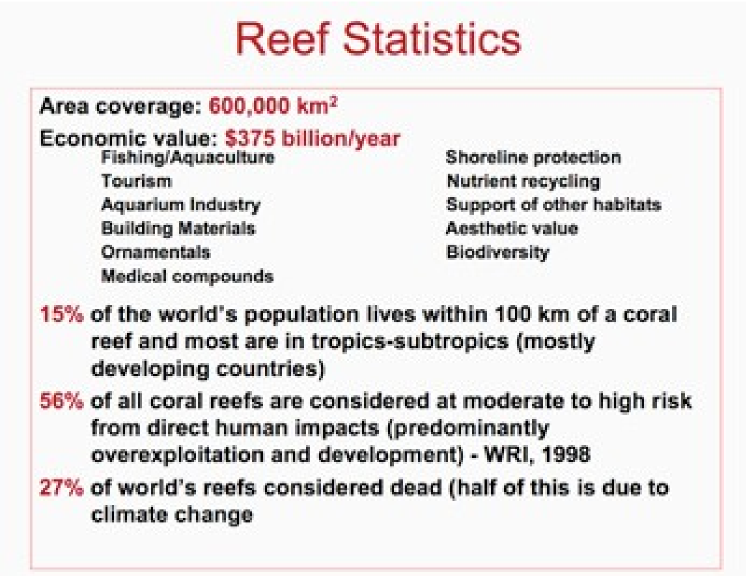
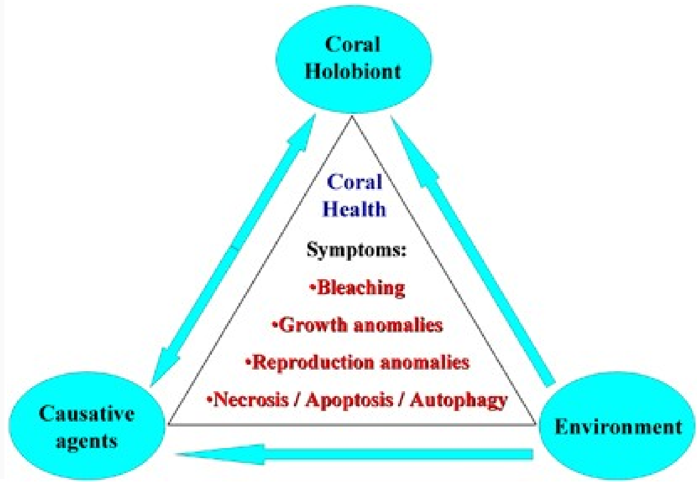
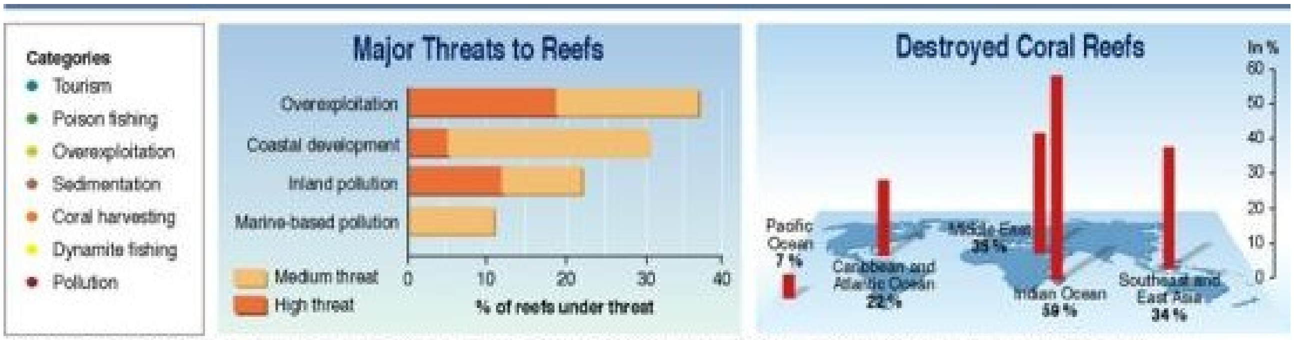
Coral Stressors





What Is Happening?	What Is Likely To Happen In This Century?	Addressing Knowledge Gaps	Key Adaptation Options
Sea surface warming has led to extensive coral bleaching events and declines in coral condition on the Great Barrier Reef and on north-western reefs **(HIGH confidence)**. Ocean acidification and increased thermal stress are the likely causes of a >10% reduction in the growth rates of massive Porites corals on the Great Barrier Reef **(MEDIUM confidence)**	Frequency and severity of mass coral-bleaching events will increase as temperatures warm, leading to declines in coral reef health **(HIGH confidence)**. Ocean acidification will reduce coral growth rates making reefs more susceptible to erosion and disturbance from storms **(HIGH confidence)**	Undertake experimental studies to strengthen predictions of thresholds for coral-algal phase shifts and loss of ecosystem function under climate change	Improve and maintain coastal water quality and healthy populations of herbivorous reef fishes to help sustain the resilience of coral reefs



Source: Bryant et al., *Reefs at Risk: a Map-Based Indicator of Threats to the World's Coral Reefs*, World Resources Institute (WRI), Washington DC, 1998.

