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## 2. The resilience of Rowley Shoals and future reefs

- a) *Bleaching 2020*
- b) *Hydrodynamic connectivity*
- c) *Genetic connectivity and adaptation*





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## *The resilience of Rowley Shoals and future reefs*



AIMS: Australia's tropical marine research agency.

## Coral bleaching 2020

Nicole Ryan, James Gilmour – AIMS

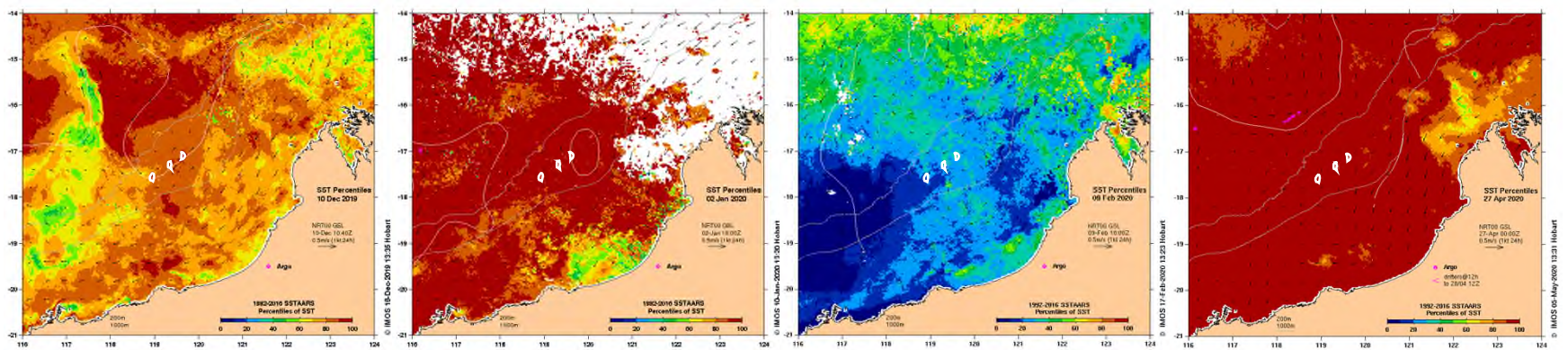
Christopher Nutt, Tom Holmes- DBCA

Claire Spillman - BOM

Michelle Glover, Glen Salmon- Parks Australia  
(Australian Border Force)

Great Escape Cruises



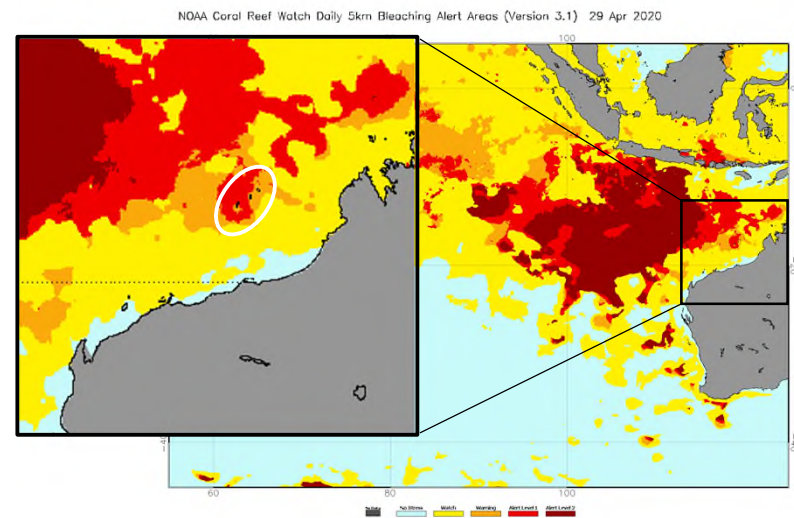
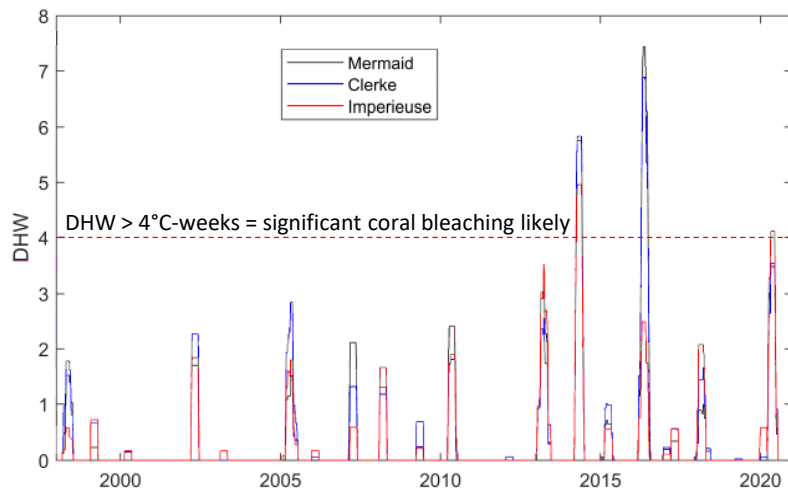


