# Relationship between copper and non-indigenous marine species

Richard Piola[1], Emma Johnston[2], Katherine Dafforn[2], Tim Glasby[3]

[1] Cawthron Institute, New Zealand
[2] University of New South Wales, Australia
[3] NSW Department of Primary Industries, Australia

CAWTHRON

SCIENTIA
MANU ET MENTE

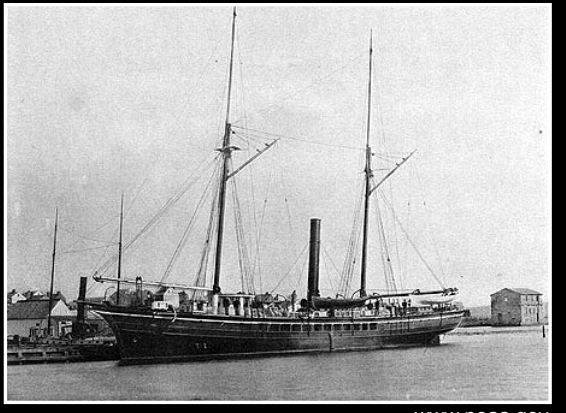
NSW DEPARTMENT OF PRIMARY INDUSTRIES

# Copper as an anti-foulant

- 18th Century: Copper sheets
  - Wooden vessels sheathed in copper
  - General antifouling properties of Cu realised

- Mid 1800's: Copper paints
  - Paints containing oxides of Cu, Pb, Sn, Me

www.boat-links.com/PT/PT2003/Snookwis-1.jpg



www.noaa.gov

# Copper as an anti-foulant

- 1960's: Tributyltin (TBT)
  - Anit-fouling silver bullet? – No
- Copper remains only real alternative to TBT
  - Recreational vessels since 1980's
  - Commerical vessels after 2008

www.biosecurity.govt.nz/files/images/hull.jpg

www.sailinport-services.co.uk/gallery.html

# Copper tolerant organisms

- Less effective against broad range of taxa
- Numerous taxa resilient to copper antifoulants

