Vectors of introduction and spread of non-native marine species in California

Chela J. Zabin, Ian Davidson and Gregory M. Ruiz
Smithsonian Environmental Research Center

Talk format

- Vectors = mechanisms by which non-native species are spread
- Critical information and regulatory gaps
- Where we are with addressing those

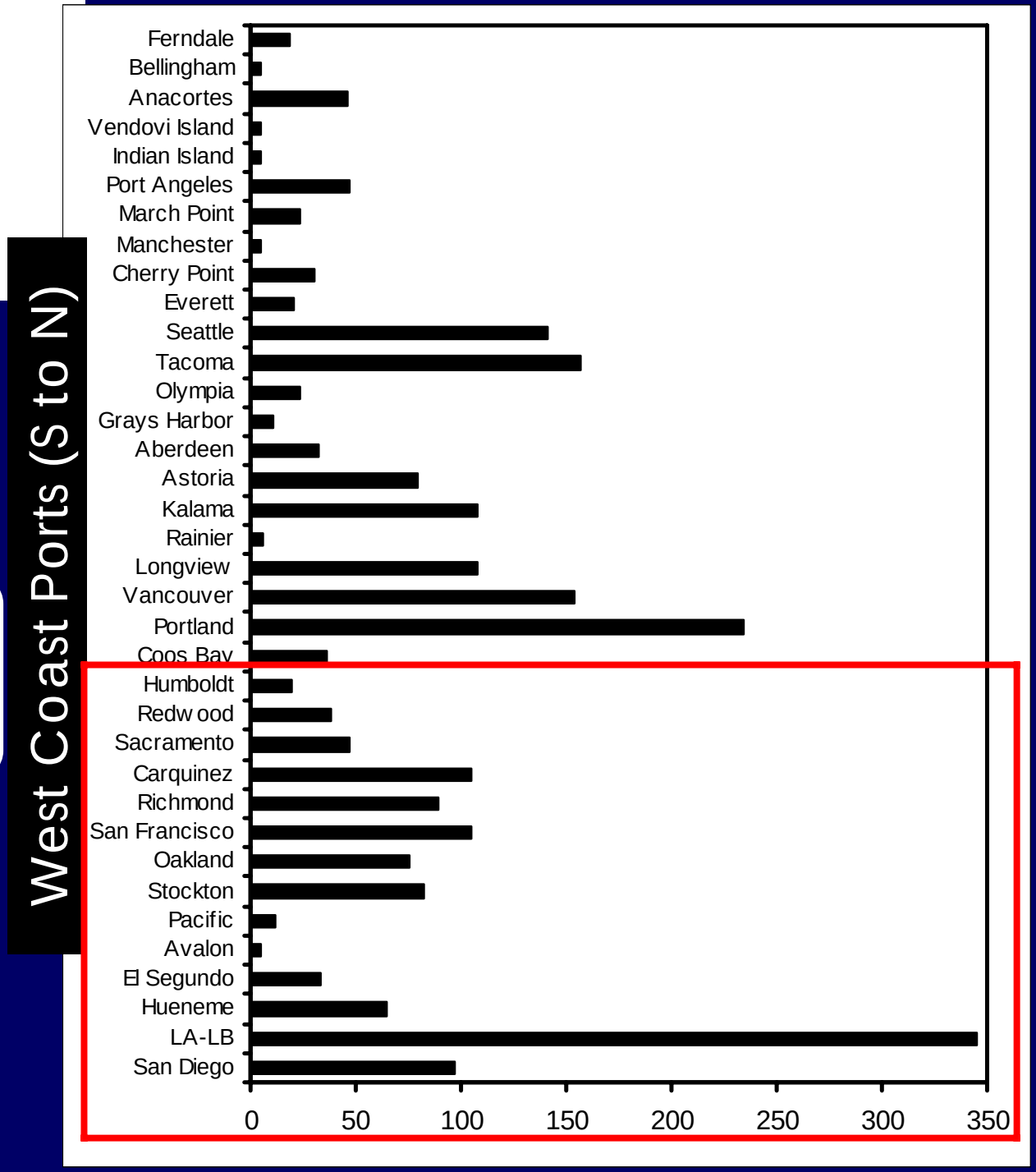
