Understanding coral range expansion to enhance management strategies

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Climate Change
Warming Waters

- SST increased 0.7°C since 1920s and will continue to increase 2.5°C by 2100
- Southeast Australia - expected to experience the greatest change
- SE Australia is a global warming hotspot

(Lough et al. 2012)
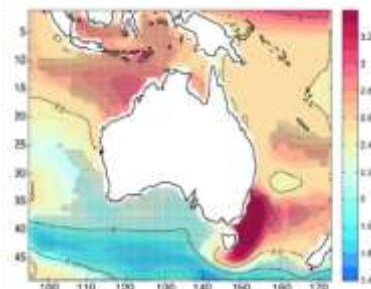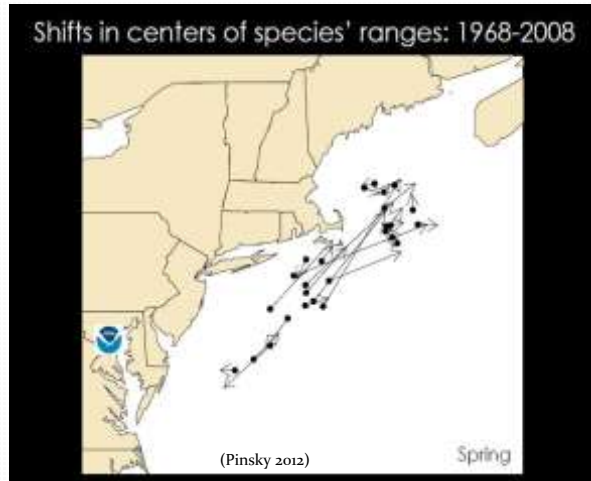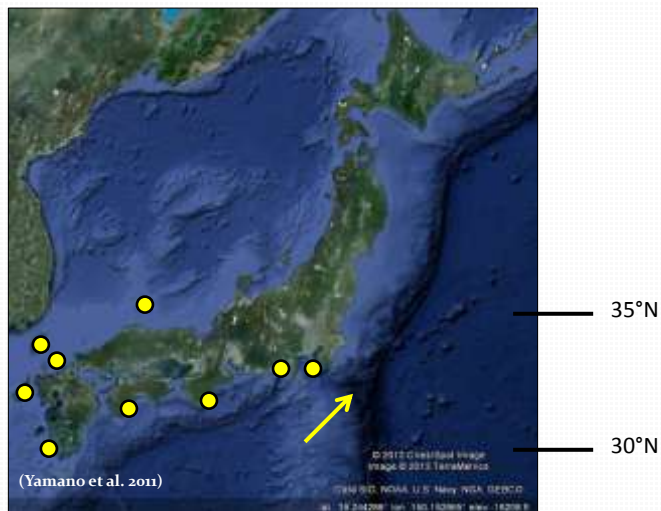
Range Shift:
US Commercial Fisheries

Shifts in centers of species' ranges: 1968-2008

(Pinsky 2012)

Spring

Range Shift:
Corals in Japan

35°N

30°N

(Yamano et al. 2011)

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)
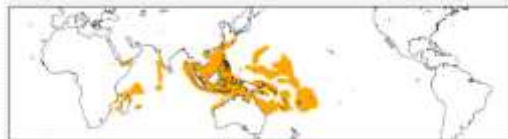

