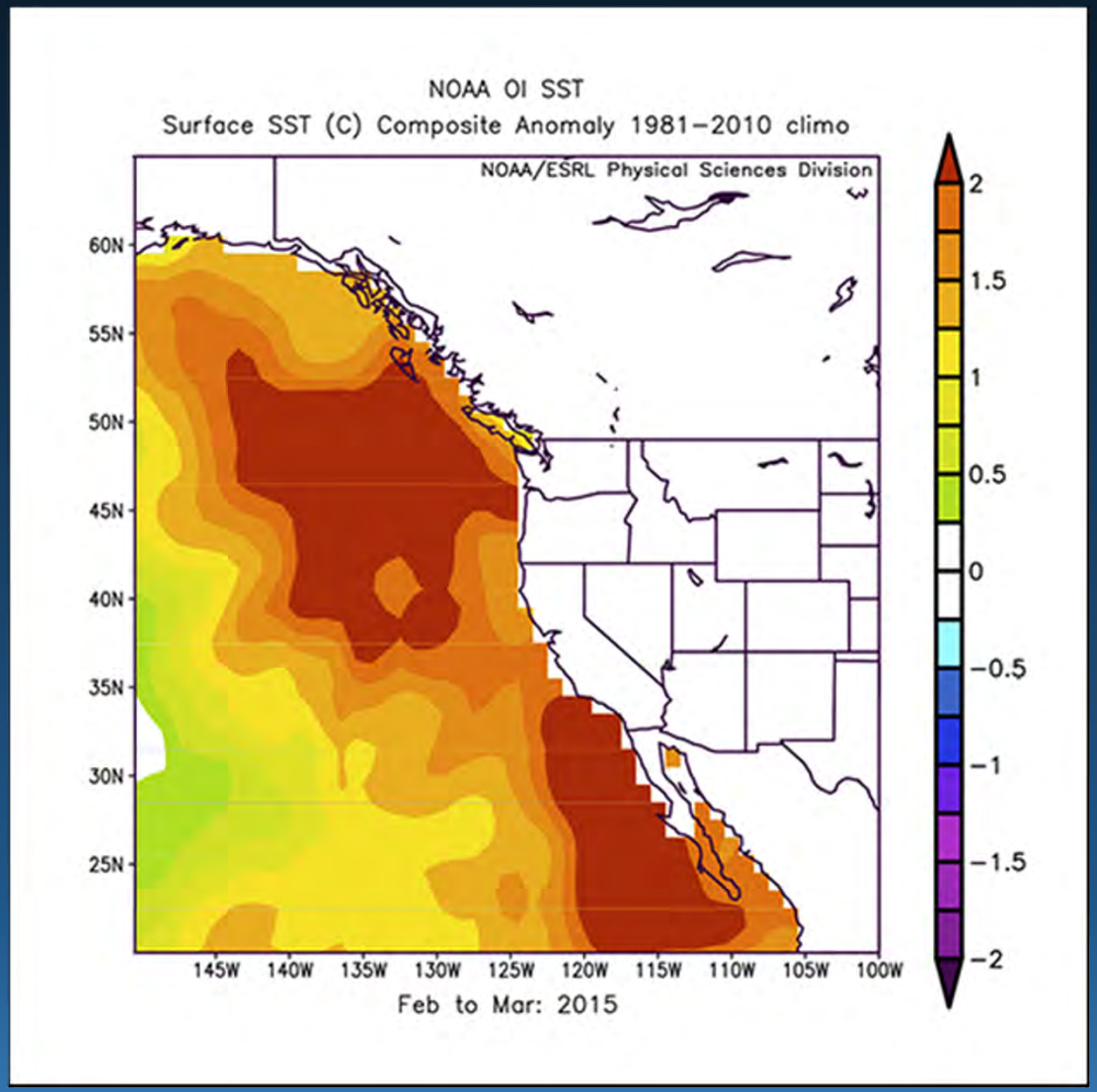
Looking Ahead

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

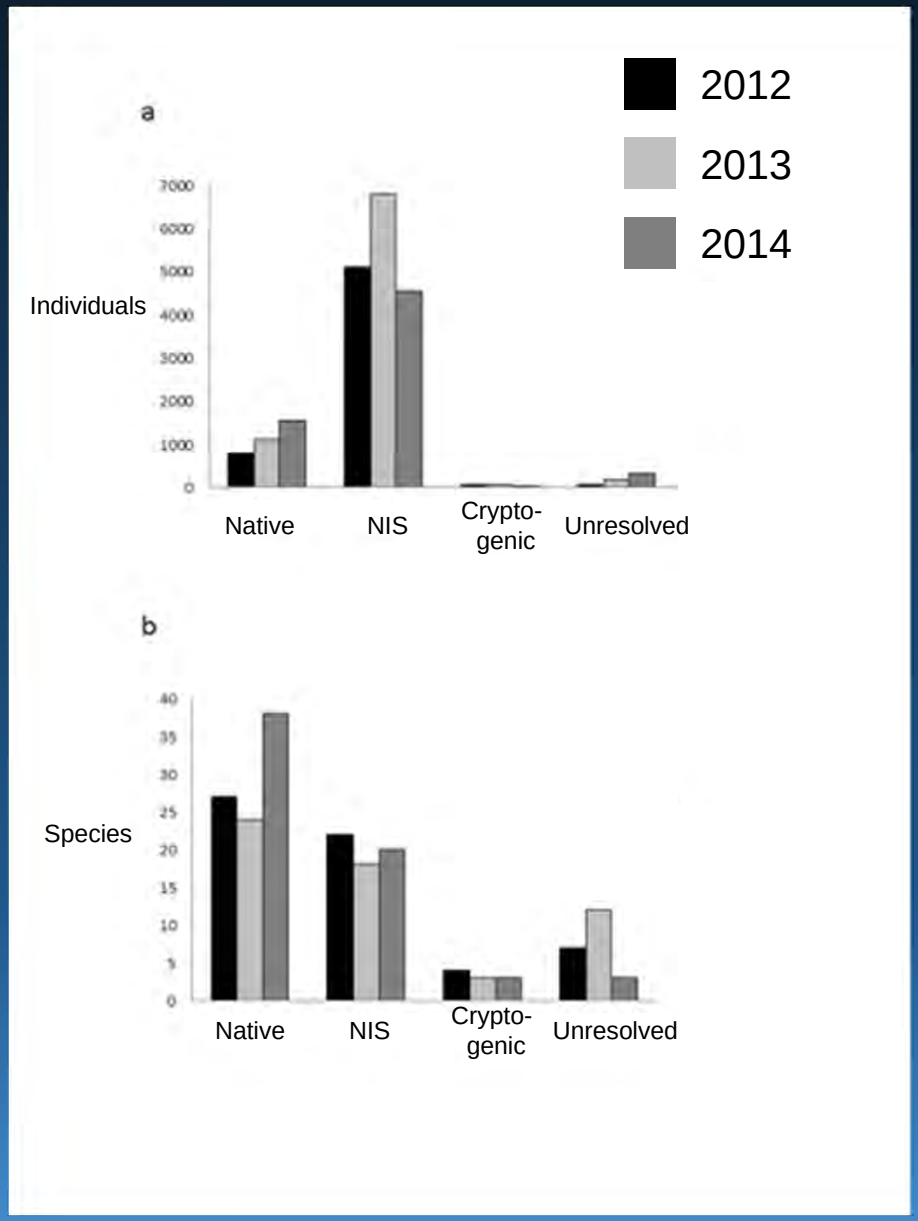
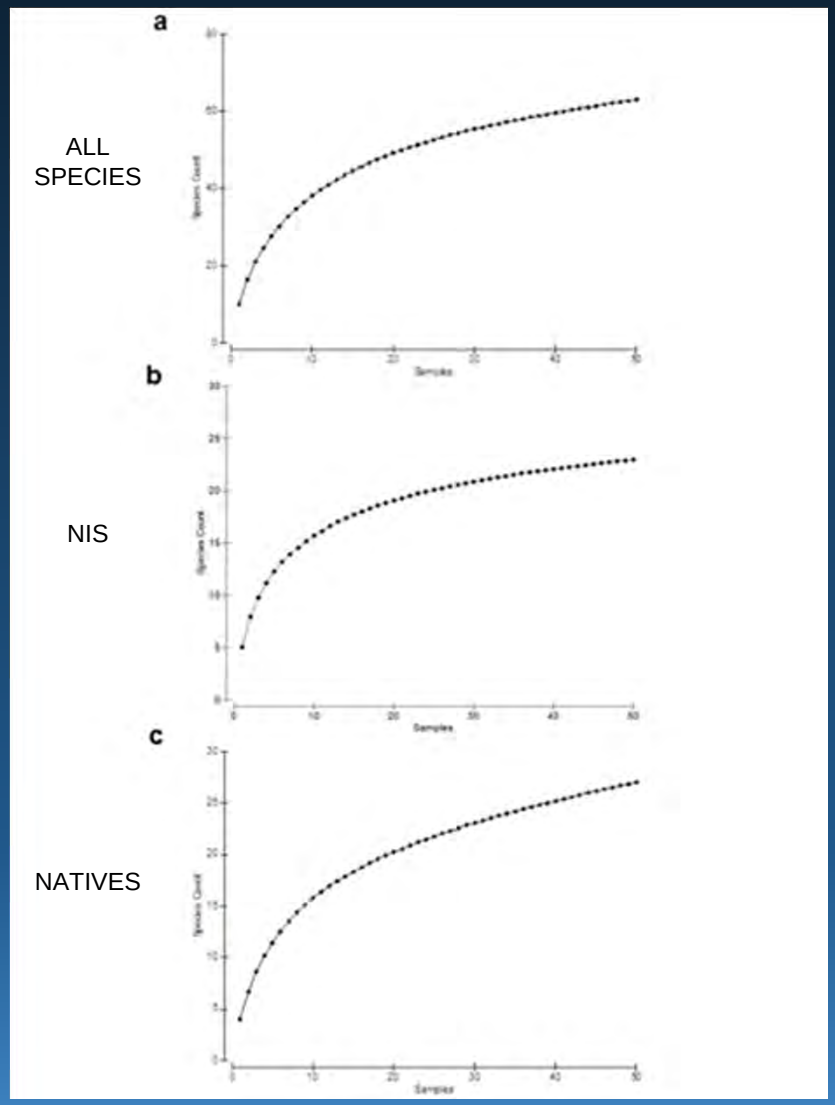
Romberg Tiburon Center for Environmental Studies

SF STATE

Smithsonian Environmental Research Center

Soft sediment

Abundance and richness similar across years



Species accumulation