# Have we set the bar too high? Implications of climate change for regions of high biodiversity.

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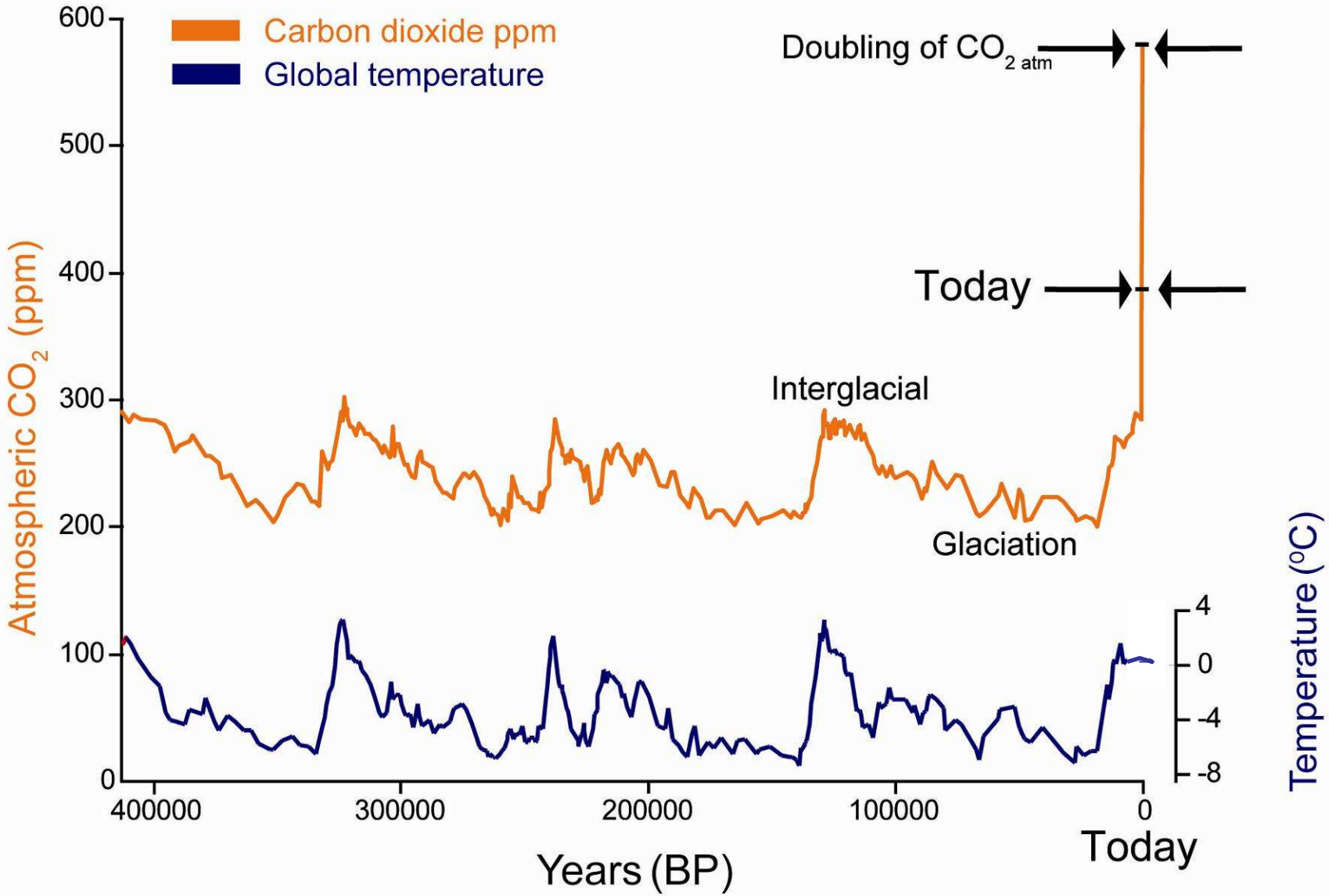
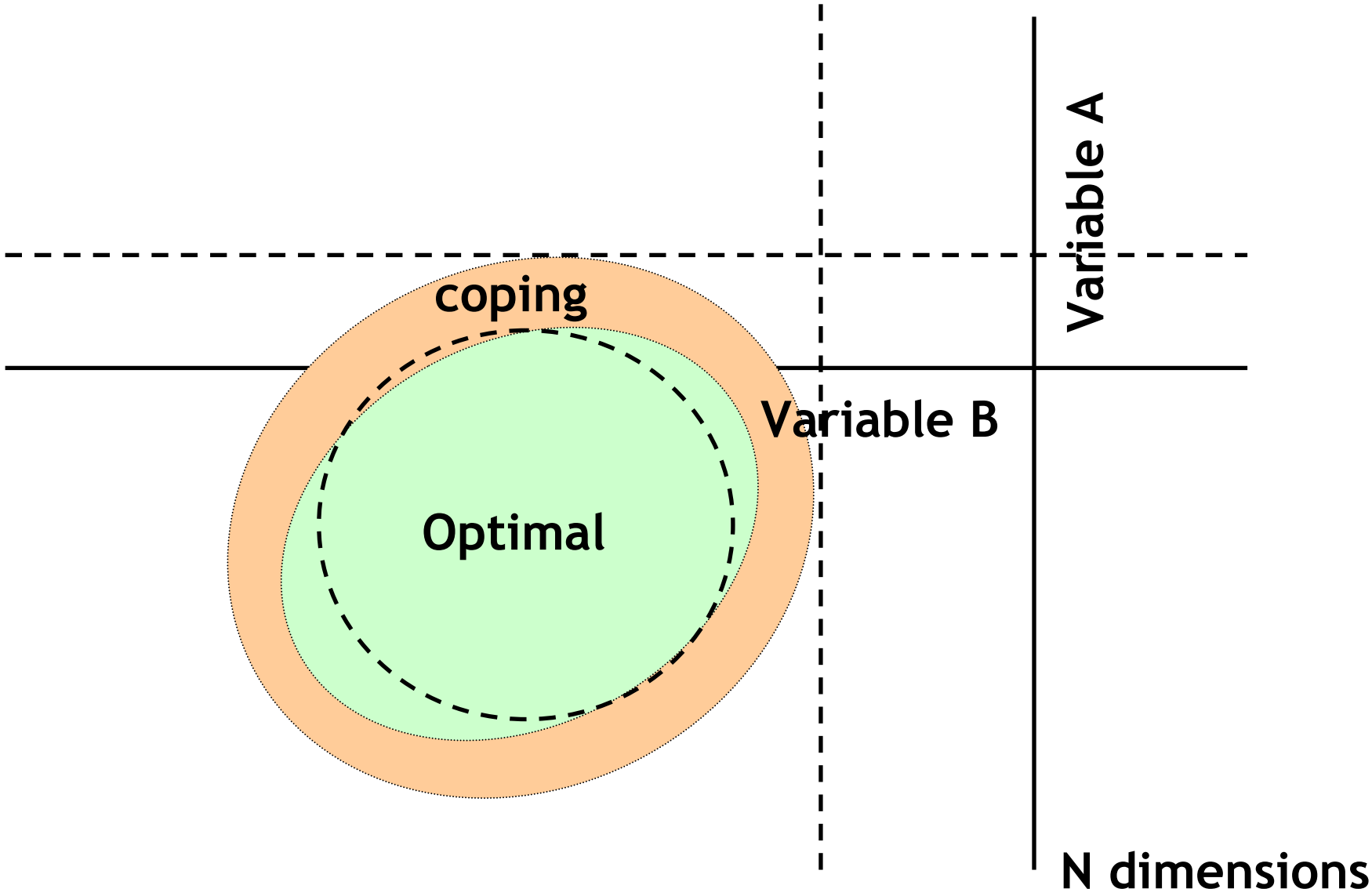
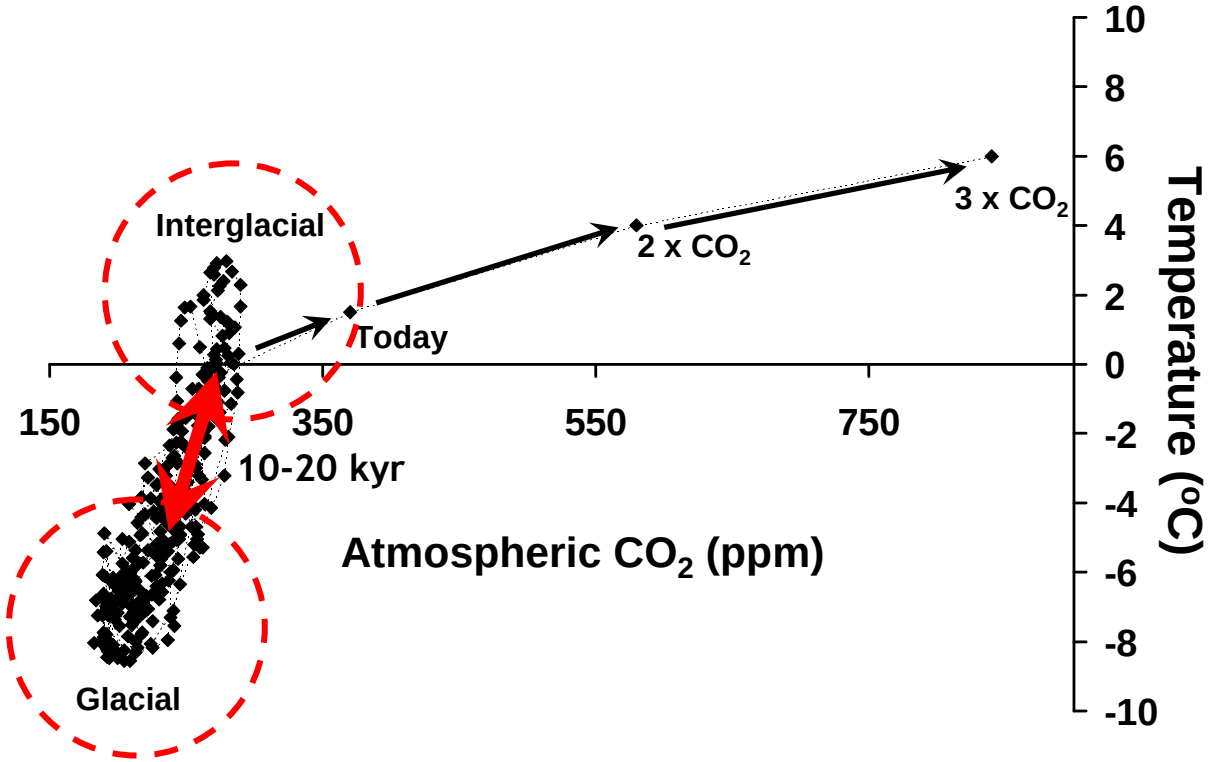

