

State of the Bay 2010

A Conference about Tomales Bay and its Watershed



Photograph: © KathleenGoodwin.net 2010

Friday, October 22 and Saturday October 23, 2010

presented by the Tomales Bay Watershed Council



Conference web-page - <http://www.tomalesbaywatershed.org/stateofthebay2010.shtml>

Abstract:

Invasive Marine Species in Tomales Bay

Dr. Ted Grosholtz, Professor and Swanz Chair in Cooperative Extension, University of California at Davis

Tomales Bay has many introduced species in the marine environment. The source of many new invasions is dispersal along the coast from major ports. Screening and quarantine procedures minimize aquaculture introductions, but commercial and recreational boaters may be introducing some species. Many of the introduced invertebrates and fish have been catalogued in the All Taxa Biological Inventory (ATBI) by PRNS and in the Species of Local Interest (SOLI) by local scientists. Removal and control programs for *Spartina* and the Asian mud snail have shown varying levels of success. Population trends for the European green crab and introduced whelks (oyster drills) show concentration of these invasive species in the inner bay, relative to the middle and outer bay. Many potential invaders that are prevalent in SF Bay have not made it to Tomales Bay. Climate change may have a significant impact on the rate and success of invasions by exotic species.

See video of this presentation at: <http://vimeo.com/17158871>

Complete proceedings, individual presentations, and links to video from the 2010 State of the Bay Conference are available on the Tomales Bay Watershed Council's website:

<http://www.tomalesbaywatershed.org/stateofthebay2010.shtml>

Speaker Biography:

Ted Groholz is Professor and Swantz Chair in Cooperative Extension at UC Davis. He received his undergraduate degree in Biology from Brown University, and received his Ph.D. Zoology (1990) University of California, Berkeley in 1990. His fields of interest include population dynamics and community ecology, invasion biology, conservation biology, biodiversity of marine and estuarine systems, and applications of ecological theory to coastal management problems. His approach involves field and laboratory experiments that answer basic ecological questions and provide solutions to management problems. He accepts graduate students through the Graduate Group in Ecology.

Zebra and Quagga Mussels: Changing North America's Freshwater Ecosystems

**Edwin Grosholz
Department of Environmental
Science and Policy
UC Davis**

Invasions in Tomales Bay

- **Like most estuaries in western North America, Tomales Bay has many introduced species**
- **Far too many to discuss in a sweeping survey**
- **Far too little to say much about broad patterns of introduction, vectors of introduction, or overall impacts**

Invasions in Tomales Bay

- **Source of many/most new invasions in Tomales Bay is dispersal along the coast from major ports**
- **Current screening and quarantine procedures minimized aquaculture introductions**
- **Some contribution likely from small boats (recreational/commercial fishing)**

Survey of Invasive Species

- **Incomplete knowledge of which species are native, introduced or cryptogenic (uncertain)**
- **Approximately 60 introduced invertebrates, 14 introduced fishes (mostly in watershed)**
- **Comprehensive lists assembled in 2003 (ATBI) by PRNS**
- **Very recent list assembled for SOLI by local scientists**

Today's Talk

- **General overview of estuarine and marine invasions in Tomales Bay**
- **Discuss current studies and knowledge of high priority species**
- **Examine conclusions from this work and discuss future of invasions in this region**

South American Cordgrass

Spartina densiflora



Spartina densiflora

- **Native to Pacific coast of South America (Chile) and established in SF Bay, Humboldt Bay**
- **Vector uncertain, possibly drift or accidental movement**
- **Substantial impacts in Humboldt Bay**
- **Small clones recently established in Tomales Bay**
- **Removal undertaken by SF Bay Invasive *Spartina* Project**



Tom's Point
S. densiflora removed from 16 square meters of marsh adjacent to oyster racks

Hog Island Oyster Company
S. densiflora seedlings dug and removed from less than 1 square meter of marsh

