

Impact of a marine heat wave in a biodiversity hotspot.



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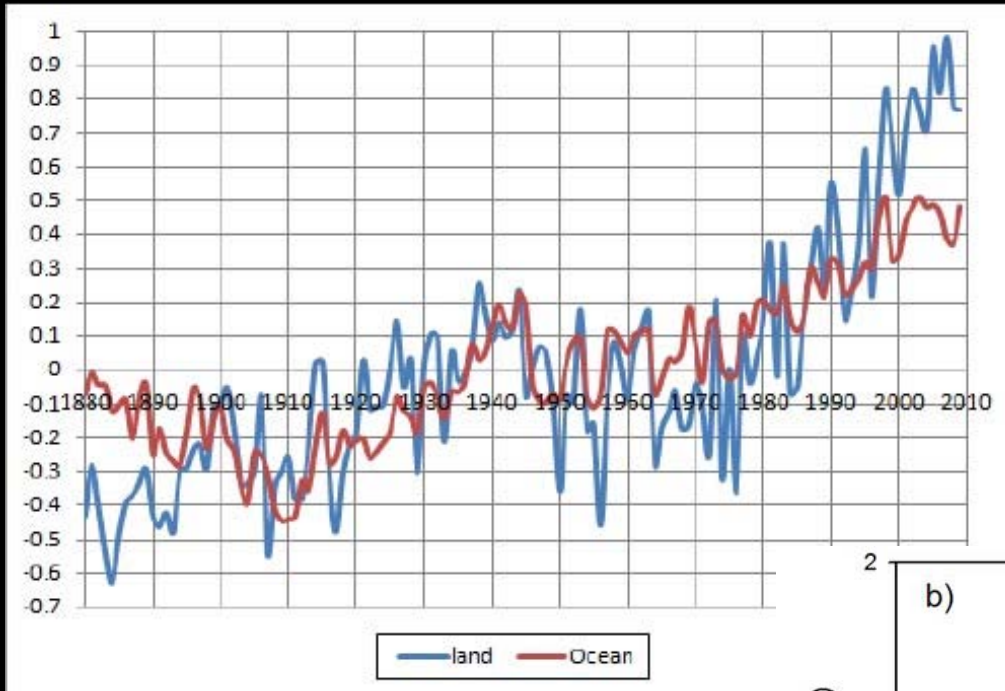


Extreme climatic events

IPCC special report (2012): the magnitude, frequency and location of extreme events is changing and it likely that this is associated with anthropogenic climate change.

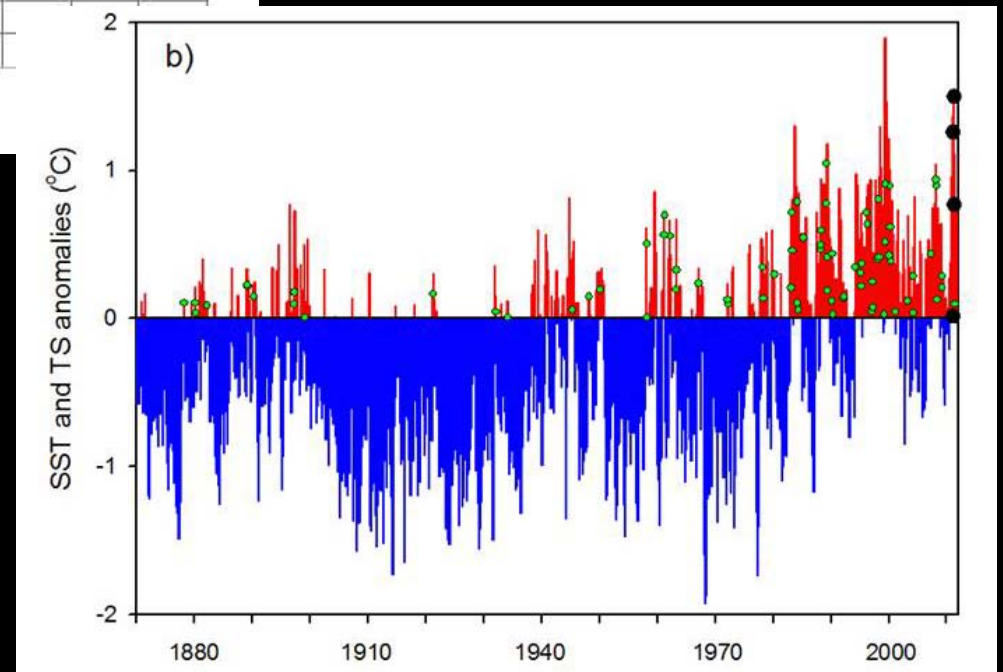


Marine heat waves



Gradual mean warming.....