California: Major vectors

- Shipping
- Live Trade

Shipping Traffic

All Arrivals

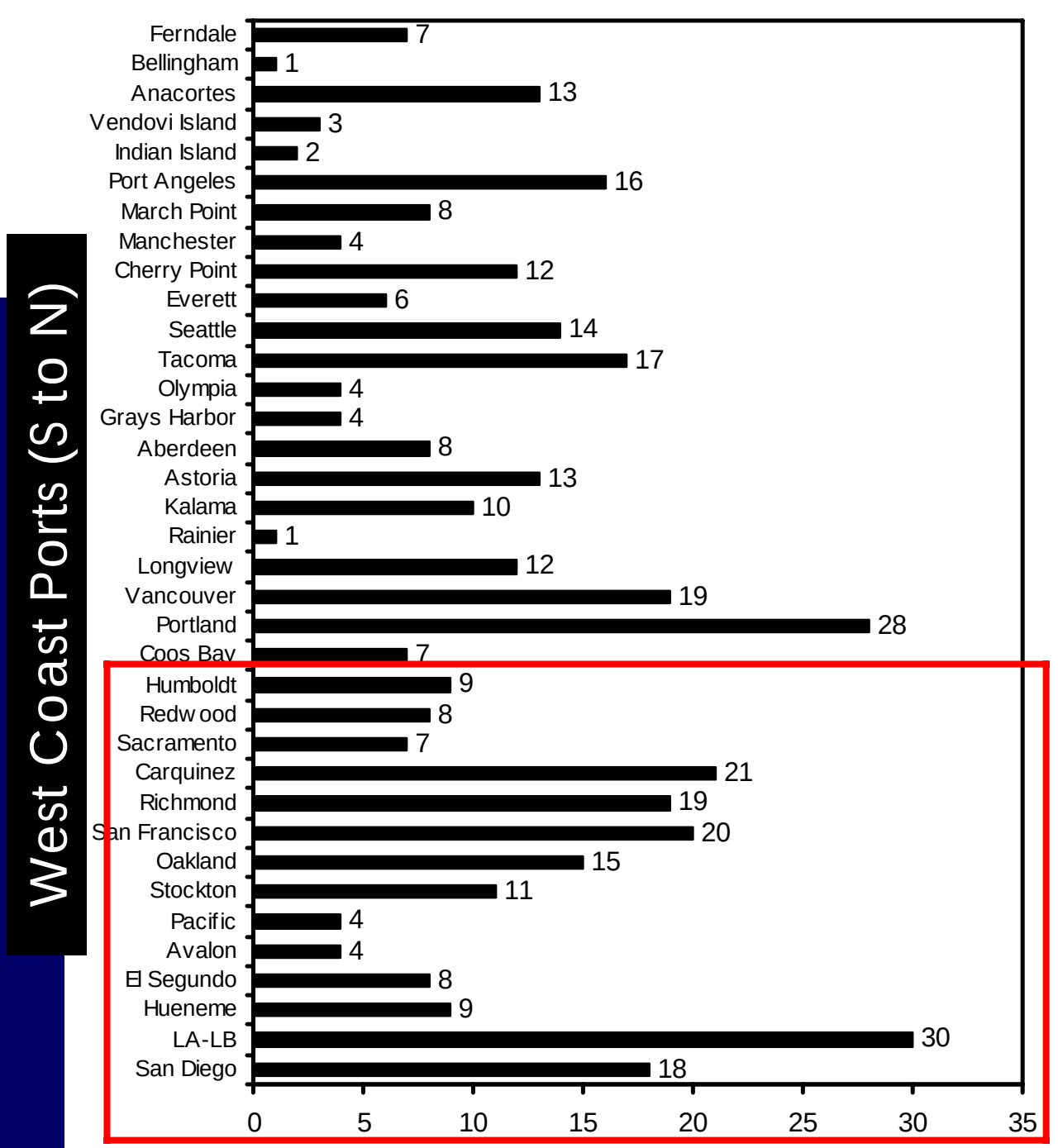
Last ports of call



Shipping Traffic

Domestic Coastwise Arrivals

Port Connectivity



Ballast Water

- Reduces stress on hulls
- Provides stability
- Aids propulsion through propeller submergence
- Aids maneuverability

