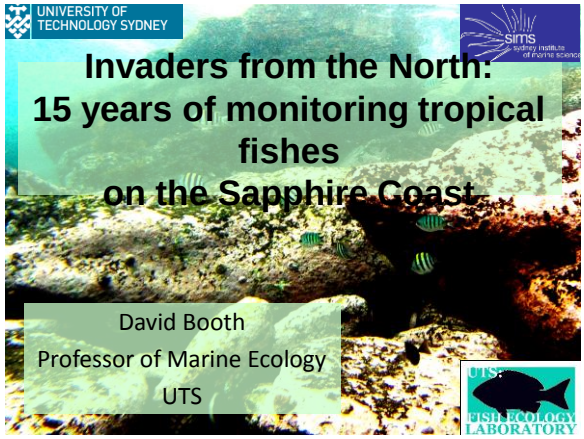
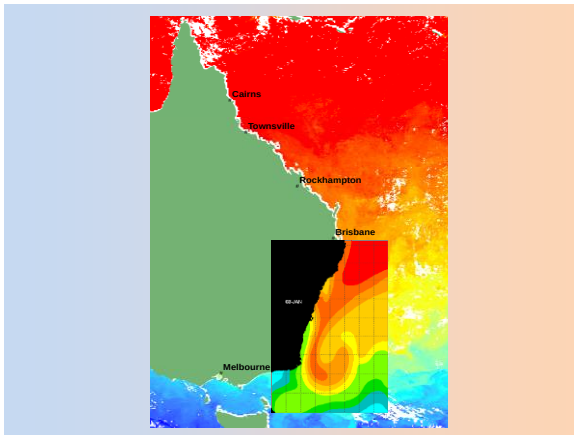
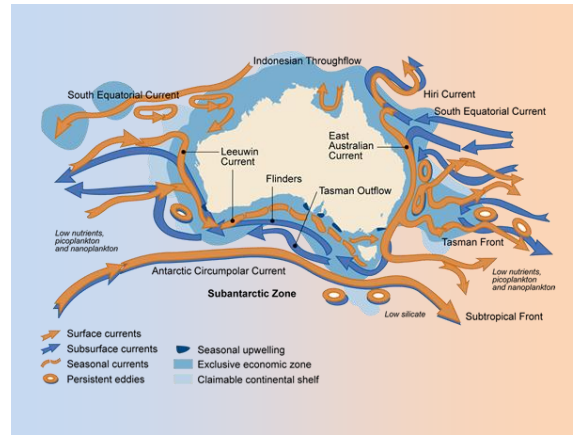


Outline

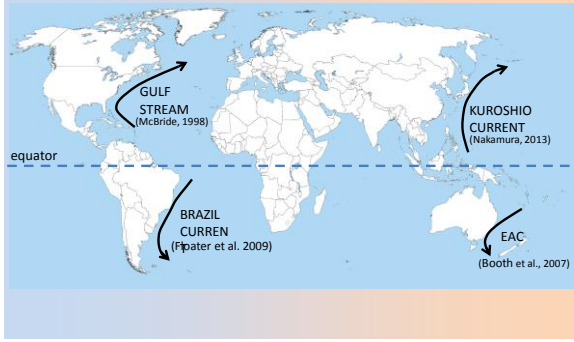
1. The dynamic Sapphire Coast
2. Surprise visitors! 15 years of monitoring vagrant fish: patterns and citizen science
3. Why is it so? Getting here and what happens next…
4. The future: coral reefs on the Sapphire Coast??

