Spatial-ecological relationships of Sydney rock oyster (*Saccostrea glomerata*) reefs across multiple spatial scales

Rick Leong, Ana Bugnot, Ziggy Marzinelli, Alistair Poore & Paul Gribben

✉ rick.leong@unsw.edu.au   @rickcleong

The Malacological Society of London · UNSW SYDNEY · CMSI CENTRE FOR MARINE SCIENCE & INNOVATION · THE UNIVERSITY OF SYDNEY · MACQUARIE University SYDNEY·AUSTRALIA · sims sydney institute of marine science The Sydney Harbour Research Program · NSW GOVERNMENT | Department of Primary Industries · The Nature Conservancy · Australian Government Australian Research Council

Spatial configuration and habitat scales of foundation species

Patch-size

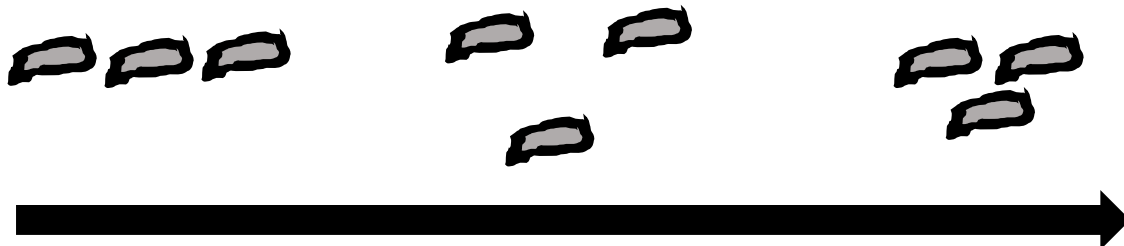Island Biogeography Theory *sensu* Wilson & Macarthur (1967); Species-area relationships (Tjorve et al., 2021)

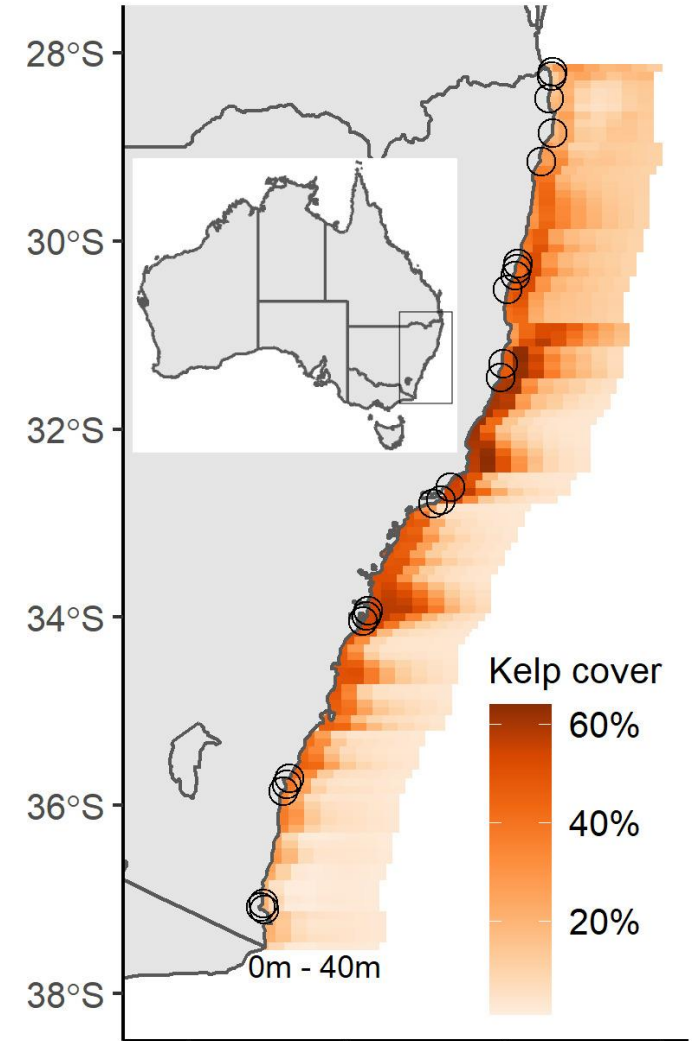**Patch-shape**

Edge-effects *sensu* Murcia (1967)

Patch-connectivity

Fahrig et al., (2017,2019)