Ballast water

Transports larvae and small adults

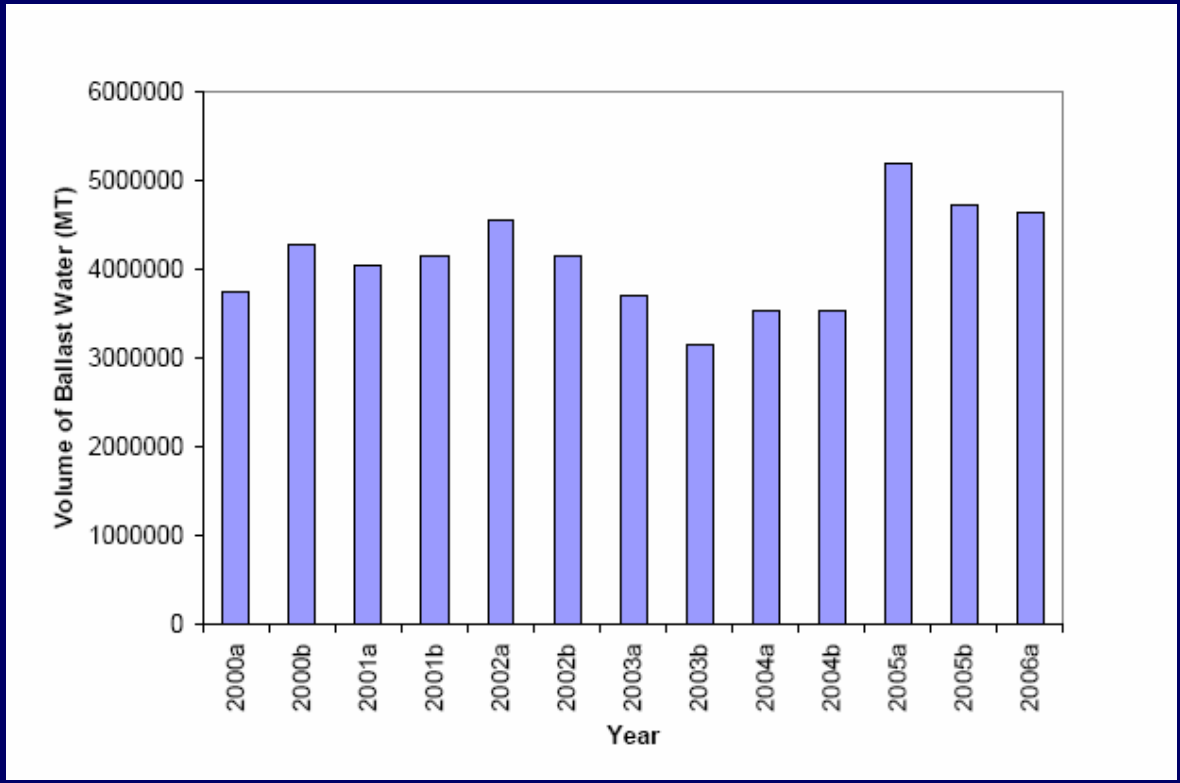
Ballast Water

- Up to 300 species have been identified in ballast of single ship
- Some major pest species have arrived via ballast water

Asian Clam
Potamocorbula amurensis

- Can reach abundances of 25,000/sq m in SF Bay
- Filter the volume of the bay in shallow areas 3 x/day
- Has eliminated seasonal cycle of planktonic plants that support the SF Bay foodweb

