DEVELOPMENTS IN COMMERCIAL VESSEL FOULING RESEARCH

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Nonindigenous species in California

Biofouling process

Vessel sampling

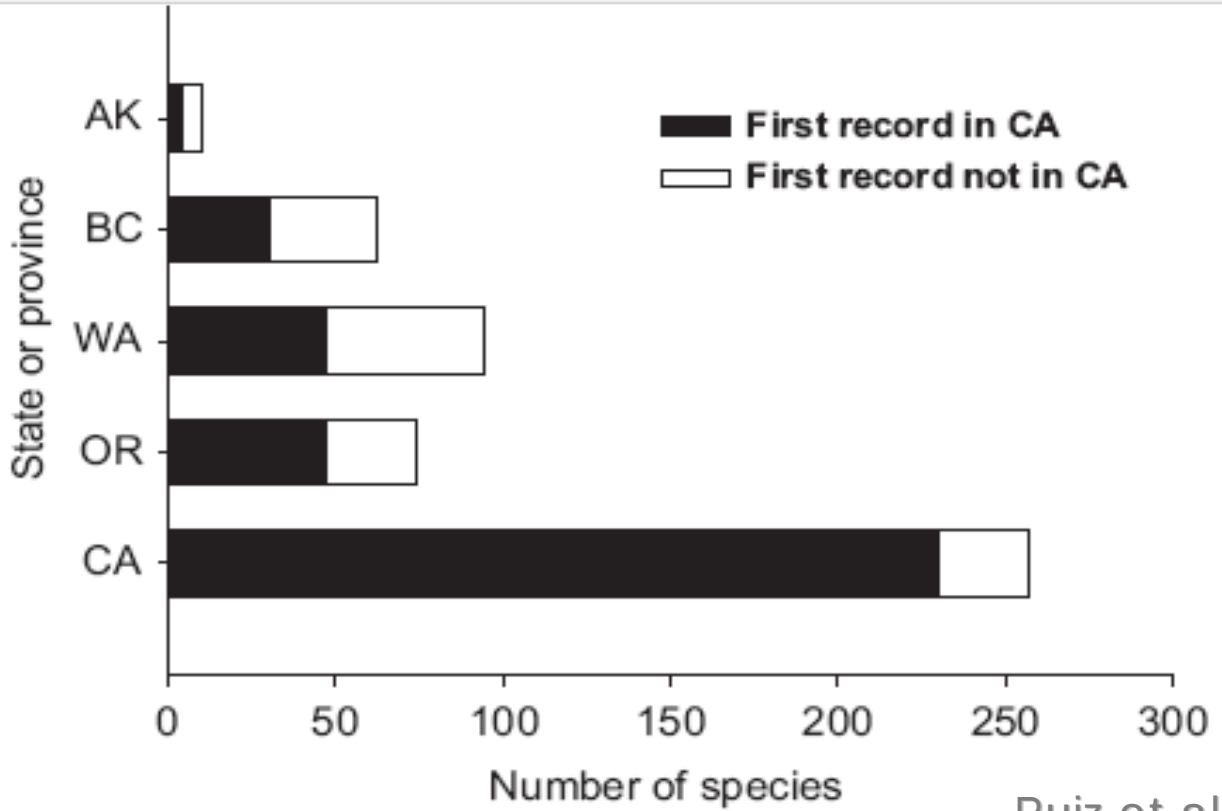
Interpretation & future work

Smithsonian Environmental Research Center

S E R C

