Hull Fouling:
species transfers & vector management

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AIS Vector Workshop, Baltimore Md, Dec 2nd, 2009

Presentation Outline

Biofouling vector process

Hull-mediated invasions

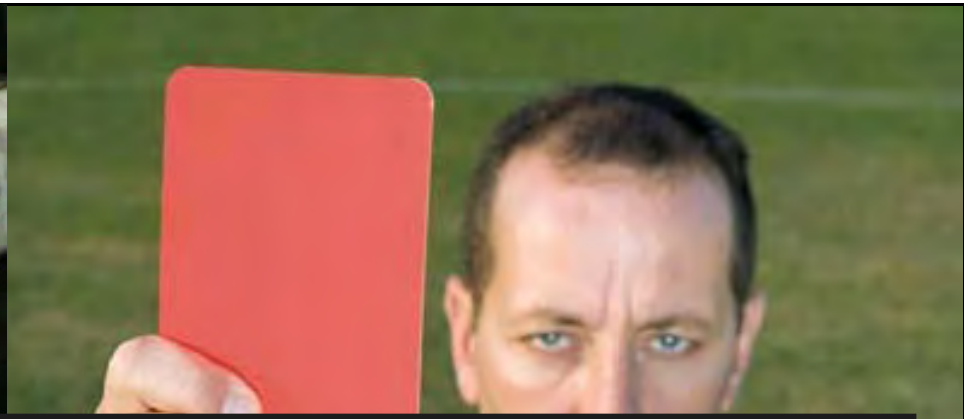
Commercial ships

Stochastic vessels

Recreational boats

Vector management

Fouling



“the accumulation of unwanted material on solid surfaces, most often in an aquatic environment”