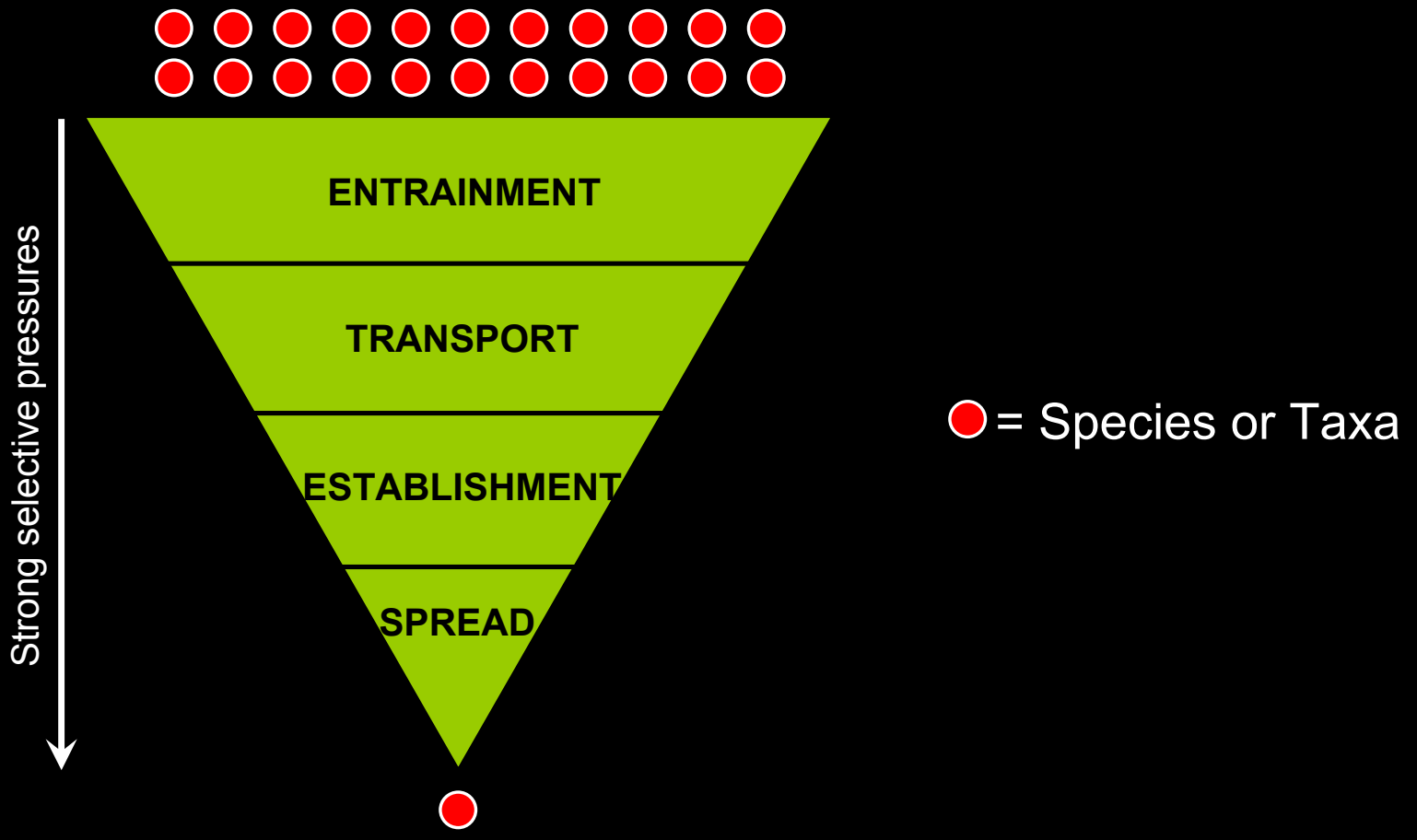

**Calcareous tubeworms**



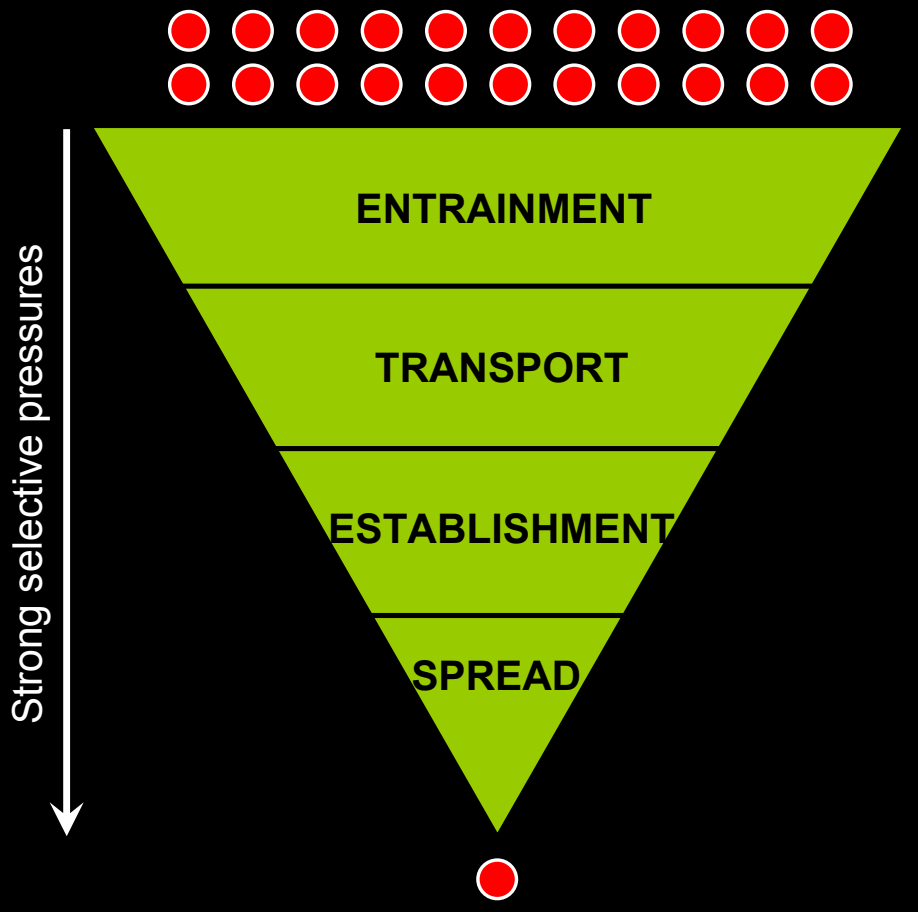
**Barnacles**


**Bryozoans**

# Copper and the marine invasion process



# Copper and the marine invasion process




**Hull-fouling Vector**

Tolerance to copper antifouling biocides

Tolerance to copper antifouling biocides

Copper pollution in recipient environments