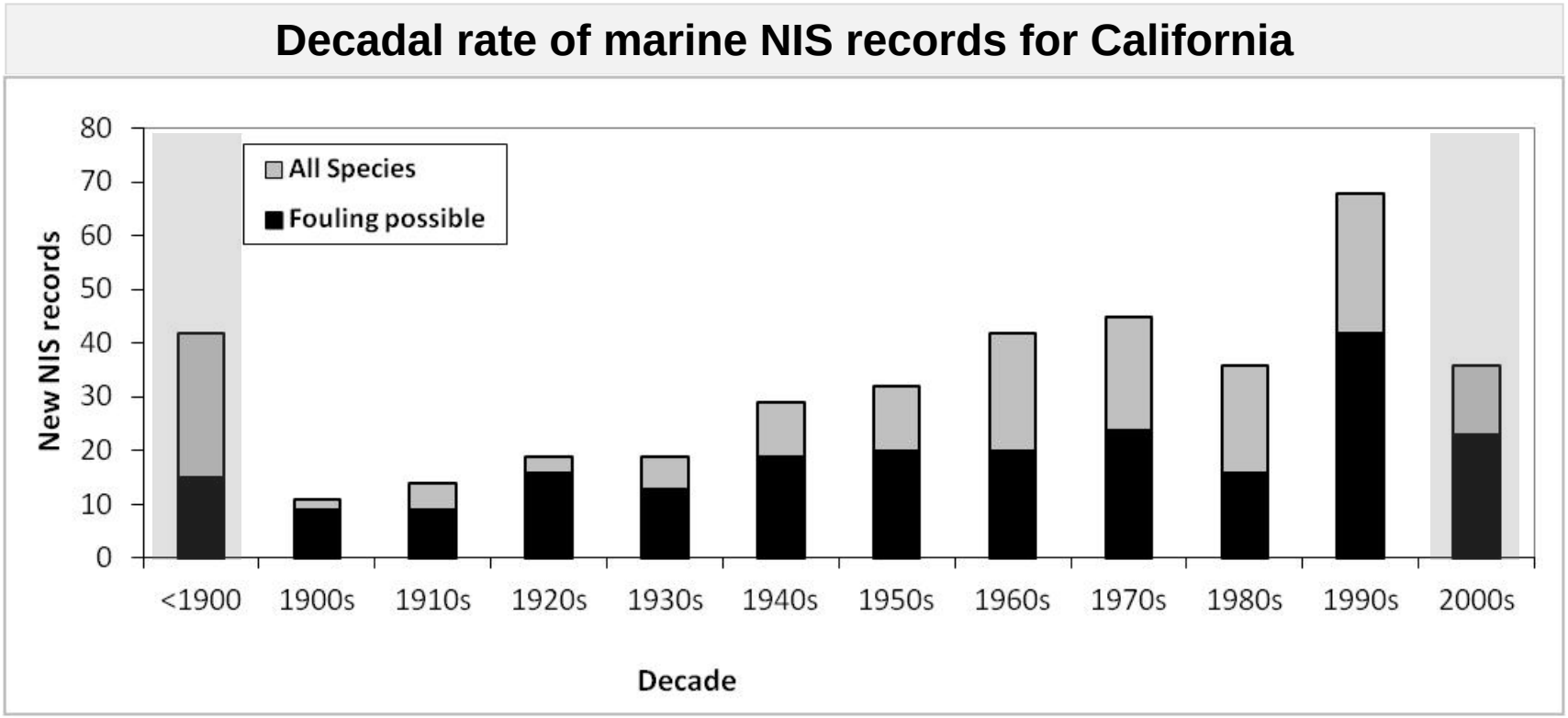
California: a hub for introductions

Number of nonindigenous species for western North America



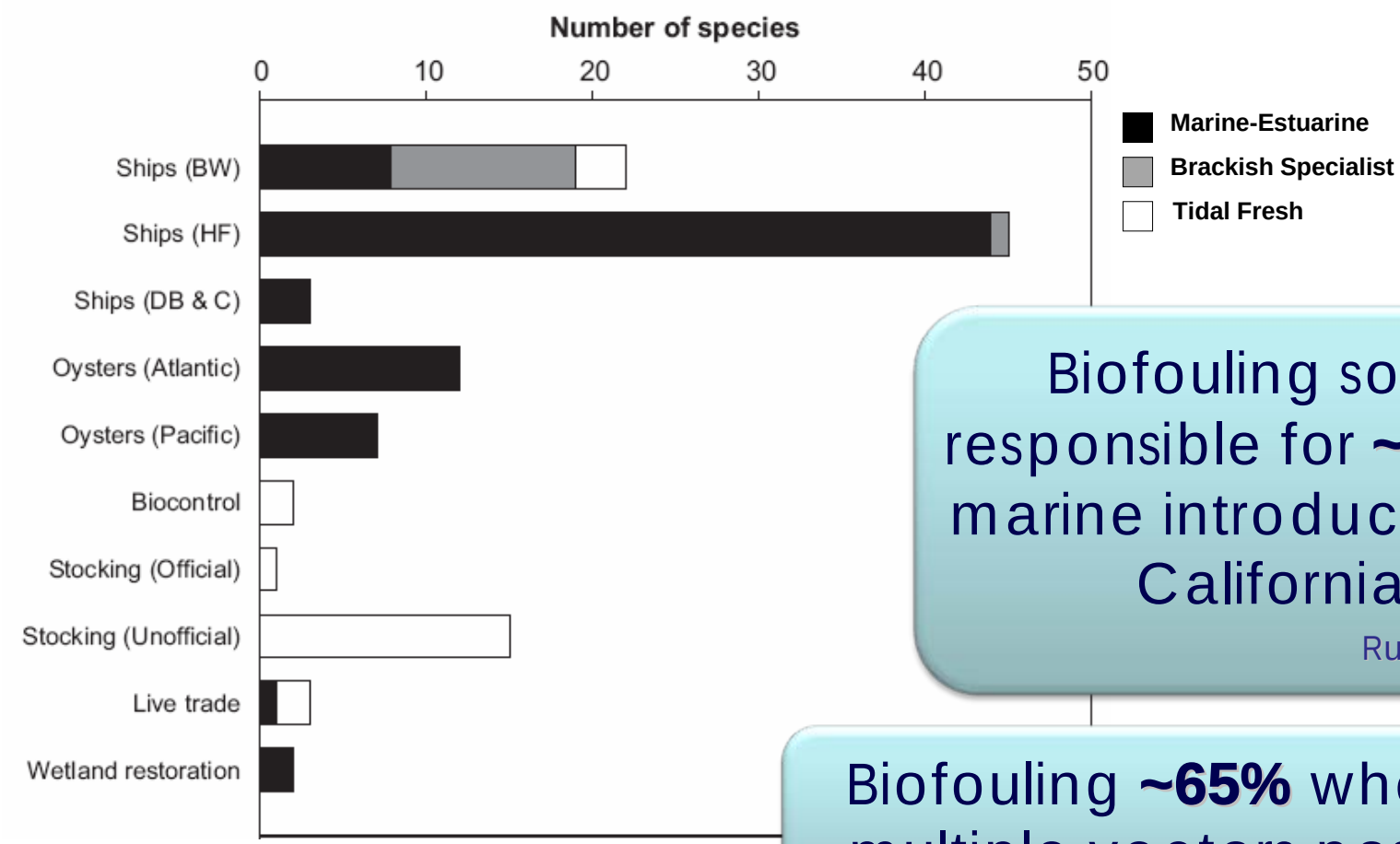
Ruiz et al. 2011

NIS in California



Ashton et al. 2012

Biofouling introductions in California