December 2019  
IMOS 2020

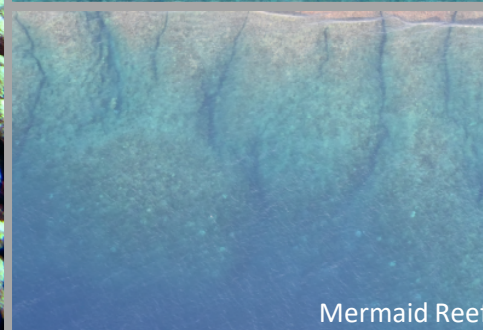
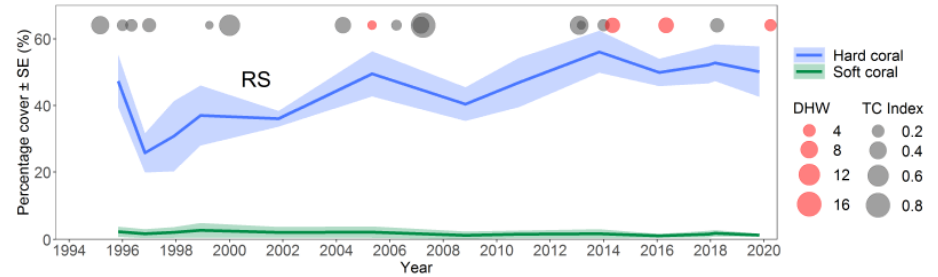
January 2020

February 2020

April 2020



Healthy coral  
community on the  
eastern slope of  
Clerke Reef in 2017

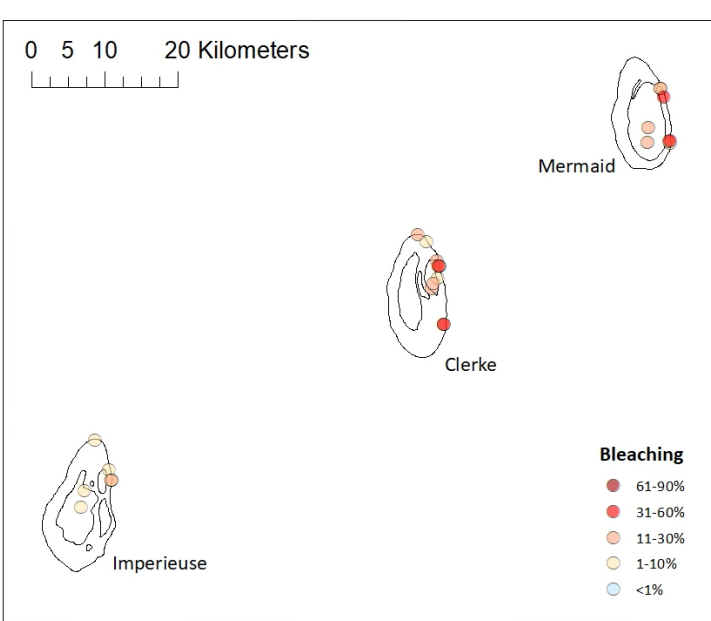


Bleaching was detected at  
each reef during Australian  
Border Force aerial surveys in  
late April 2020