Edge
Centre

Low Species diversity and abundance, biodiversity, recruitment, etc. **High**

Kelp cover
60%
40%
20%
0m - 40m

Davis et al. 2021 Diversity & Distributions

Using Sydney rock oyster (*Saccostrea glomerata*) reefs as a model species
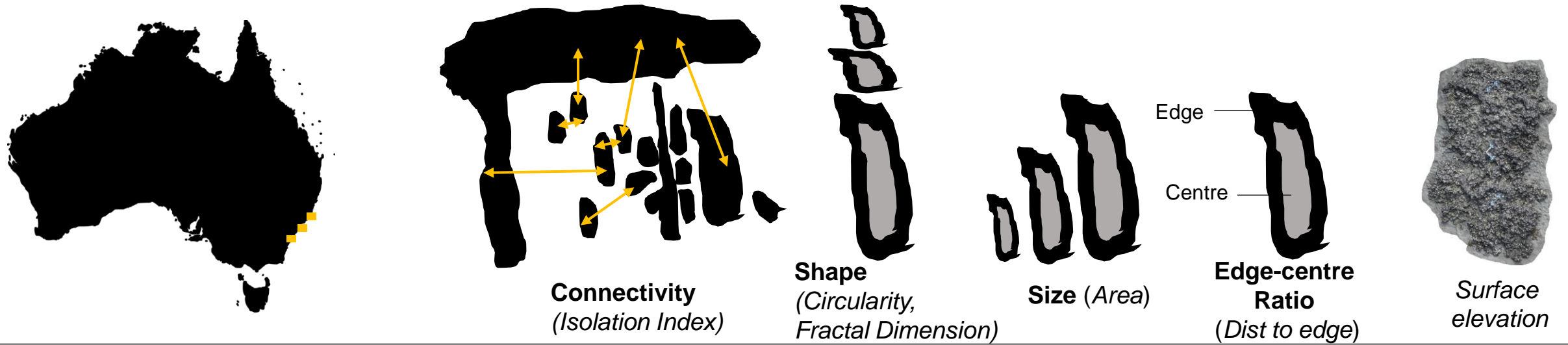

Australia

Maria Vozzo

Sydney Living Museums
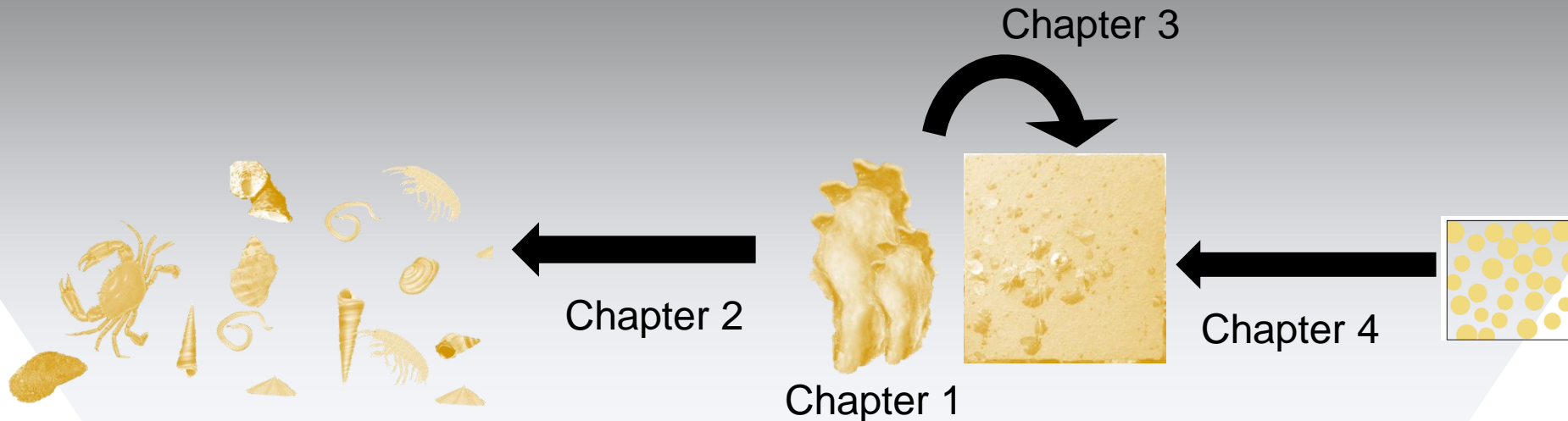
Rick Leong

PhD thesis (2018 – 2022)

Connectivity *(Isolation Index)*

Shape *(Circularity, Fractal Dimension)*

Size *(Area)*

Edge

Centre

Edge-centre Ratio *(Dist to edge)*

Surface elevation

Amongst estuaries

Amongst patches

Patch-scale

Within-patch scale

Chapter 3

Chapter 2

Chapter 1

Chapter 4

Ch 1: Leong et al. 2022 Variation in the density and body size of a threatened foundation species across multiple spatial scales. Restoration Ecology e13670

Natural vs artificial reef configuration for restoration?