Species Across a Gradient
   15 sites
   338 Species
   Presence/Absence

Species Traits

Acropora monticulosa

Coral Trait Database

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

Species Traits
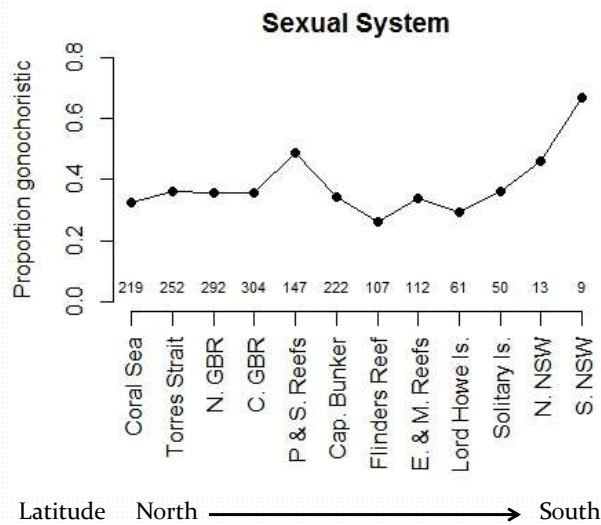
<u>Coral Trait Database</u>

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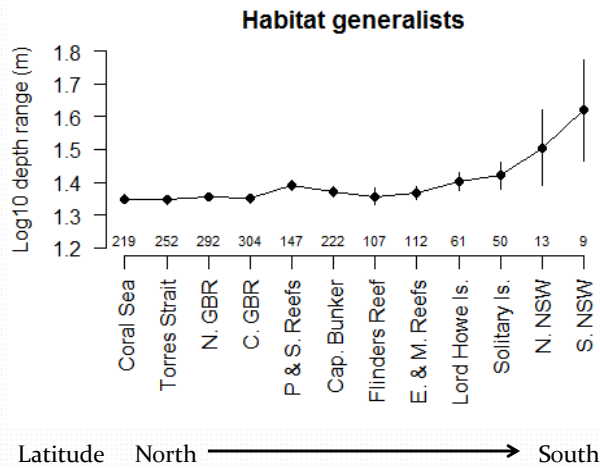- Physiological
- Conservation
- Reproductive
- Taxonomic

*Selected 13 relevant traits (expert opinion)

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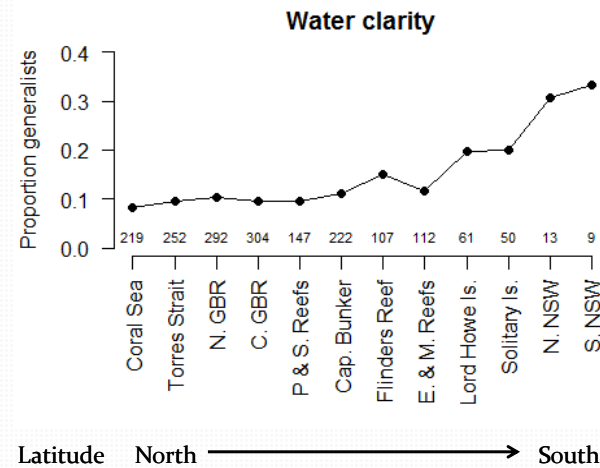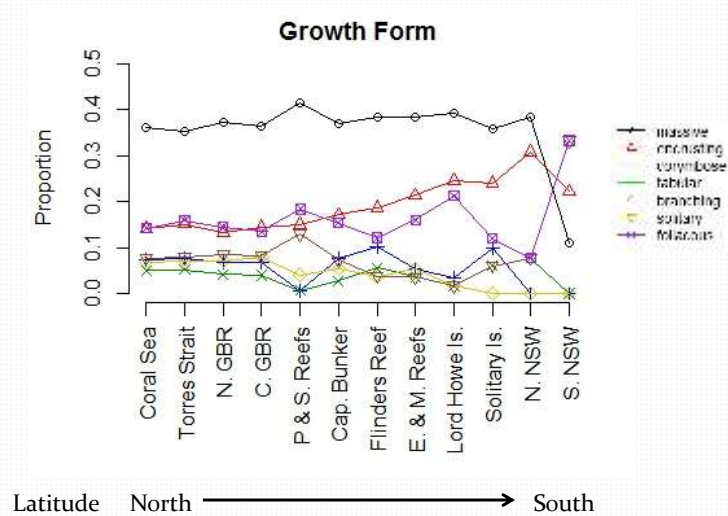
Latitudinal trait patterns