.... vs discrete warming events

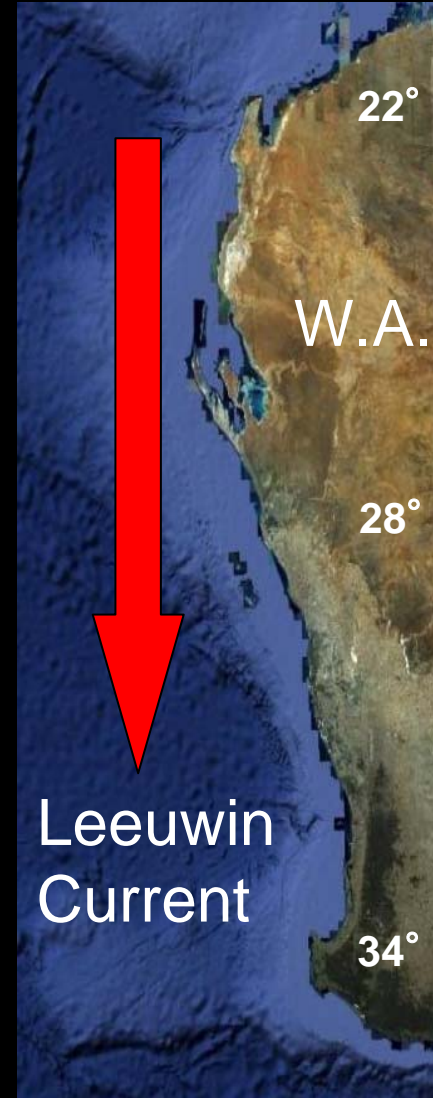


Extreme warming episodes are superimposed onto a long term **warming trend**

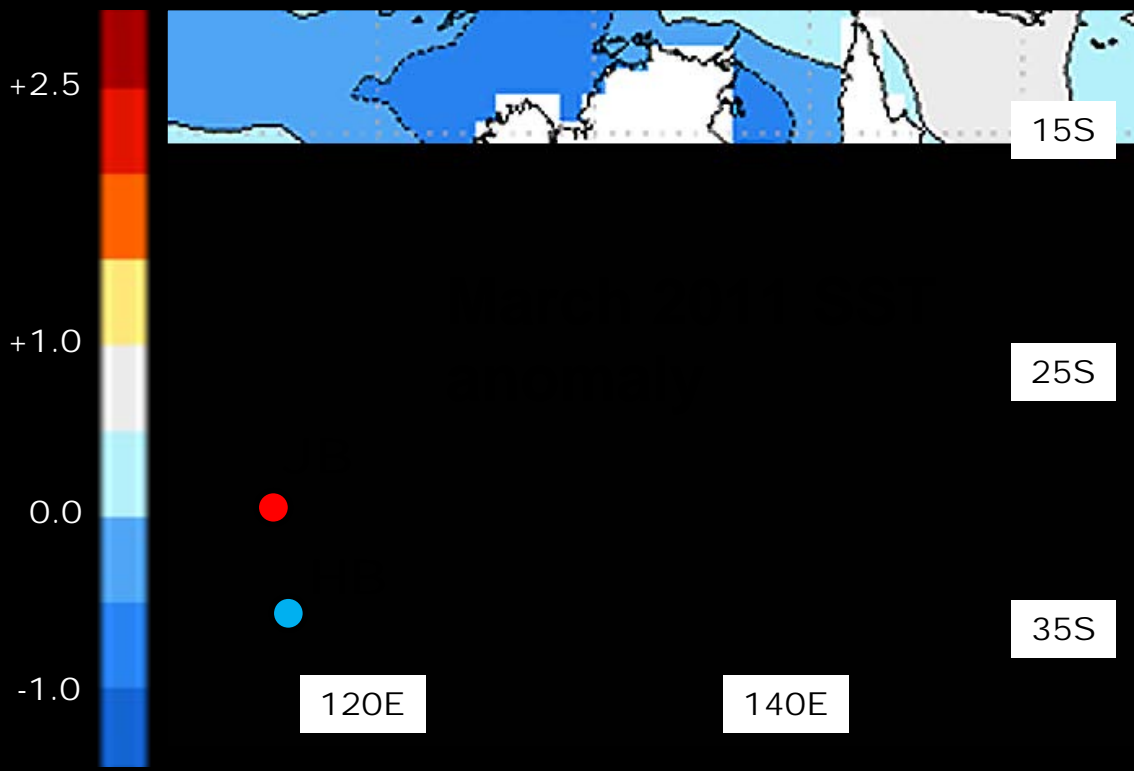