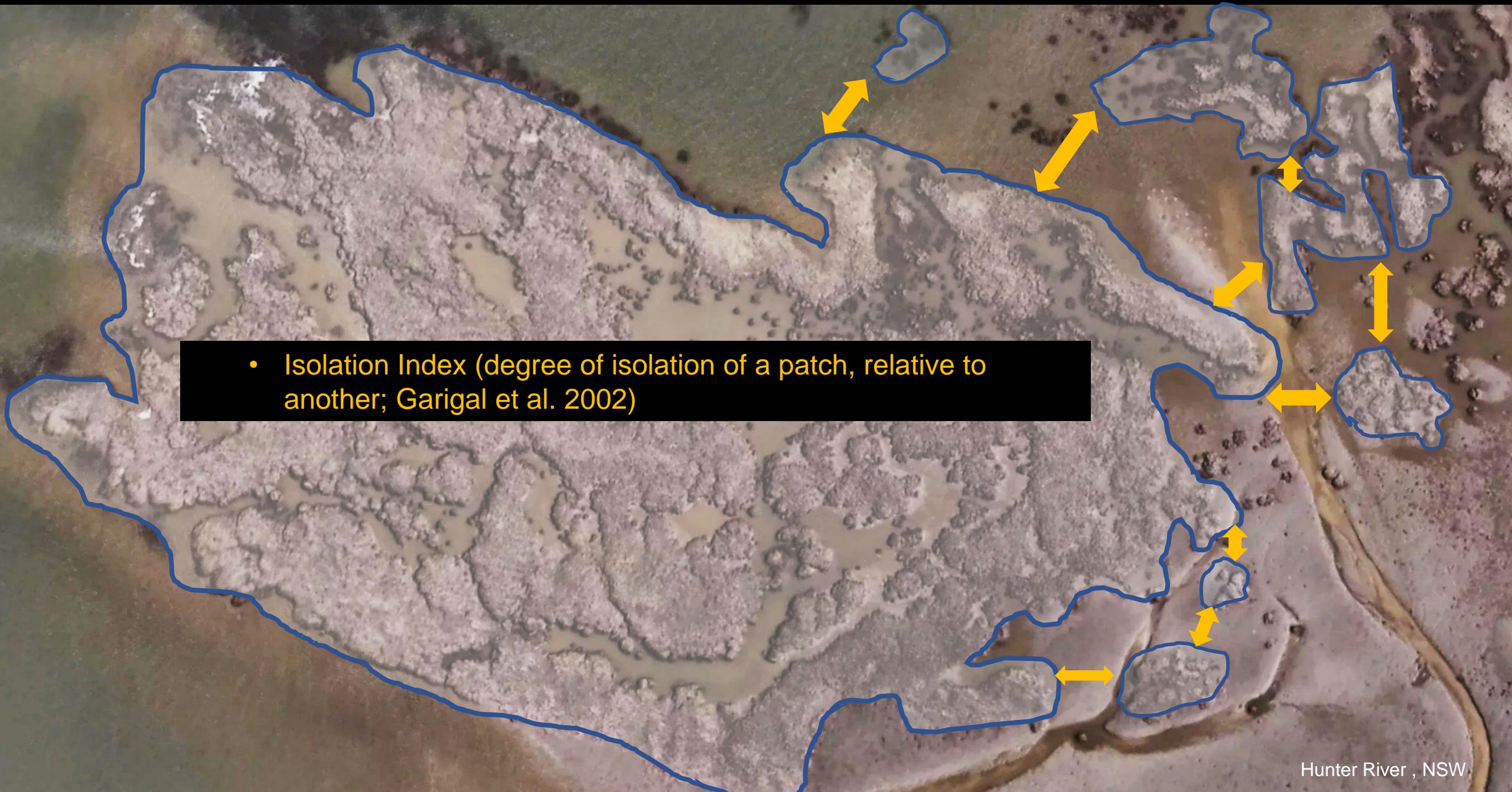Google Earth aerial, Hunter River, NSW

Port Hacking, NSW

VS

Chesapeake Bay Restoration Foundation

Hunter River (HR)

Port Hacking (PH)