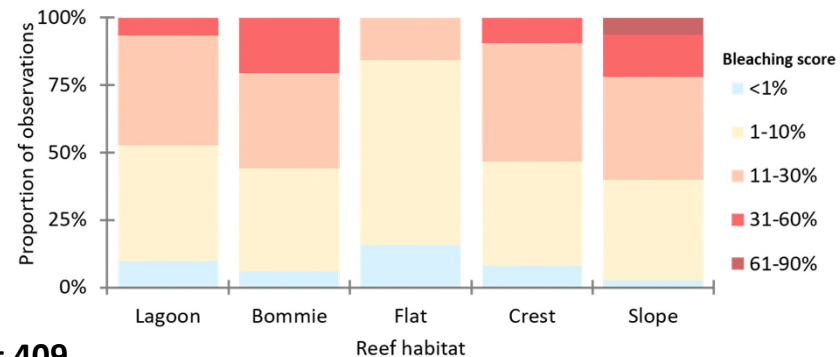
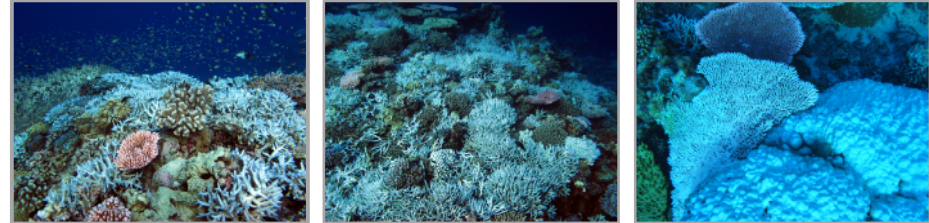
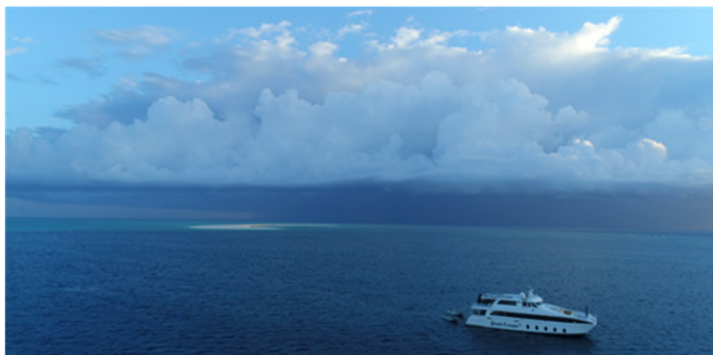
Photo: N Thake

Mermaid Reef

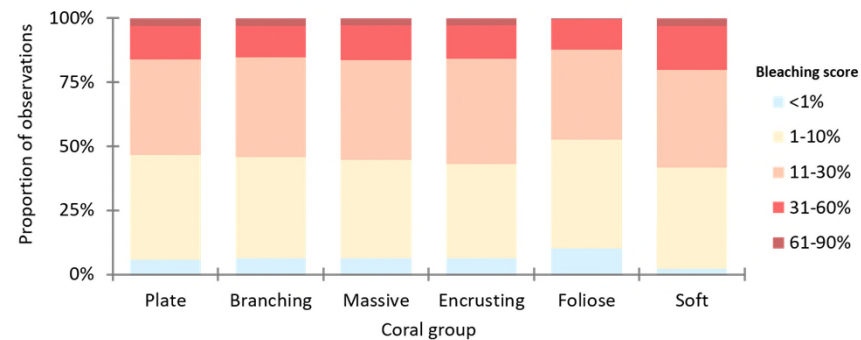




Mean bleaching estimates from photo observations



n= 409



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# Modelling hydrodynamics and coral connectivity

Camille Grimaldi, Ryan Lowe, Jessica Benthuisen,  
Rebecca Green and James Gilmour

# Reef hydrodynamics

- Reef hydrodynamic processes  
i.e. waves, tides, wind,...
- Regulates distribution of water and material on coral reefs.  
i.e. heat, nutrients, coral larvae,...
- Influence key ecosystem processes.  
i.e. coral bleaching, genetic connectivity,...