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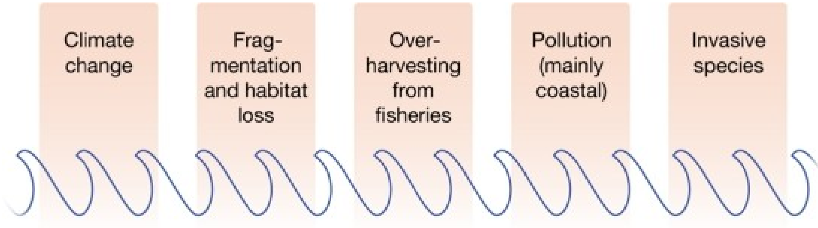


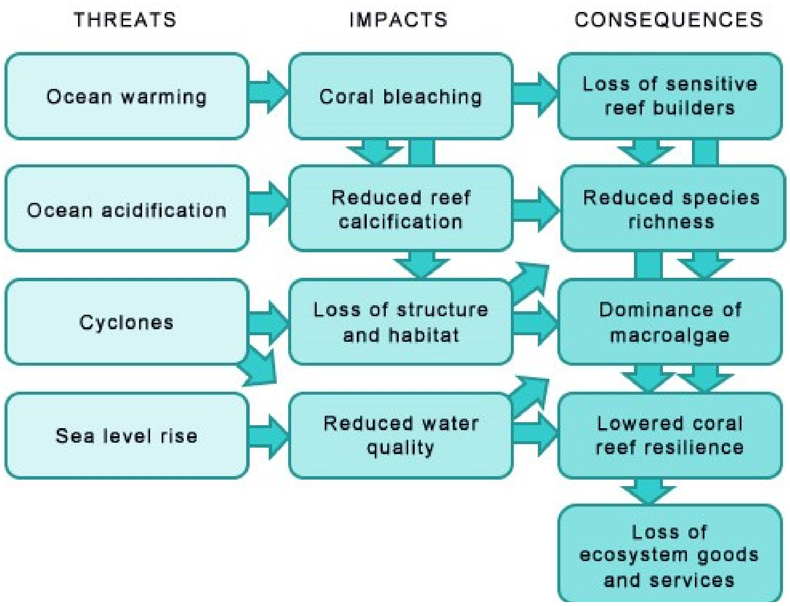
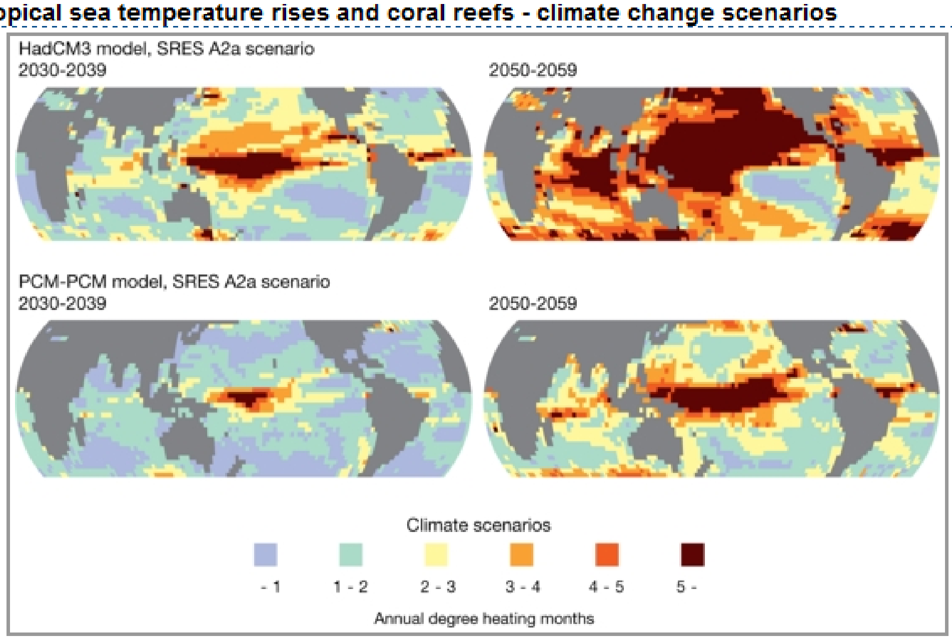


Figure 1. Flow diagram of functional links between climate-change threats, biological and ecological impacts and downstream consequences for ecosystem function. Only a subset of the key links and interactions (arrows) are shown.

