

Eradication failure and the use functional eradication for managing aquatic invasive species using community scientists and volunteers



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Impacts of European Green Crab *Carcinus maenas*

Substantial impacts on native species in western North America (Grosholz et al. 2000 Ecology, Yamada, SG Press 2001, Grosholz 2005 PNAS)

Annual fisheries losses \$20 million on east coast of U.S. (Grosholz et al. 2011 Ecol. Appl.)

Listed among the 100 of the world's worst invaders (Global Invasive Species Database)



Green Crabs in Central CA Seadrift Lagoon

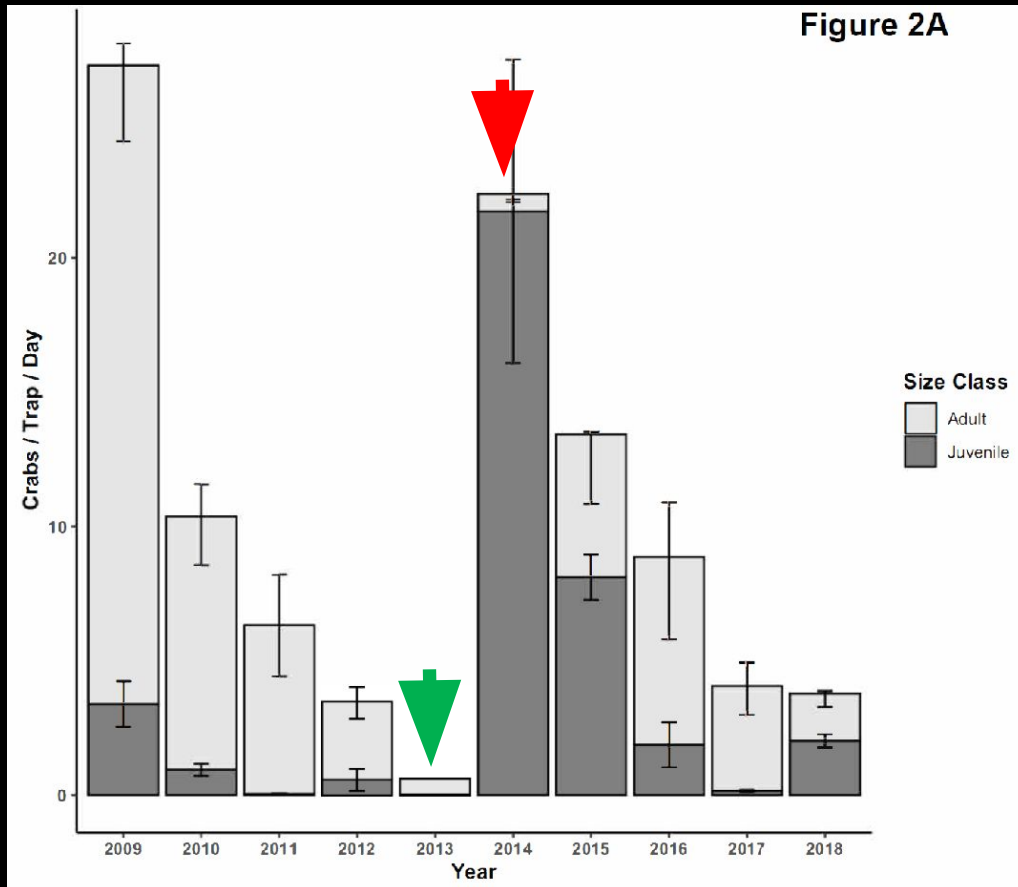
Green crabs were initially found in Bolinas and Seadrift Lagoon in 1994

In Seadrift Lagoon we undertook a 'local eradication' program in 2009 to quantify effort investment vs. level of control for future containment programs

Used annual trapping program with nearly 100 traps per day in Seadrift for several weeks each summer



