Status and Trends of Biological Invasions in Coastal Marine Ecosystems of California Based on Recent Monitoring

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CDFW's MISP

Authority:

- California's Coastal Ecosystem Protection Act of 2006
- **Monitor** California marine and estuarine waters for new NIS

Why do we monitor?

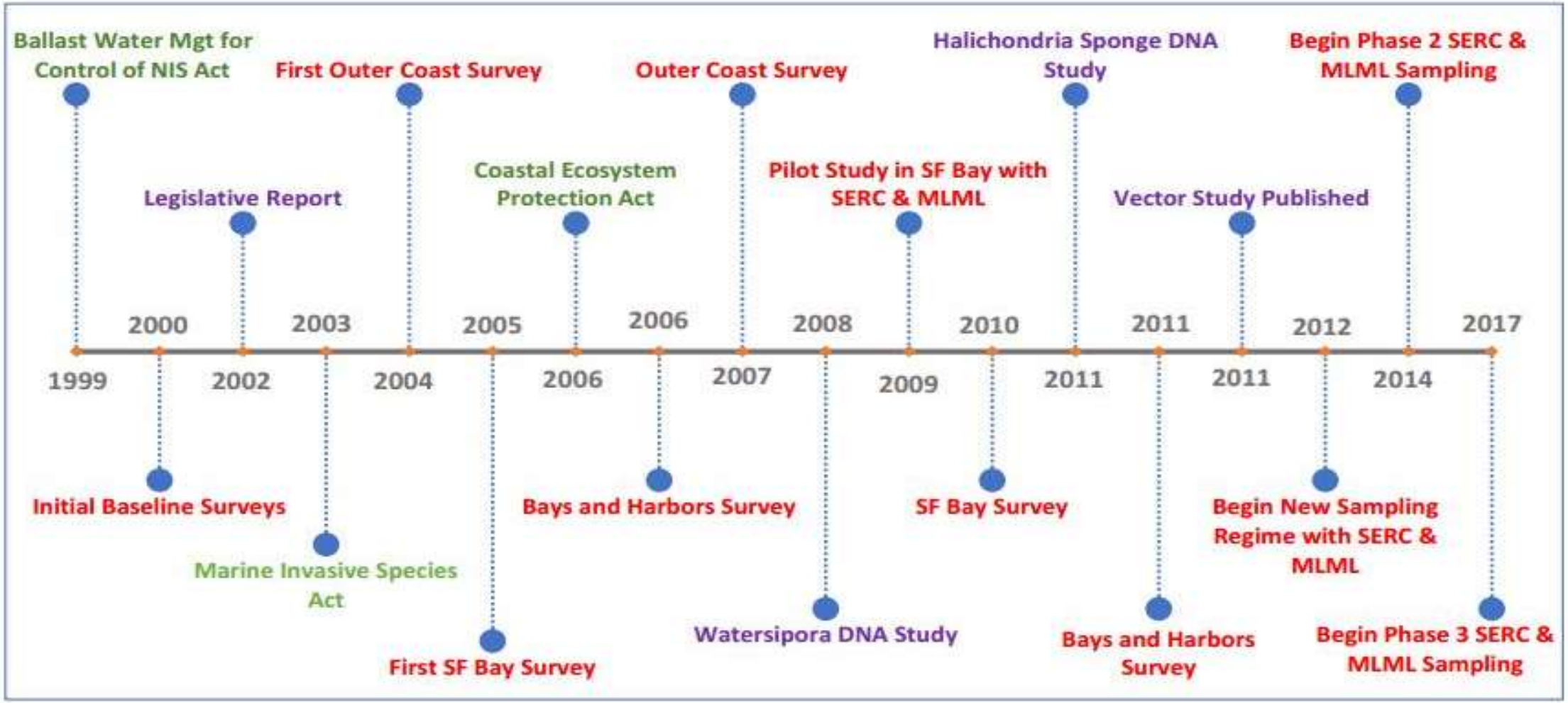
- Measure status and trends of biological invasions in coastal marine ecosystems;
- Understand geographic distribution, habitat distribution, and patterns of spread for NIS;
- Evaluate the vectors of introduction and spread of NIS in California;
- Detect changes in the patterns (rate, spread, prevalence) of NIS in response to shipping management regulations.

What are current ballast water regulations?

- Retain BW
- Shipboard ballast water treatment systems
- Open Ocean Exchange (BWE) is primary tool, since 1999.

  - This is what we are measuring the effect of.