Biofouling solely responsible for **~20%** of marine introductions in California

Ruiz et al. 2011

Biofouling **~65%** when multiple vectors possible

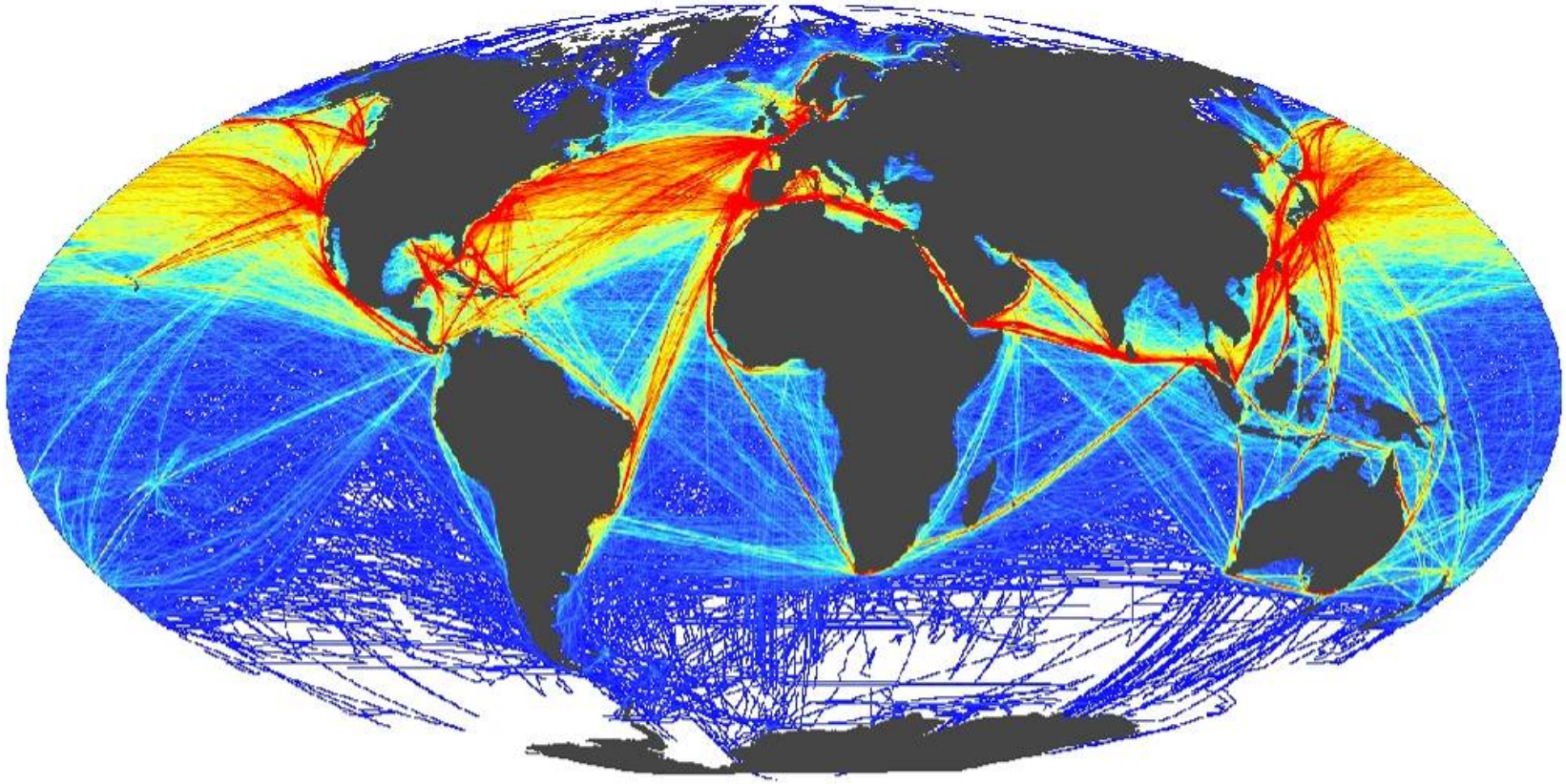
Ruiz et al. 2011

Biofouling: a contemporary vector

1997-2007

- **50** new NIS
- Fouling **sole vector for 32%** (possible for 64%)

