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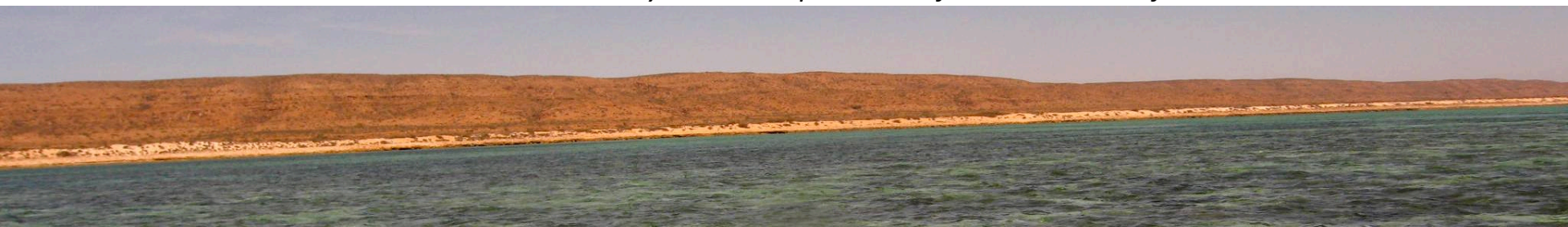
# Corals: Past & Future

James Falter, Malcolm McCulloch

ARC Centre of Excellence for Coral Reef Studies

The Oceans Institute at UWA

*This project is funded by the Gorgon Barrow Island Net Conservation Benefits Fund,  
which is administered by the WA Department of Parks and Wildlife.*

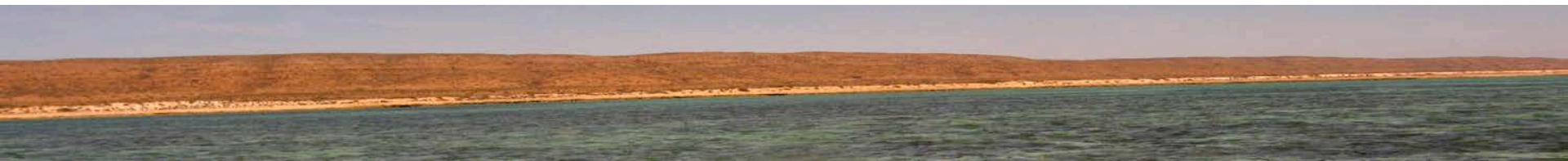
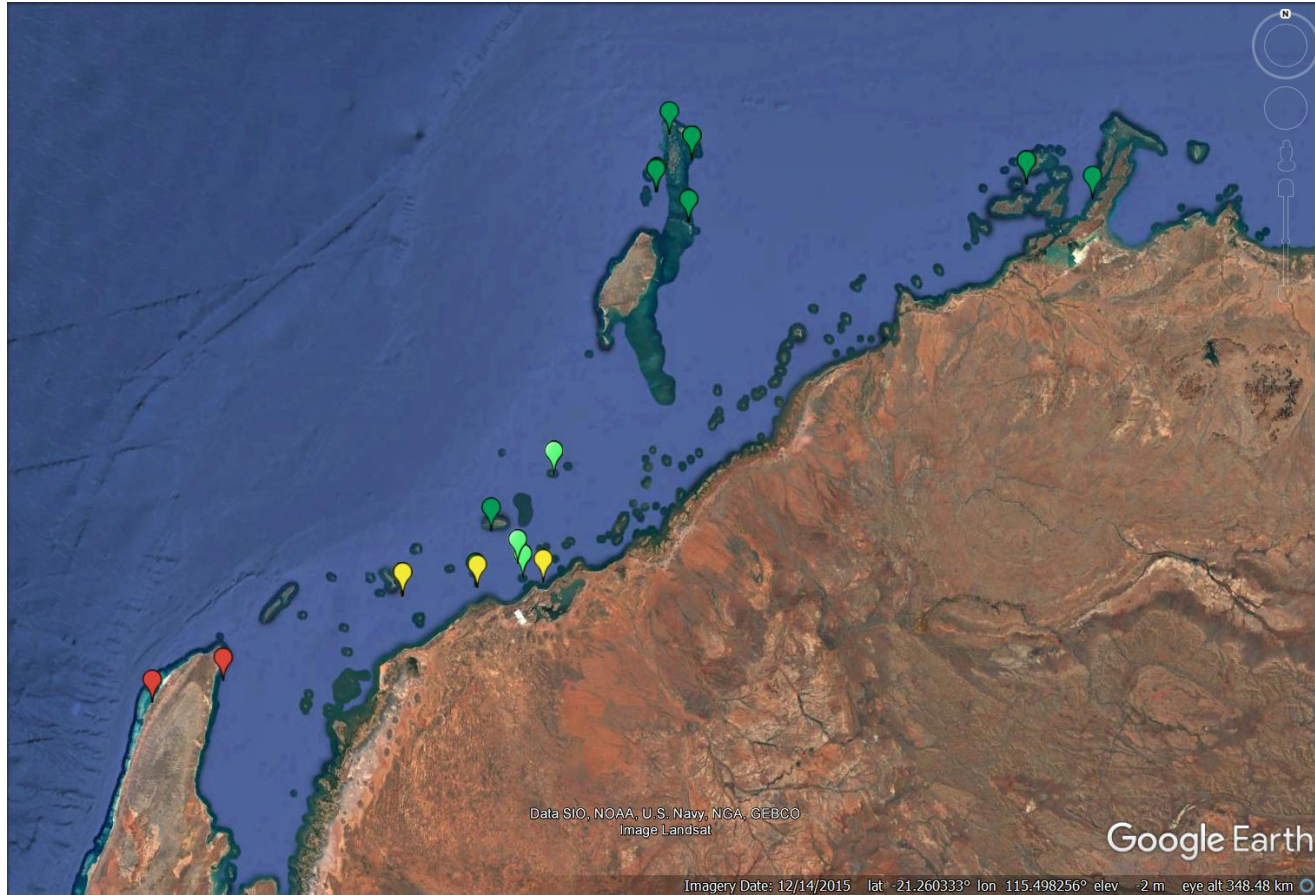




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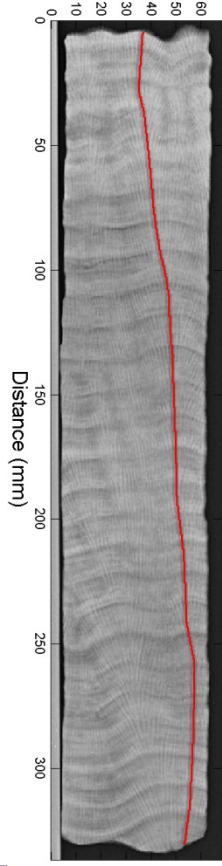