- Copper pollution
- Tolerance to copper antifouling biocides

# 1 & 2: ENTRAINMENT & TRANSPORT: Hull-fouling, NIS & copper antifouling paints

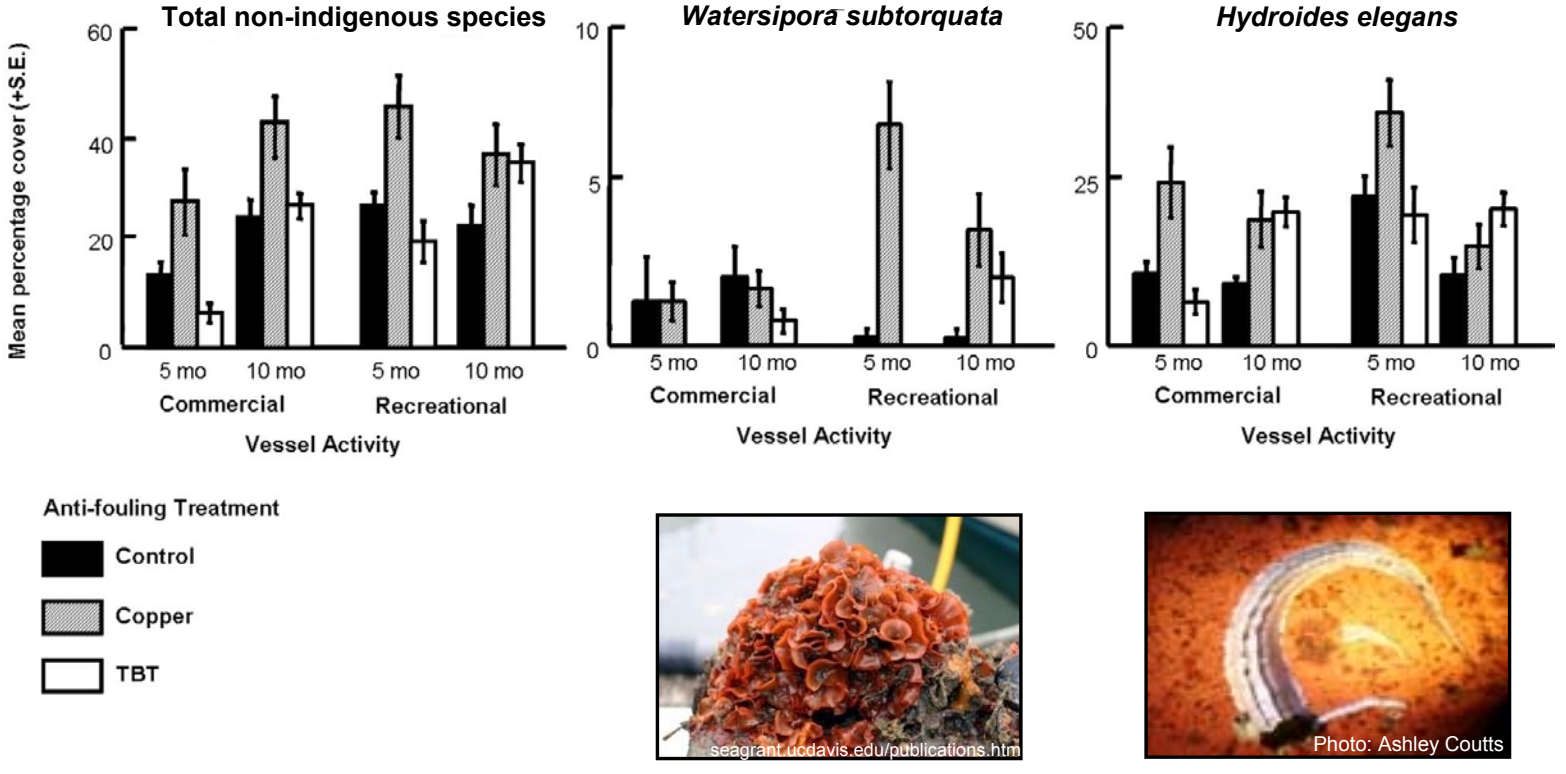
- Up to 70% of NIS in New Zealand, Australia and Hawaii likely arrived on ship hulls
  Floerl et al. (2006)

- Despite the use of copper-based anti-fouling paints

- Copper tolerant invaders?

