

## Understanding coral range expansion to enhance management strategies



Toni Mizerek

PhD. Candidate  
Macquarie University  
Sydney, Australia  
SCCS, Jan. 2013

## Climate Change Warming Waters

- SST increased  $0.7^{\circ}\text{C}$  since 1920s and will continue to increase  $2.5^{\circ}\text{C}$  by 2100
- Southeast Australia - expected to experience the greatest change
- SE Australia is a global warming hotspot

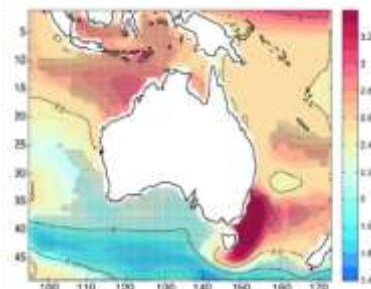
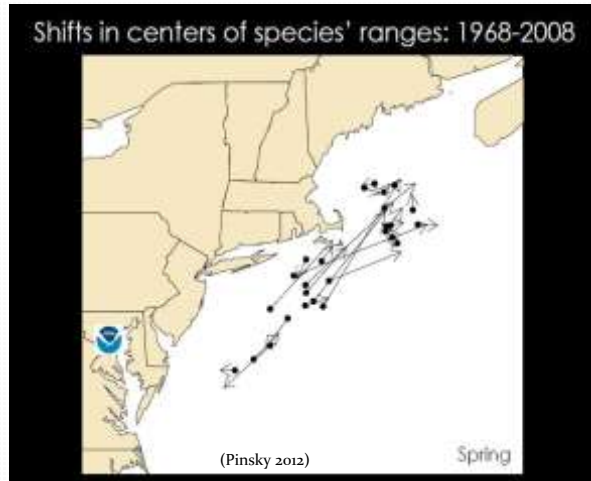


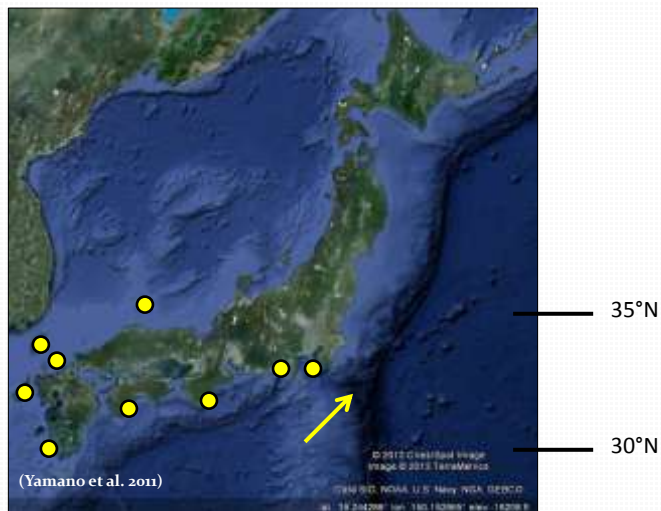
Figure 16: Projected change in SST by the end of 21<sup>st</sup> century based on RCP8.5 scenario. Areas where at least 20% of models agree that warming is greater or less than the region average are shaded.

(Lough et al. 2012)

## Range Shift: US Commercial Fisheries



## Range Shift: Corals in Japan



## Range Shift? Corals in Australia



2011-New observations:



*Acropora intermedia*



*Acropora microclados*



*Acropora monticulosa*



*Acropora gemmifera*

Solitary Islands (30 °S)

**Potential range expansion of corals along the east coast of Australia**

## Primary Objectives

1. Are these species random or can we predict which species we may see farther south?
2. If these species are predictable, how can we use the information to inform management decisions?