Legend: Spartina

◆ *S. densiflora*

Pacific Ocean

Removal of Small Clone from Tom's Point



Invasive *Spartina* Project

Asian Mud Snail

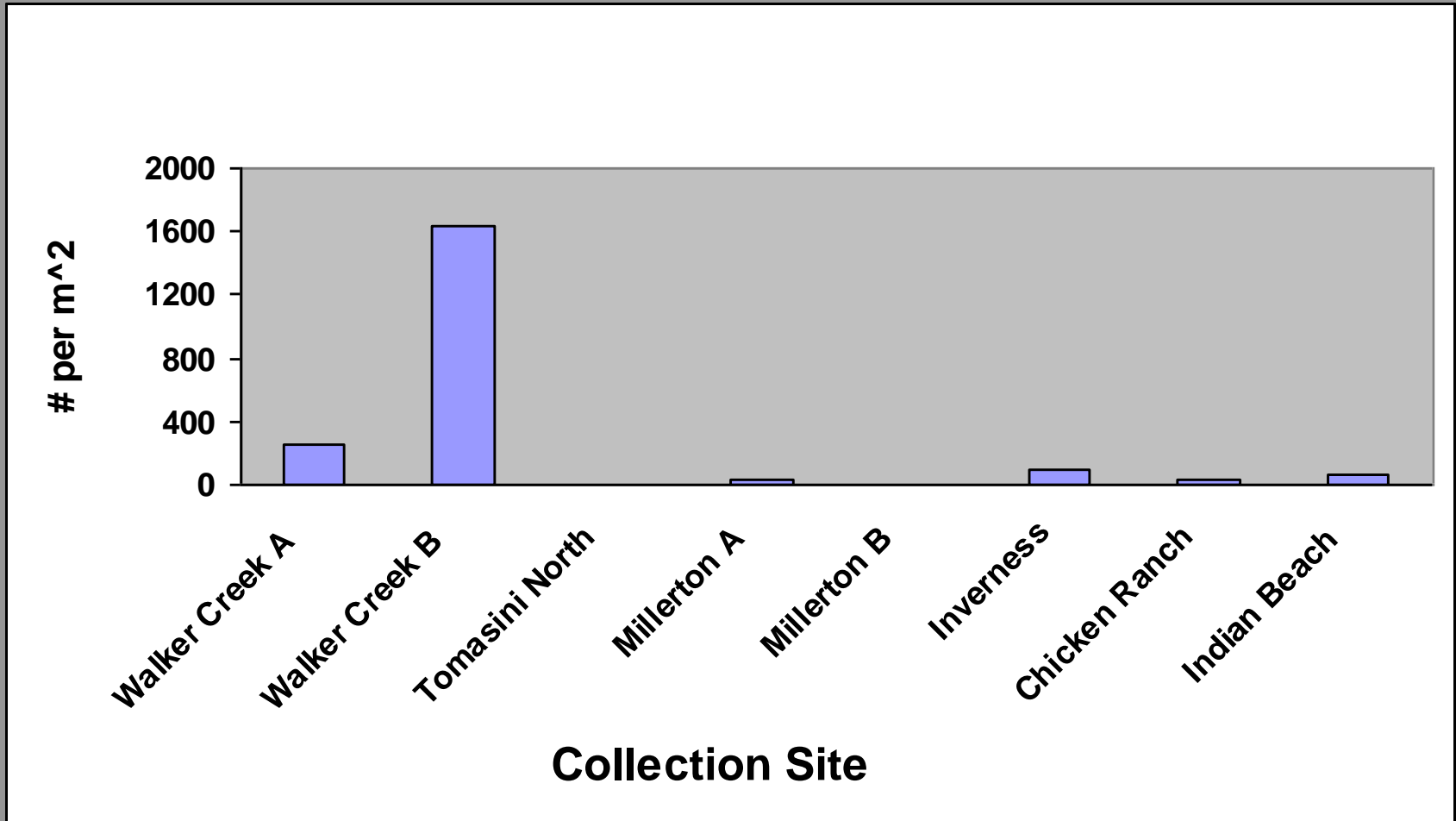
Batillaria attramentaria



Determining Density and Distribution



Batillaria Densities in Tomales Bay 2008

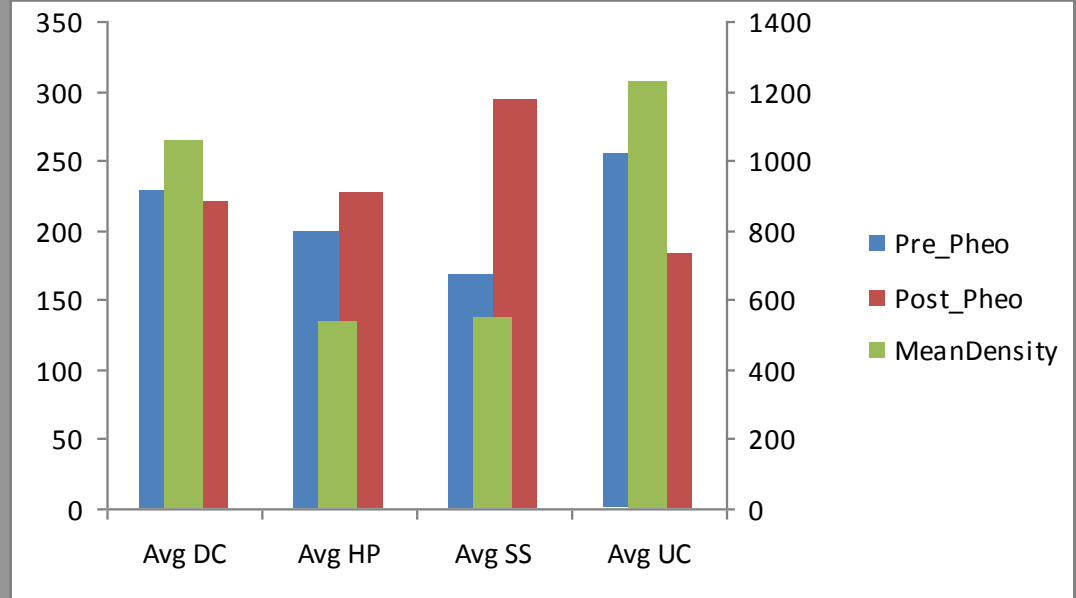
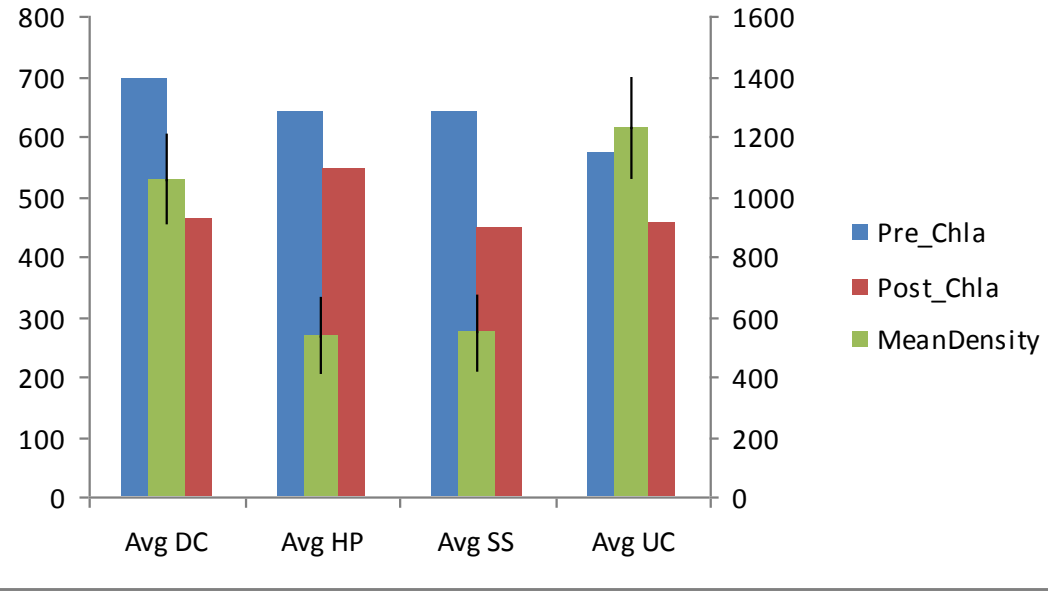