Latitudinal trait patterns

Habitat generalists

Latitude   North ——————————▶ South

Latitudinal trait patterns

Water clarity

Latitude   North ——————————▶ South

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

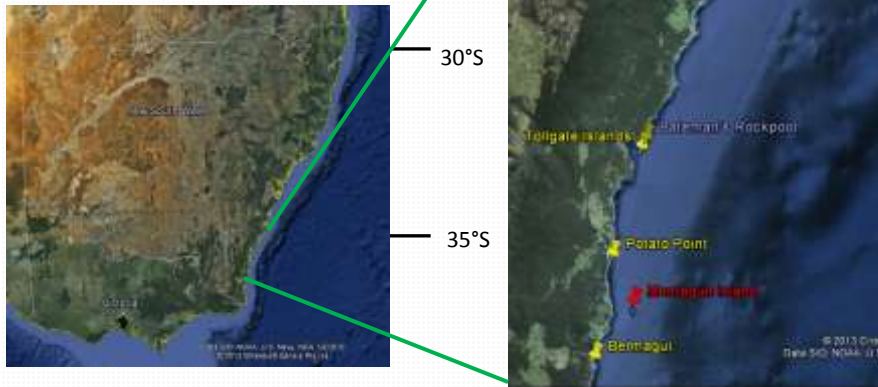| Variables:	Estimate	Std. Error	p
Intercept	-2.3379	0.9730	0.01627
Depth range(log10)	1.4827	0.6378	0.02009
Unattached to substrate	-2.3420	0.8500	0.00586
Found off reef	0.7470	0.3132	0.01707
water_clarity(specialist)	-0.9226	0.4029	0.02201

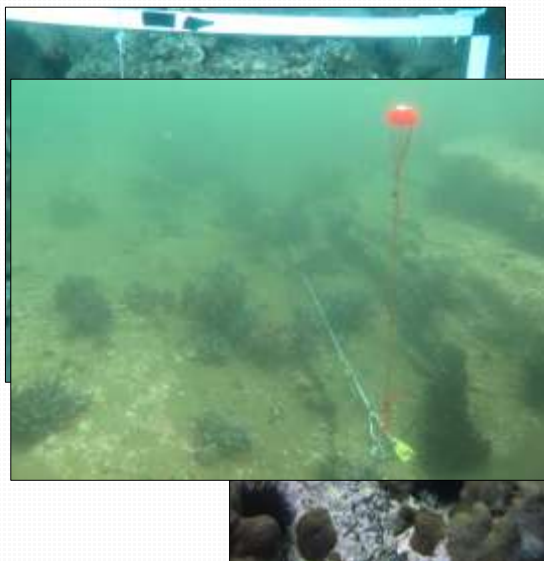**Probability of occurring south**

8

Future work

- Coral scouting!