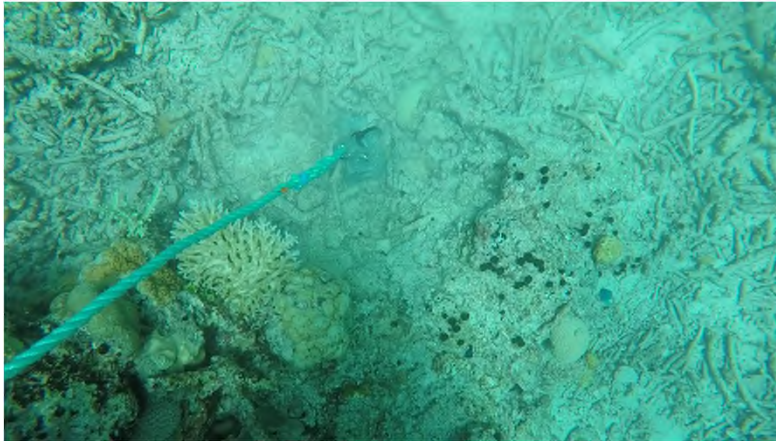
Mermaid reef, Rowley Shoals



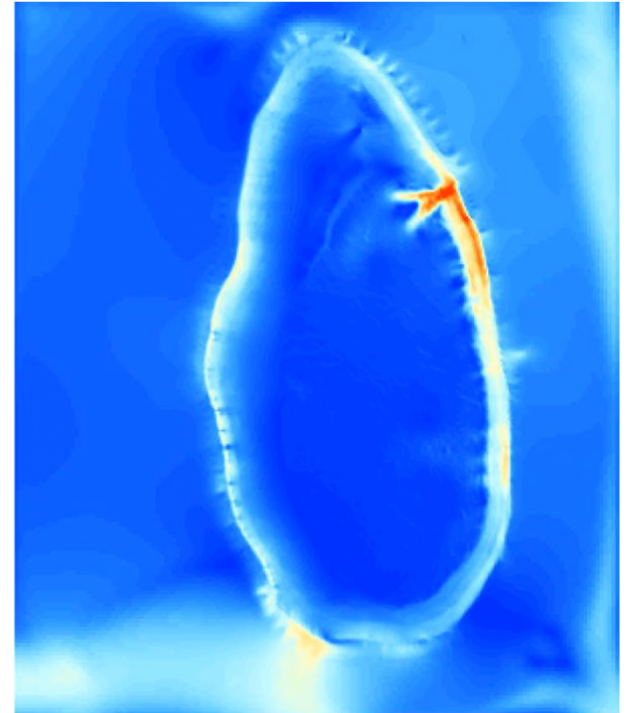
# Measuring reef hydrodynamics

- **In situ measurements**

More than 45 instruments deployed across the reef

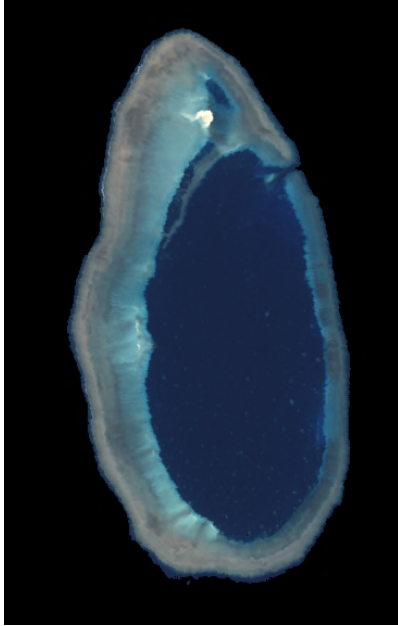


- **Numerical modelling**



# Mermaid reef hydrodynamics

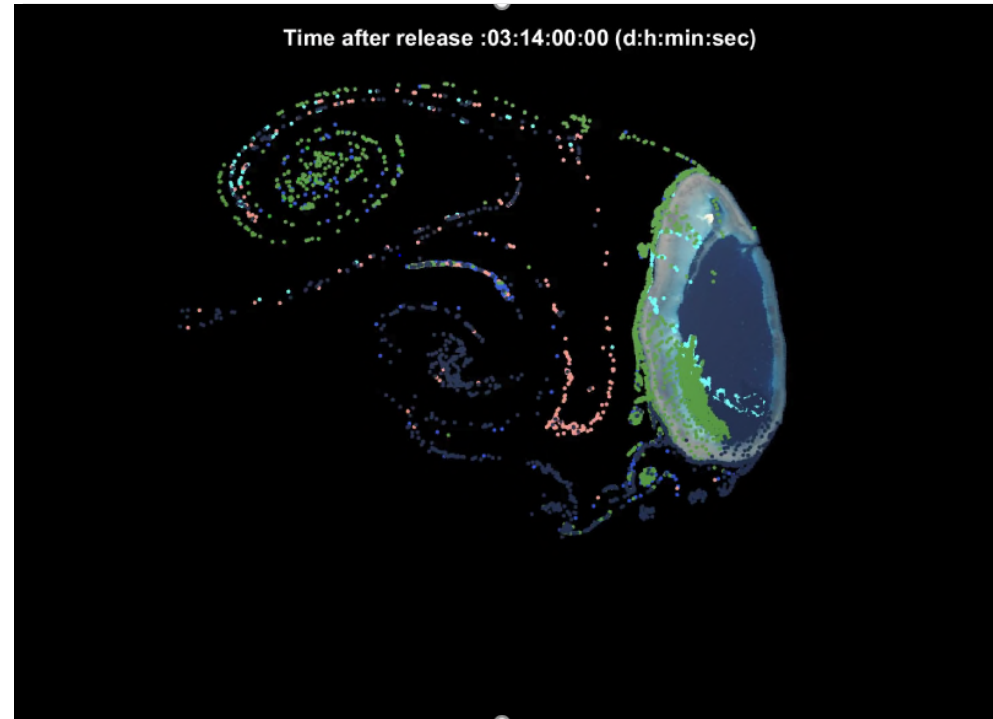
## Atoll morphology, tides and waves





# The resilience of Rowley Shoals and future reefs

- Numerical modelling is a powerful tool
- Apply hydrodynamic understanding to physical connectivity of populations
