Biogeography, Function and Impacts of Herbivory on Australian Temperate Reefs.

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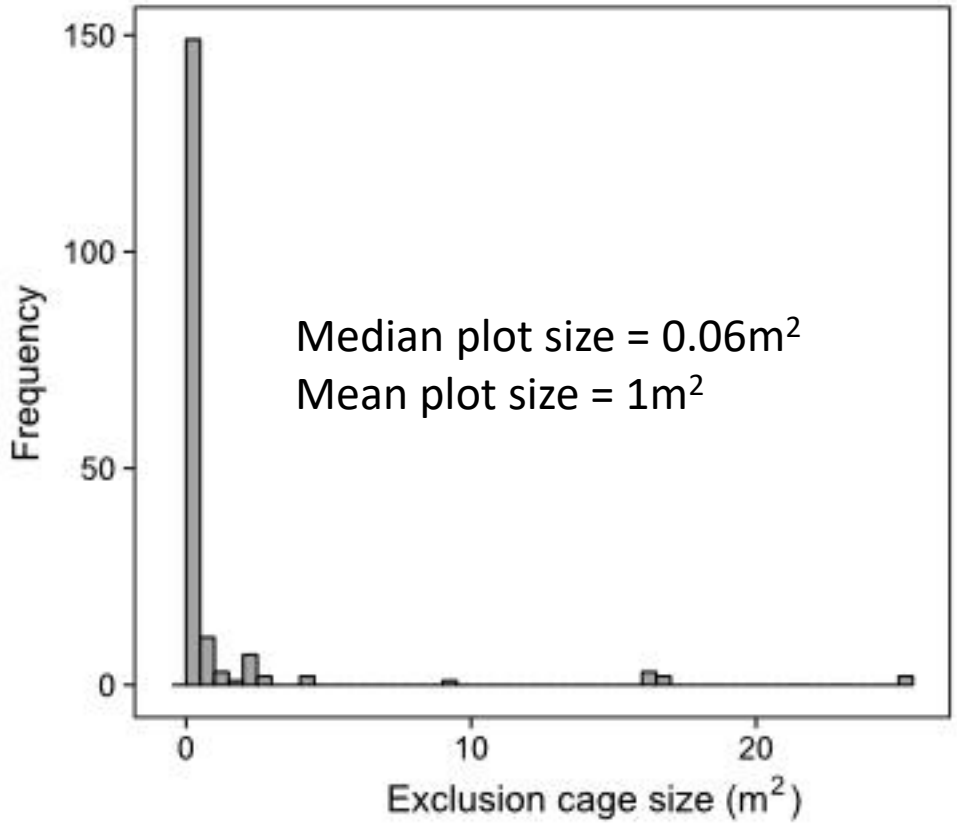
What is herbivory?

- Consumption of plants by animals
- Local process between individuals
- Herbivory can have large impacts on the structure of ecosystems
- Replicated *en masse* throughout the seascape.
- Localised nature of herbivory makes it patchy

Studies small scale and taxa specific

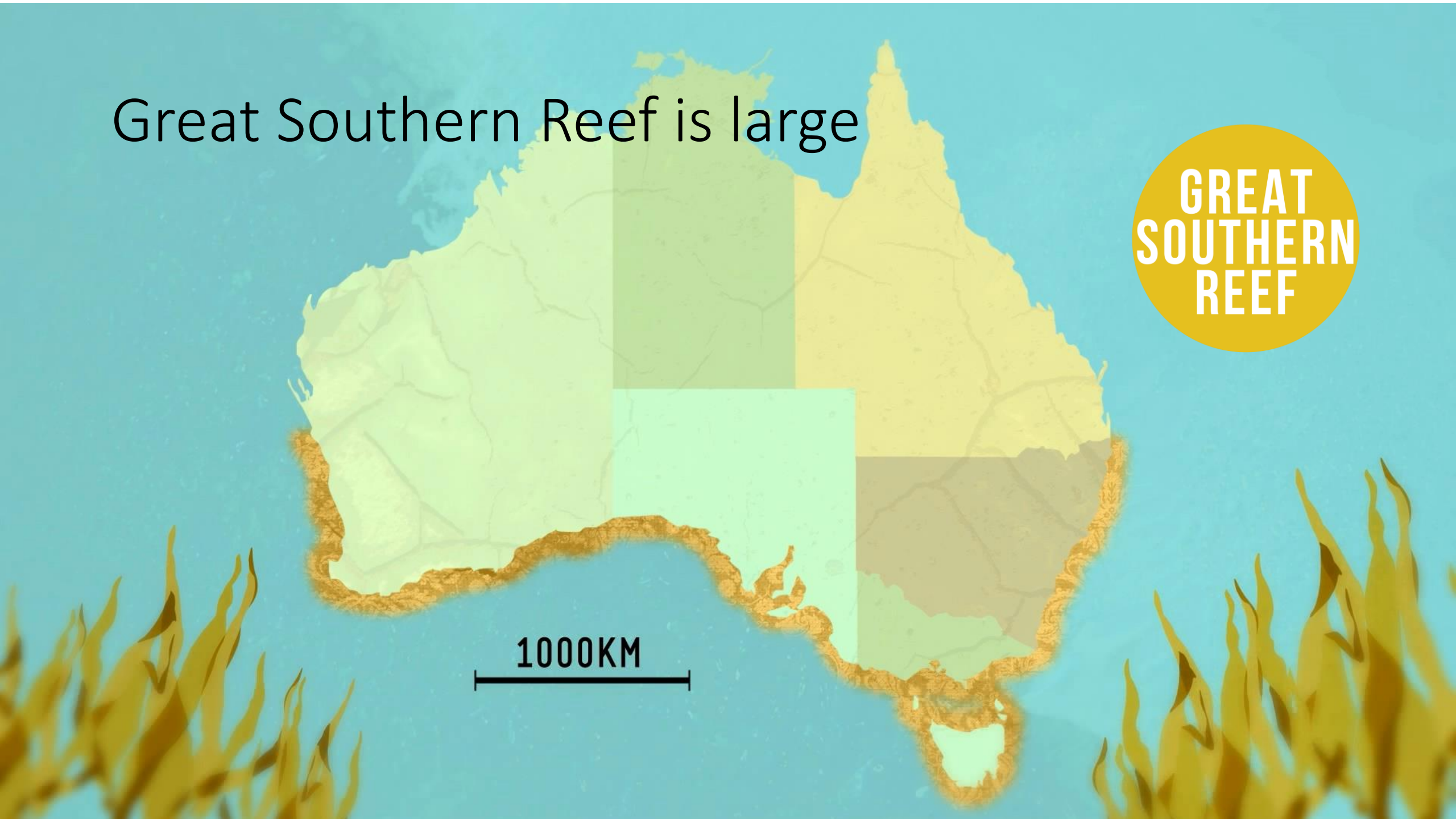
- Focus on specific taxa and local areas
- Hard to determine generality of patterns beyond the localised context of the study

Global herbivory exclusion experiments



Bennett et al. 2017; Poore et al. 2012

Great Southern Reef is large



Biogeography of herbivores on GSR

- 3-4 Biogeographical provinces
- Distributions shaped by prevailing currents and Bass Strait isolation
- High endemism: 70% endemism among reef fishes and mobile invertebrates. 50-70% endemism among seaweeds
- 36% of herbivorous fishes cosmopolitan across GSR, 64% regionally unique to SW or SE

Three prevalent narratives about temperate reef herbivory

1) the catastrophic overgrazing of kelp forests by sea urchins

Three prevalent narratives about temperate reef herbivory

2) Tropicalization and overgrazing by fishes

Three prevalent narratives about temperate reef herbivory

3) Benign functional importance of herbivores on temperate reefs.

