

Summary of Biological Status Review of Climate Change Risks to Corals



NOAA Technical Memorandum NMFS-PIFSC-27

September 2011

Status Review Report of 82 Species of Corals Under the U.S. Endangered Species Act



Russell E. Brainard, Charles Birkeland, C. Mark Eakin,
Paul McElhany, Margaret W. Miller, Matt Patterson,
and Gregory A. Piniak

Pacific Islands Fisheries Science Center
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
U.S. Department of Commerce

C. Mark Eakin
Margaret Miller

Evaluation of Extinction Threats



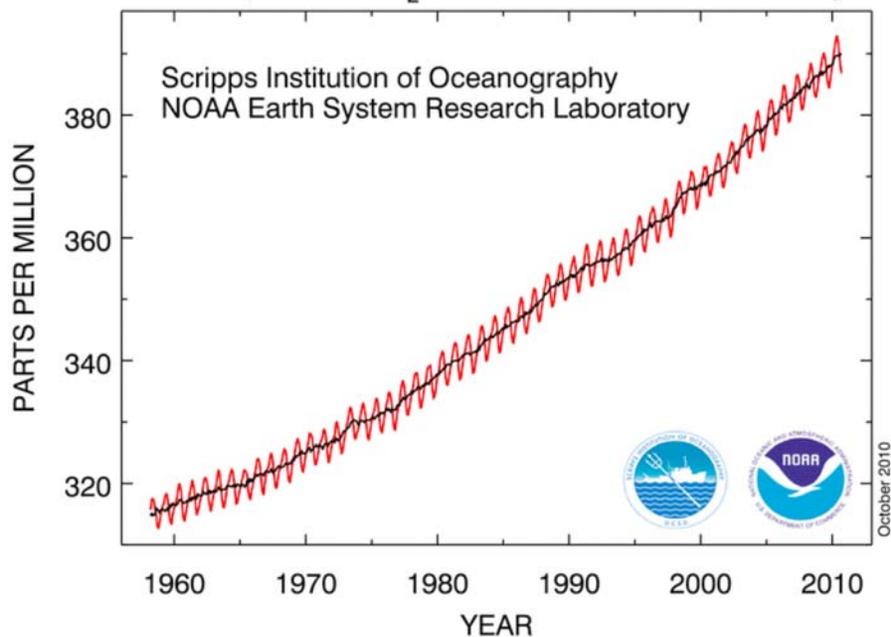
Threat	Importance
Ocean warming	high
Disease	high
Ocean acidification	med-high
Fishing- trophic effects	medium
Sea-level rise	low-medium
Sedimentation	low-medium
Nutrients	low-medium
Changing circulation	low
Changing storms	low
Predation	low
Fishing - destructive practices	low
Physical damage - storms	low
Coastal construction	low
Aquarium and curio trade	low
Toxins*	not negligible
Invasive species	negligible-low
Insolation*	probably negligible
Salinity	negligible
Dust	negligible
Physical damage - debris	negligible
Physical damage - tourism/divers	negligible
Physical damage - vessels	negligible