- Essential for management and conservation of coral reef systems





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*The resilience of the Rowley  
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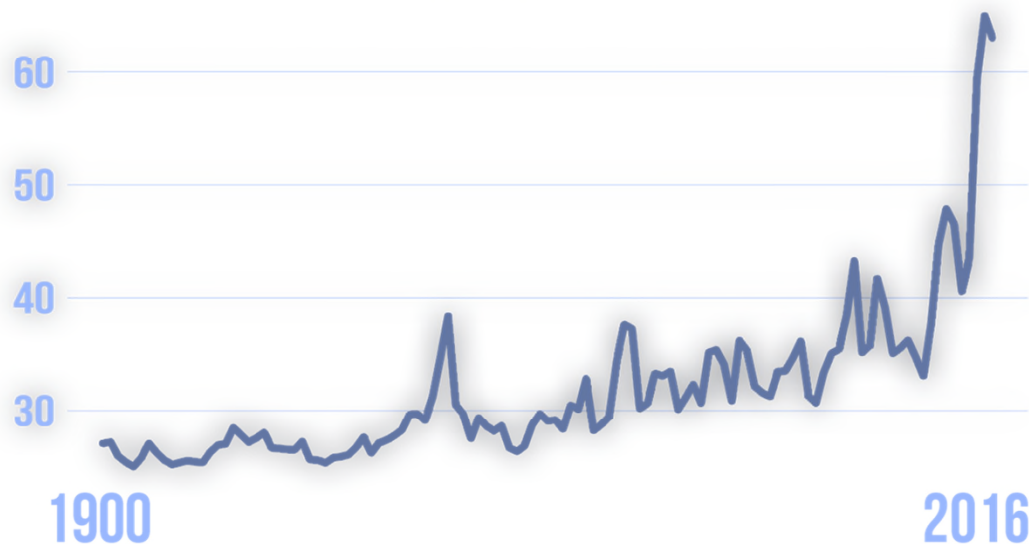
# Mechanisms of coral resilience at the Rowley Shoals

Luke Thomas, Jim Underwood, James Gilmour



# MORE OCEAN HEATWAVES

## GLOBAL MARINE HEATWAVE DAYS 1900-2016



Average annual global marine heatwave days from 1900-2016  
(HadISST, CERA-20C, ERSST, SODA, and COBE sea surface temperature datasets)  
Source: Holbrook et al. 2020