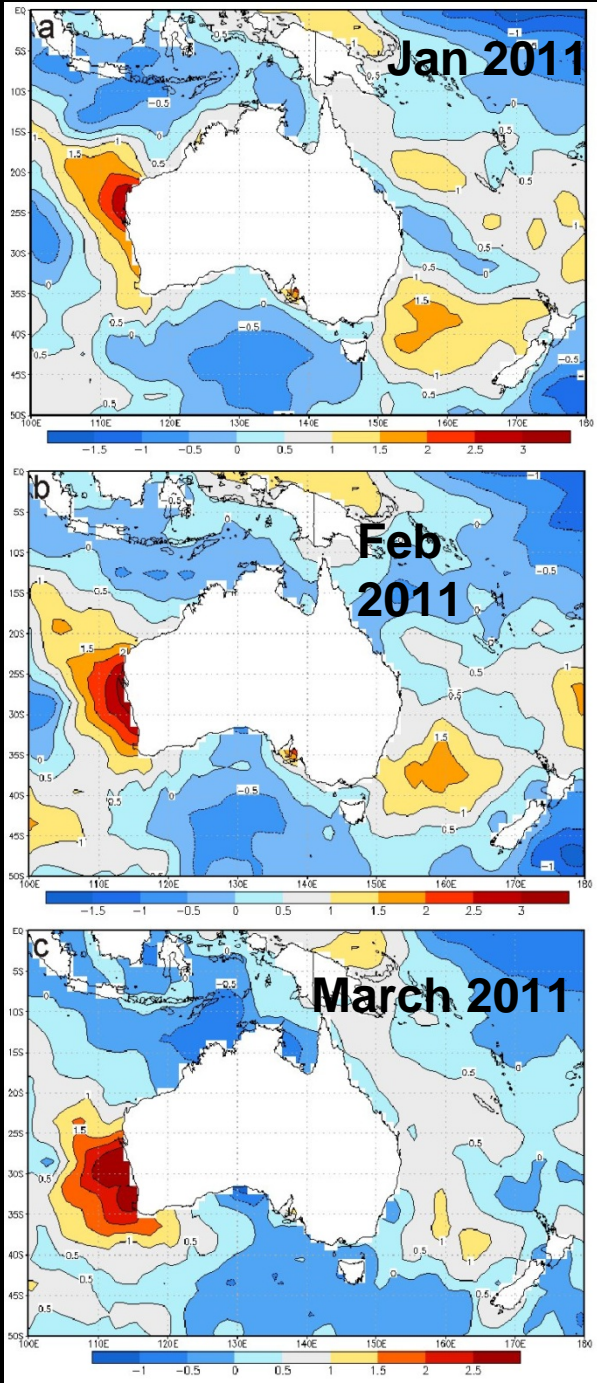
Number of extremely **hot days** (SSTs) has increased along **38%** of the worlds coastlines in last 30 yrs
(*Lima and Wethey 2012, Nature Comms*)



