Milan EXPO 2015

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OCEAN SPECIES RESPOND TO CLIMATE CHANGE

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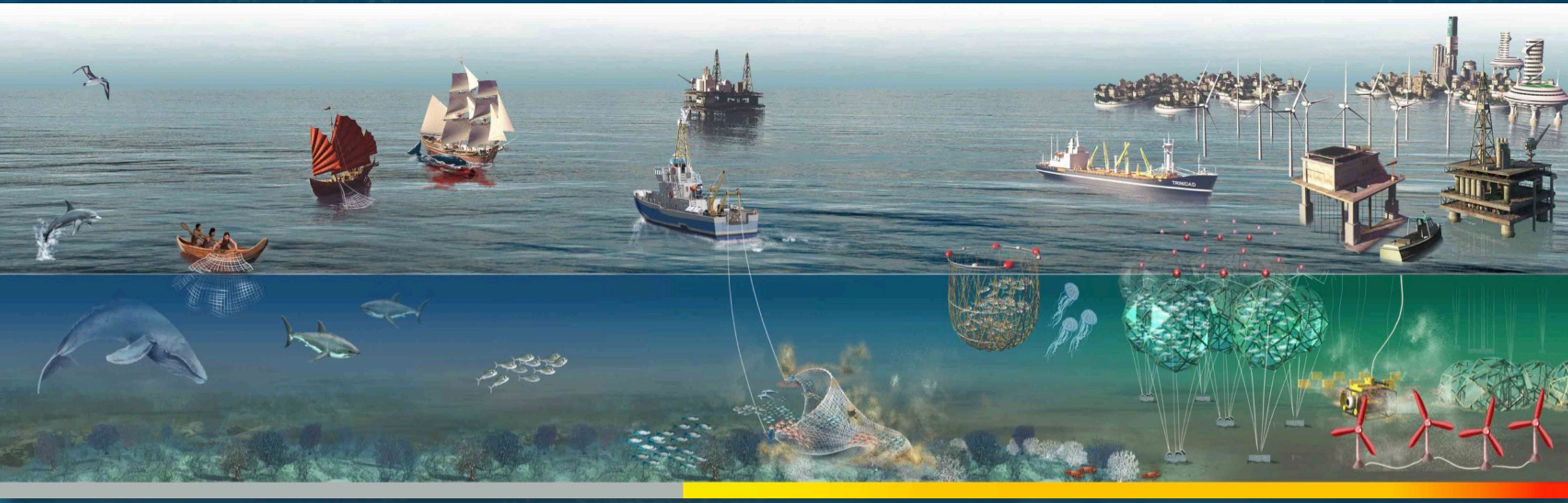
USA