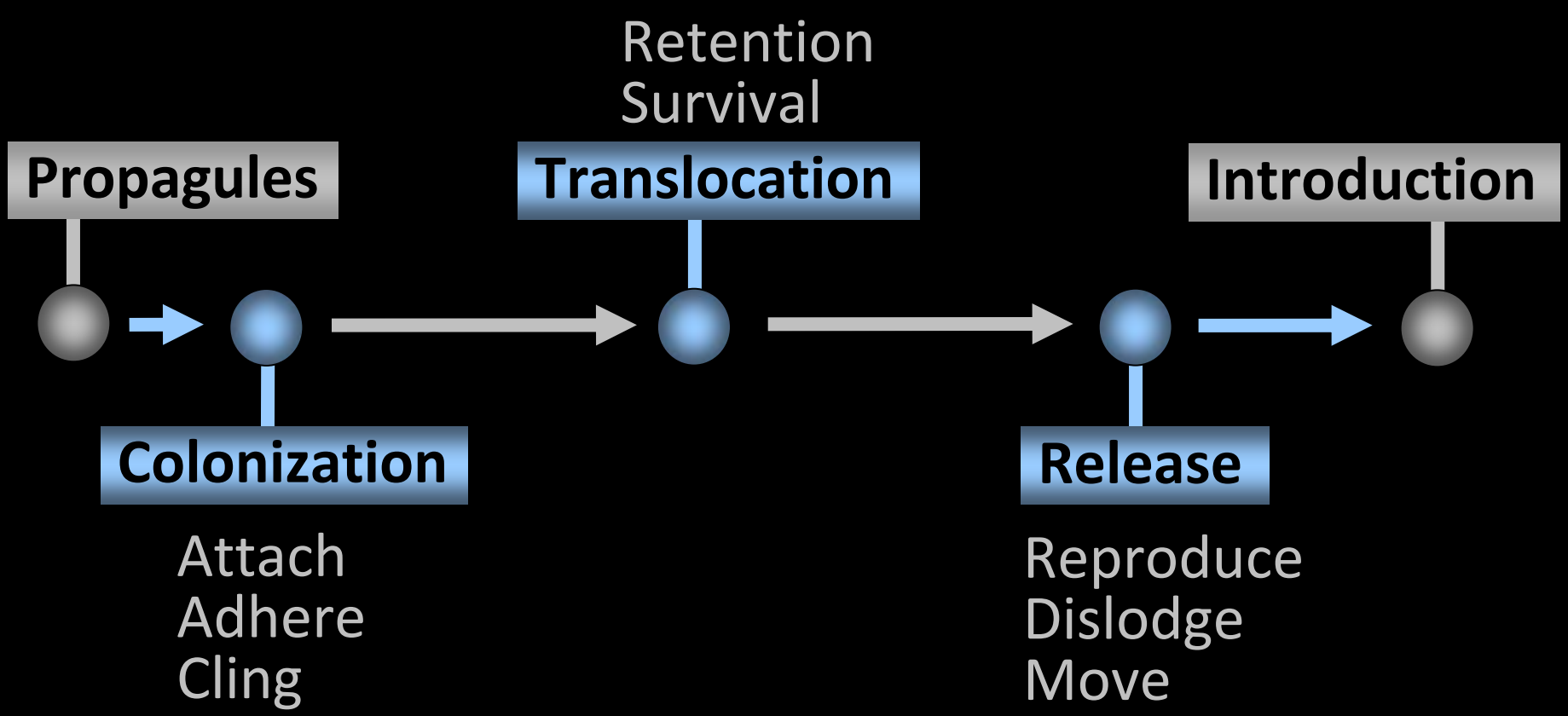
Biofouling

Photo: New York Sea Grant

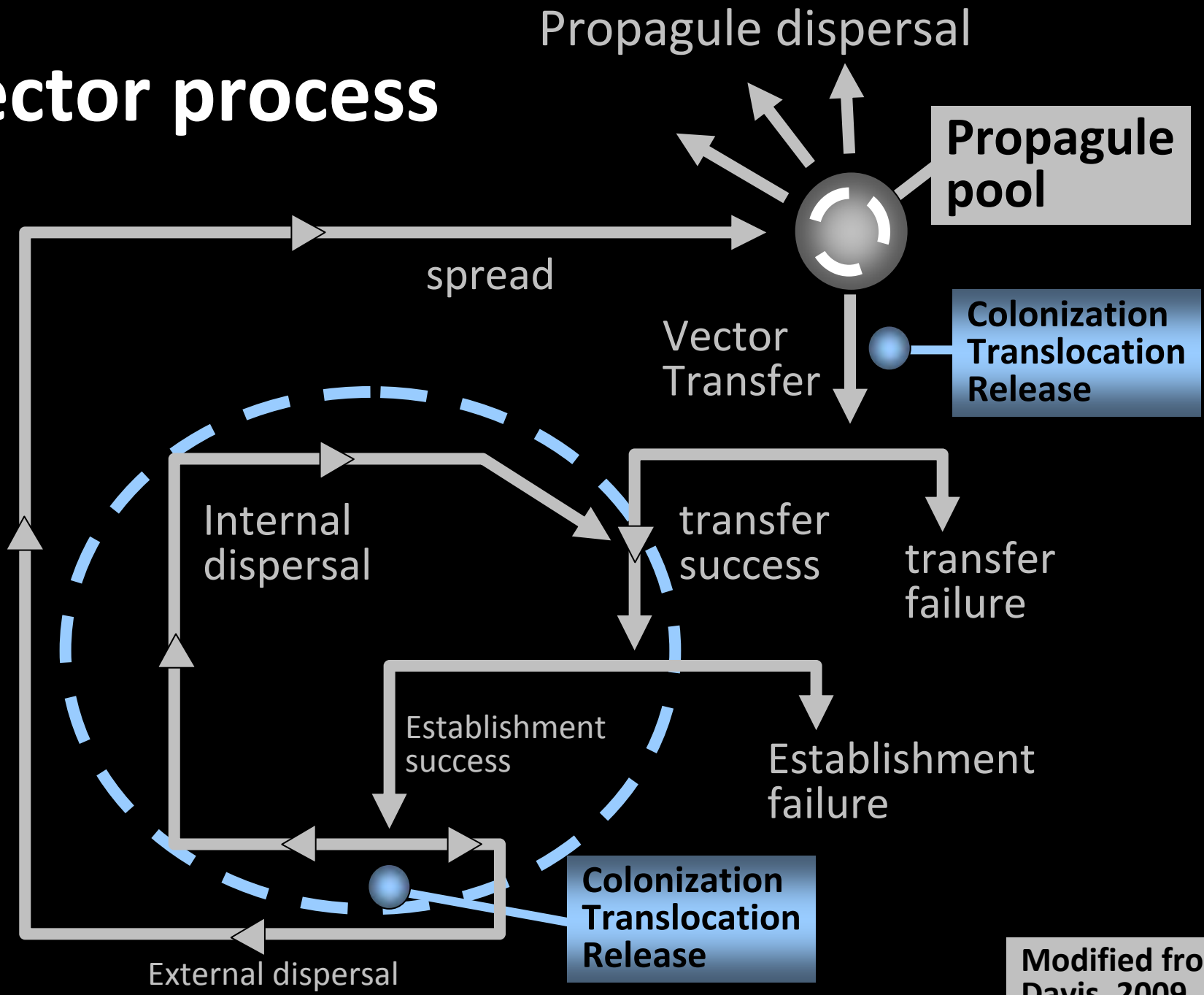
Biofouling

Photo: Marine Invasive Species Program, California State Lands Commission

Biofouling Vector Process

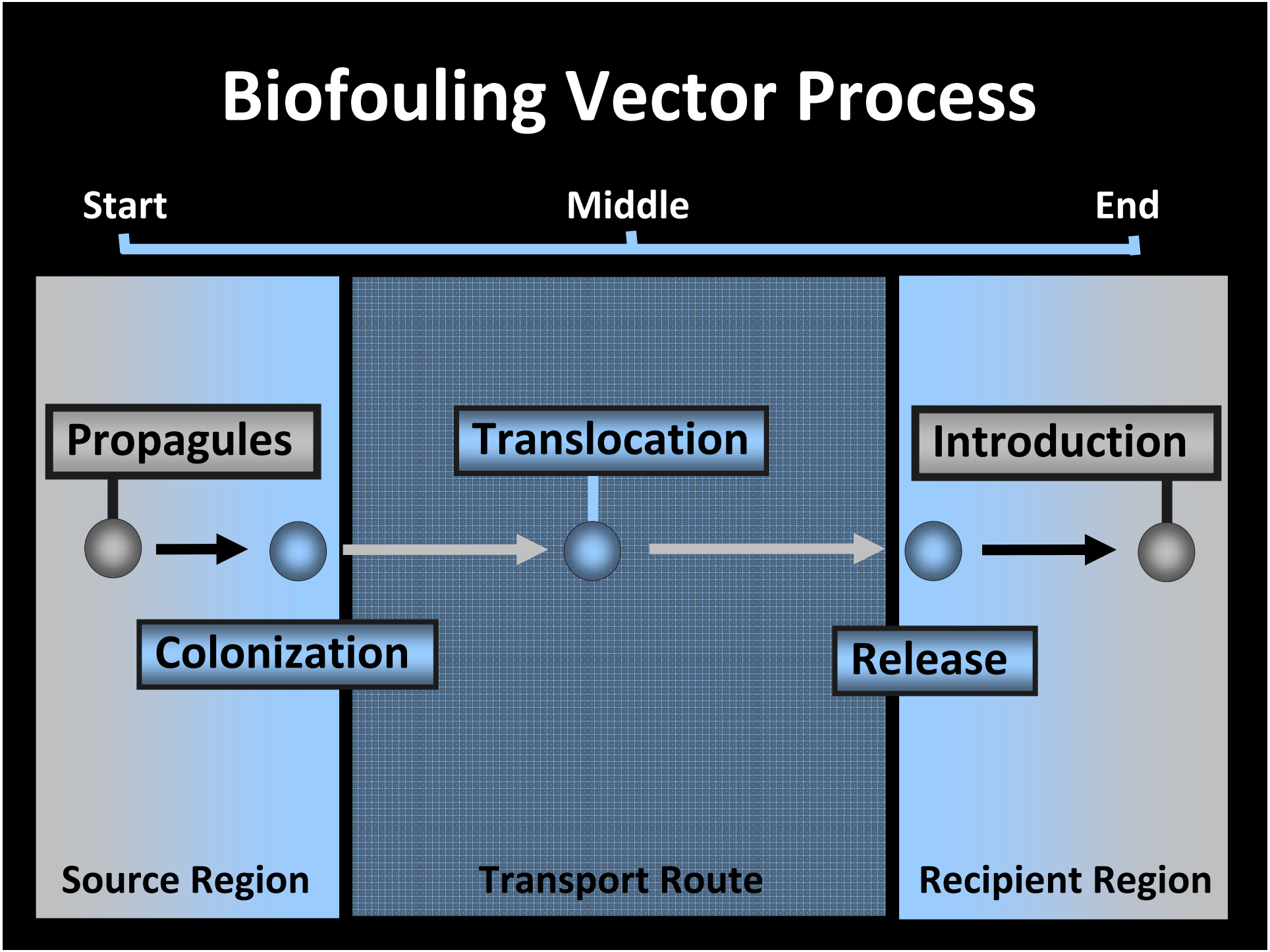


Vector process

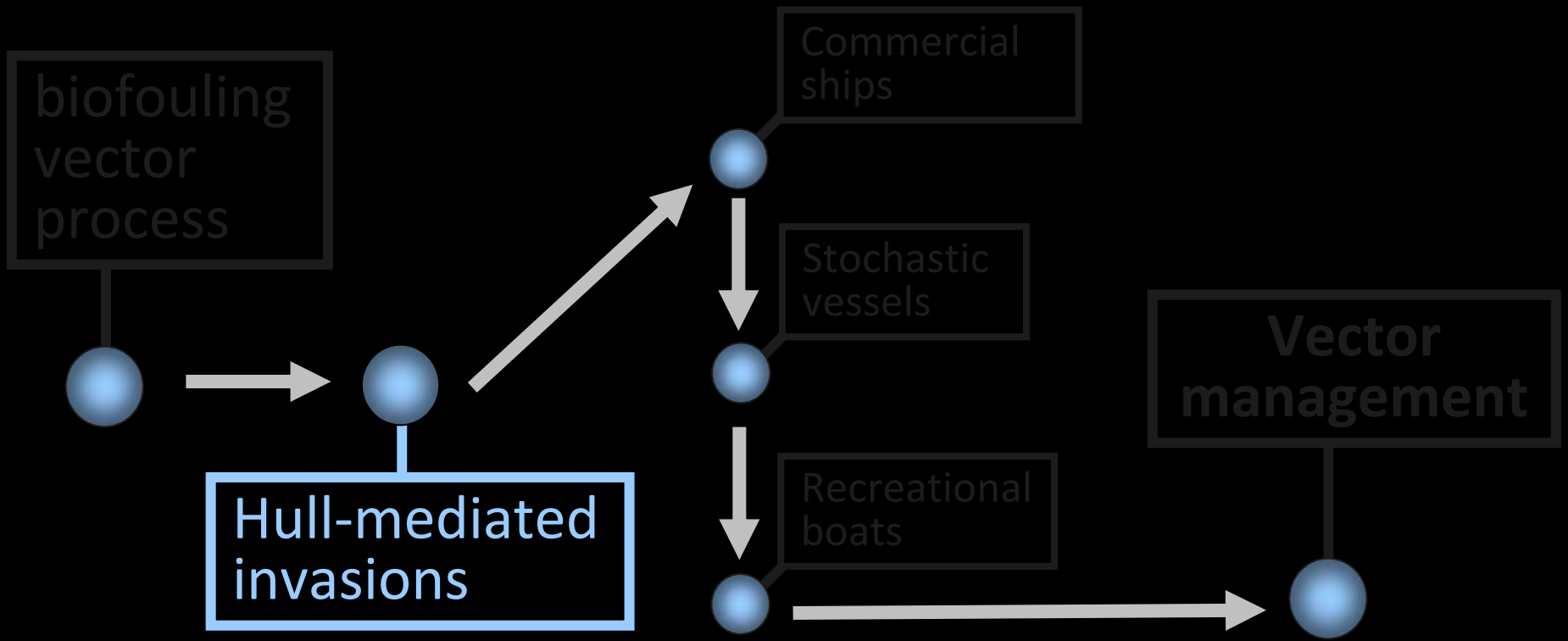


Modified from Davis, 2009

Biofouling Vector Process

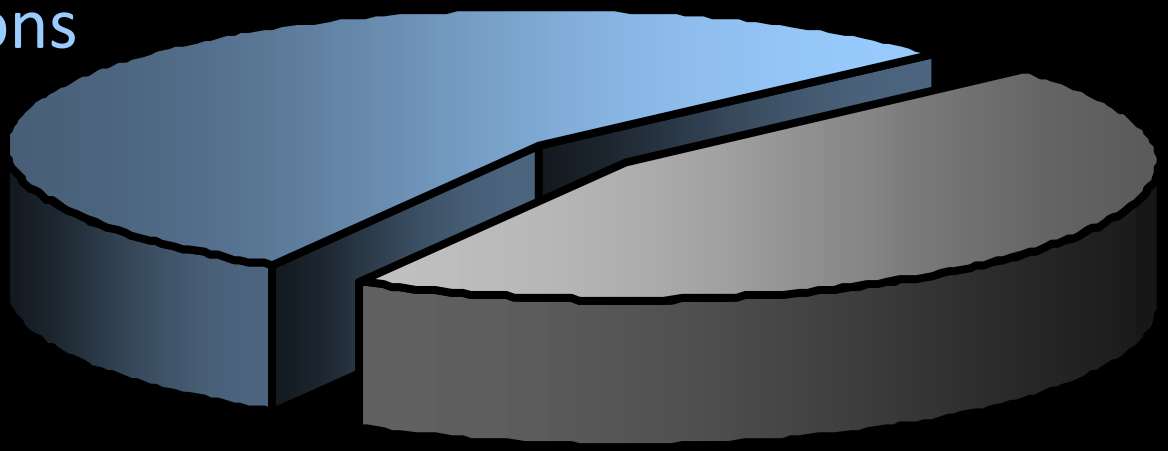


Presentation Outline



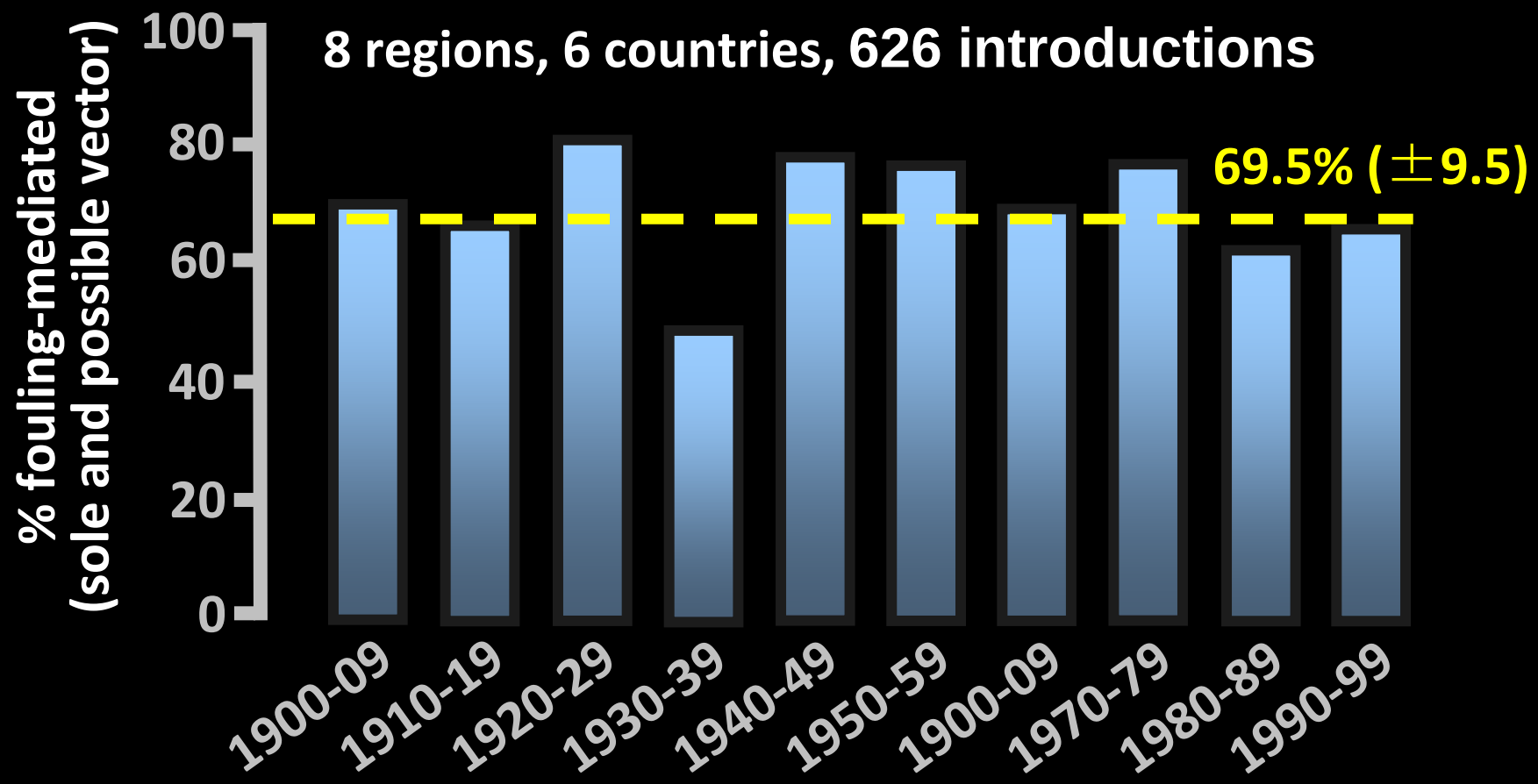
45% of marine introductions worldwide are linked (unambiguously) to biofouling

Data:
1781 introductions
by invertebrates
and algae
worldwide



Data from Hewitt & Campbell (2009) Report to Dept. Agriculture, Fisheries & Forests, Australia

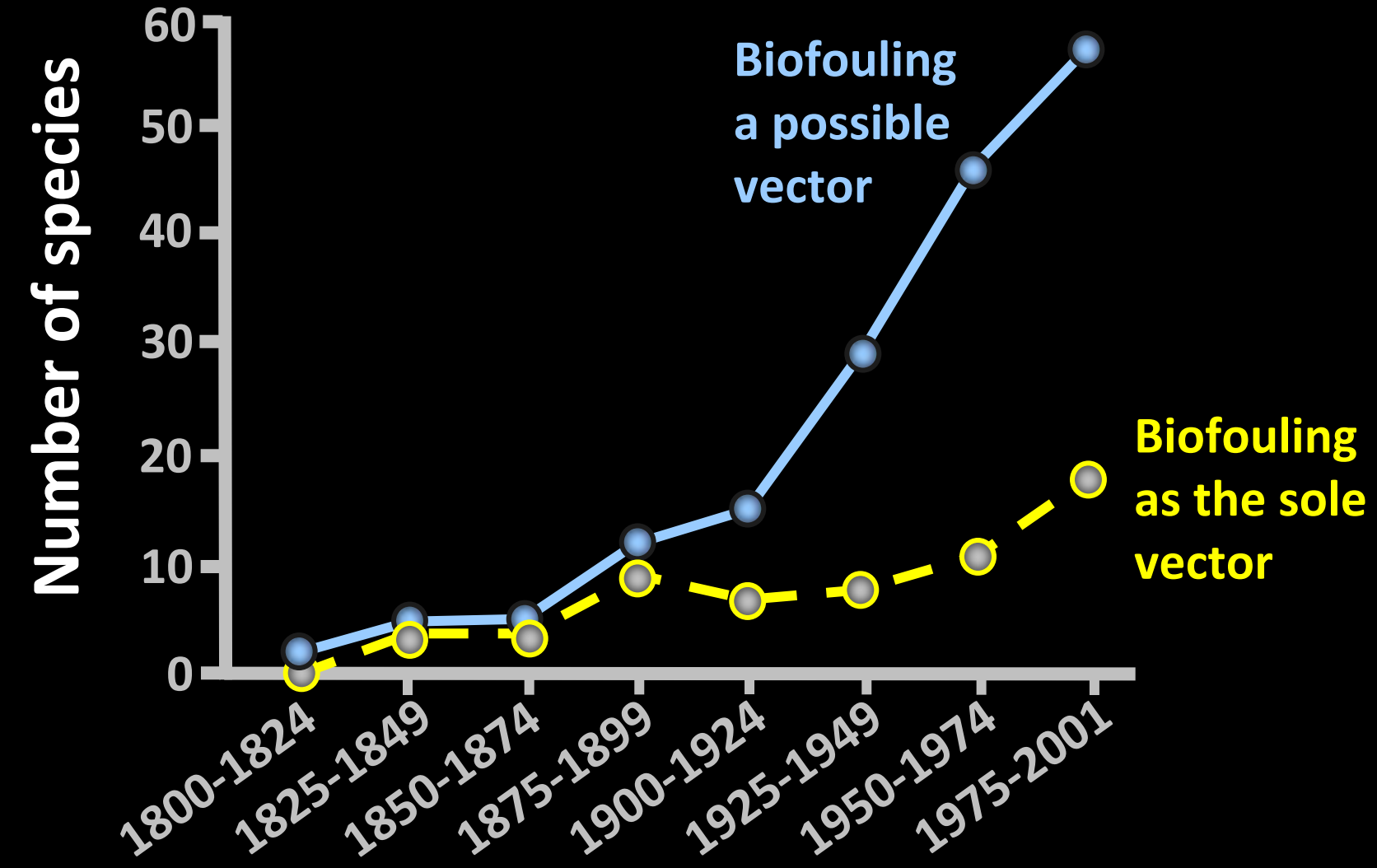
Biofouling vector strength…



…does not appear to be diminishing over time

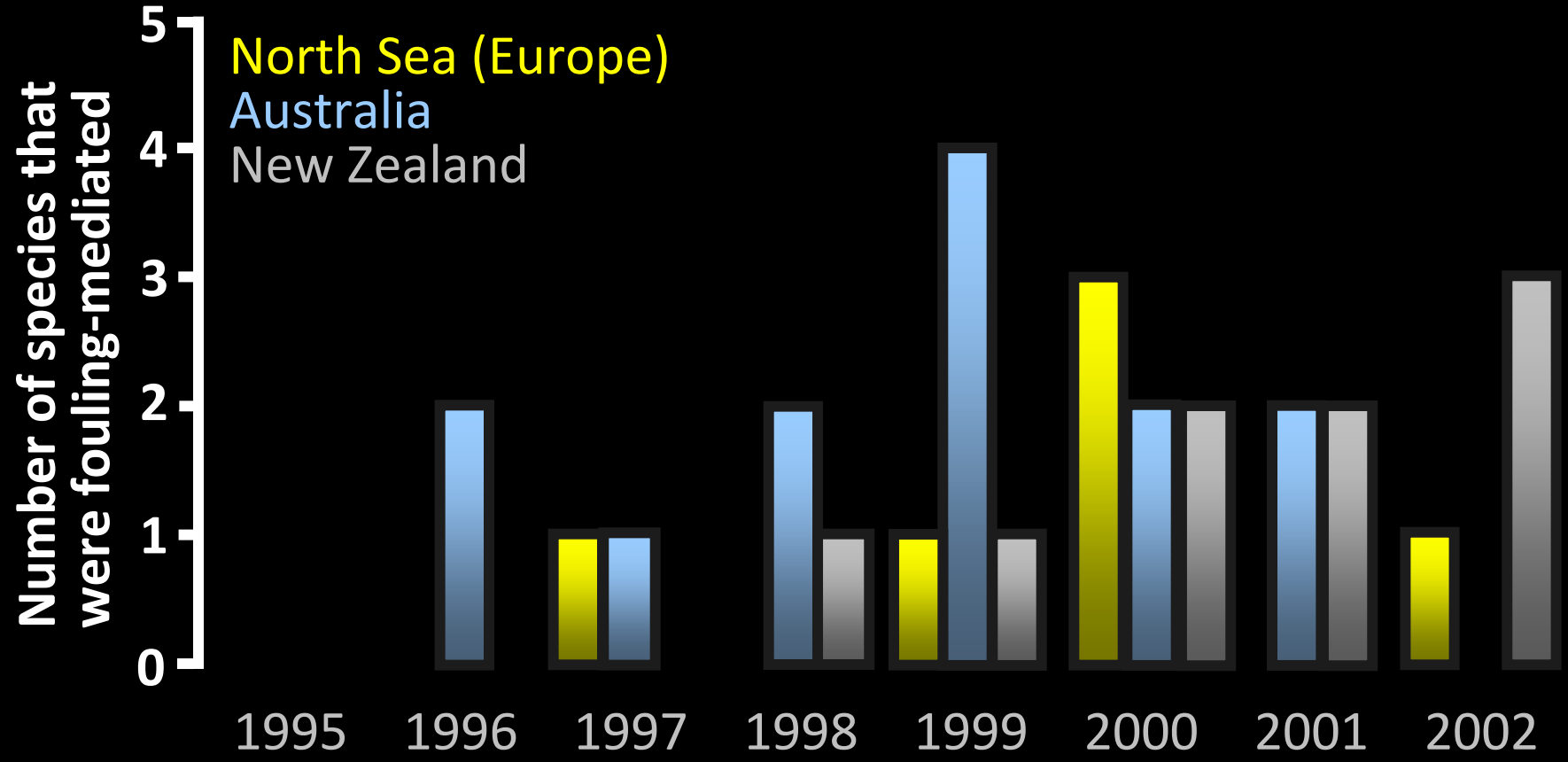
Data from Davidson et al (in prep)

In North America, 171 introductions out of 316 were possible hull fouling transfers



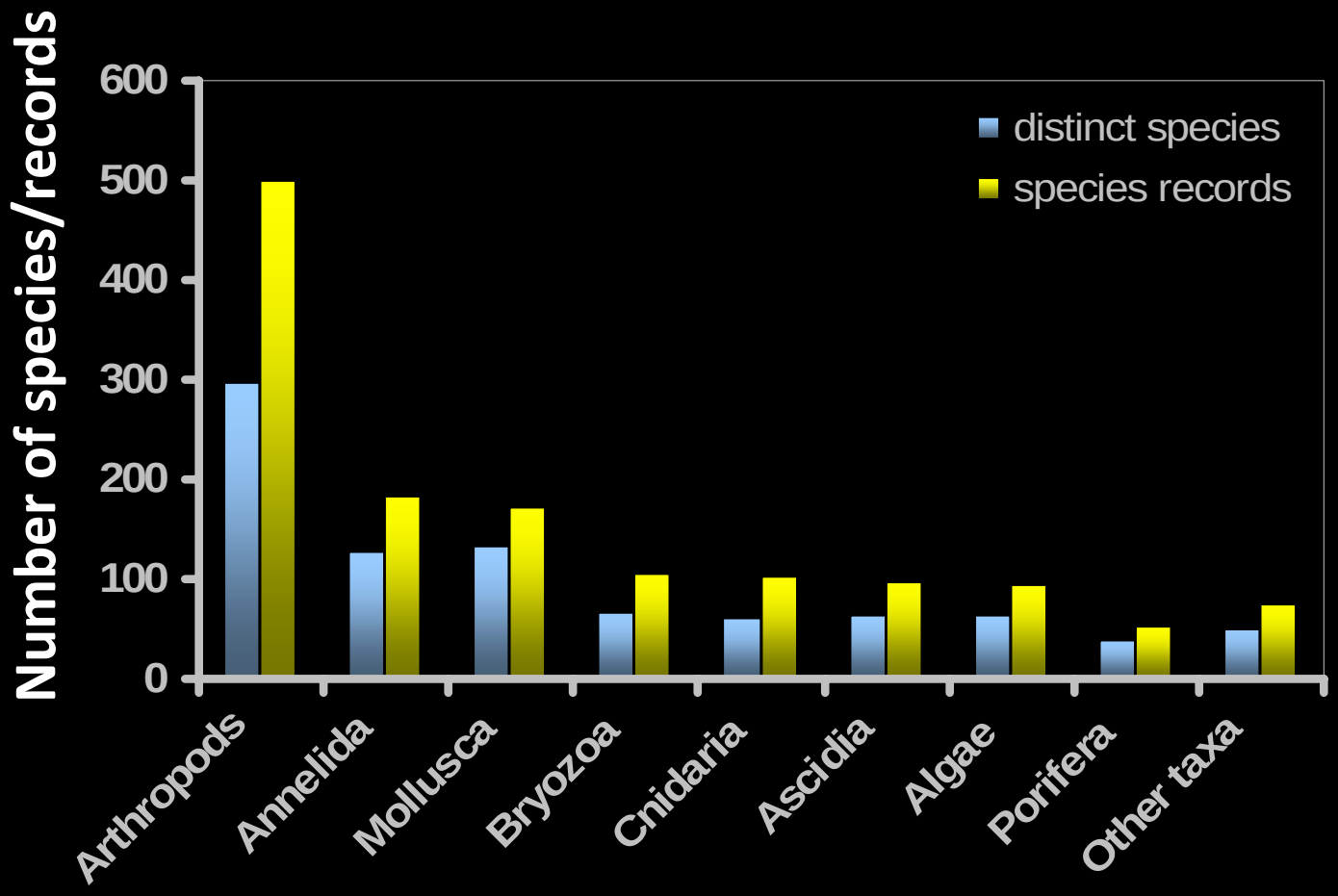
Data: Fofonoff et al (2003) Invasive species vectors and management (Chapter 7)

