

NORTH WEST SHOALS TO SHORE RESEARCH PROGRAM

Rowley Shoals: past, present and future



James Gilmour

Acknowledgements

AIMS

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- Sharyn Hickey

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CURTIN

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DBCA

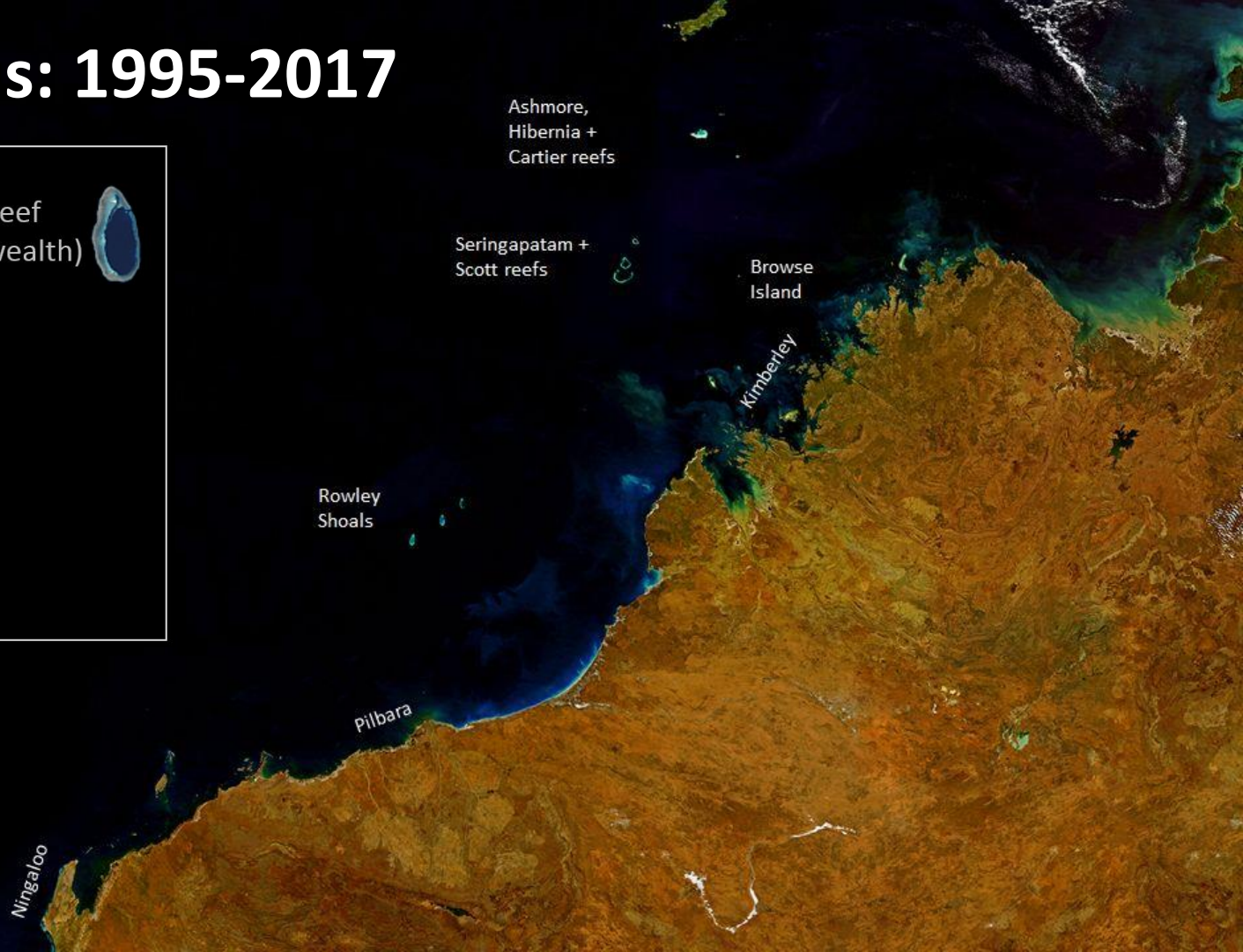
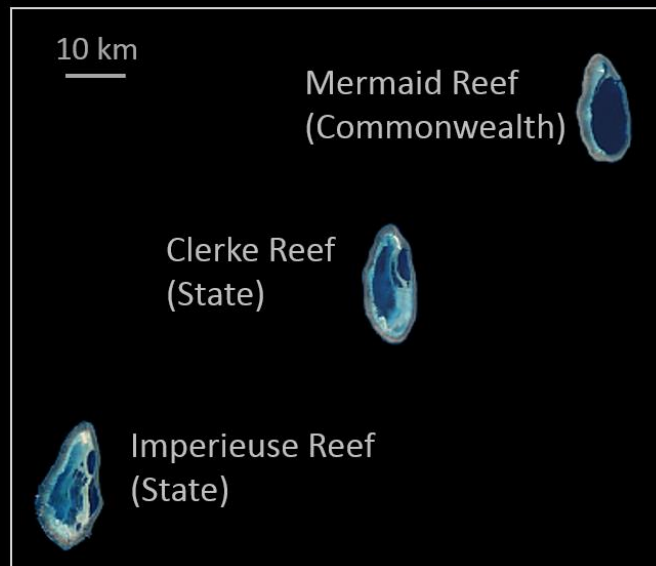
- Tom Holmes
- Shaun Wilson

RV Solander + Arden Marine

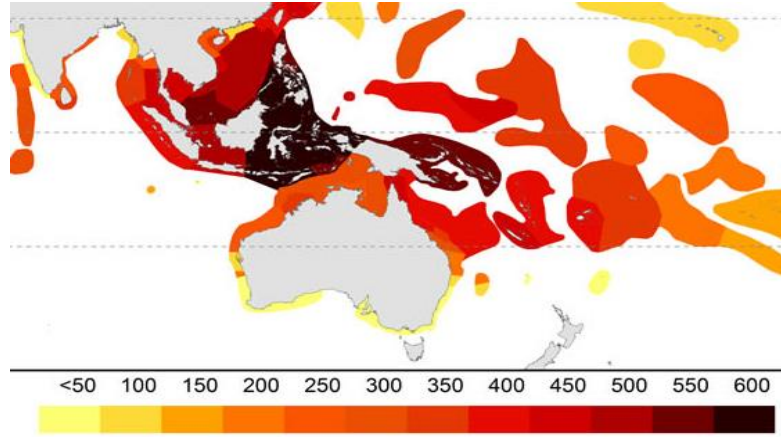
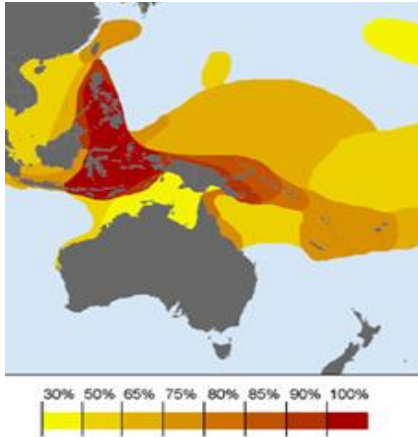
Nick Thake Photography

**Those I've forgotten +
many more over 25 years**

Rowley Shoals: 1995-2017



Biodiversity: fish + coral



Diversity, type, abundance + size of marine animals



10 km

Mermaid Reef
(Commonwealth)



Clerke Reef
(State)

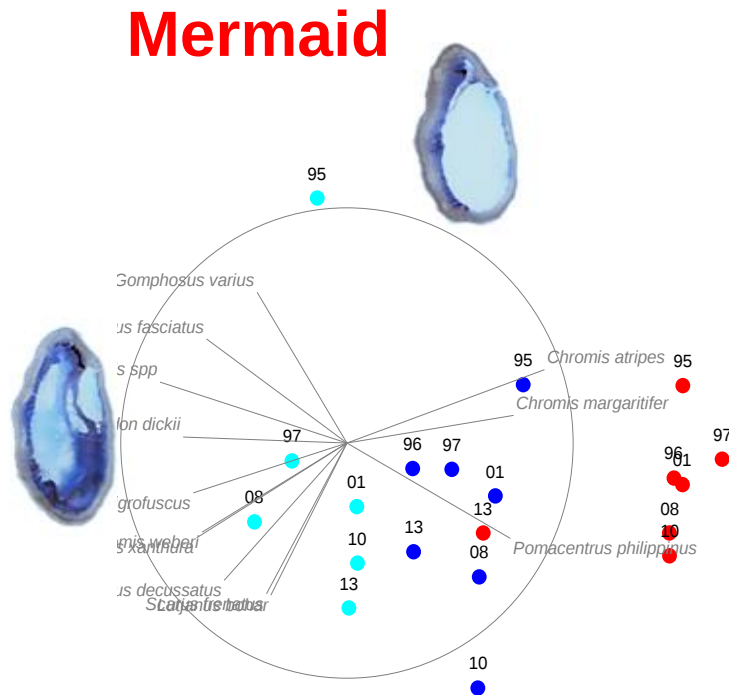


Imperieuse Reef
(State)