Carbon dioxide ppm
Global temperature
Doubling of $CO_{2\ atm}$
Today
Interglacial
Glaciation
Atmospheric $CO_2$ (ppm)
600
500
400
300
200
100
0
400000
300000
200000
100000
0
Today
Years (BP)
4
0
-4
-8
Temperature (°C)


Variable A
coping
Variable B
Optimal
N dimensions


Interglacial
Glacial
Today
10-20 kyr
2 x CO2
3 x CO2
150
350
550
750
Atmospheric CO2 (ppm)
10
8
6
4
2
0
-2
-4
-6
-8
-10
Temperature (°C)

# Biodiversity and climate change

- How will biodiversity change?
- What can we do to minimize this change?
- What steps can we take to adapt to the inevitable changes?

180°
120°
60°
0°
60°
120°
180°
60°
30°
0°
Equator
30°
60°
Scale by latitude
60°
30°
0 1,000 2,000 mi
0 1,610 3,220 km
Principal regions where tropical rainforest is the natural vegetation
1997
dia Britannica, Inc.

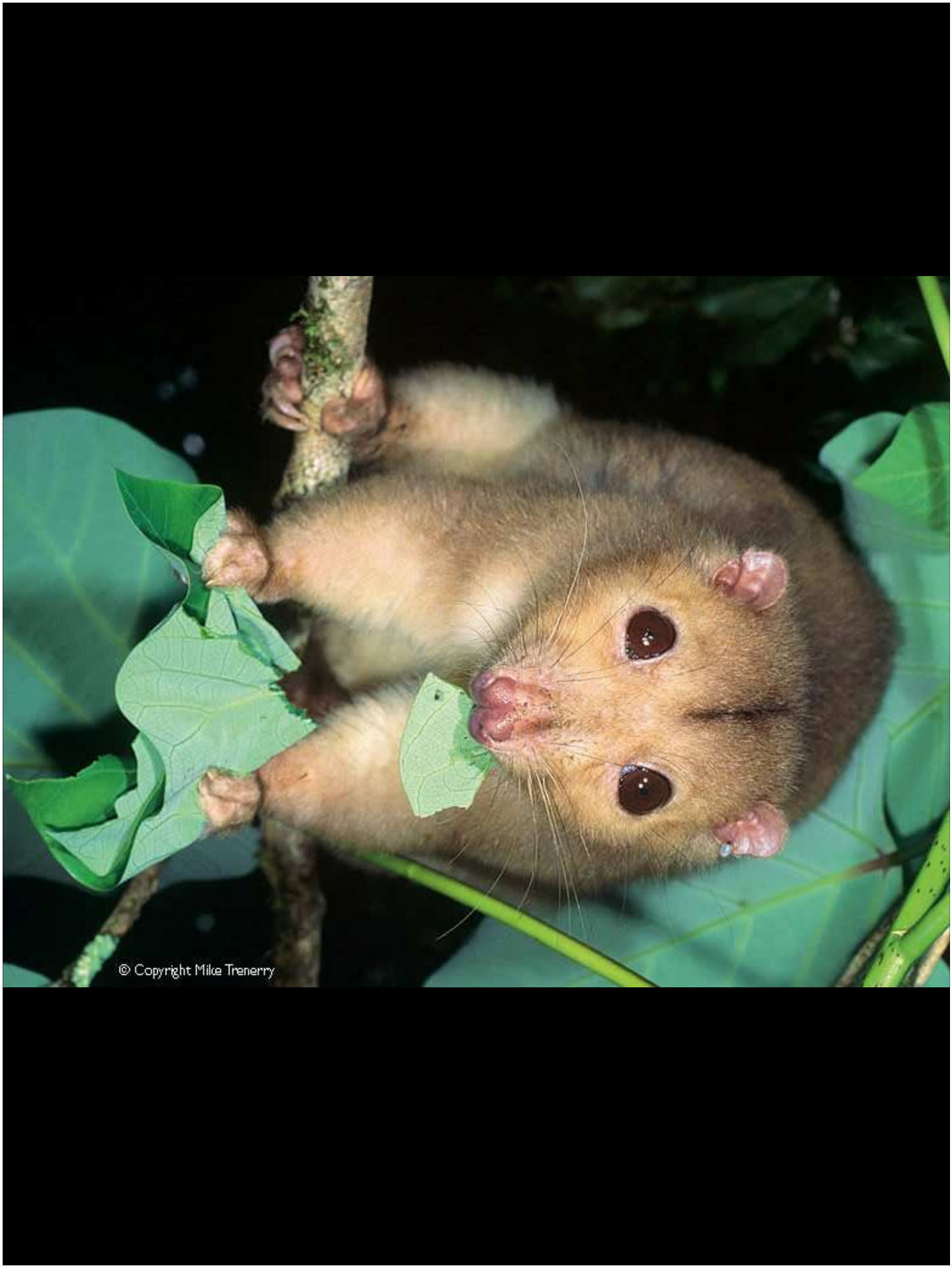
WET TROPICS (Australia)