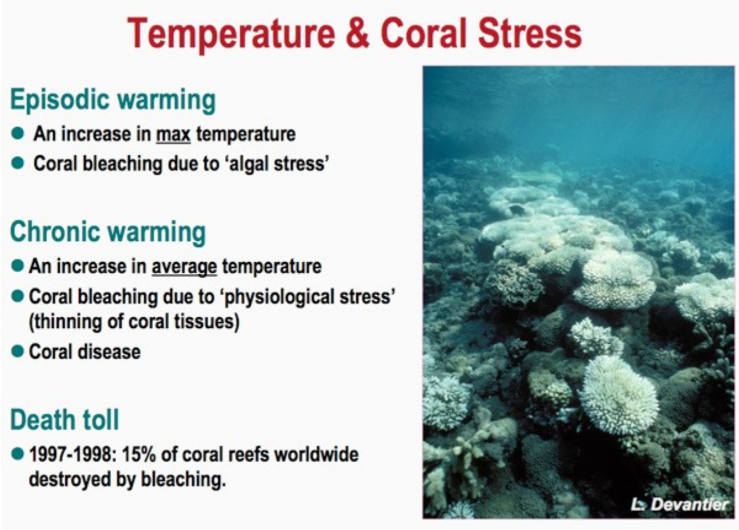
Tropical sea temperature rises and coral reefs - climate change scenarios