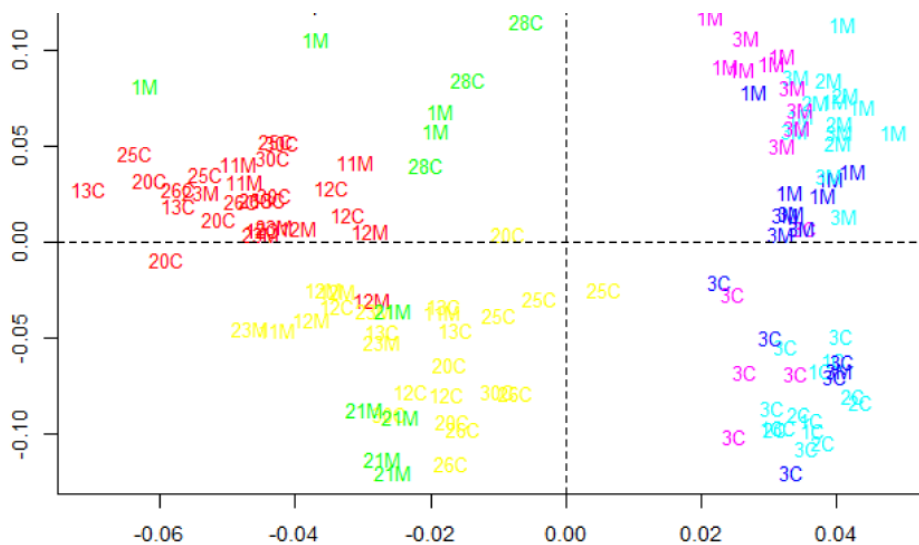
Clerke



Reefs: coral + fish communities

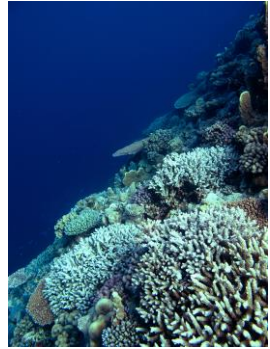
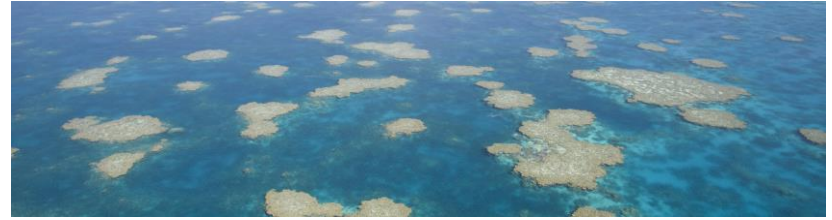
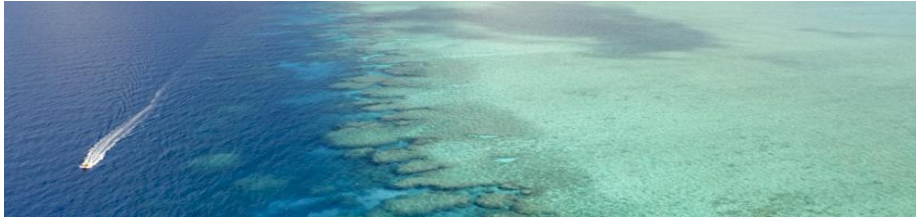


Reef flat
(variable)

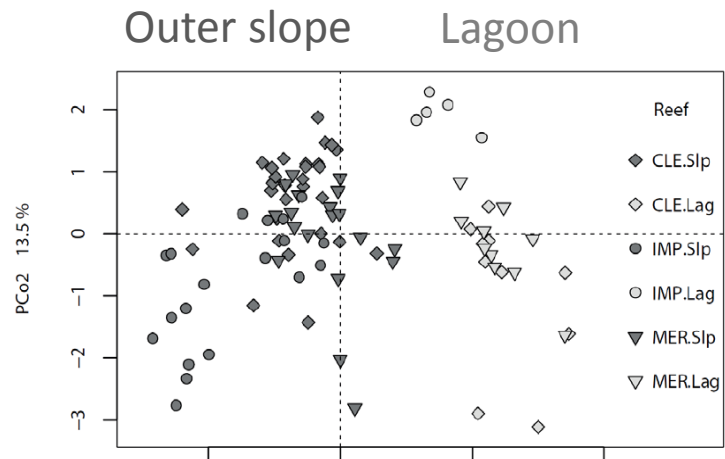
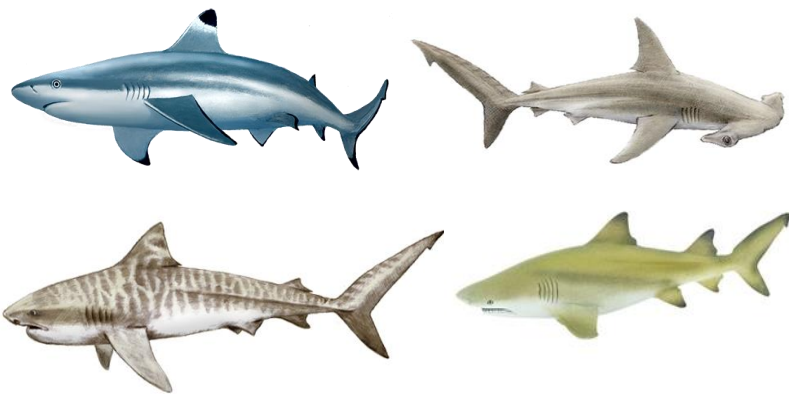


Bommie tops
Bommie base
Lagoon floor

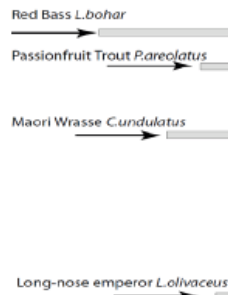
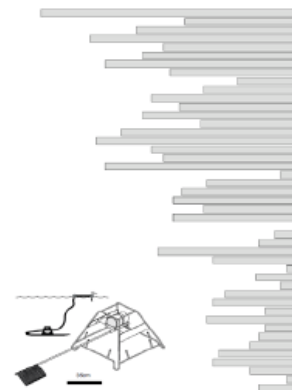
Habitats: coral + fish communities