# WET TROPICS (Australia)

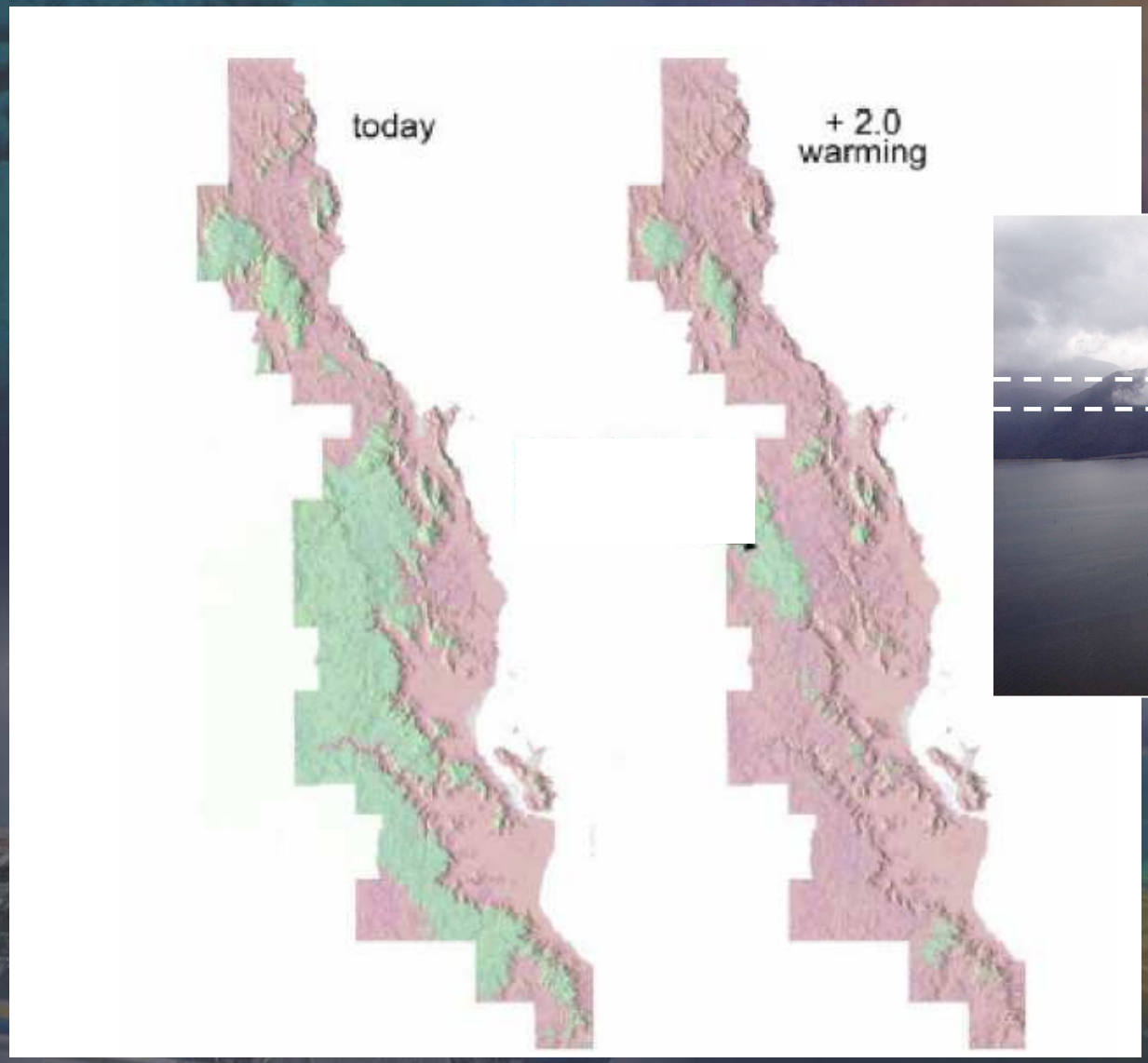
<1% of the continent:

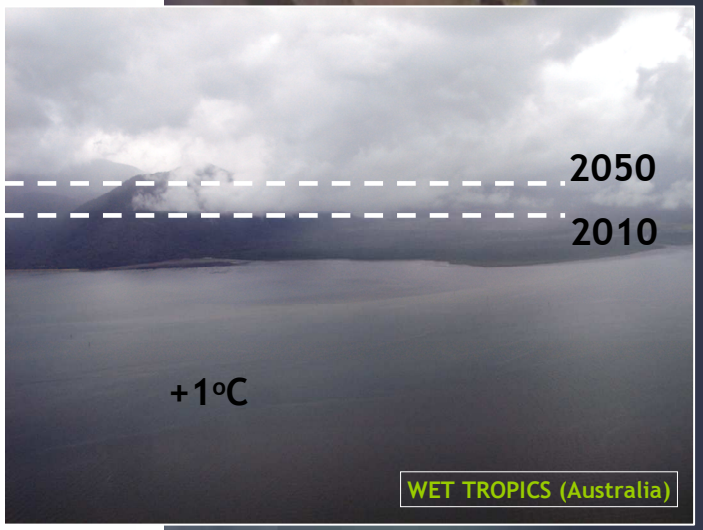
- 36% mammals
- 48% birds
- 17% reptiles
- 26% frogs
- 41% fish
- 58% butterflies
- 65% ferns
- 21% cycads
- 37% conifers
- 30% orchids
- 30% vascular plants
- 12 of world's 19 most primitive families of flowering plants (1 family endemic)