# Learning about coral expansion

A Biogeographic Database of Hermatypic Corals (Veron 1993)



## Species Across a Gradient

15 sites

338 Species

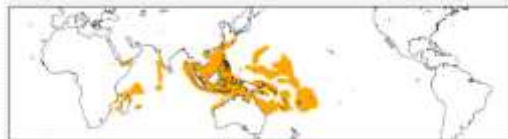
Presence/Absence

# Species Traits

## Coral Trait Database

- Ecological
- Geographical
- Biomechanical
- Morphological
- Physiological
- Conservation
- Reproductive
- Taxonomic

### *Acropora monticulosa*



#### Measurements

New Observations: 828 Corals / 1000

#### Biomechanical

substrate\_attachment: attached category [no ref]

#### Conservation

list\_cat: category [no ref]

featured\_ref\_or\_destroyed\_and\_critical\_ref: 0 category [11]

red\_list\_category\_hypothetical\_year\_1990: 1C category [11]

#### Ecological

upper\_depth\_m: 1 m [no ref]

abundance\_msd: 1000000 category [11]

generates\_brooth\_aria: 10 yr [11]

lower\_depth\_m: 22 m [no ref]

abundance\_ahr: 100000 category [10]

annual\_rate\_of\_recruitment: 1 category [no ref]

max\_depth: 11 m [11]

order\_classification: 100 category [10]

order\_classification: 100 category [10]

#### Geographical

range\_size\_km2: 21427236.62 km2 [no ref]

range\_size: 21427236.62 km2 [no ref]

area\_dist\_sq: 2632 km2 [10]

area\_dist\_sq: 2632 km2 [10]

area\_dist\_sq: 2632 km2 [10]

area\_dist\_sq: 2632 km2 [10]

area\_dist\_sq: 2632 km2 [10]

area\_dist\_sq: 2632 km2 [10]

area\_dist\_sq: 2632 km2 [10]

area\_dist\_sq: 2632 km2 [10]

area\_dist\_sq: 2632 km2 [10]

area\_dist\_sq: 2632 km2 [10]

area\_dist\_sq: 2632 km2 [10]

area\_dist\_sq: 2632 km2 [10]

area\_dist\_sq: 2632 km2 [10]

area\_dist\_sq: 2632 km2 [10]

area\_dist\_sq: 2632 km2 [10]

area\_dist\_sq: 2632 km2 [10]

area\_dist\_sq: 2632 km2 [10]

## Species Traits

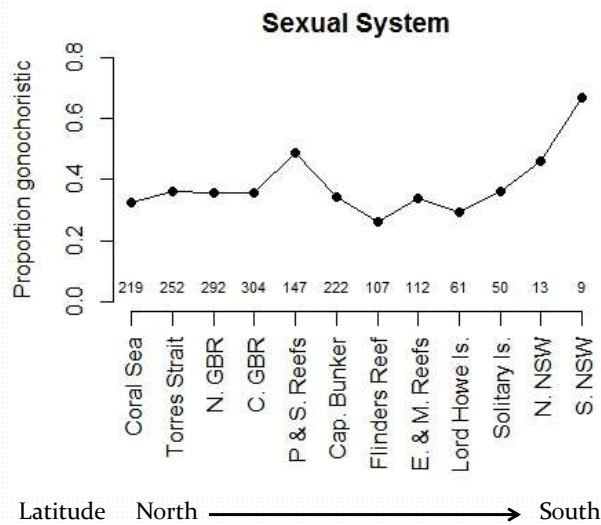
### Coral Trait Database

- Ecological
- Geographical
- Biomechanical
- Morphological
- Physiological
- Conservation
- Reproductive
- Taxonomic