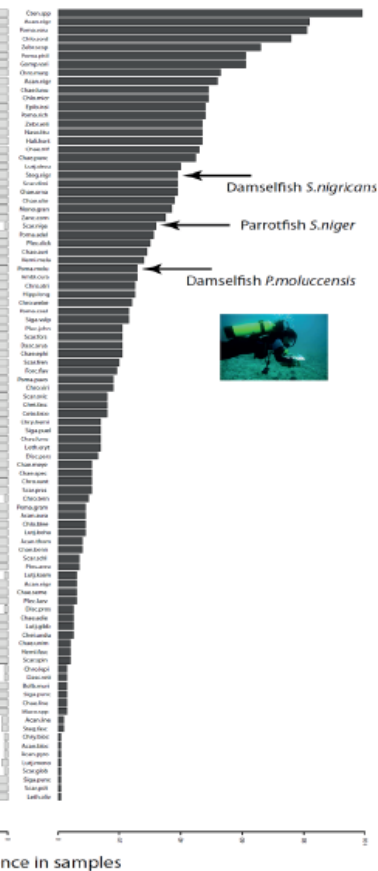
Predatory fish + sharks



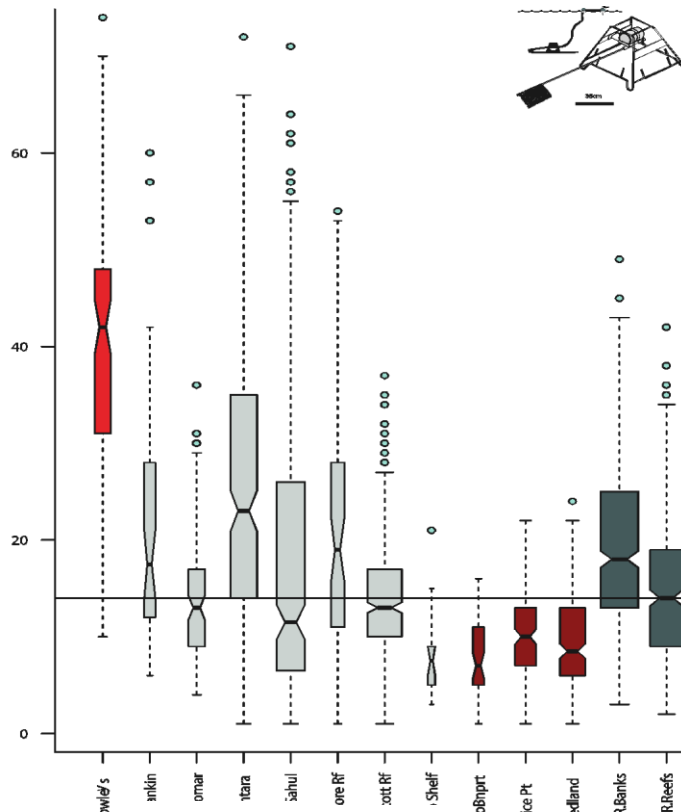
Baited video



Diver counts



number of species



Rowley's

Deep
shoals

Ashmore

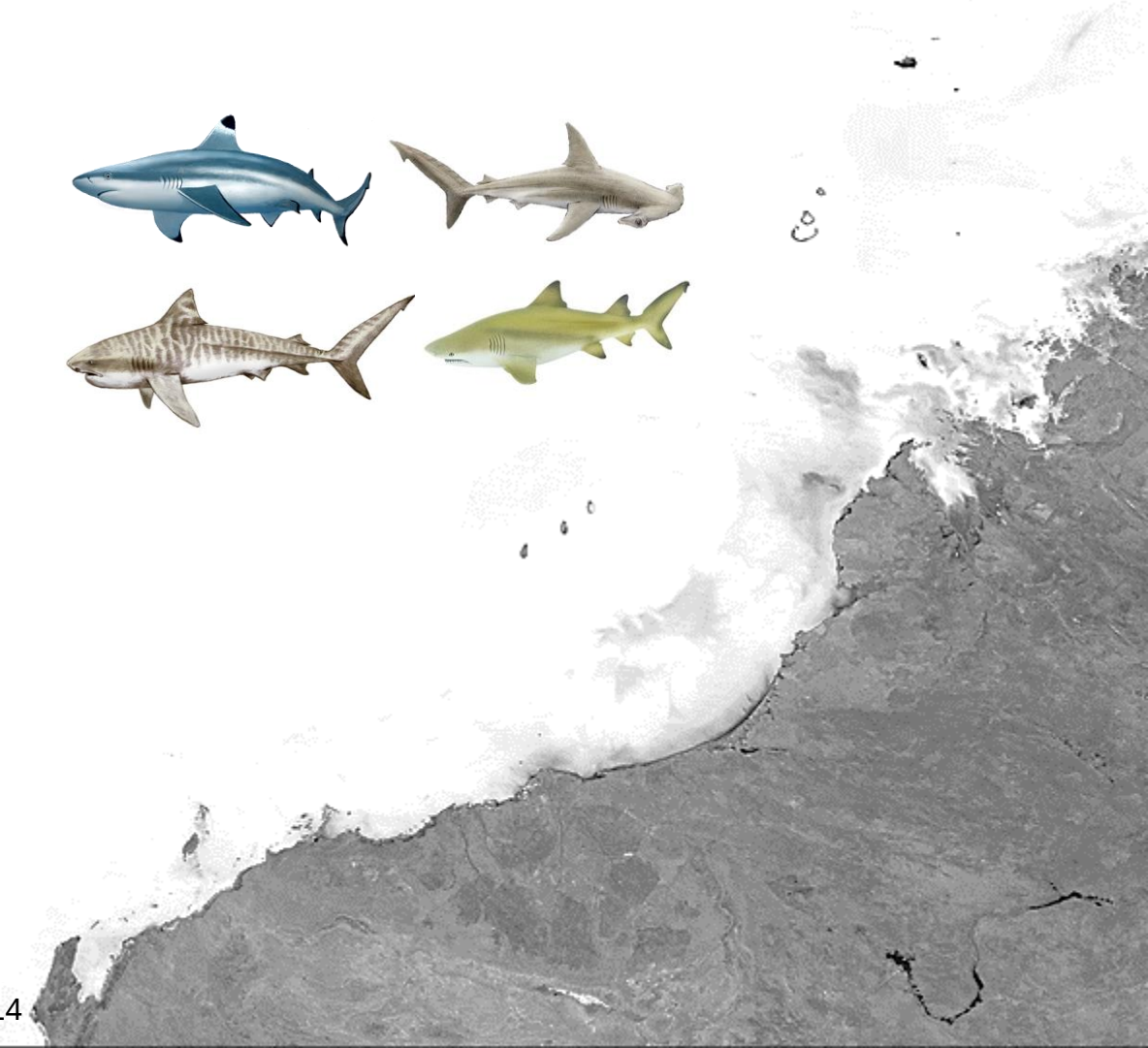
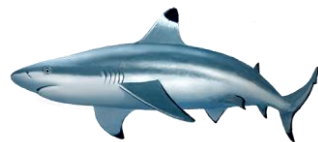
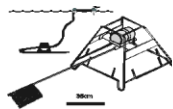
Scott

Ningaloo

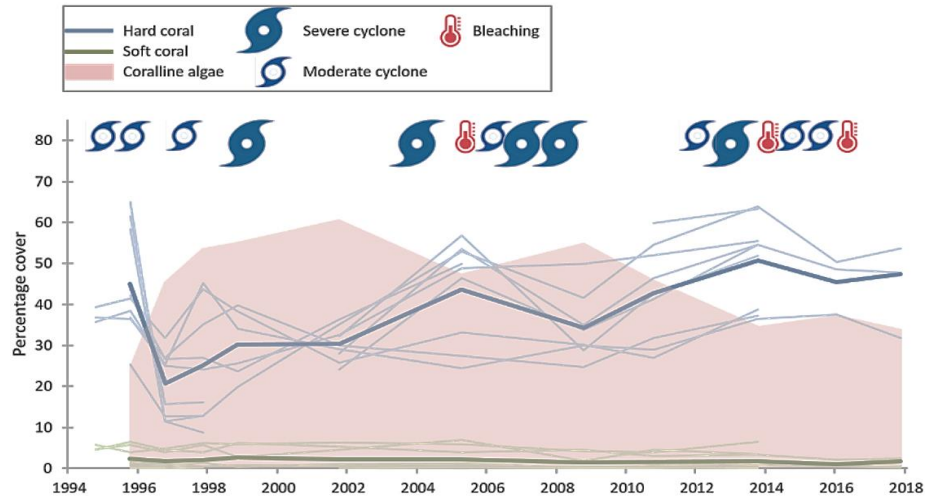
Pilbara

GBR

Cappo et al. 2014

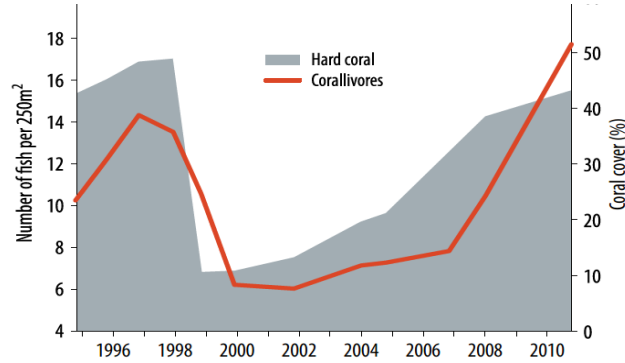


Coral community dynamics

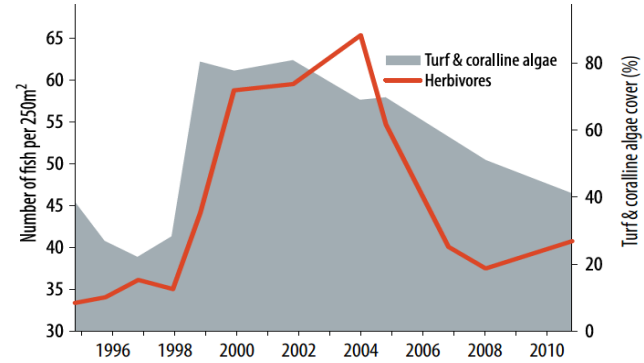


Coral + fish associations: Scott Reef

Coral + corallivores

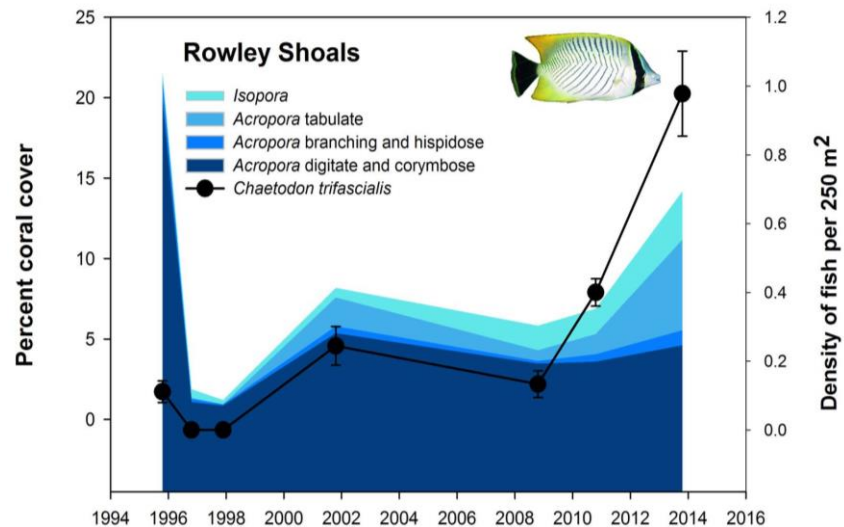
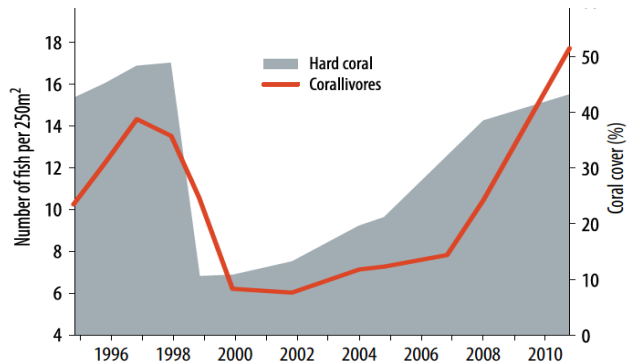