Highlights

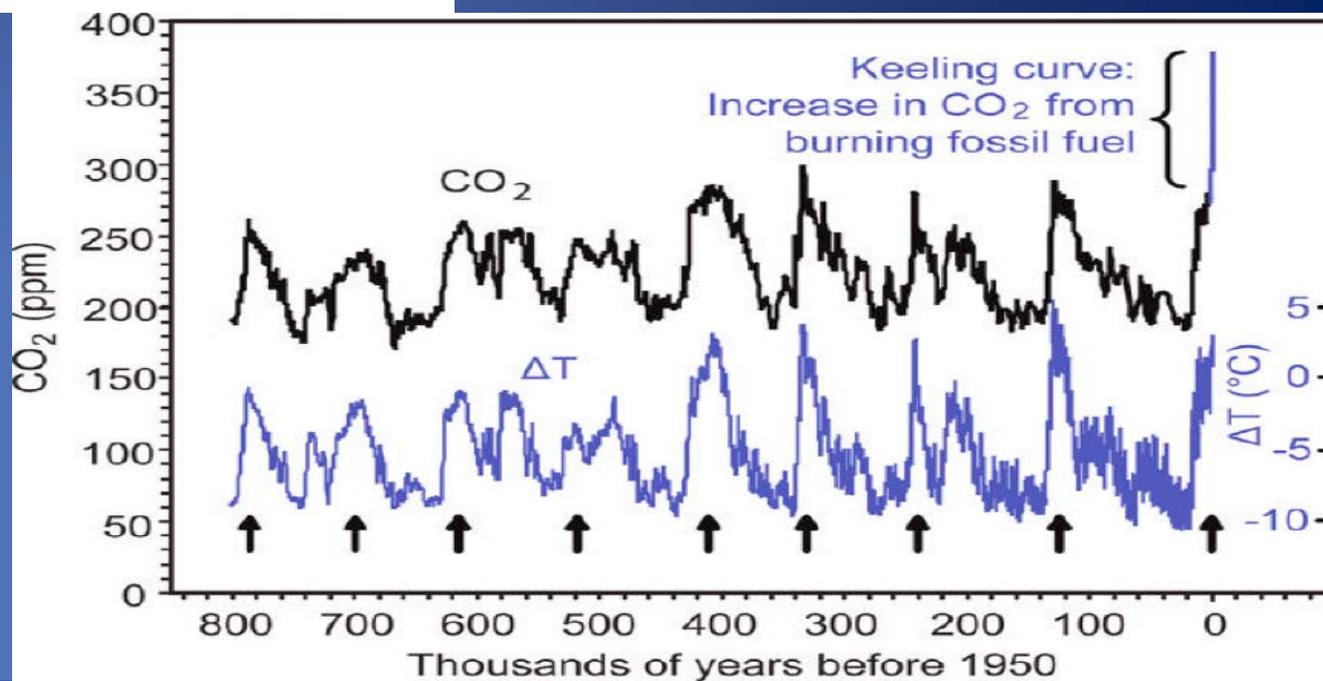


-  Ocean warming is a clear and present threat to corals and coral reefs
-  Ocean acidification is likely to be a major threat in coming decades
-  Other climate threats are concerns, but have limited extinction risk
-  The pervasive nature of climate threatens even the best managed and most remote reefs
-  Climate change a major reason that most of the 82 candidate coral species are 'more likely than not' to fall below the Critical Risk Threshold by 2100.