Five Years of Reduction then Population Explosion Overcompensatory Recruitment



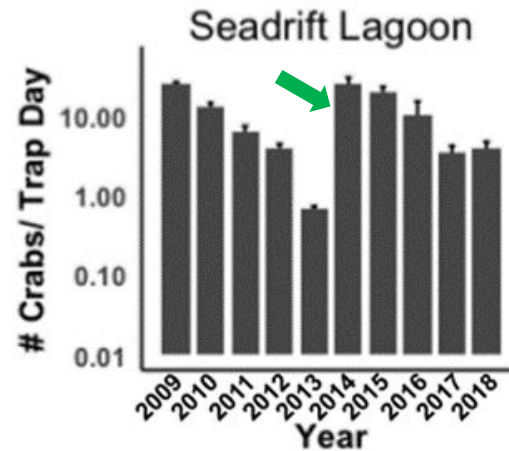
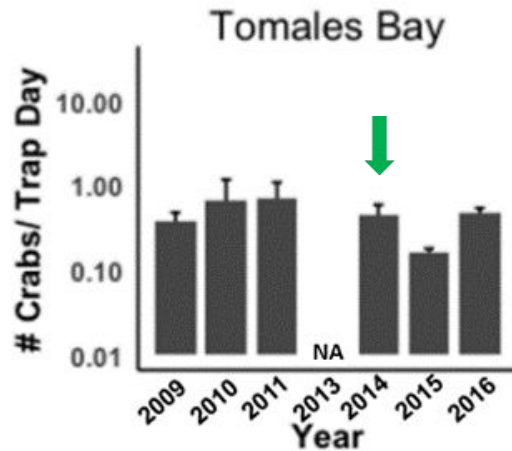
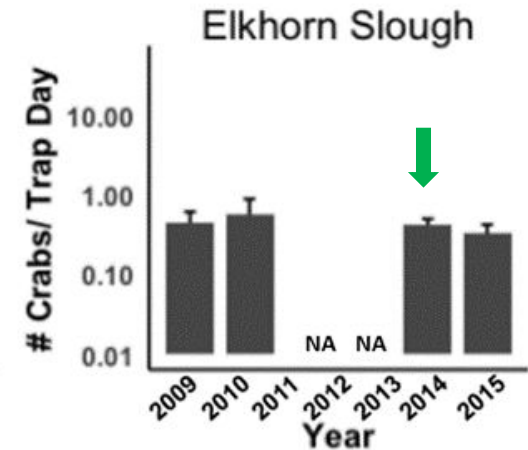
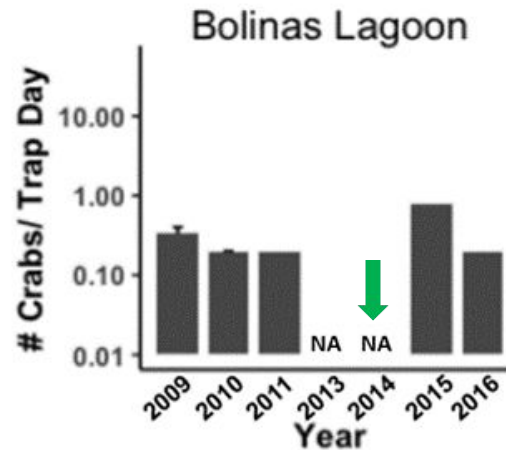
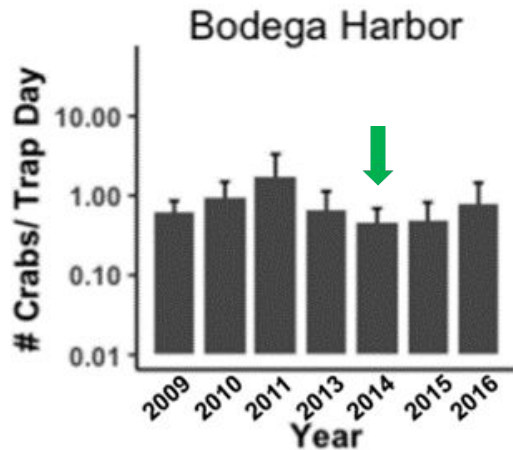
Adult green crabs typically cannibalize smaller crabs, thus controlling recruitment