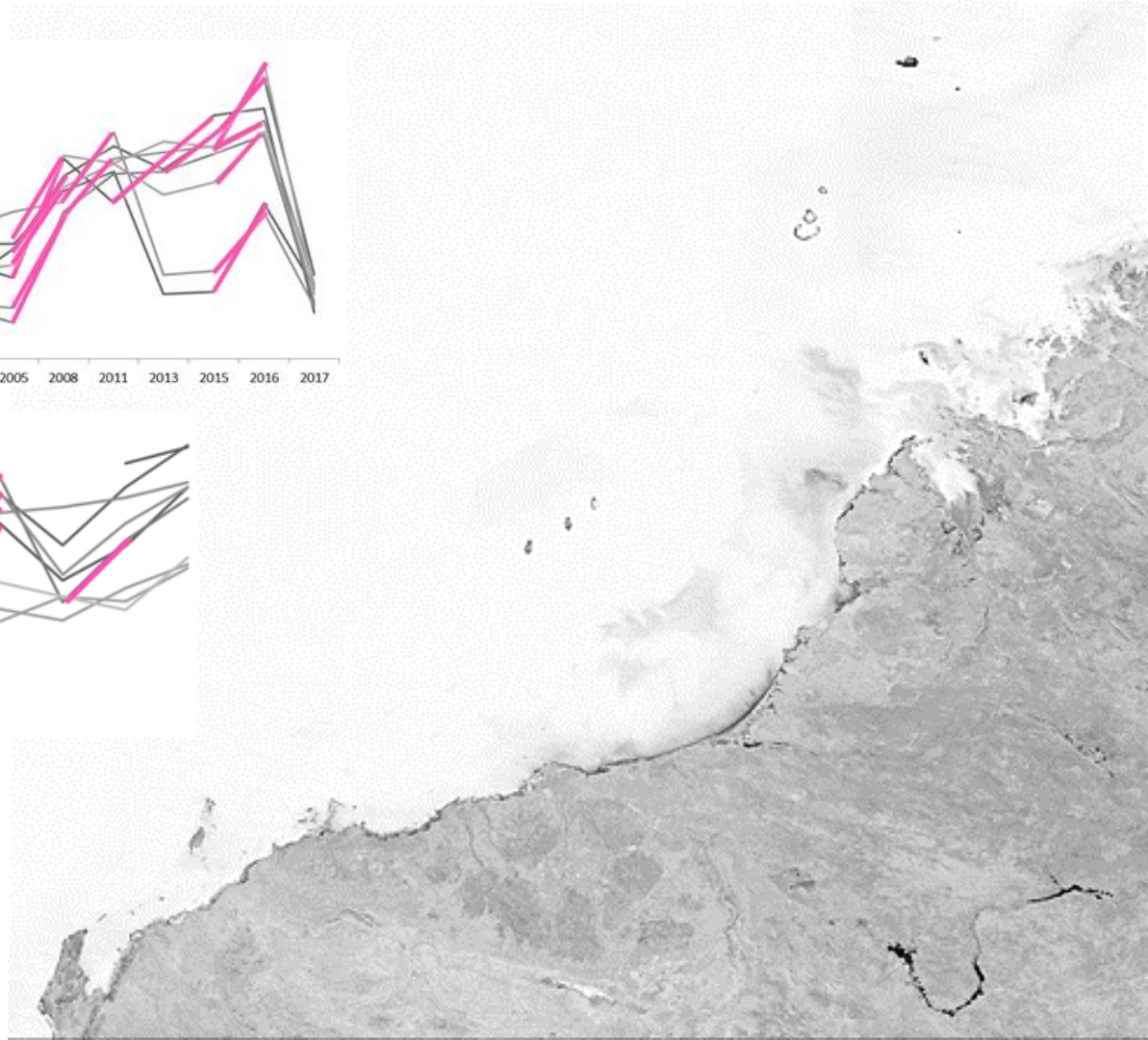
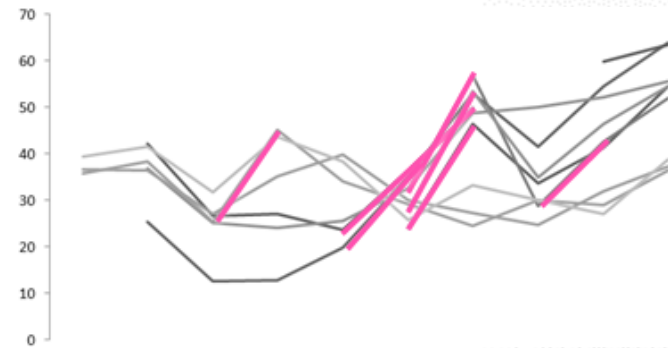
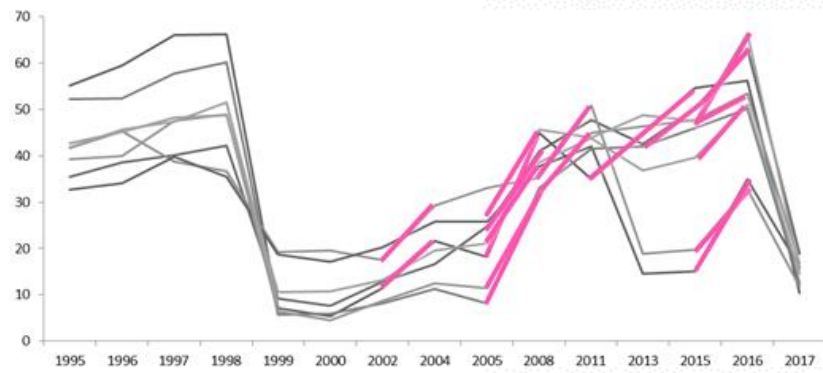
Coralline, turf + herbivores



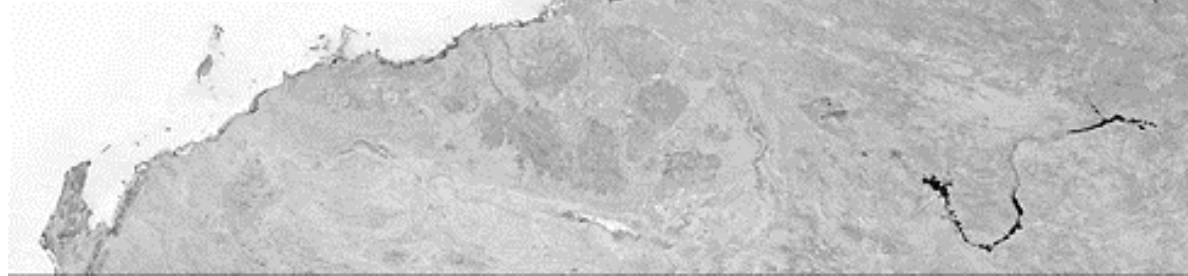
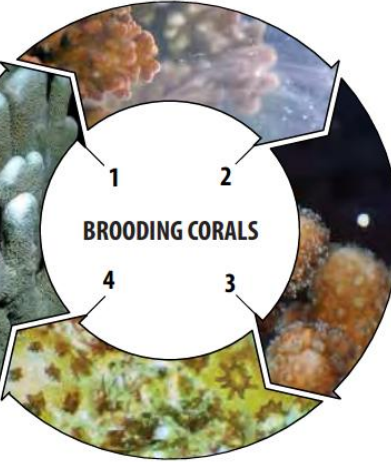
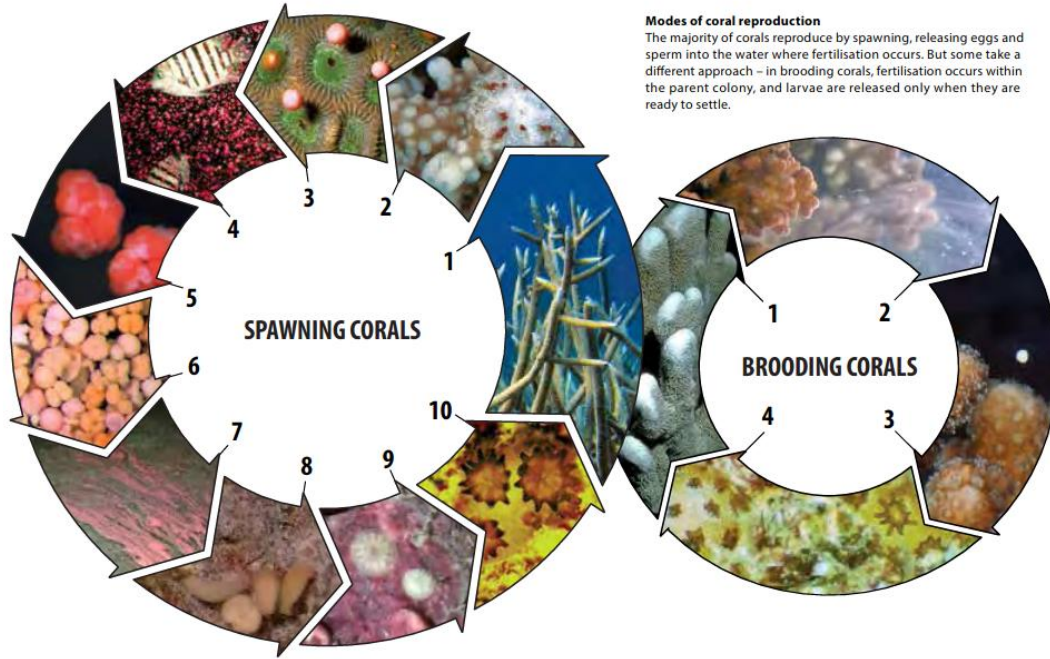
Coral + fish associations: Scott Reef