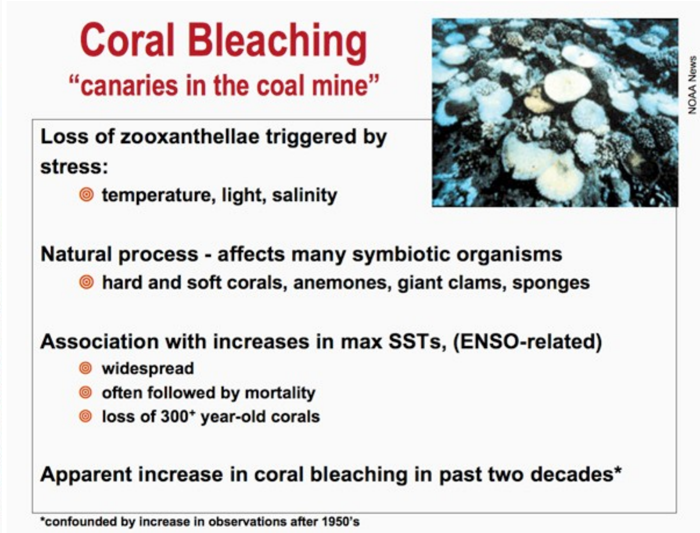


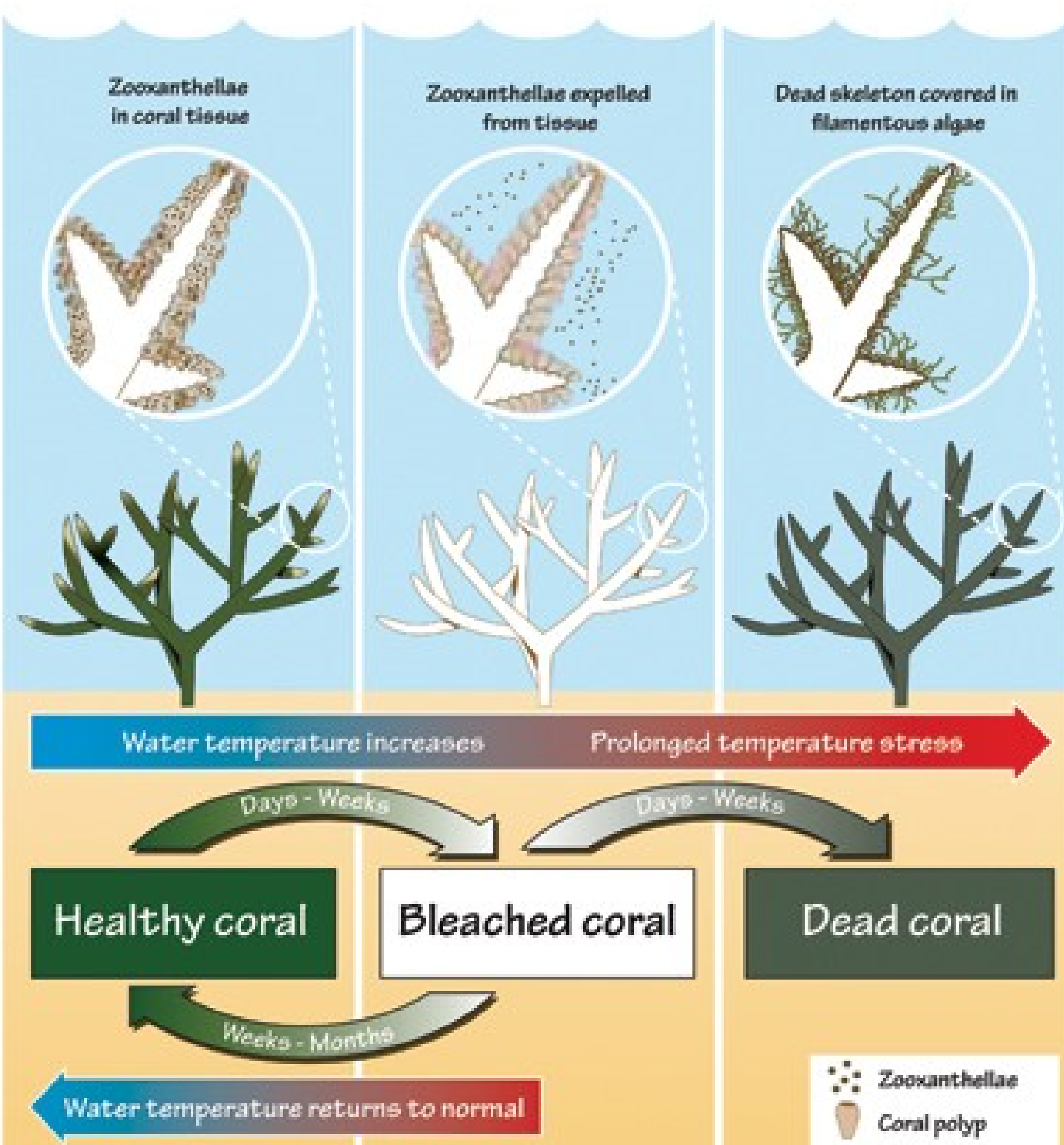
Click here, or on the graphic, for full resolution.

Tropical sea temperature rises and coral reefs - climate change scenarios. The impacts of coral reefs from rising sea temperatures. When coral reefs become heat-exposed they die, leaving the white dead coral, also known as bleaching. With even moderate pollution, the coral are easily overgrown with algae, or broken down by wave activity or storms, leaving only "coral rubble" on the ocean bed.