(Source: WTMA)


© Copyright Mike Trenerry

# The drying of the Wet Tropics

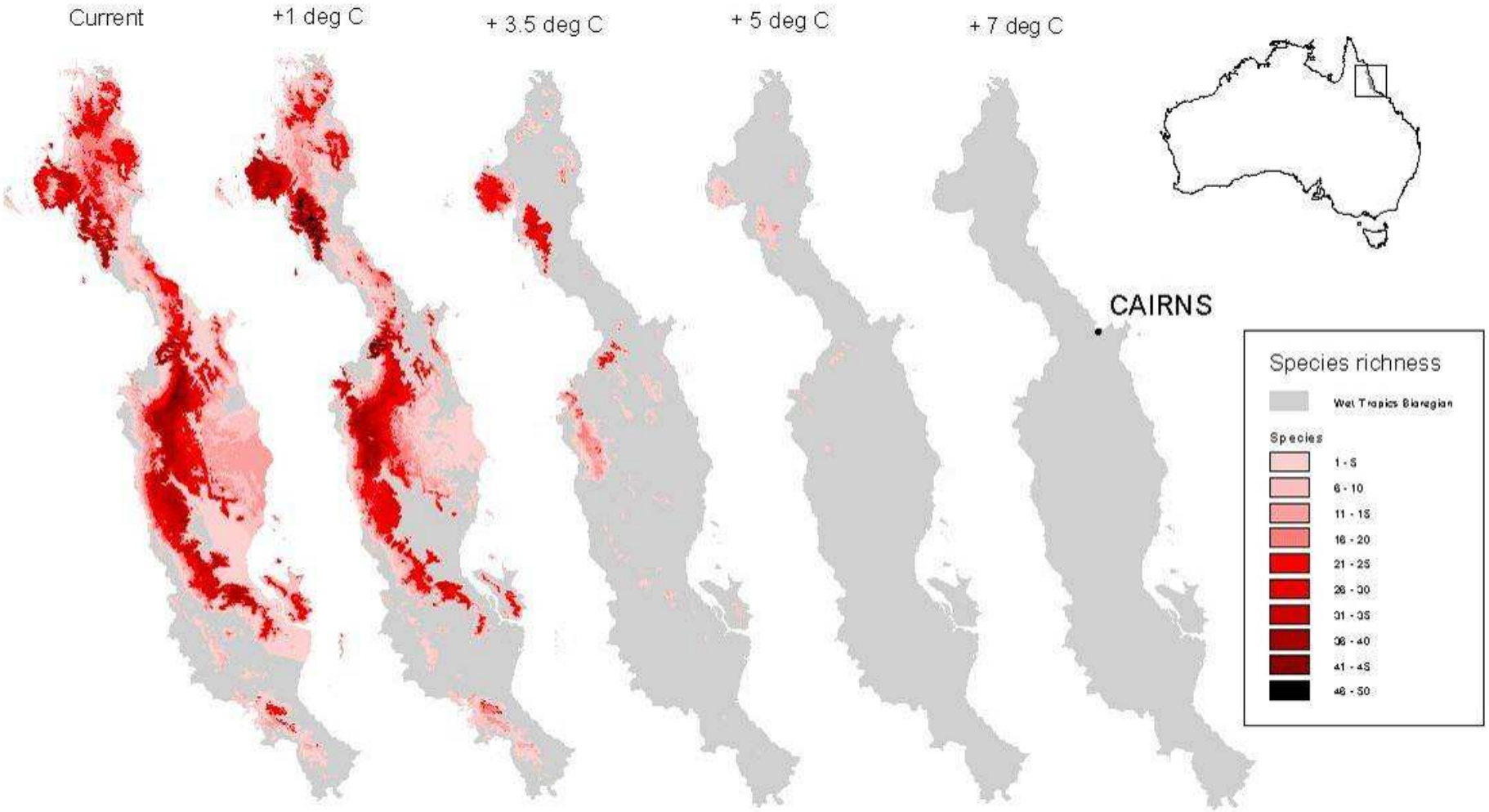


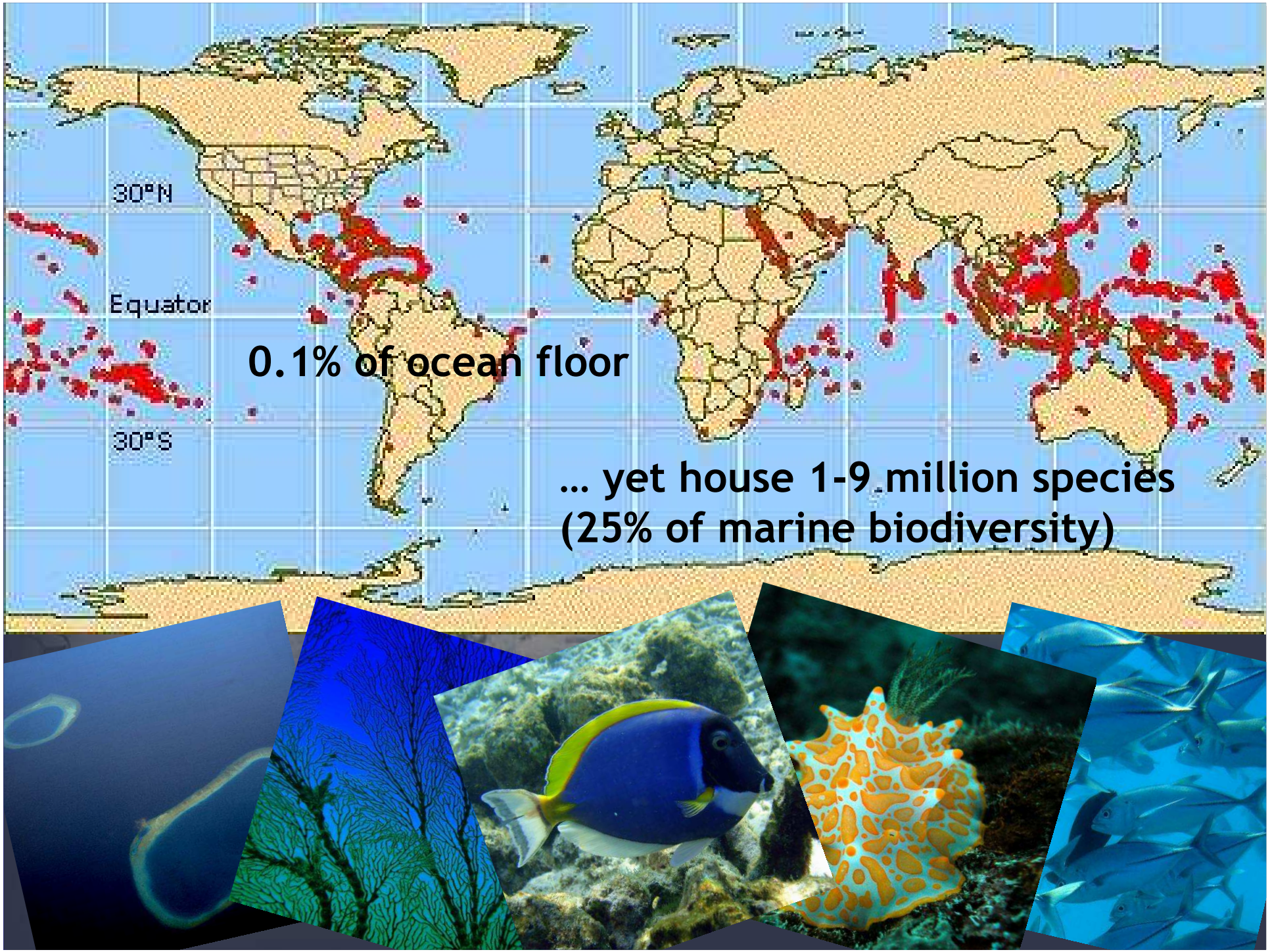

Hilbert D, Ostendorf B and M Hopkins (2001). Sensitivity of tropical forests to climate change in the humid tropics of north Queensland. *Austral Ecology* **26(6)**: 590-603.