Ballast Water Discharged

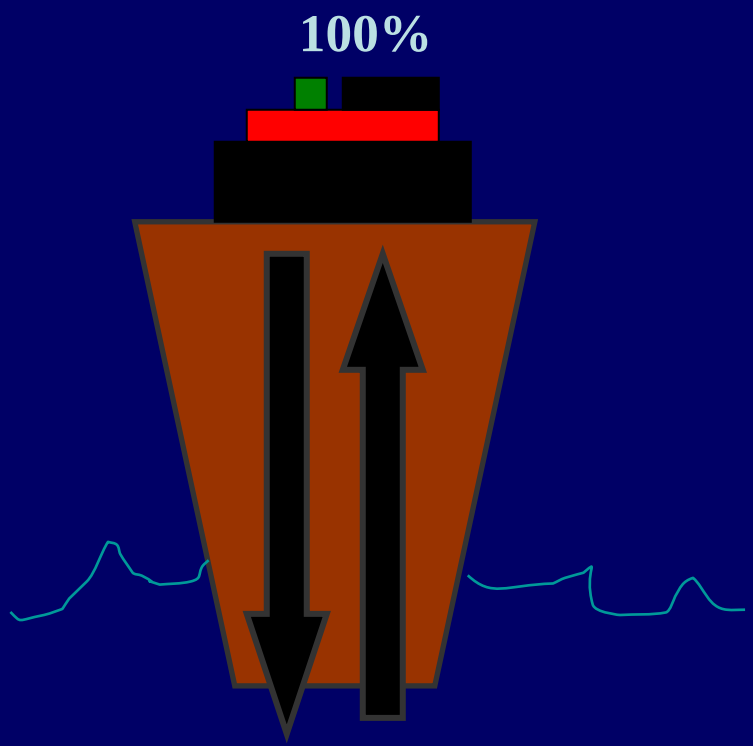


California State Lands Commission, 2007

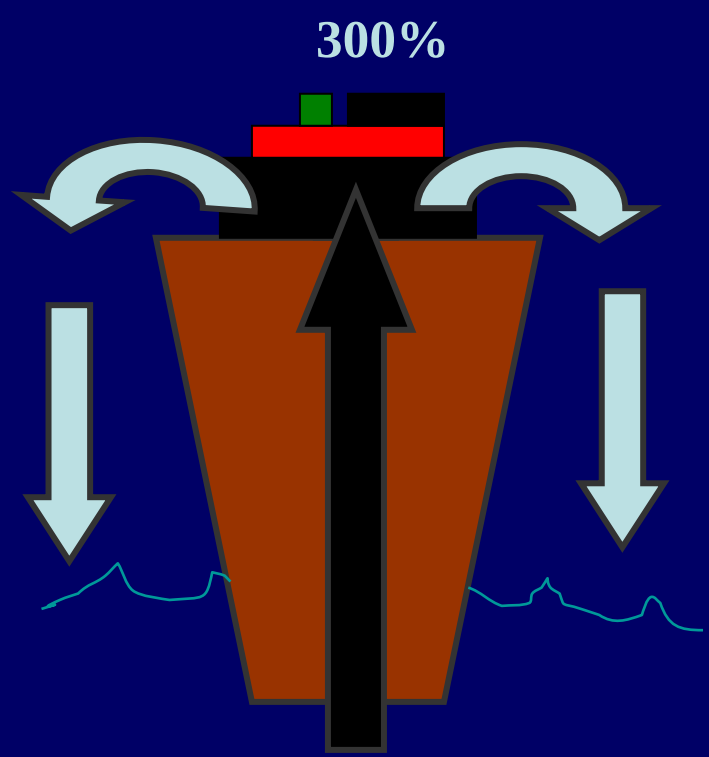
Ballast Water – Reducing Density

Mid-ocean ballast water exchange at 200 nm foreign; 50 nm domestic

Empty/Refill



Flow-Through



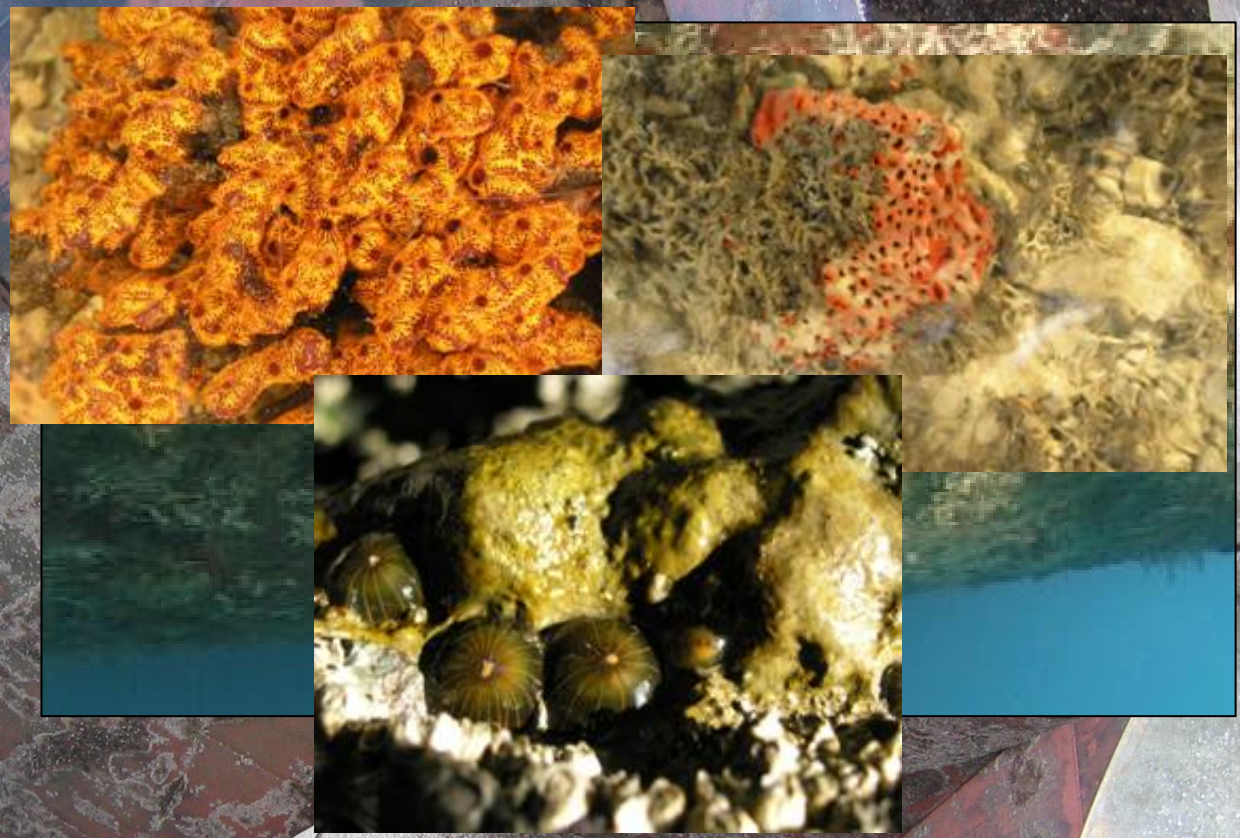
Ballast Water Exchange