From Heidi Weiskel et al., UC Davis

Testing Removal Techniques



Removal of *Batillaria* Influences Microalgae



From Heidi Weiskel et al.
UC Davis

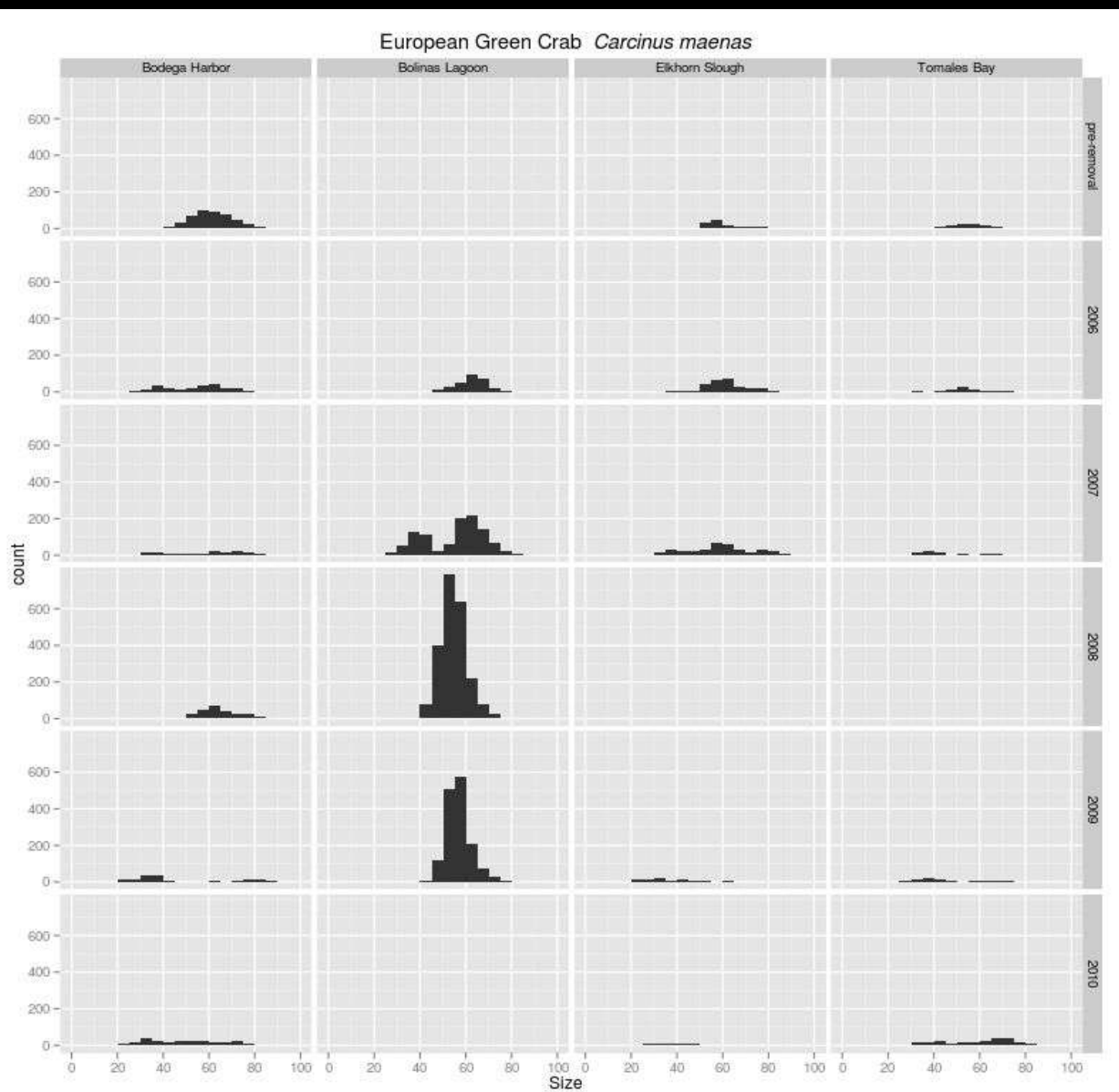
European Green Crab

Carcinus maenas



Green Crab Population Trends

from deRivera et al. 2010



Tomales Bay

From Ocean to Watershed

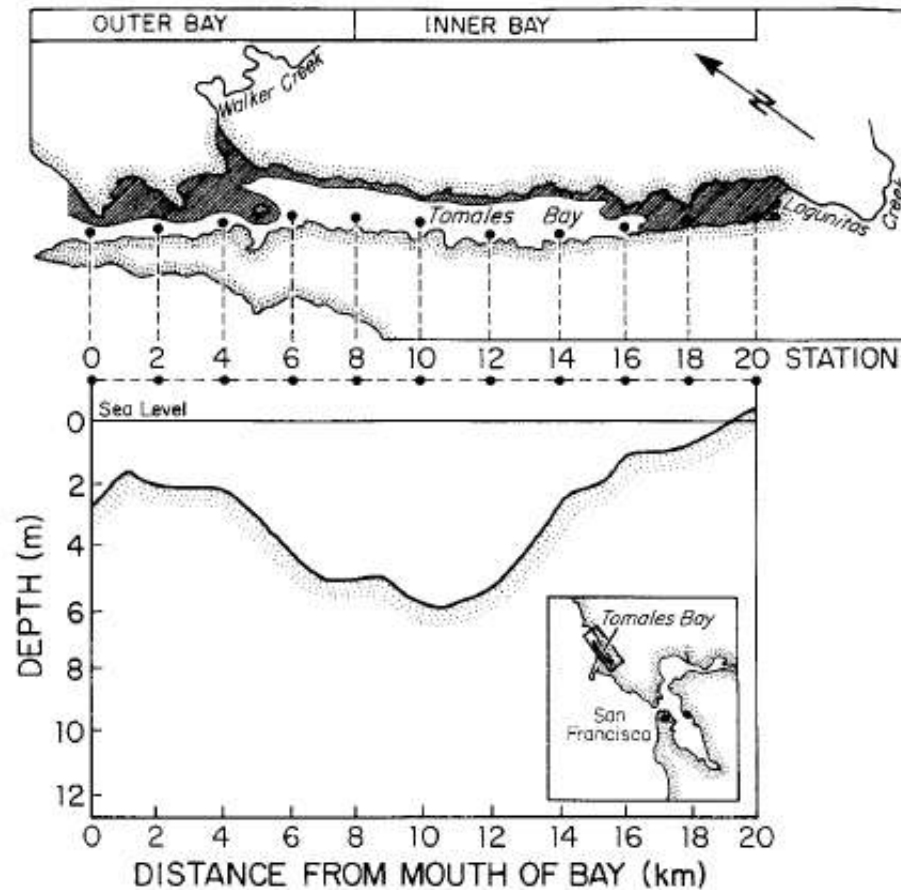


Fig. 1. Tomales Bay, CA showing study sites and depth vs. distance from the mouth (from Smith and Hollibaugh 1997)