# Pilbara & Ningaloo



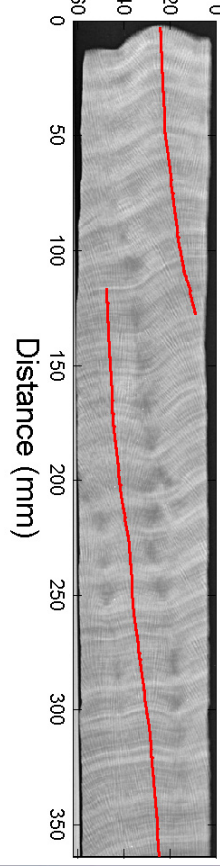


# The Great, the Good, and the Ugly

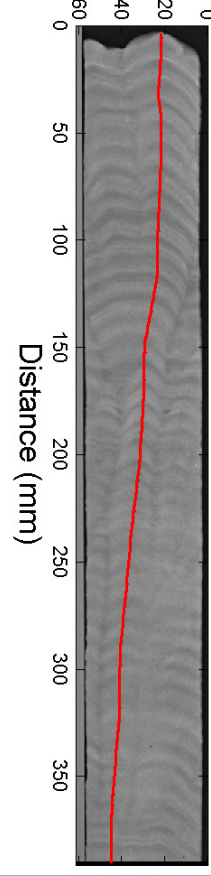


**TNT13-01 → GREAT**

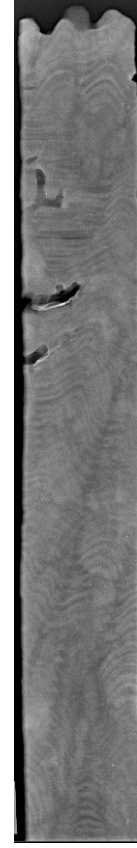
**MONT14-02 → GOOD**



**MONT14-08 → GOOD**



**THV14-01 → UGLY**

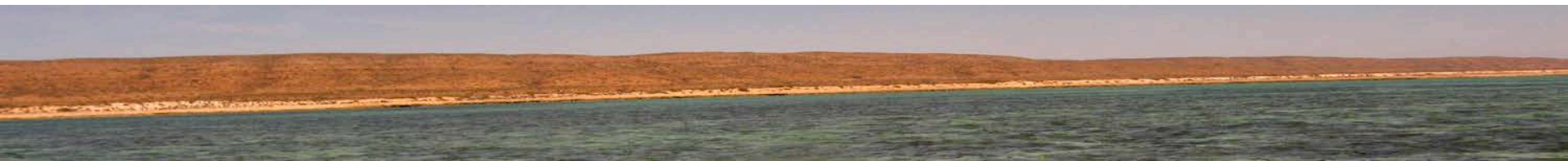
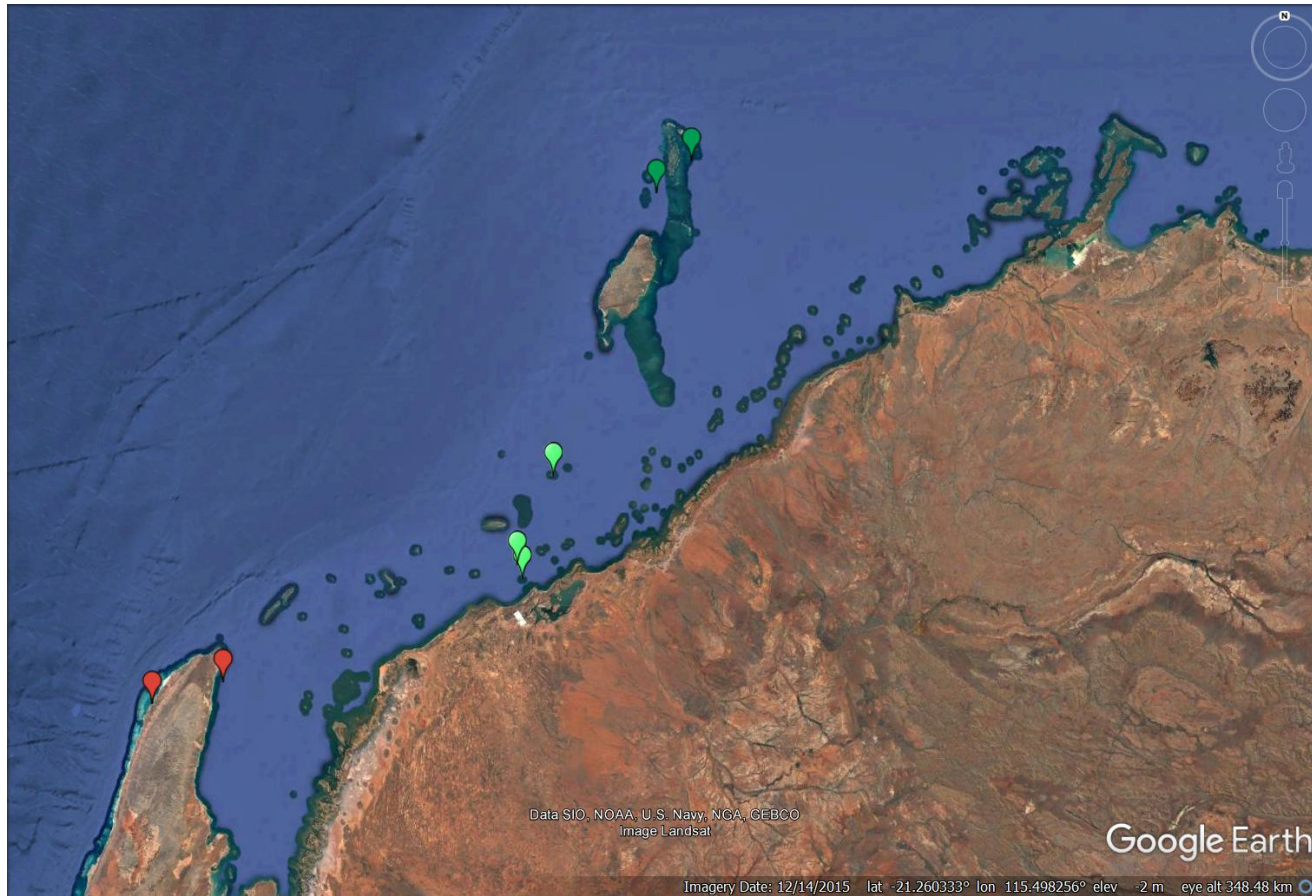




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# Pilbara & Ningaloo



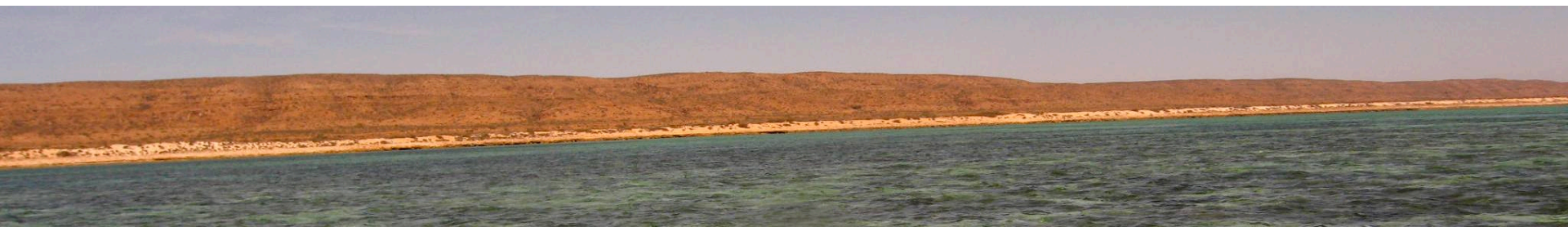


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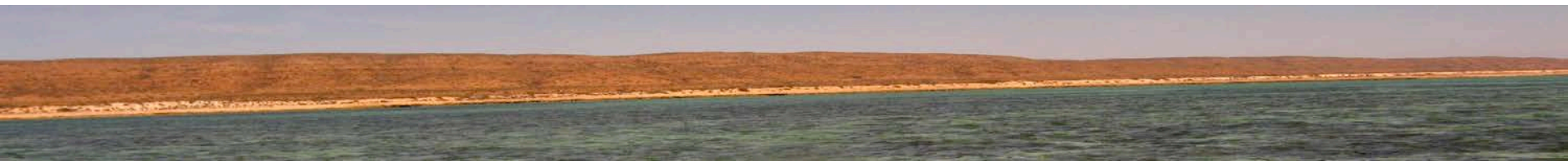
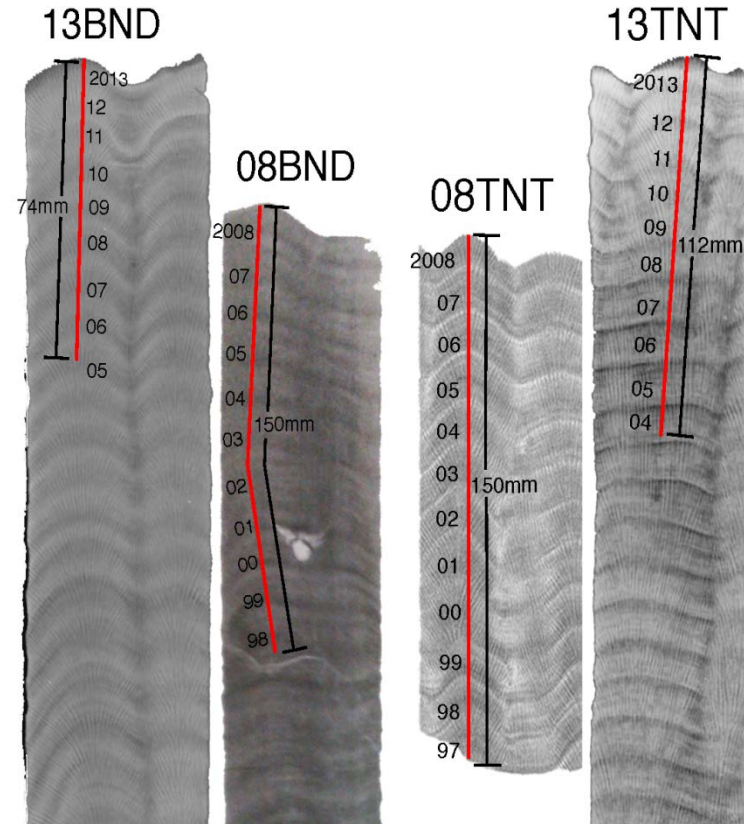
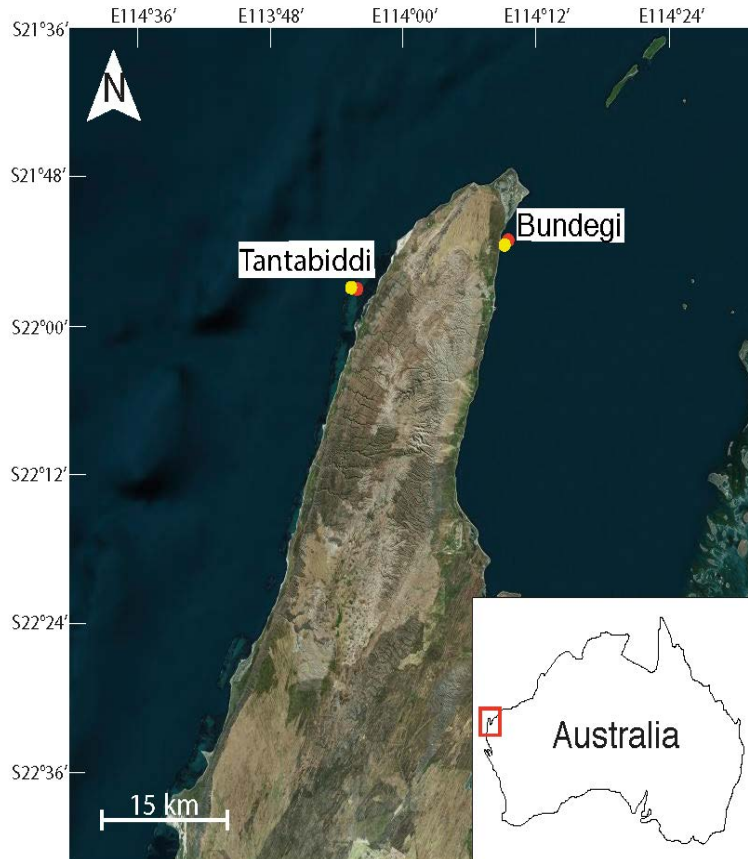