Coral + corallivores

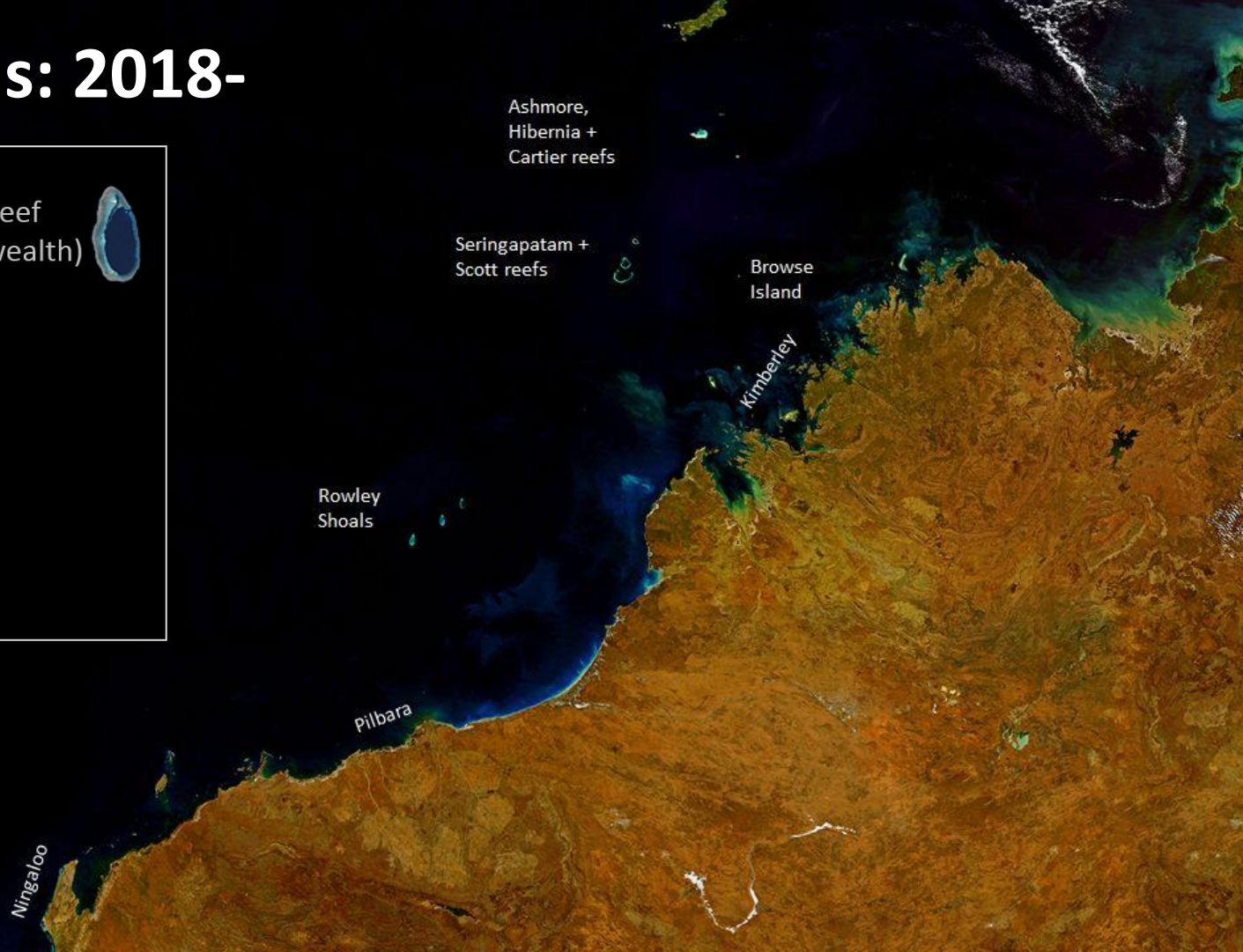
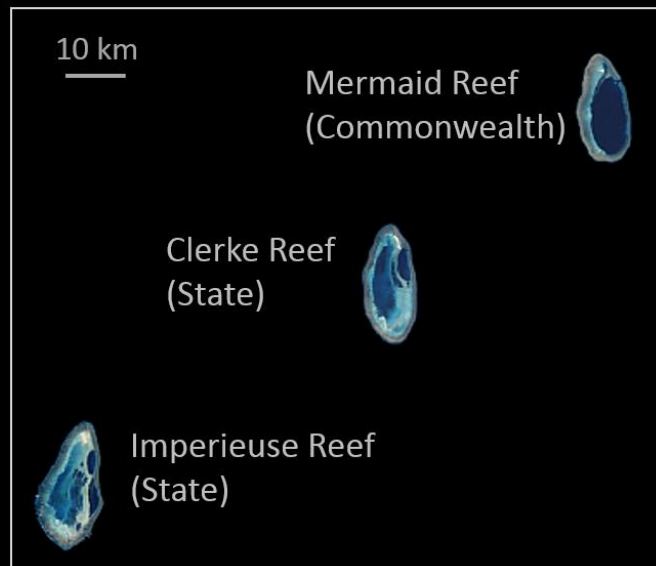




Coral reef resilience: exposure, impact + recovery



Rowley Shoals: 2018-



Monitoring review: what, where, how

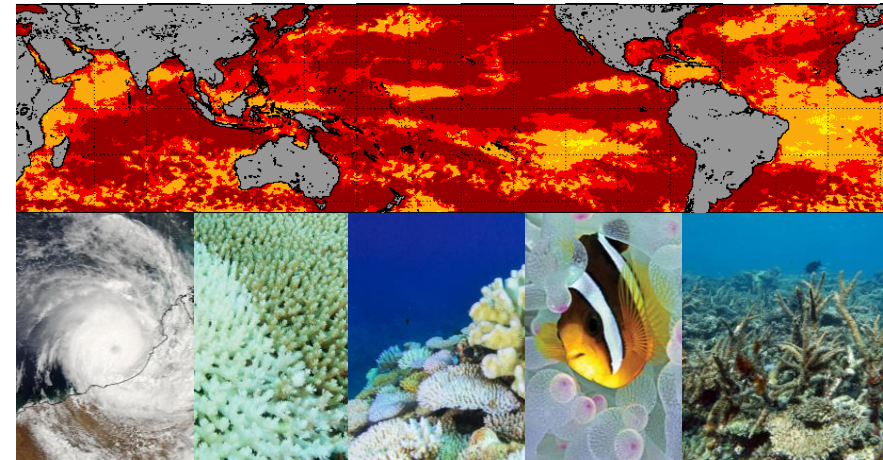
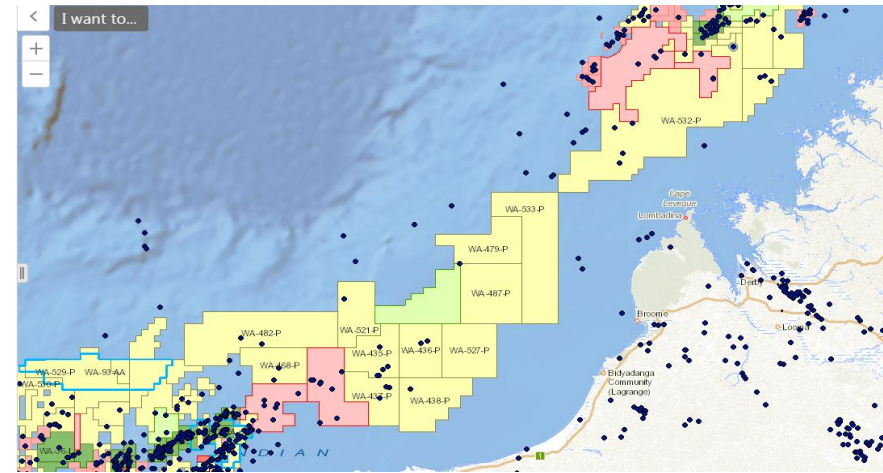
Pressures

Habitats + benthic organisms

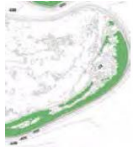
Coral + fish communities

Mobile + predatory fishes

Coral resilience, acclimation + adaptation



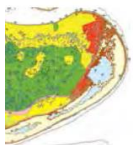
Habitat map + model



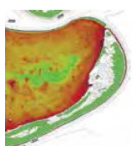
Bathymetry



Satellite



Descriptive

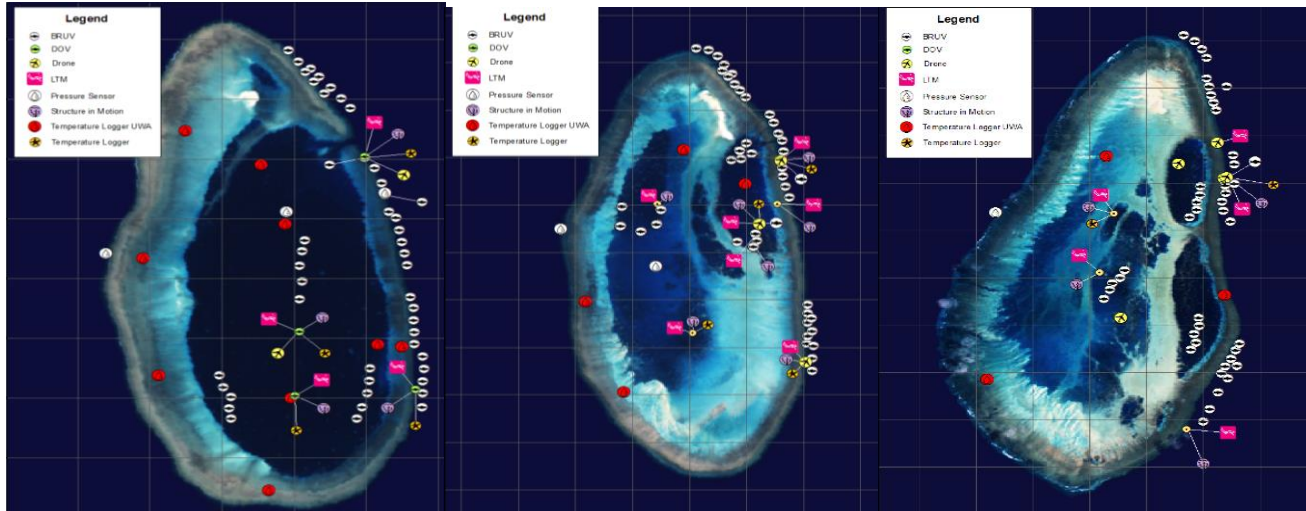


Quantitative

Model underlies much of the proposed research

- Expansion of monitoring sites (habitats, communities, pressures)
- Quantifies habitat area- monitoring change
- Differentiate habitat distributions- physical drivers + processes
- Distribution + movement of predatory fishes + sharks
- Hydrodynamic + heat models