Distribution of Native and Introduced Crabs 2005

Native crab

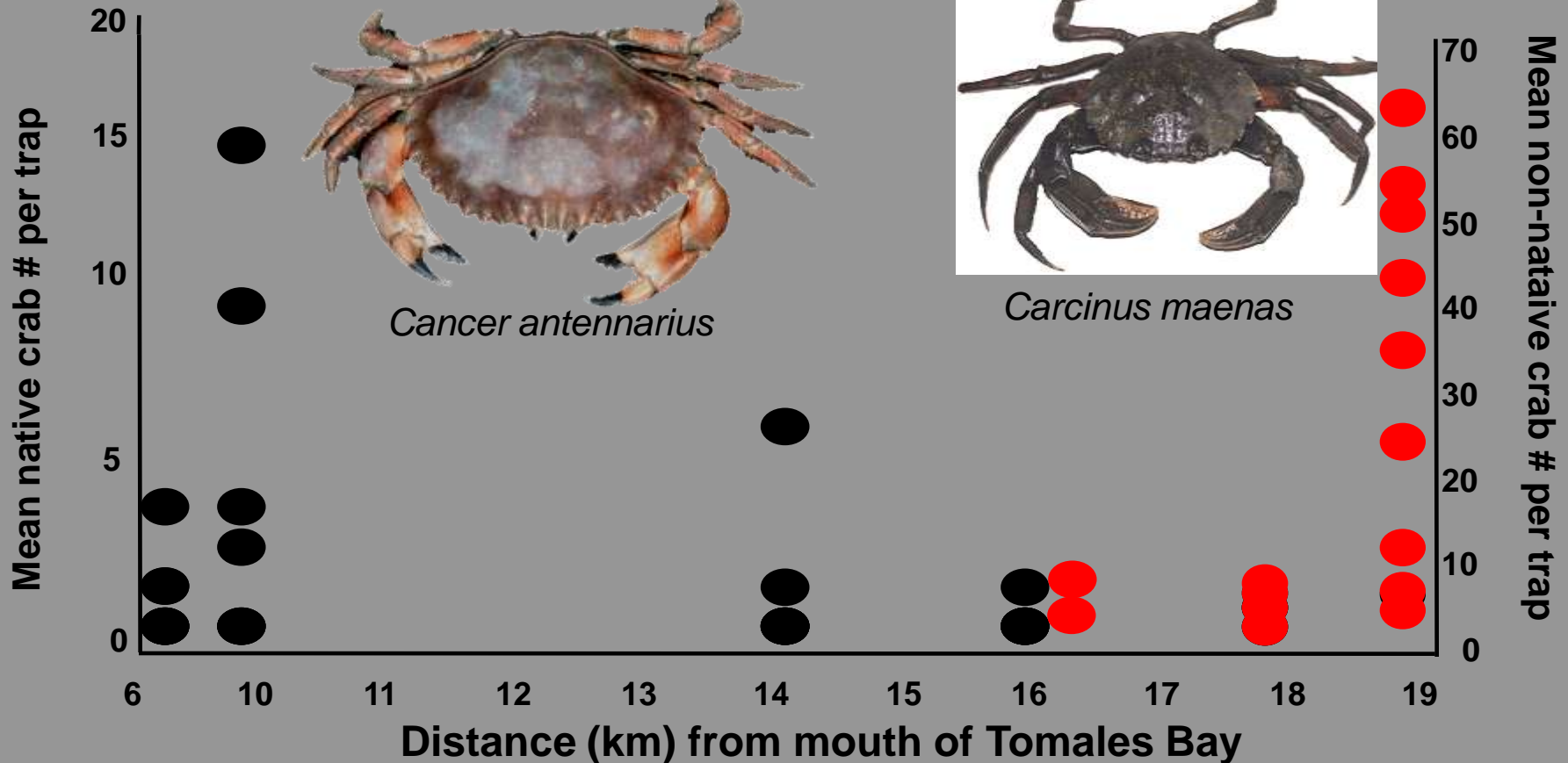


Cancer antennarius

Non-native crab



Carcinus maenas



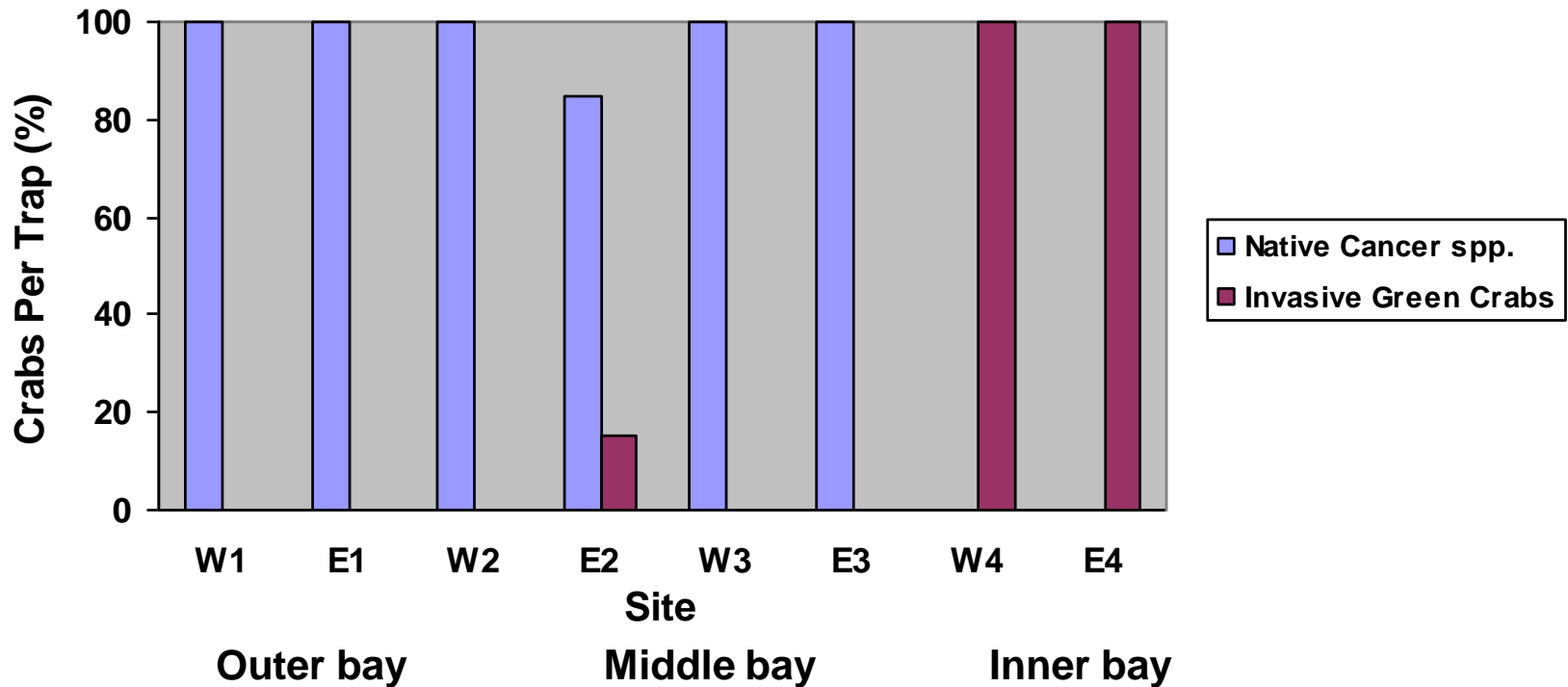
Outer bay

Middle bay

Inner bay

Data from Kimbro et al.