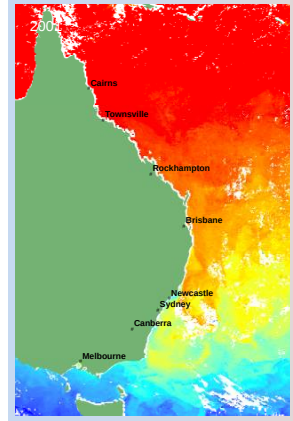
1. Setting the scene: the ocean





Western Boundary Currents: key poleward dispersal agents



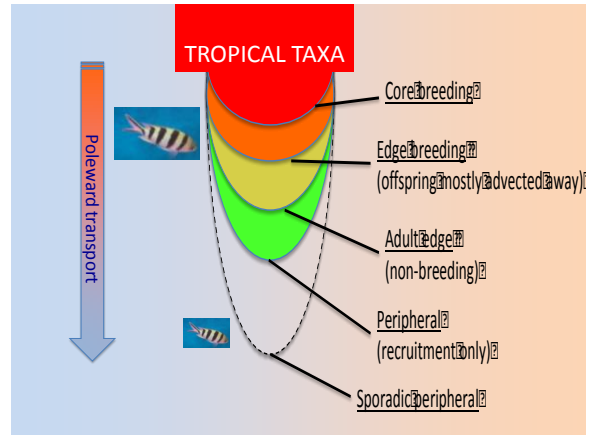


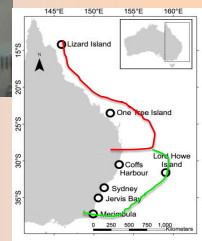
NSW Fish diversity

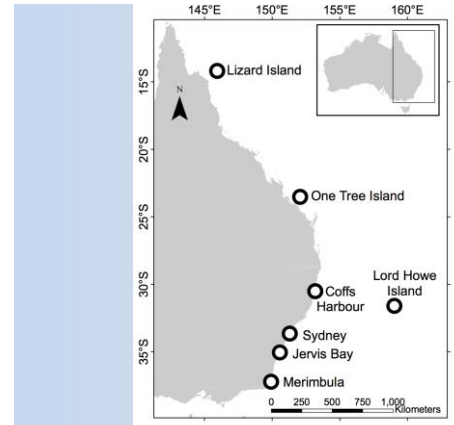
Tropical fish range advance

Temperate fish range retraction

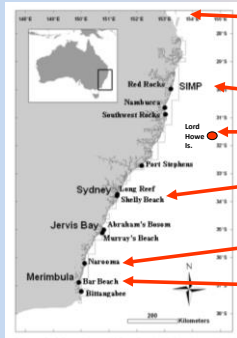
An extreme case: tropical fish incursions into temperate seas







Latitudinal patterns



One Tree Island (23°S) 600 tropical species

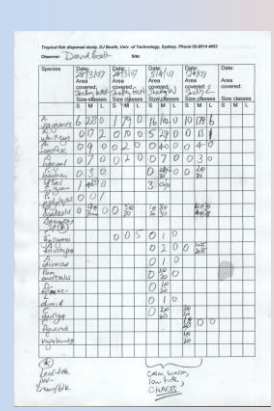
Solitary Islands (30° S) 250 tropical species

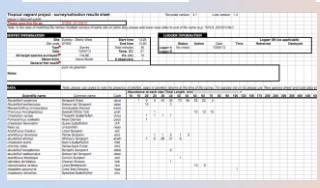
LHI (31.5° S) 400 trop. spp.

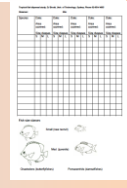
Sydney (33.5 ° S) 86 tropical species

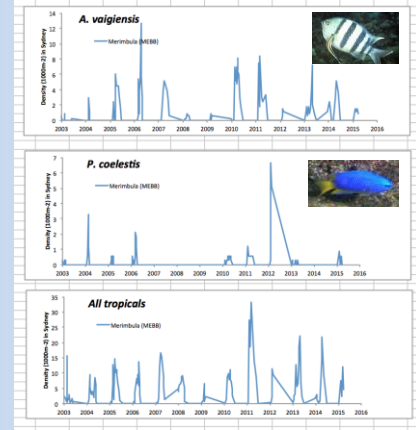
•Montague Island (36°15′ S) 75 tropical species