30°S

35°S
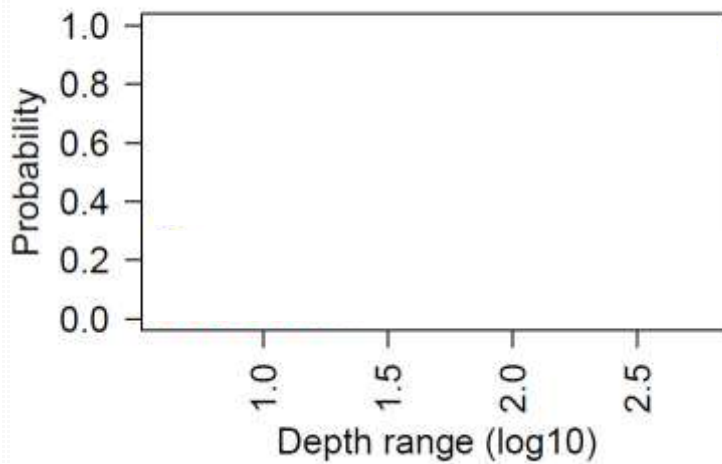
Future work

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

4/19/2013

10

Adaptive Management

Adaptive Management
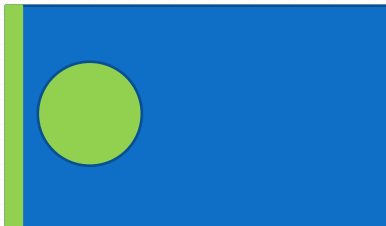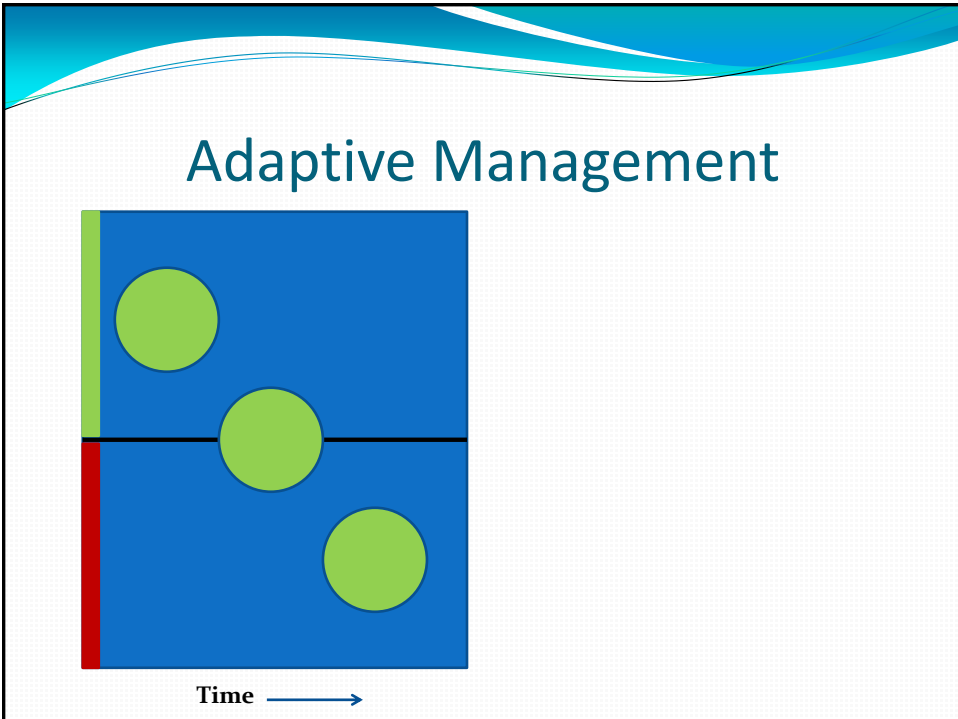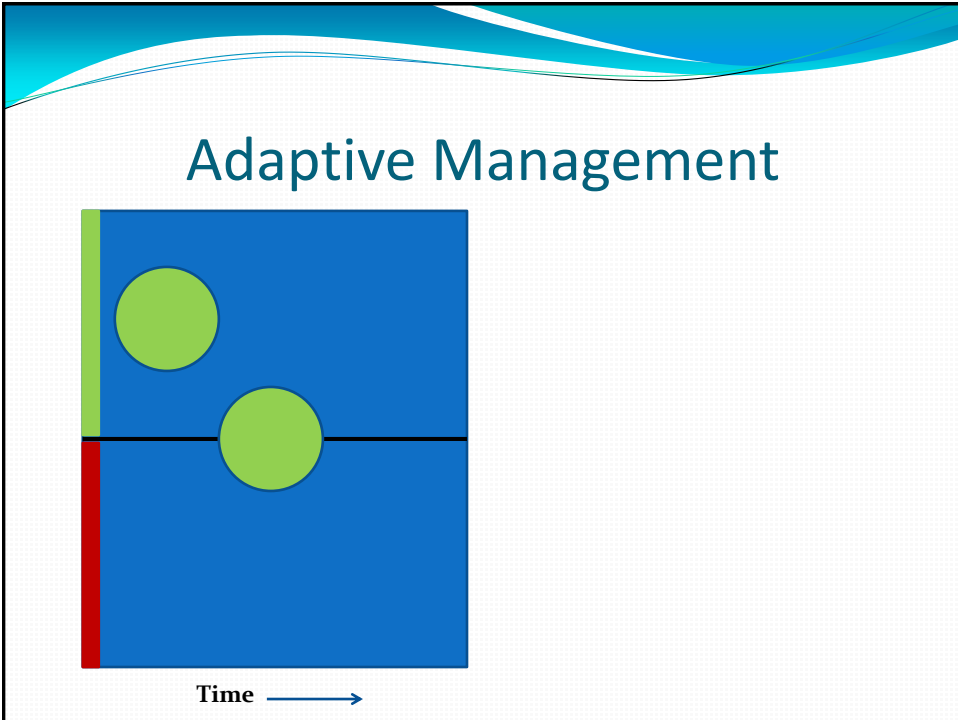
Future work