A global biodiversity hotspot

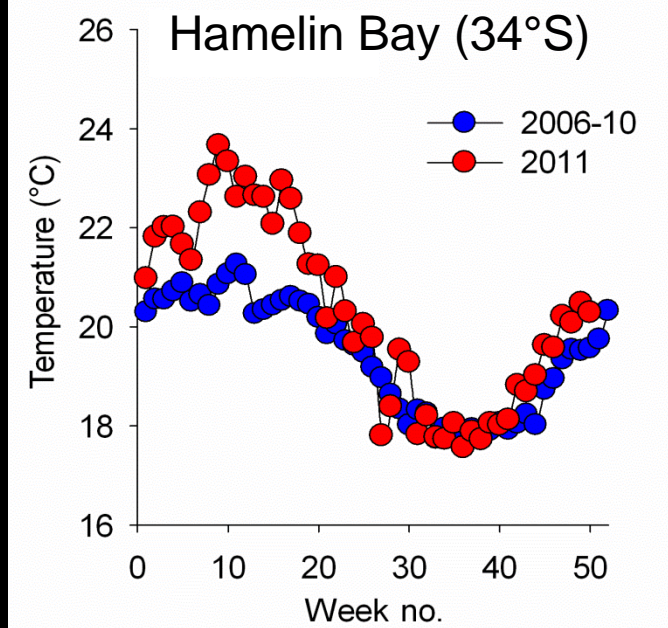
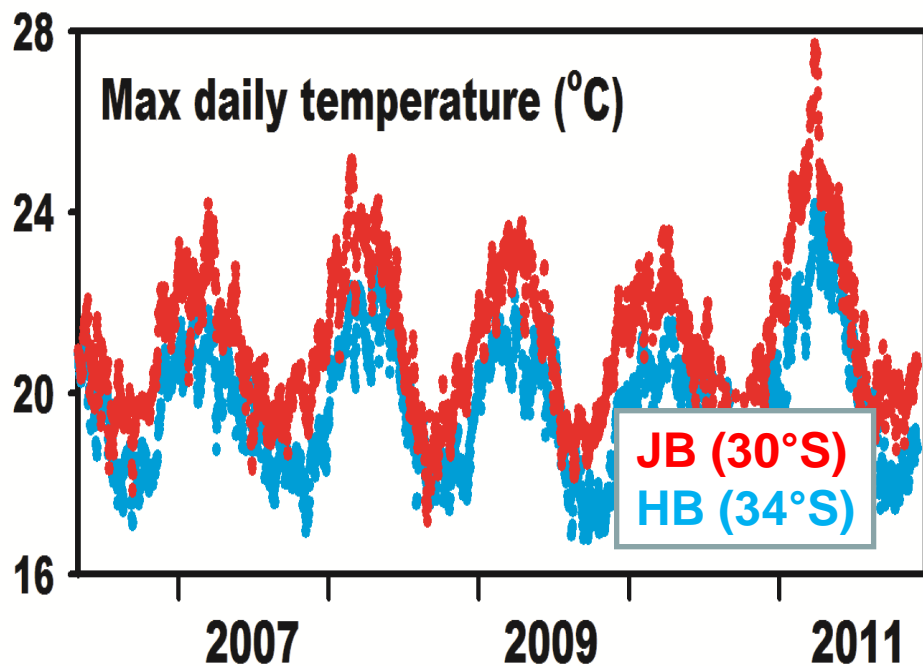
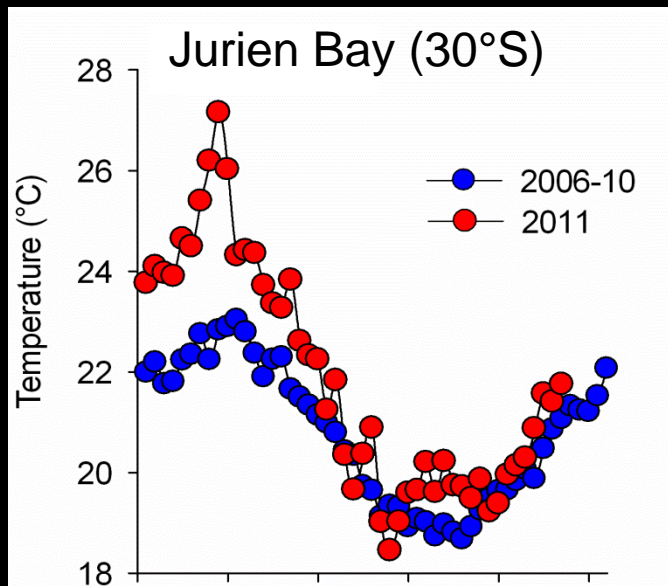