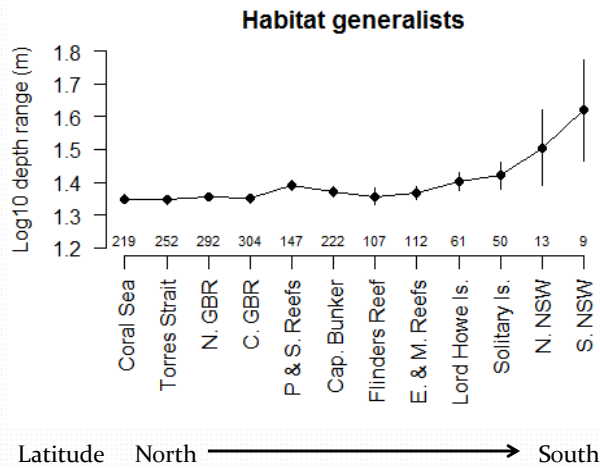
\*Selected 13 relevant traits (expert opinion)

What traits are more likely to be found in southern sites/at the leading edge of range expansion?

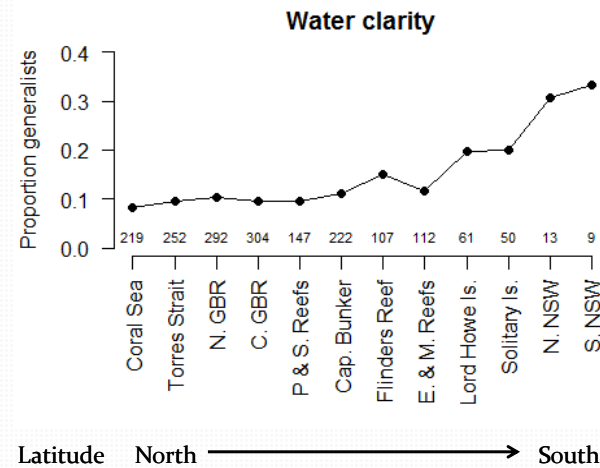
## Latitudinal trait patterns



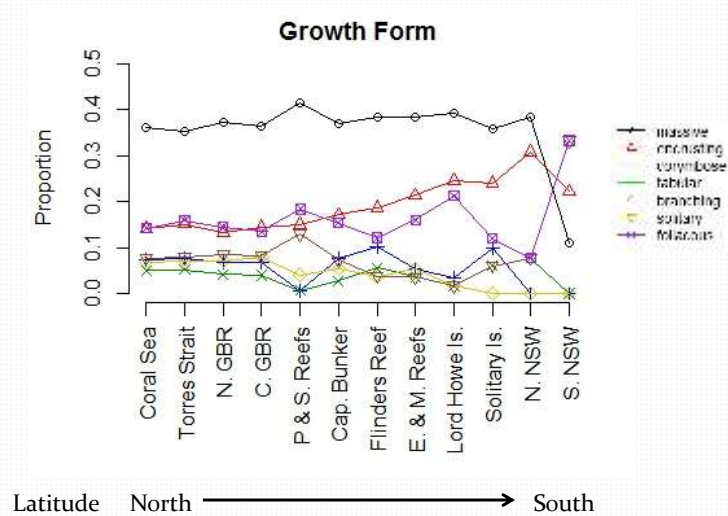
## Latitudinal trait patterns



## Latitudinal trait patterns



## Latitudinal trait patterns



## Latitudinal trait patterns



Depth range  
 Substrate attachment  
 Found off reef  
 Reproductive mode  
 Sexual system  
 Water clarity  
 Wave exposure