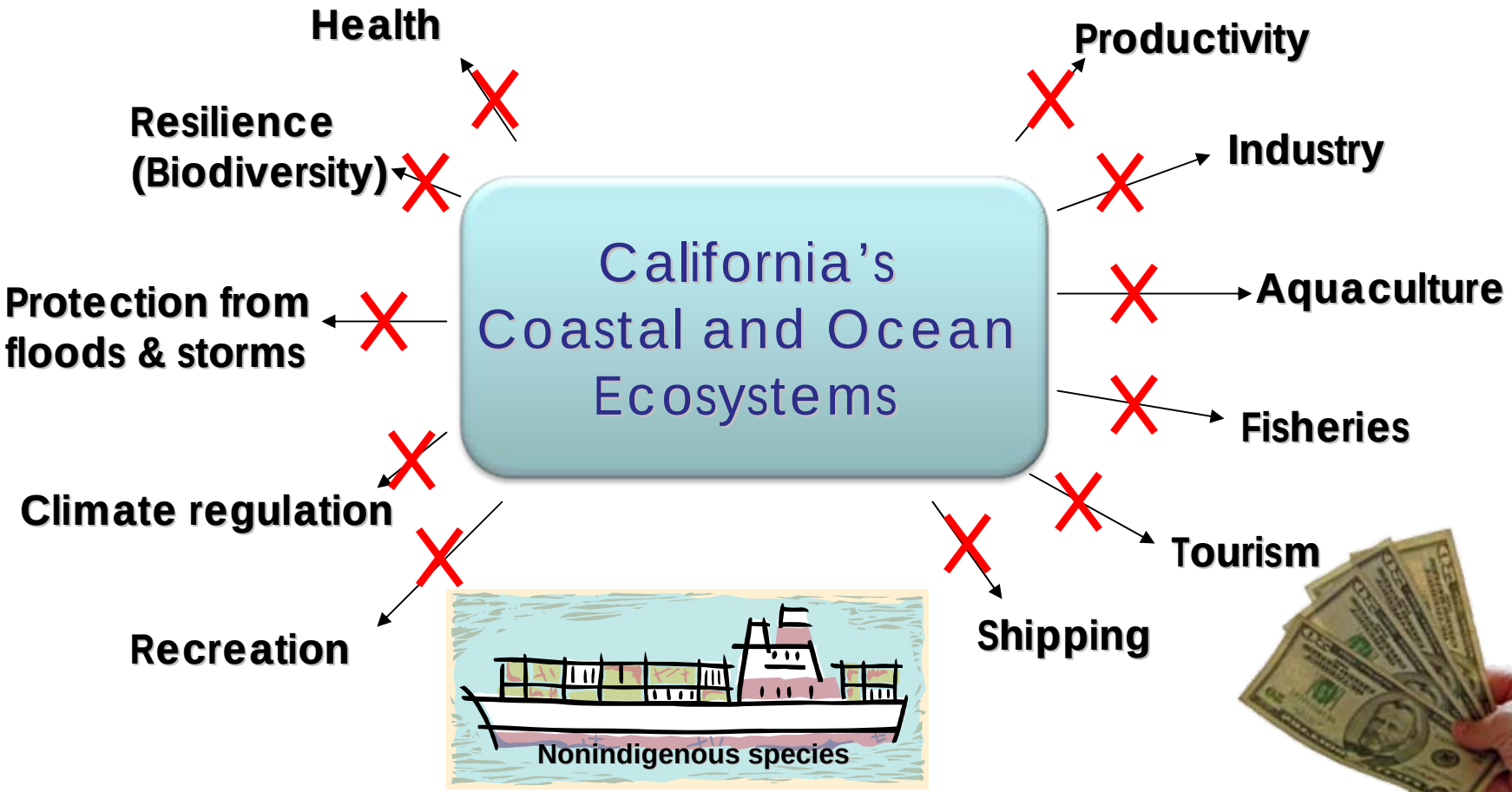
Source Ports



World Shipping Traffic




Introductions: a problem for CA



Vector assessment

Analyses:

Vector Process

Vector Strength

Information

Efficacy?

Information

Efficacy?