Atmospheric CO₂ at Mauna Loa Observatory

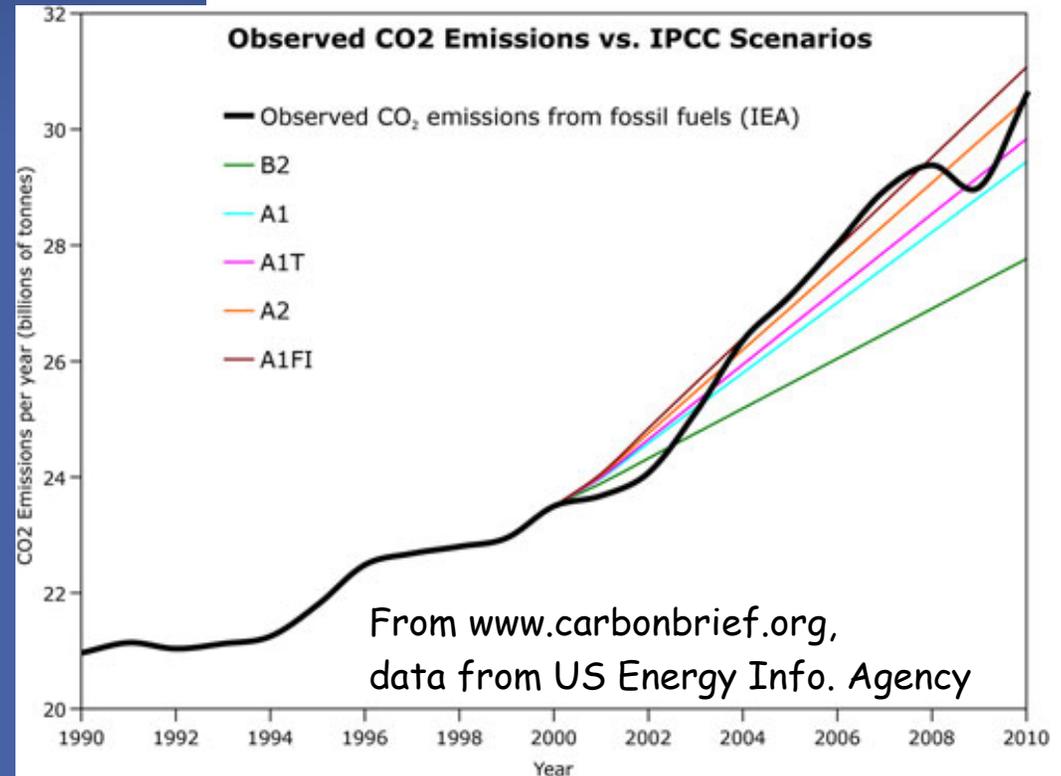
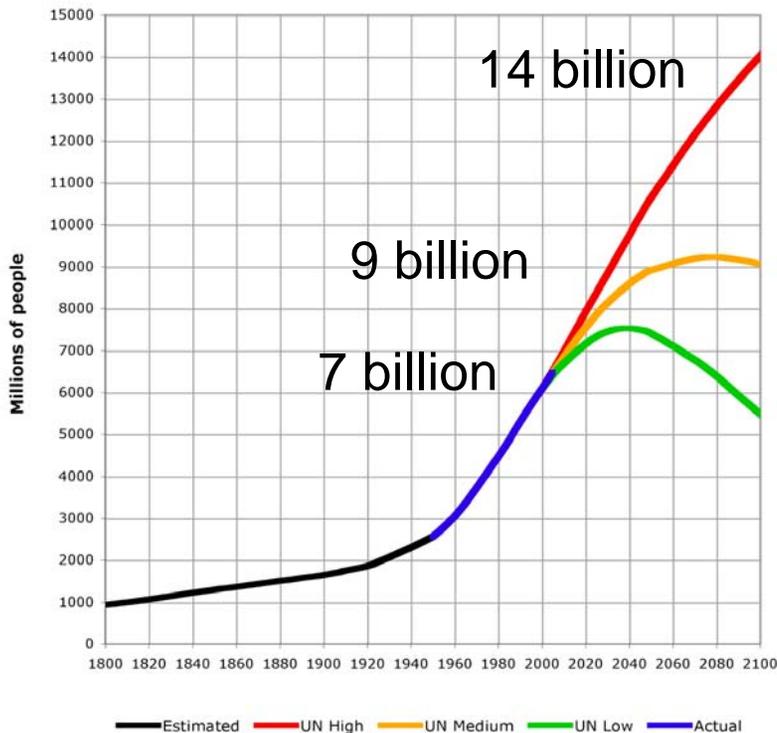
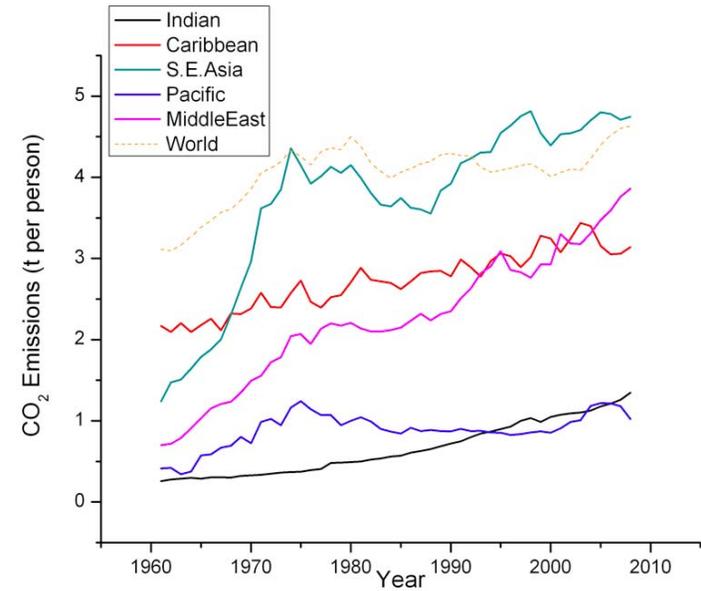


Carbon dioxide is rising and is now at highest levels in over 800,000 and probably 24 million years