Recently detected introductions



Hewitt et al (2009) Biological invasions in marine ecosystems (Chapter 6) Springer-Verlag

Species recorded in ship biofouling



Data from
20 studies

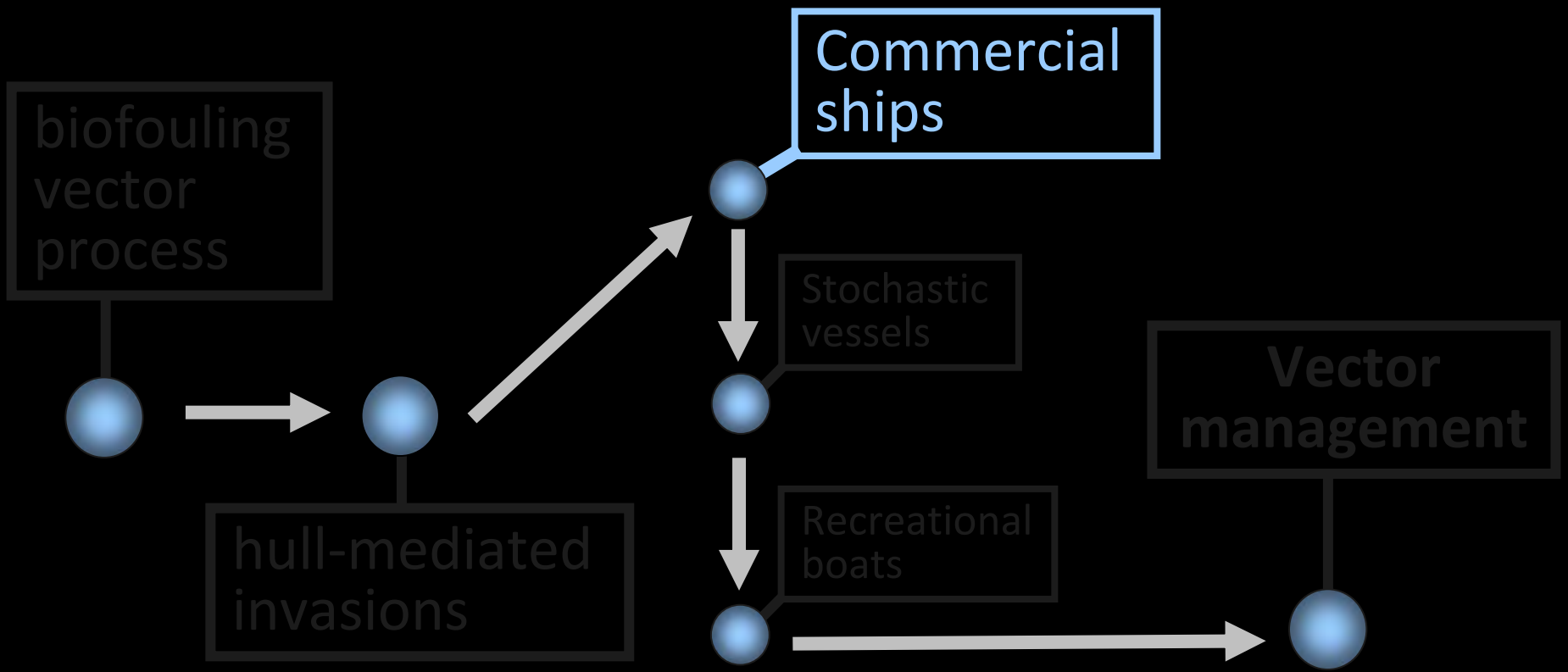
904 species
1381 records

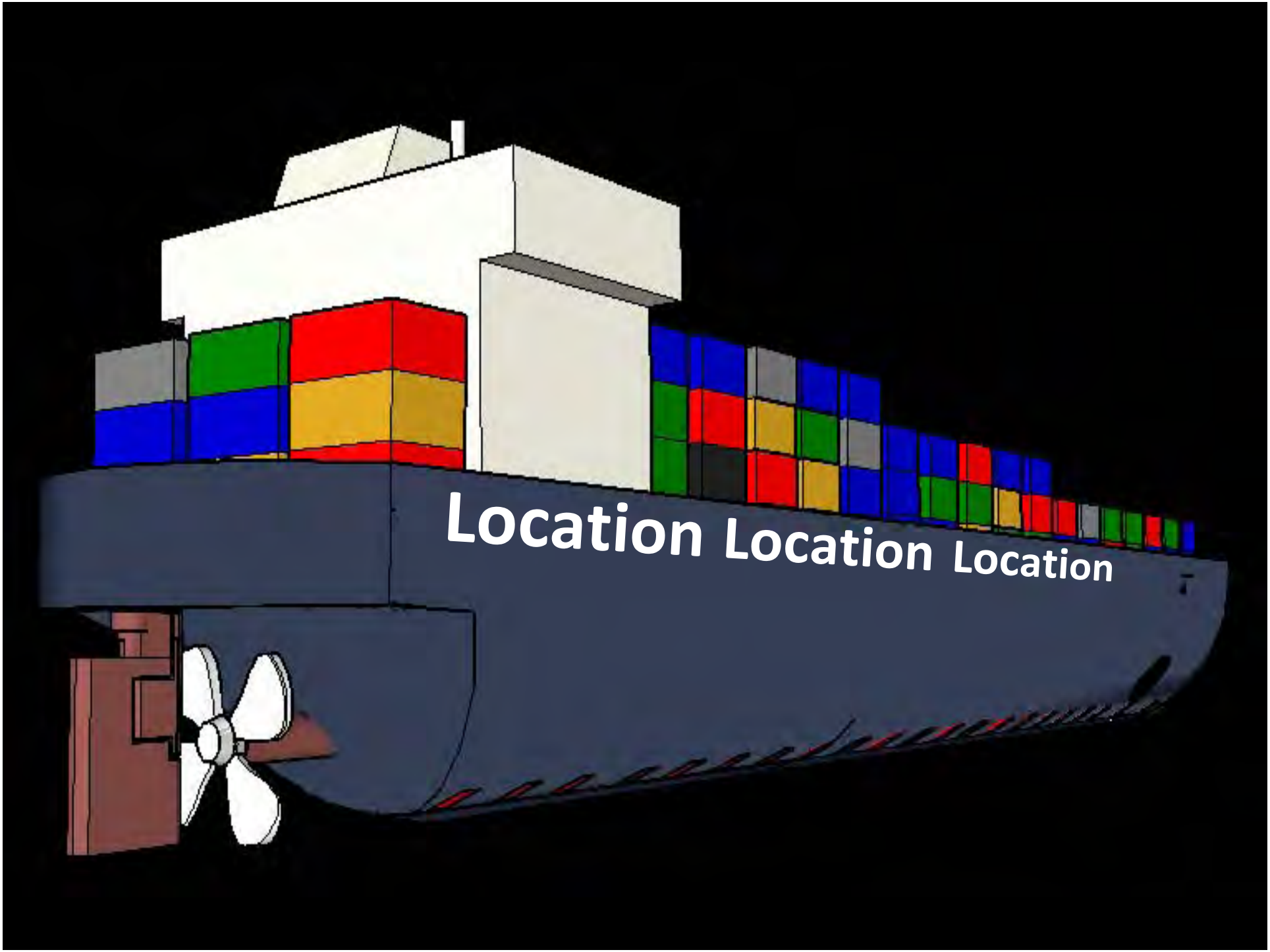
Data from Davidson et al (in prep)

Vector strength of biofouling

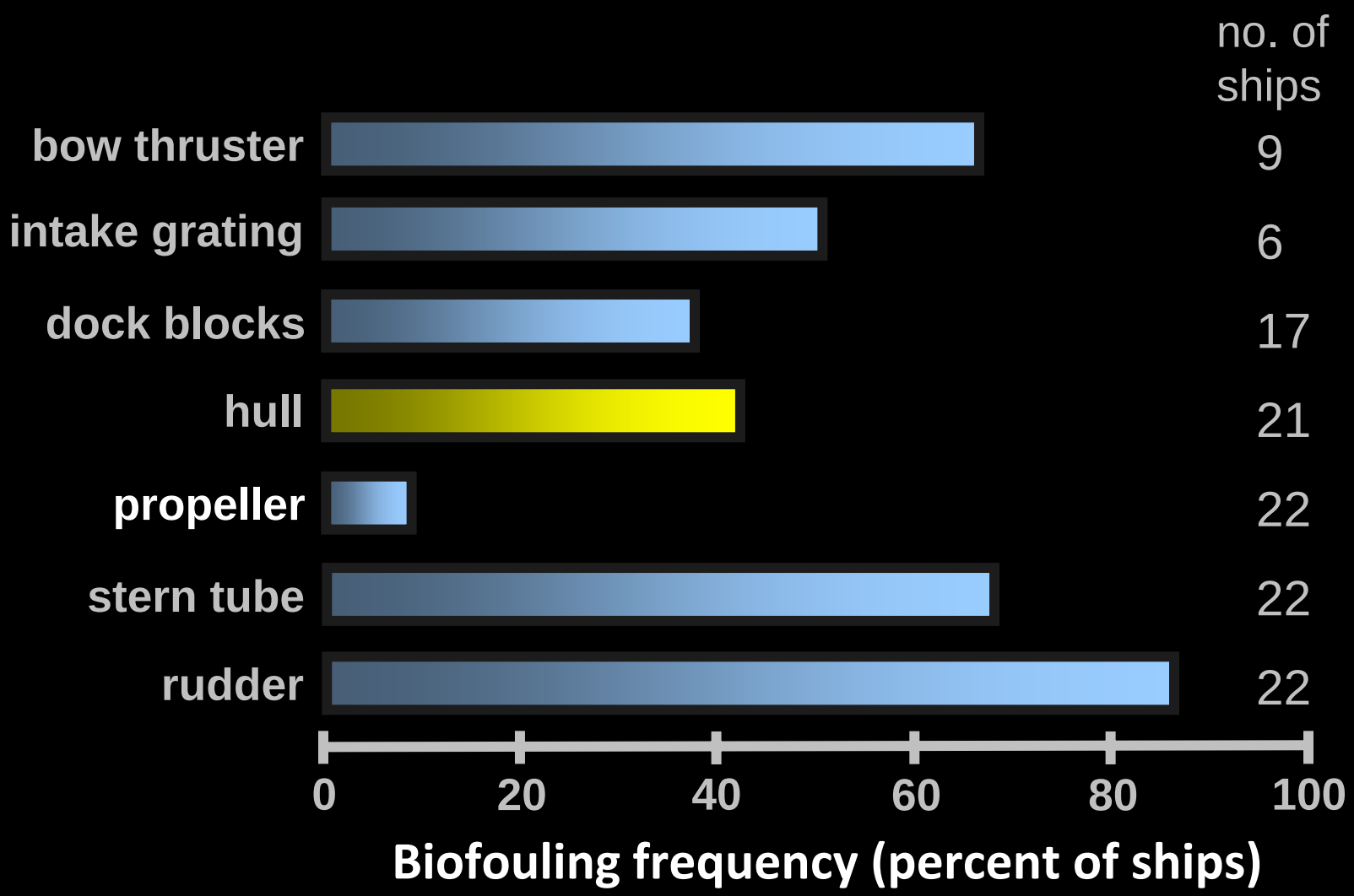
- Biofouling is a potent vector
- A transfer mechanism of diverse assemblages
- It is a contemporary vector

Presentation Outline



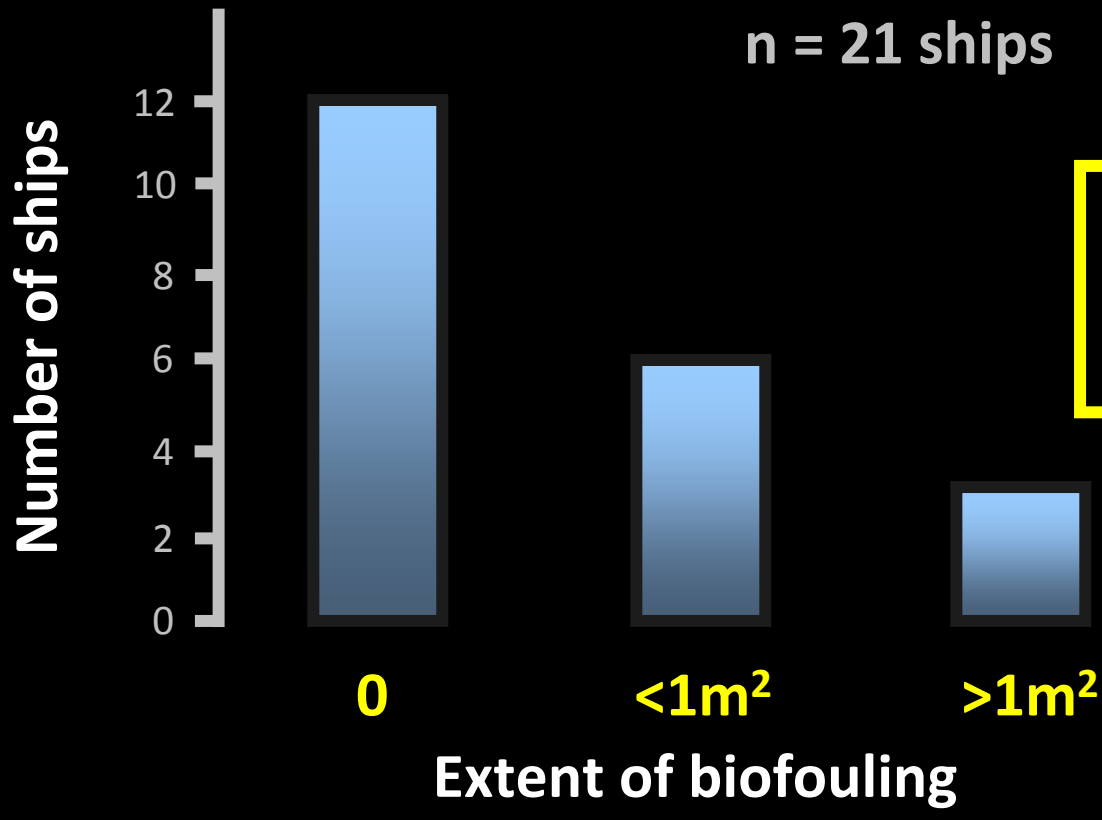

Location Location Location

Biofouling of containerships in Oakland, Ca



Data from Davidson et al (2009) Biofouling 7: 645-655

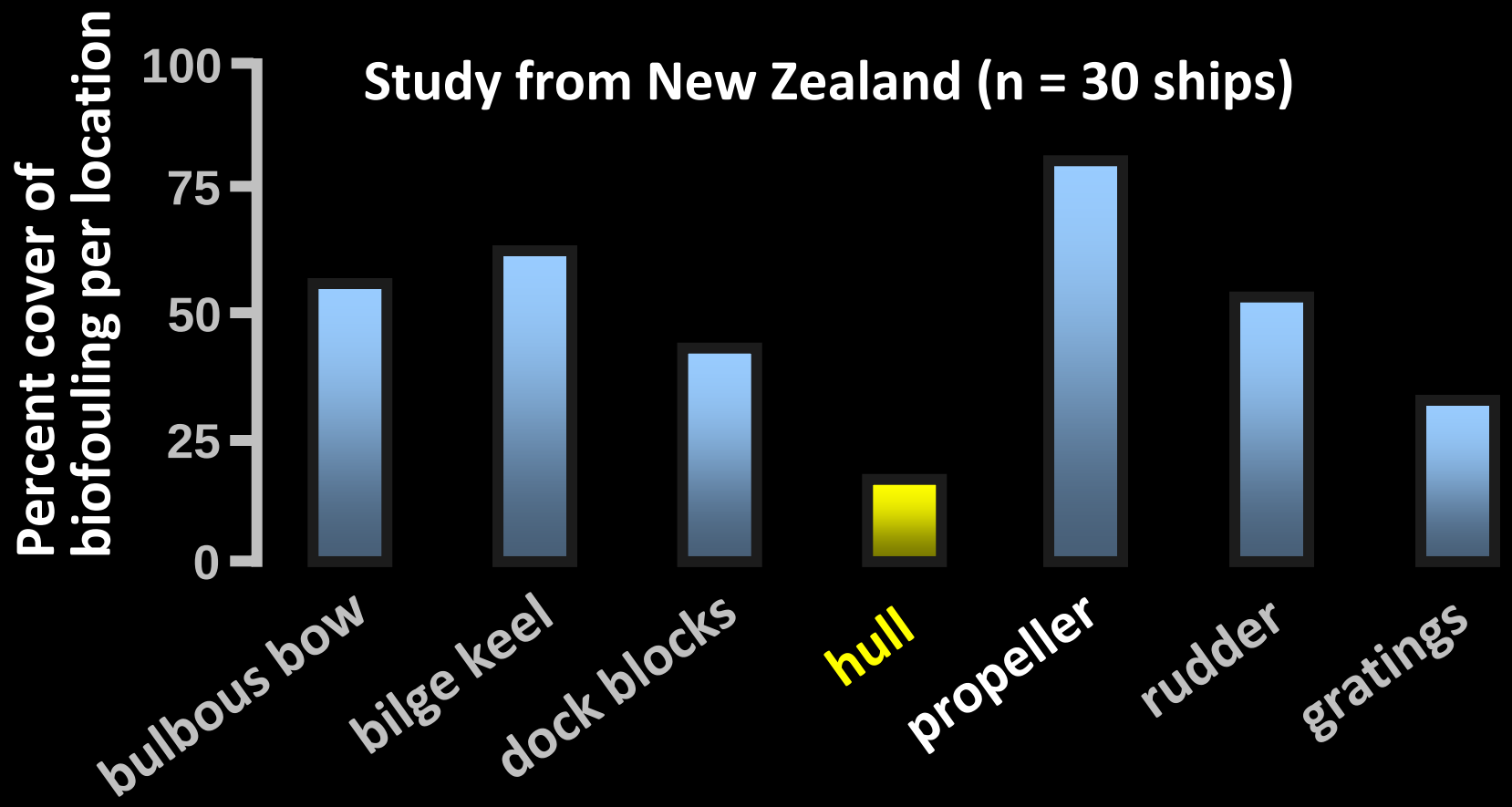
Biofouling extent on hulls



Average wetted surface area = 11321 m^2

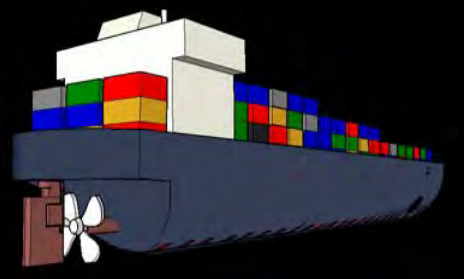
Data from Davidson et al (2009) Biofouling 7: 645-655