The 2011 marine heat wave off western Australia

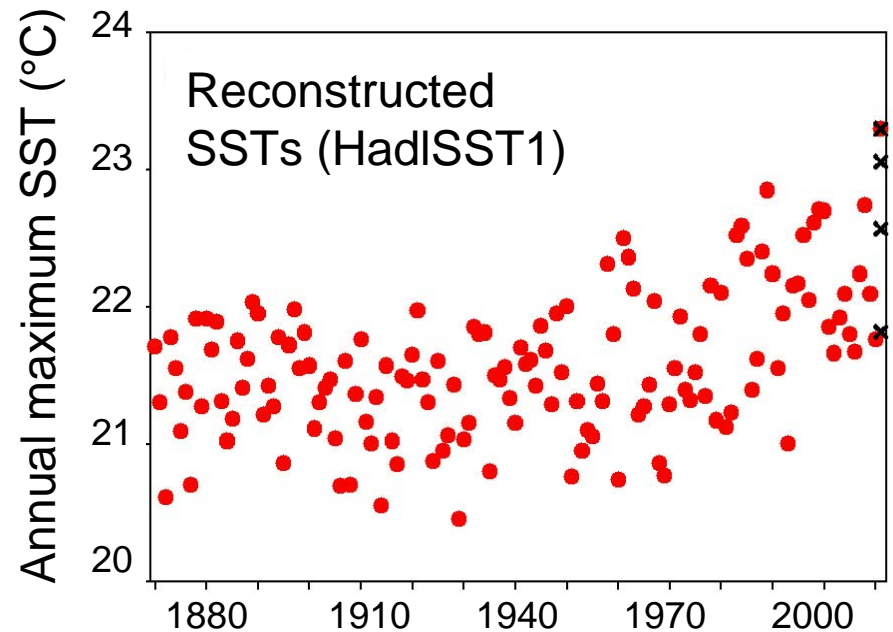
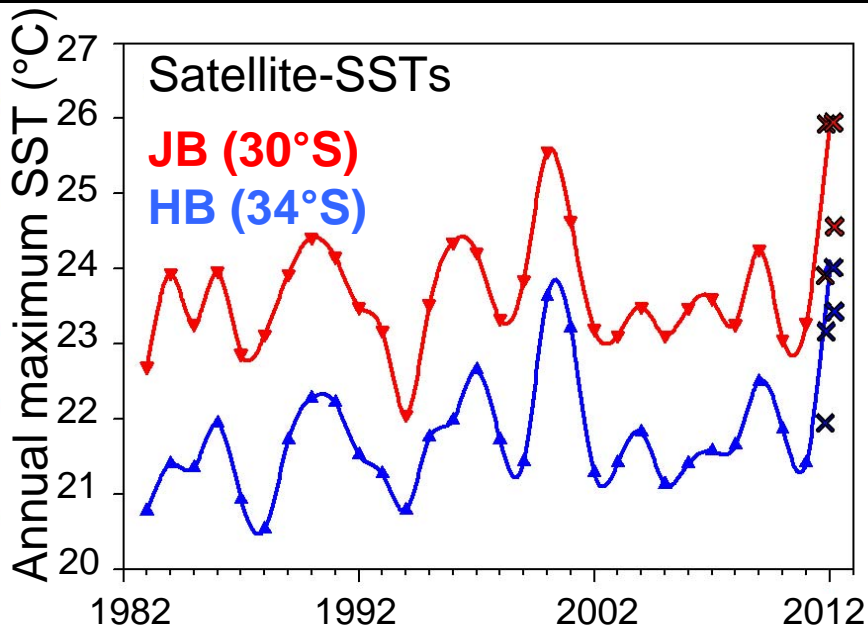


Blended SST anomalies relative to a 1971-2000 baseline of monthly averages (NOAA)