# IMPACTS ON BIODIVERSITY?

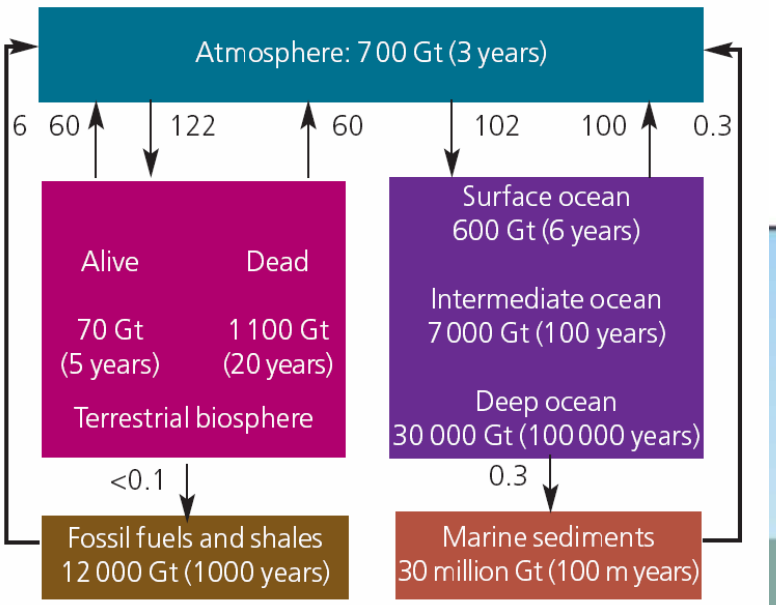
## Regionally endemic vertebrates richness



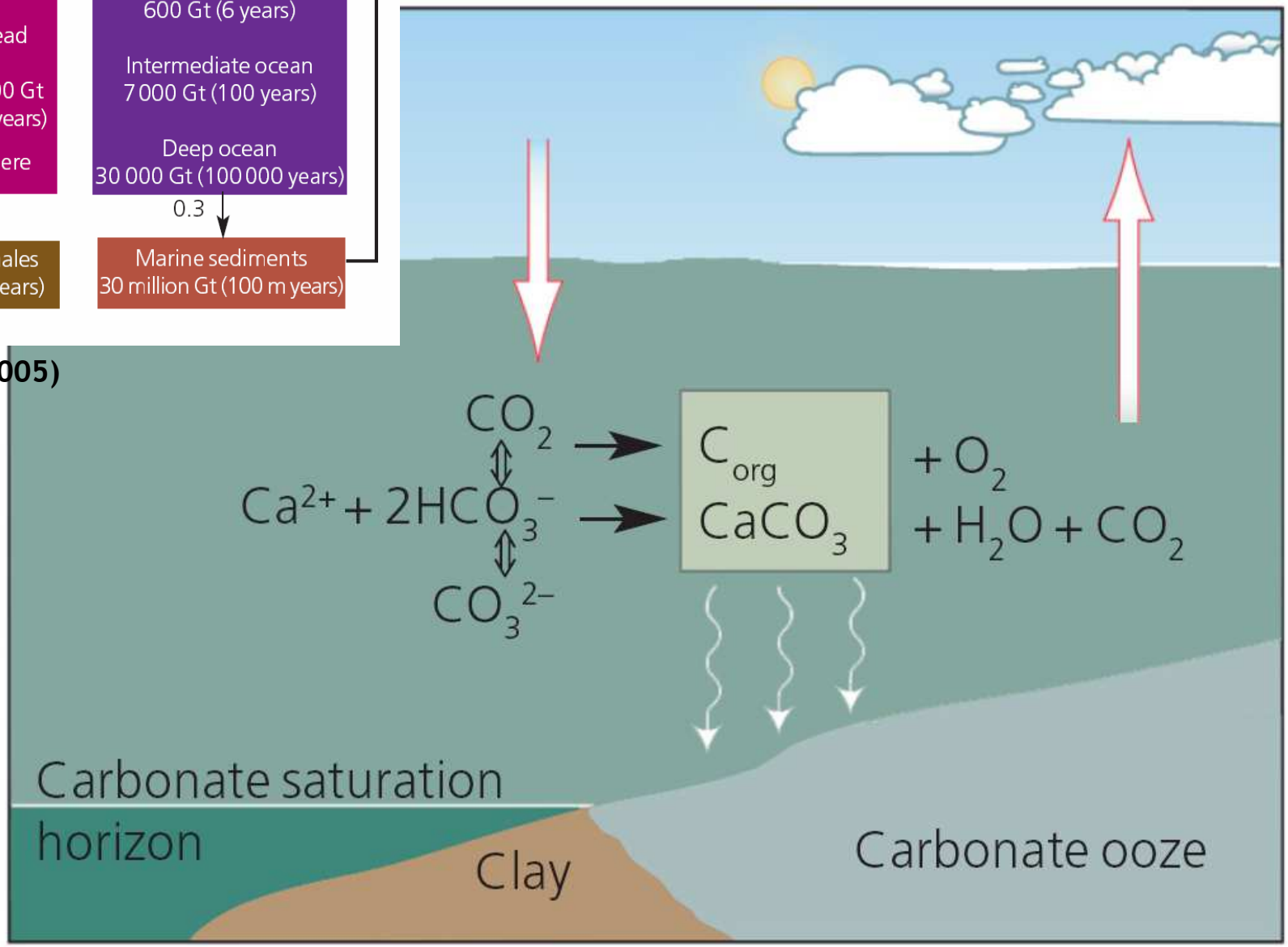

**(Williams et al. 2003)**


30°N
Equator
30°S
0.1% of ocean floor
… yet house 1-9 million species
(25% of marine biodiversity)