- Can reduce density by 10-fold
- On-paper compliance good
- Performance standards coming
- Likely to be phased out in favor of other technologies

Ballast Water
Current Questions

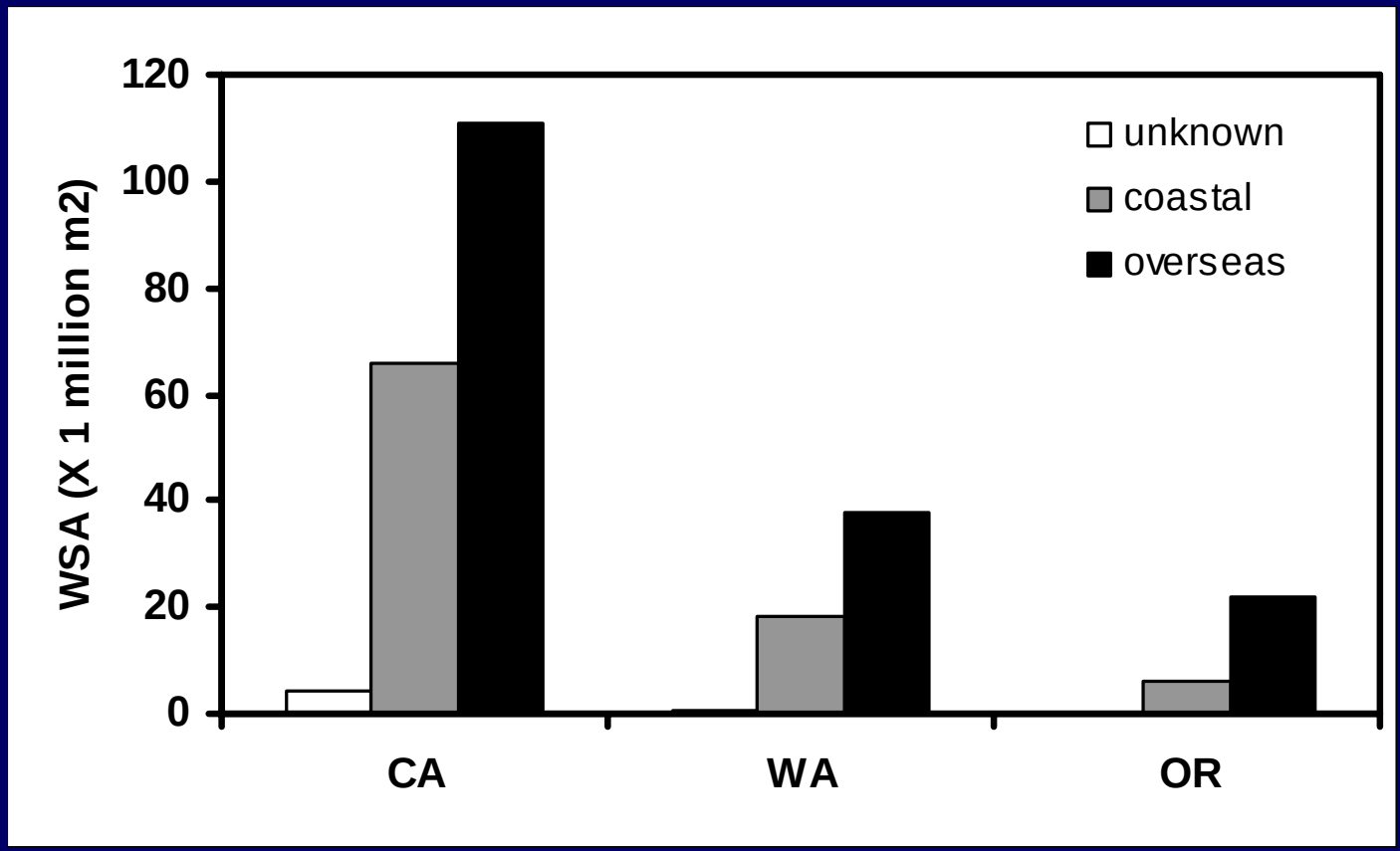
- Are performance standards adequate? Achievable?
- How to set standards for bacteria and viruses?
- How best to verify compliance?