Crookhaven River (CR)
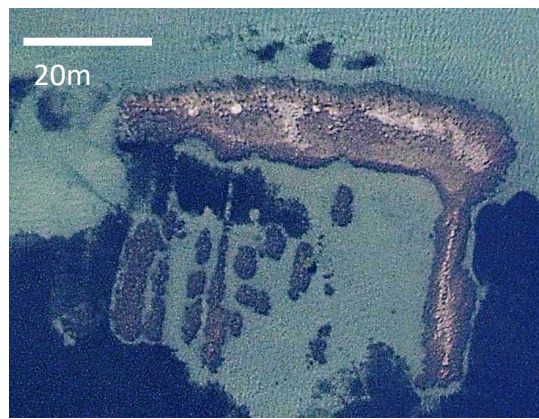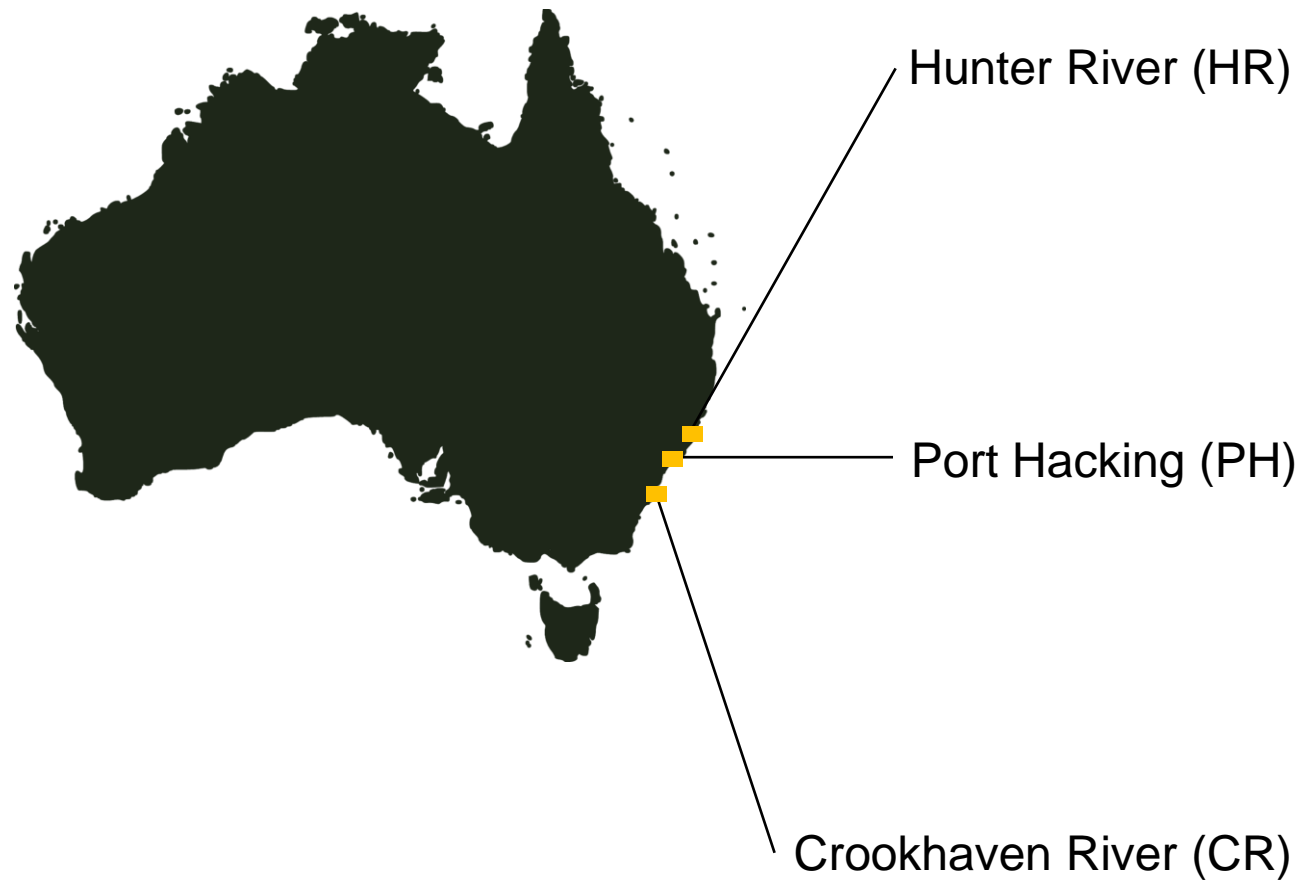
Amongst-patch (landscape-connectivity) attribute

- Isolation Index (degree of isolation of a patch, relative to another; Garigal et al. 2002)

Hunter River , NSW

Patch & Within-patch scale attributes

- Area
- Circularity

- Surface elevation
- Distance from the edge
- Rugosity *sensu* (Figueira et al. 2015)

Hunter River, NSW

Port Hacking, NSW

Sampling oyster recruits on reefs throughout multiple recruitment events

Per tile
➤ **Total of** live recruits

Leong et al. 2023 (in-prep)

Relationships between spatial attributes and oyster metrices

Oyster abundance per core
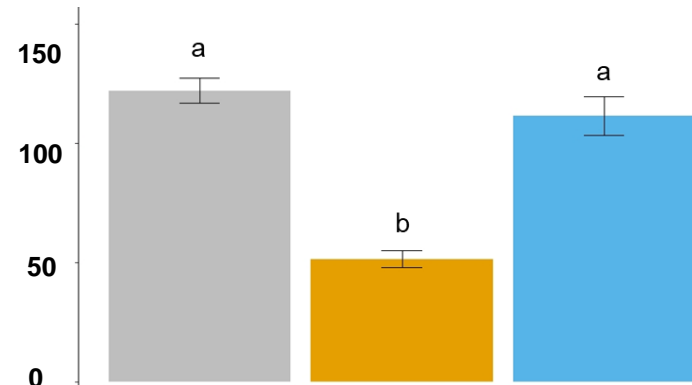
Epifauna richness per core

Recruits per tile

GLMM, regression lines with shaded areas represent statistical significance and 95% confidence interval respectively

Landscape-scale
(Isolation Index, log_{10}-scaled)

Patch-scale
(Reef area, m^2, log_{10}-scaled)

Within-patch scale
(Relative surface elevation, m)

Estuary

Crookhaven River

Hunter River

Port Hacking

Within estuaries, oyster metrices have mixed relationships with spatial-attributes

GLMM, regression lines with shaded areas represent statistical significance and 95% confidence interval respectively

Landscape-scale
(Isolation Index, log$_{10}$-scaled)

Patch-scale
(Reef area, m^2, log$_{10}$-scaled)

Within-patch scale
(Relative surface elevation, m)