CHANGES RANGES  
OF SPECIES' HABITATS



IMPACTS ECONOMICS  
OF FISHERIES



BOOSTS TROPICAL  
STORMS & HURRICANES



BLEACHES CORAL

CLIMATE  CENTRAL

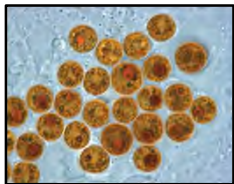


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## *'The Darwin Paradox'*



symbiont



polyp



colony



reef

## Symbiosis breakdown





# Resilience (n)

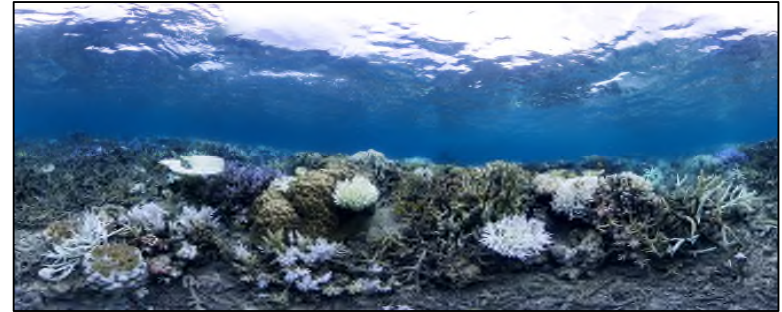
*...maintain structure, function and feedbacks in the face of disturbance.*

## Recovery



How connected are coral populations at the Rowley Shoals?

## Adaptation



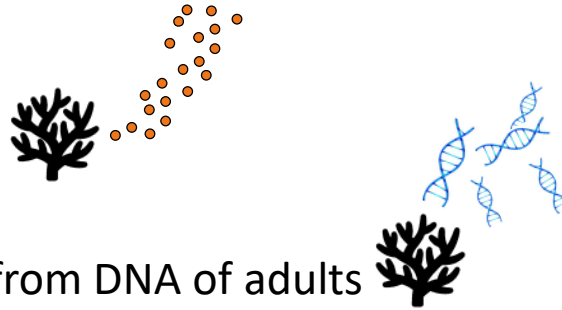
Do they have the necessary genetic toolkit to adapt?