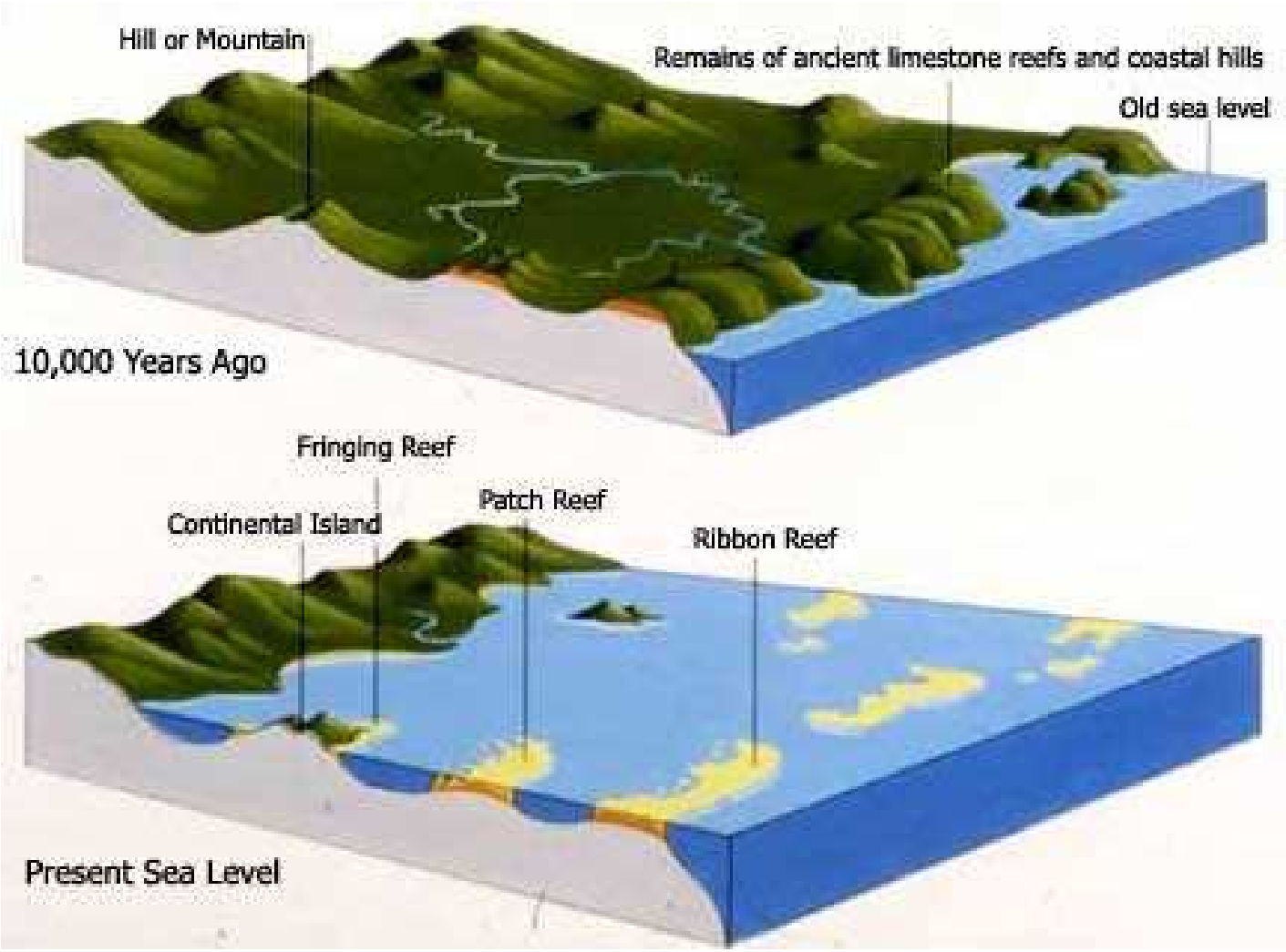
# Important part of carbon cycle (along with other marine calcifiers)




Raven et al. (2005)



# Coral Reef Hypothesis

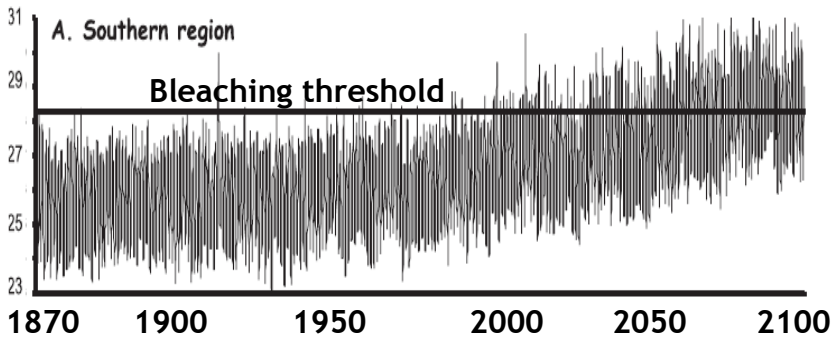


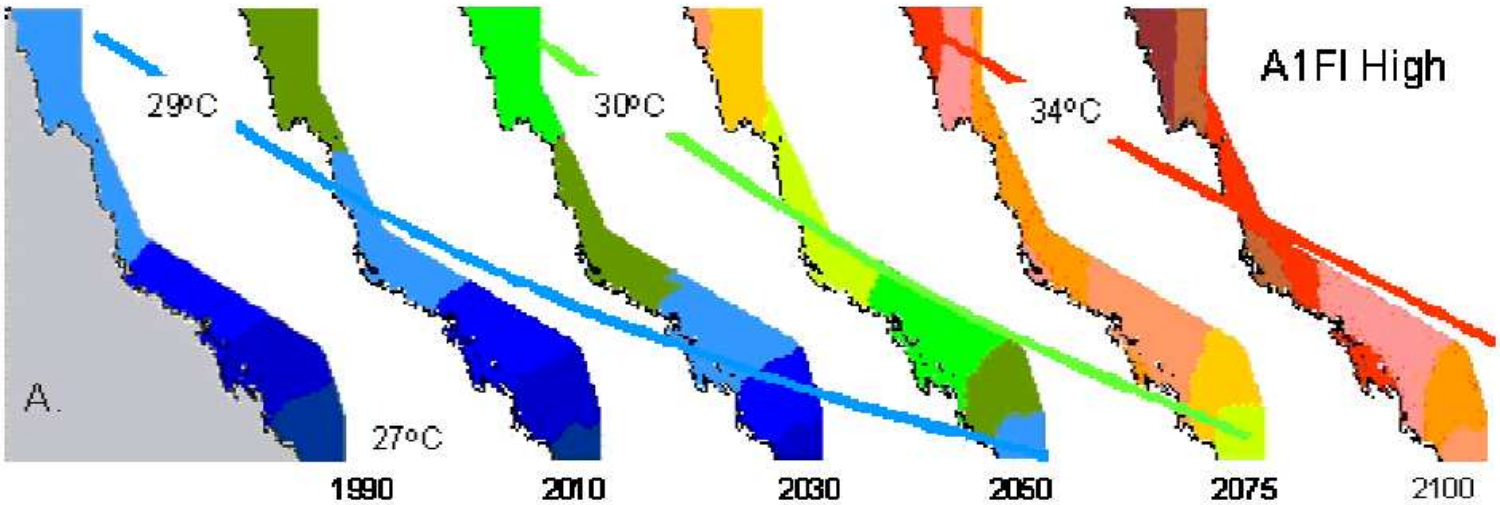

Opdyke, B. N., and Walker, J. C. G., 1992, The Return of the coral reef hypothesis: Basin to shelf partitioning of CaCO3 and its effect on atmospheric $pCO_2$, Geology, 20:733-736.