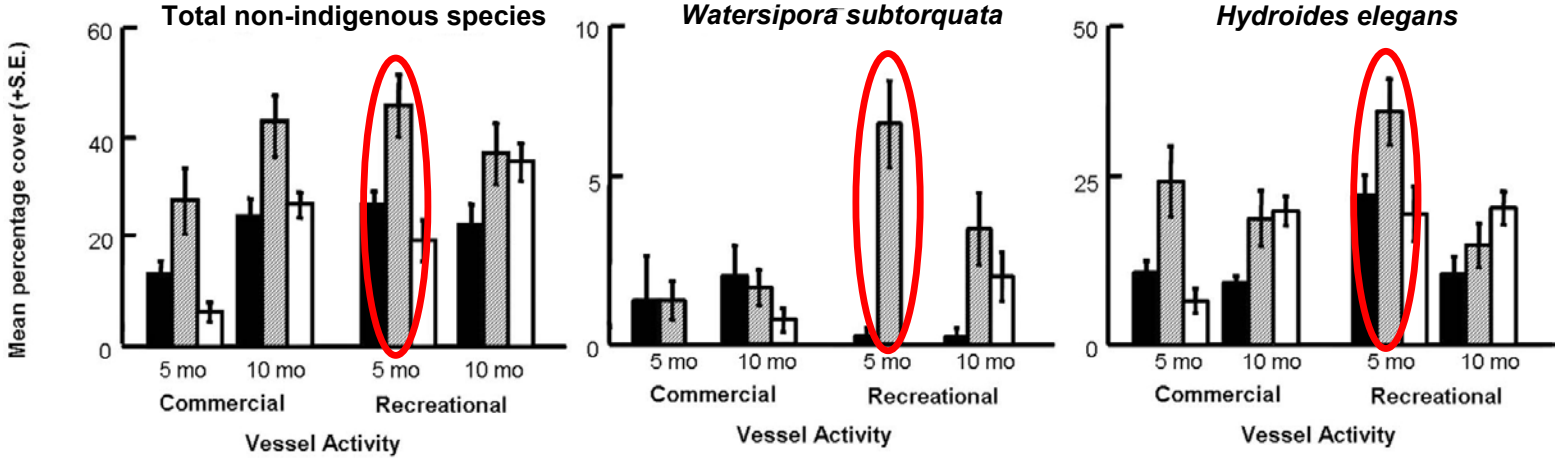
Photo: The Nelson Mail

# Recruitment to copper-treated surfaces




Dafforn *et al.* (2008). Biofouling 24(1): 23-33

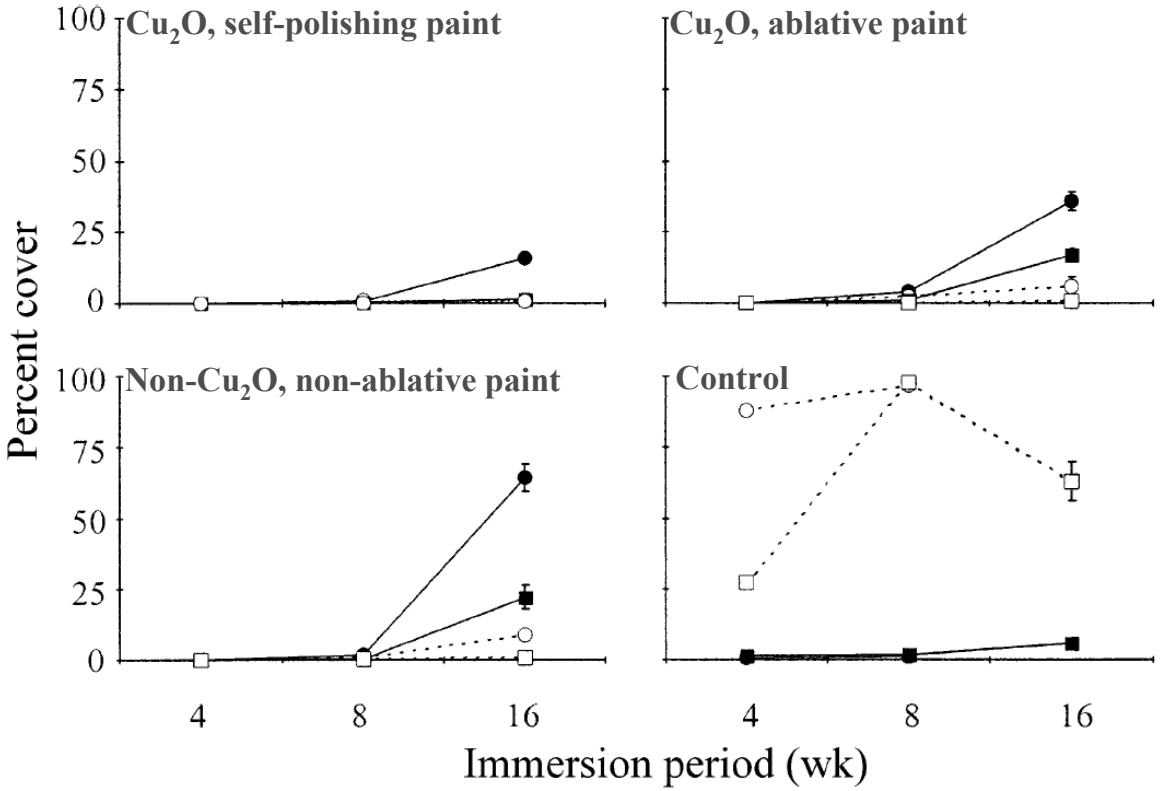
# Recruitment to copper-treated surfaces