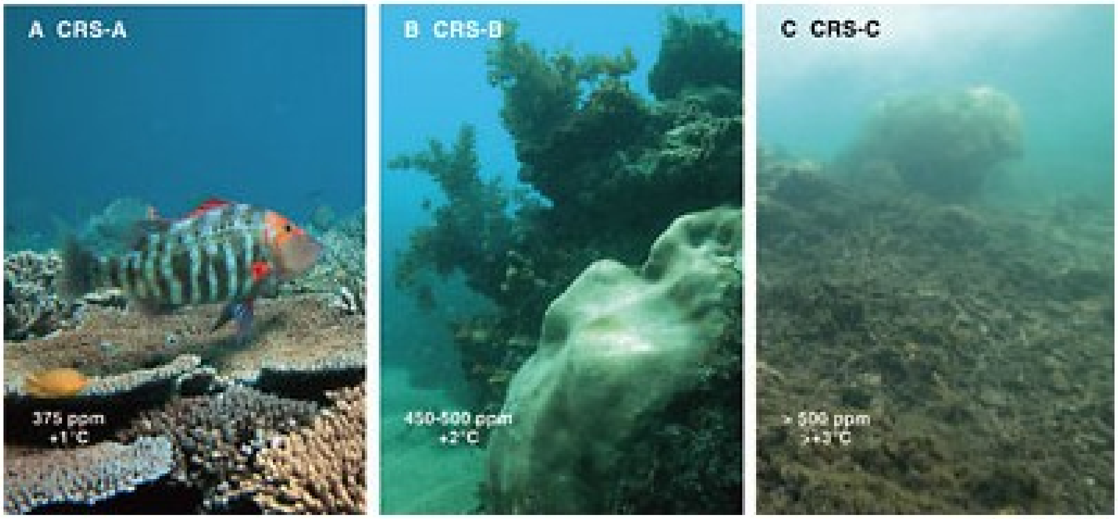
Coral Stressors





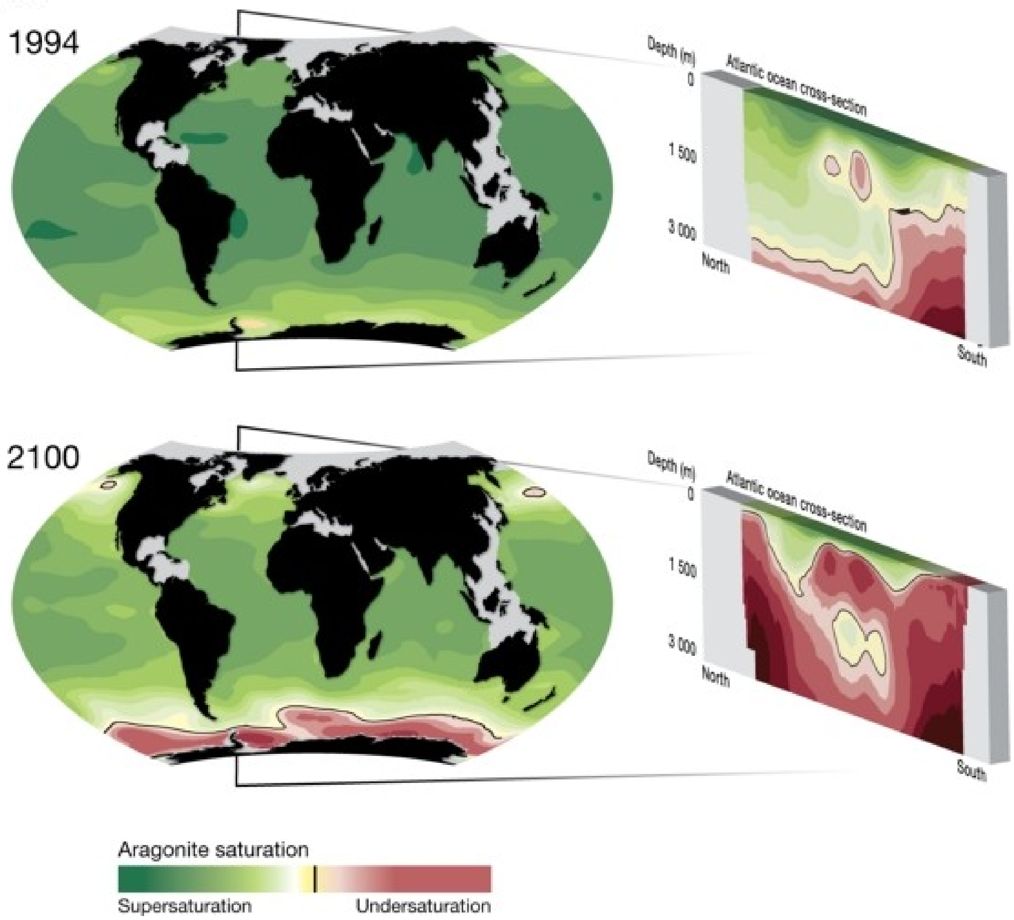


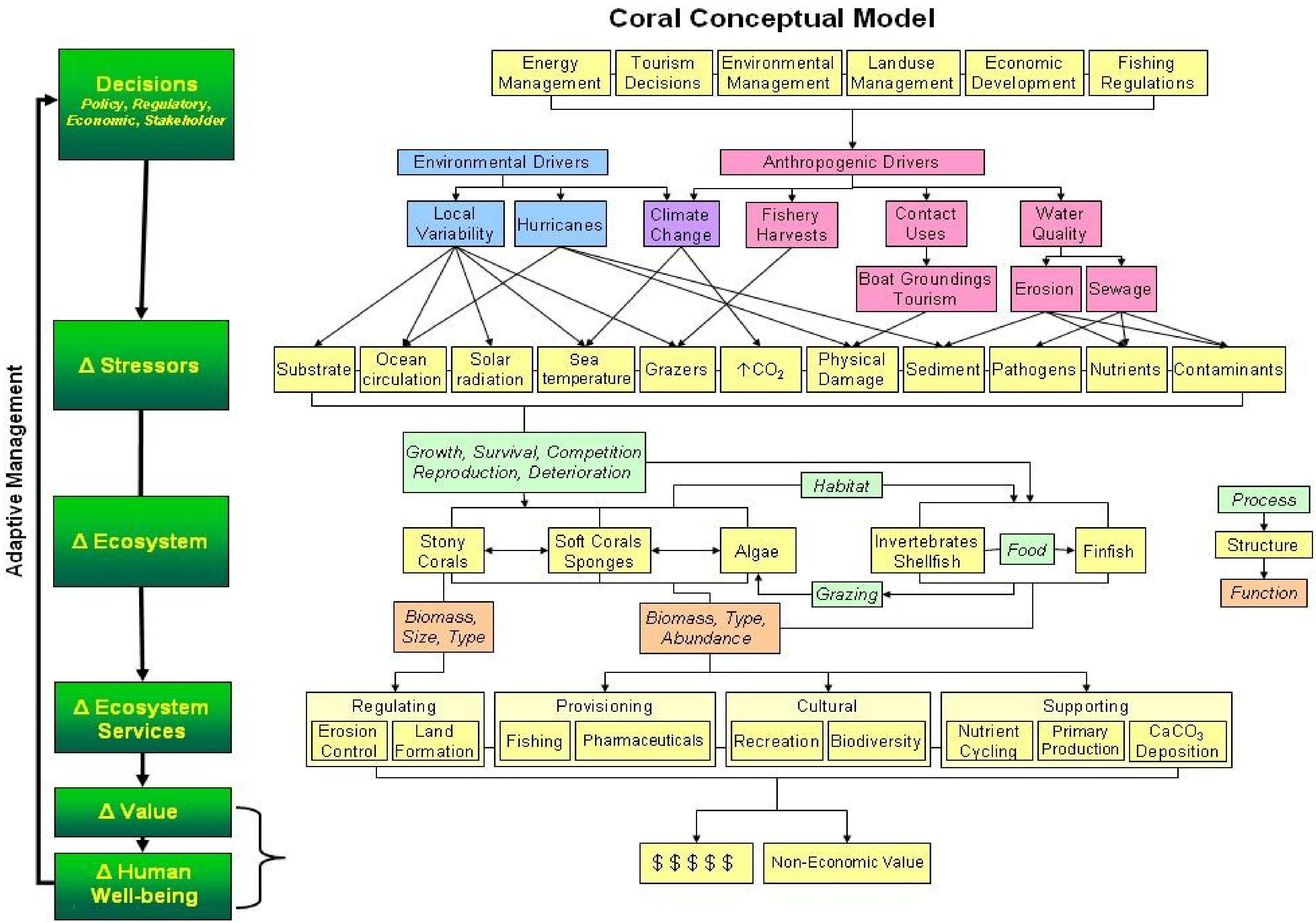
Coral Stressors



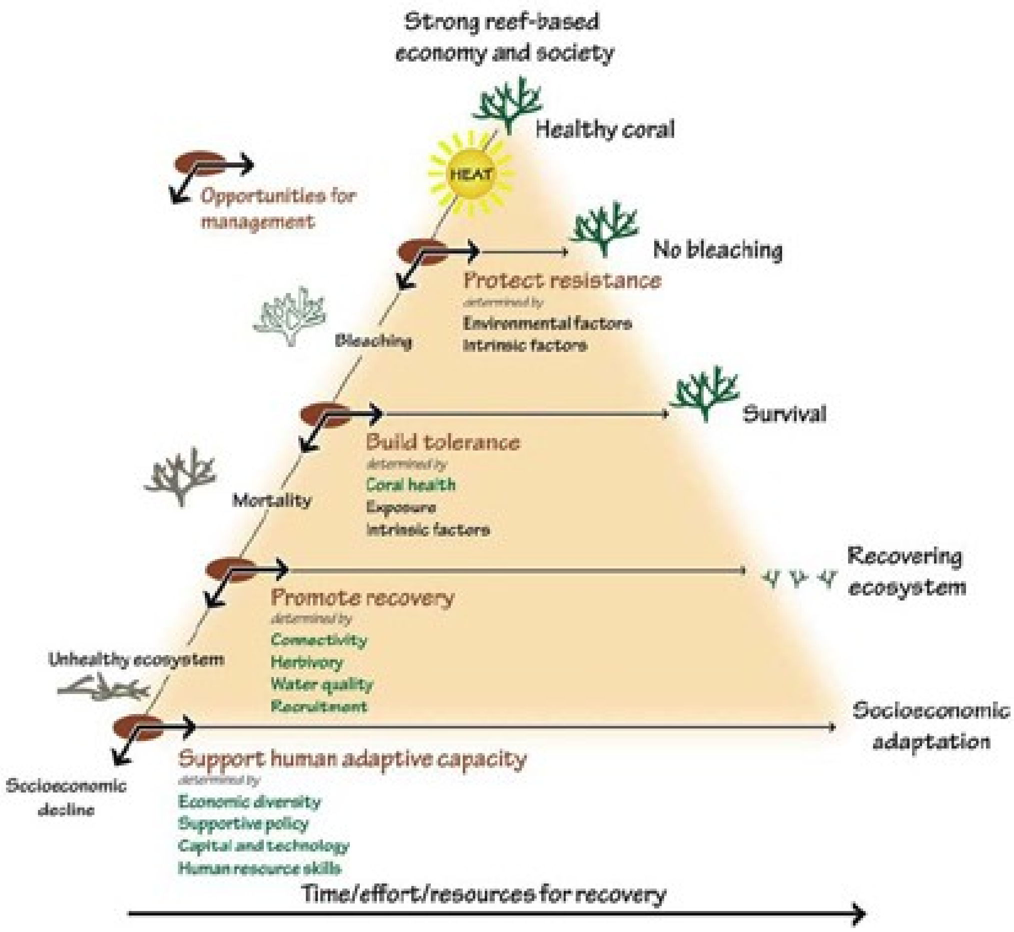
Provided