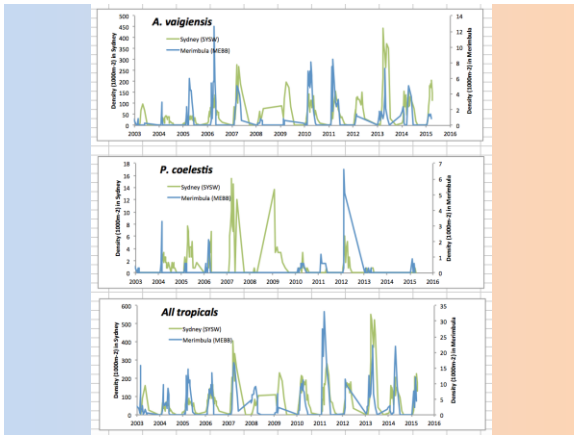
•Merimbula (37° S) 44 tropical species

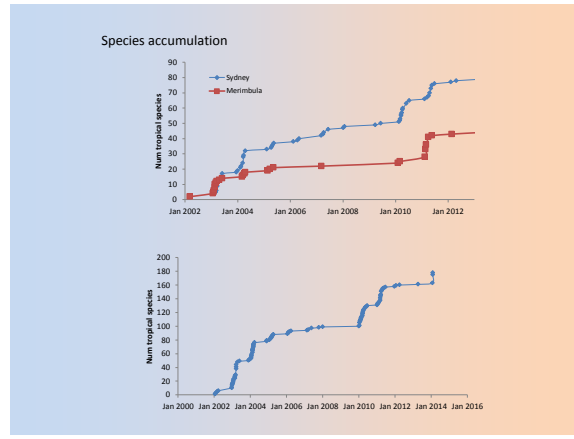


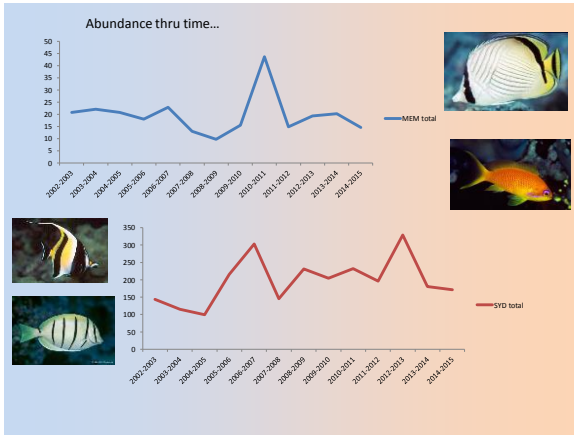


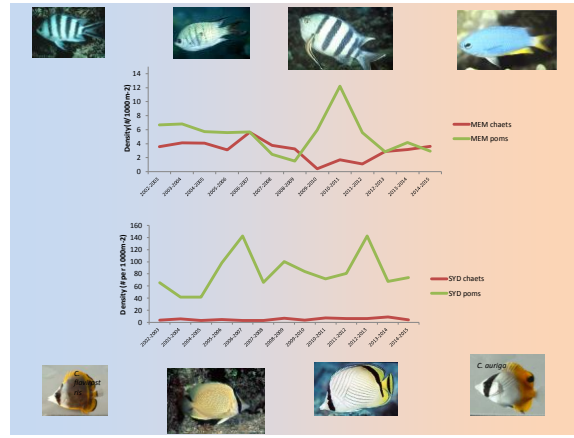


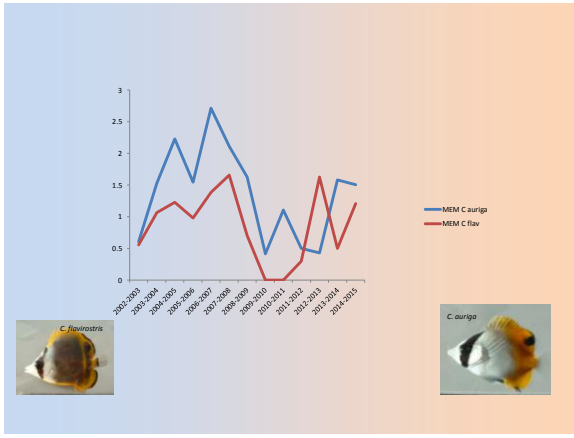


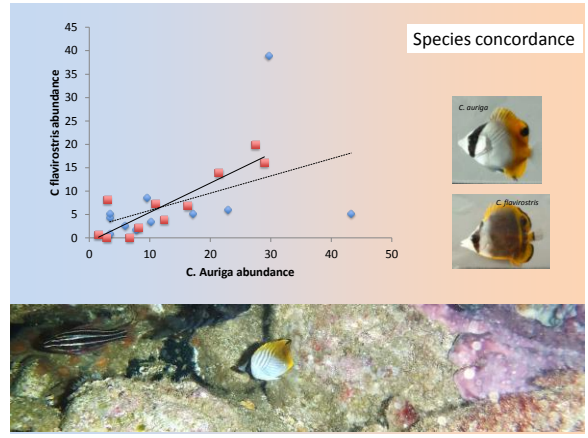

A. vaigiensis
Sydney (SYSW)
Merimbula (MEBB)
P. coelestis
Sydney (SYSW)
Merimbula (MEBB)
All tropicals
Sydney (SYSW)
Merimbula (MEBB)


Species accumulation
Sydney
Merimbula
Num tropical species
Jan 2002
Jan 2004
Jan 2006
Jan 2008
Jan 2010
Jan 2012
Num tropical species
Jan 2000
Jan 2002
Jan 2004
Jan 2006
Jan 2008
Jan 2010
Jan 2012
Jan 2014
Jan 2016


Abundance thru time…
MEM total
SYD total


MEM chaets
MEM poms
SYD chaets