Monitoring- what, where, how



Fish communities

Demersal + mobile fishes

Expand at permanent coral monitoring sites

Review

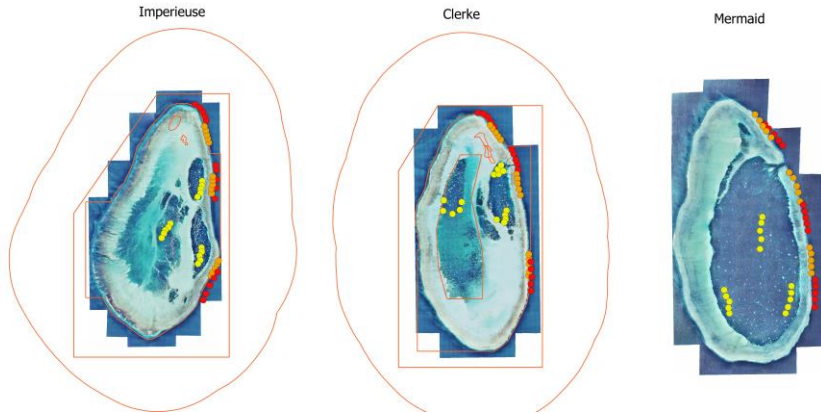
- Target species + functional groups
- Metrics of change (diversity, density, size, biomass)
- Methods of assessment (visual, video, stereo)



Fish communities

Predatory fish + sharks (baited stereo-video)

- 135 sites, lagoon, shallow + deep slope
- Time series (2003, 2013, 2016, 2018)
- Habitat model, coral + fish monitoring



Stereo-BRUV deployments October 2018

• Deep (50-70m)

• Lagoon (5-16m)

• Slope (5-16m)

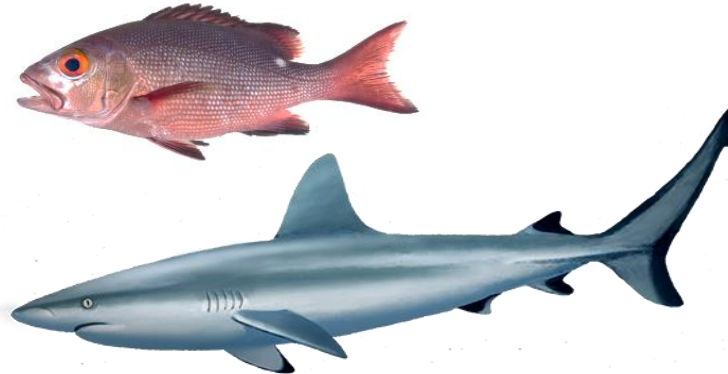
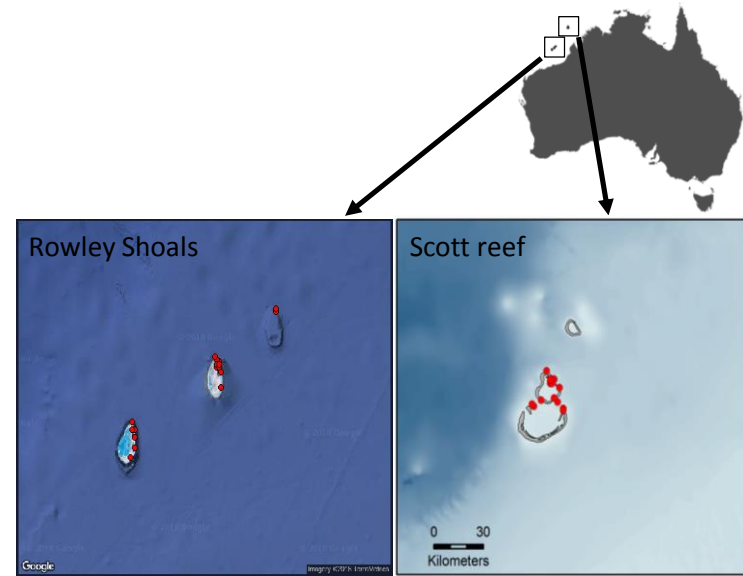
— WA marine park boundaries



Fish communities

Predatory fish + sharks (acoustic tags)

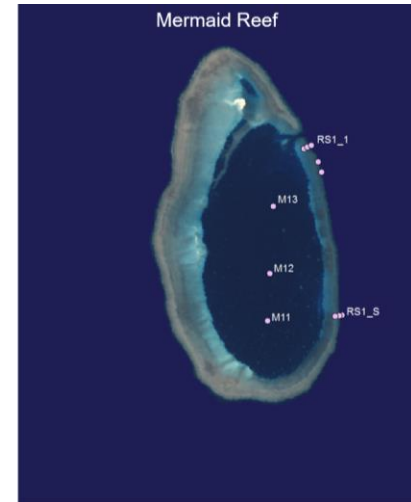
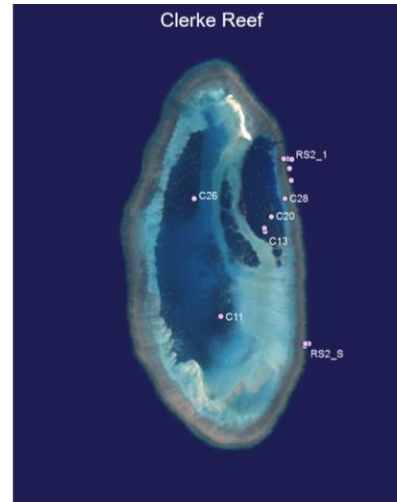
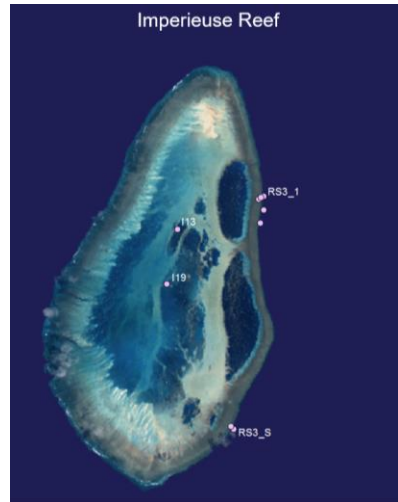
- IMOS* receivers (Rowley Shoals + Scott Reef)
- 61 grey reef sharks + red bass tagged
- Probability distributions for species
- Movement among habitats
- Behavioural comparisons with Scott Reef
- *Habitat model, coral + fish monitoring, BRUVS*



Coral communities

Review

- Expand- Reef slope, crest, flat, lagoon bommies (top, base)
- Metrics of change (coral cover, coral groups)
- (Lagoon floor still uncertain; 10-20m + patchy)
- **Primary method won't change** (trialing various others)



Coral communities

Primary method won't change (trialing others)
eDNA for community distribution + monitoring

- biodiversity assessments + long-term monitoring?