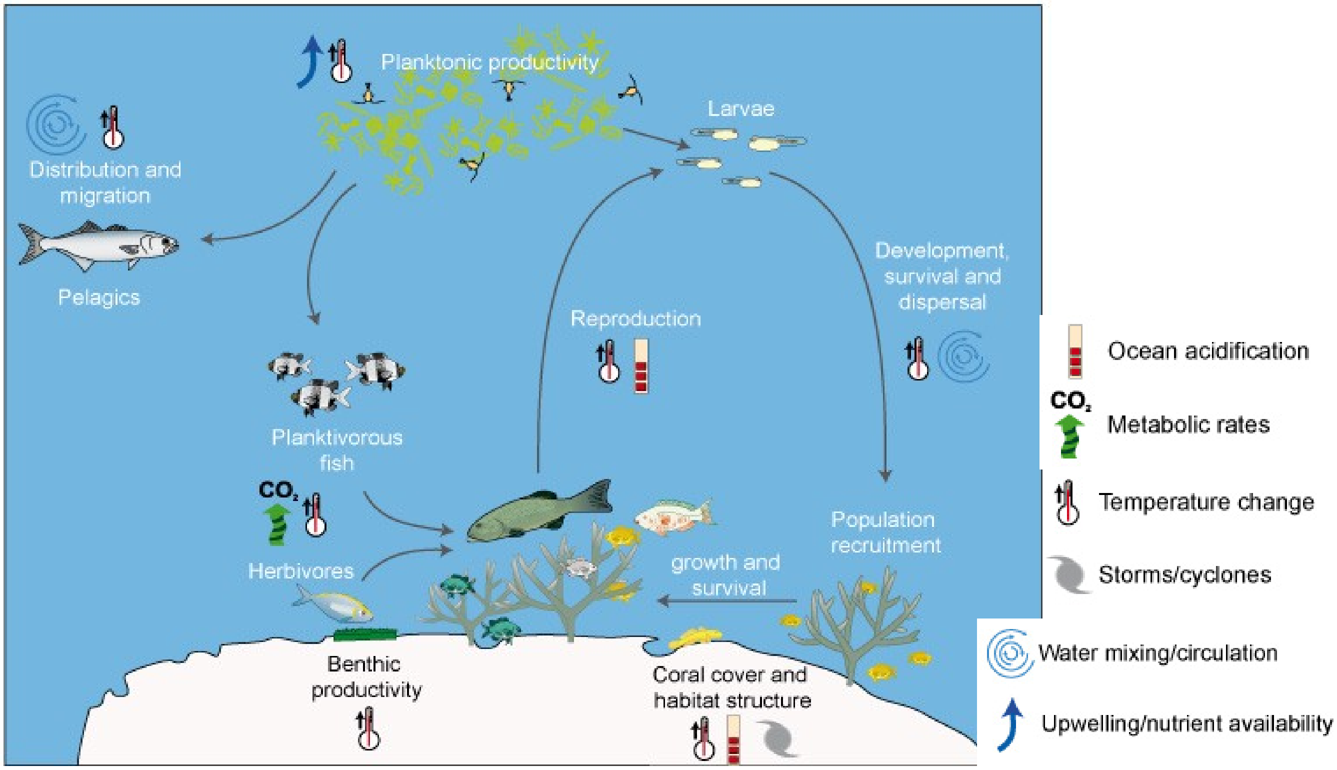
Pictured at left is the typical coral reef today on the southern Great Barrier Reef, which has endured a rise of 1 degree C and 375 parts per million of atmospheric carbon dioxide concentration. The middle frame shows what a reef would look like if global temperatures rise one more degree and CO2 concentrations increase, as predicted. The right frame shows what a reef would like if temperatures and CO2 levels rise even more.