Estuary
- Crookhaven River
- Hunter River
- Port Hacking

Distinct variations in oyster metrices **amongst estuaries**

Mean ±SE
Small-case letters represent GLMM statistical significance by estuary groupings
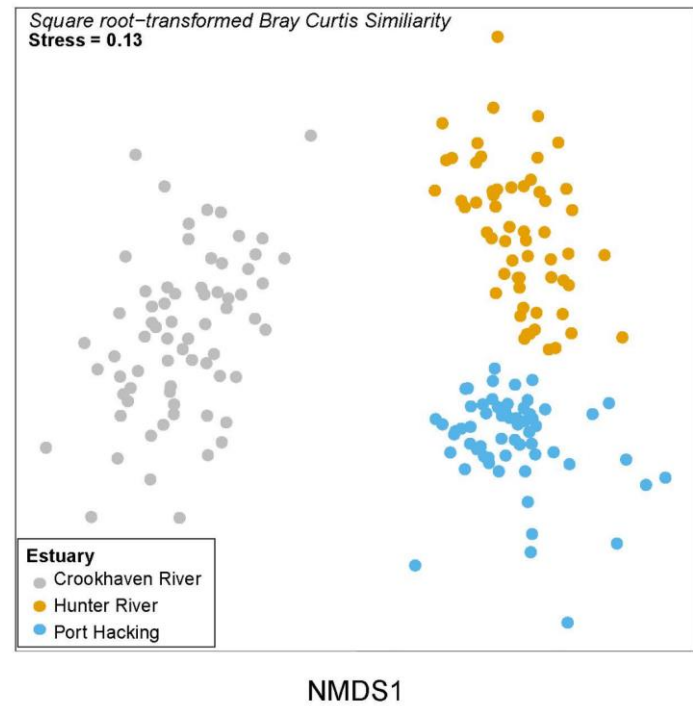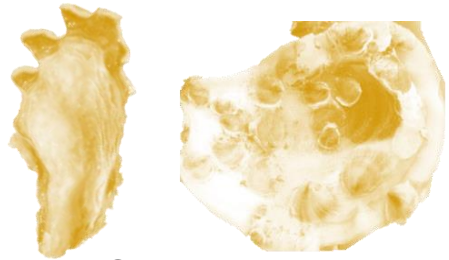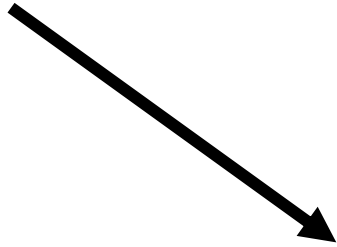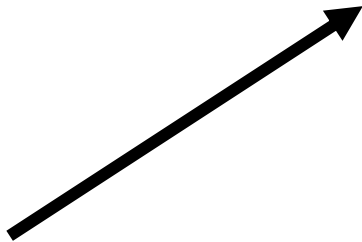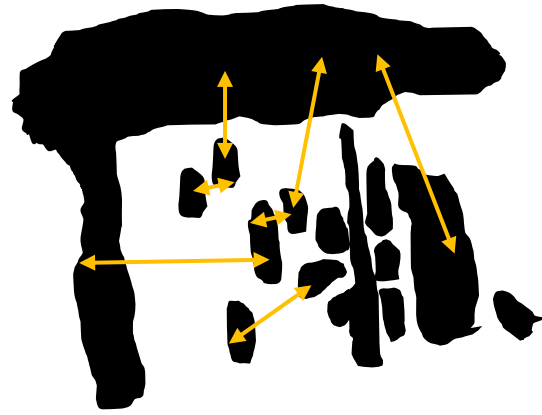
Chapter 1

Chapter 2

Chapter 3

- Largest variance of densities, epifaunal diversity and recruits. **amongst estuaries**
- Relationships with patch- and landscape- scales are localised

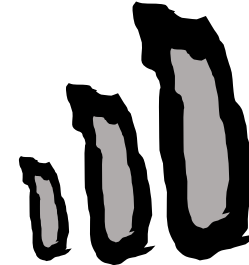# Differences amongst estuaries matter, but what's driving these differences?

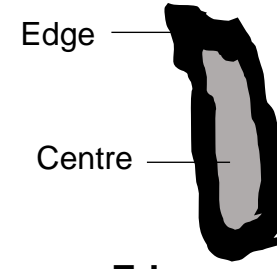**Connectivity**
(Isolation Index)

Shape
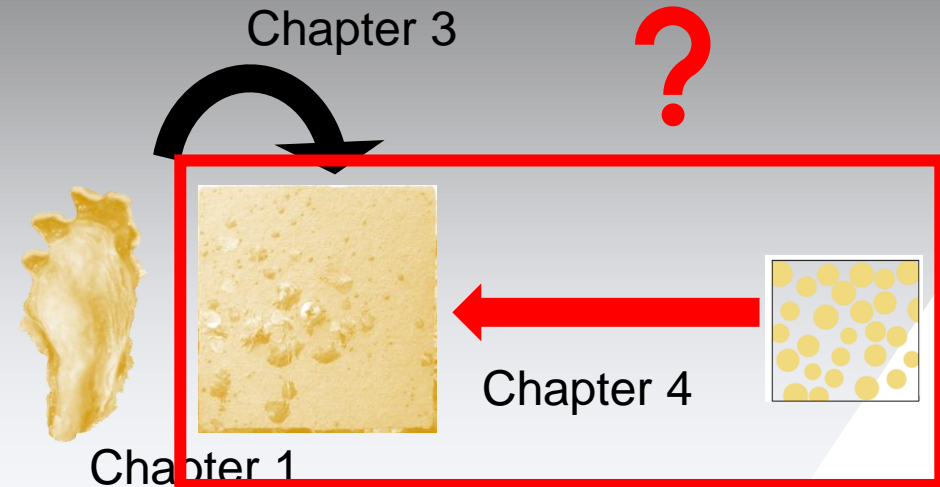*(Circularity, Fractal Dimension)*

Size *(Area)*

Edge

Centre

Edge-centre Ratio
(Dist to edge)