# Differential response of corals to anomalous ocean warming as evident from skeletal Sr/Ca and Mg/Ca ratios

Harry Clarke<sup>1,2</sup>, Juan Pablo D'Olivo<sup>1,2</sup>,  
James Falter<sup>1,2</sup>, Jens Zinke<sup>3</sup>, Ryan Lowe<sup>1,2</sup> and  
Malcolm McCulloch<sup>1,2</sup>

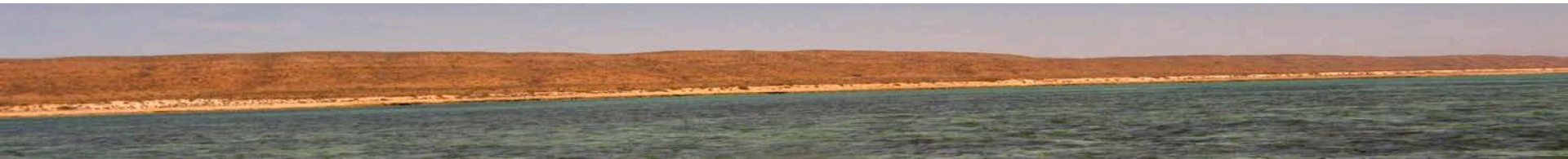
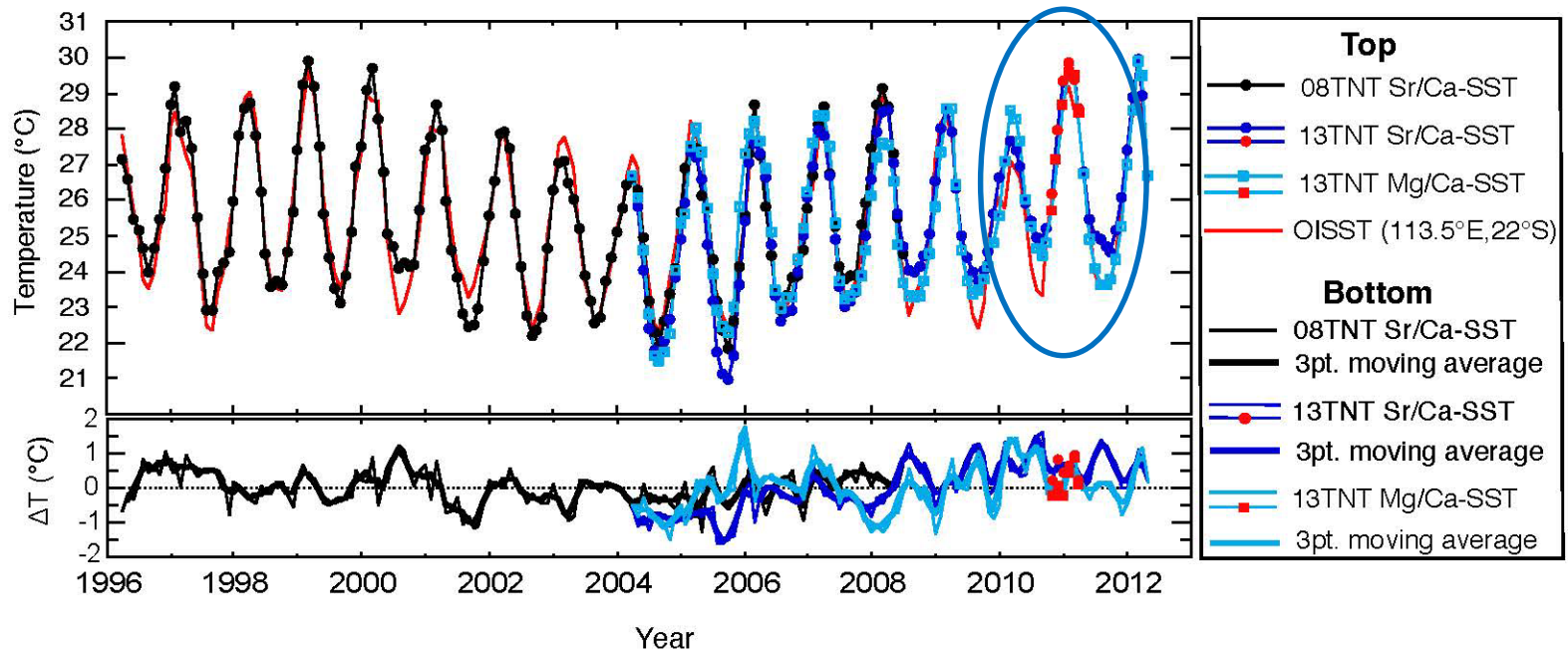


# (In)Effects of 2010-2011 heat wave



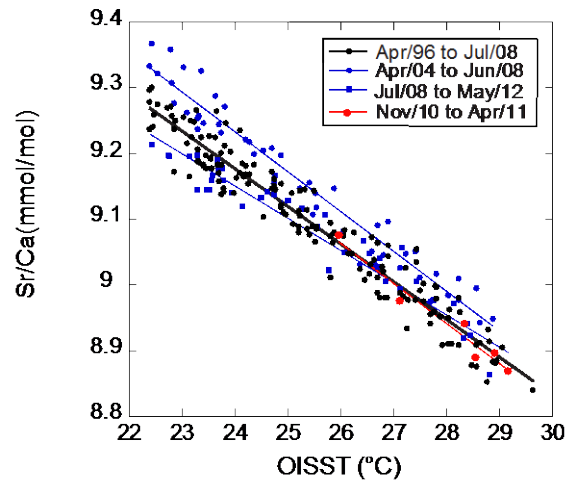
# Little impact at Tantabiddi

## Tantabiddi coral Sr/Ca-SST and Mg/Ca-SST records



# Little impact at Tantabiddi

**A) Tantabiddi Sr/Ca-SST correlations**



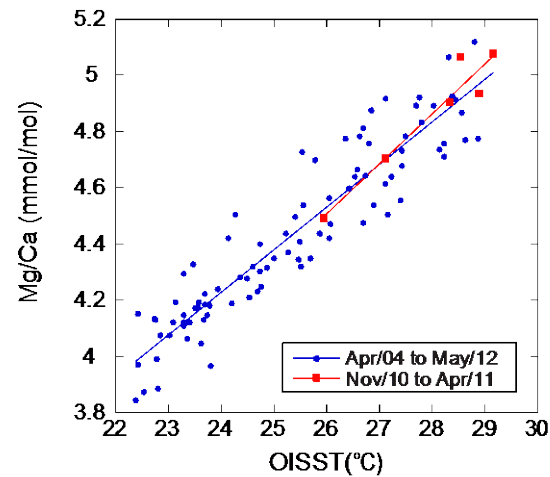
**Bulk 08TNT and 13TNT core record Sr/Ca-SST correlations**

$\bullet$  08TNT Sr/Ca =  $-0.057(\pm 0.002) \times \text{SST} + 10.552(\pm 0.061)$   $R = -0.97, n = 148, p < 0.001$   
 $\bullet$  13TNT Sr/Ca =  $-0.056(\pm 0.004) \times \text{SST} + 10.549(\pm 0.104)$   $R = -0.93, n = 98, p < 0.001$

**Subdivided 13TNT core record Sr/Ca-SST correlations**

$\bullet$  Sr/Ca =  $-0.061(\pm 0.004) \times \text{SST} + 10.692(\pm 0.099)$   $R = -0.98, n = 51, p < 0.001$   
 $\bullet$  Sr/Ca =  $-0.049(\pm 0.004) \times \text{SST} + 10.332(\pm 0.098)$   $R = -0.96, n = 47, p < 0.001$   
 $\bullet$  Sr/Ca =  $-0.061(\pm 0.019) \times \text{SST} + 10.642(\pm 0.520)$   $R = -0.98, n = 6, p < 0.001$