SYD poms
C. auriga


MEM C auriga
MEM C flav
C. flavirostris
C. auriga


Species concordance
C flavirostris abundance
C. Auriga abundance
C. auriga
C. flavirostris

Rare species (<10 indiv over 13 years)

Acanthurus lineatus 2005, 2011, 2012, 2013

Scolopsis sp. 2013

Pseudanthias squamipinnis 2002, 2004, 2011

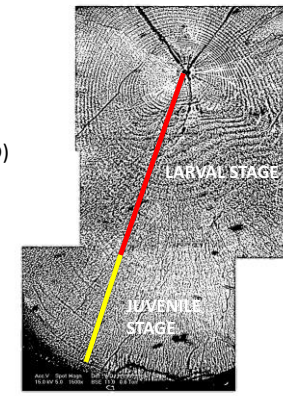
Pomacentrus wardi 2004

Pomacentrus nakasakiensis 2011

Caesio caerulaurea 2013

Growth patterns

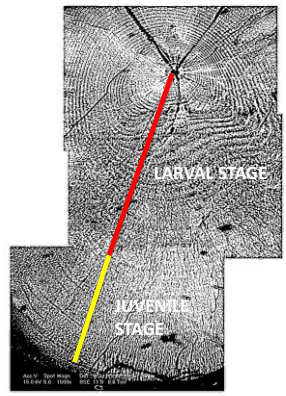
Increment number
- Time in the plankton (PLD)

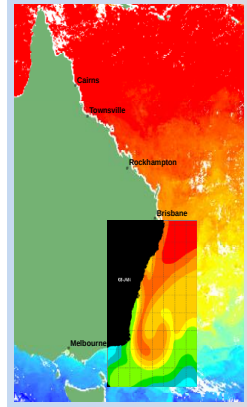


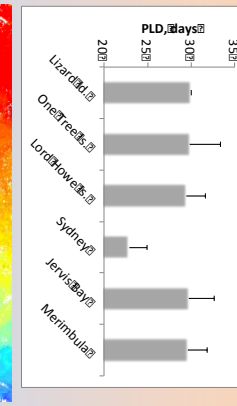
Growth patterns

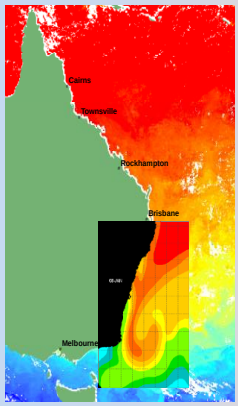
Increment number
- Time in the plankton (PLD)