Generality of these (contrasting) narratives unclear

Important to understand broadscale nature of herbivory due to the rapid rates of change along temperate coastlines

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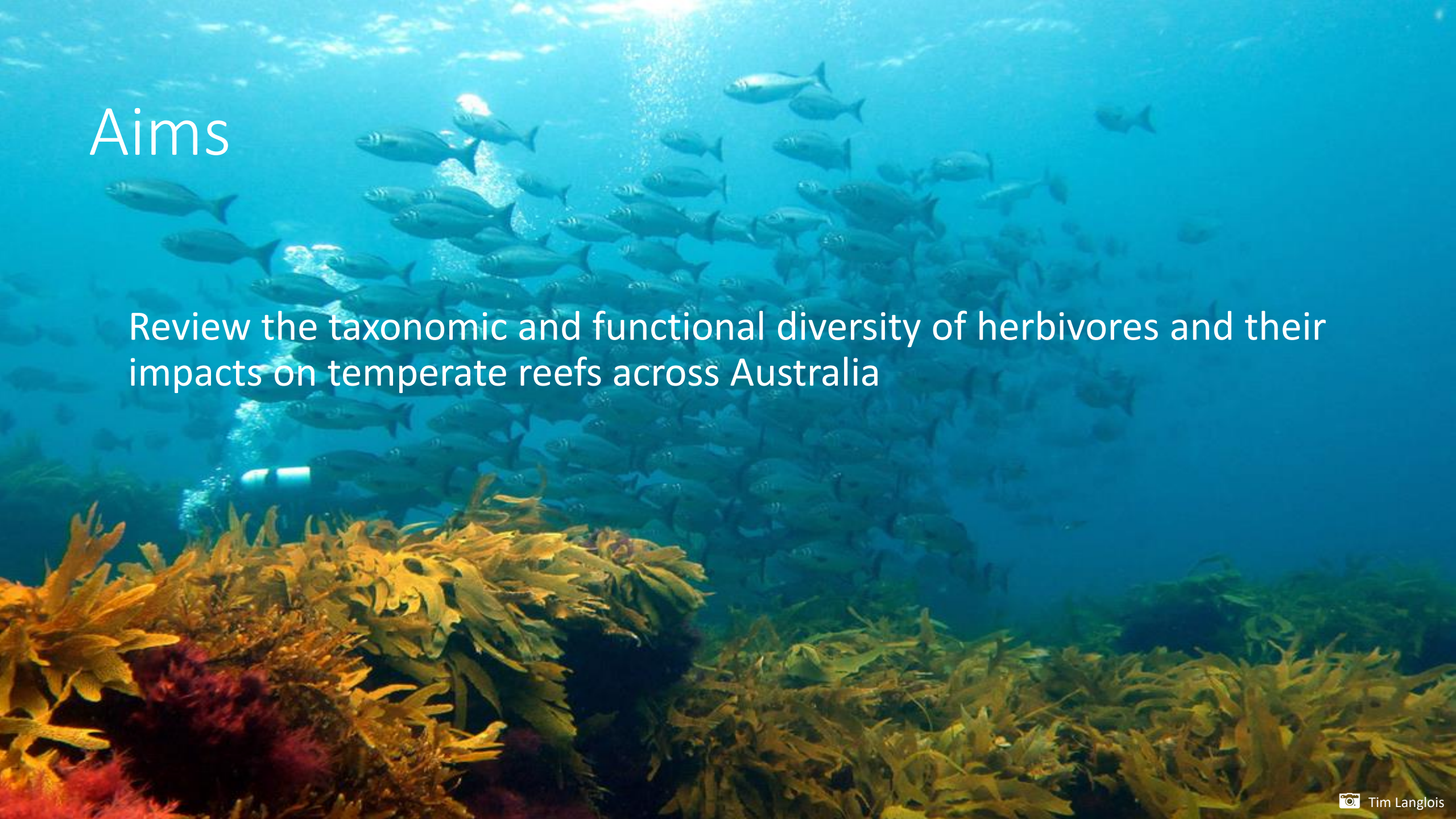
Aims

Review the taxonomic and functional diversity of herbivores and their impacts on temperate reefs across Australia



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Methods: Literature review

TS = (herbivor* OR *graz*) AND TS = (seaweed OR *alga* OR kelp OR rocky reef OR turf OR temperate reef) AND CU = (Australia) NOT TS = (coral reef OR terrestrial OR mangrove OR seagrass OR freshwater).

- Search resulted in 648 publications.
- Papers randomly allocated to authors, screened and information extracted

Rules

1. Australian temperate reefs only (no seagrass, coral reef, mangrove, freshwater)

2. Subtidal only (lab studies included if collected subtidal)

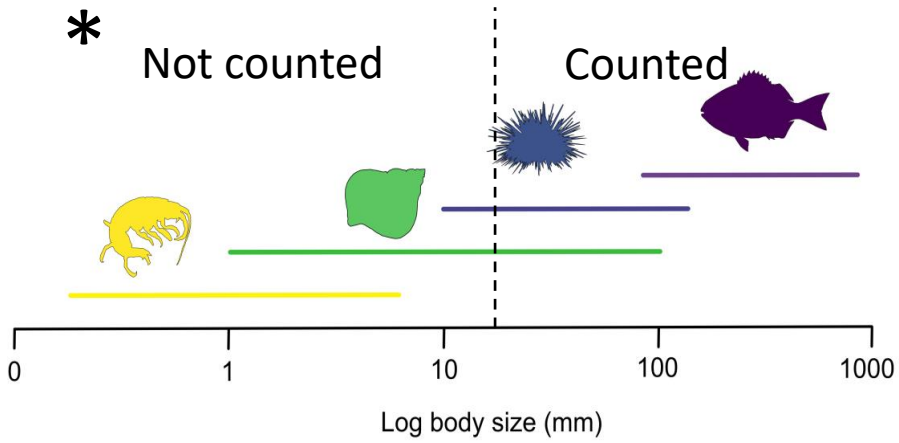
3. Empirical measures of herbivory (survey only and models not included)