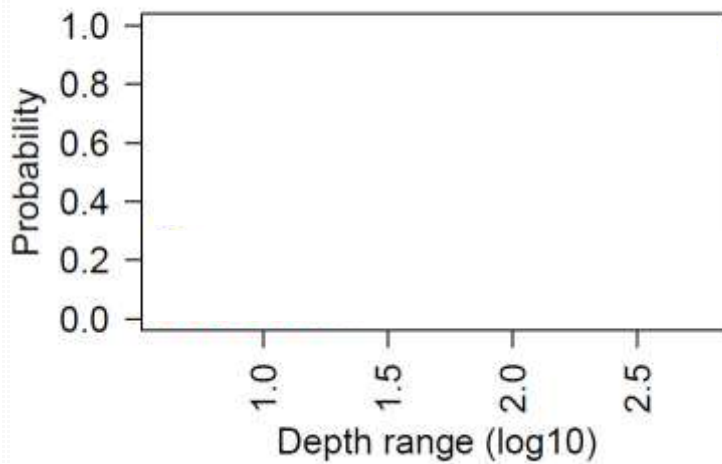
## Coral presence / trait relationship

Generalized linear mixed effect model

- predict relationship of species in the south with traits

Variables:	Estimate	Std. Error	<i>p</i>
Intercept	-2.3379	0.9730	0.01627
Depth range(log10)	1.4827	0.6378	0.02009
Unattached to substrate	-2.3420	0.8500	0.00586
Found off reef	0.7470	0.3132	0.01707
water_clarity(specialist)	-0.9226	0.4029	0.02201

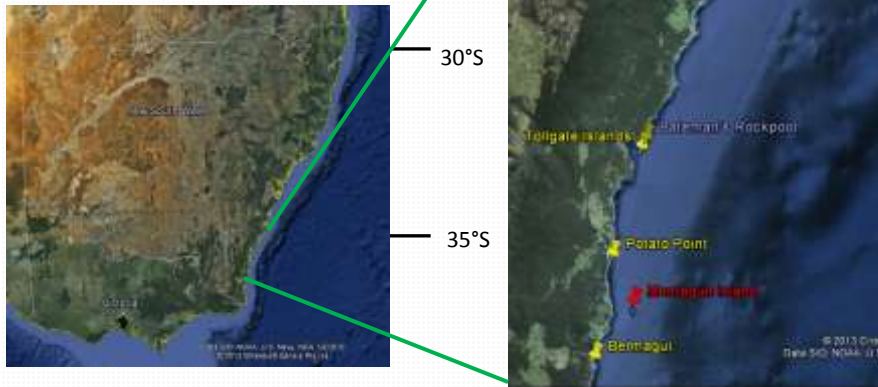
Probability of occurring south





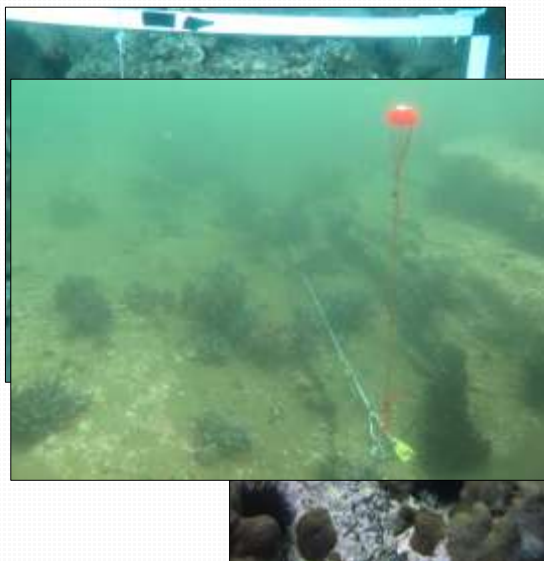
## Future work

- Coral scouting!



## Future work

- Coral scouting!
- Photo quadrats
- Permanent transects
- Collect demographic & environmental data