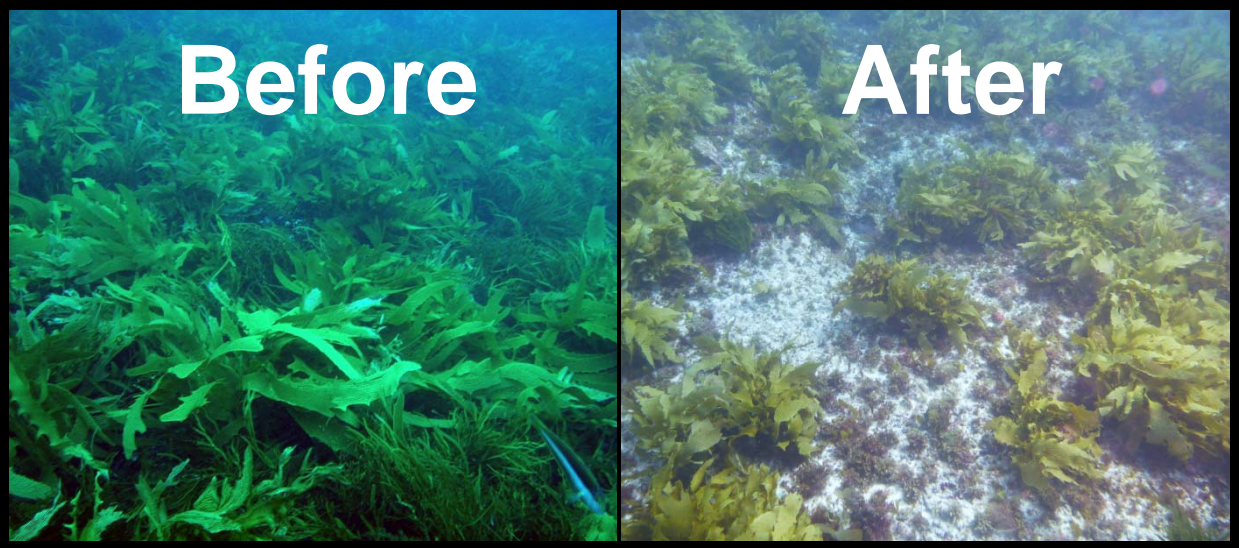
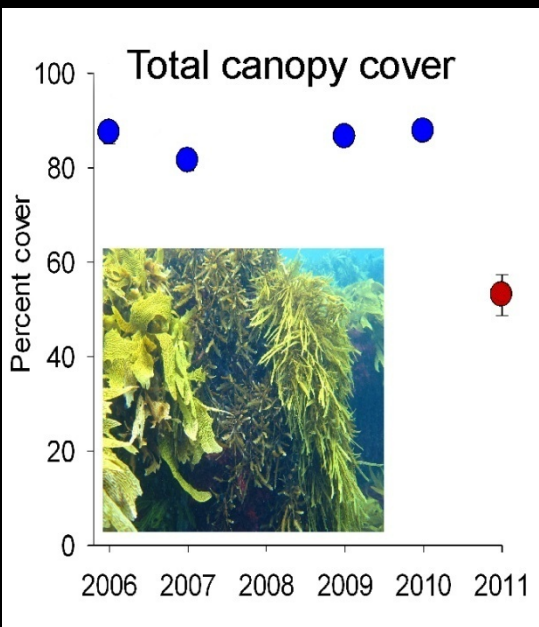
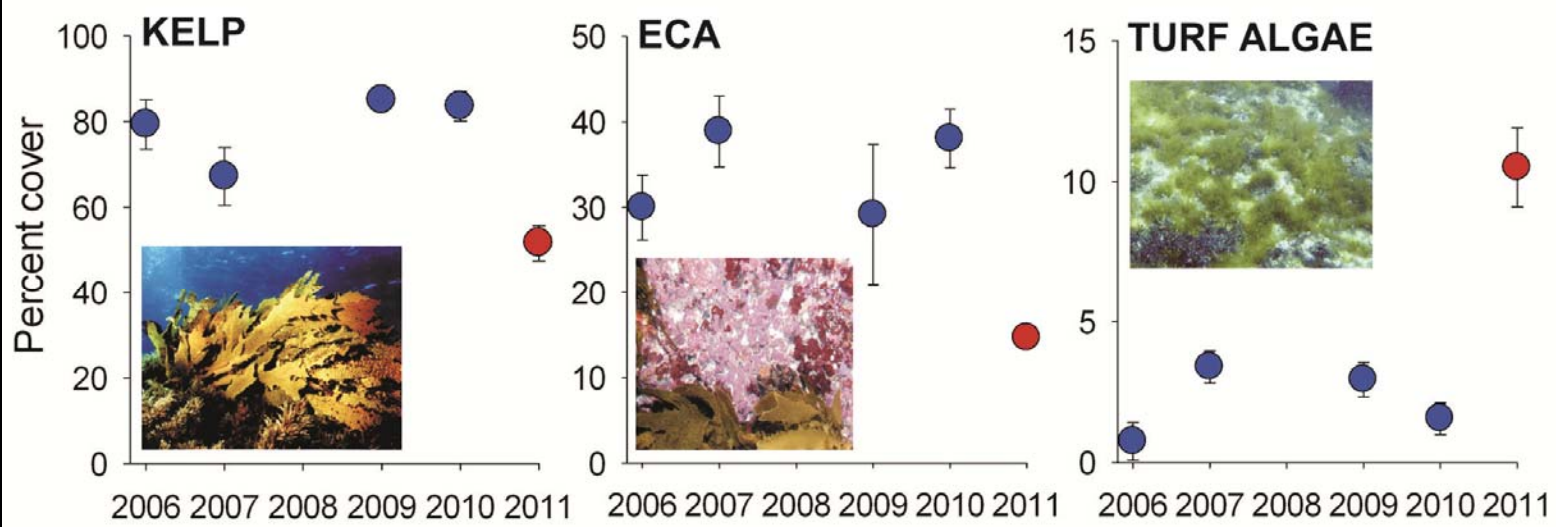
In situ temp data (~12 m depth)