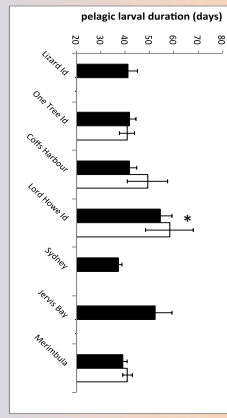
Increment width
- Somatic growth
- Lipid reserves
- Water chemistry

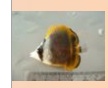








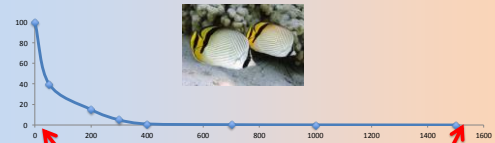




from Booth and Parkinson 2011

Within-species variation in dispersal…

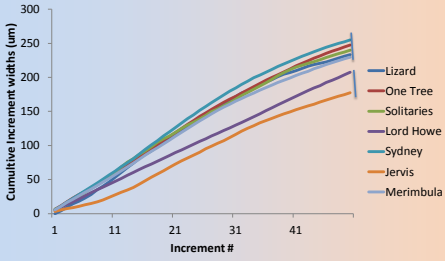
Eg *Chaetodon vagabundus*



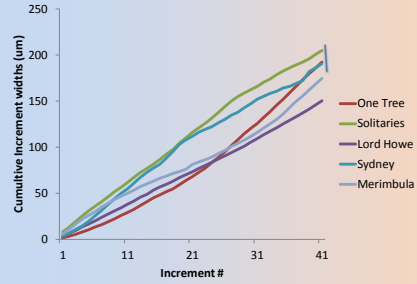
Berumen et al. 2011
40-60% self-recruit
Parentage analysis
(PLD 27-49d)

Booth et al. 2007

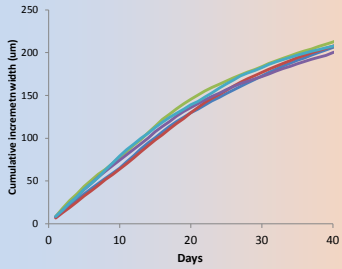
Pelagic growth



Pelagic growth



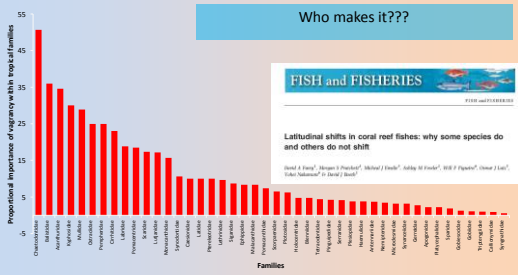
Pelagic growth



From Reef to Sapphire coast…

- Spawning on the reef
- Ocean currents
- Water temperature
- Greetings on arrival
- Finding a niche!

Who makes it???

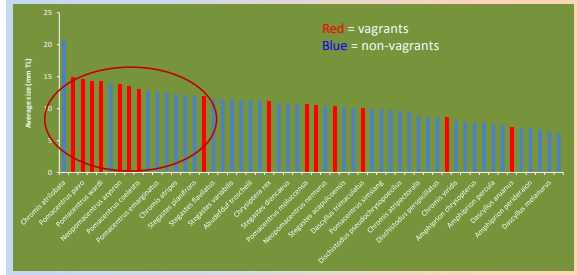


- 360 species within 55 different families

Feary et al 2013 Fish and Fisheries

IS BIGGER BETTER?

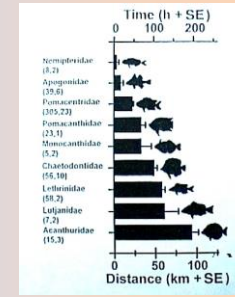
- Bigger larvae = wider dispersal?