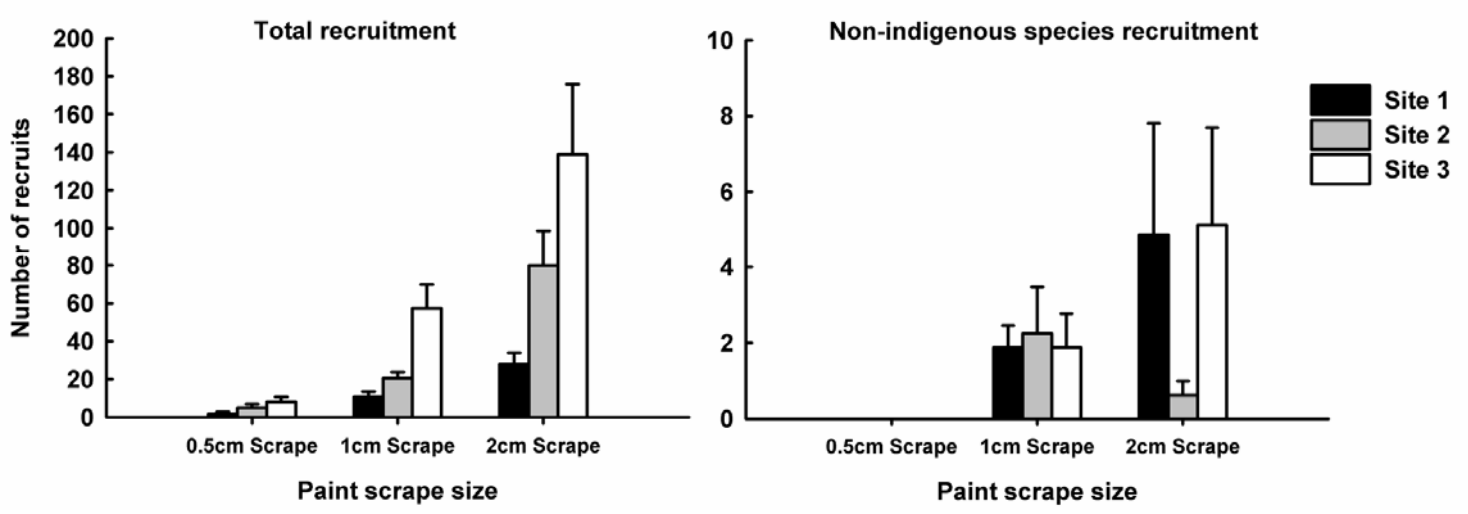

Dafforn *et al.* (2008). Biofouling 24(1): 23-33

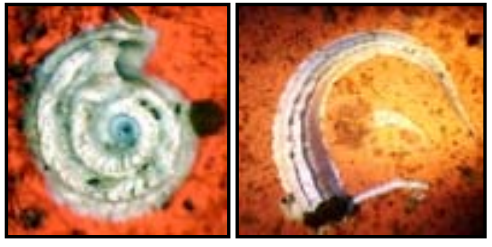
# Recruitment to copper-treated surfaces