**B) Tantabiddi Mg/Ca-SST correlations**

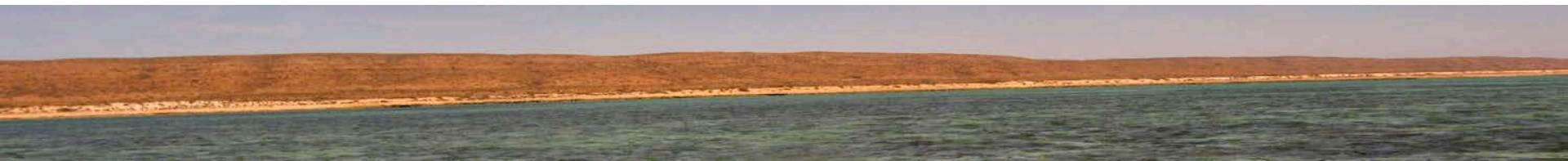


**Bulk 13TNT Mg/Ca-SST correlation**

$\bullet$  13TNT Mg/Ca =  $0.152(\pm 0.011) \times \text{SST} + 0.587(\pm 0.288)$   $R = 0.94, n = 98, p < 0.001$

**Subdivided 13TNT core record Mg/Ca-SST correlation**

$\bullet$  Mg/Ca =  $0.178(\pm 0.071) \times \text{OISST} - 0.116(\pm 1.988)$   $R = 0.96, n = 6, p < 0.01$

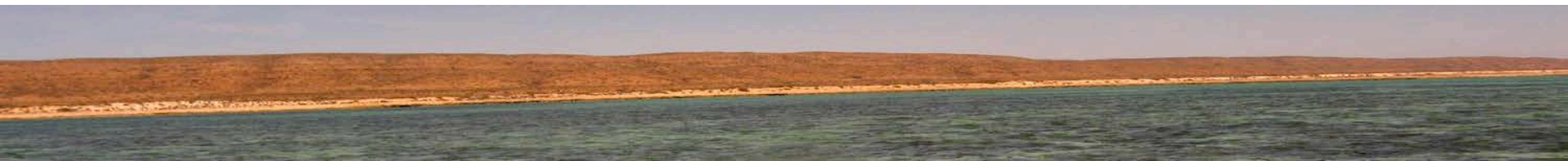
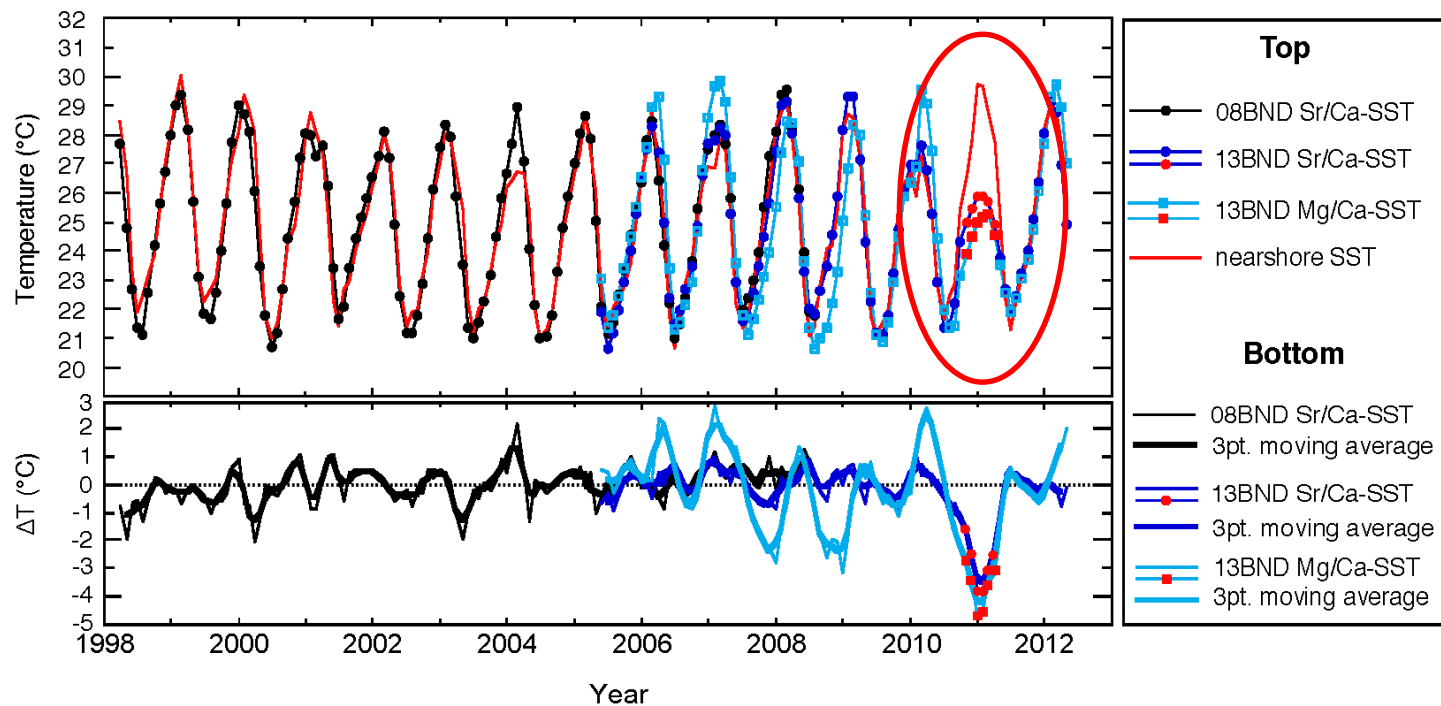






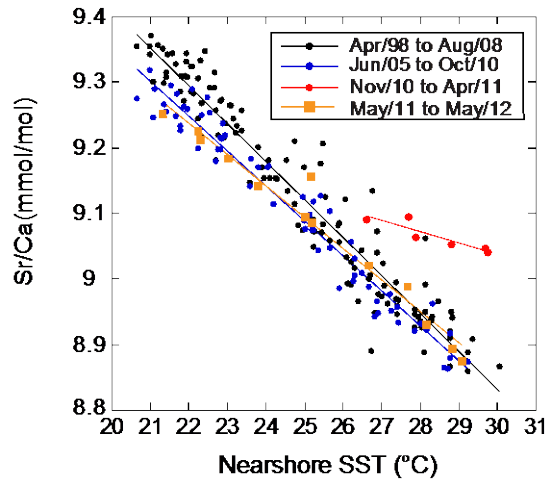
# Trace elements show Bundegi felt the heat

## Bundegi coral Sr/Ca-SST and Mg/Ca-SST records



# Trace elements show Bundegi felt the heat

**A) Bundegi Sr/Ca-SST correlations**



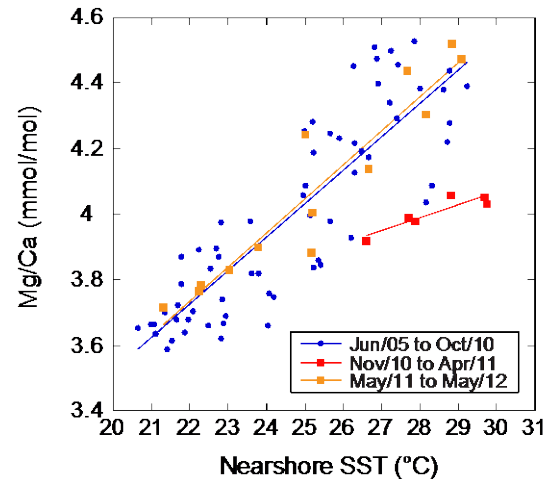
Bulk 08BND and 13BND core record Sr/Ca-SST correlations

$08BND\ Sr/Ca = -0.058(\pm 0.003) \times SST + 10.572(\pm 0.07)\ R = -0.97, n=125, p < 0.001$   
 $13BND\ Sr/Ca = -0.057(\pm 0.003) \times SST + 10.4(\pm 0.063)\ R = -0.98, n=78, p < 0.001$

Subdivided 13BND core record Sr/Ca-SST correlations

$Sr/Ca = -0.054(\pm 0.003) \times SST + 10.425(\pm 0.07)\ R = -0.98, n=65, p < 0.001$   
 $Sr/Ca = -0.048(\pm 0.006) \times SST + 10.291(\pm 0.153)\ R = -0.98, n=13, p < 0.001$

**B) Bundegi Mg/Ca-SST correlations**

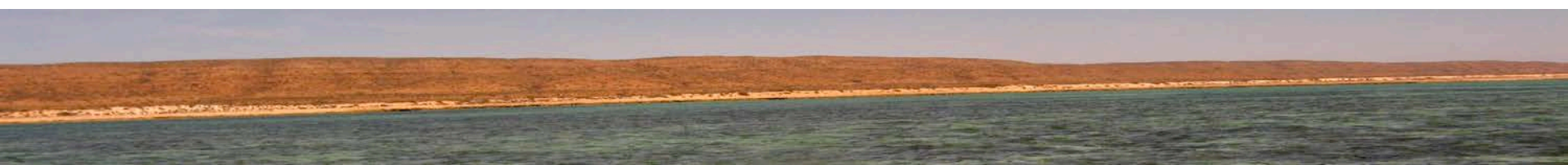


Bulk 13BND Mg/Ca-SST correlation

$13BND\ Mg/Ca = 0.102(\pm 0.013) \times SST + 1.473(\pm 0.32)\ R = 0.88, n=78, p < 0.001$