## Short-term

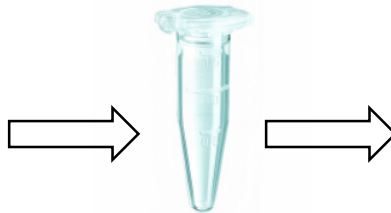
## Long-term

# How connected are coral populations at the Rowley Shoals?

- Difficult to track larvae
- But we can infer connectivity from DNA of adults



Collect sample



Extract DNA



Fragment DNA and  
sequence



Align sequence  
reads and calculate  
differences





x 450 samples



x 9 site



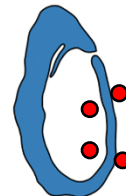
x 2 habitats



*Imperieuse*



*Mermaid*



*Clerke*

*spawner*



*brooder*



0 10 20 30 40 km

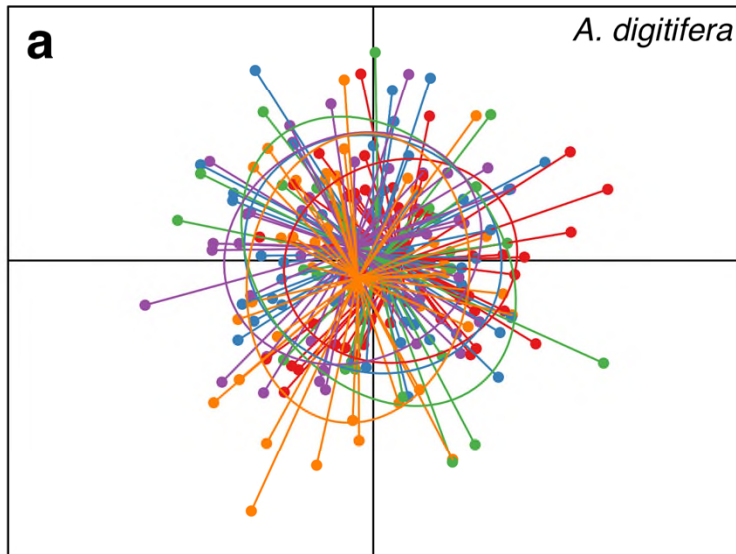


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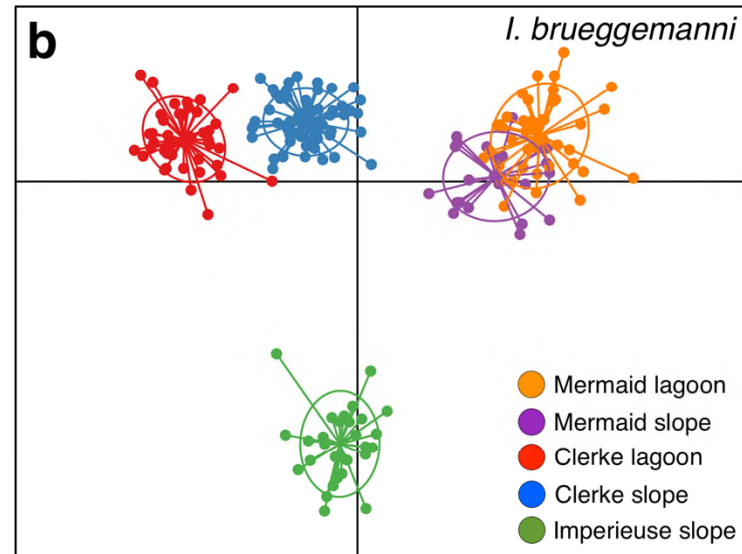


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## spawner



## brooder



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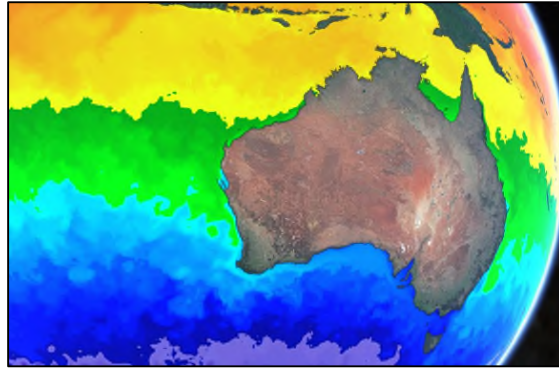
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# Do they have the necessary genetic toolkit to adapt?