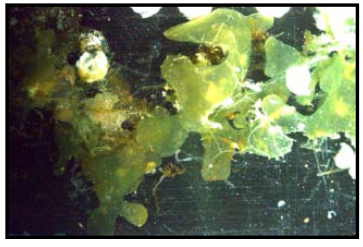

Floerl *et al.* (2004). Ecol. Appl. 14(6): 1724-1736

# Recruitment to copper-treated surfaces

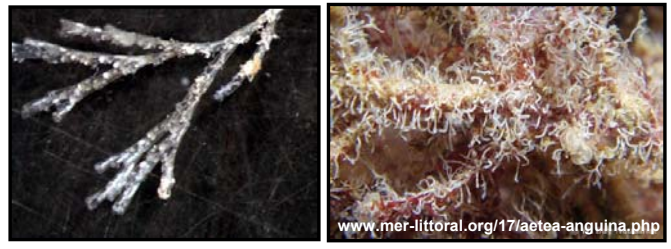


**Calcareous tubeworms**



**Algae**




**Bryozoans**

Piola & Johnston (2008). Biofouling 24(3): 145-155

# Recruitment to copper-treated surfaces

- Copper tolerant organisms can facilitate the spread of **non-tolerant** taxa

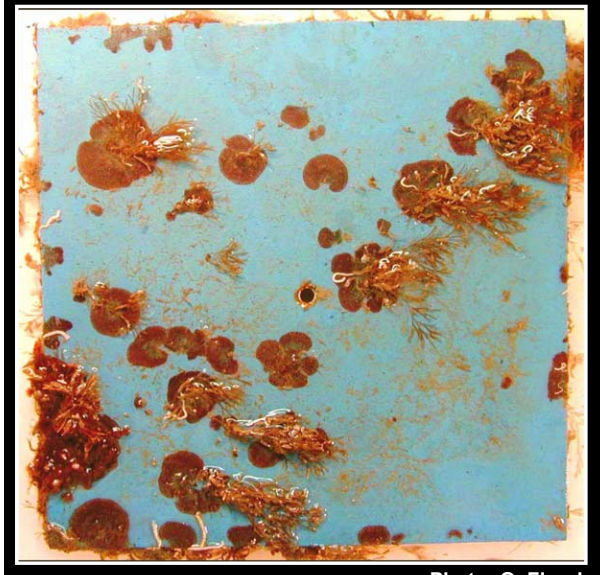


Photo: O. Floerl

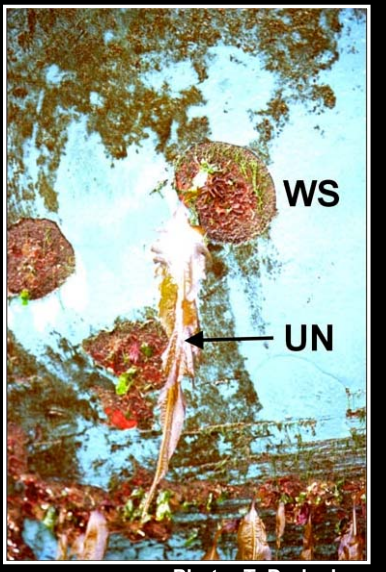



Photo: T. Dodgshun

Photo: K. Dafforn

*Watersipora subtorquata* faciliting the establishment of less-tolerant taxa to copper-treated surfaces

# 3. ESTABLISHMENT: Copper pollution

- Primary recipient locations of NIS
- Among most disturbed and polluted marine environments worldwide
- Pollution plays a role in facilitating NIS establishment

www.aucklandcity.govt.nz

www.nelsonseafarers.org

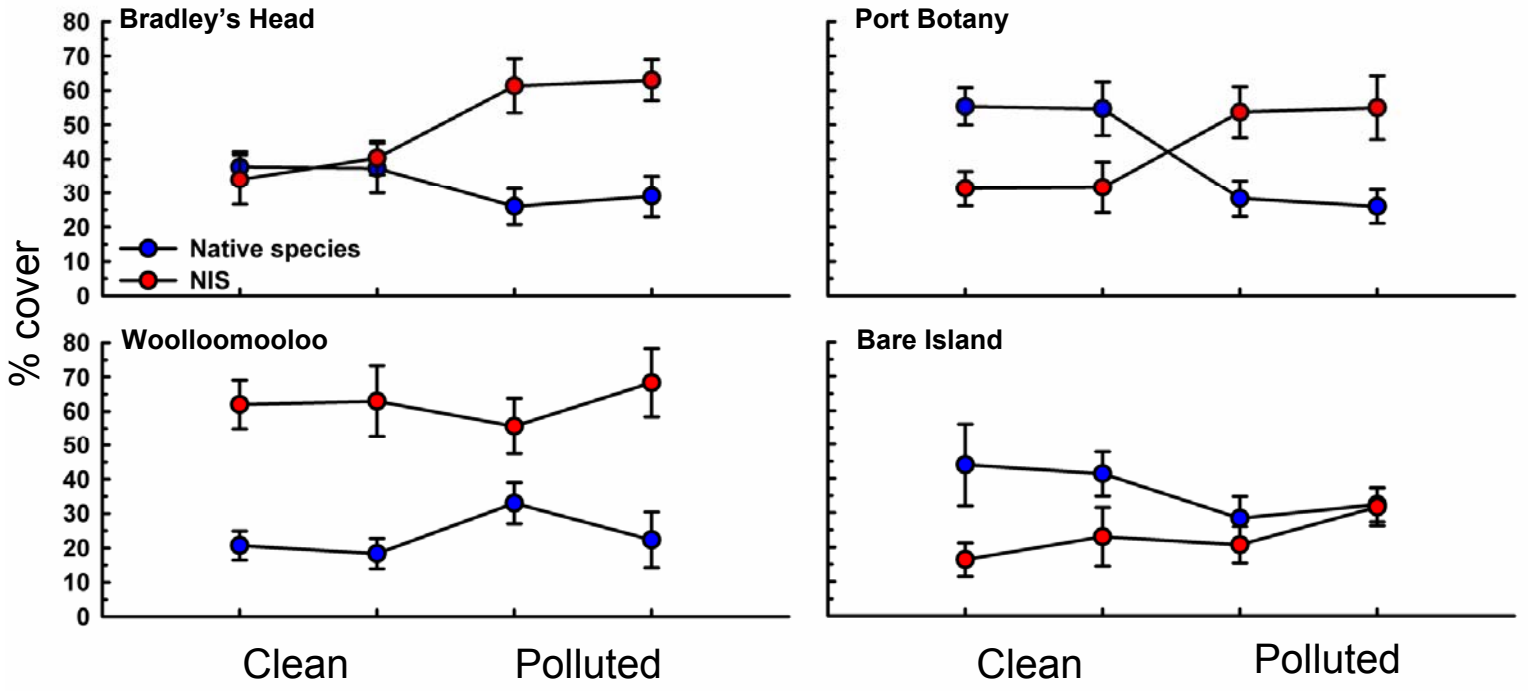
# Copper pollution in ports, harbours & estuaries