## Objective #2

## NSW Marine Protected Areas

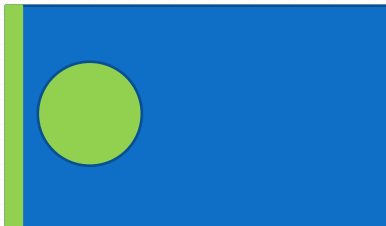


*conserving the diversity of marine life*

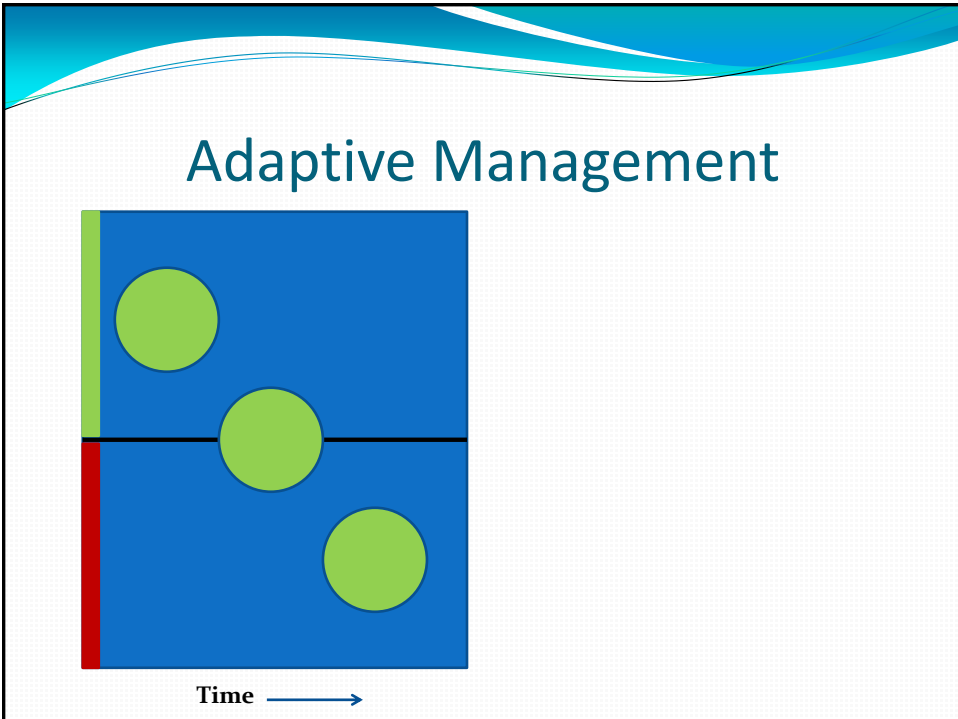
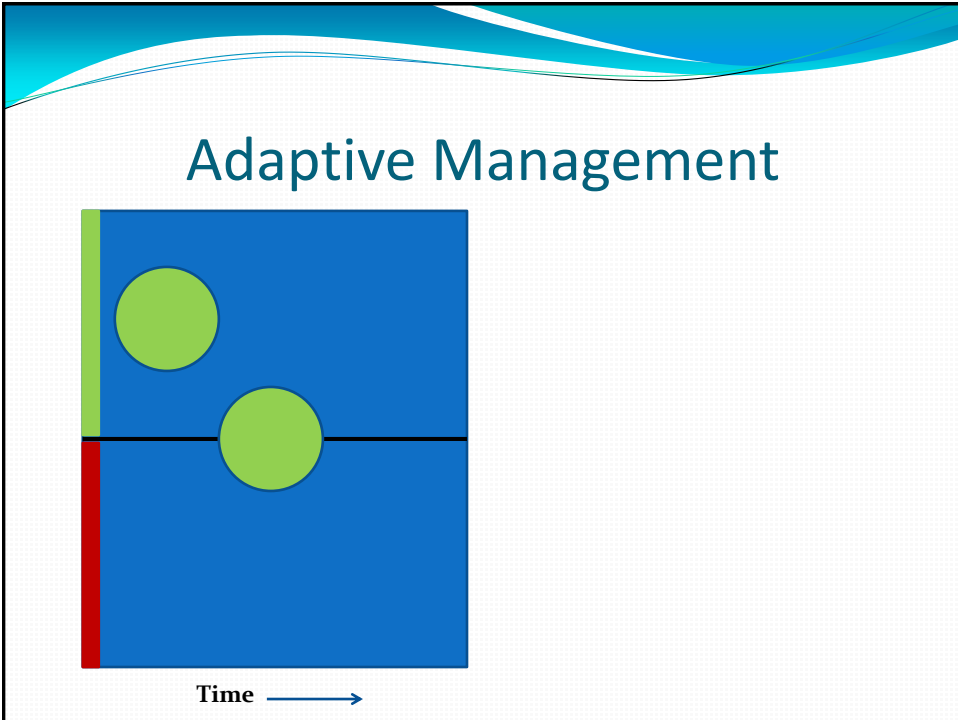
*ensuring that marine resources are carefully managed*