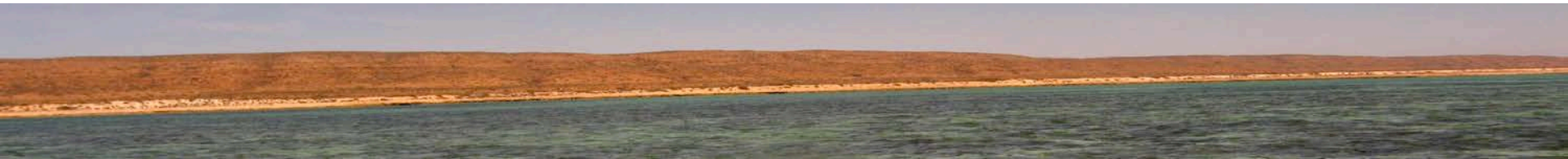
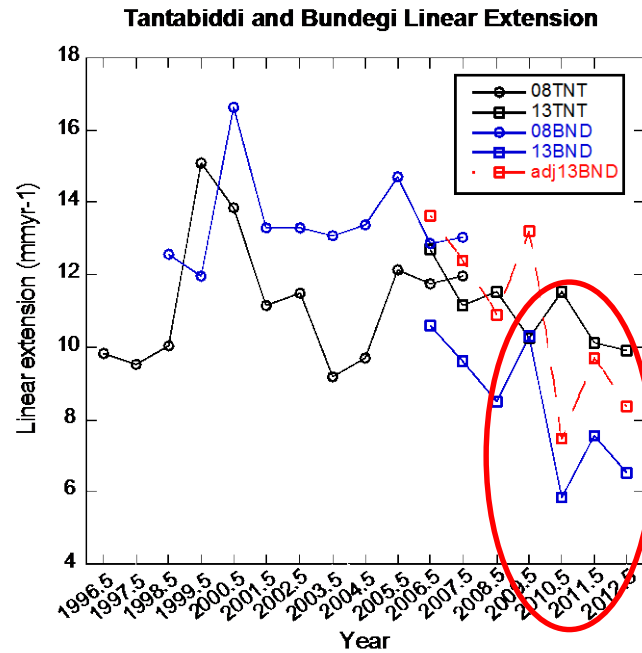
Subdivided 13BND core record Mg/Ca-SST correlations

$Mg/Ca = 0.102(\pm 0.015) \times SST + 1.485(\pm 0.373)\ R = 0.86, n=65, p < 0.001$   
 $Mg/Ca = 0.039(\pm 0.026) \times SST + 2.908(\pm 0.738)\ R = 0.9, n=6, p < 0.05$   
 $Mg/Ca = 0.104(\pm 0.024) \times SST + 1.452(\pm 0.608)\ R = 0.94, n=13, p < 0.001$



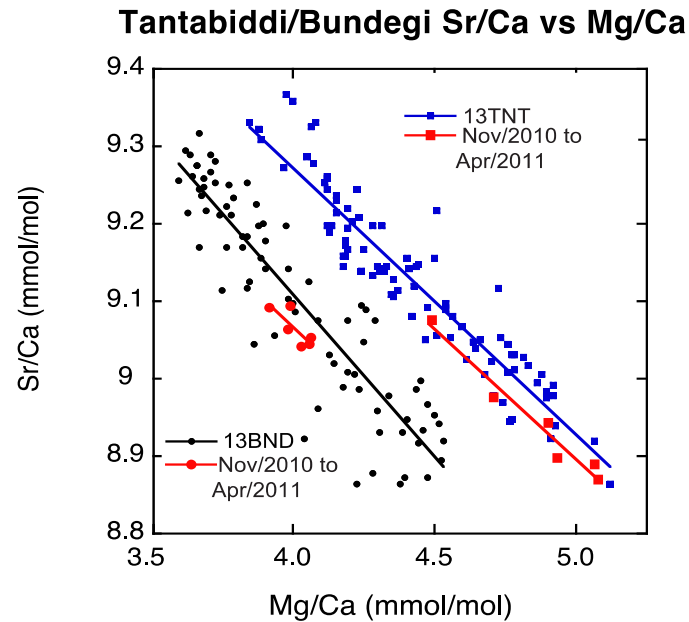


# Slowdown in coral growth at Bundegi





# Symmetric disruption suggests physiological breakdown in coral calcification

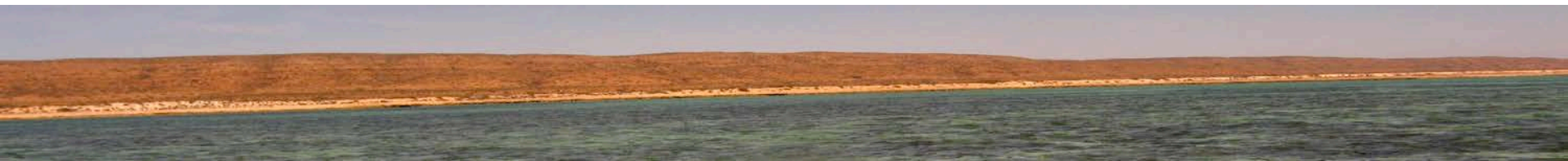


—●— 13BND Sr/Ca =  $-0.417(\pm 0.043) * (\text{Mg/Ca}) + 10.774 (\pm 0.171)$   $R = -.91$ ,  $n = 84$ ,  $p < 0.001$

—●— 13BND Sr/Ca =  $-0.348(\pm 0.359) * (\text{Mg/Ca}) + 10.461 (\pm 1.437)$   $R = -.80$ ,  $n = 6$ ,  $p > 0.05$

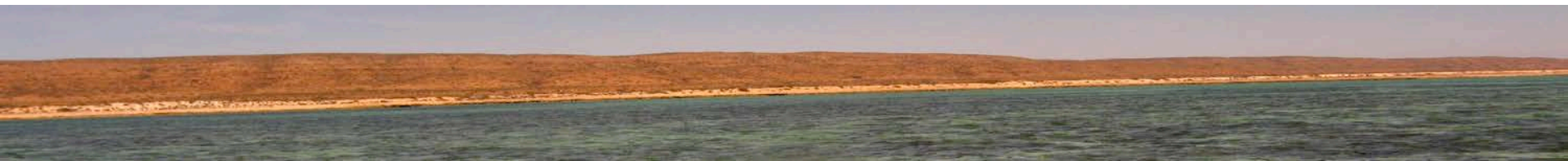
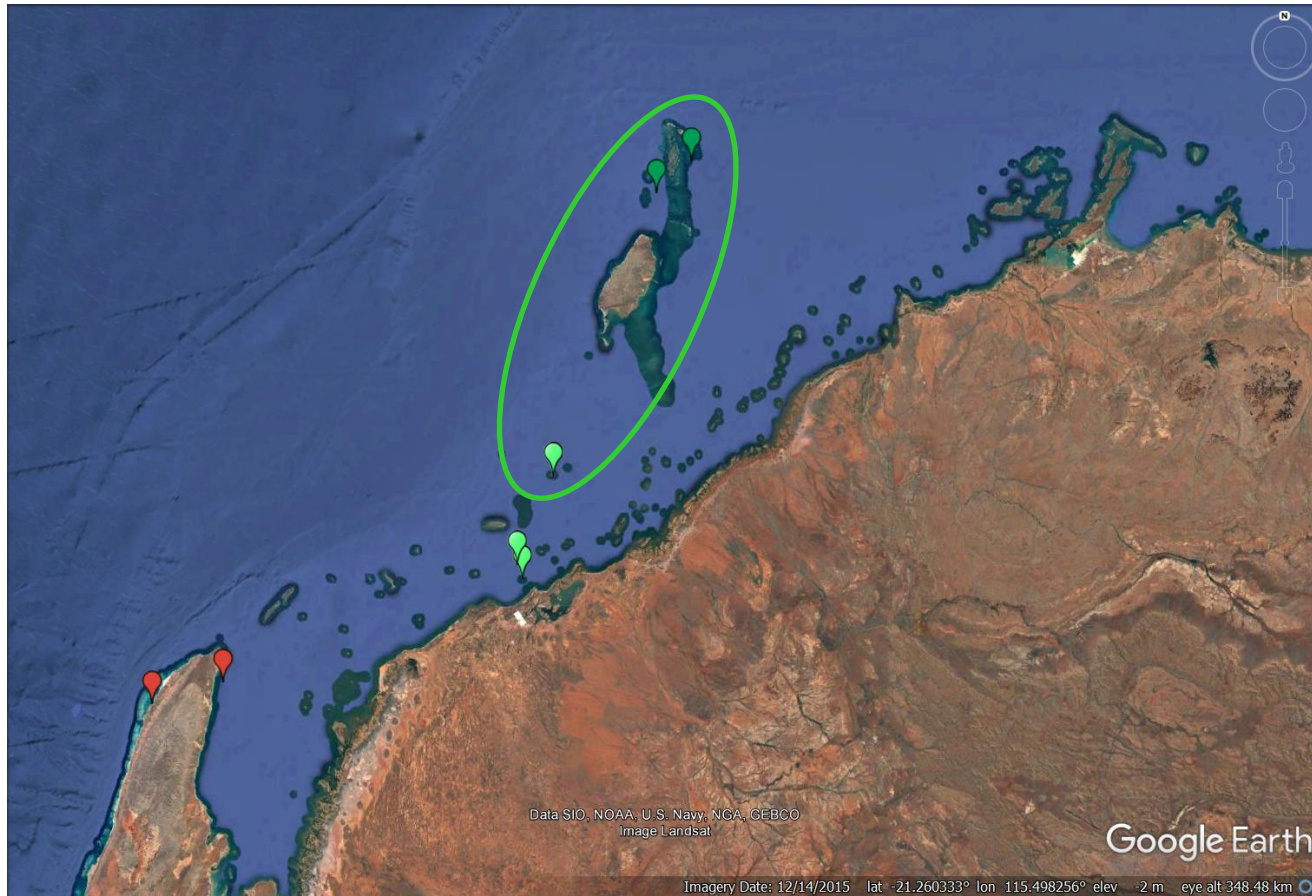
—■— 13TNT Sr/Ca =  $-0.354(\pm 0.024) * (\text{Mg/Ca}) + 10.688 (\pm 0.107)$   $R = -.95$ ,  $n = 98$ ,  $p < 0.001$