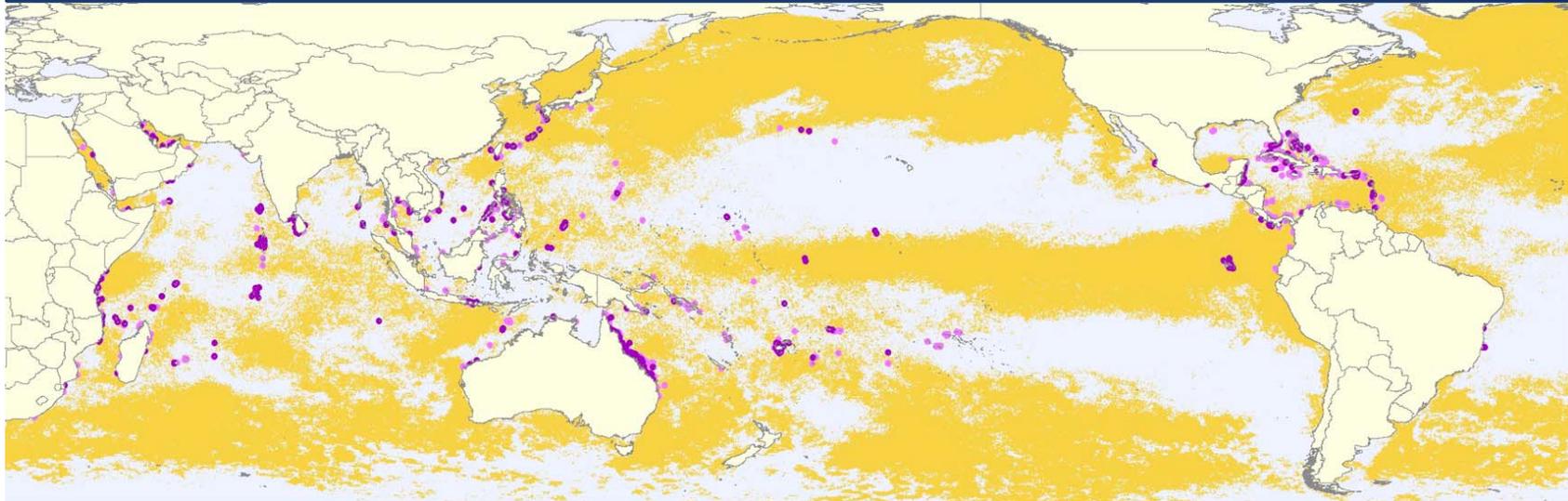


Primary drivers:

- More and more people
- Too much consumption (per capita emissions rising)
- Total emissions tracking or exceeding 'worst case' AR4 (2007) scenarios



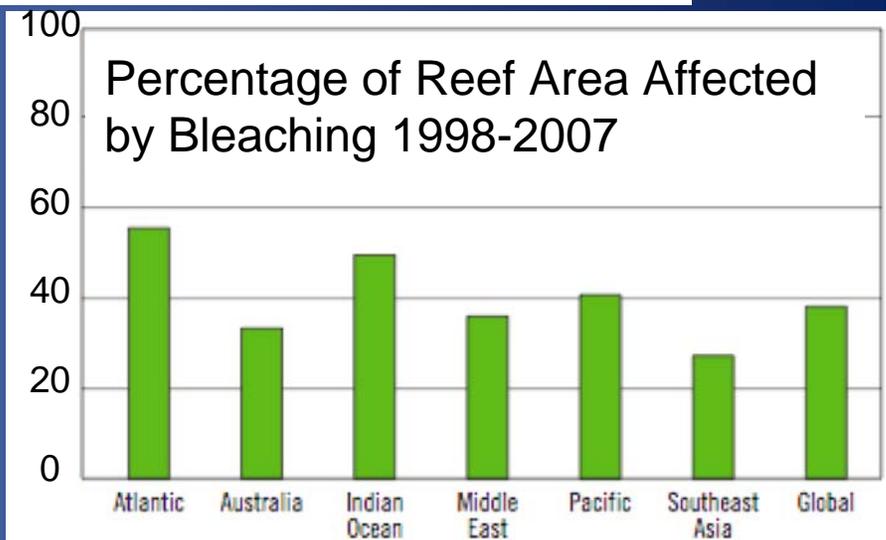
Rising temperatures have already caused widespread bleaching and mortality