Four Major Threats to the Oceans

Pollution
Habitat destruction
Overfishing
Climate change

Ecosystem uses of the Ocean



50,000 Years ago | 10,000 | 100 | 10 | Present | 10 | 100 Future

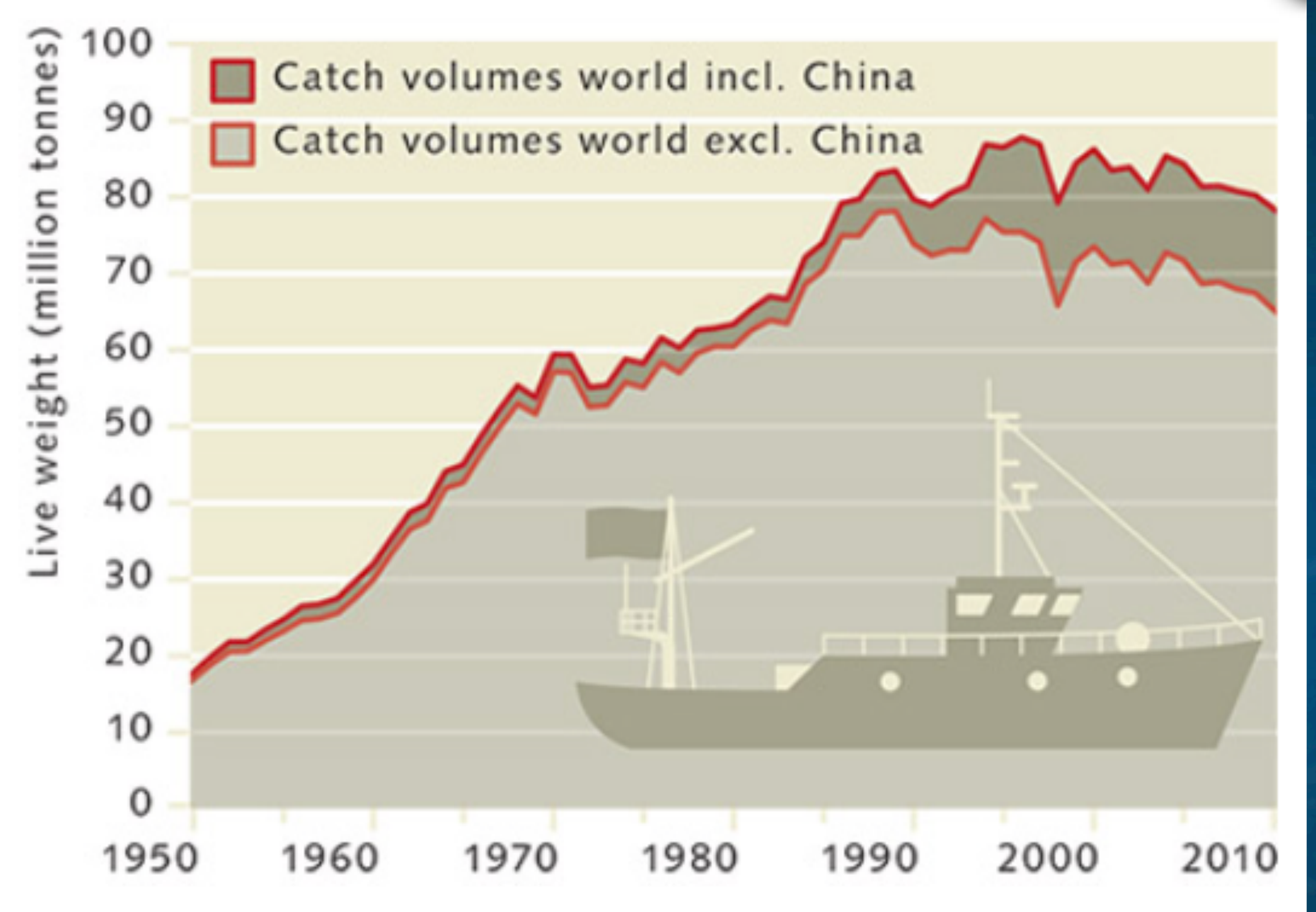
We Are Emptying the Oceans

Years before present	Event	Strong effect on…
40,000	Marine harvesting begins	Large species, shallow habitats
3,000	Intense commercial harvest	Mediterranean and China
200	Mechanized fishing	Shallow and deep habitats
100	Global hunting, dredging	Everywhere
Now	Scramble for fish	Everywhere, nearly all species