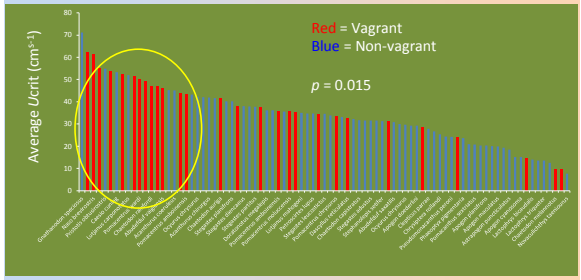
Larval swimming ability

[Predict: better performance in vagrants]

Active swimming

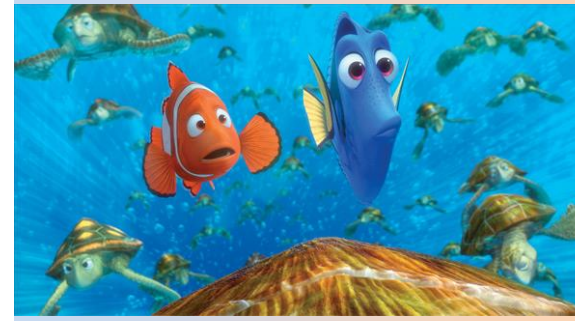


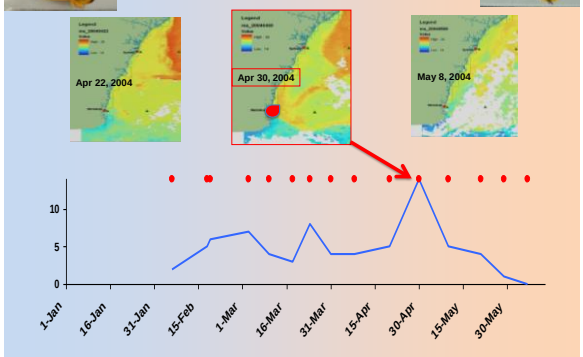
- Larval swimming ability



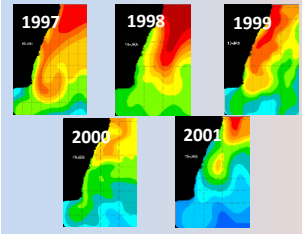
Delivered by ocean currents…

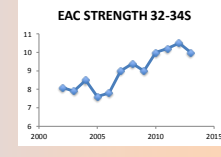
do they really ride the EAC??





Does EAC strength predict abundance?