*for the use and enjoyment of people today and in the future.*

## Adaptive Management

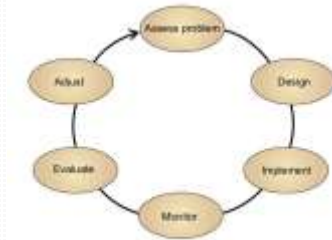


Time →



## Future work

- Identify management objectives
  - Facilitate coral?
  - How will community structure change?
  - Protect species? ecosystems? ecosystem processes and functions? ecosystem services?
- Determine optimal monitoring strategy



## Conclusion

*Observations of corals poleward of their historic range*

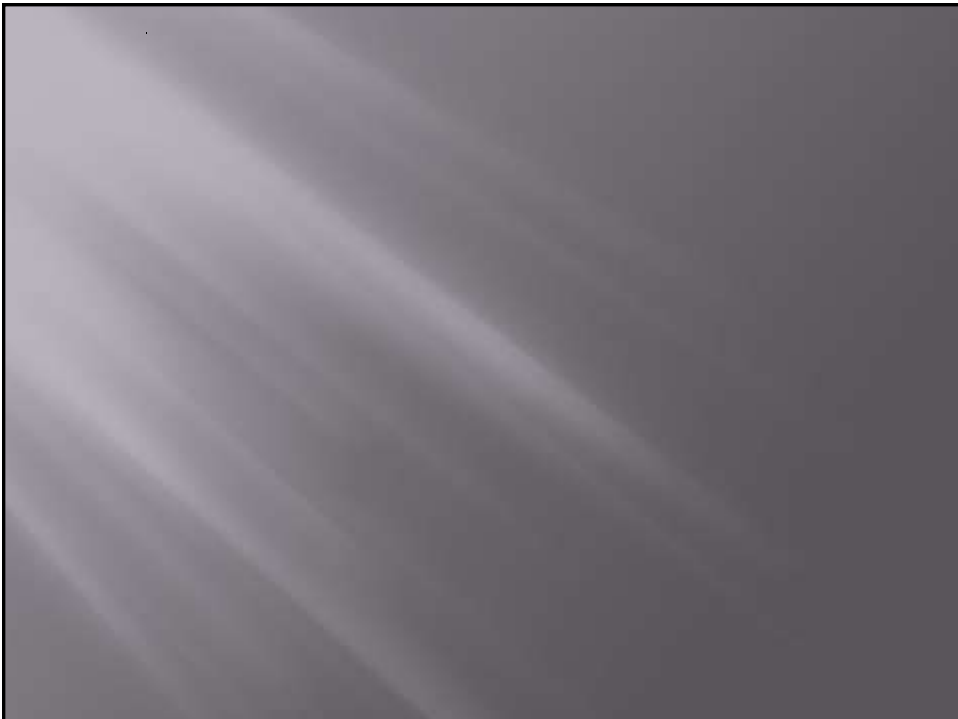
Evaluate changes along a latitudinal gradient based on:

- traits
- demographic rates
- environmental variables

➤ *Use these to predict future changes & inform management to adapt when necessary*

Thank  
You!

Josh Madin  
Andrew Baird  
CY Kuo  
Brigitte Sommer  
Julieta Martinelli  
Marcela Diaz



## Traits observed

- Substrate attachment
- Found off reef
- Depth range
- Wave exposure
- Water clarity
- Growth form
- Colony size
- Sex
- Egg size class
- Number of eggs
- Reproductive mode
- Clade
- Zooxanthellate vs. azoox.

## Potential range limits