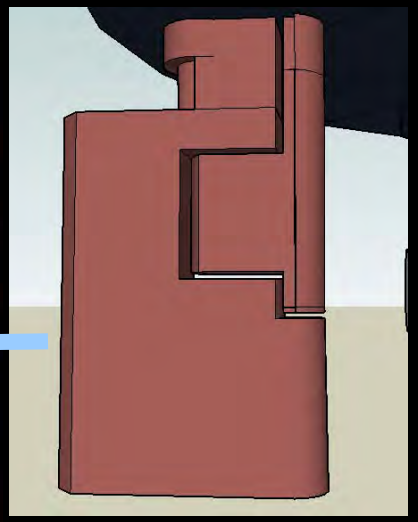
Ship ~~Hull~~ fouling

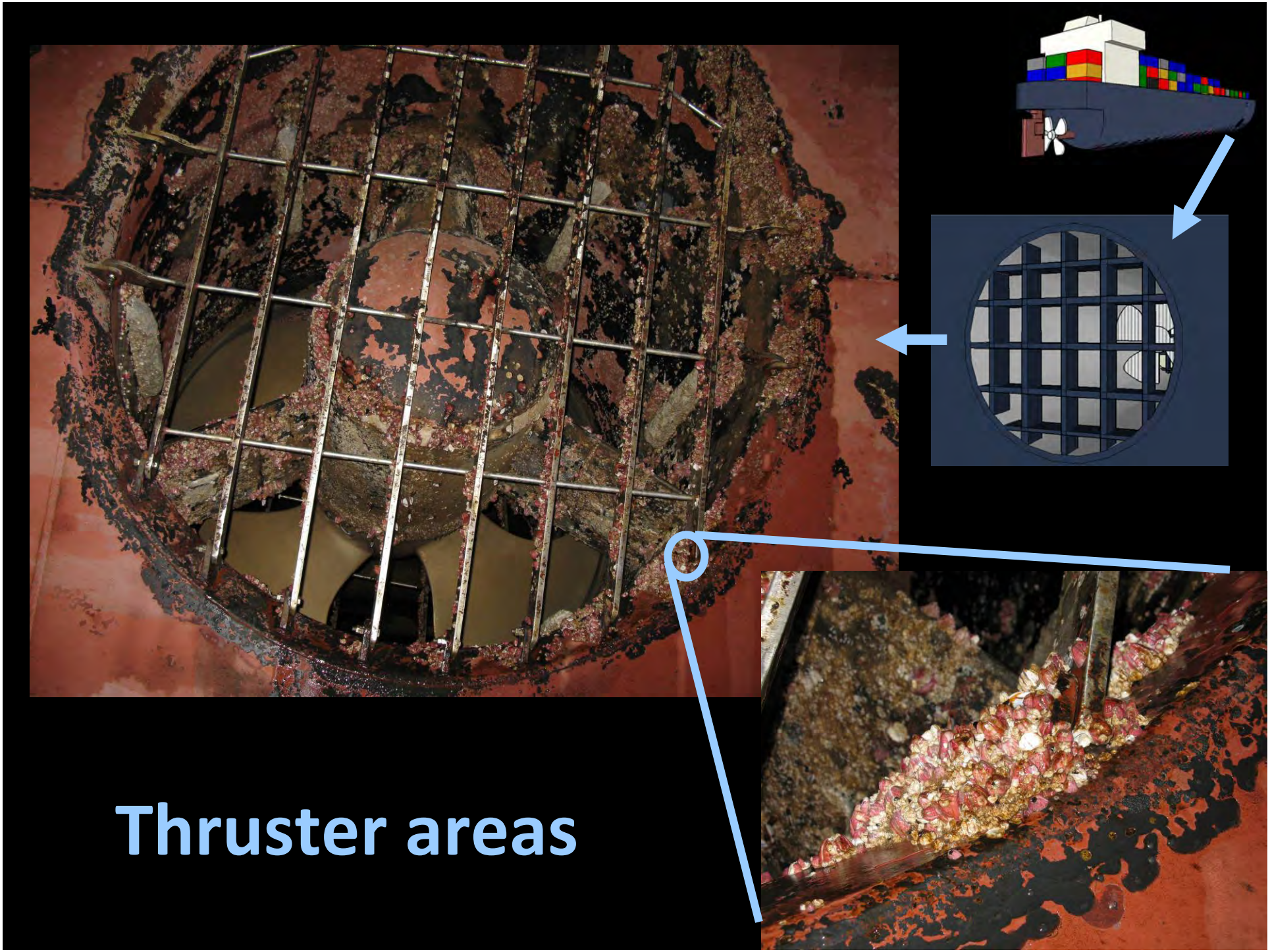


Data from Coutts & Taylor (2004) NZ J Mar FW Res 38: 215-229

Rudders







Thruster areas

Dry dock support strips (dock block areas)

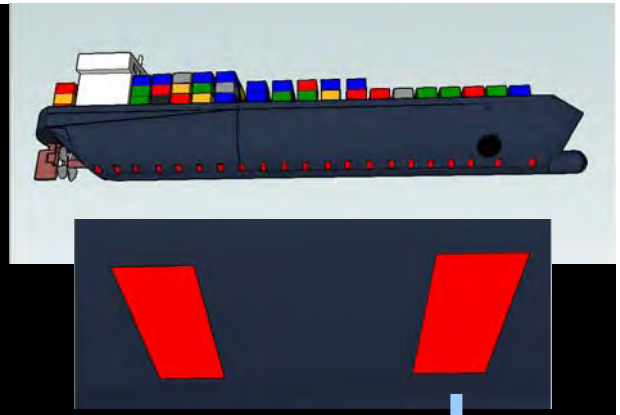
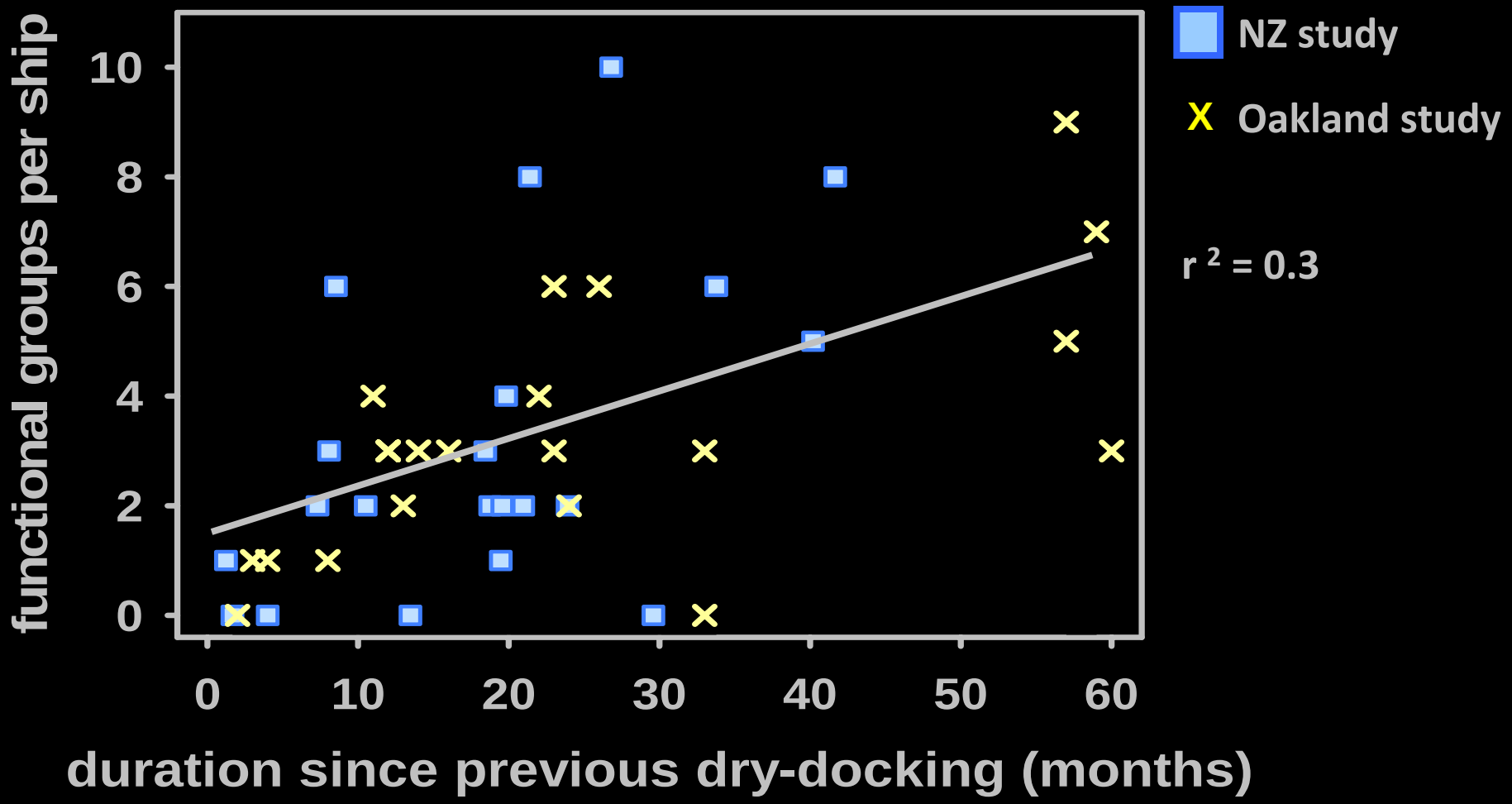


Photo: Hay & Dodgshun (1997) Seafood New Zealand (May pp 13-14)

Niche areas on ships

Bilge keels
Bow and stern thrusters
Dock block areas
Gratings
Intake pipes
Internal sea water systems
Ladder holes (barges)
Propeller articulations and covers
Propeller shafts
Propellers
Retractable propulsion units
Rudder articulations
Rudders
Sea-chests
Stabilizer fins

Age of antifouling paint



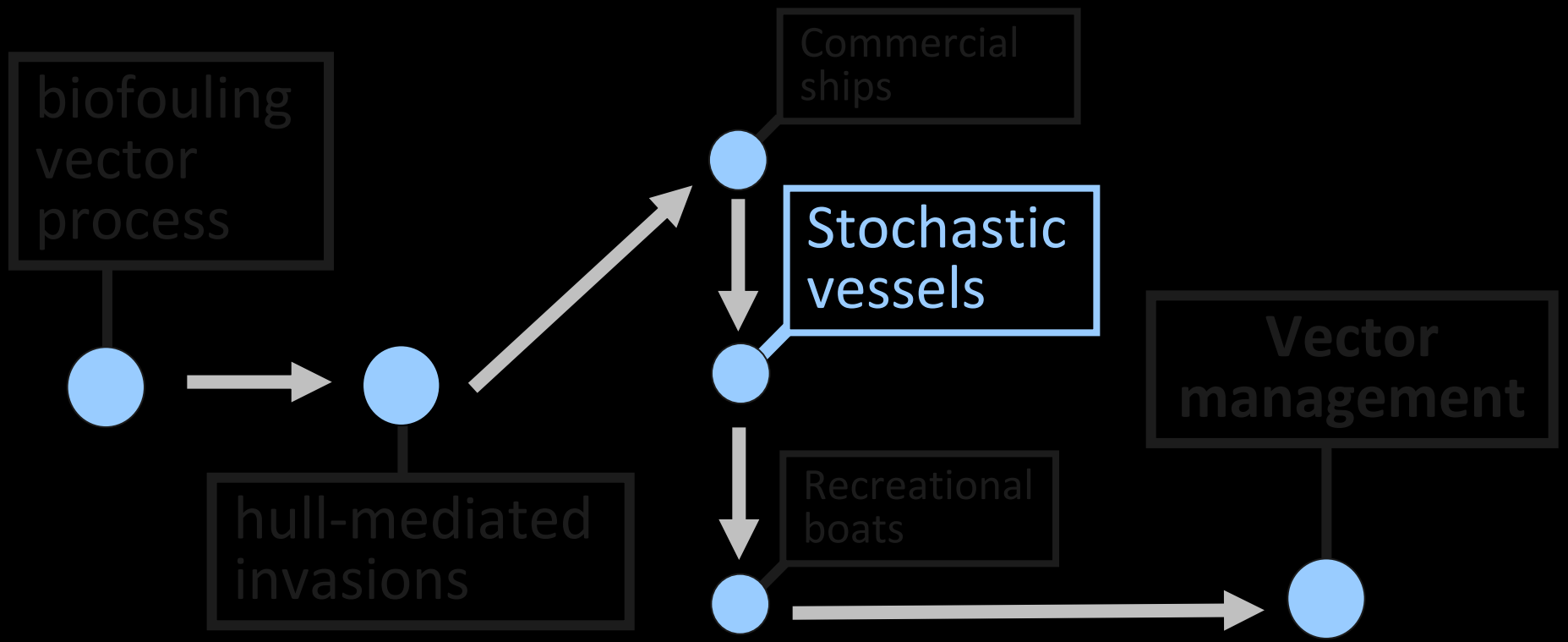
Data from Davidson et al (2009) Biofouling 7: 645-655

Commercial ships

Items to keep in mind regarding management

Niche areas
+
dry-dock durations (antifouling paints)
+
Unusual behavior (e.g. lay ups)