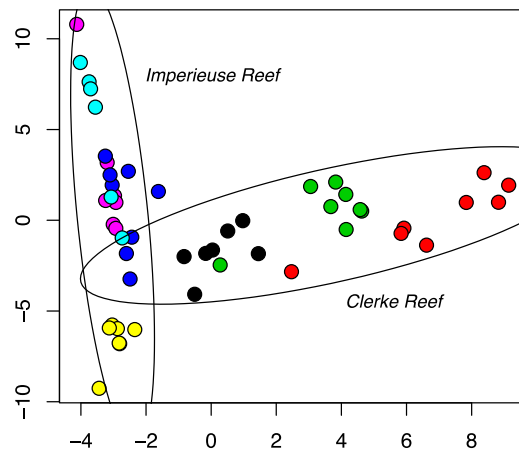
eDNA trial at Rowley Shoals

Known coral dominance + diversity

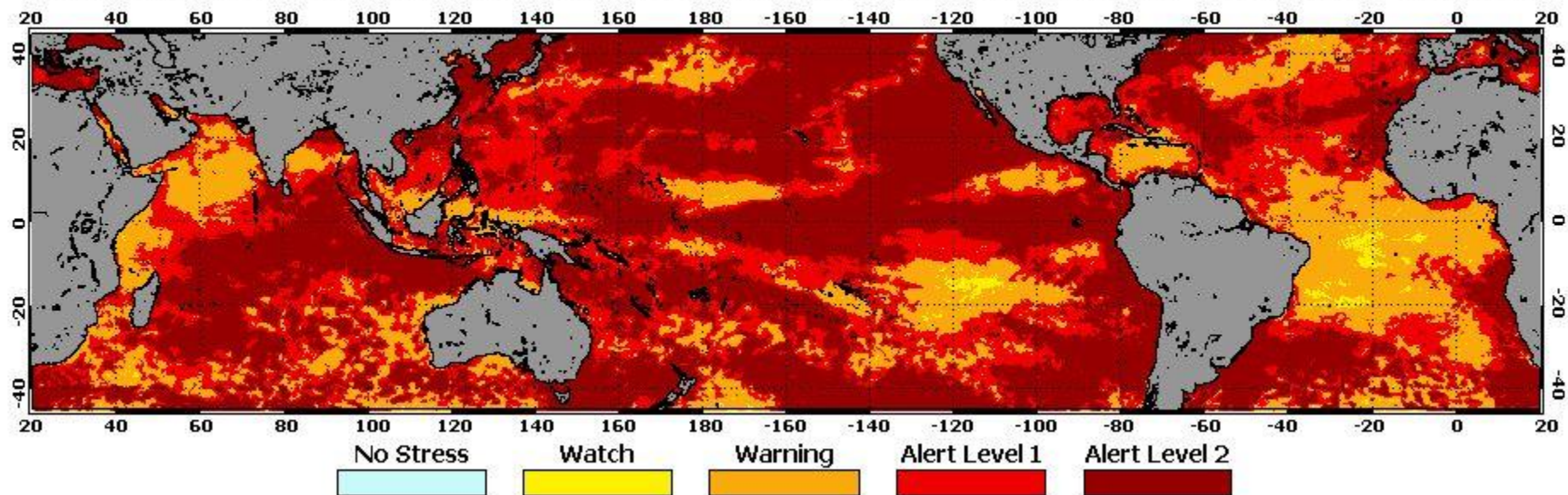
- Sites group- reefs distinct
- Identified 25 families of coral
- 45% overlap with diver surveys
- 20% increase in generic diversity



Dugal, Thomas et al. in prep



NOAA Coral Reef Watch 5 km Maximum Satellite Coral Bleaching Alert Area June 2014 - May 2017



Monitoring + climate change at the Rowley Shoals

Mass-bleaching + mortality depend on:

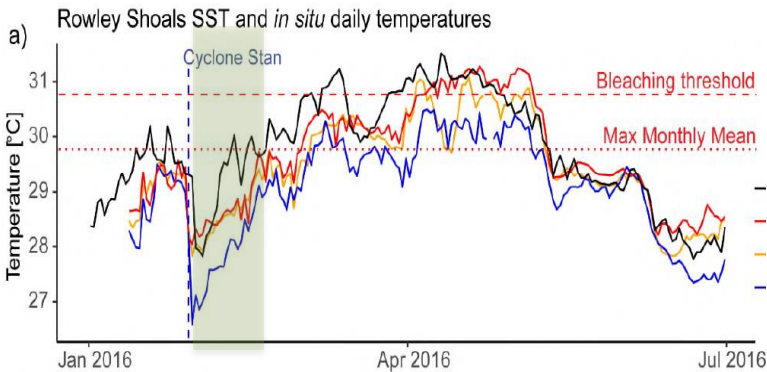
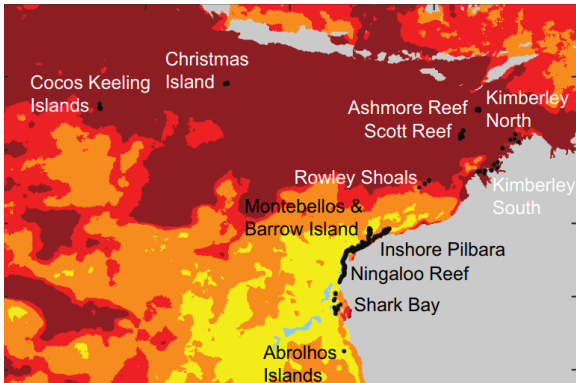
1. Exposure to heat stress
2. Resistance + resilience to heat stress
3. Acclimation + adaptation to heat stress



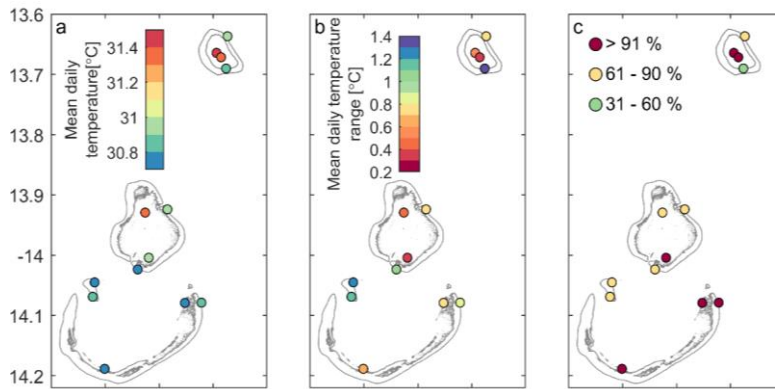
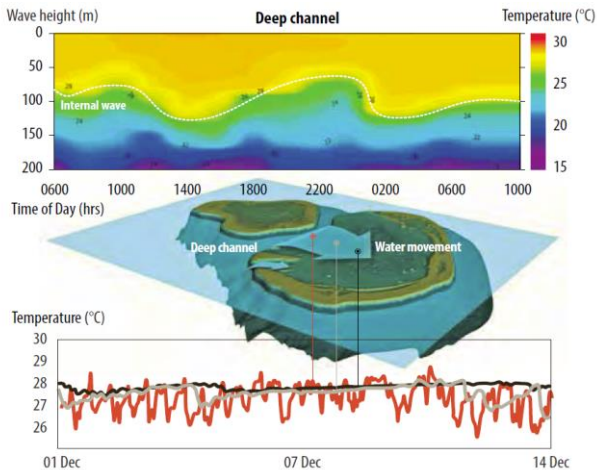
1. Exposure to heat stress

Regional exposure + cyclone cooling

Gilmour et al. 2019



Local exposure
Cool water intrusions
Atmospheric cooling

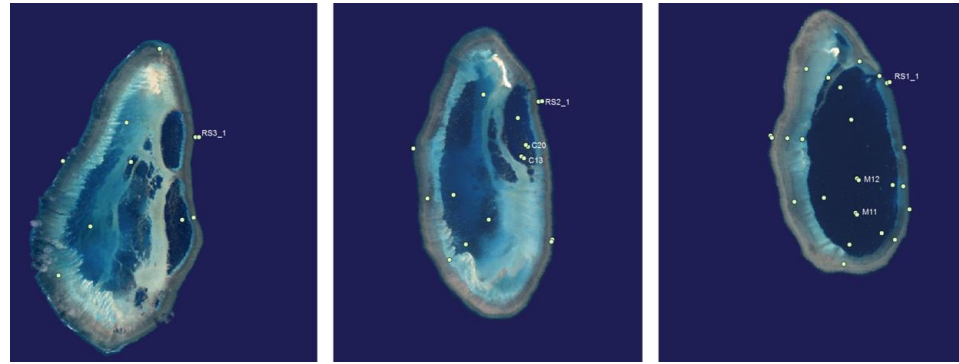


Green et al. 2019

1. Exposure to heat stress

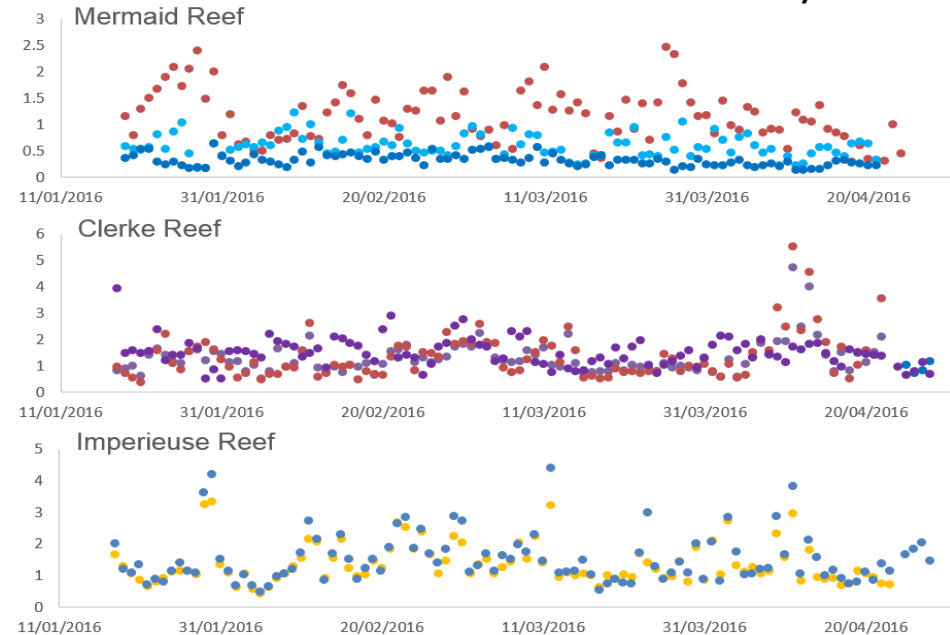
Local exposure

Overlaying satellite SST and *in situ* loggers at monitoring sites: 47 at sites, habitats + depths



Hydrodynamic heat stress model

- Fine-scale variability in bleaching
- Local processes of cooling
- Genetic differentiation + acclimation



2. Resistance + resilience to heat stress

Species resistance
'Winners + losers'