Reinforce & Refine

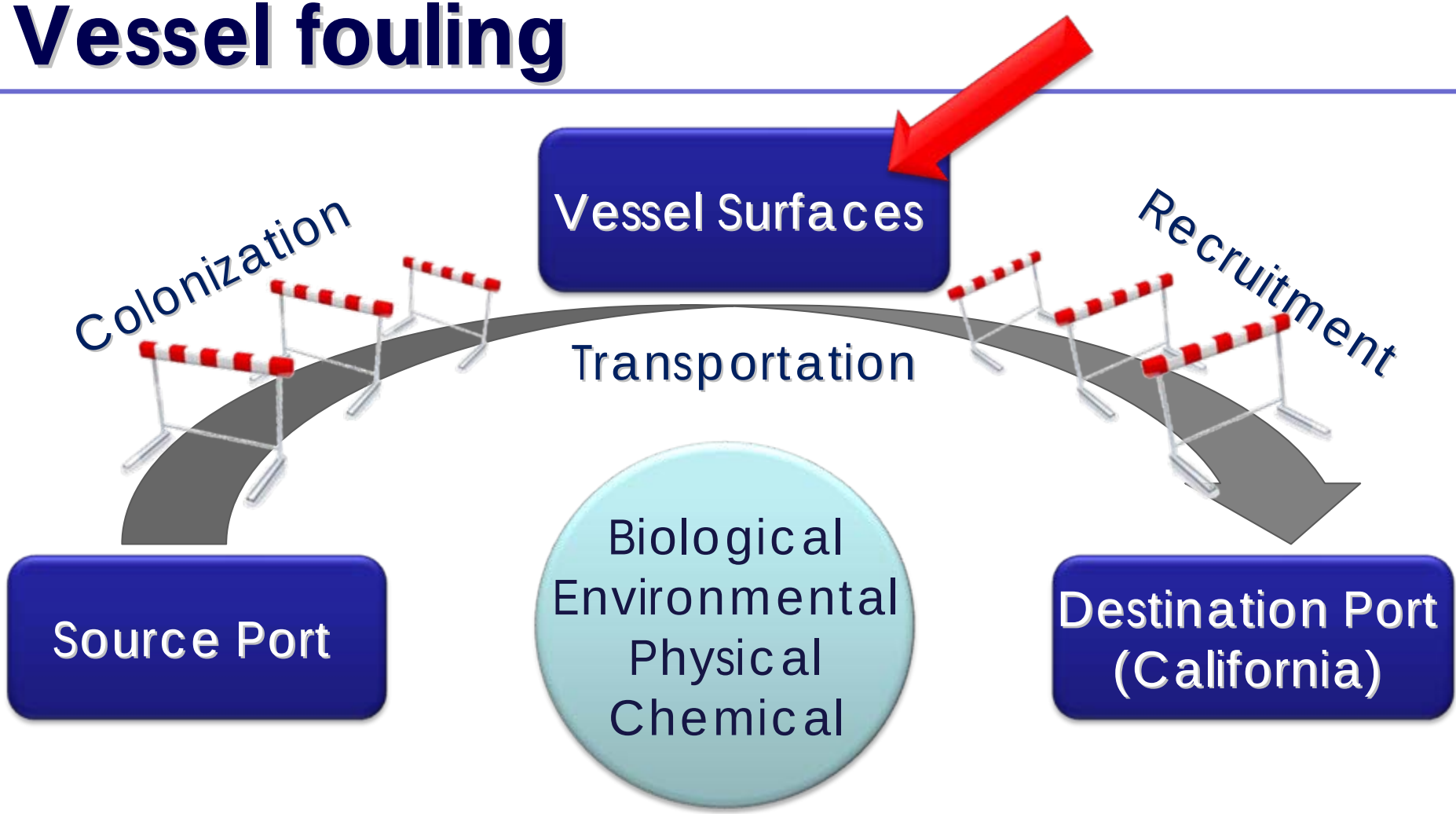
Reinforce & Refine

Guidelines/regulations:

Vector Management




Vessel fouling



Study Process

Hull History

- Dry-dock interval
- Anti fouling paint age
- Vessel speed
- In-port duration
- Travel through freshwater/multiple climates

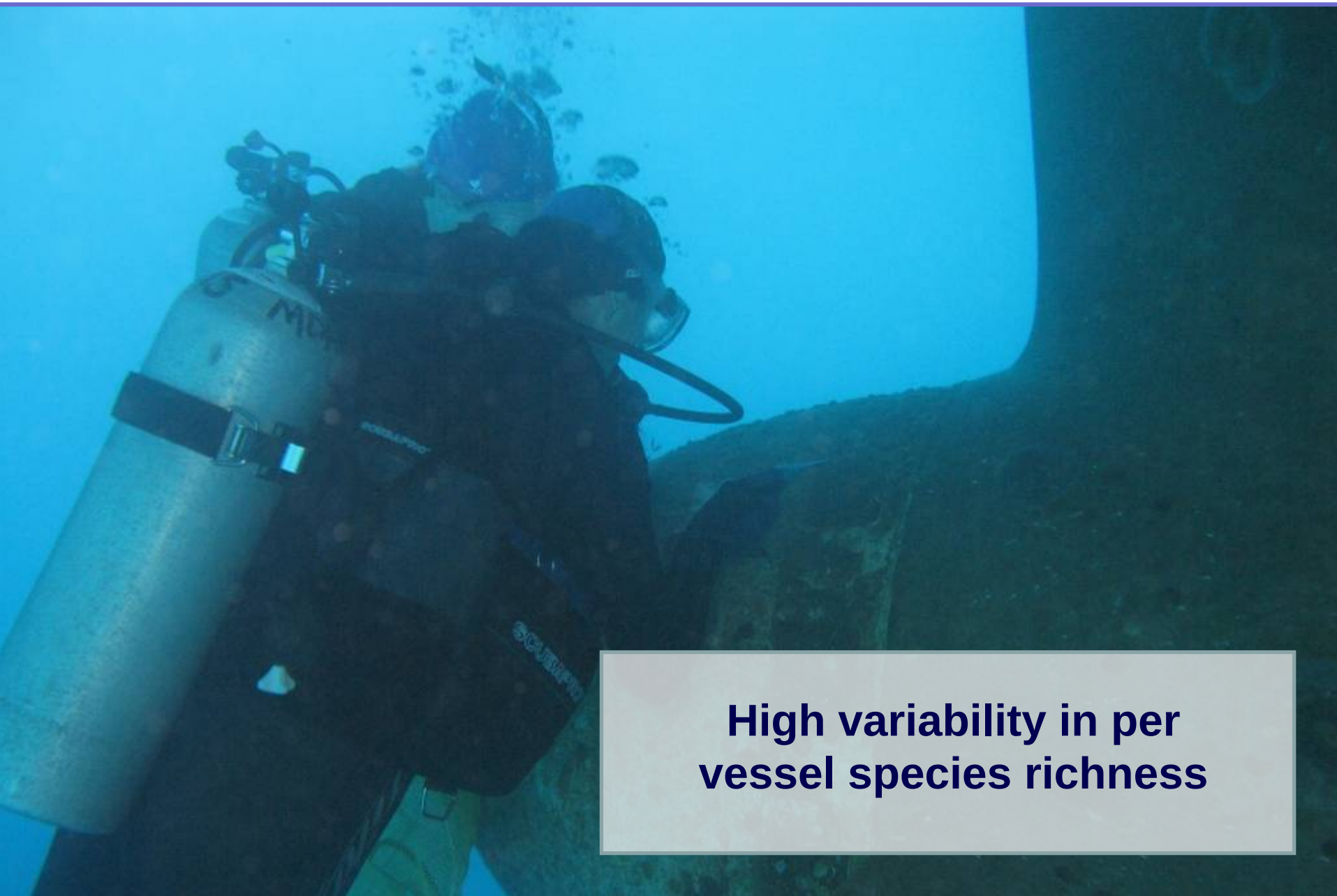
Prediction (risk assessment)