Hull Fouling



- Adult, reproductive organisms are moved from harbor to harbor
- Centuries-old vector
- Likely to increase in importance as most toxic paints are phased out

Hull Fouling



Commercial shipping West Coast (2003-2005)

Hull Fouling – Reducing Risk

- CSLC recommending regulations for commercial ships
- Currently, no regulation planned for small vessels such as pleasure craft and fishing vessels

Hull Fouling: Current Questions

- Risk of introduction: extent of fouling by vessel type, port of origin, length of stay
- 841,000 registered small vessels in CA; 232,000 in SFB area
- Little known about their potential to spread invasives

Live Trade: Aquaculture

Aquarium Introductions

- **Many non-native species of fish, invertebrates and algae sold in U.S.**
- **In CA, there are 900 non-native species of fish for sale in aquarium stores**
- **Pets commonly “released” when get too big or aggressive**
- **Many species could potentially become established**

Aquarium Introductions

- **The invasive alga *Caulerpa taxifolia* had huge impacts in Mediterranean where no control measures used**
- **Cost millions to eradicate San Diego and Orange counties**

Live Seafood

- **Many species of non-native fish and invertebrates (oysters, mussels, clams) are sold on live seafood market**
- **Potential for release during storage or after sale**

Live Seafood

- **Chinese mitten crab (*Eriochier sinensis*)**
- **New England seaweed *Ascophyllum nodosum* (packing material)**

Live Bait

- Non-native species of fishes and many species of invertebrates are sold live as bait
- Bait boxes (worms) also contain up to two dozen species
- Poorly regulated, little inspection capacity

Live Bait

- **European green crab (*Carcinus maenas*)**
- **Large impacts on coastal ecosystems**
- **Impacted local shellfish stocks**

Backyard Ponds

- Fastest growing segment of horticulture industry
- Millions of backyard ponds
- Little regulation regarding placement near waterways or storm security

Backyard Ponds

- **Invaders include:**
- ***Hydrilla***
- **Water hyacinth (*Eichhornia crassipes*)**
- ***Egeria densa***
- **Eurasian watermilfoil (*Myriophllum spicatum*)**

California: Major vectors

- Shipping (ballast water and fouling)
- 78 percent of invaders in SF Bay
- 100 percent of invaders in LA-Long Beach
- 98 percent of invaders in San Diego

- Live Trade
- 54 percent of invaders in SF Bay
- 68 percent of invaders in Elkhorn Slough

Addressing Information Gaps: Ballast Water

1. Are current performance standards adequate? Unknown, very difficult to determine.
2. What about viruses and bacteria? Would require a major research program; potentially difficult to determine.
3. Can we verify compliance?
4. Can new technologies do better than ballast water exchange?

Developing technologies promising.

Addressing Information Gaps
Hull Fouling

1. What factors increase fouling, i.e., vessel type, transit speed, anti-fouling measures? Research underway, likely tractable.
2. What is the risk of spread by small craft? Pilot study underway in SF Bay; could be easily addressed for state.
3. Do we need to regulate small craft? Unknown, pending results of above research.

Addressing Major Information Gaps Live Trade

- Significance of vector? Likely overlooked and growing.
- Is regulation needed? Yes, but education may be more effective.