Presentation Outline



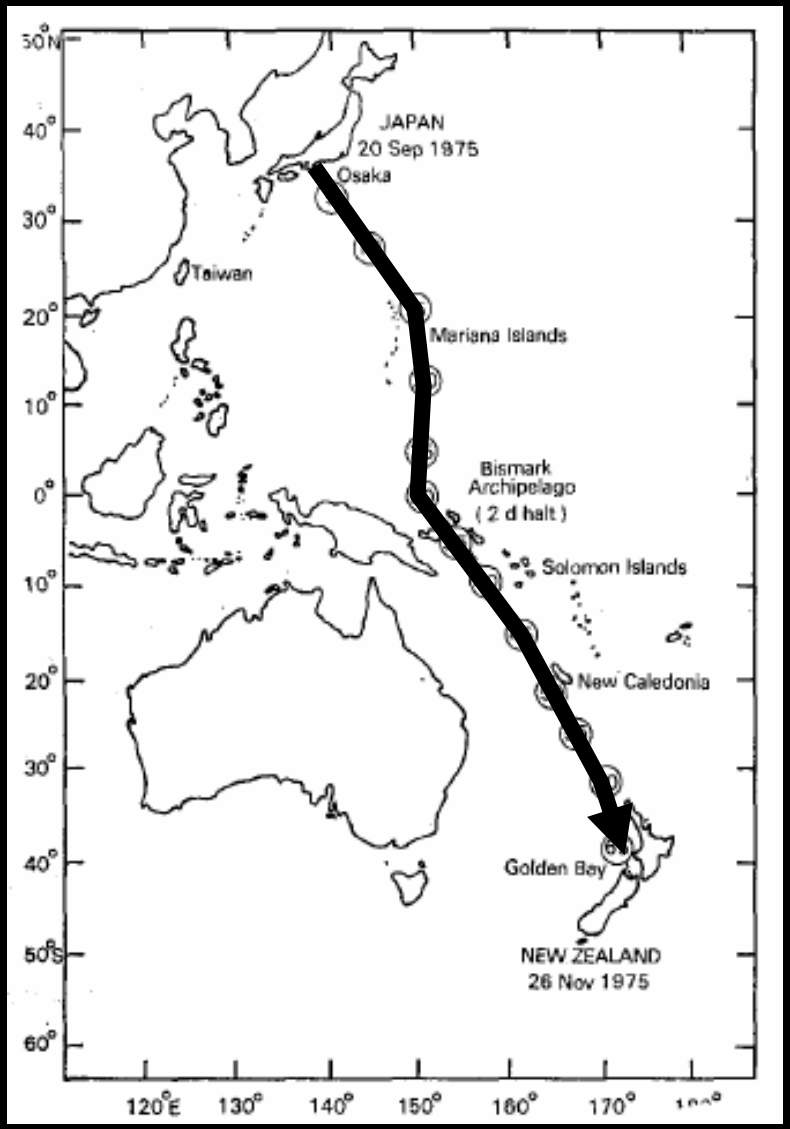
Stochastic vessels

1) Occasional vessel movements under unusual circumstances

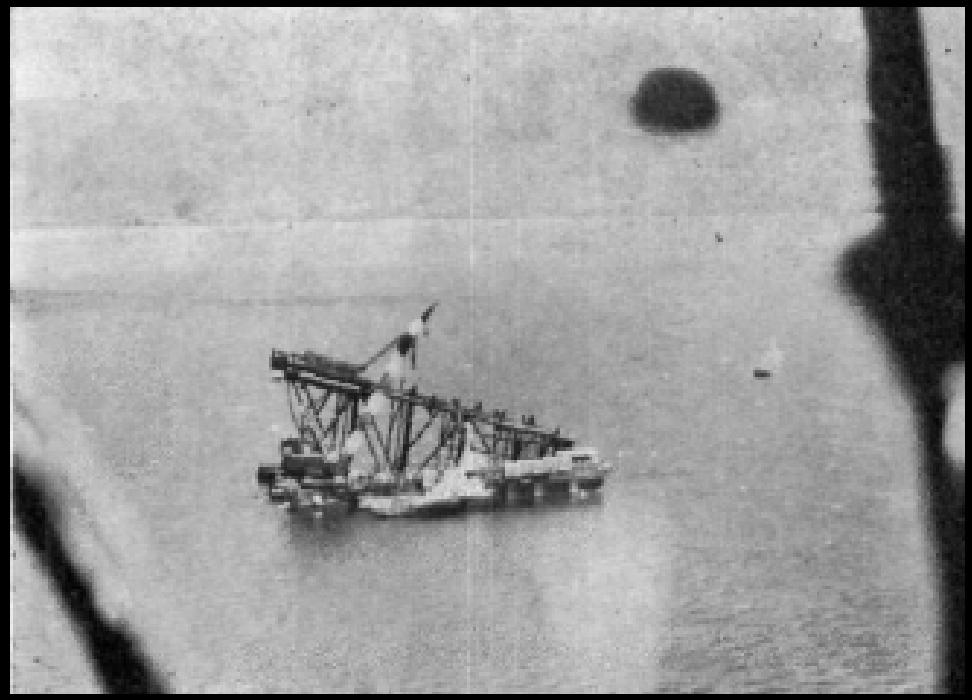
2) Marine platforms, floating docks, laid-up barges, decommissioned ships

3) i.e. very different from regular commercial shipping

Example



Oil platform
Japan to New Zealand
68 day tow
17 species
12 barnacles



Study: Foster & Willan (1979)
NZ J Mar FW Res 13: 143-149


Another Example
USS Missouri
Photo: US Navy & Hawaiiforvisitors.com

Yet another example

‘Ghost’ fleet ships

Retired from service

↓

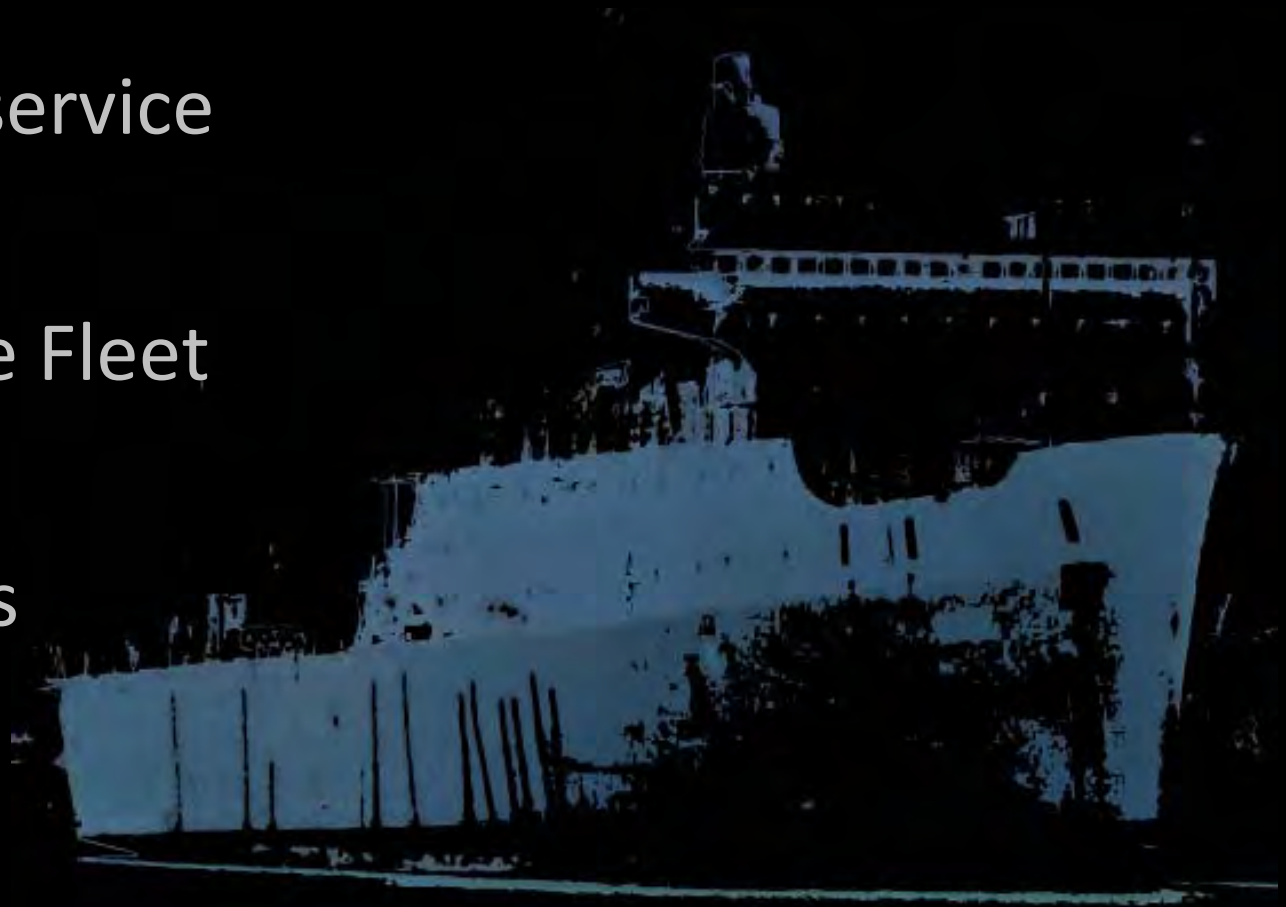
Ready Reserve Fleet

↓

Obsolete ships

↓

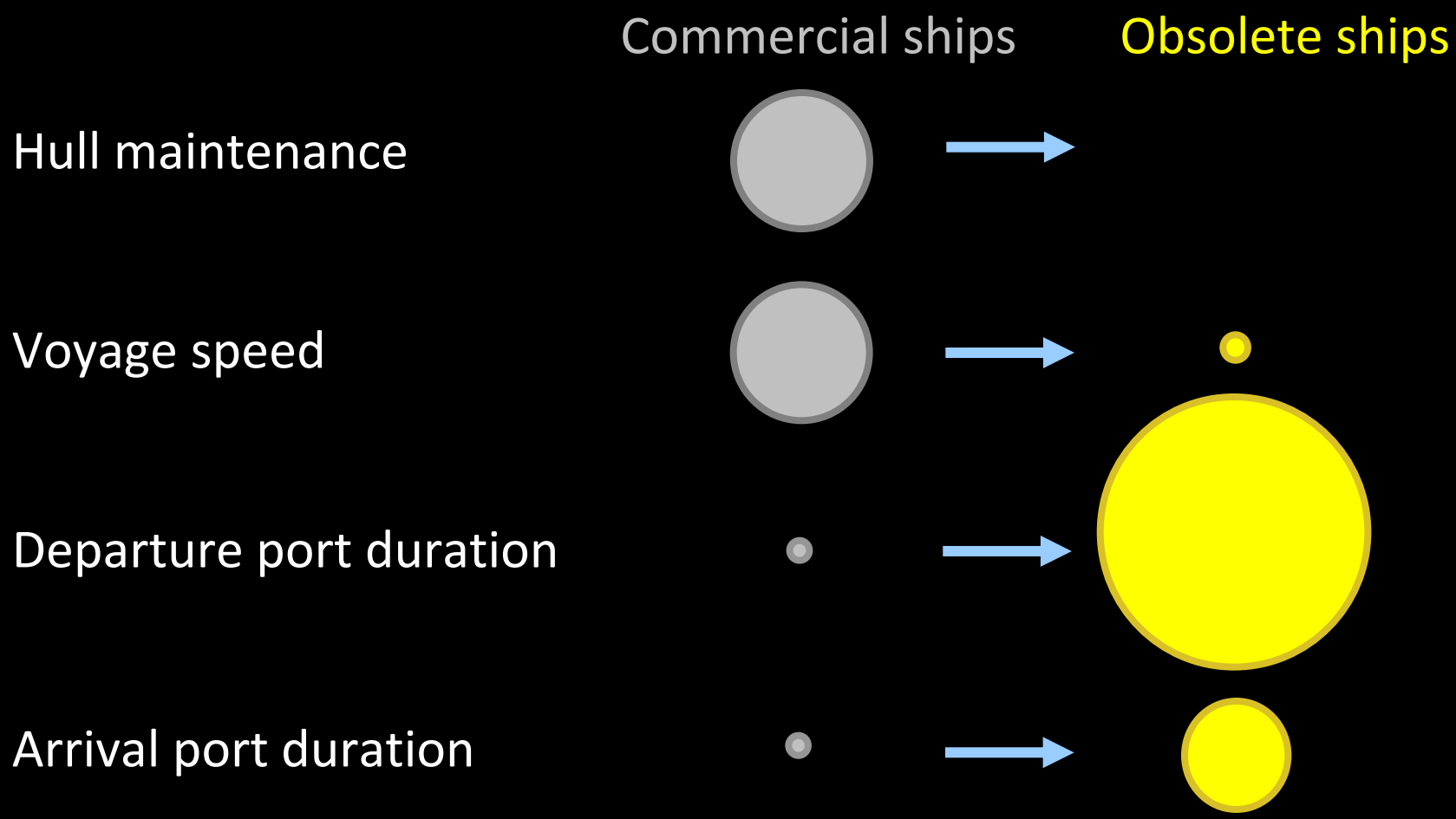
Disposal



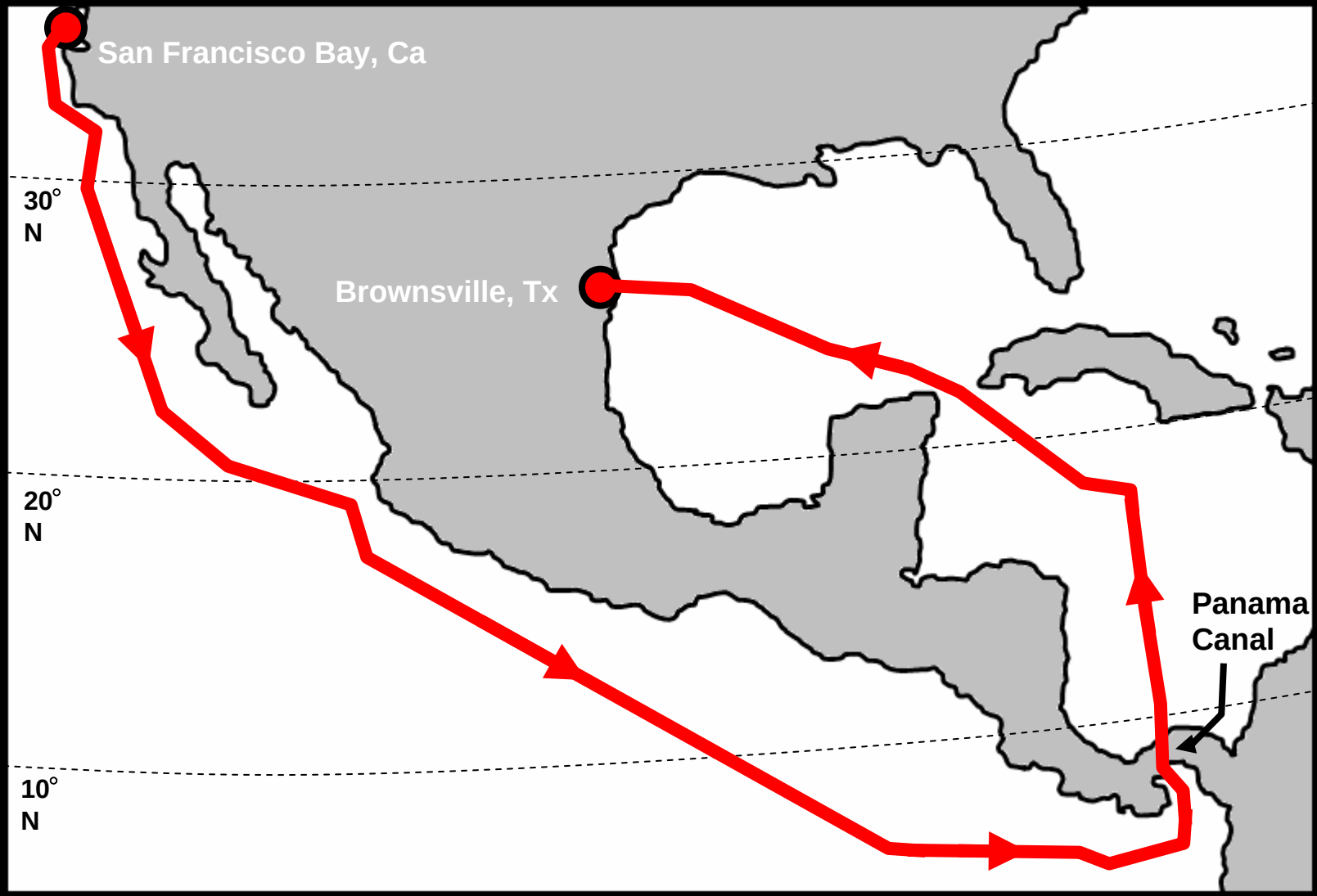

CGB 2418


952
NOKL
321981
SPILL
KIT

Obsolete ship vector risk?