MISP Timeline



Monitoring Approach

Designed to:

- Establish a robust, quantitative baseline
- Implement a time-series of repeated measures
- Evaluate temporal changes in invasion rate / dynamics associated with management of ballast water and other vectors

Sampling

Bays/Harbors

- Intensive sampling of 10 estuaries, 5 with commercial shipping and 5 without.
- Focus on fouling (sessile), plankton, and soft-sediment communities

Sentinel Sites

- San Francisco Bay (hot-spot)
- LA/LB

Outer Coast - Spillover

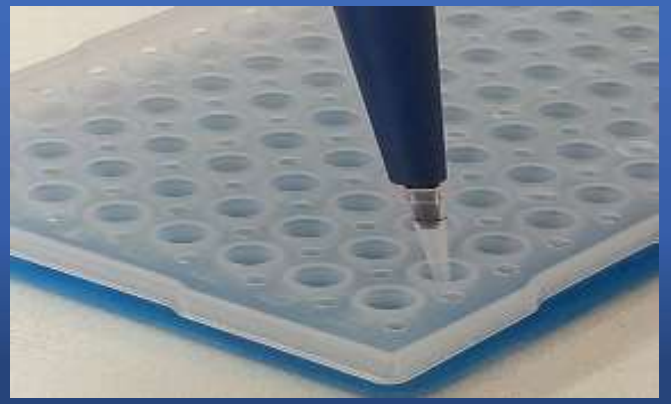
- Most comprehensive statistical community analysis of invasion patterns across multiple estuaries to date

Sample Processing

SERC - Sampling

SERC – Morphological ID

MLML – Molecular ID



Final ID

Genetic Analyses

Issues of traditional taxonomic identification:

- Organisms difficult to identify
  - damaged or juvenile specimens
  - morphologically indistinguishable species
- Slow turnaround time

Benefits:

- Assures consistent taxonomic assignment
- Identifies cryptic and unresolved taxa
- DNA barcode database for rapid detection.

Advantages: Cost-Efficient, Faster & More Accurate

State-of-the-art genetic tools

Fouling Community

PVC settlement plates - sessile invertebrates

2017

2018

Fouling Community

Chang, A.L., et al. (2017):

- San Francisco Bay, sessile invertebrate communities are dominated by nonnative species
- These communities are very sensitive to the interannual climatic fluctuations

- Water management - lowers average flow and stablizes spring/summer flows
- Climate warming is projected to reduce average precipitation levels

Fouling Community

Brianna M. Tracy, et al. (2017):

- 3 Tunicate species spread beyond their previous range in S. California to San Francisco Bay

- Trend: increasing number of NIS expanding their range northwards on the Pacific coast of N. America.

- Both human vectors and ocean warming are implicated.

Soft sediment community

Soft sediment community

Haizea Jimenez and Greg Ruiz (2016):

- NIS numerically dominant in SF Bay
  - 76 % of all organisms detected
  - abundance 3.5 times higher than natives

- NIS contributed to 36 % of observed taxa and 24–29 % of total estimated diversity.

- % contribution of NIS to species richness was > 2 times higher than 20 years ago

Outer Coast

- Previous statewide surveys found total of 9 established species. Records are known for 22 species.

- 2014-2015 Survey in intertidal and subtidal locations at increasing distances from harbors.

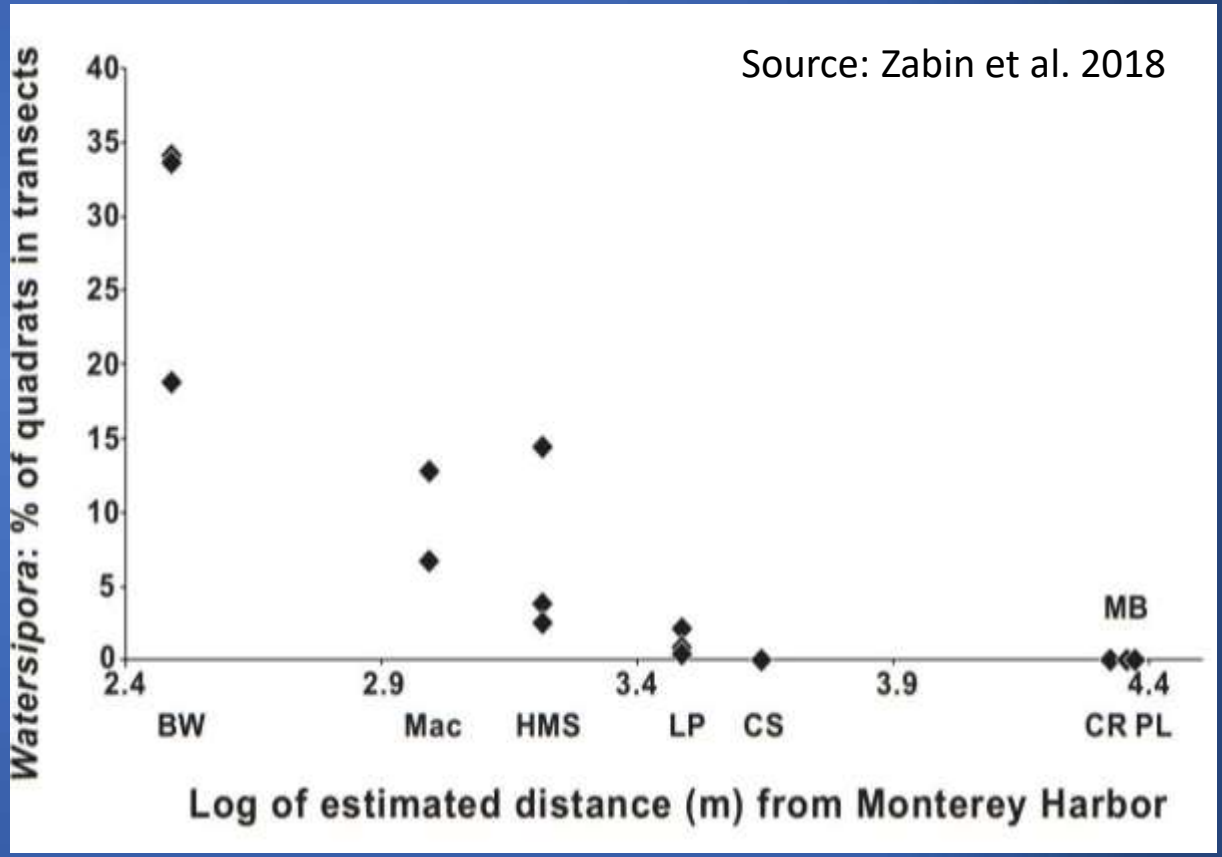
- Test for possible spillover from bays to exposed outer coast habitat