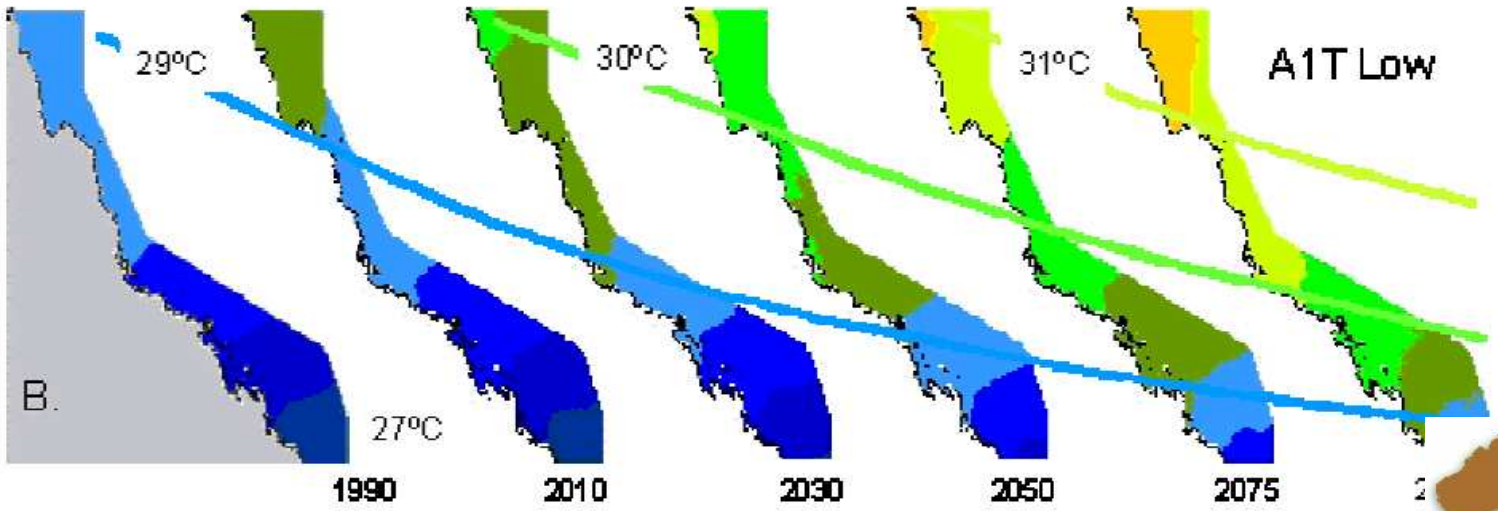
# Southern Great Barrier Reef 2002

+2°C, 4 weeks

Hoegh-Guldberg (1999)





**Done et al. 2003**

**Thermal (1°C) isotherms moving at the rate of 10 km per year …**

$CO_2$ $CO_2$ $CO_2$

Atmosphere

Ocean

$+ H_20 \Leftrightarrow H_2CO_3$

$\Leftrightarrow HCO_3^- + H^+$

$CO_3^{2-} + H+ \Leftrightarrow HCO_3-$

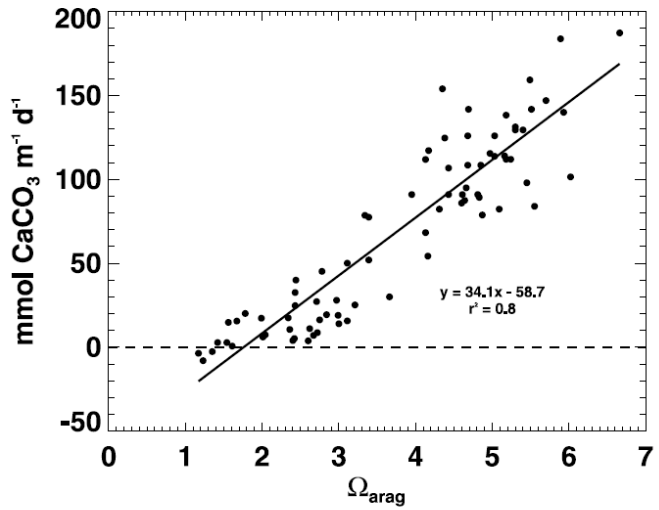
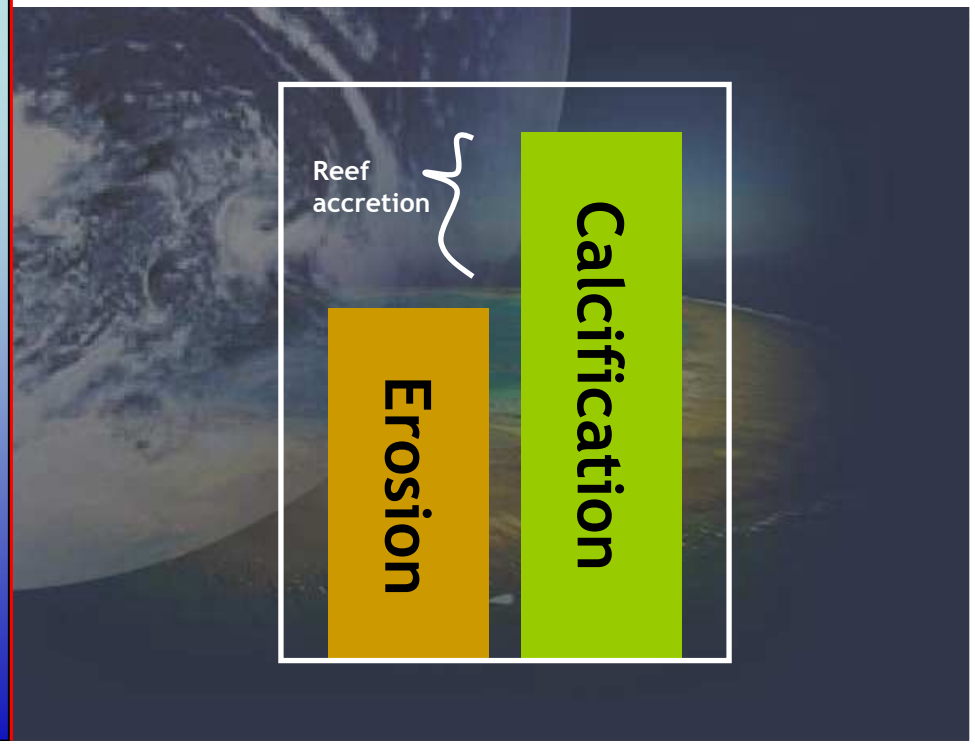



Figure 5. Calcification data from the Biosphere 2 mesocosm. Community was dominated by *Amphiroa fragillisma*, a coralline algae that secretes high-Mg calcite (22% $MgCO_3$). Calcification goes to 0.0 at $\Omega_{arag} = 1.7 \pm 0.2$ (data from Langdon et al. [2000] and other Biosphere 2 results).