Current Distribution of Native and Non-Native Crabs 2009



Introduced Whelks

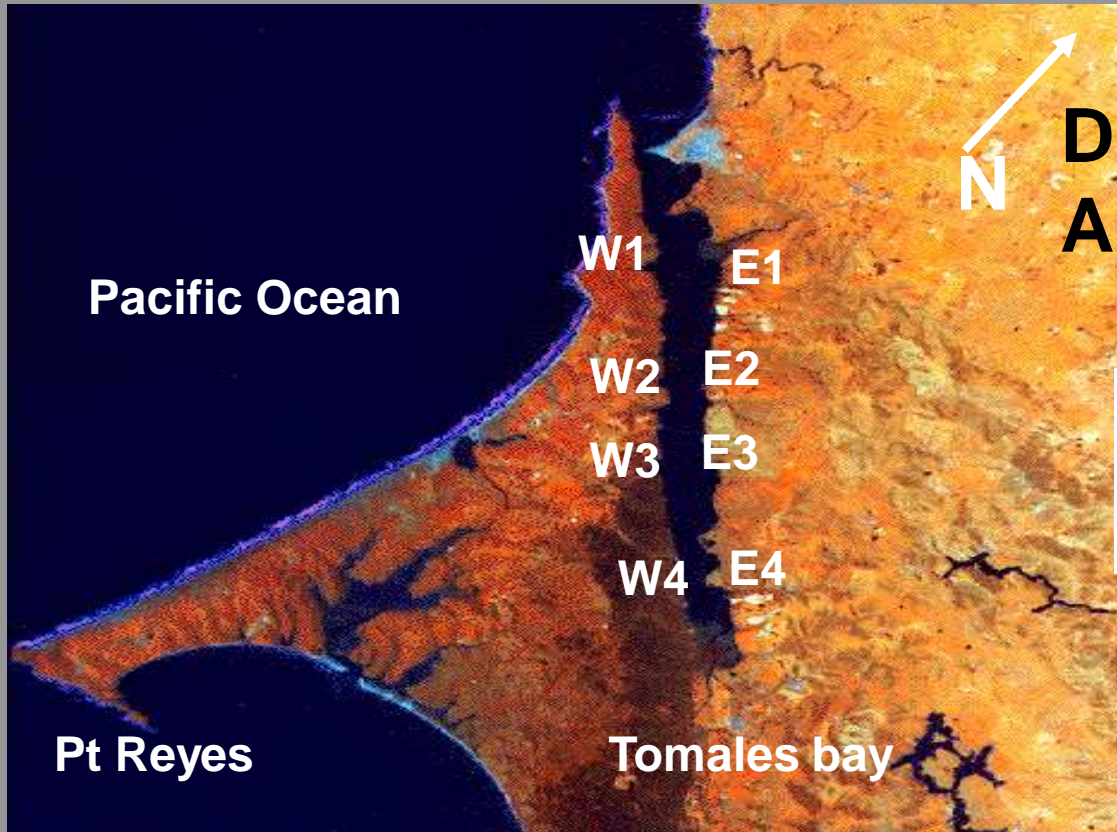


Atlantic Oyster Drill
Urosalpinx cinerea



Japanese Oyster Drill
Ocinebrellus inornatus

Distribution of Native And Introduced Whelks 2005

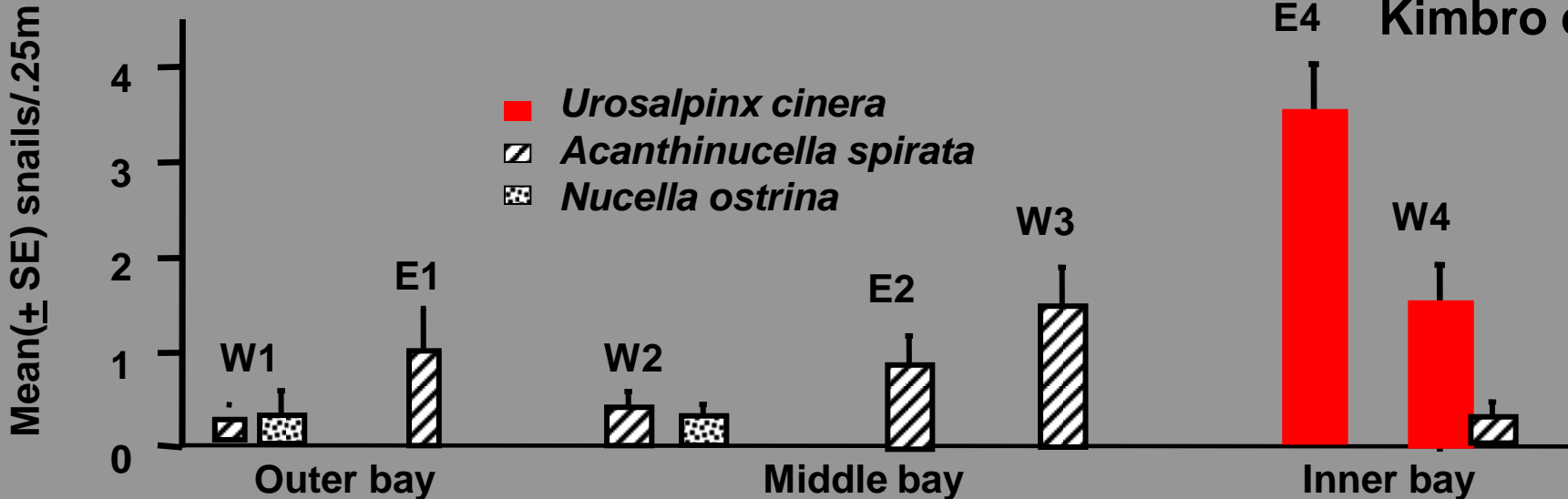


 Native Whelk

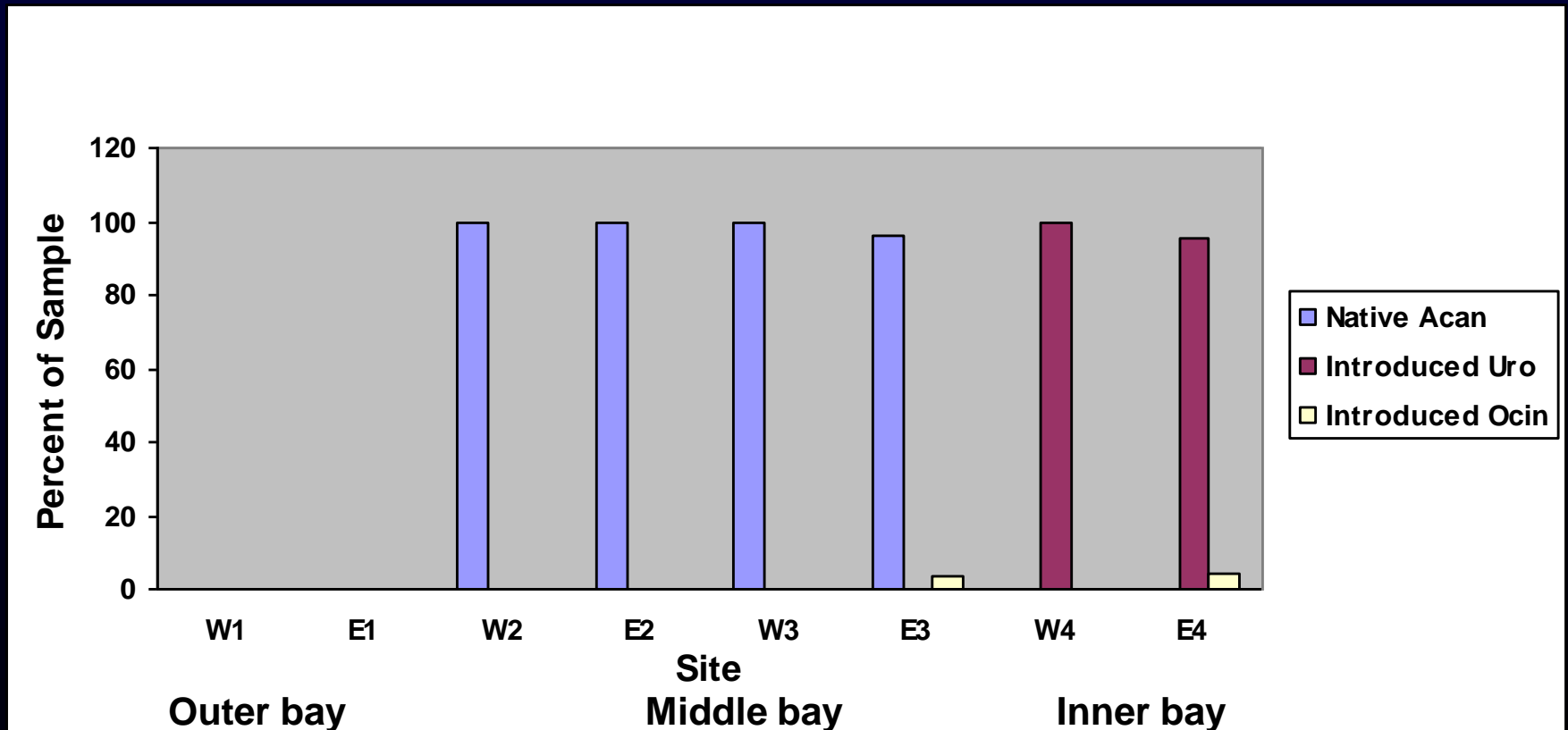


 Non-native Whelk

Data from Kimbro et al.



Distribution of Native and Non-Native Whelks 2009



Introduced Crabs and Whelks

- **Patterns of distribution consistent over time**
- **Introduced crabs and whelks dominant in inner bay (head)**
- **Reappearance of Japanese whelk (oyster drill) after near local extinction**

Tomales Bay



Cancer antennarius
Pacific rock crab



Carcinus maenas
European Green crab

Top
predators



Acanthina spirata
Angular unicorn



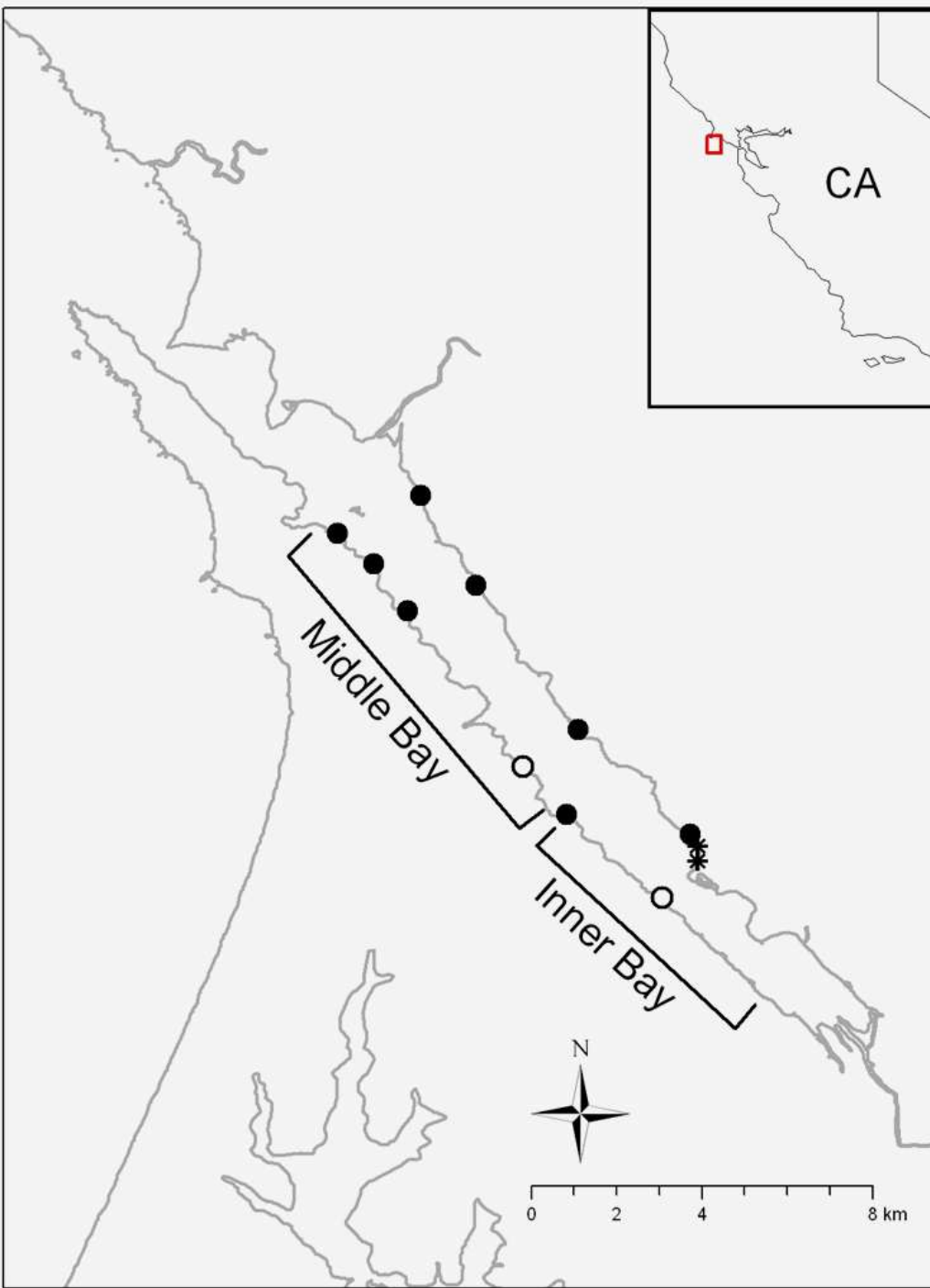
Urosalpinx cinerea
Atlantic oyster drill