- Sites near San Francisco Bay and harbors at Pillar Point, Santa Cruz, and Monterey.

Outer Coast

Chela Zabin et al. (2018):

- At least one NIS detected at 50% of the sites surveyed, but most not widespread or abundant.
- Watersipora found at multiple sites, abundant at some.
- For subtidal sites, proximity to harbor correlated with abundance of NIS.
- Study area relatively uninvaded, but success of Watersipora shows potential vulnerability of open-coast.



Plankton

Advantage of Sampling:

- Complements sampling of other habitats

- Includes both holoplankton and meroplankton (larvae of benthic species)

Advantage of Genetic analysis

- Larvae are either morphologically undescribed or difficult to identify

Statewide Results (2014-2016)

- 8 new NIS detected for San Francisco Bay
  - previously known from CA
  - coastwise spread
  - 3 tunicates from S. Cal.
  - 5 polychaetes

- For hard substrate habitats, only one NIS (a bryozoan found in Humboldt Bay), was new to CA.

- No new NIS detected in SF Bay soft-sediment or in Zooplankton surveys across four different bays.

Conclusions

- Given the spatial and temporal scale of our sampling efforts, including 3 years in SF Bay, and comprehensive analyses, lack of new records is surprising.

Results suggest:

1. Invasion rate or detection may be variable over time, or
2. A decline in invasion rate has occurred.

If a decline in invasion rate has occurred:
1. It may be a result from changes in management, or
2. It could reflect changes in trade patterns or environmental conditions over time.

Repeated sampling over time in each Bay will help determine whether this is a lasting or ephemeral pattern.

Cal-NEMO Database

http://invasions.si.edu/nemesis/calnemo/intro.html

SERC > Marine Invasions Research Lab > Invasions Lab Online Databases

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

Smithsonian Environmental Research Center

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Cal-NEMO Database
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Taxonomy Search: Submit

Eriocheir sinensis

Taxonomic Group: Crustaceans-Crabs

Common name: CHINESE MITTEN CRAB

Image courtesy of Leif-Matthias Herborg

Overview:

The Chinese Mitten Crab, *Eriocheir sinensis*, is native to China where it ranges from the Bohai Sea and the Southern coast of South Korea, south to Macau, near Hong Kong. This crab is catadromous, breeding in brackish-to-marine waters, and moving upstream as a juvenile to mature in fresh water, sometimes up to 1000 km from the sea. It has been introduced throughout Europe and North America. In Europe, it was first discovered in Germany in 1912 and now ranges from Sweden and Finland to the Atlantic coast of Spain and into the Black Sea. It has established populations on the East and West Coasts of US. Its long planktonic stage suggests that ballast water is a likely introduction vector, but some populations may have been introduced through 'live trade'. *Eriocheir sinensis* was listed by the Invasive Species Specialist Group of the World Conservation Union (IUCN) as one of the '100 worst invasive species'. It has had economic and ecological impacts throughout its introduced range.

Taxonomy | Distribution | Occurrences | Ecology | Impacts | References