4. Observations over multiple locations or years = separate interactions

5. Observations over different life stages = separate interactions

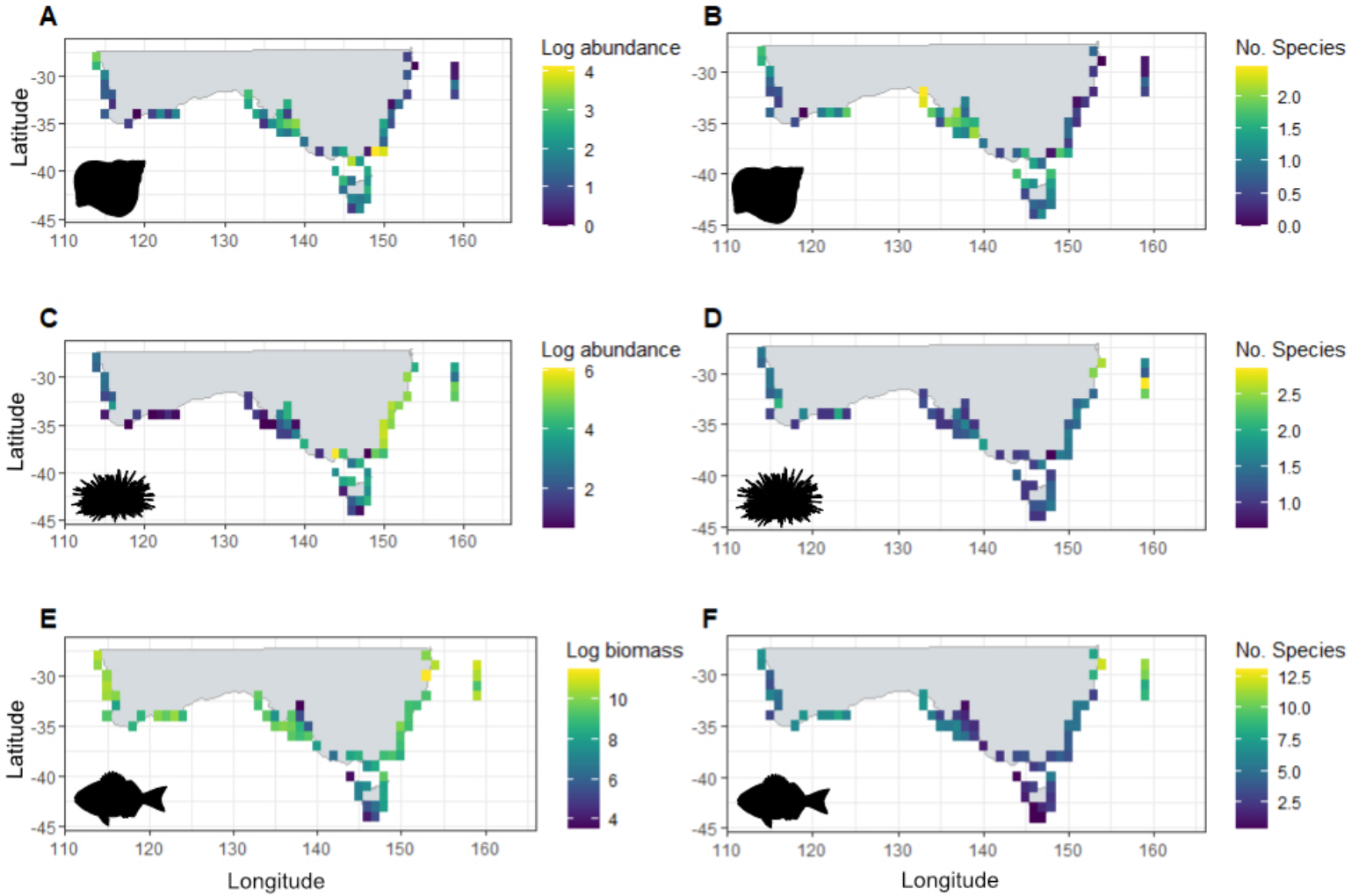
Herbivore diversity

- 100 studies
- 1076 plant herbivore interactions
- 88 herbivores, 112 seaweeds



	Literature review		Surveys
Class	**Families**	**Species**	**Species**
	12	39	212 (18.9%)
	5	6	45 (13%)
	7	22	
	2	7	99 (29%)*
	15	13	?
	1	1	?
TOTAL	**42**	**88**	

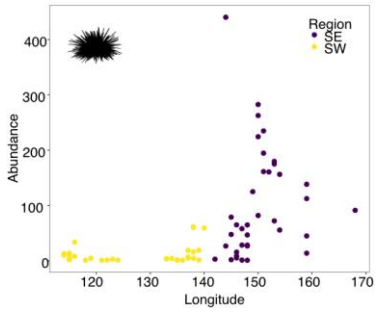
Spatial distribution of herbivory: Surveys

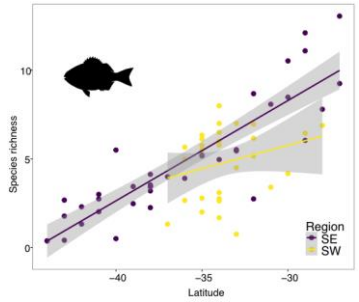


Richness

Abundance

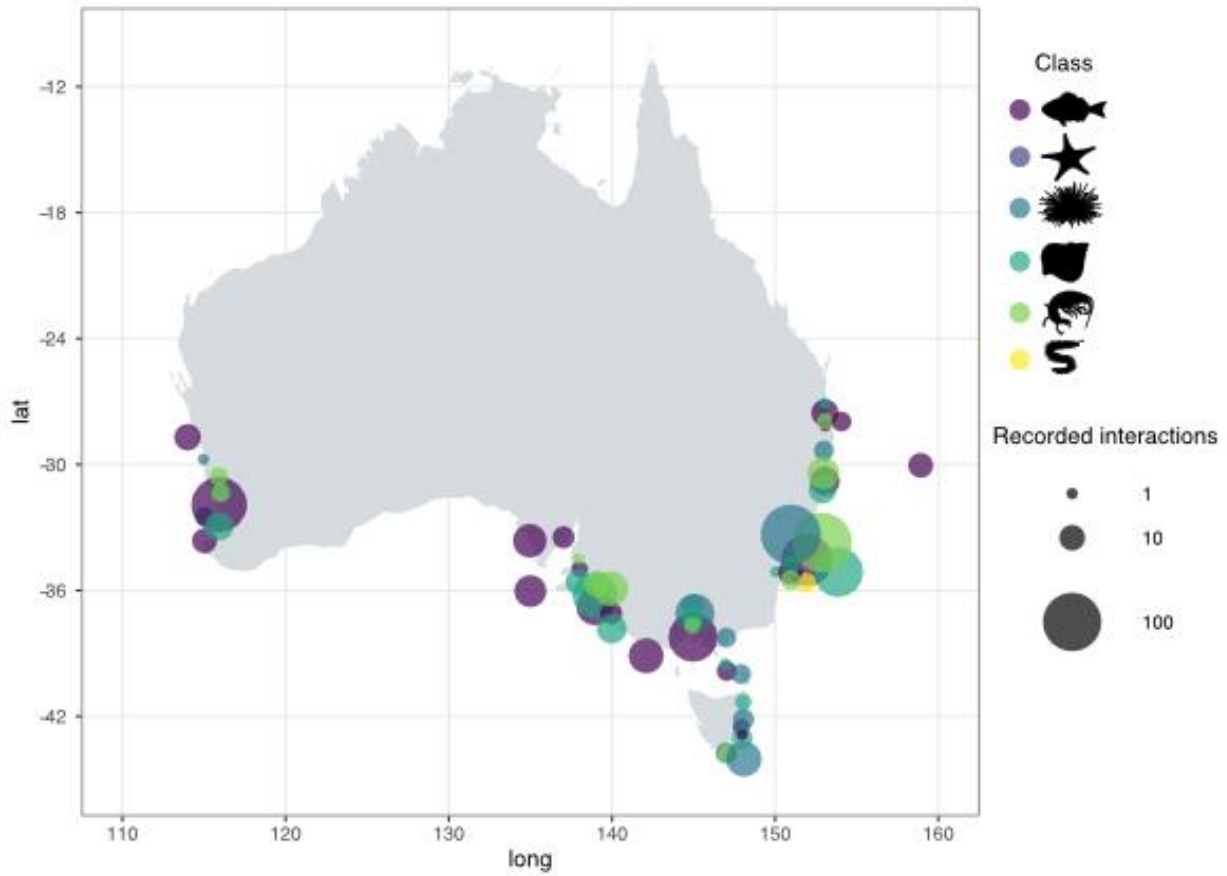
[Paradigm 1]