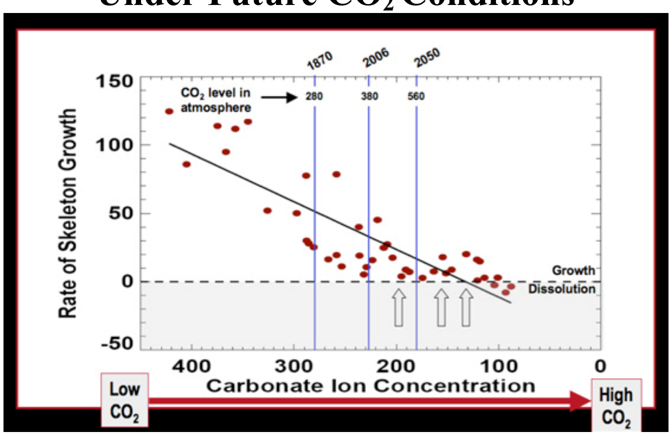

Coral Conceptual Model
Decisions
Policy, Regulatory, Economic, Stakeholder
Δ Stressors
Δ Ecosystem
Δ Ecosystem Services
Δ Value
Δ Human Well-being
Adaptive Management
Energy Management
Tourism Decisions
Environmental Management
Landuse Management
Economic Development
Fishing Regulations
Environmental Drivers
Anthropogenic Drivers
Local Variability
Hurricanes
Climate Change
Fishery Harvests
Contact Uses
Water Quality
Boat Groundings Tourism
Erosion
Sewage
Substrate
Ocean circulation
Solar radiation
Sea temperature
Grazers
↑CO2
Physical Damage
Sediment
Pathogens
Nutrients
Contaminants
Growth, Survival, Competition Reproduction, Deterioration
Habitat
Stony Corals
Soft Corals Sponges
Algae
Invertebrates Shellfish
Food
Finfish
Grazing
Biomass, Size, Type
Biomass, Type, Abundance
Process
Structure
Function
Regulating
Erosion Control
Land Formation
Provisioning
Fishing
Pharmaceuticals
Cultural
Recreation
Biodiversity
Supporting
Nutrient Cycling
Primary Production
CaCO3 Deposition
$ $ $ $ $
Non-Economic Value

Coral Stressors





Skeletal Growth in the B2 Reef Decreased Under Future CO_2 Conditions

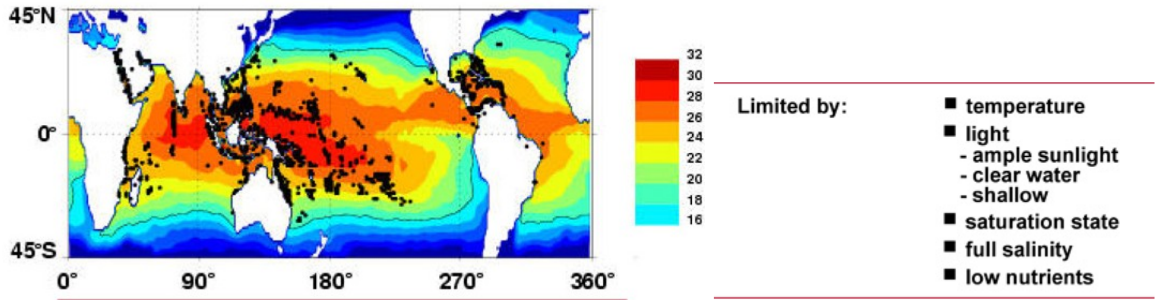


As greenhouse gases rise, they push down the levels of calcium carbonate in the oceans, resulting in a slower rate of coral skeletal growth.

Slowing Down the Carbonate Factory

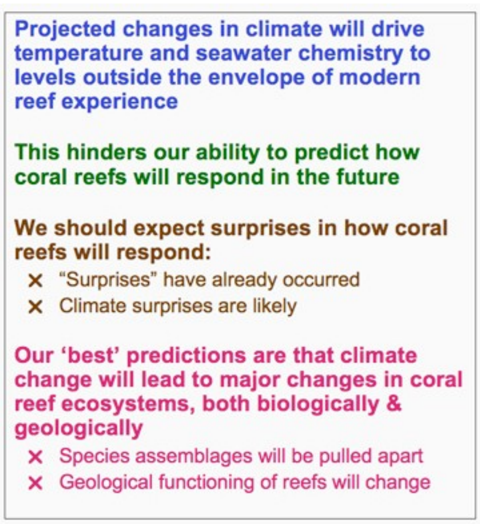
Slowing down the 'carbonate factory' adversely effects ecosystems that are dependent on the reefs. (figure: Joannie Kleypas, NCAR)

Coral Reef Distribution



The natural distribution of coral is affected by ocean temperature, light, clear and shallow water, salinity, ocean chemistry and available nutrients (figure: Joannie Kleypas, NCAR)

Conclusions



Projected changes in climate will drive temperature and seawater chemistry to levels outside the envelope of modern reef experience. Researchers are trying to determine what the possible long-range changes to our oceans might be, whether ecosystems can adapt to the predicted changes, and why certain reef systems are adapting to current changes better than others. This will help us to understand how our oceans, and the whole earth system, may change. (figure: Joannie Kleypas, NCAR)