Intermediate
predators



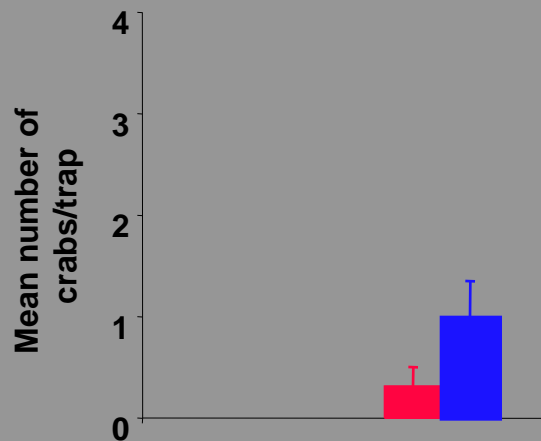
Ostreola conchaphila
Native California oyster
Kimbro and Grosholz (2006) *Ecology*
Kimbro et al. (2008) *Oecologia*

Foundation
species

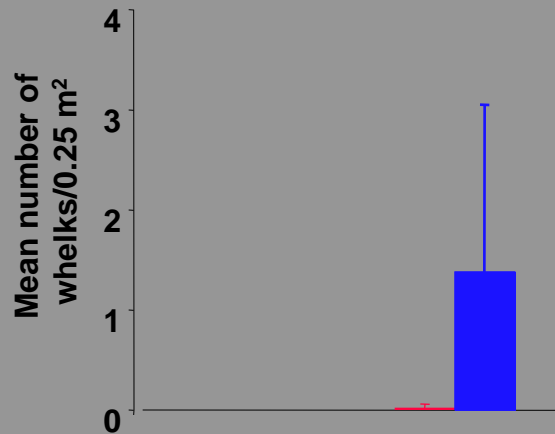


Trophic Cascade in Middle and Outer Bay Oyster Thrive

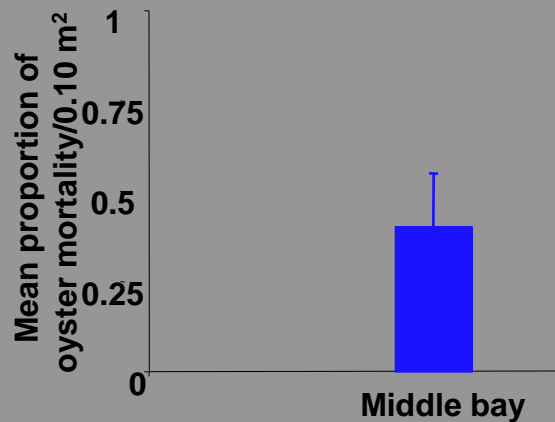
Kimbro et al. (2008)
Oecologia





Native crab
Cancer spp.



Native whelk
(Acanthinucella spirata)

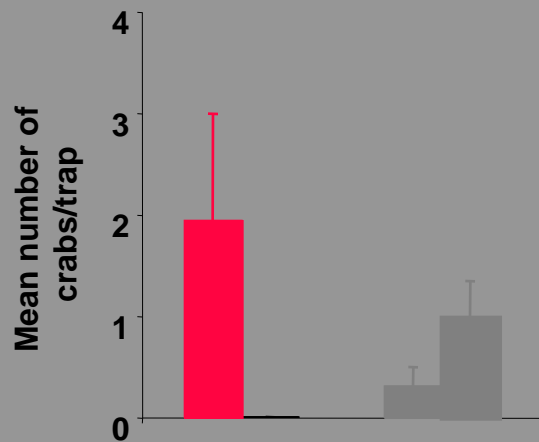


Native Olympia Oysters

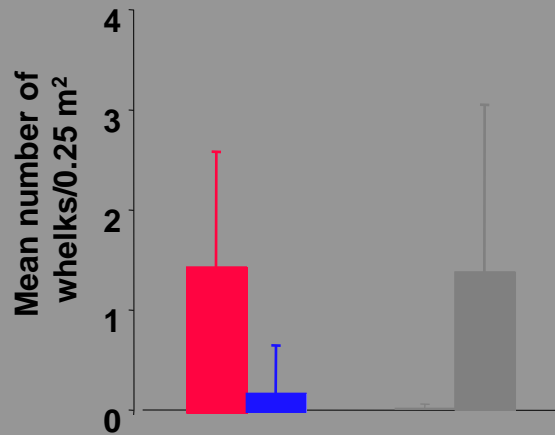
 Native species
 Invasive species

Trophic Cascade Breaks Down In Inner Bay Oysters Depleted

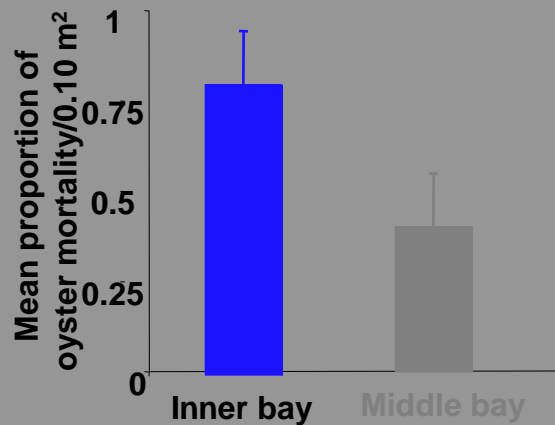
Kimbro et al. (2008)
Oecologia



Introduced Green Crabs
(*Carcinus maenas*)



Introduced Whelks
(*Ocenebrellus inornatus*)



Native Olympia Oysters

Blue square: Native species
Red square: Invasive species

Impacts of Fouling Species For Native Oyster Restoration

- Efforts are underway to develop a program to restore native oysters (*Ostrea lurida*) in Tomales Bay (and elsewhere)
- An important question for restoration is to what degree will fouling species act as space competitors for growing oysters