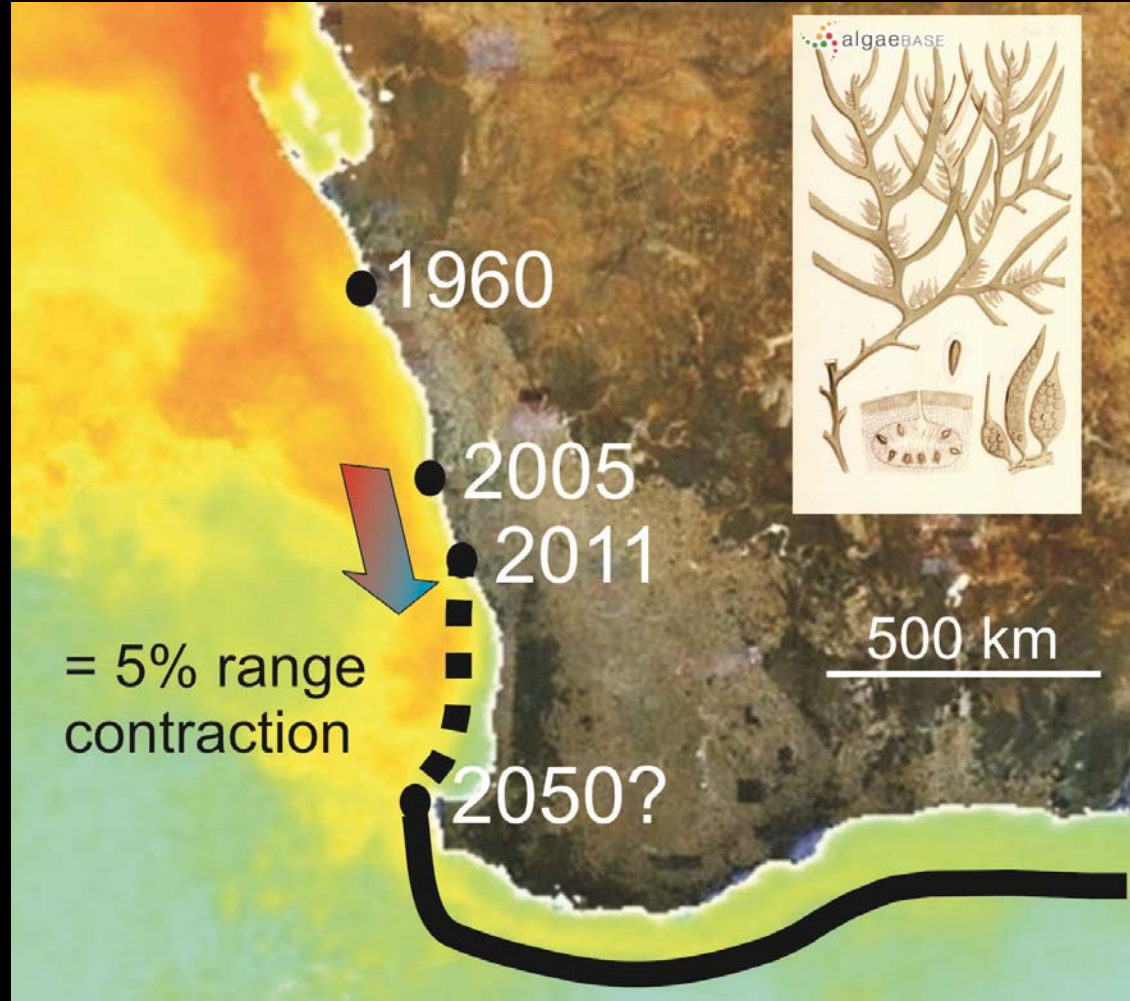
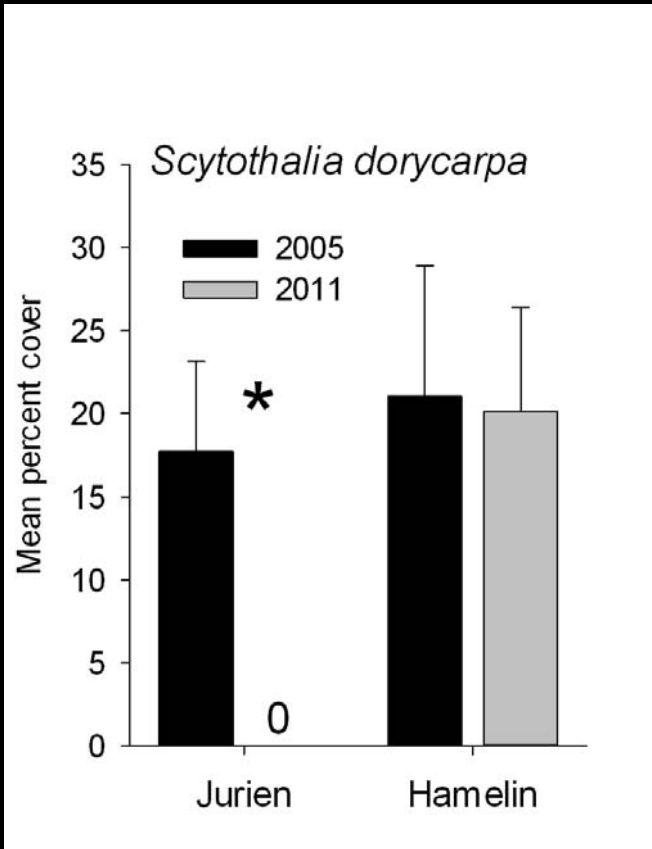


- +2-4°C warming event lasted for 8-12 weeks along most of WA coastline
- Driven by La Nina = strong Leeuwin Current
- Superimposed onto longer-term warming trend
- **SSTs highest on record**: ~30 yrs for satellite-derived data, ~140 yrs for reconstructed SSTs)