- Major pollution source in estuaries & harbours

- Occurs in form of:
  - Antifouling coatings
  - Sewage discharge
  - Urban & industrial runoff
  - Agriculture

- Ever increasing copper pollution
  - Background concentrations
  - Frequency & magnitude of pulse events

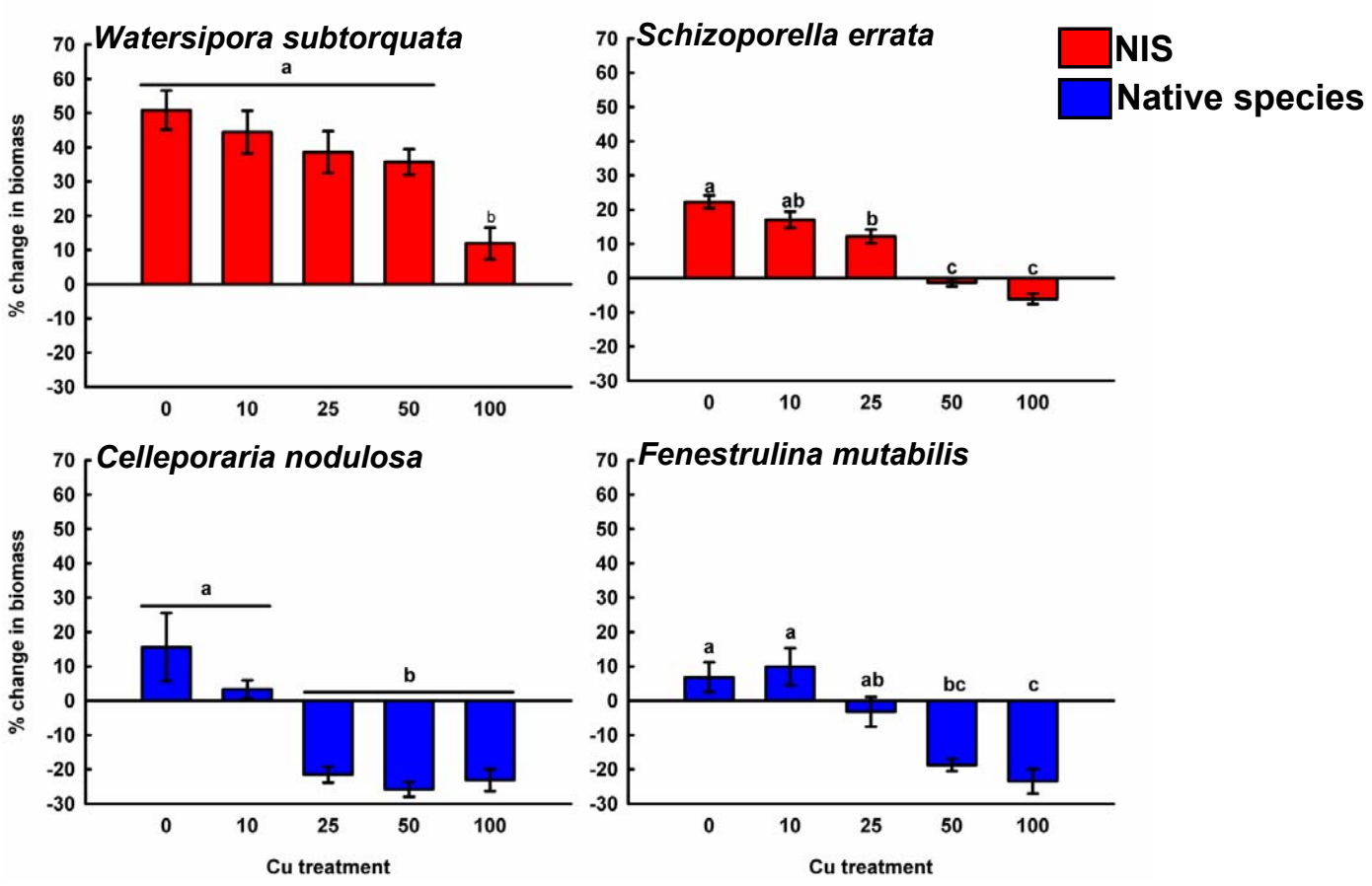
# Copper pollution in recipient locations