—■— 13TNT Sr/Ca =  $-0.329(\pm 0.098) * (\text{Mg/Ca}) + 10.540 (\pm 0.479)$   $R = -.98$ ,  $n = 6$ ,  $p < 0.001$





# Past evidence of thermal stress in the central Pilbara?

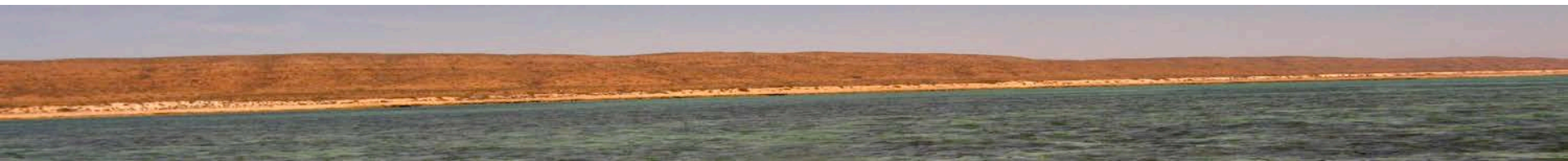
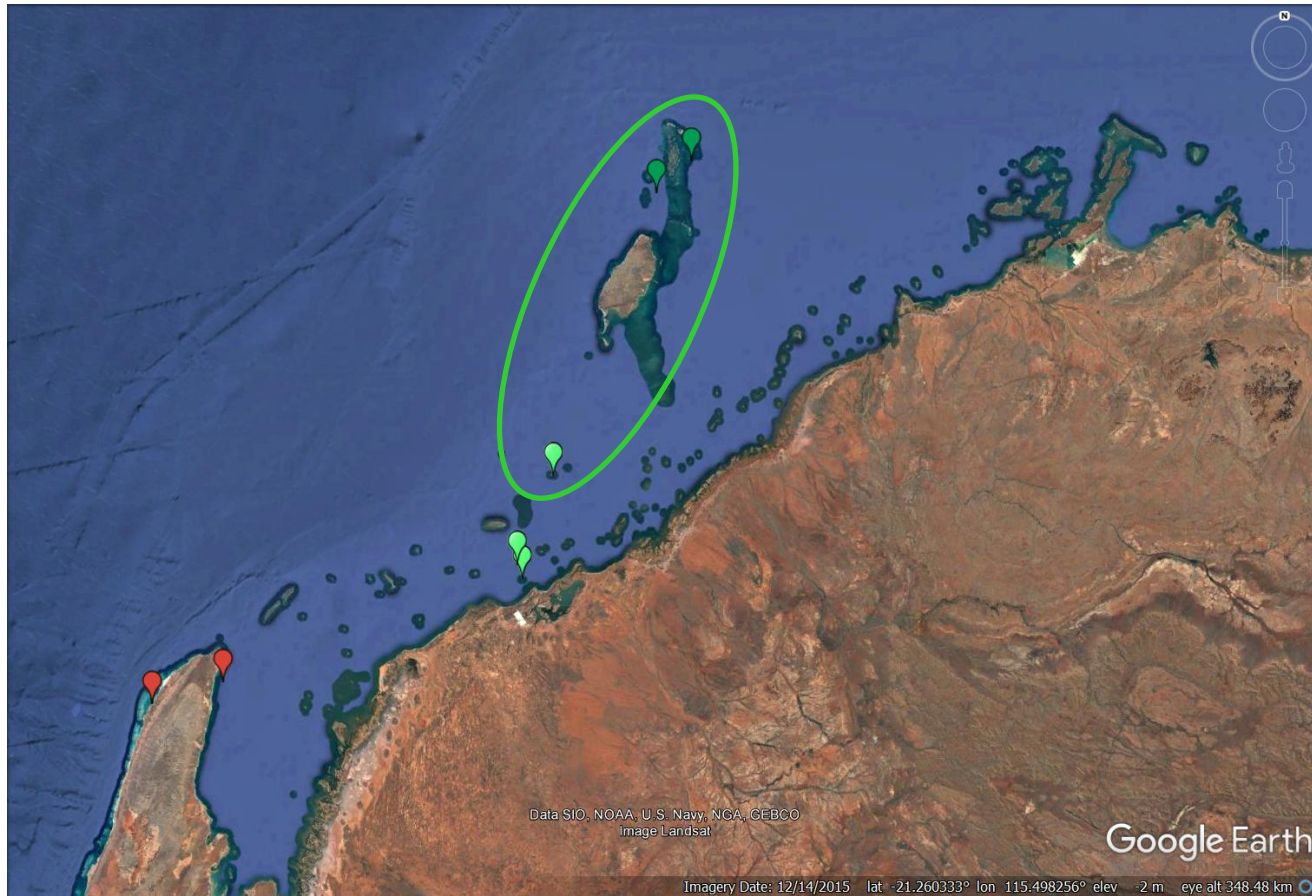




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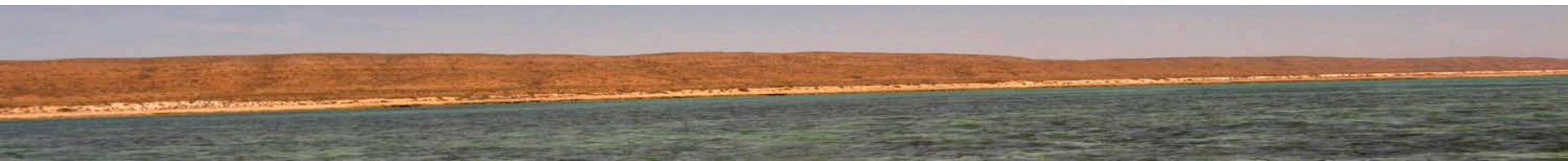
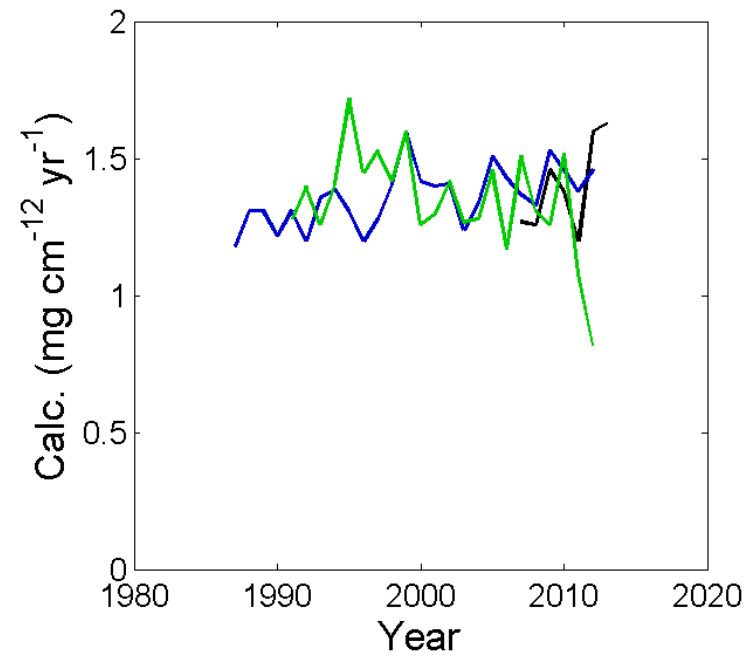
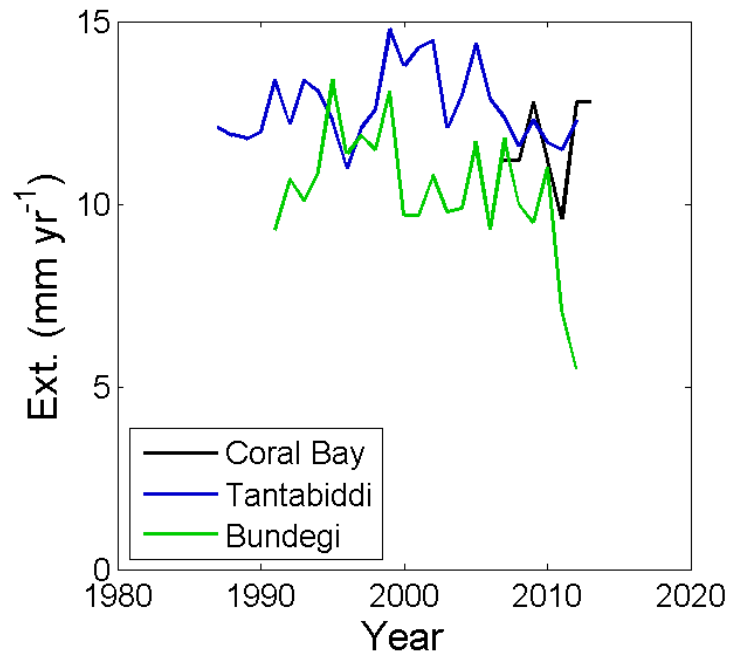