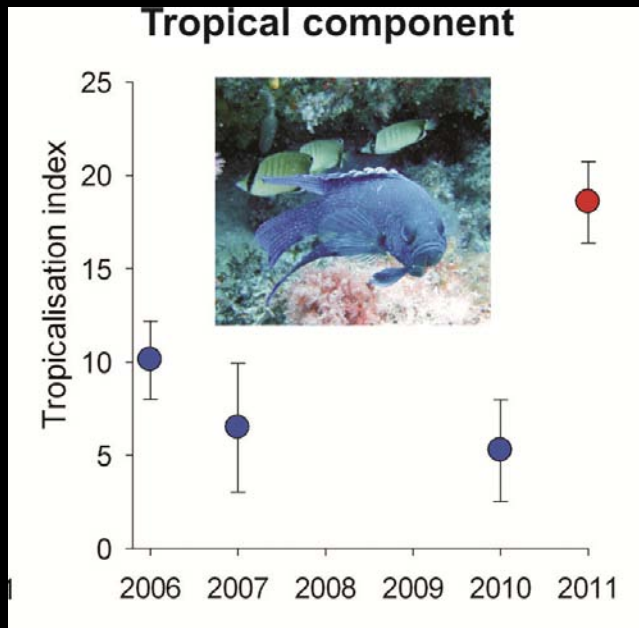


Ecological responses: *macroalgae*





Ecological responses: *fish*

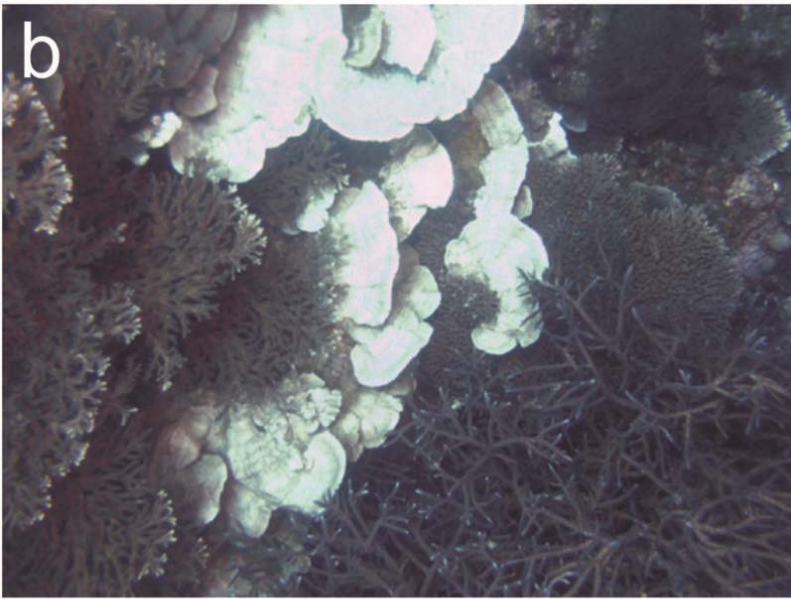


Wernberg, Smale et al (in review) Nature Climate Change

Ecological responses: coral

Houtman Abrolhos AUV monitoring site (28°S)





- Extensive, abnormal levels of coral bleaching
- >20% bleaching at high latitude sites
- Much higher bleaching elsewhere (e.g. Ningaloo)
- Preliminary reports of high mortality
- High epibiosis (fouling by ECA) on kelps at warm range limit

Ecological responses: *other reports*

- Mass kills of fish and molluscs
- Unusual observations (range expansions?)



Conclusions

Extreme event led to major changes in ecological structure:

- A reduced cover of large cool water seaweeds
- Increased cover of 'weedy' turfs
- Range contraction of habitat forming seaweed
- Increased abundance of some warm water fish
- A tropicalisation of the fish assemblage
- Abnormal and extensive coral bleaching (and mortality?)

Knowledge gaps:

- Rates and trajectory of recovery?
- Mechanisms of change?
- Species traits?
- Frequency and magnitude of El Niño/La Niña in future?

Few examples of marine heat waves:

- Dayton et al El Niño 1983 and Californian kelps
- El Niño 1998 and widespread coral bleaching
- European HW 2003 and Mediterranean ecosystem

Wider context

Extreme warming events are increasing in severity:

- Key drivers of biodiversity patterns
 - Predictive models largely based on gradual warming
 - 'Return times' and 'magnitude' of events important
 - 'Step-wise' ecological shifts, rather than gradual
 - Extreme events may act in conjunction with chronic stressors to reach ecological tipping points
-
- *Provide novel insights into effects of long term warming
BUT rely on monitoring data and ability to conduct
opportunistic sampling*

Collaborators/acknowledgements

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