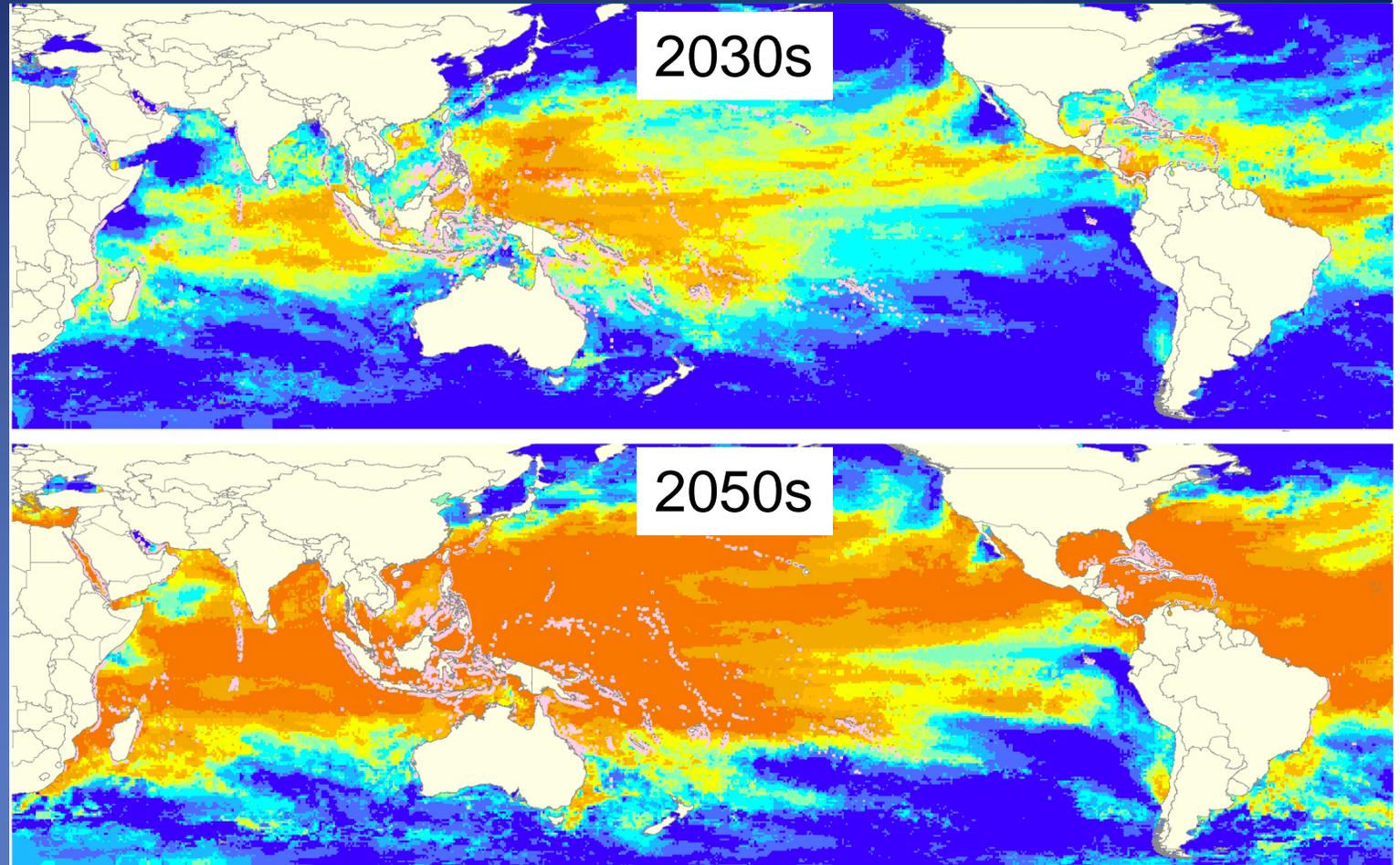
● Severe Bleaching ● Moderate or Low Bleaching ■ Satellite-detected Severe Thermal Stress

Source: WRI, *Reefs at Risk Revisited*, 2011.