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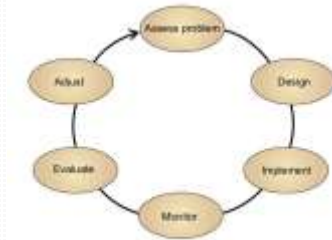 - Protect species? ecosystems? ecosystem processes and functions? ecosystem services?
- Determine optimal monitoring strategy

Conclusion
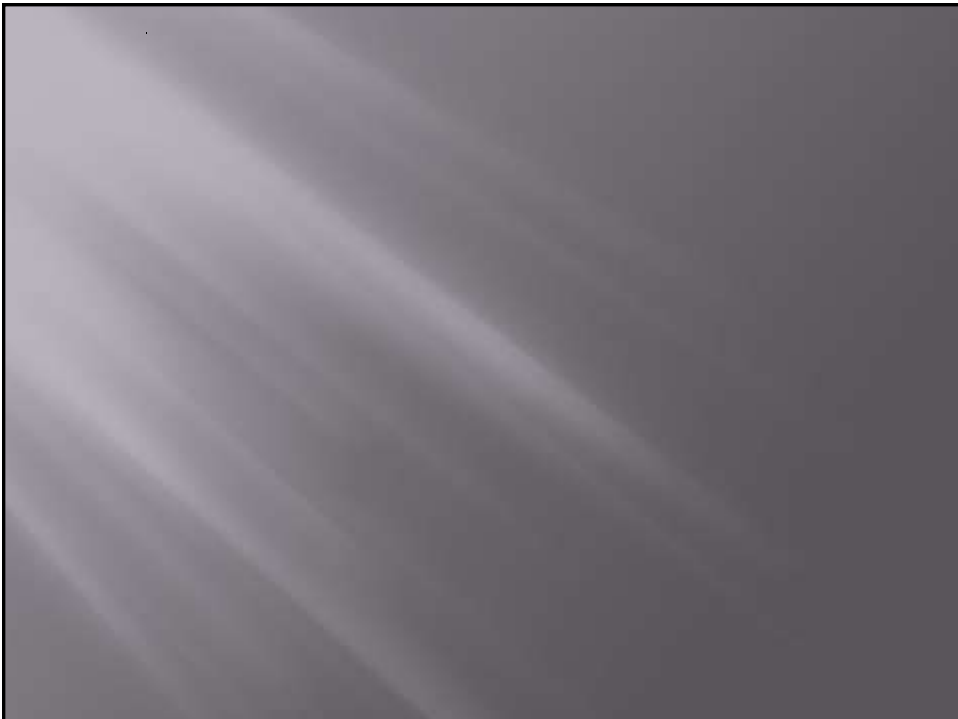
Observations of corals poleward of their historic range

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*

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