- Pollution decreased native species richness (all sites) and increased **NIS** dominance (3 sites)
- NIS have competitive advantage in polluted harbours and ports

Piola & Johnston (2008). Diversity & Distribution14: 329-342

# Native vs. NIS copper tolerance

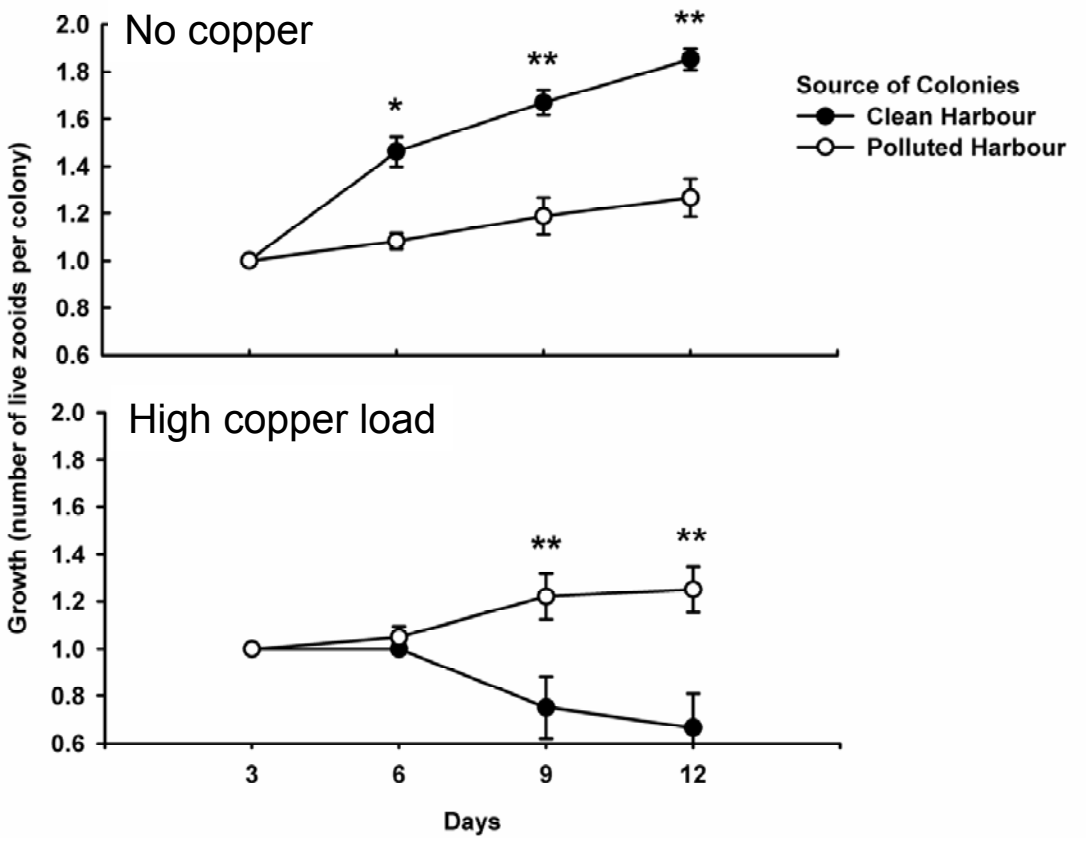



Piola & Johnston (unpubl. data)

# 4. SPREAD

- Continued transfer of NIS via hull-fouling
- Natural migration along copper-pollution gradients
- Advantageous exploitation of one-off or episodic copper-pollution events

# Copper pollution aids spread?




Piola & Johnston (2006). Marine Biology 148: 997-1010

# Management of NIS

- Effective vessel anti-fouling practices are vital
- Use the right paint for the job!
  - Non-ablative hard paint [**fast-moving** vessels]
  - Self-polishing paints [**regular** use vessels]
  - Soft ablative paints [**irregularly** used vessels]
- Need to start considering water quality
  - Mooring vessels in areas of low metal pollution
  - Short-term pollution events may be all that's needed for NIS to establish and dominate

# Ongoing research

- Compare copper tolerances between similar native and NIS

- Evolution of tolerance in NIS
  - Heritability and genetic studies
  - Role of environmental factors
  - Costs associated with metal tolerance

- Attributes of donor and recipient environments
  - Commercial versus recreational ports
  - Types of organisms at risk of transfer from each

# Acknowledgments

- Johnston & Poore Labs (UNSW)
- Ports & harbour authorities involved
- Marina operators involved

# Funding Sources