WRI (2011) Reefs at Risk: Revisited

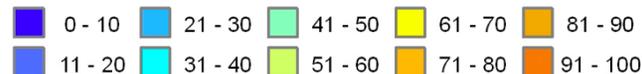


Ocean temperatures around reefs likely to rise 0.8°C by 2030s, 2.8°C by 2100, increasing bleaching frequency and intensity



● Coral Reefs

Frequency (Percent of Years) of NOAA Bleaching Alert Level 2 Events

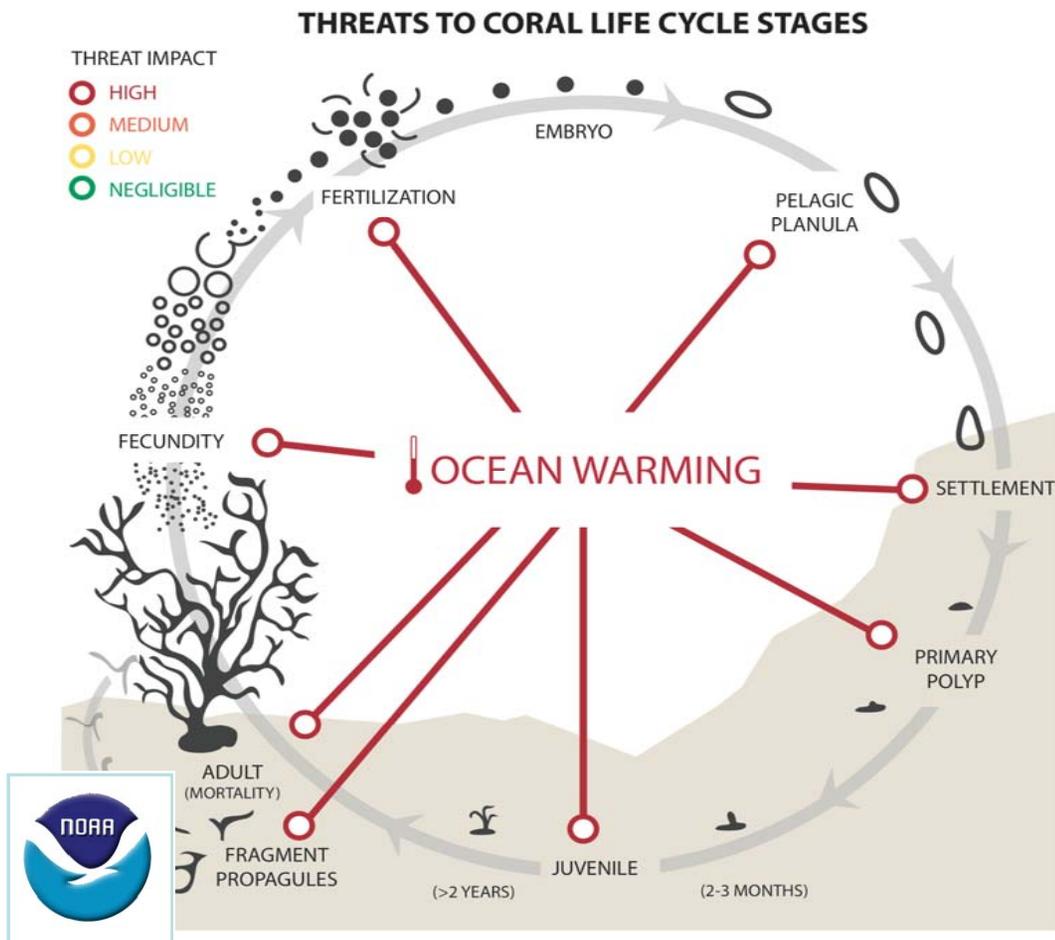


Source: Adapted from Donner, S.D. 2009. "Coping with Commitment: Projected thermal stress on coral reefs under different future scenarios." PLoS ONE 4(6): e5712 for use in the Reefs at Risk Revisited project.