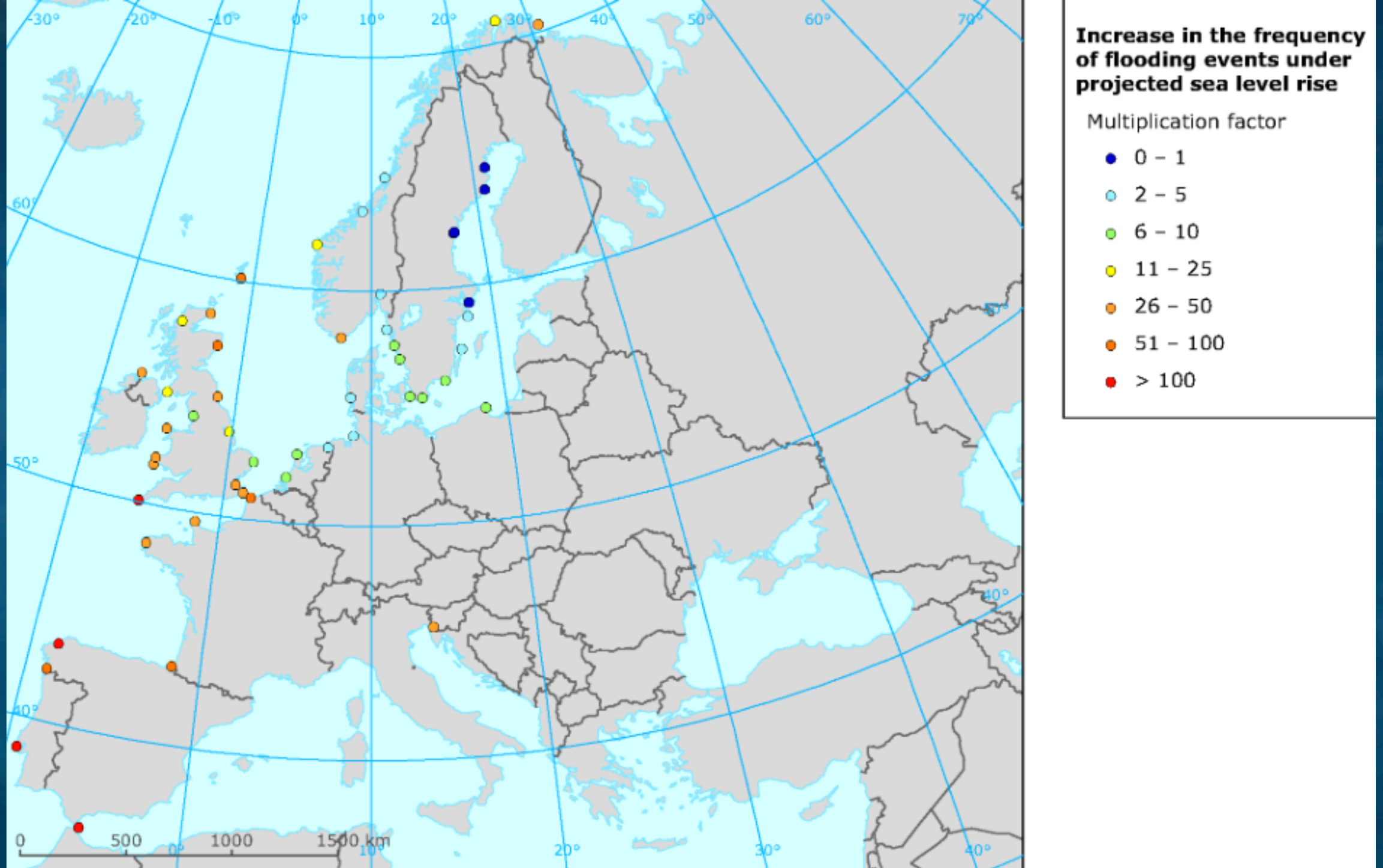
Ocean harvests can not keep pace

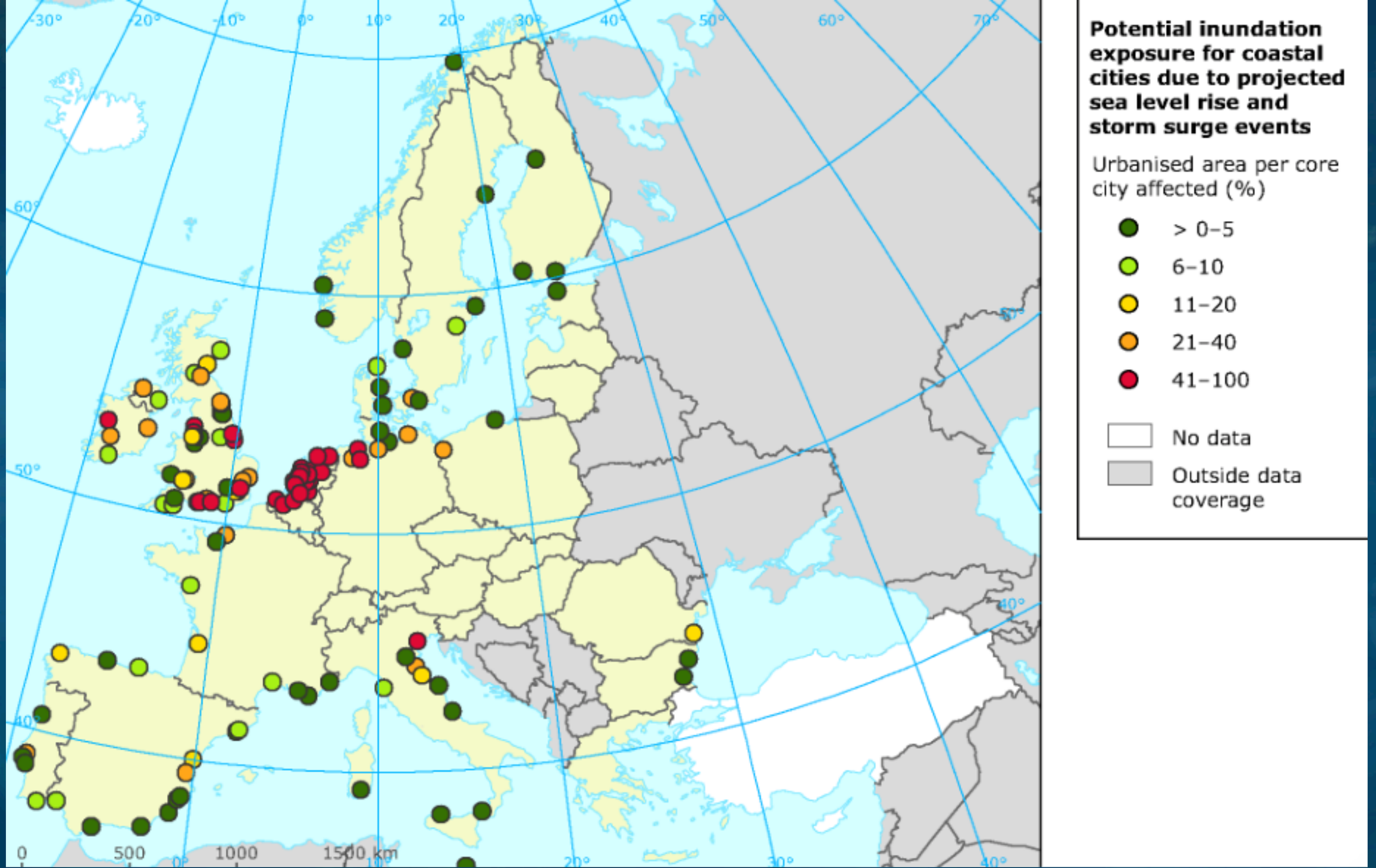
- About 100 million metric tons are harvested a year
- 100s of millions of people rely on wild ocean harvest for their main animal protein
- Billions of people derive some income from the sea
- Aquaculture makes up for declining wild catch

Changes in food from the sea



Three of Four Climate Effects: Warmer temperatures, Sea Level Rise and Increased Storms


-30°
-20°
-10°
0°
10°
20°
30°
40°
50°
60°
70°
60°
50°
40°
0
500
1000
1500 km
Increase in the frequency of flooding events under projected sea level rise
Multiplication factor
0 – 1
2 – 5
6 – 10
11 – 25
26 – 50
51 – 100
> 100



Potential inundation exposure for coastal cities due to projected sea level rise and storm surge events

Urbanised area per core city affected (%)

- > 0–5
- 6–10
- 11–20
- 21–40
- 41–100

No data

Outside data coverage

A Fourth Effect: Ocean Acidification

26% increase in ocean acidity since 1970

Shells are harder to make

Fish sensory systems impaired

Growth rate suffers

Different Kinds of Extinction in the Sea

Commercial extinction:
When a species becomes so rare that it no longer pays to hunt it.