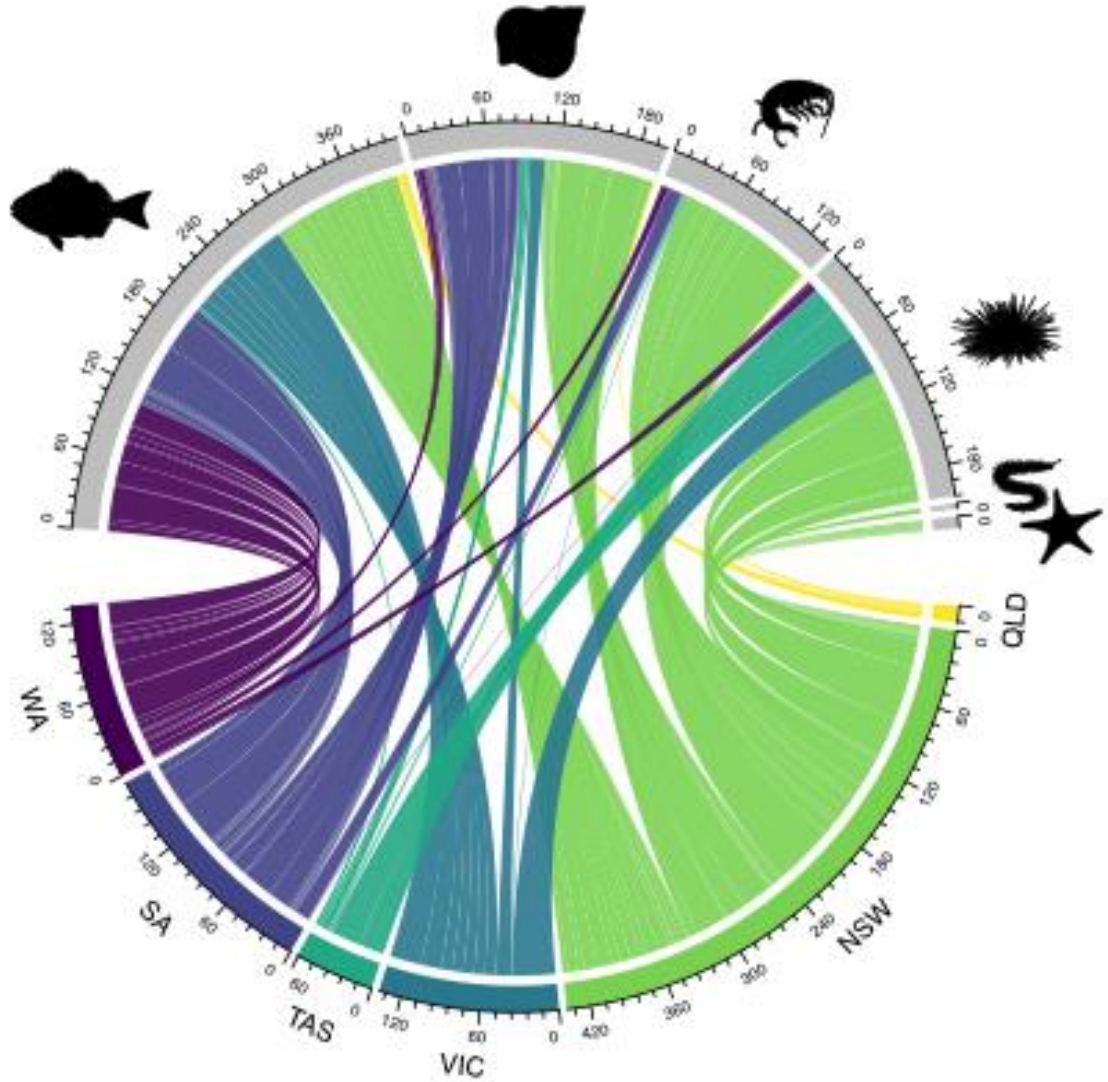




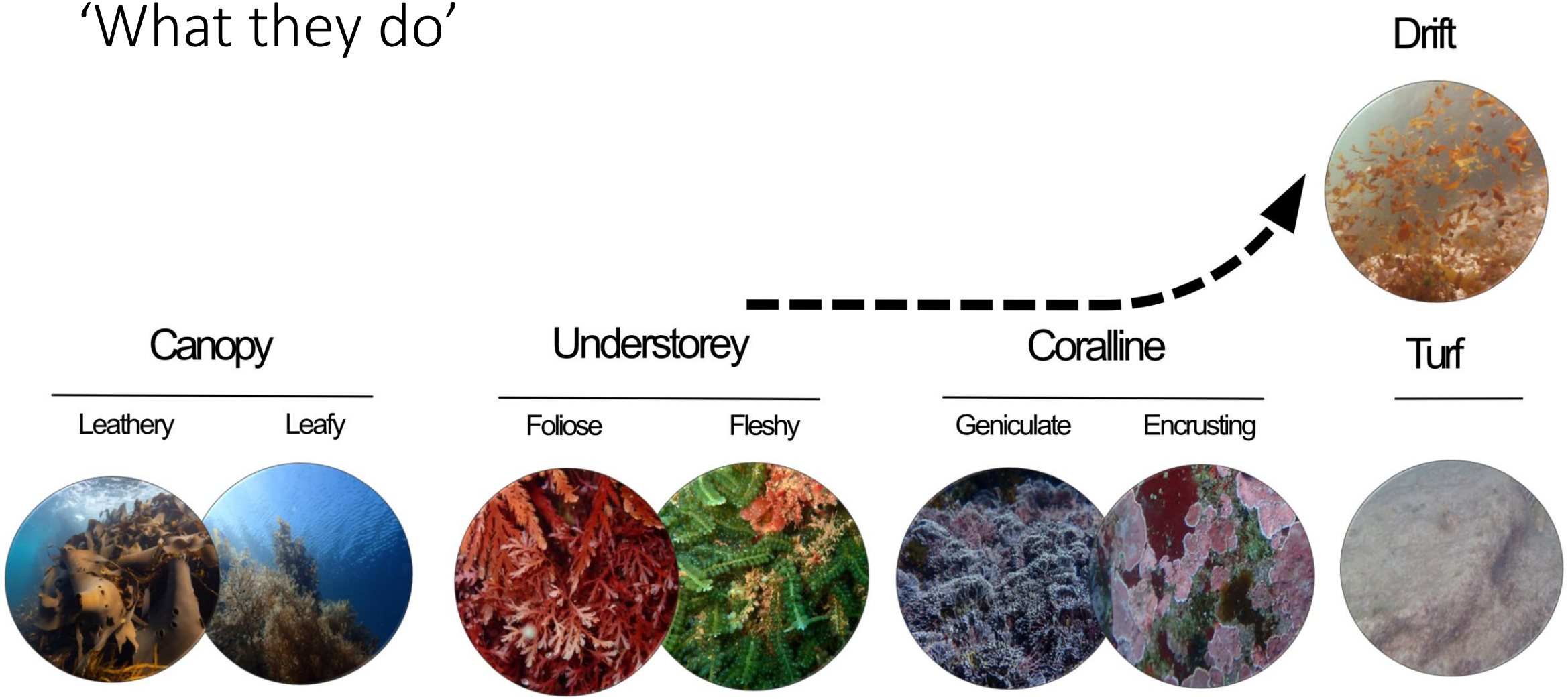
[Paradigm 2, 3]

Spatial distribution of herbivory: Interactions