# Boundary conditions (thresholds)

- +2$^{o}$C
  - Above this, corals experience catastrophic mortalities

- 200 μmol kg$^{-1}$ ($CO_3^{2-}$) Below this, coral and other) calcification can't keep up with erosion (net reef accretion falls to or below zero

# What’s at stake?

- Food (subsistence, fisheries)
- Industry (tourism)
- Coastal protection

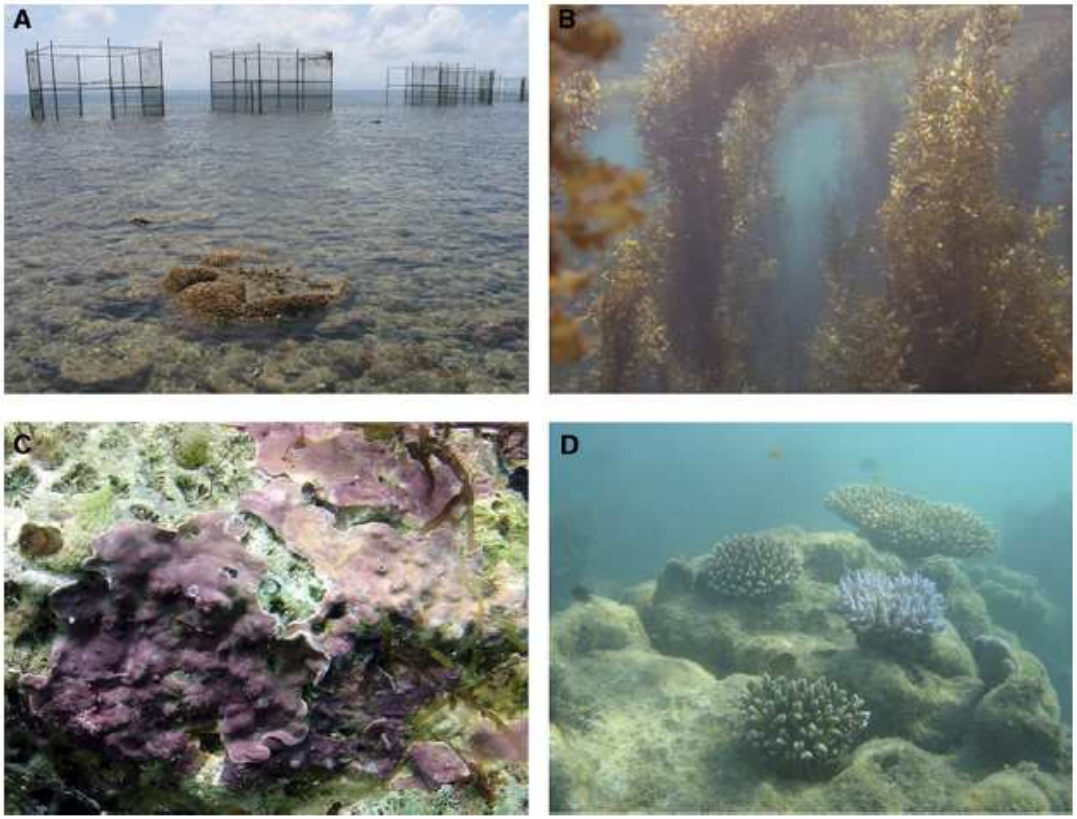
What are we trying to manage?

450-560 ppm
+2°C

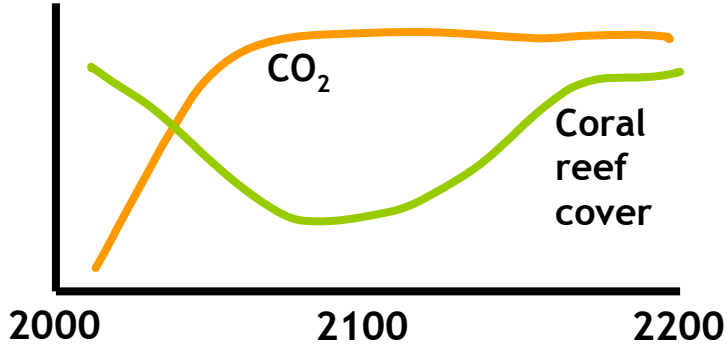
Periodic impacts
Coral cover < 10%
Minimal reef accretion
More macroalgae
Reduced diversity

Lost resilience - greater sensitivity to other factors (over-fishing, water quality issues)

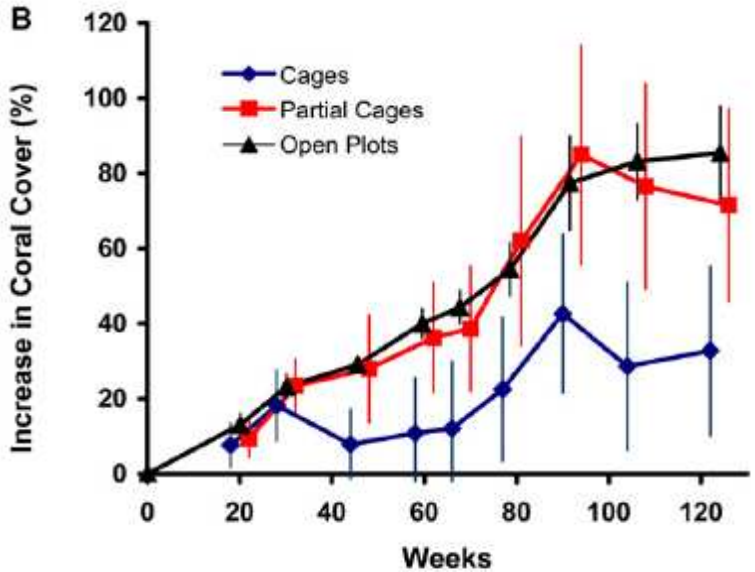
Manage other factors while trying to get emissions stabilized.




1. Stabilize at 500 or below




2. Manage local factors (fishing pressure, water quality) to give coral reefs best chance



Hughes et al. 2007

# Five key messages

1. **Wet tropical rainforests and coral reefs** represent the Achilles Heal for the world's biodiversity

2. **Major impacts occur at anything near 500-560 ppm.** Targets must be more aggressive or 25% of the world's biodiversity will be lost within the next 50-100 years.

3. **Must rapidly reduce other pressures** (over-exploitation, pollution, habitat erosion) on these ecosystems while urgently pursuing stabilization

4. **Adaptation must be a priority and impacts are real.** Real money and real action must follow.

5. **Developed countries (major emitters) should be encouraged to assist impacts developing countries** (where impacts occur) to reduce these other pressures.