Warming a threat to all coral life cycle stages

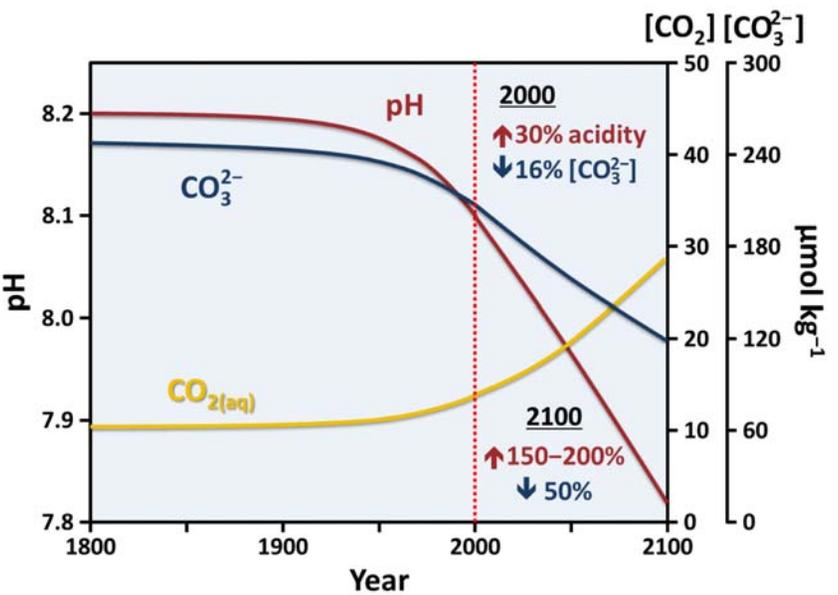
Threat : HIGH



Other Impacts of Warming

-  Strong relationship between rising temperatures and increase in coral diseases
-  Evidence high temperatures impair reproductive success
-  Warming is leading to increased stratification and oligotrophy
-  Potential for range shifts
 -  Good news: some corals demonstrating range shifts
 -  Bad News: poleward movement of corals likely limited by other factors
-  Reduced reef resilience