We had reduced adult green crab density to the point where recruitment was uncontrolled

We demonstrated overcompensatory recruitment

Grosholz et al. *Proc Natl Acad Sci* 2021

Annual CPUE for Green Crabs No Increase in 2014 at Other Bays

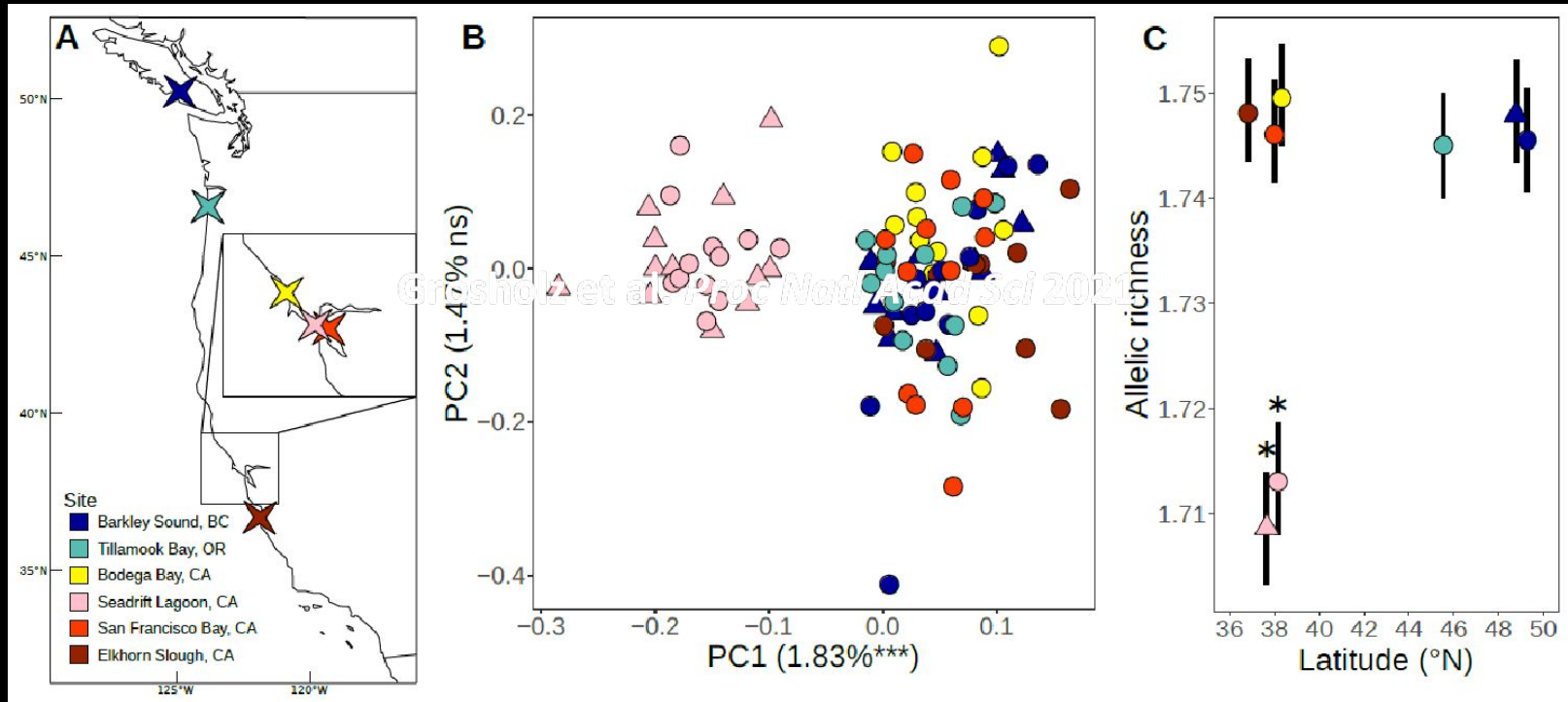


Green Crabs in Seadrift Are Genetically Distinct Recruits Not Coming From Other Bays