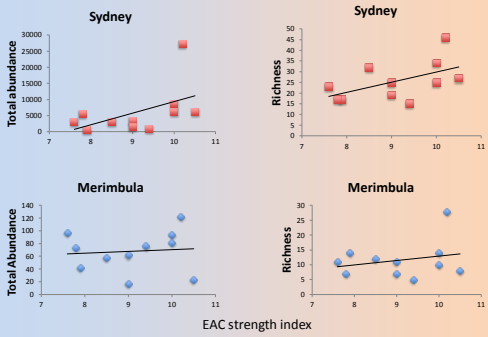




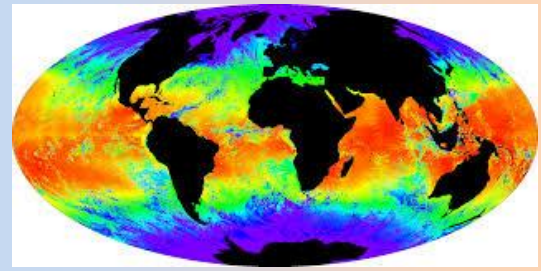
32-34°S

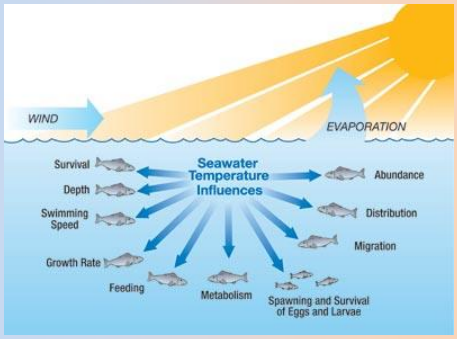
Sun et al. 2012

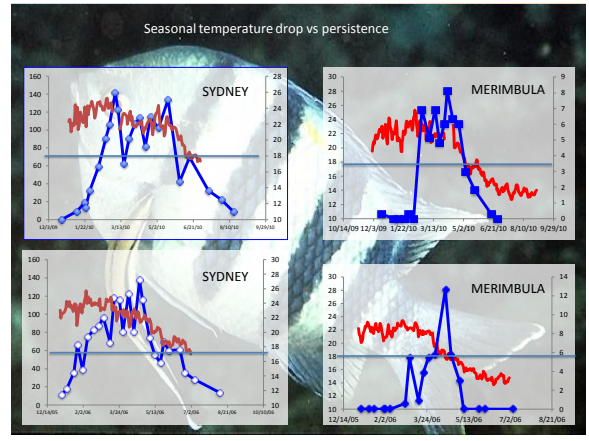
EAC strength vs abundance, richness



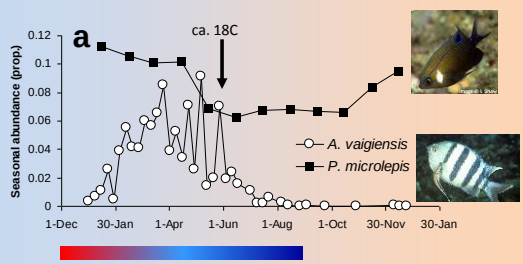
What about ocean temperature?



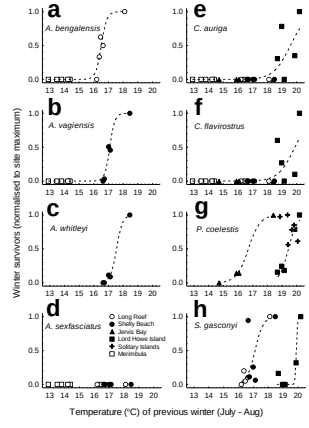


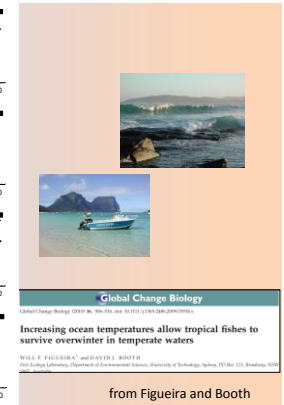


Winter decline in abundance of tropical vagrants



"overwintering threshold" (18C)> lower lethal temperature (~15C)

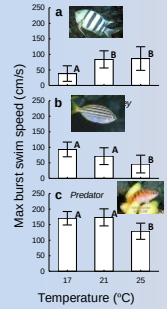




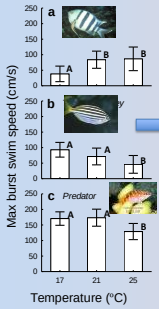
from Figueira and Booth *Global Change Biology* 2010

Indirect temperature effects??

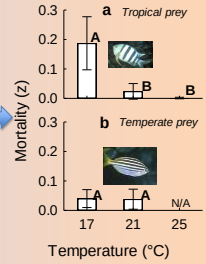
Lab-based approaches: Example- relative predation risk of tropical vagrants as winter water temperatures approach



Lab-based approaches: Example- relative predation risk of tropical vagrants as winter water temperatures approach