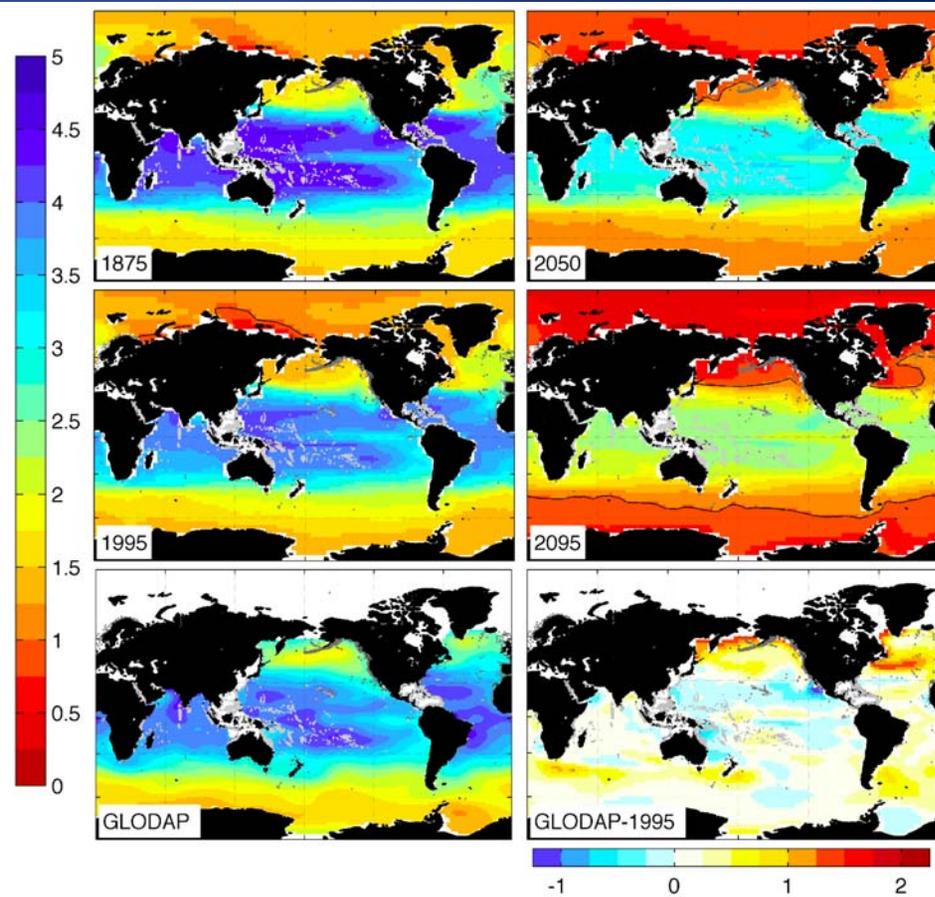




Rising CO_2 : Reducing carbonate concentrations and pH

Reduced coral calcification and growth

optimal
adequate
marginal
poor



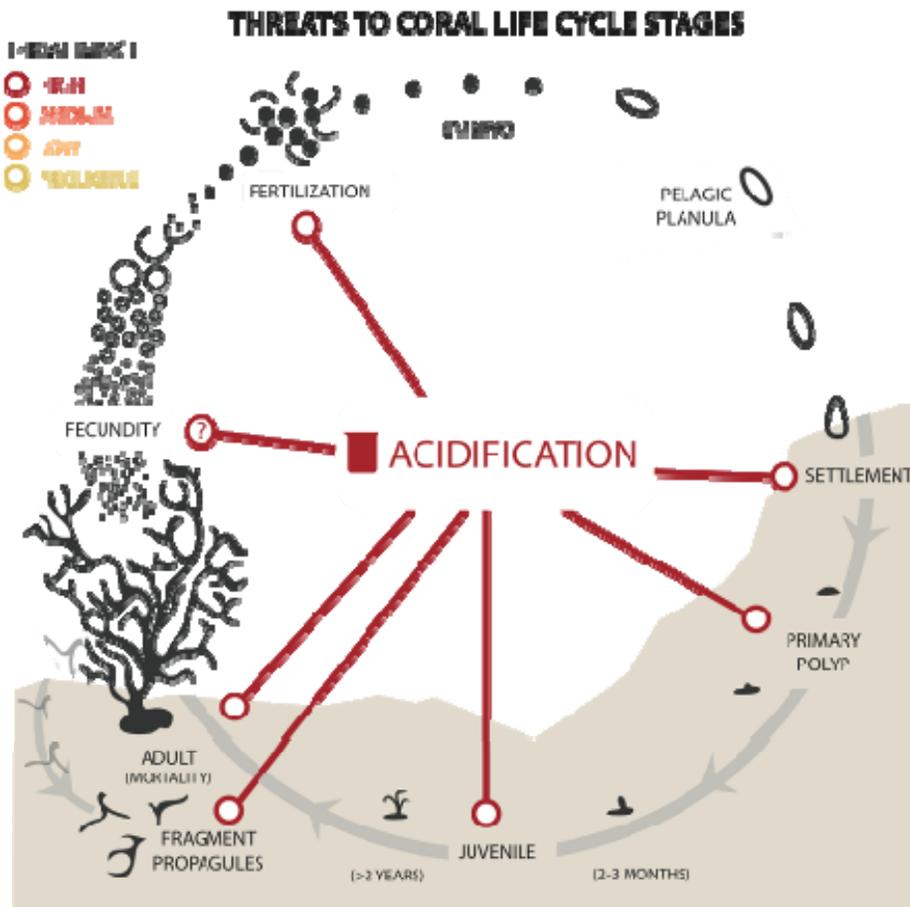
Other Impacts of Acidification

-  Decreased cementation
-  Increased bioerosion and chemical erosion
-  Evidence acidification impairs reproductive success
-  Even stronger impact on coralline algae with important role in coral settlement
-  Reduces detection of reefs by coral larvae
-  Reduced reef resilience



Threat : Med-High

Ocean acidification probably a threat to all coral life cycle stages; but possibly not for all species



Settlement maybe more affected by altered cues than by physiological effects on larvae themselves

Geographic Variability of Climate Change Threats

	Indo-Pacific	Eastern Pacific	Western Atlantic
Coral Genera	91	10	25
Coral species	~ 700	40	65
Concentration of Thermal Stress	Varied	Very High	Medium-High in Gulf & Caribbean
Bleaching Impact	Generally lowest	Very high, probable extinction (<i>Millepora boschmai</i>)	High
Rate of Acidification	Generally lowest	Slow change, pH already low	Highest
Impact of Disease	Low	Uncertain	High

Table from information in Brainard et al 2011



Summary



-  Ocean warming is a clear and present threat to corals and coral reefs
-  Ocean acidification is likely to be a major threat in coming decades
-  Other climate threats are concerns, but have limited extinction risk
-  The pervasive nature of climate threatens even the best managed and most remote reefs
-  Climate change a major reason that most of the 82 candidate coral species are 'more likely than not' to fall below the Critical Risk Threshold by 2100.