Populations Samples

PCA Analysis
smartpca

Allelic Richness
5,118 Neutral SNPs

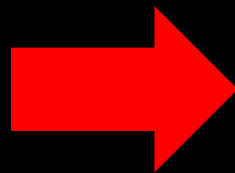


A Better Way Forward

Ecologically-Informed Targets for

Aquatic Invasive Species Management

**Numerical
eradication**



**'Functional'
eradication**

Survey of AIS managers

- Surveyed 250 individuals in AIS management across government, NGO, private sector, and public research institutions in U.S. and Canada
- Asked about their management goals (eradication, control, etc.), how they determined these and what data they used to determine goals



Bi-national Survey of North American 250 AIS Managers and Practitioners

60%

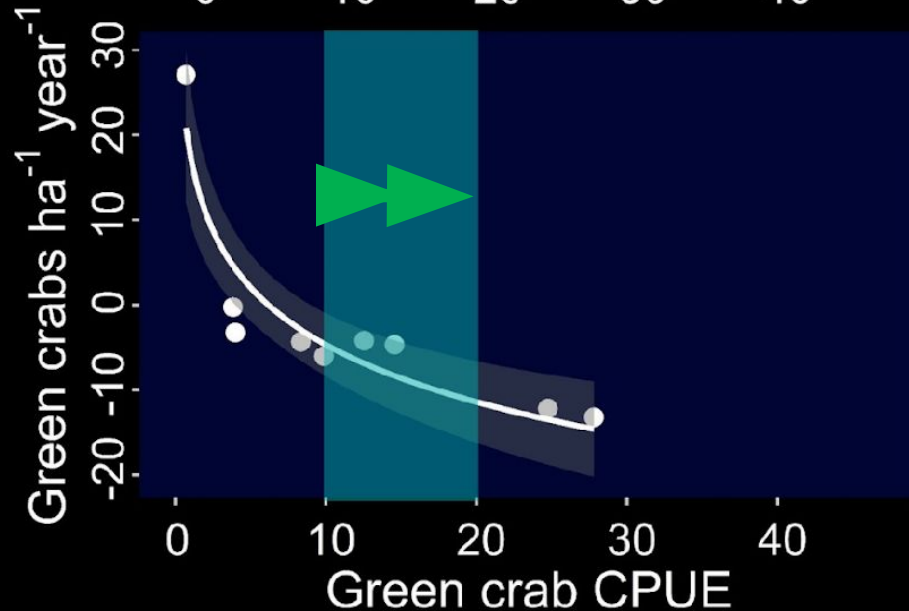
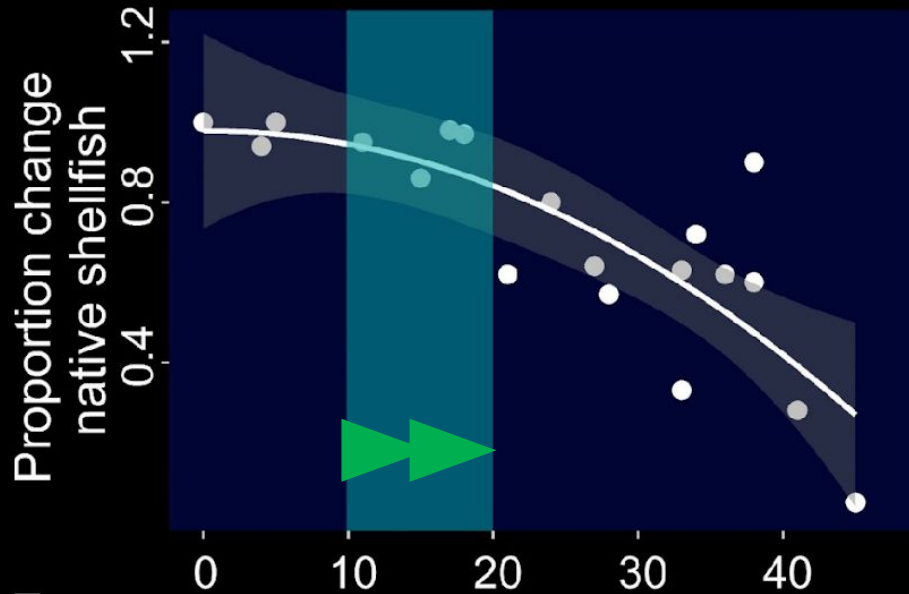
Invasion occurring at scale
beyond resources for eradication