Surface elevation

Amongst estuaries

Amongst patches

Patch-scale

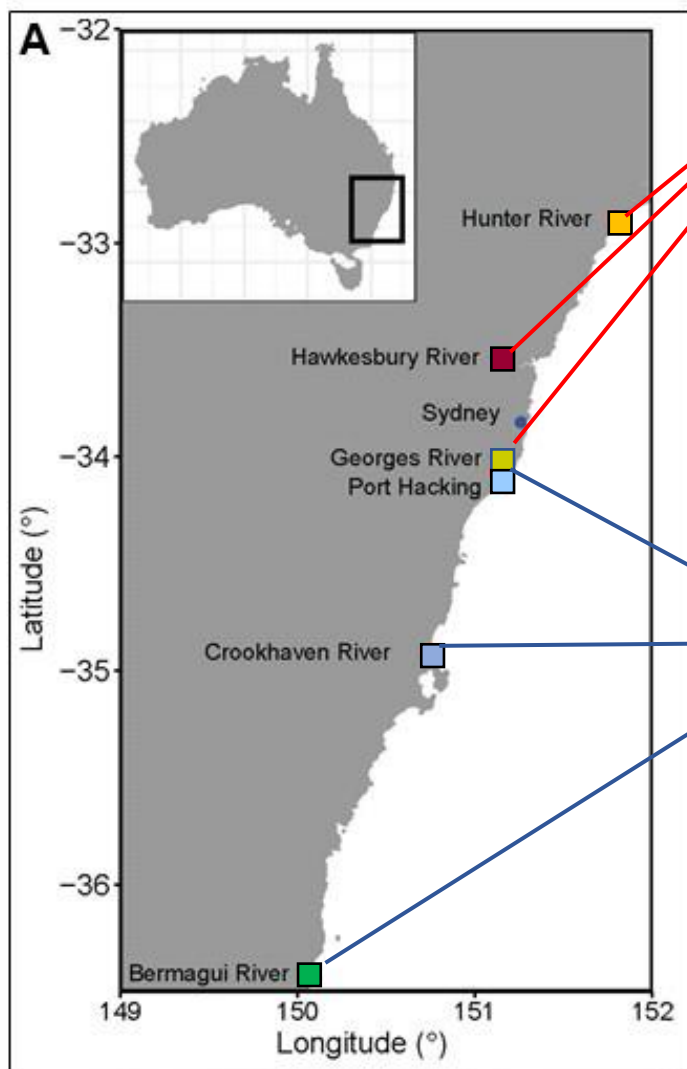**Within-patch scale**

Chapter 3
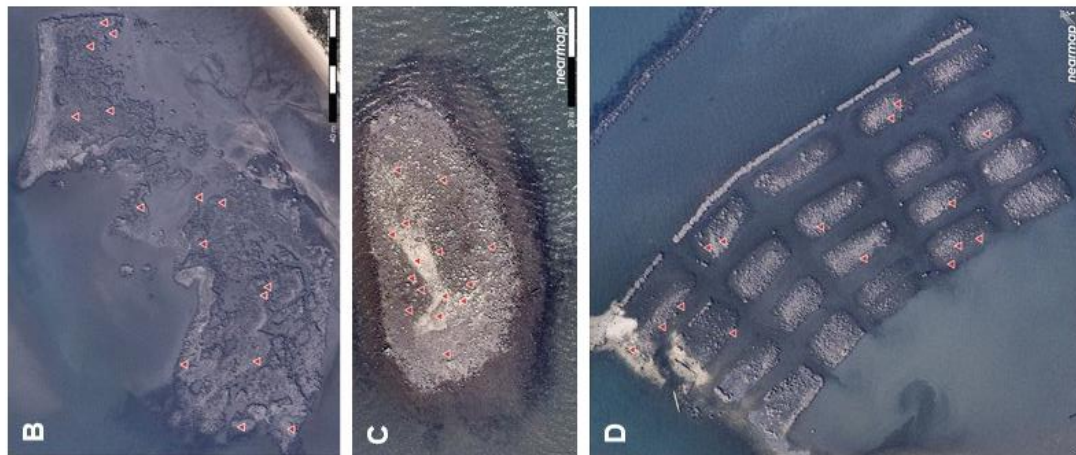
Chapter 2

?