# Long-term trends in coral calcification throughout the central Pilbara?



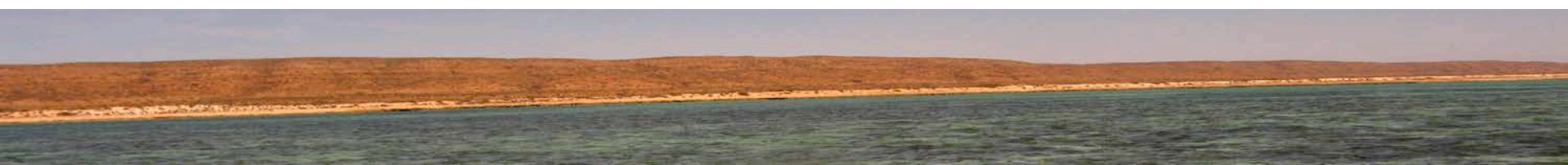
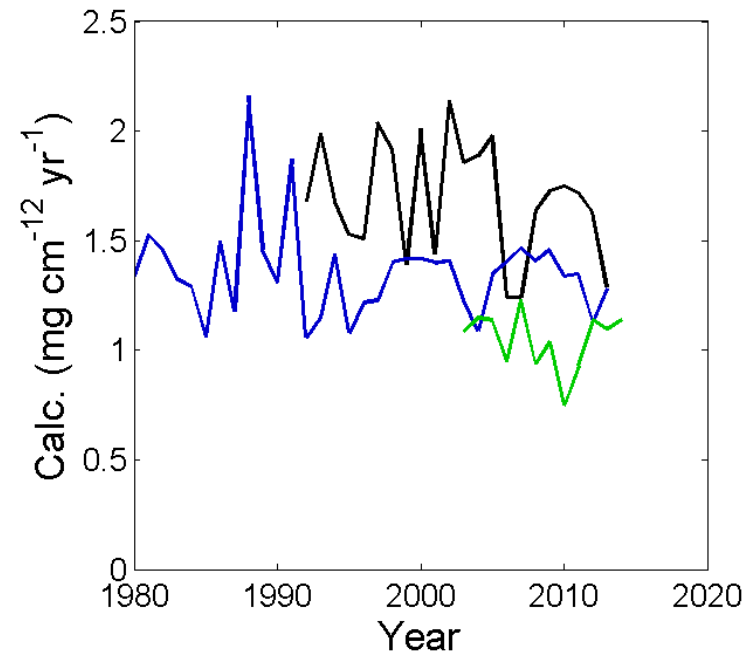
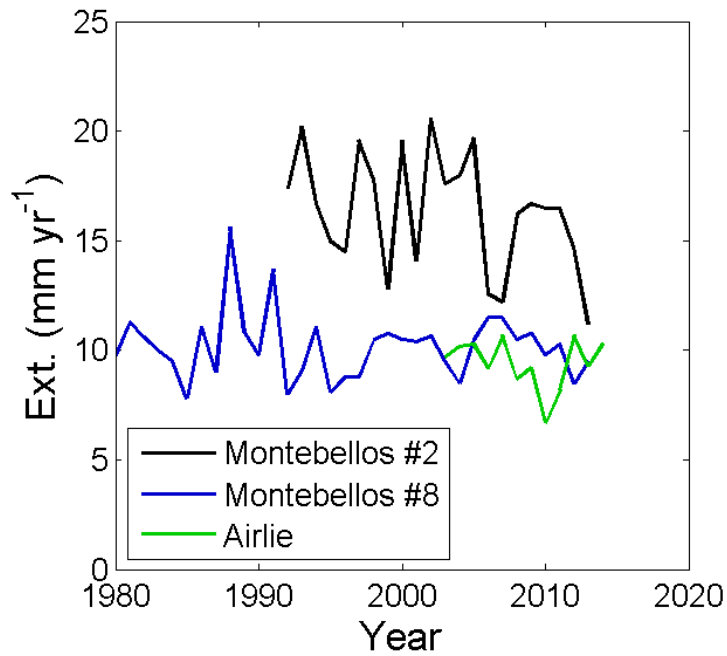


# First evidence: growth rates





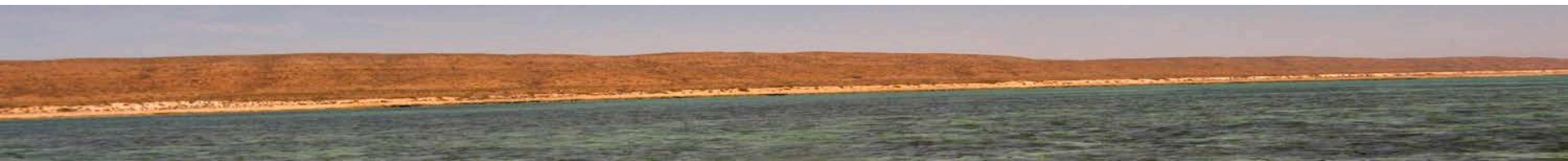
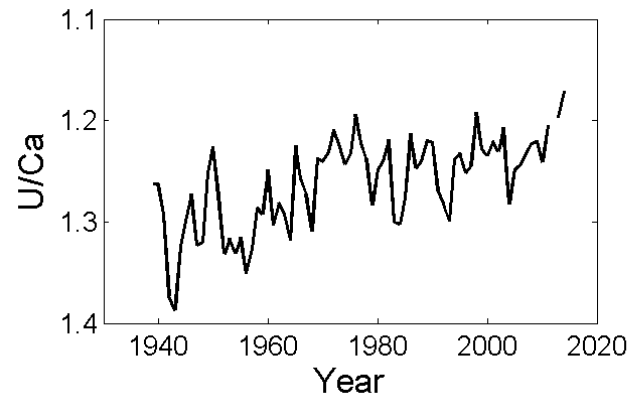
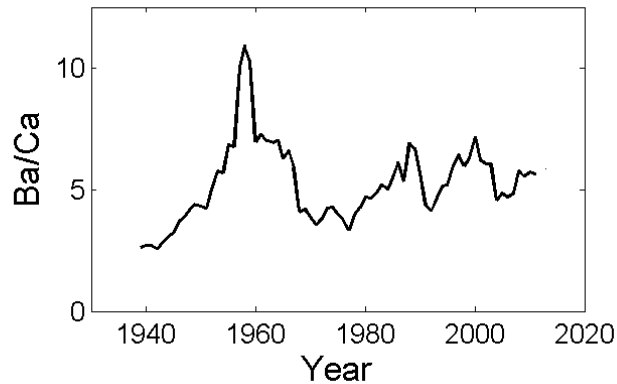
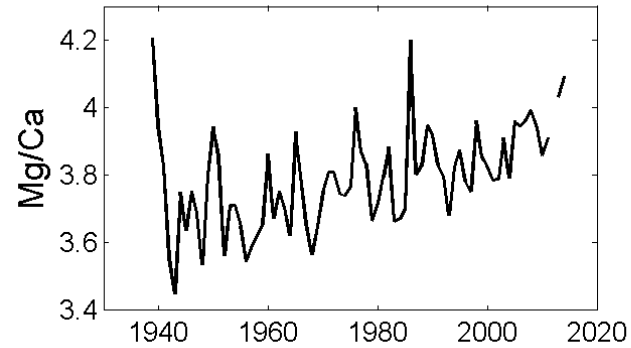
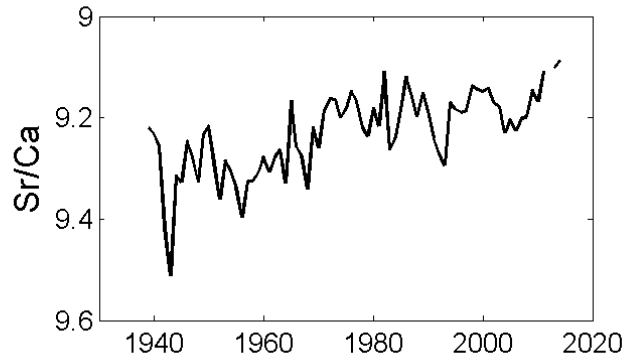
# First evidence: growth rates