98%

Lack targets for suppression
or ecological recovery

Most had data that would allow
developing management
targets

Non-linear dynamics inform management targets



Relationship between invader density and ecological impacts are frequently non-linear (Baxter et al. 2008, Norbury et al. 2015)



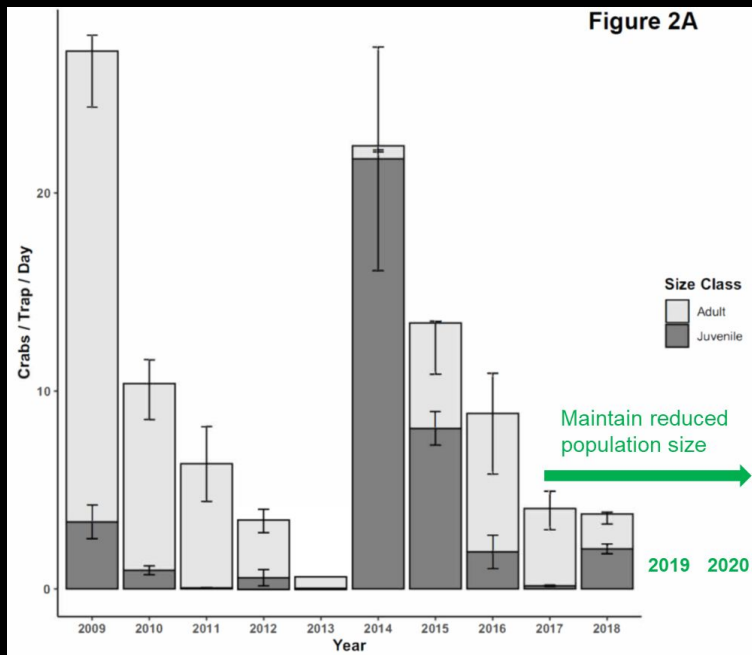
European green crab (*Carcinus maenas*)

- Eradication often not possible in aquatic systems (many fishes, crustaceans, etc.)
- Functional eradication can allow recovery of native species abundance/ecosystem functions
- Most managers have the data to estimate the suppression goal needed
- **Community scientists and volunteers can help maintain functional eradication**

Community Scientists and Volunteers at Seadrift Lagoon



- Green crab management in Seadrift was only possible with community scientists and volunteers
- They donated kayaks, dock space and use of their property
- We engaged Greater Farallones National Marine Sanctuary (GFNMS) and Kate Bimrose
- Most recently included 57 members and 460 work hours with 40 receiving regular updates
- Continuing to maintain relative low abundances of green crabs with community scientists/volunteers



Grosholz et al. 2021. Engaging the importance of community scientists in the management of an invasive species. *California Agriculture*

Educational and Management Goals

- ▣ Increase community understanding of management projects
- ▣ Increase awareness and understanding of the consequences of invasions
- ▣ Continue maintaining green crabs at small portion of the original population
- ▣ Work to improve ecosystem function and native species recovery

Acknowledgements for Community Science

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- San Francisco State University's Research Experience for Undergraduates Program
- California State University System's STEM Teacher and Researcher Internship Program



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