Chapter 4

Chapter 1

Variation of sedimentation amongst estuaries on oyster recruitment

- Repeated settlement tile setup in same estuaries and three new estuaries (total 6),15 tiles per estuary
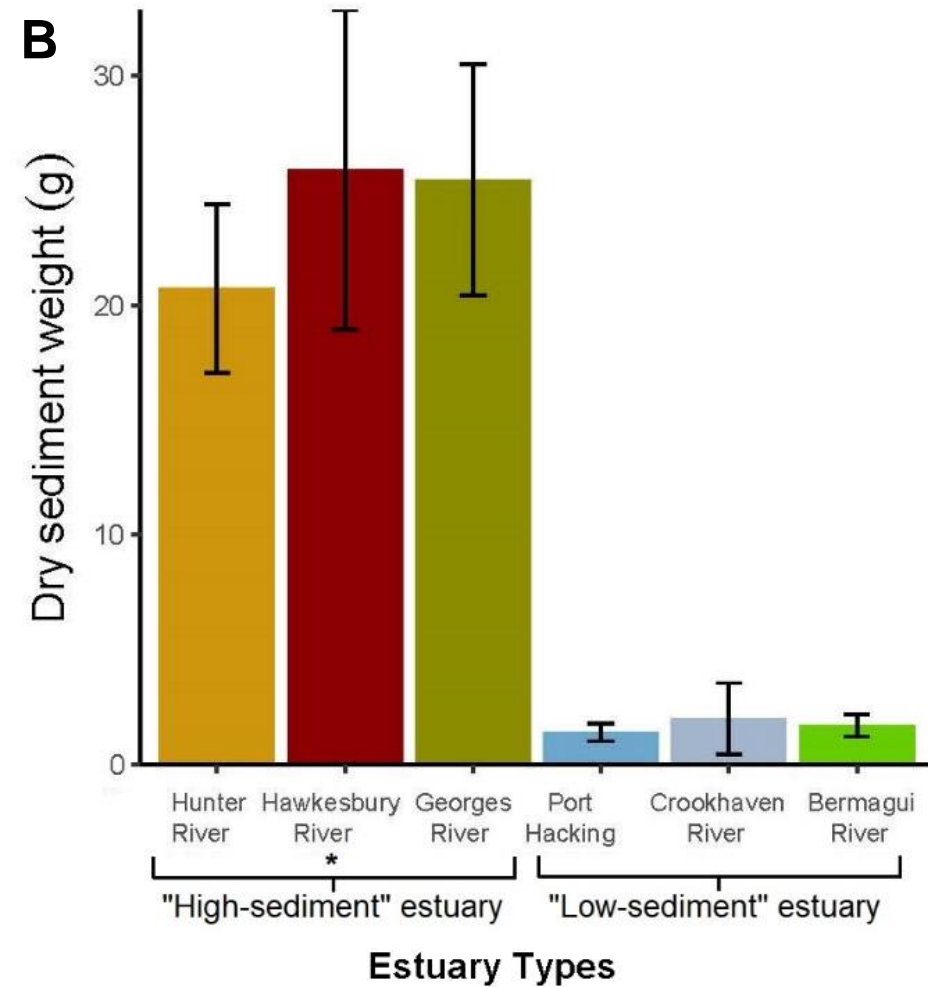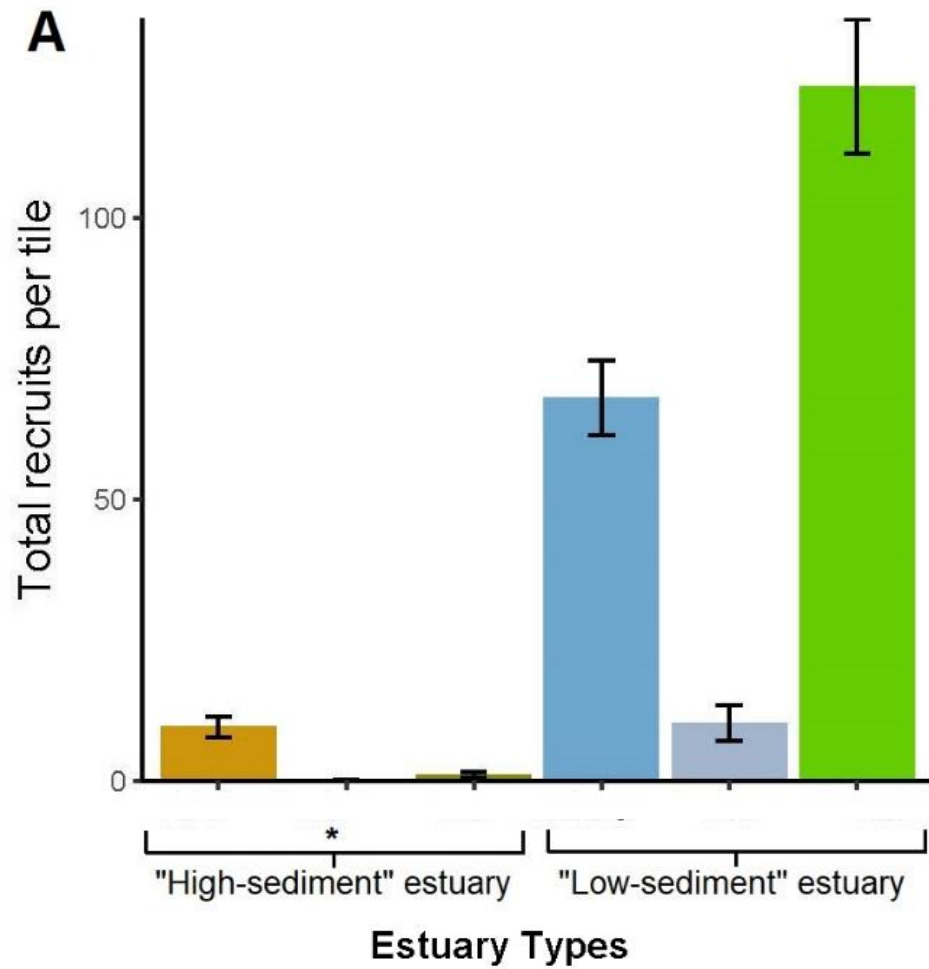- Estimated sedimentation with sediment traps, 15 traps per estuary