Ecosystem functions:
‘What they do’



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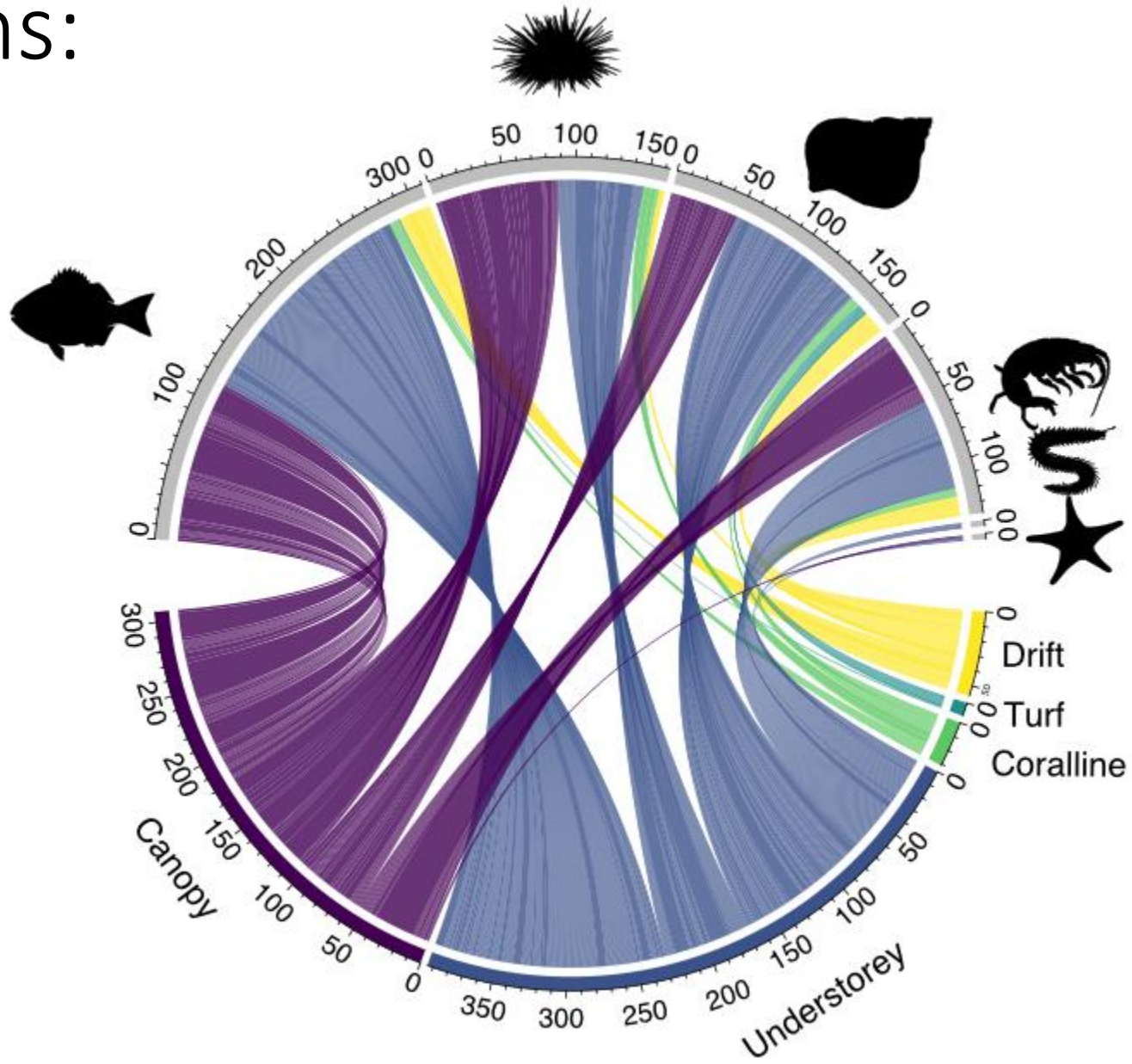
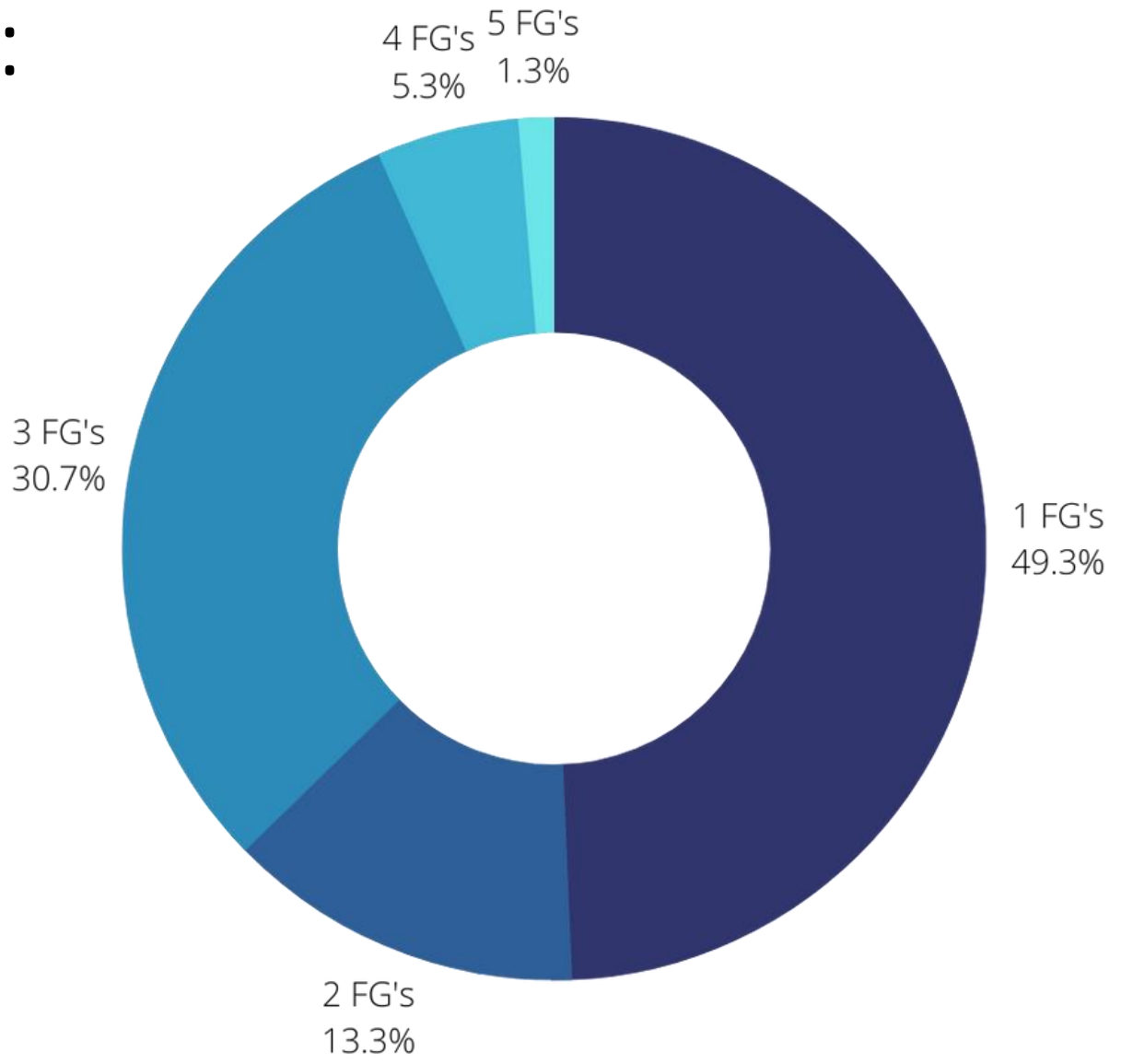