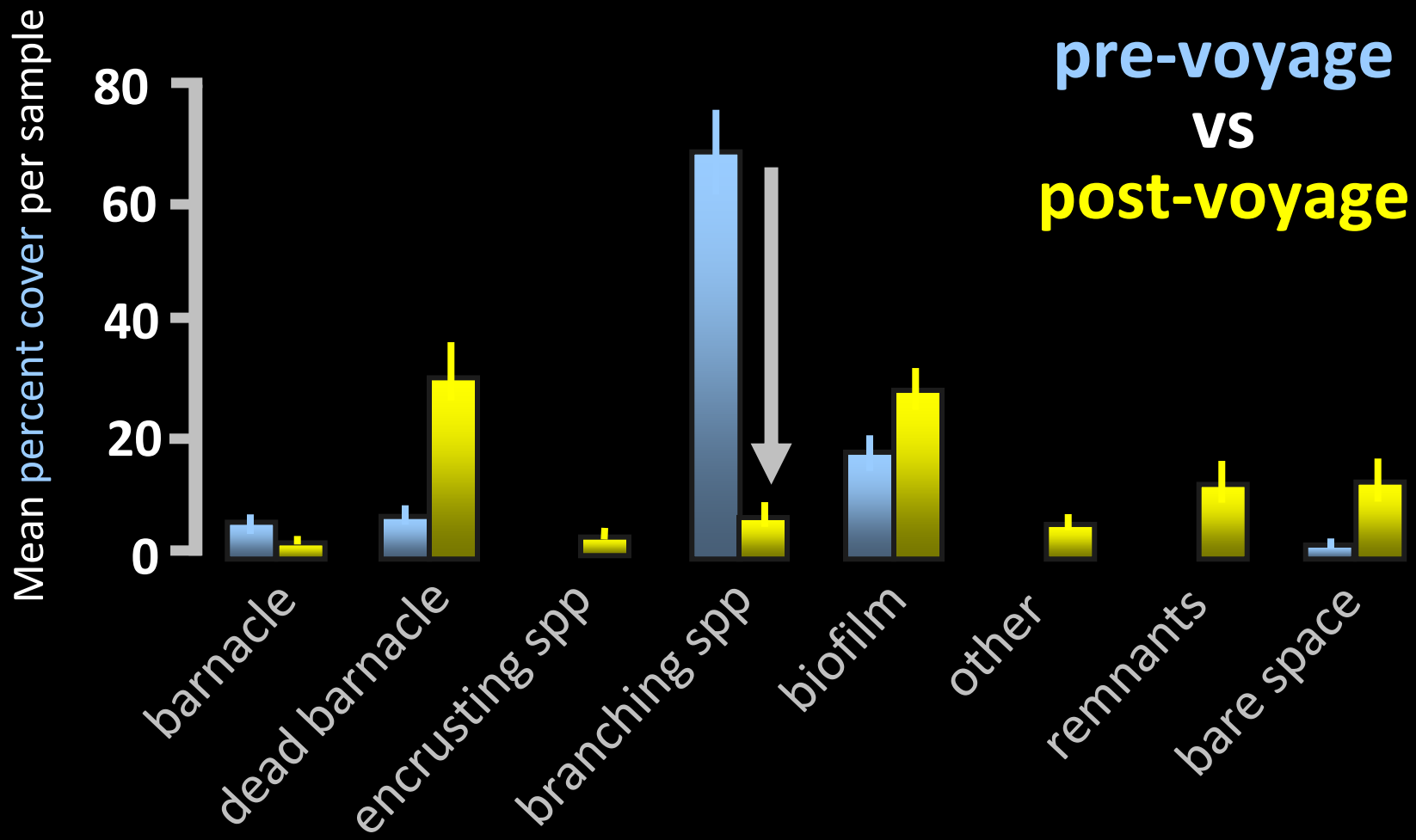


Obsolete ships: case study



Davidson et al (2008) Diversity & Distributions 14: 518-529

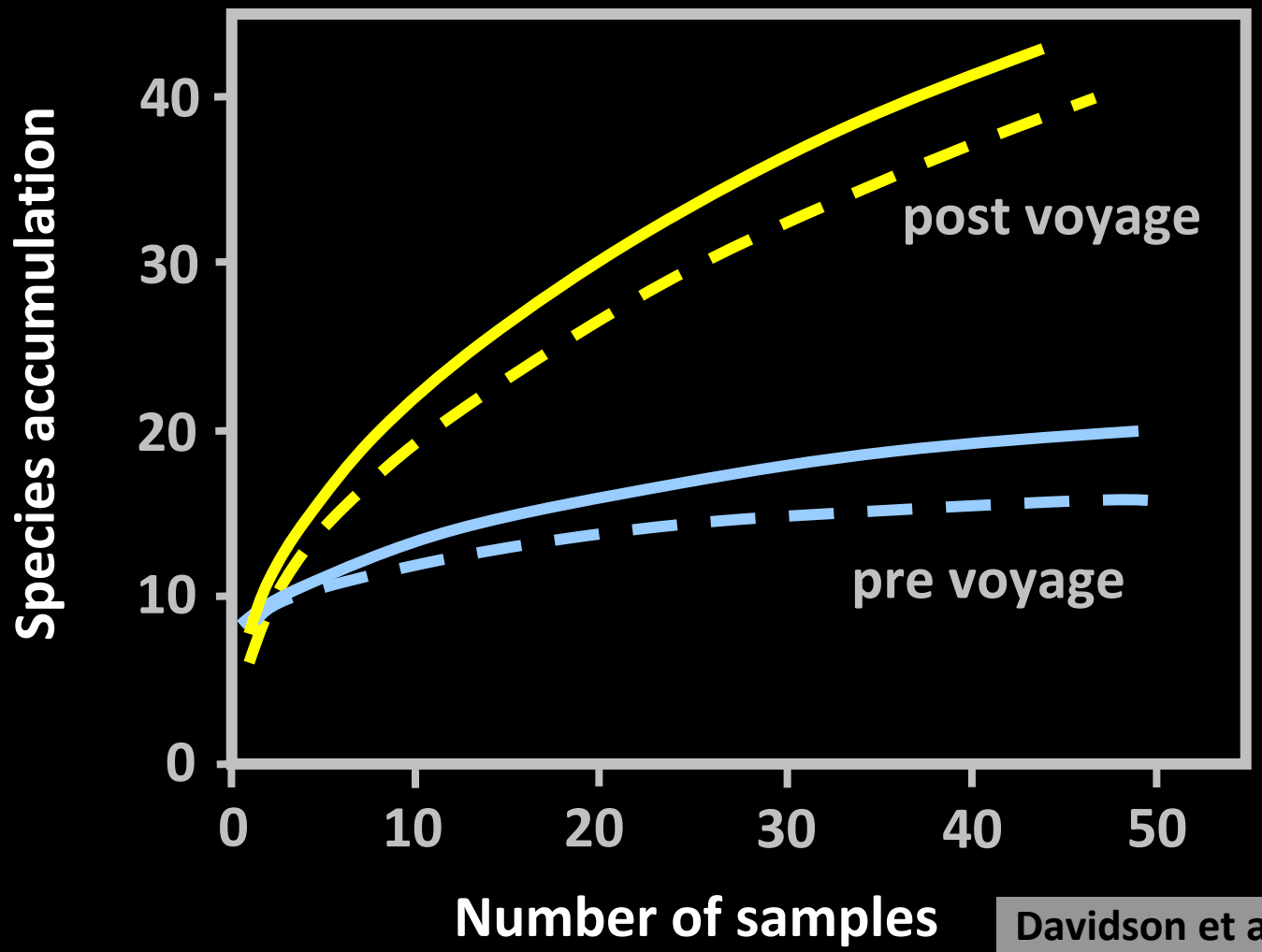
Biofouling extent



Davidson et al (2008) Diversity & Distributions 14: 518-529

Biofouling richness

pre-voyage vs post-voyage



Solid line = 'Florence'

Dashed line = 'Point Loma'

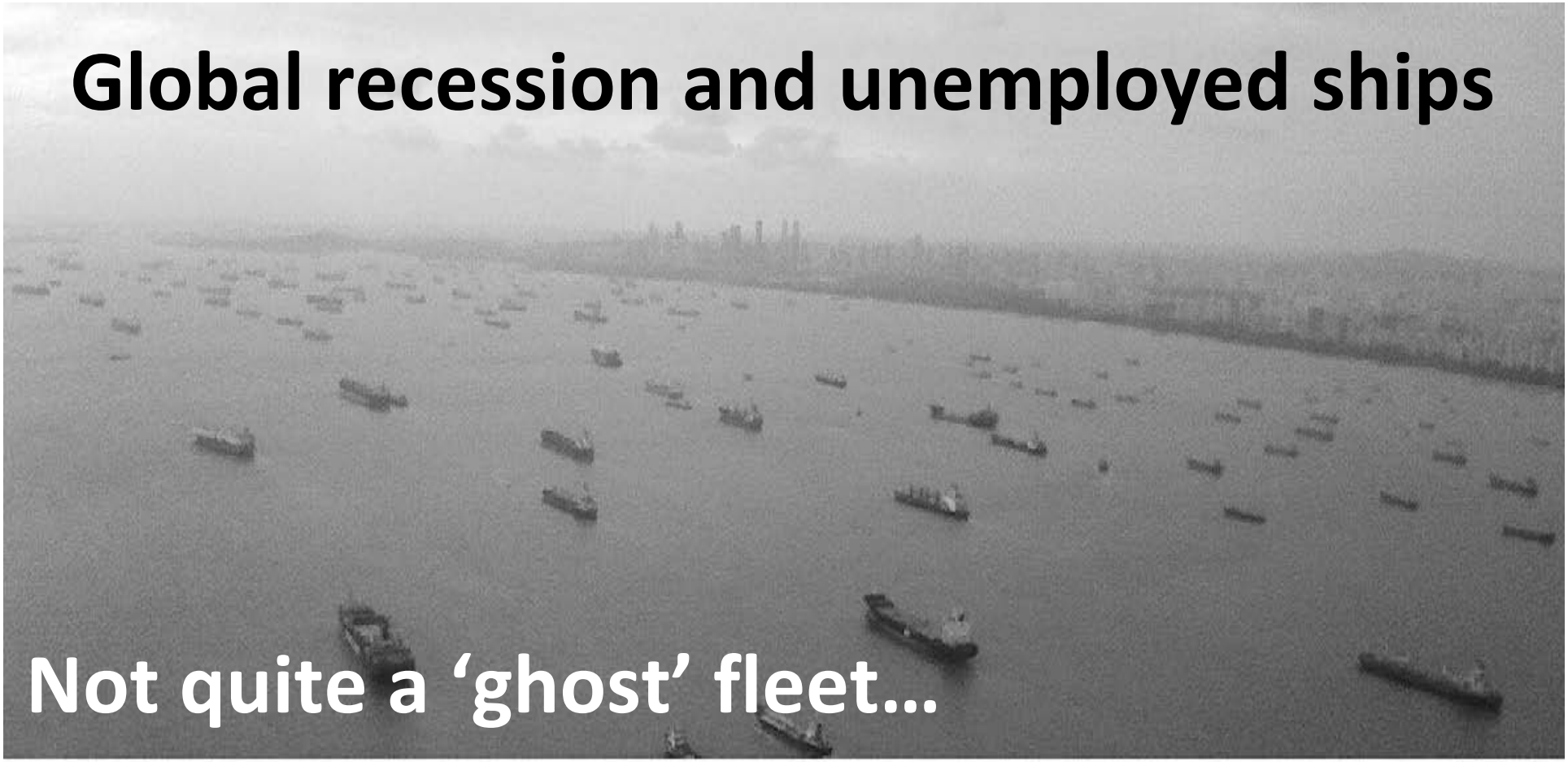
Davidson et al (2008) Diversity & Distributions 14: 518-529

Stochastic vessels

Long lay up duration
+
Almost no hull maintenance
+
Slow voyage
+
Interoceanic event
+
Duration at destination port
=