Biofouling

- In-water sampling
- Sample collection & analysis




Vessel sampling



High variability in per vessel species richness

Vessels with biofouling

Few clean vessels

Region	Vessels with biofouling	
CALIFORNIA	**21/**23	2009-2011
	20/22	Container vessels Davidson et al, 2009
New Zealand	**30/**30	Coutts & Taylor, 2004
	328/508	Containers + Bulk: 55% Reefers 38% Passenger vessels 55 % Inglis et al, 2010
Brazil	**15/**15	All commercial Farrapeira et al, 2007
Canada	**36/**40	Sylvester et al, 2010

Vessel sampling

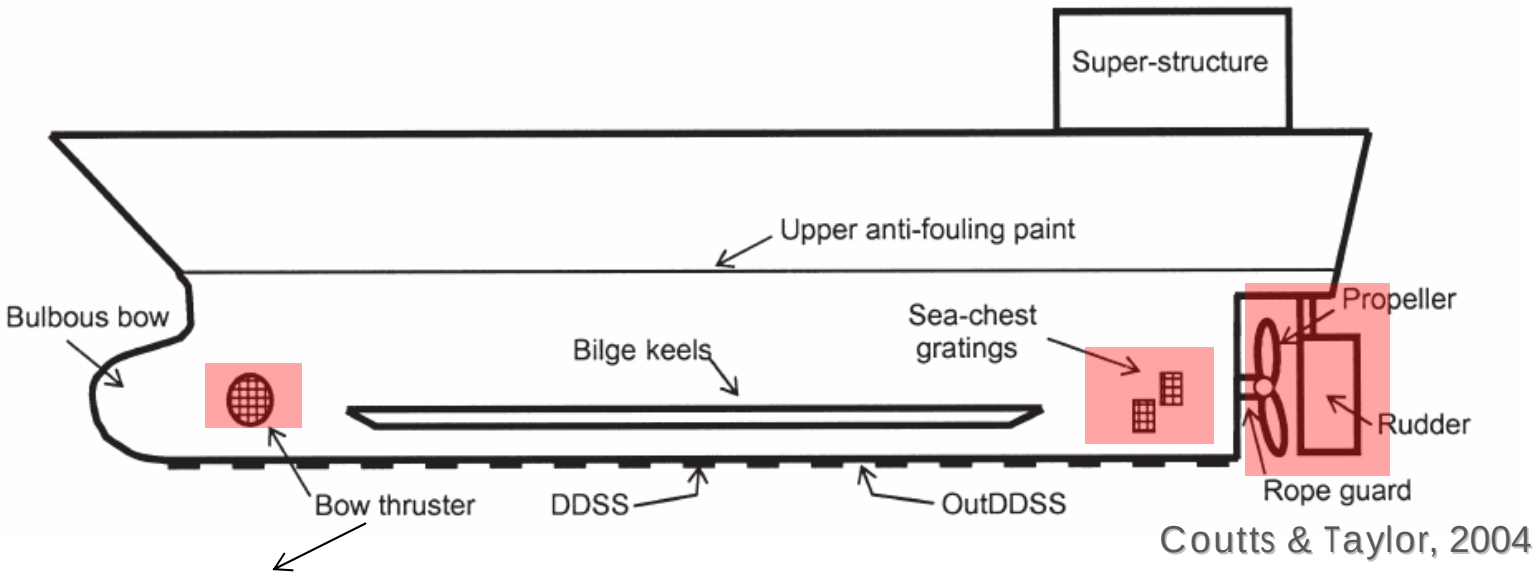
Communities included established NIS and species yet to be recorded from CA

Vessels with NIS

CALIFORNIA	>15 NIS among 85 taxa recorded
New Zealand	**72% NIS** Inglis et al, 2010
Brazil	**4 novel NIS** Farrapeira et al, 2007
Canada	**90% NIS** Sylvester et al, 2010