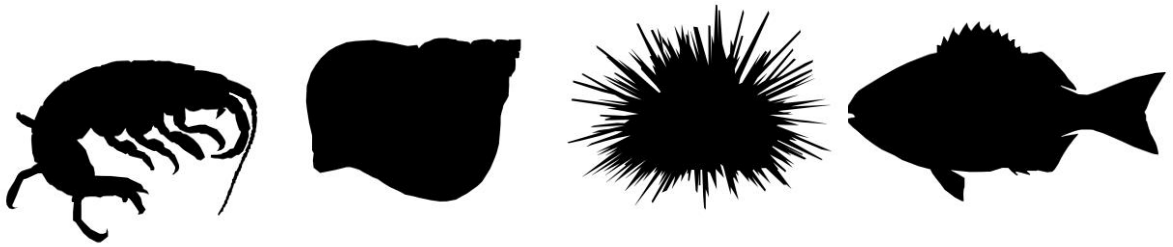
Ecosystem functions:
‘What they do’

Multiple functional roles per species



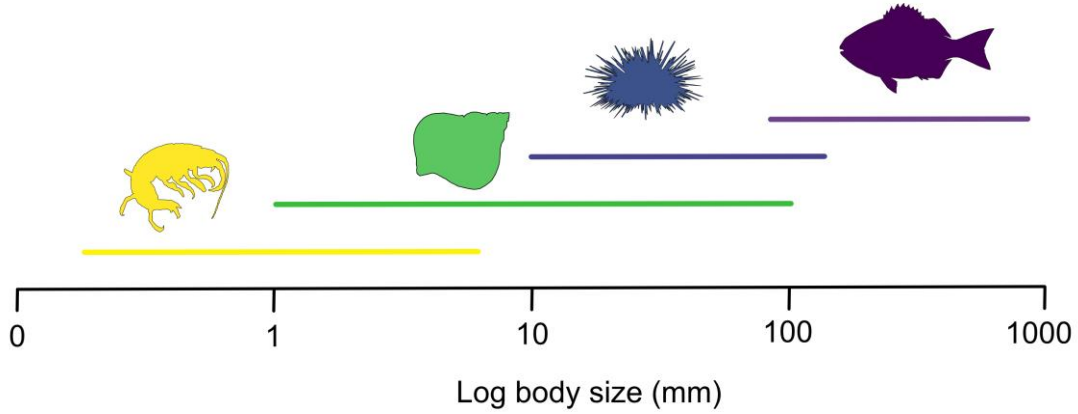
Functional groups:
‘How they do it’

Taxa

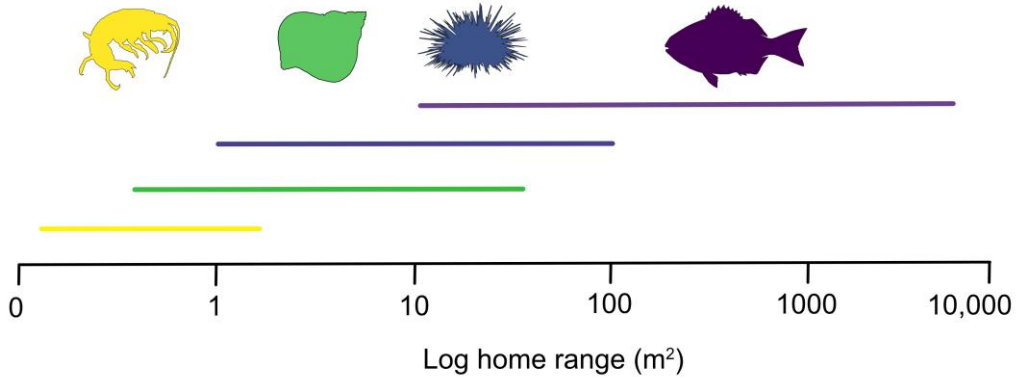


- High functional diversity across full herbivore assemblage
- Major delineations are taxonomic (e.g. Class)
- orders of magnitude difference in size and mobility between Classes

Size



Mobility



Functional groups:
‘How they do it’

- Within Classes, important differences in functional morphology and behaviour shape ecosystem function
- E.g. Length of tubed feet relative to spines