Invasive Tunicates and Bryozoans Fouling Species



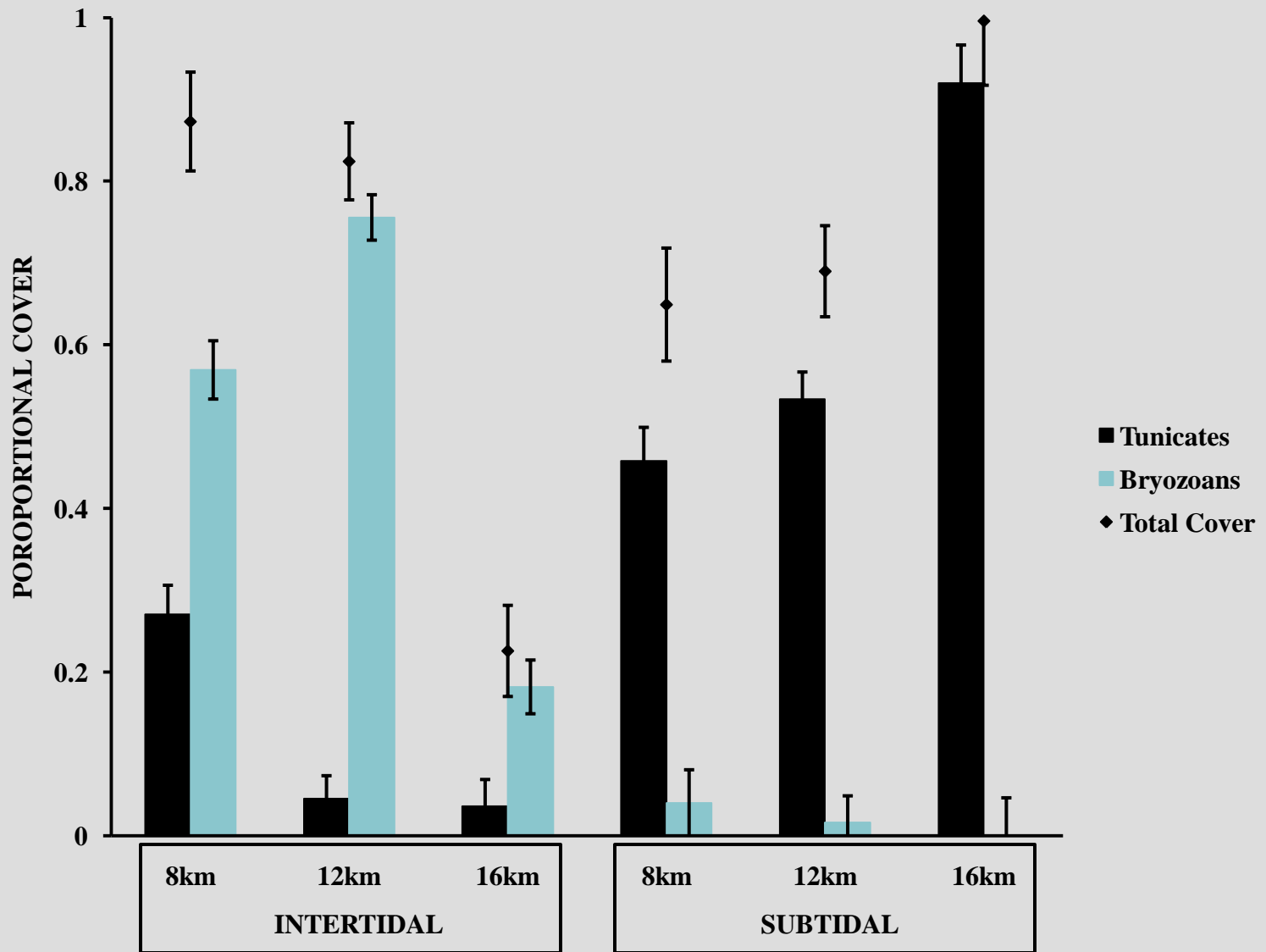
Didemnum vexillum

Watersipora subtorquata

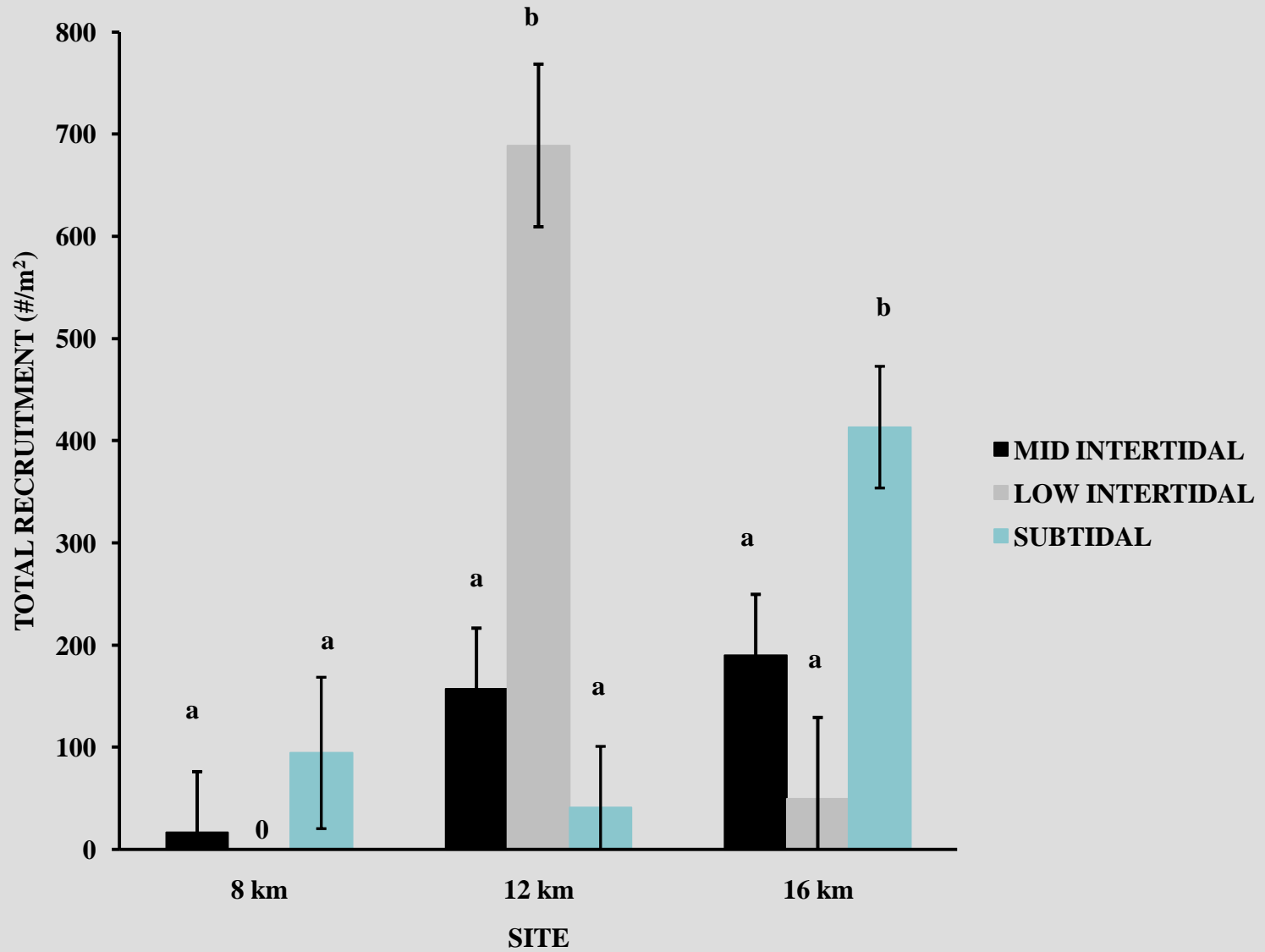


Didemnum vexillum

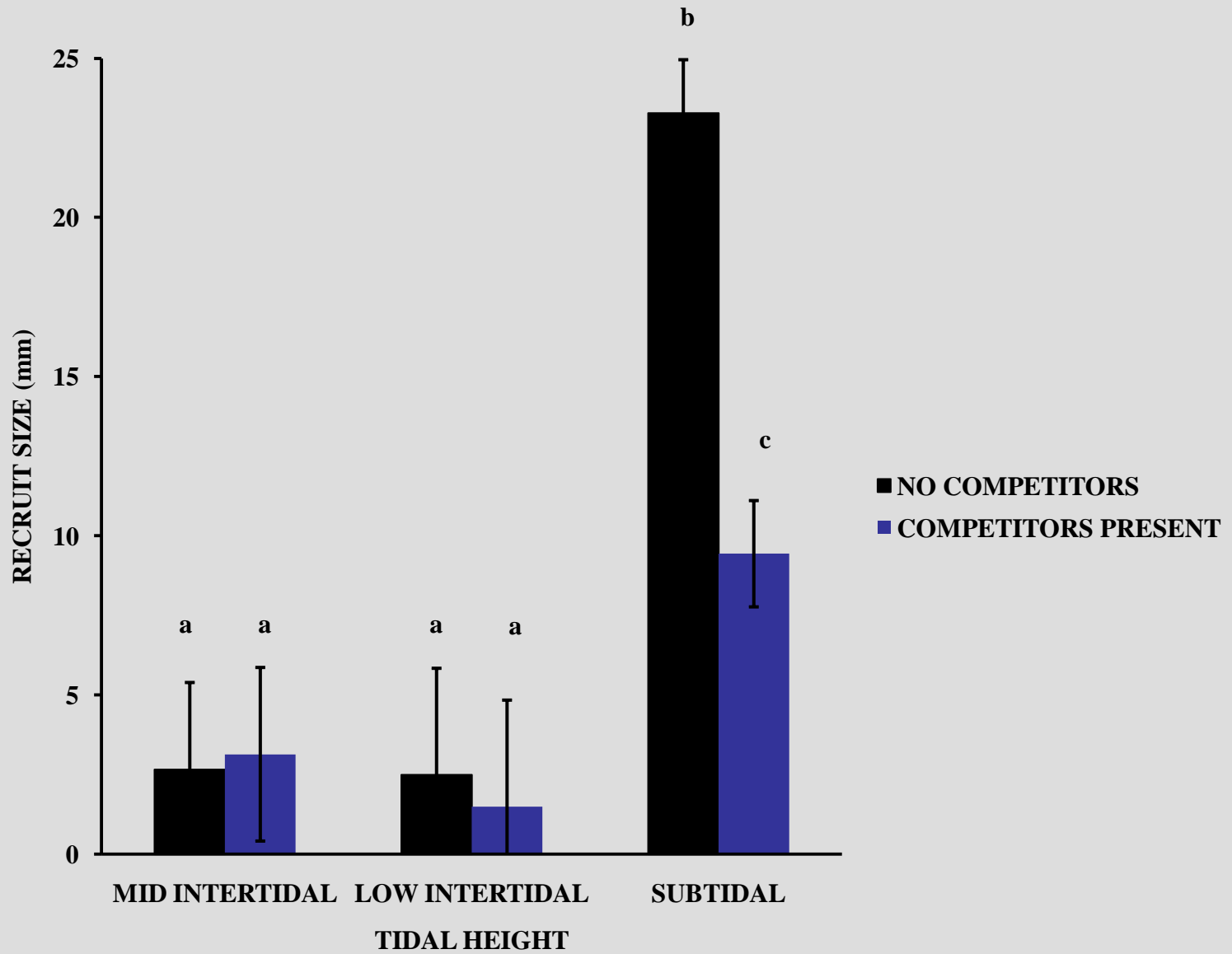
- Found attached to hard substrate low intertidal to subtidal
- Can extensively foul eelgrass
- Found at several sites around Tomales Bay
 - Sacramento Landing
 - Nick's cove jetty
 - Jetty south of Marshall Boatworks
 - Many long-term boat and buoy moorings



From Anna Deck et al., UC Davis



From Anna Deck et al., UC Davis



From Anna Deck et al., UC Davis

Not Everything is Everywhere

- Despite being only 65 km from San Francisco Bay, a significant number of invaders have not made it
- Mitten crab (*Eriochier amurensis*), Harris Mud crab (*Rhithropanopeus harrisi*), Asian clam (*Corbula amurensis*)
- Important to maintain regular monitoring to detect new invasions

Changing Climates and Invasions

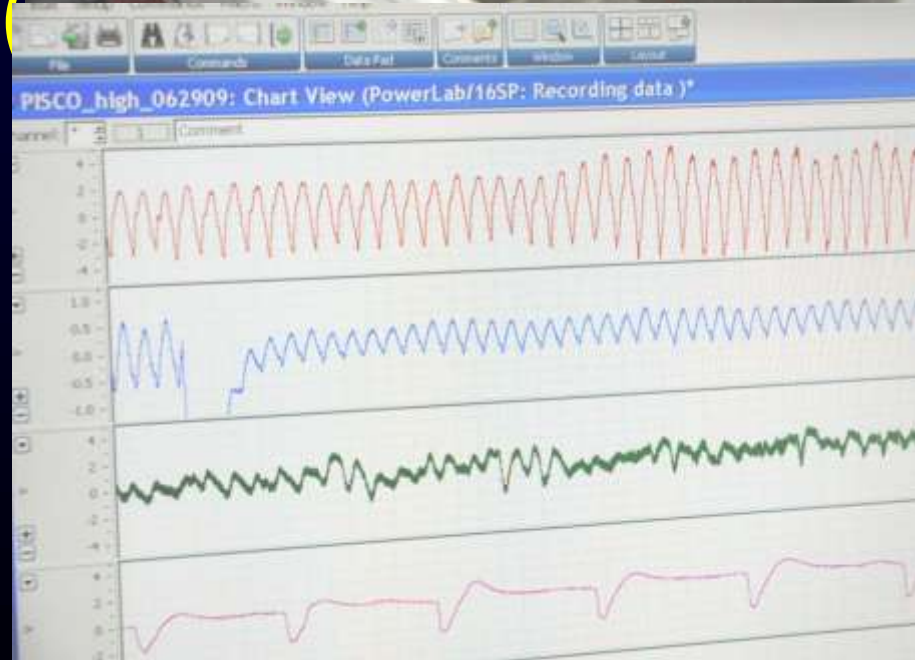
- **Potential for spread of invasive species along the coast**
- **Increased SST may allow invaders to spread northward along coast**
- **However, very difficult to project with any certainty how climate change may influence future invasions**
- **Studies have shown invaders to be more tolerant of stressful conditions**
- **Projected changes in pH, salinity, etc. may differentially benefit new invaders**

Brian Cheng's Graduate Research

Question: How will changing **temperature** and **salinity** affect the Tomales bay food web?

Tools: **Heart rate physiology** can indicate lethal and sub-lethal responses to stress

Lab / field experiments to determine how species perform



Changing Climates and Invasions

- **Increasing variability in precipitation and outflow, upwelling, etc. may contribute to cycling populations of invaders**
- **May have new invaders on west coast if climate change results in better habitat matching**
- **Climate change may facilitate dispersal of invasive species along the coast resulting in new invasions**

Conclusions

- The overall rate of invasion in Tomales Bay is moderate given proximity to SF Bay
- Several invasive species more abundant towards upper end (head) of bay
- Some species have become (nearly) locally extinct and then recovered Japanese oyster drill (*Ocenebrellus*)
- Several high risk invasive species have impacted native oysters
- Several newly arrived species including *Didemnum* sp. are still expanding their distribution