very high risk of species transfers

Global recession and unemployed ships

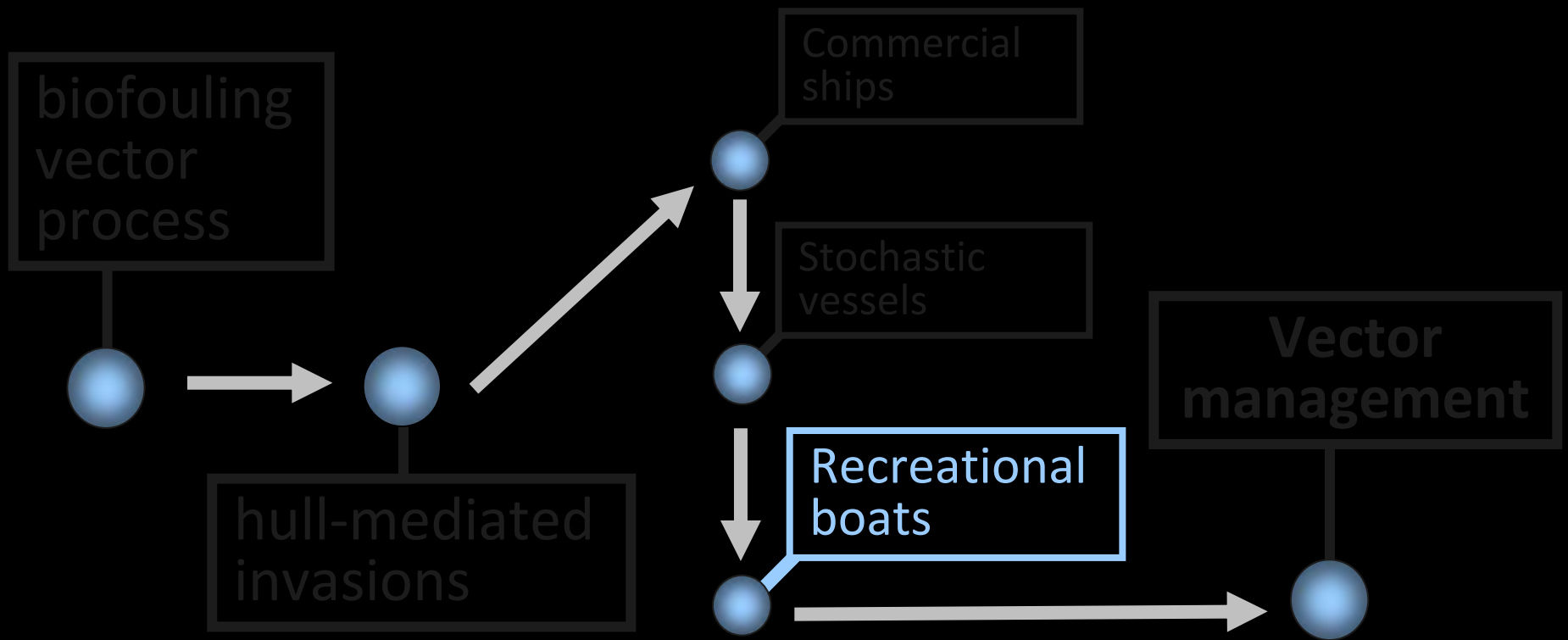


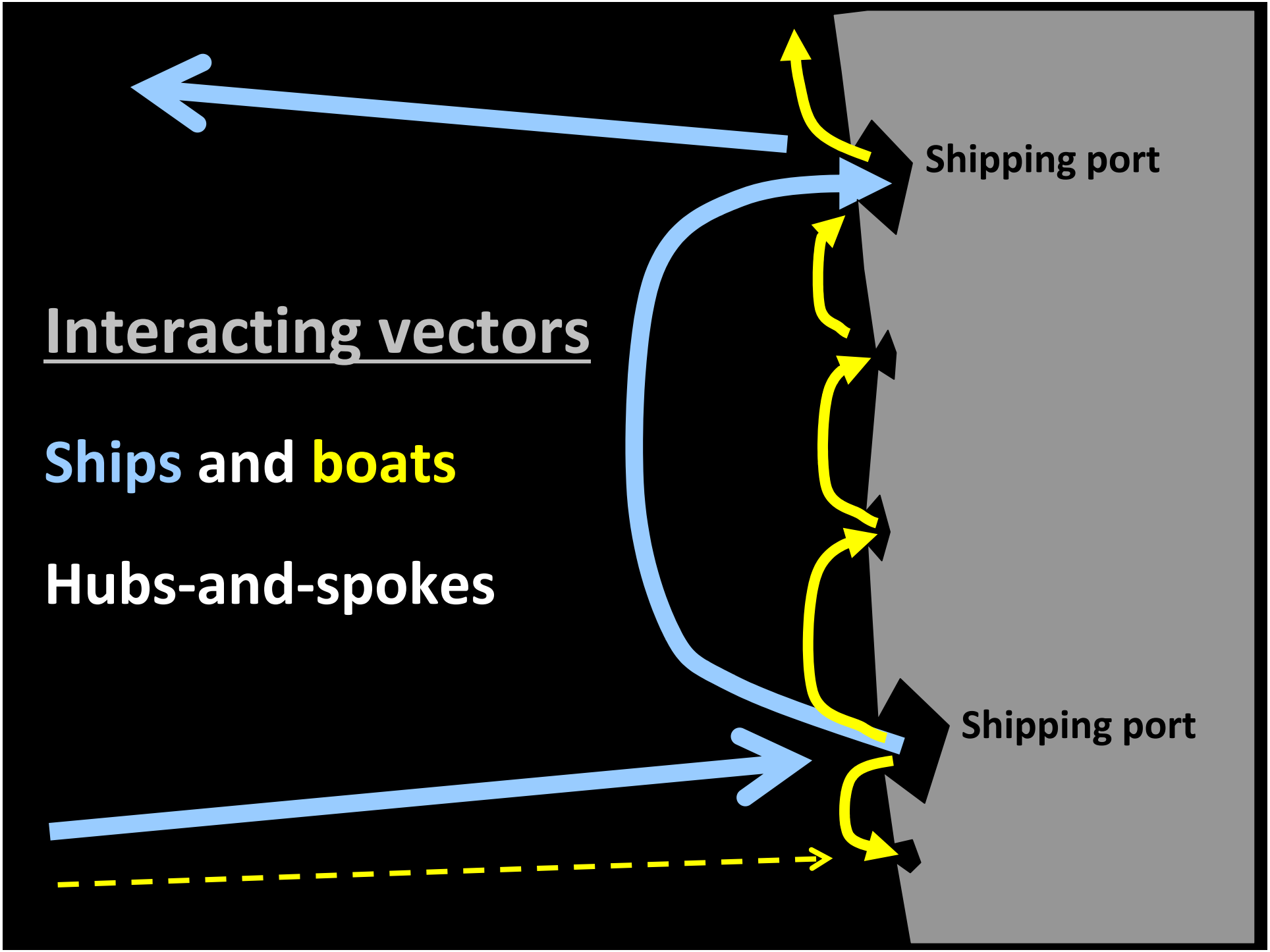
Not quite a ‘ghost’ fleet…

..but haunting nonetheless

Photo: Ashley Coutts, from Floerl & Coutts (2009) Mar Poll Bull 58: 1595-1598

Presentation Outline

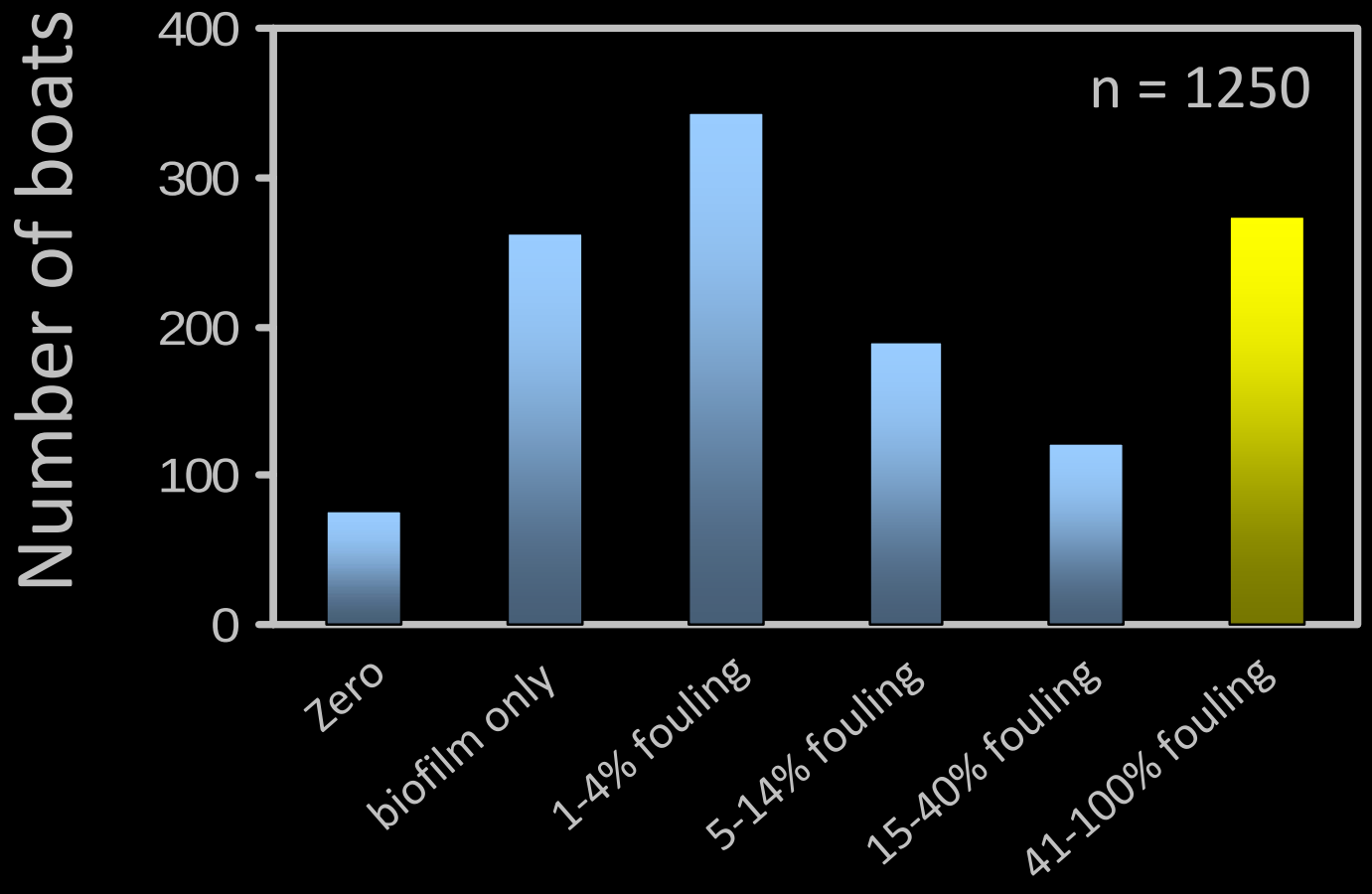



Interacting vectors
Ships and boats
Hubs-and-spokes
Shipping port
Shipping port


Boater motivation for clean hulls?

San Francisco Bay Study

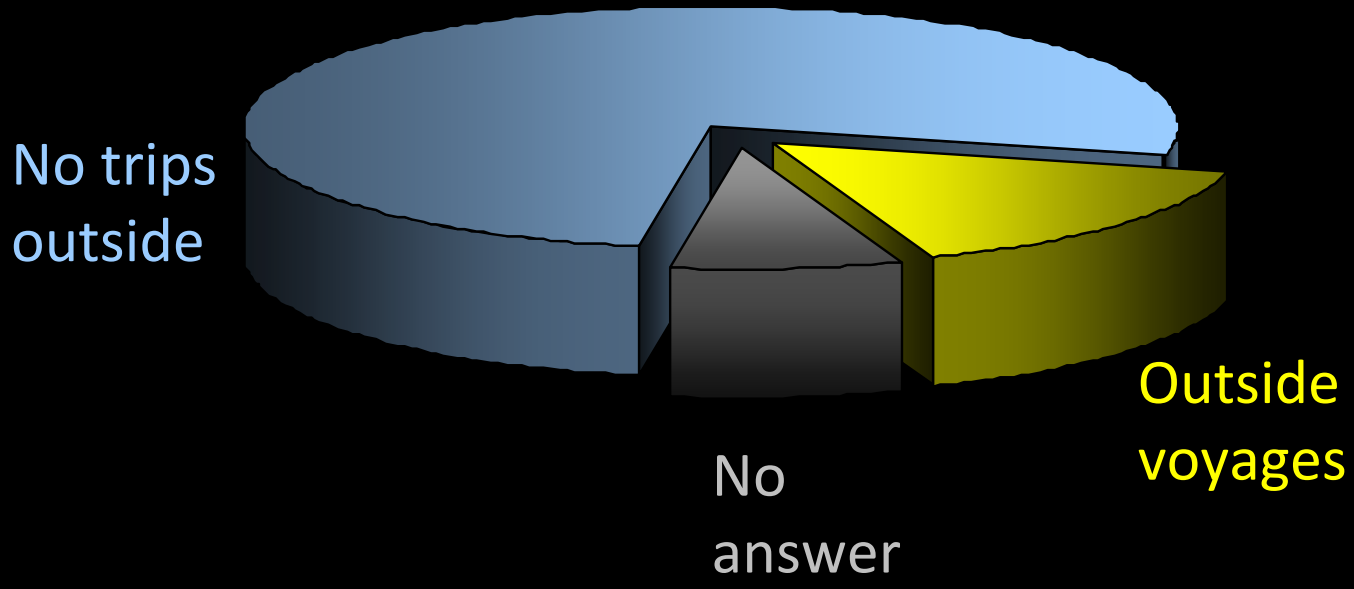
Variable fouling among vessels



High number of heavily fouled vessels

Data: Davidson et al (2010) submitted

Just 15% of boaters said they take boat trips outside of the Bay

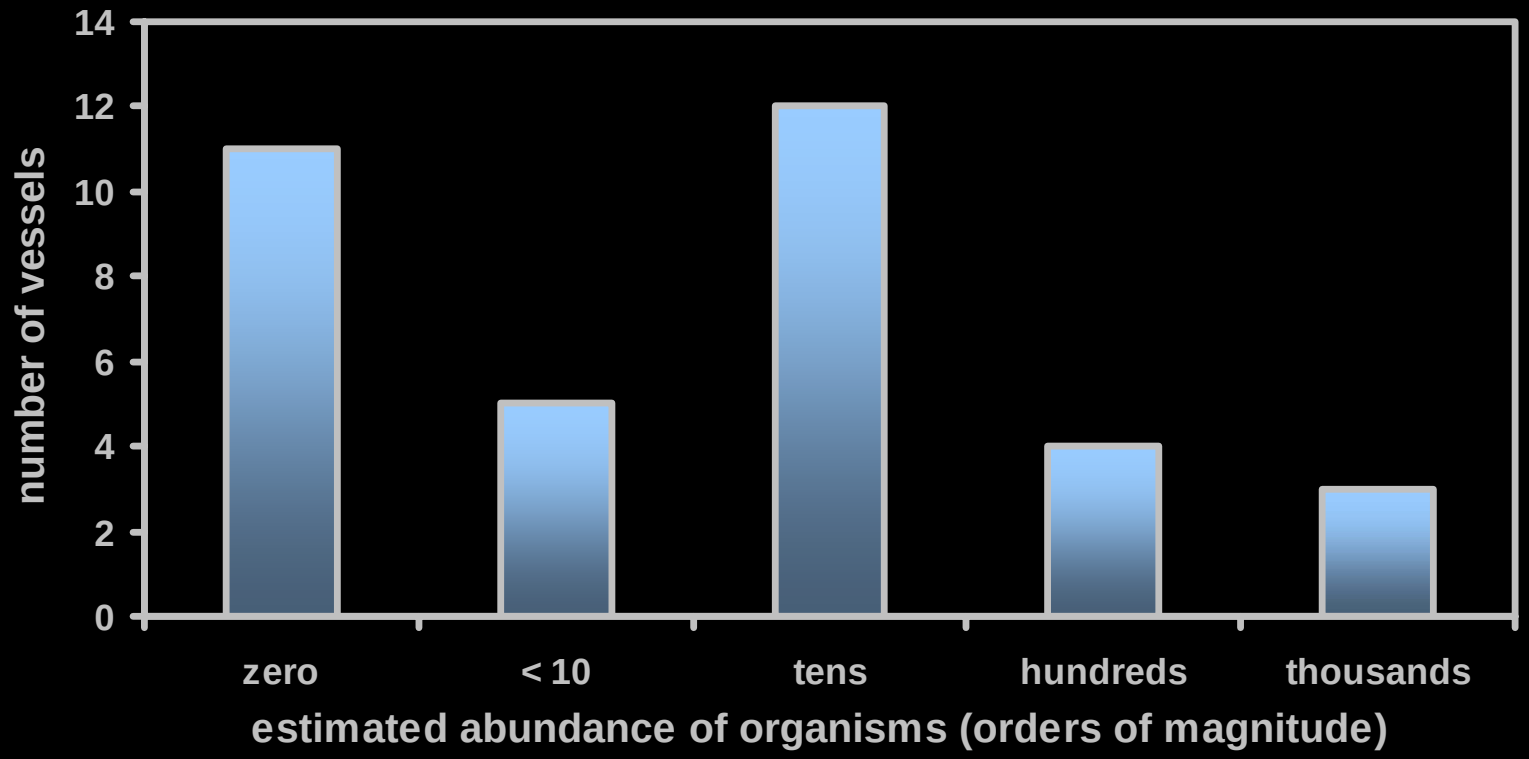


More than 150,000 boats are registered in adjacent counties

Data: Davidson et al (2010) submitted – Recreational Boat fouling in San Francisco Bay

Study in Ketchikan Alaska

Transient vessels only



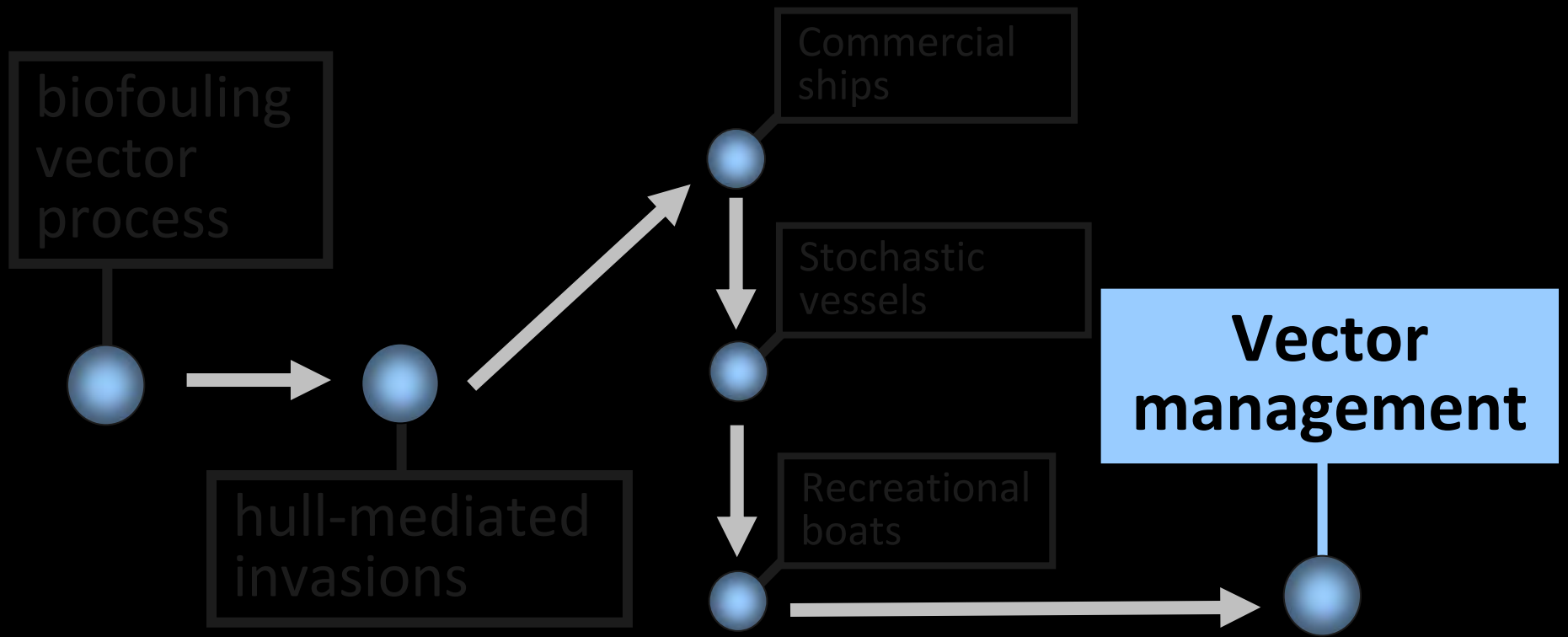
Ruiz, Ashton, Davidson (in progress) Transient boats as vectors of marine species to Alaska

Recreational boats

Large fleet of recreational boaters
+
Variable boater maintenance
+
Long periods in marinas
+
Proximity to other vectors
+
AIS prevalence in marinas
=
Risks of species transfers