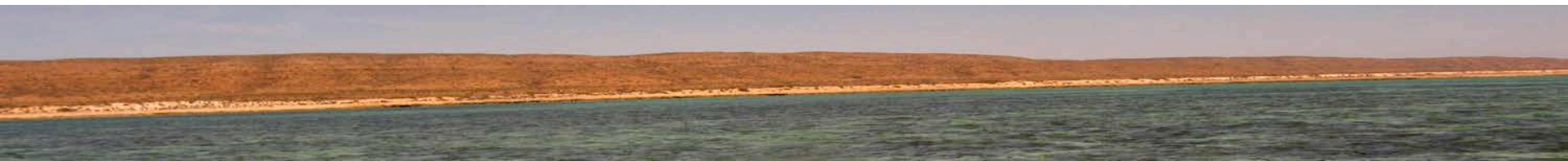
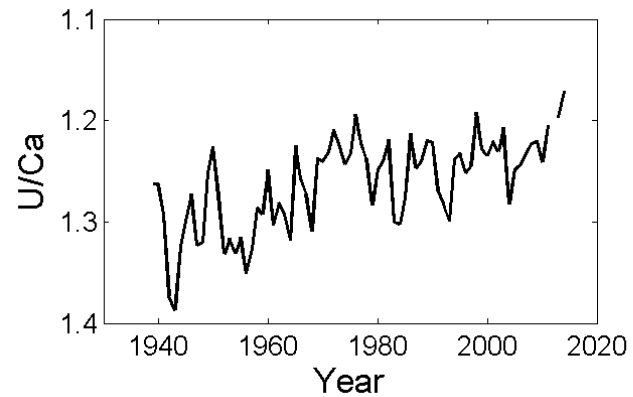
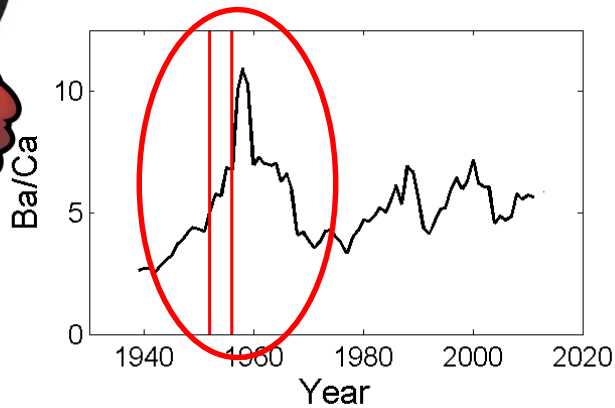
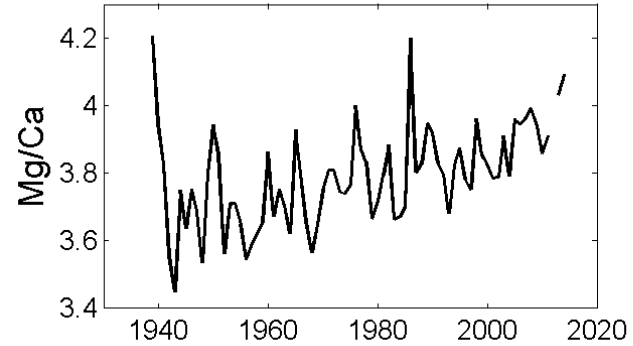
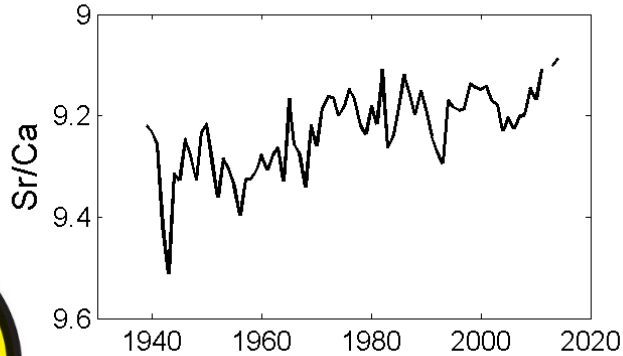
# More refined evidence: trace elements





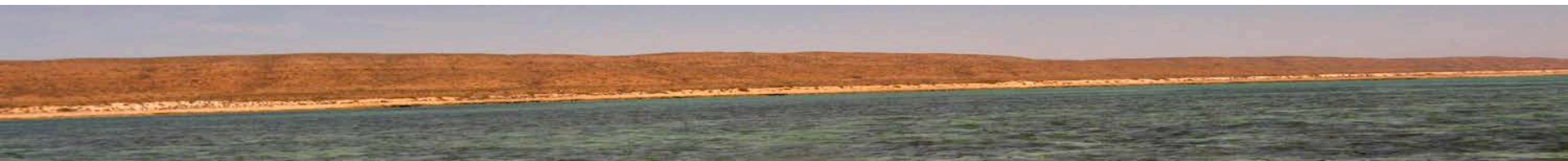
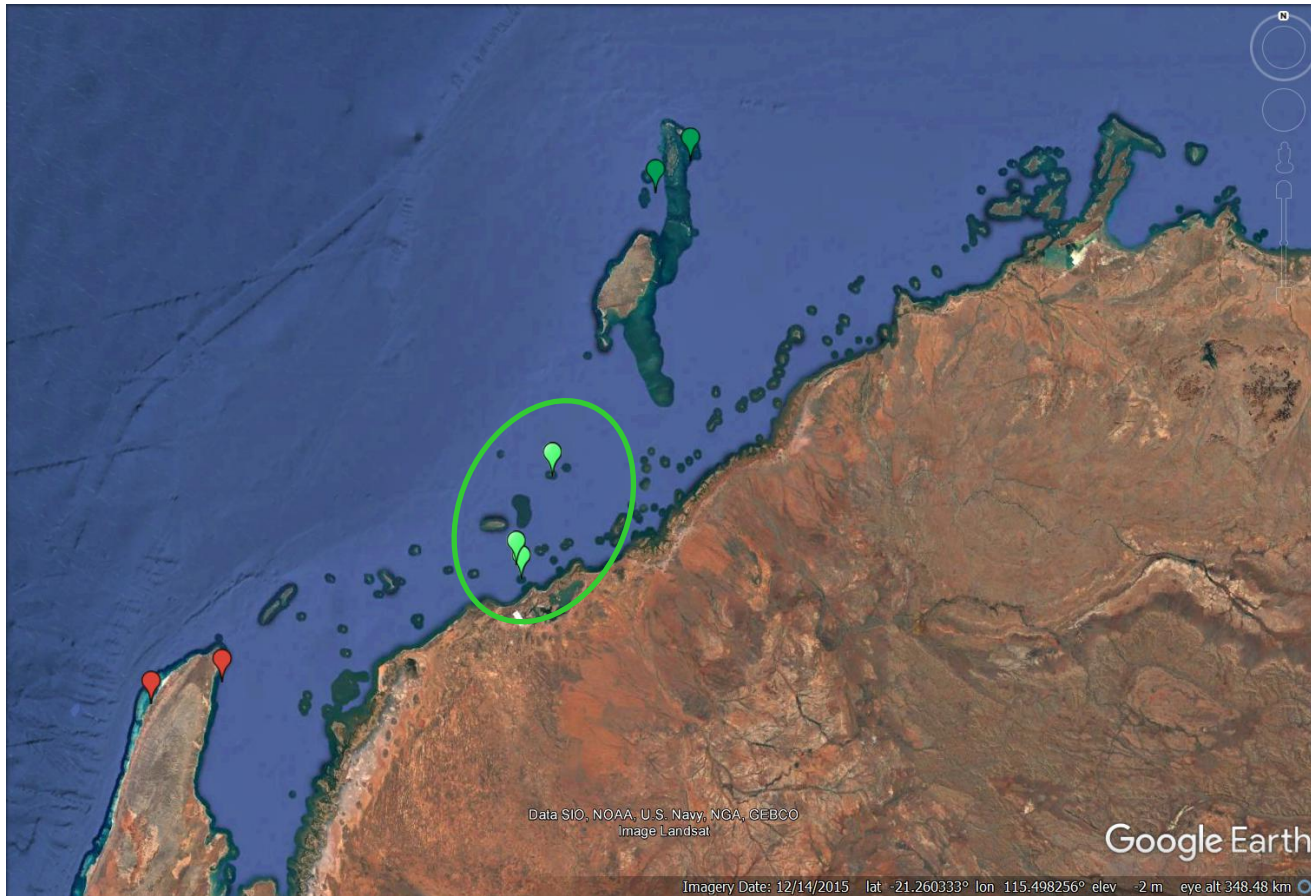
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# More refined evidence: trace elements





# Have corals in the recorded major runoff and dredging events in the Pilbara?





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# Acknowledgements

Gorgon Barrow Island  
Net Conservation Benefits Fund  
[www.ncb.org.au](http://www.ncb.org.au)