Obligate benthic grazer

Scott Bennett

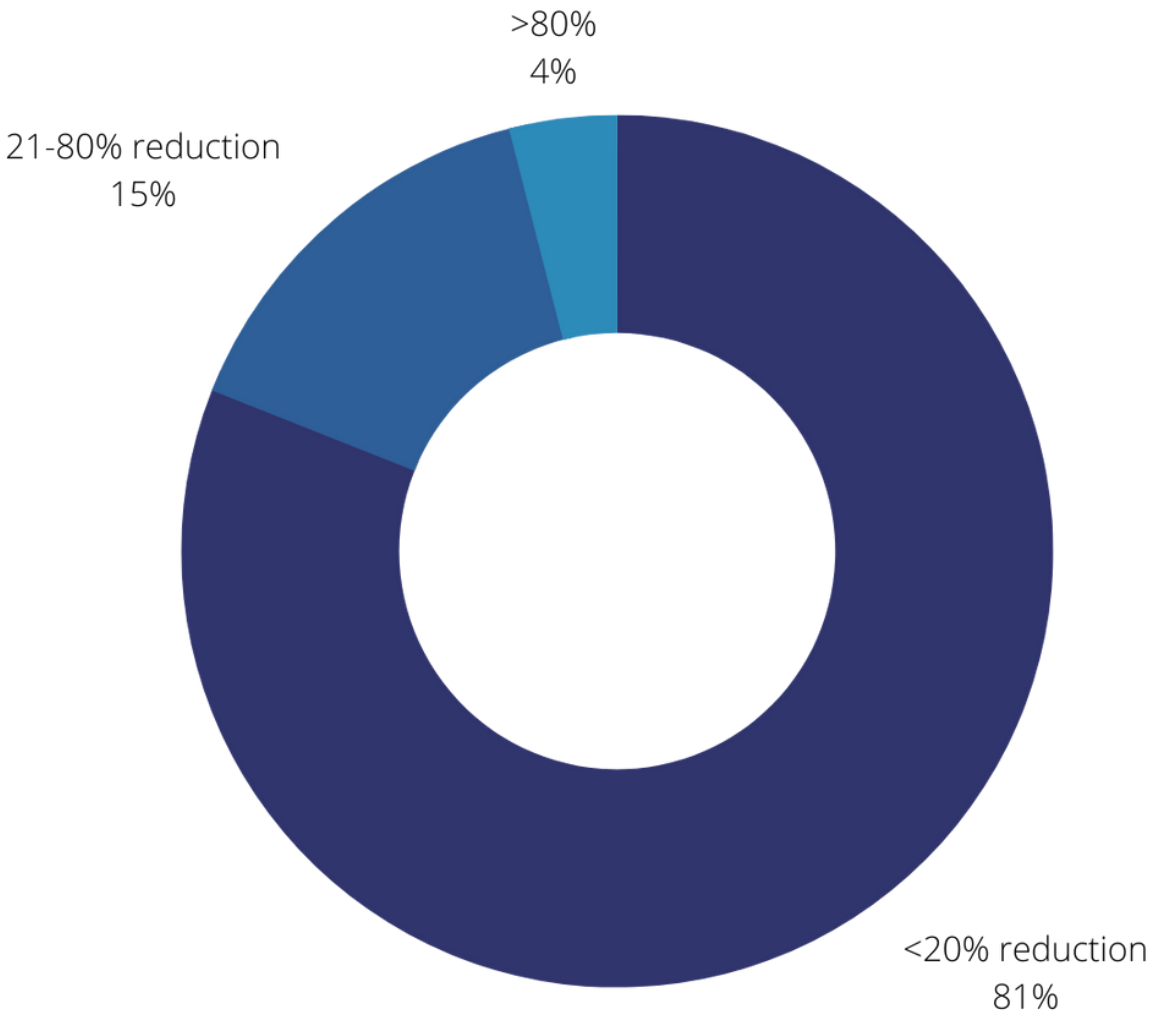
Facultative drift-dependent grazer

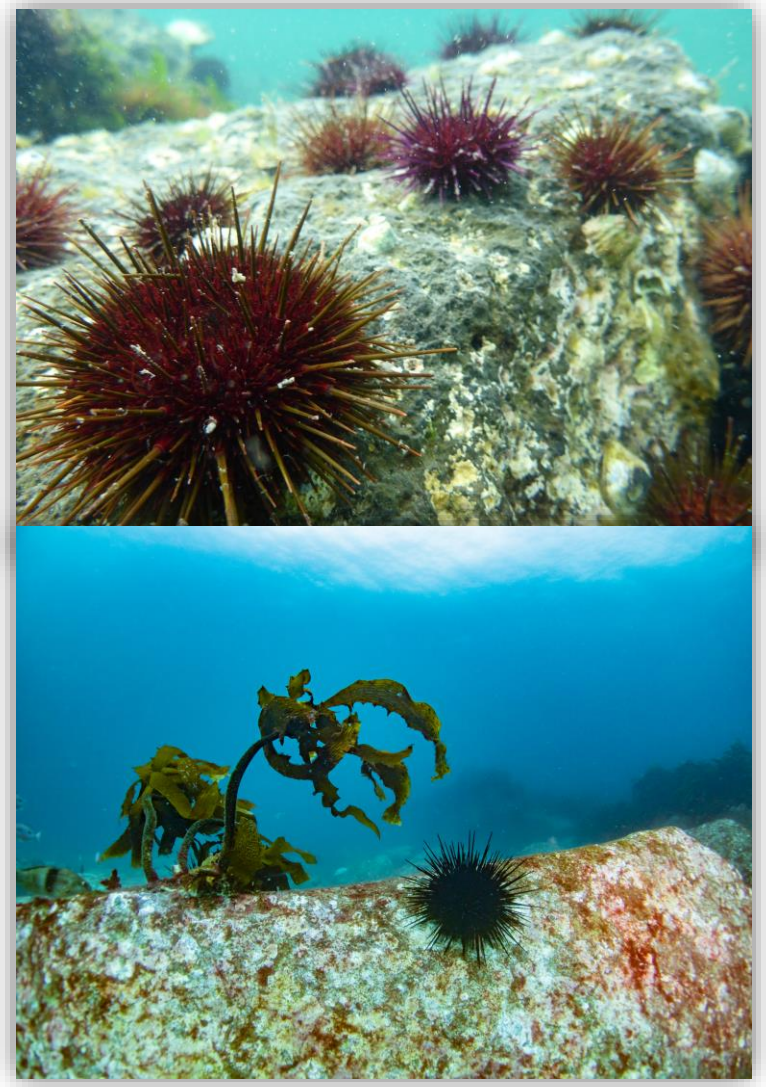
IMAS

Facultative canopy grazer

Andrew Green

Impacts: Seaweed removal by herbivores





Conclusions

- Strong regionalization in herbivory on GSR
- Urchin herbivory: strongest impacts - east coast only
- Fish herbivory: strong in warm margins + increasing poleward
- Mesograzer herbivory: Understudied in most regions.
    - High biomass = large function (?)
- For the most part, herbivory impacts are benign and herbivores support rich trophic networks/nutrient cycles