Susceptibility



Isopora
95% decrease



Branching *Acropora*
92% decrease



Encrusting corals
67% decrease



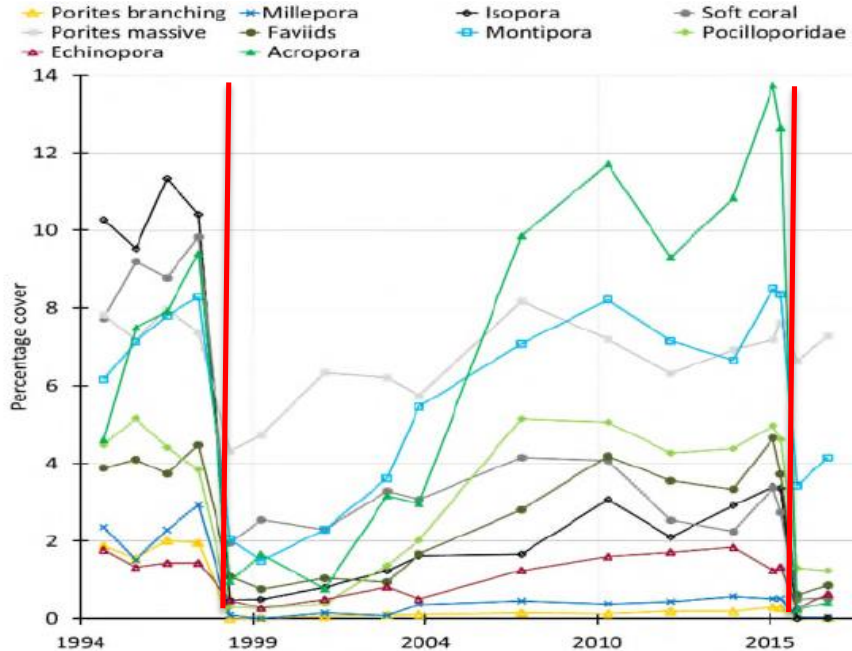
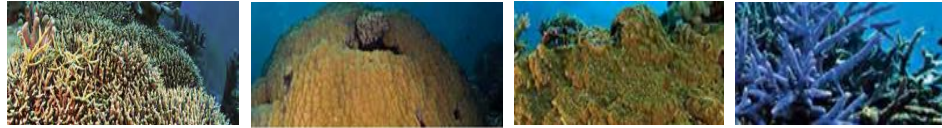
Massive *Porites*
48% decrease



2. Resistance + resilience to heat stress

Species resilience

- timeframe
- severity + scale of impact
- coral life histories



2. Resistance + resilience to heat stress

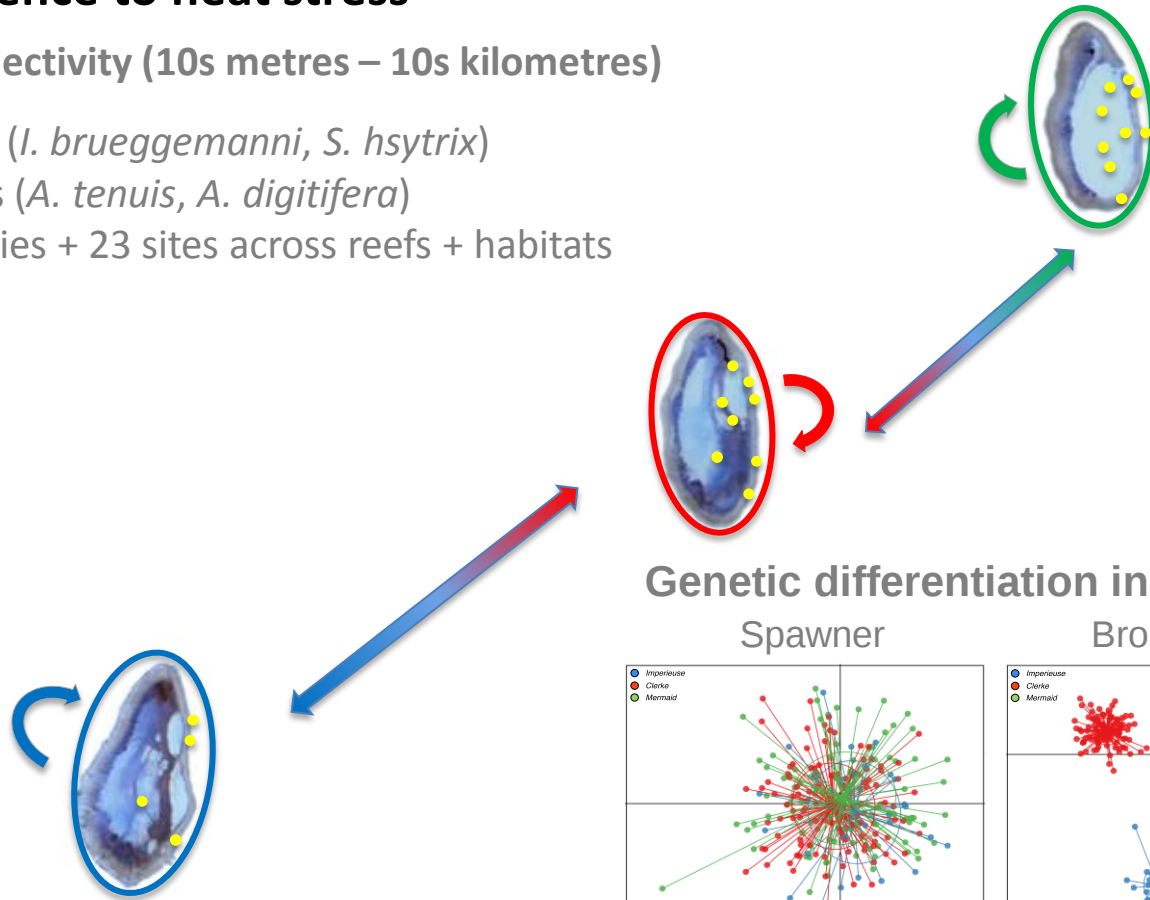


Larval connectivity (10s metres – 10s kilometres)

2 brooders (*I. brueggemanni*, *S. hsytrix*)

2 spawners (*A. tenuis*, *A. digitifera*)

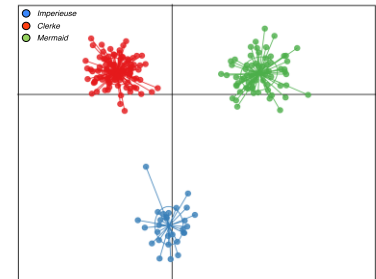
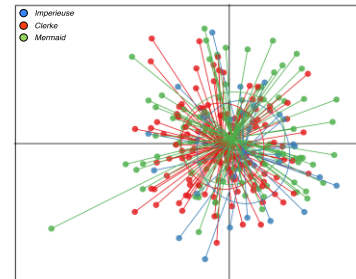
1200 colonies + 23 sites across reefs + habitats



Genetic differentiation in corals

Spawner

Brooder

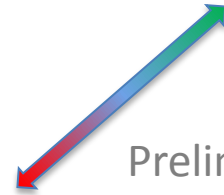
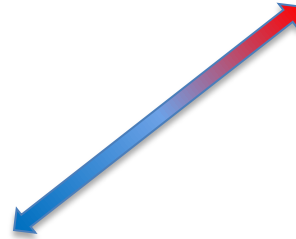
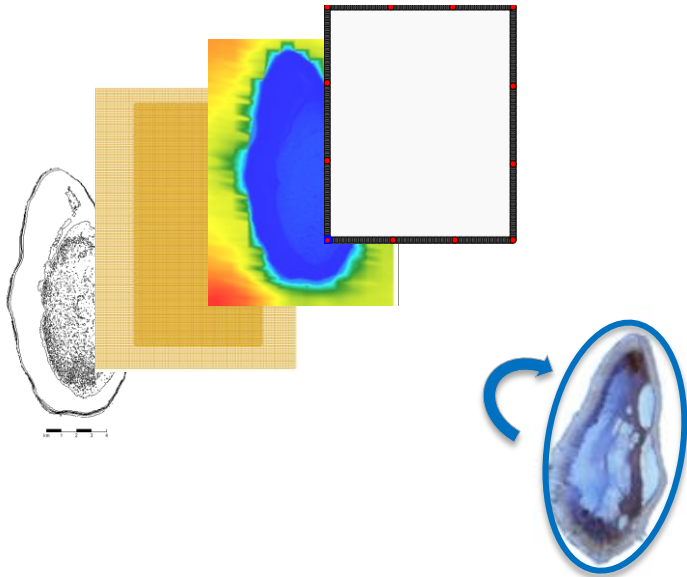


2. Resistance + resilience to heat stress

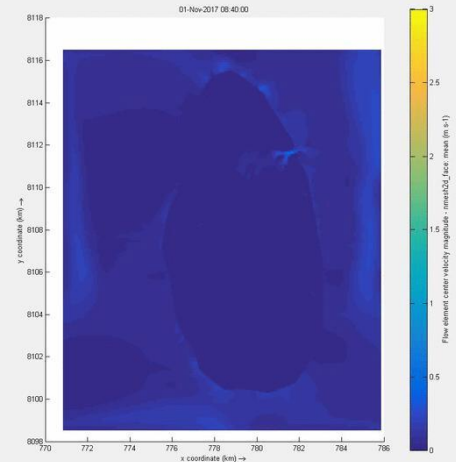
Larval connectivity (10s metres – 10s kilometres)

Hydrodynamic model + larval dispersion

- Numerical simulations using Delft3D Flexible
- Simulations on high performance cluster (HPC)
- Expected resolution (10 min – 30m)



Preliminary output



3. Heat stress, adaptation, acclimation + symbionts (*A. tenuis*)