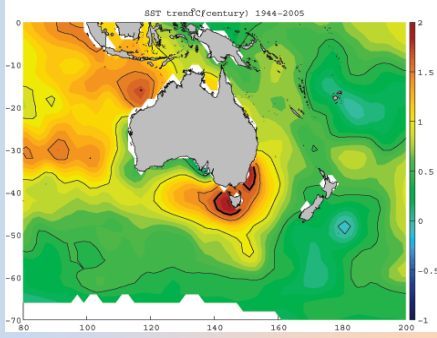


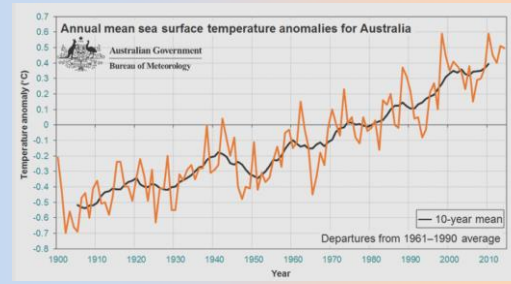
Tropicals are relatively slower to flee from predators as water temperatures drop, so suffer higher predation risk as winter approaches…



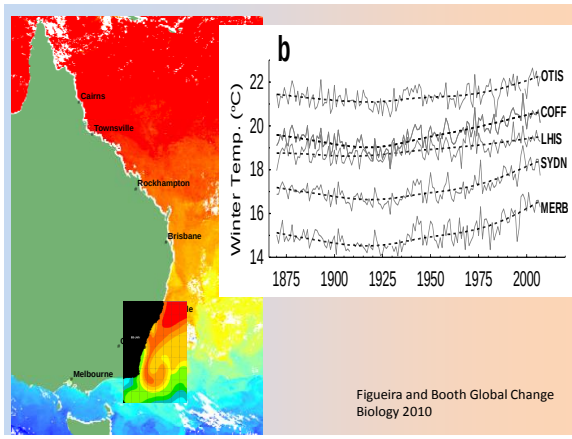
The future under climate change

SST on the rise….

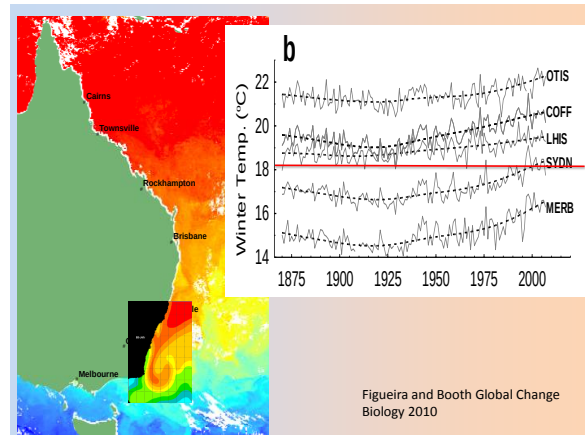




http://www.bom.gov.au/climate/current/annual/aus/



Figueira and Booth Global Change Biology 2010



Figueira and Booth Global Change Biology 2010

- **EAC strengthening** (350 km further south in last 50 years, expected to continue)
- **SST rising poleward** (partly EAC-related)
- **Habitat destruction** (eg bleaching) on coral reefs
- **Habitat expansion poleward** (urchin barrens and coral habitat spreading poleward)

Tropicalisation…..an increasing phenomenon?

Tosa Bay Japan
A) Early 1990s B) 1997: isoyake C) Barren 2000 D) Coral-dominated 2013

Nakamura et al. 2008

Thanks…

Funding
NSW Environmental Trust, Australian Research Council, Sydney Aquarium Conservation Fund.

Permits
All work was conducted under NSW Fisheries Permit number F96/146-6.0 and University of Sydney Ethics Permit numbers 5200 and 5214.

Collaborators
UTS- Booth, Feary, Fowler, Parkinson, Beck, Tegart, Yui, Beretta, Donelson, Klanten, Beretta
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Mac U- Madin, Luiz
JCU: Munday, Pratchett
UQ: Cynthia Riginos, Libby Liggins
Overseas: Hixon (U Hawaii), Nakamura (Japan)
NSW DPI: Malcolm, Harasti, Creese, Jordan
Sapphire Coast: Luke Brown, Michael McMaster