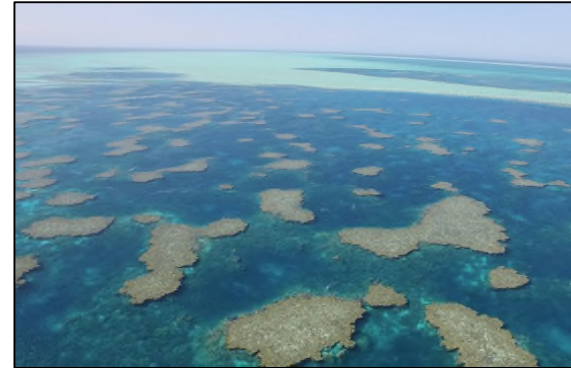
*Rapid adaptation is widespread!*



Warm environments breed heat resistant coral



latitudes

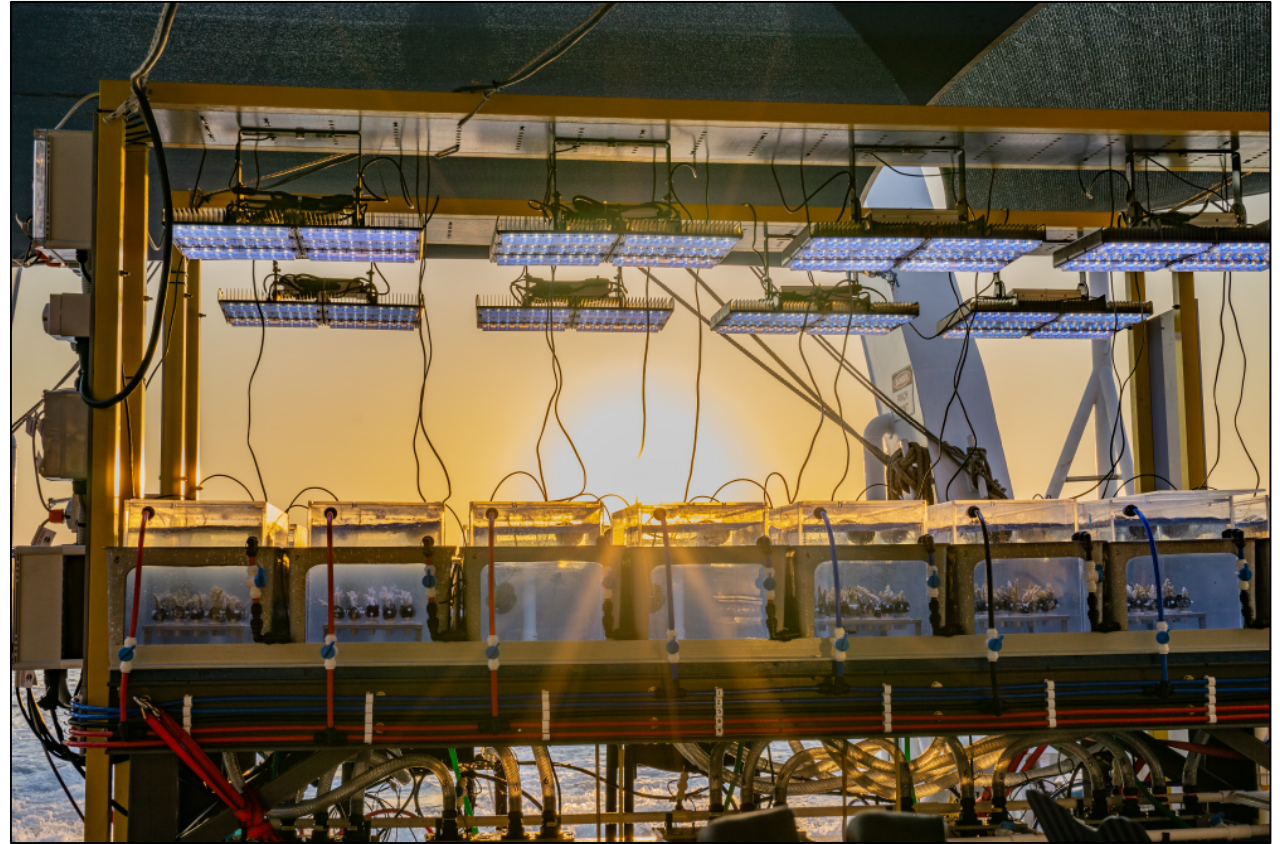


seascapes

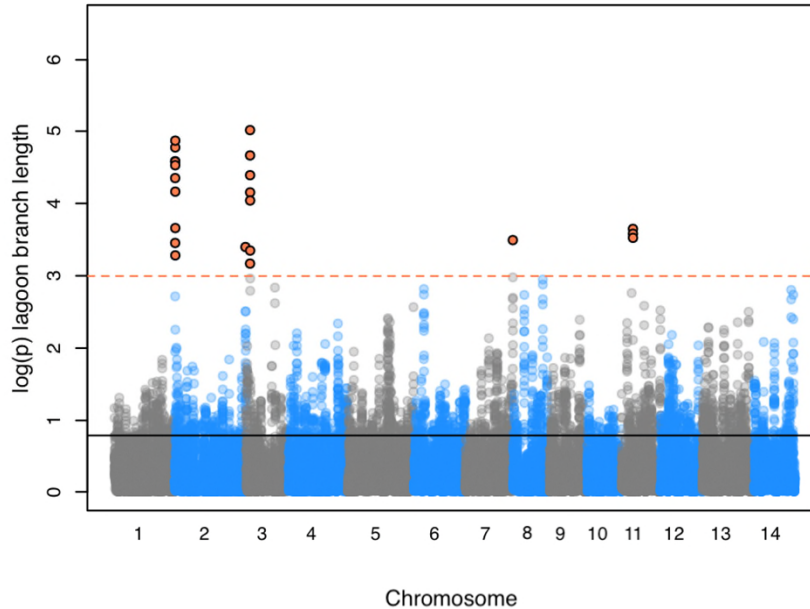




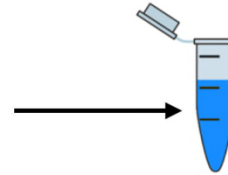
## An experimental tool to measure thermal tolerance *in-situ*



# Expand our portfolio of heat adapted corals



Assay of heat tolerance



Prioritize areas for spatial conservation



Brood stock for restoration initiatives



Improve accuracy of models



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### 3. The resilience of Rowley Shoals and future reefs

# QUESTIONS?

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