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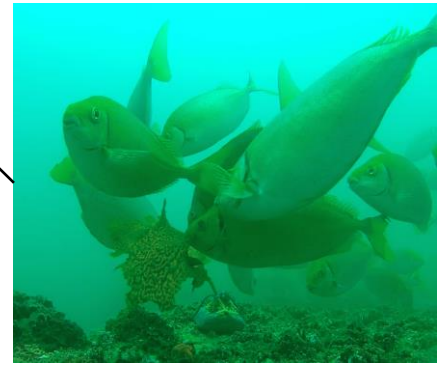
GREAT SOUTHERN REEF

Impacts: Fish herbivory on the rise

- Fish impacts increasing poleward
- Warm edge biomass and grazing comparable to coral reefs
- Attribution to habitat loss challenging

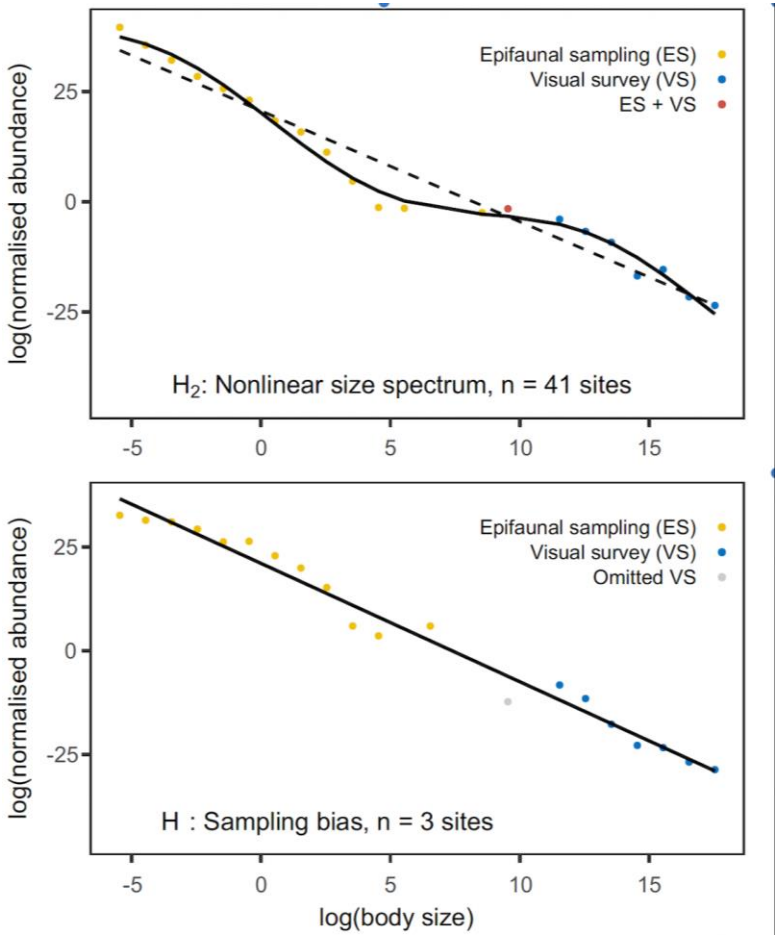


Bennett et al. 2015; Zarco Perello et al. 2020; Bosch et al. 2022

Vergés et al. 2016

Impacts: Mesograzer impacts

- Mesograzers are understudied throughout most of the GSR
- Mesograzers have significant impact on algal biomass (Poore et al. 2012)
- Strong log body size - abundance relationships on GSR. What they lack in size they make up for in abundance (Heather et al. 2021)
- Hidden importance of mesograzers

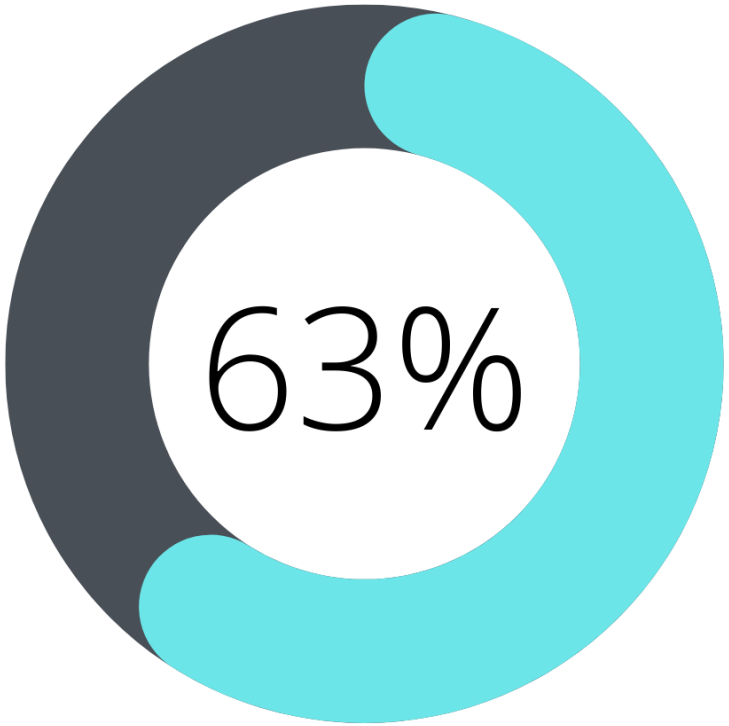


Heather et al. 2021

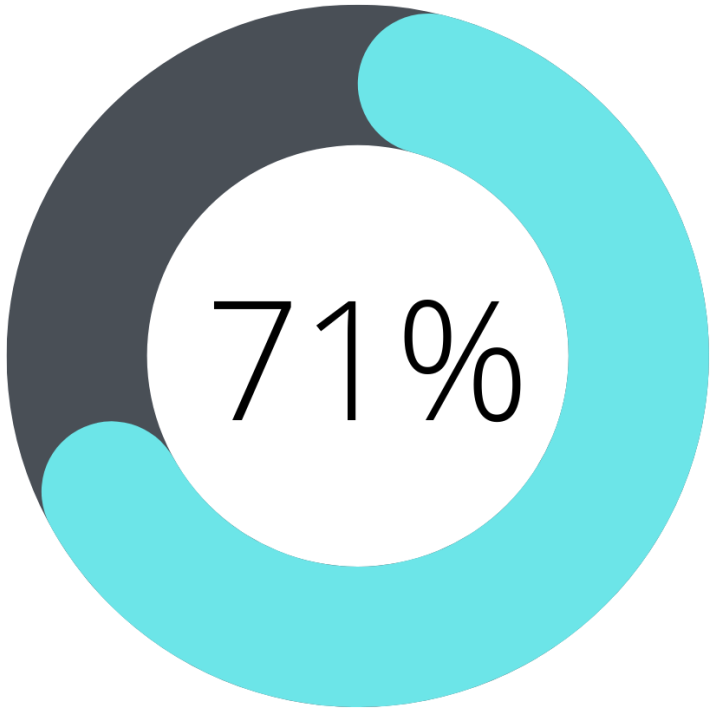
Impacts:

Functional differences mean that not all herbivores have same impact on reefs

Interactions recorded in field



Interactions recorded on natural habitat



Results

Impacts