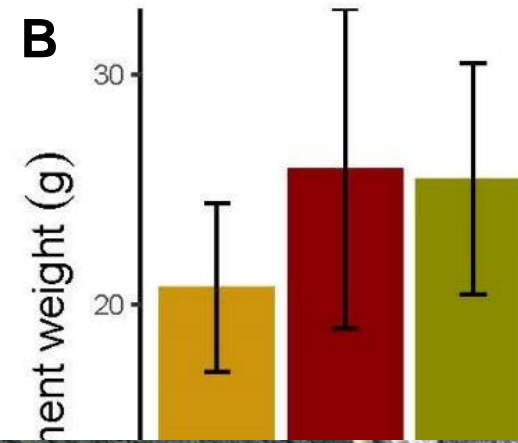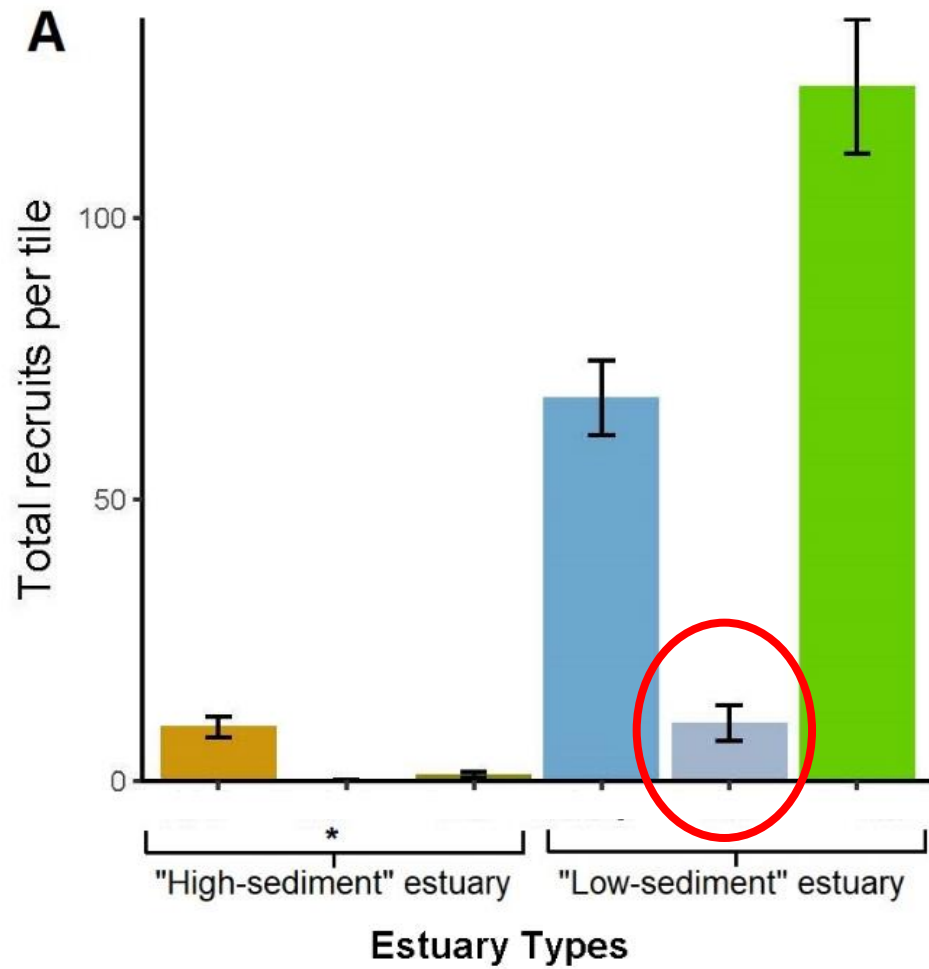**"High-sediment" estuaries**

"Low-sediment" estuaries

"Sediment-heavy" estuaries are associated with lower recruitment

Means (bar heights) ± SE (error bars)

…but sedimentation may not be the only driving factor of recruitment amongst estuaries

Means (bar heights) ± SE (error bars)

Take-home messages

- Oyster densities, epifaunal biodiversity and recruit densities have the largest variation **amongst estuaries;** may be driven by variation in abiotic factors such as sedimentation.

- At smaller scales (i.e., within estuaries), relationships between spatial attributes and metrices are localised.

- Restoration efforts can prioritise on site selection (i.e., estuaries) with favourable environmental conditions (e.g. lower sedimentation rates) to improve restoration outcomes and take into account of localised spatial scales.

Podcast & thesis link:

✉ rick.leong@unsw.edu.au   🐦 @rickcleong