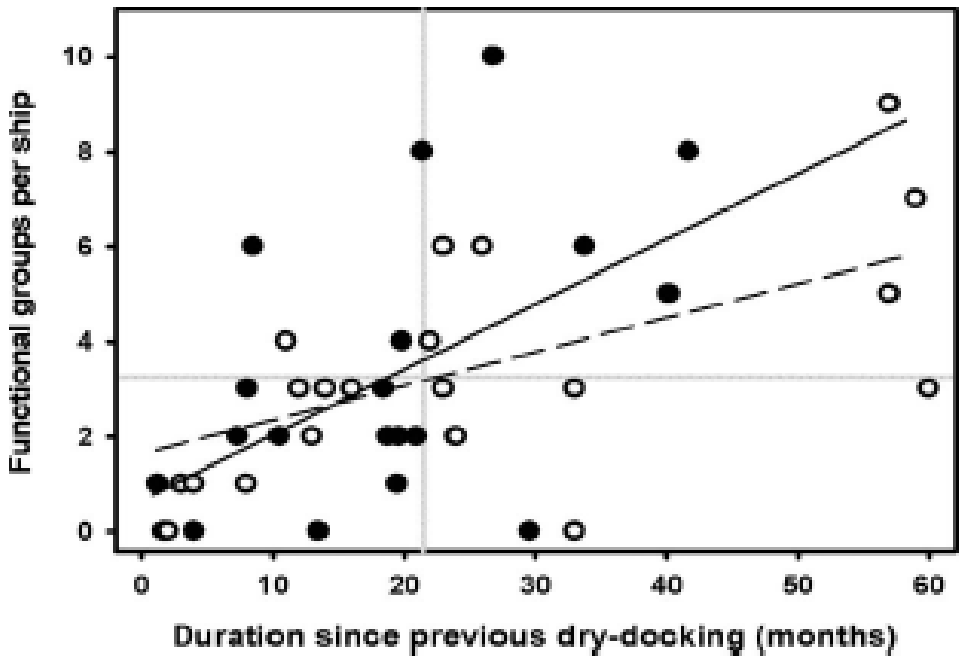

Niche areas



Coutts & Taylor, 2004

Biofouling diversity and extent were greatest among niche areas

Modelling biofouling (prediction)



Davidson et al, 2009

- Time since dry-dock
- Age of anti fouling paint
- Presence and complexity of niche areas
- Vessel speed
- In-port duration
- Travel through freshwater/multiple climates




Modelling biofouling (prediction)

Multiple levels of complexity and significant variability:

Dry dock time

4 yrs out of dry dock→ 5 spp
2 yrs out of dry dock→ 49 spp

4 months out of dry dock → clean
48 months out of dry dock → clean

Speed

Vessels with higher speeds- higher spp richness

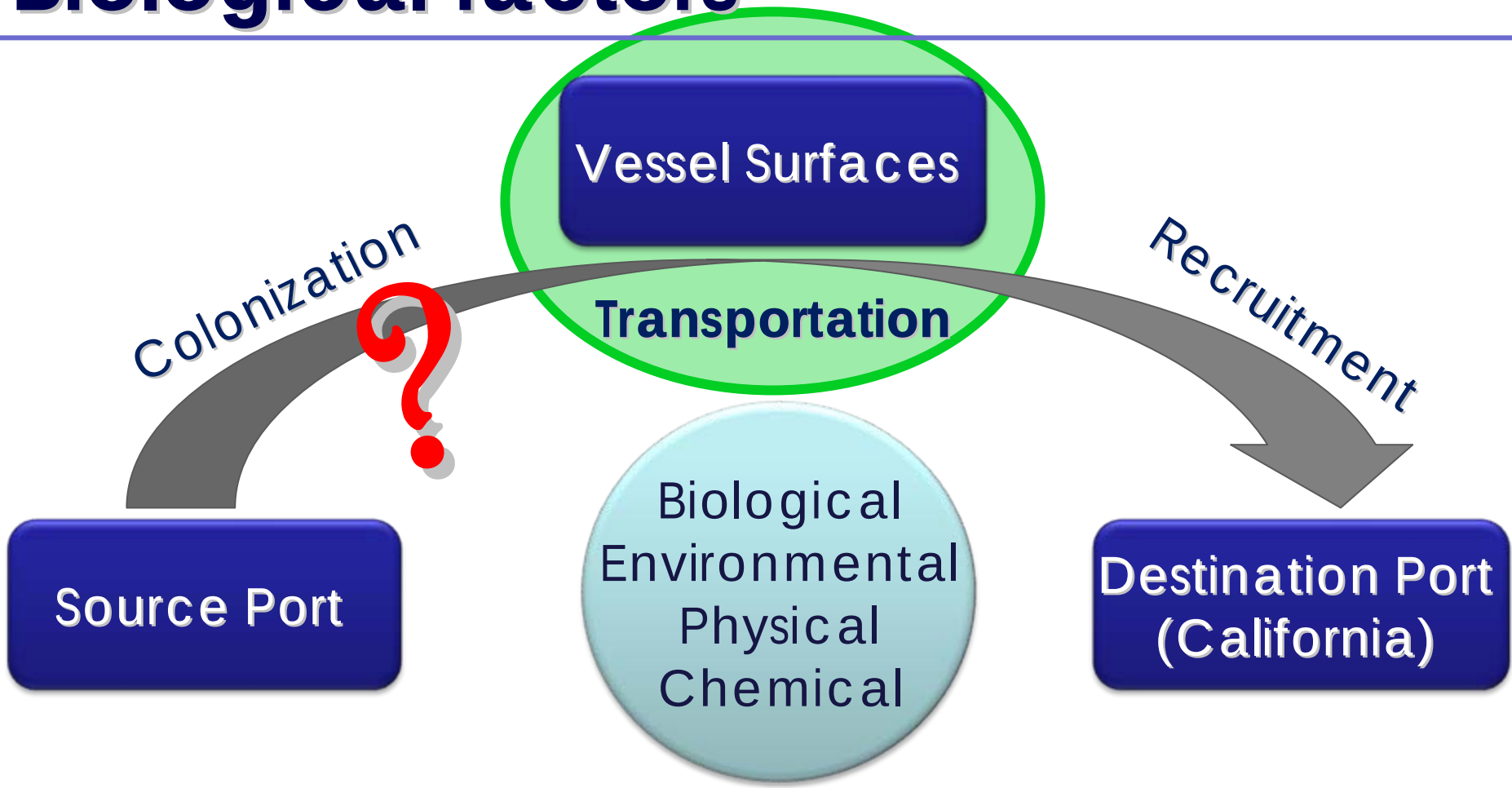
Port duration

Longer port durations- lower spp richness

Often explanatory factors, but needs to be assessed on a per-vessel basis



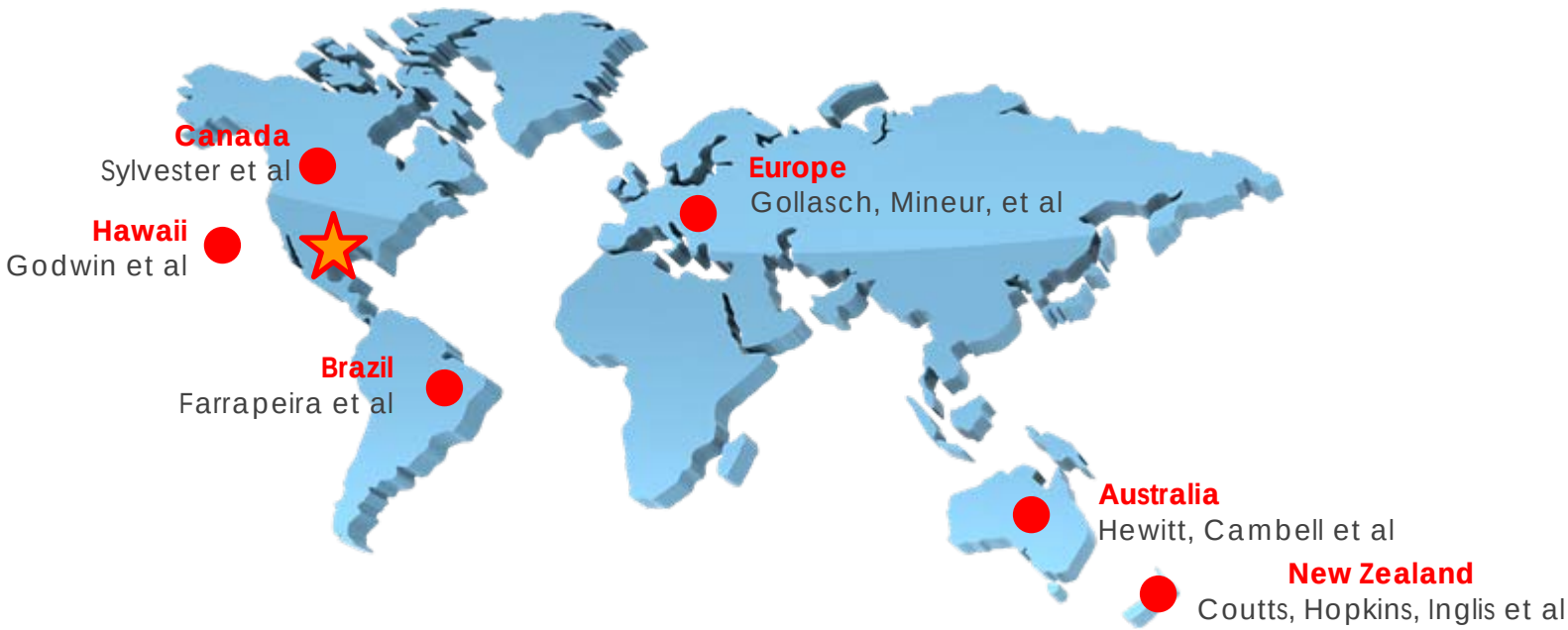

Biological factors






State of knowledge

- Modern vessels are **active vectors**, NIS recorded often, with few records of zero biota
- **Biofouling variable** among regions and studies
- **Poor ability to predict** fouling extent and richness
- Distribution of biofouling strongly associated with **niche areas**

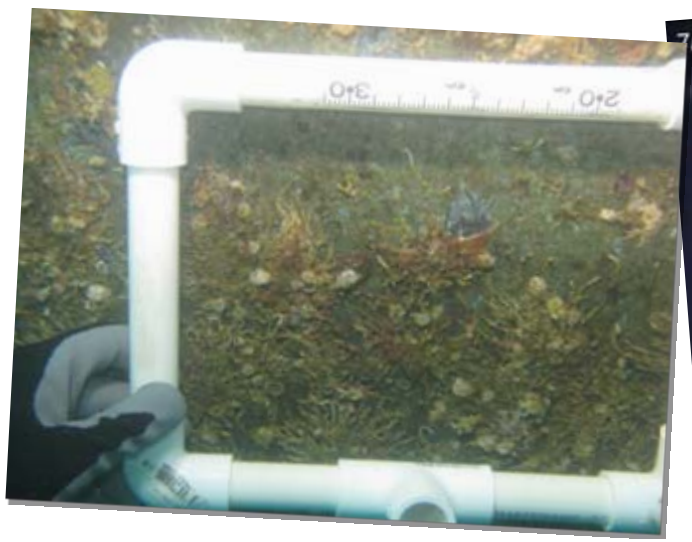


Future work:

- Continue to **increase understanding** of fouling process

- Assess **efficacy** of proposed biofouling guidelines + regulations

- Develop accessible **quantitative methods** to assess fouling condition



Collaborators & Sponsors:

CALIFORNIA STATE LANDS COMMISSION

CALIFORNIA DEPARTMENT OF FISH&GAME

U.S. FISH & WILDLIFE SERVICE

PRINCE WILLIAM SOUND RCAC Regional Citizens' Advisory Council

Smithsonian Institution

Ports of:
Long Beach
Los Angeles
San Francisco
Guam
Ketchikan

Vessel operators- Muldoon marine services-Taxonomists