Photo: Damien Offer in Minchin & Sides (2006) Aquatic Invasions 1:143-147

Presentation Outline



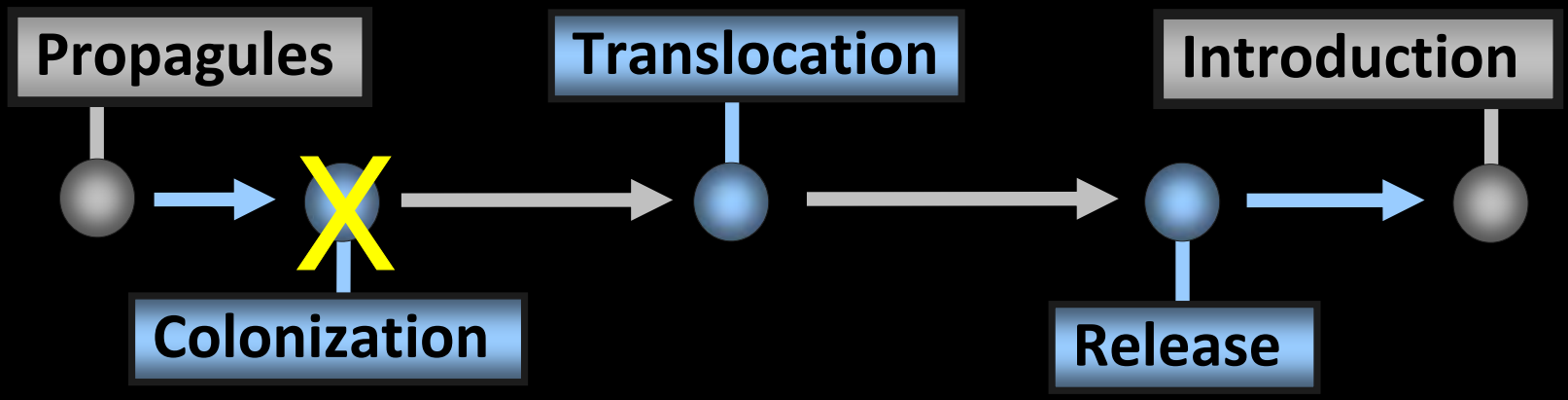
Management Strategies & Policy

US Code of Federal Regulations (33 CFR 151) "remove fouling…..on a regular basis"

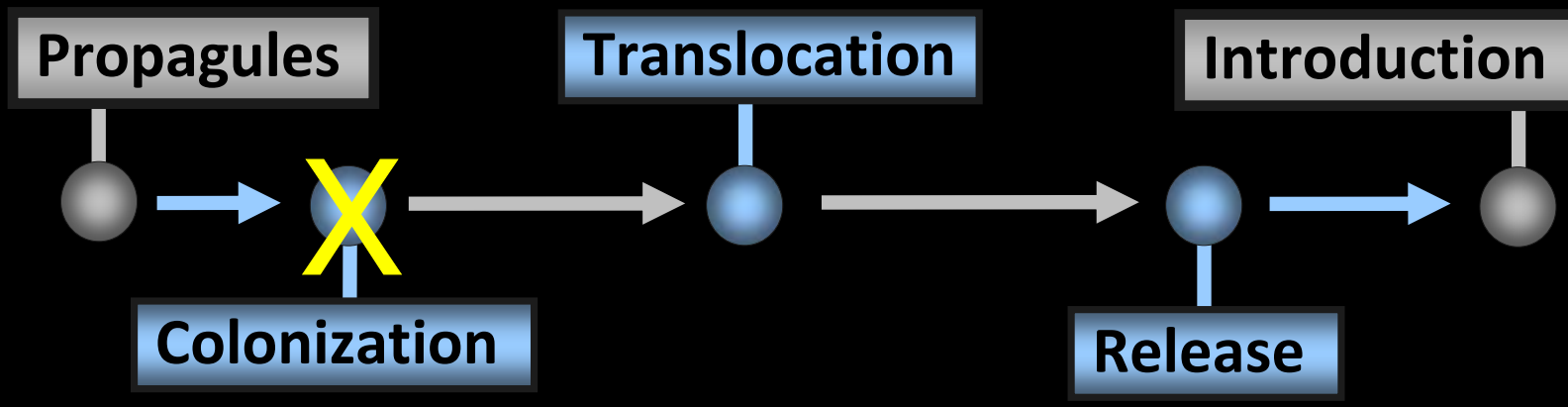
Best practice management (Australia)

State rules for in-water cleaning & ship disposal

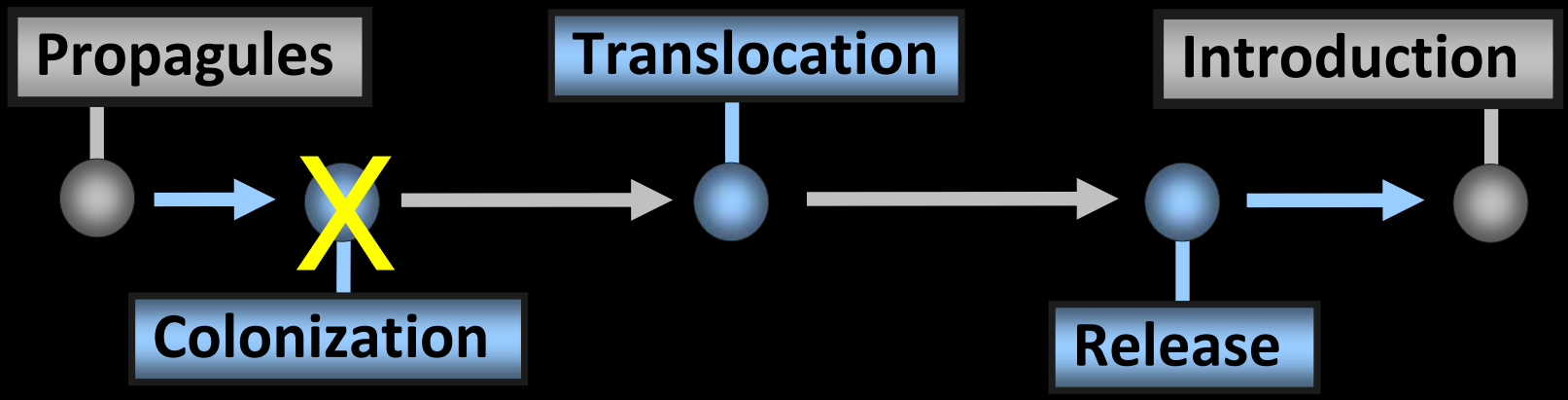
Clean marina and boat fouling management



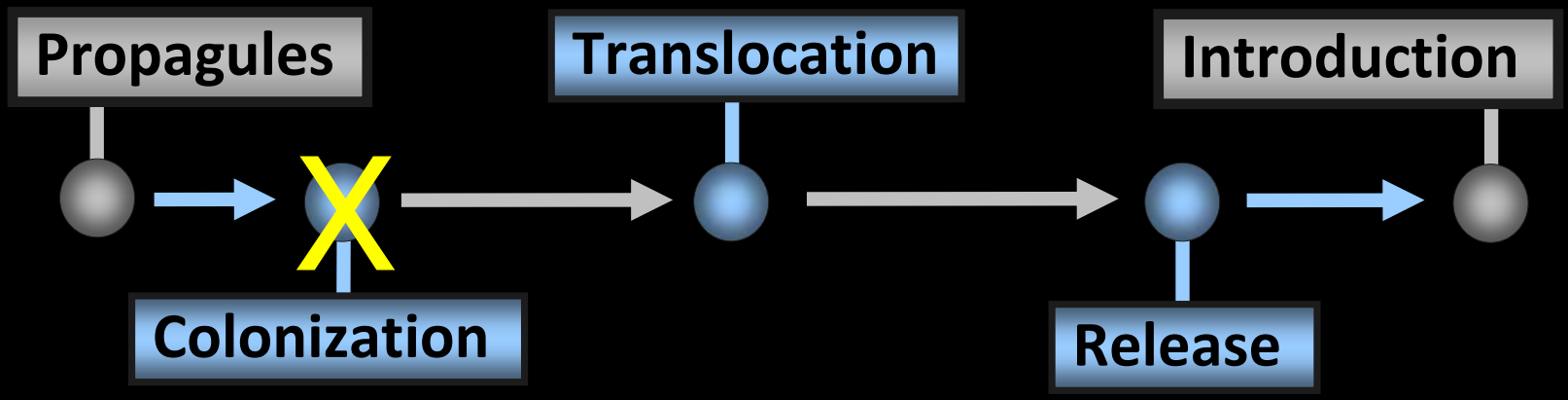
Antifouling paints


Propagules
Translocation
Introduction
Colonization
Release

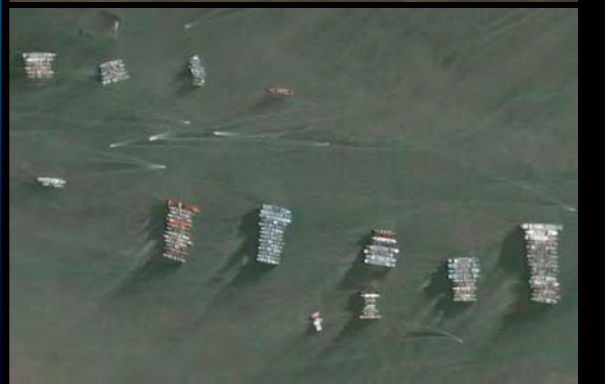
Boat lifts



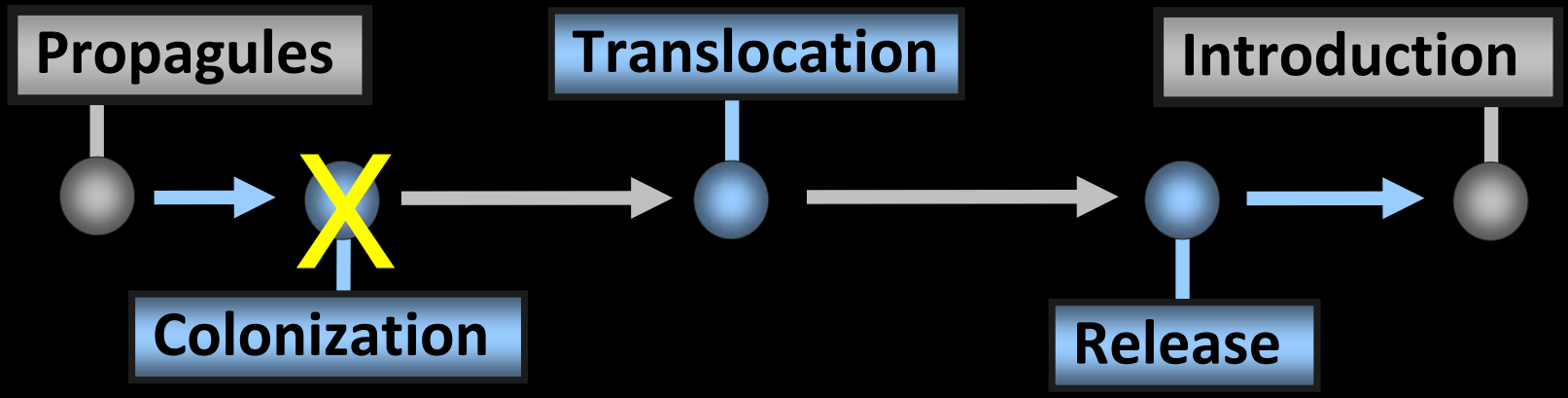
Boat bath system



e.g. Ghost fleet locations



Photos: US Maritime Administration & Google Earth



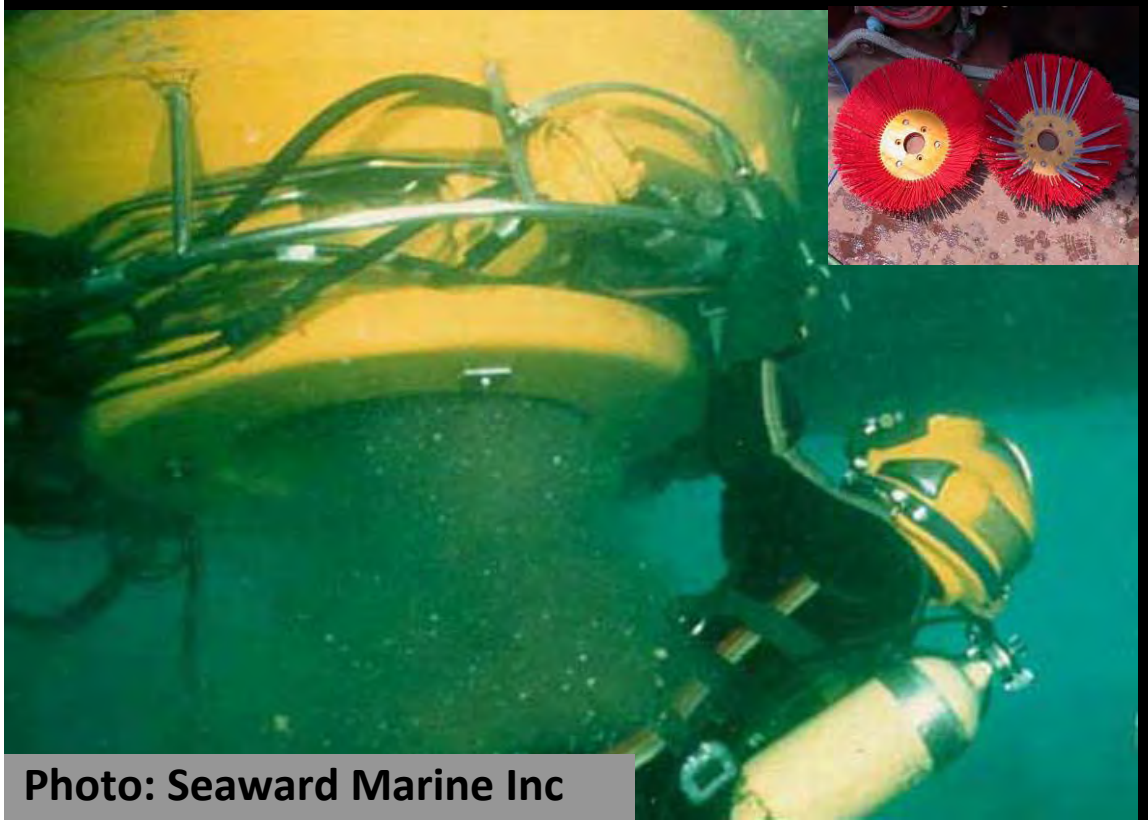
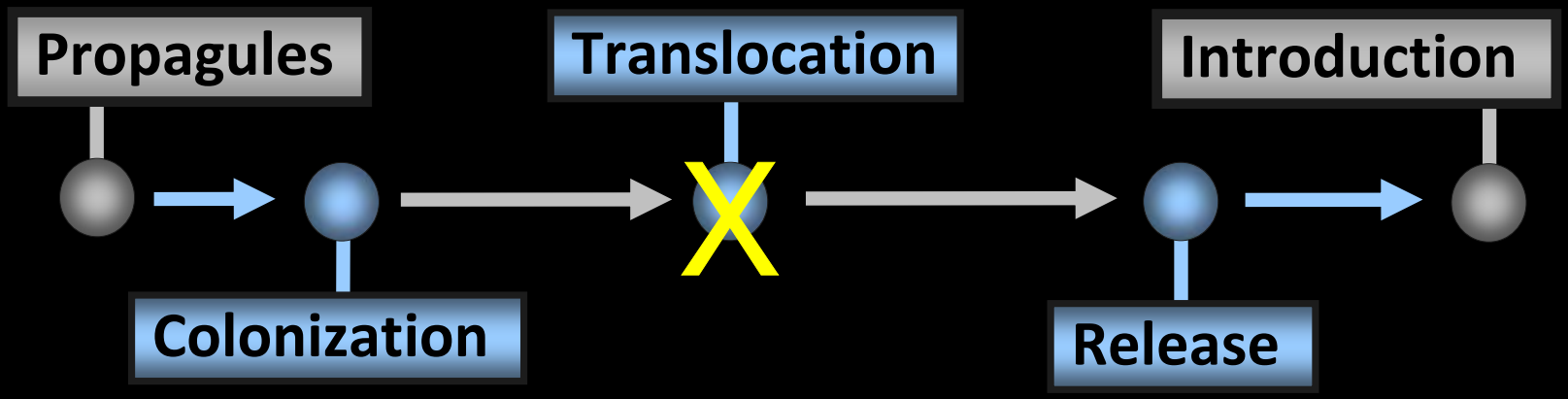


Photo: Seaward Marine Inc

in-water cleaning



in-water cleaning with underwater vacuum & filter

Hull ‘wrapping’ (polyethylene wrap)

Removal from water

Time is of the essence

Why use vector management for hull biofouling?

- **prevention** rather than cure
- **multi-species** rather than mono-species
- cost effective
- Existing **tools** are effective
- Eradication/control **must address vectors** anyway

Thanks !

Supervisors:
Greg Ruiz & Mark Sytsma

Colleagues:
@ Portland State University
@ Smithsonian (SERC)

Fieldwork:
Shipping industry
Boating community

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California State Lands Commission
US Maritime Administration
US Coast Guard
Alaska Dept Fish & Game

&
Maryland Sea Grant