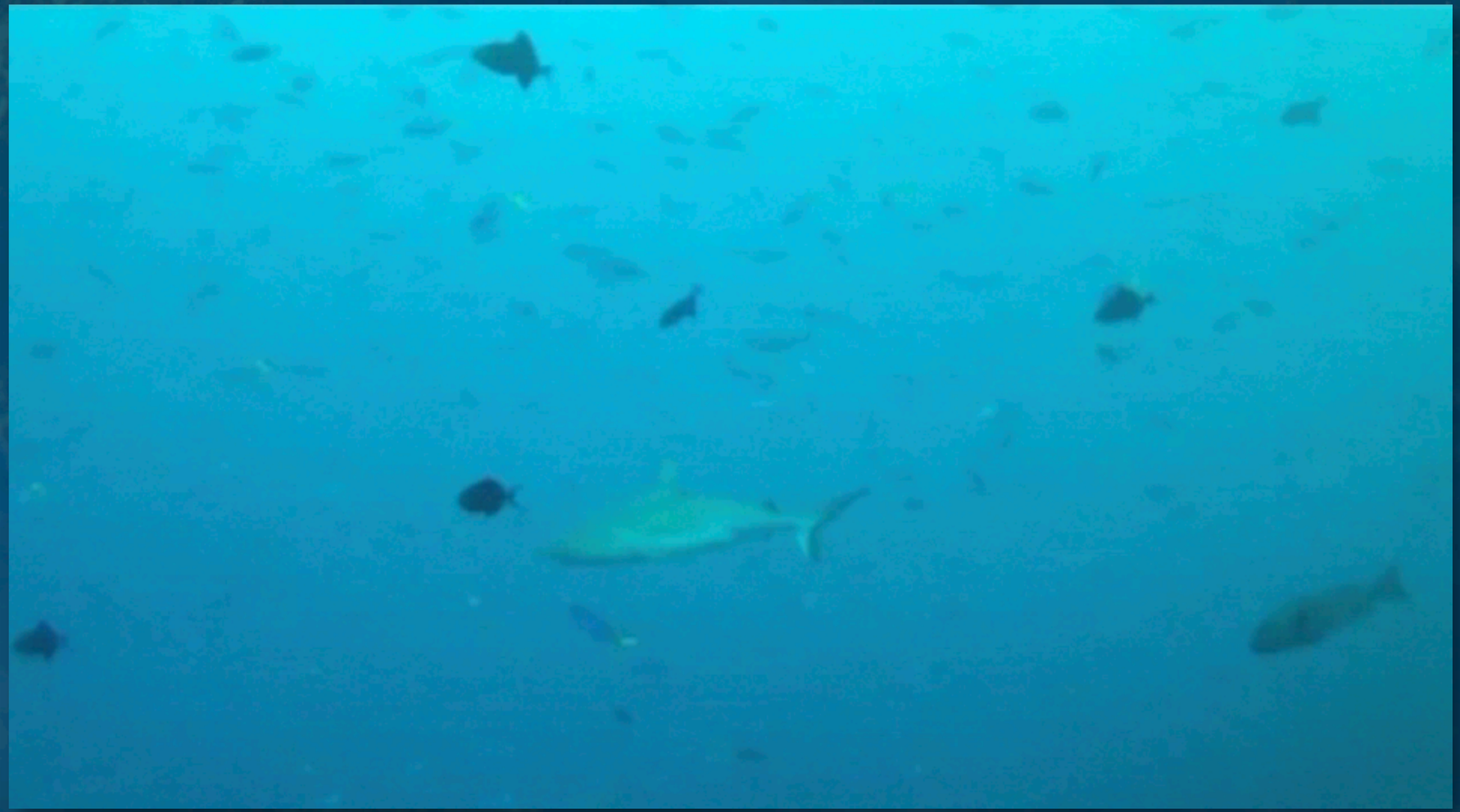
Grey whales were hunted down to 1000 animals and then the hunt failed.

Different Kinds of Extinction in the Sea

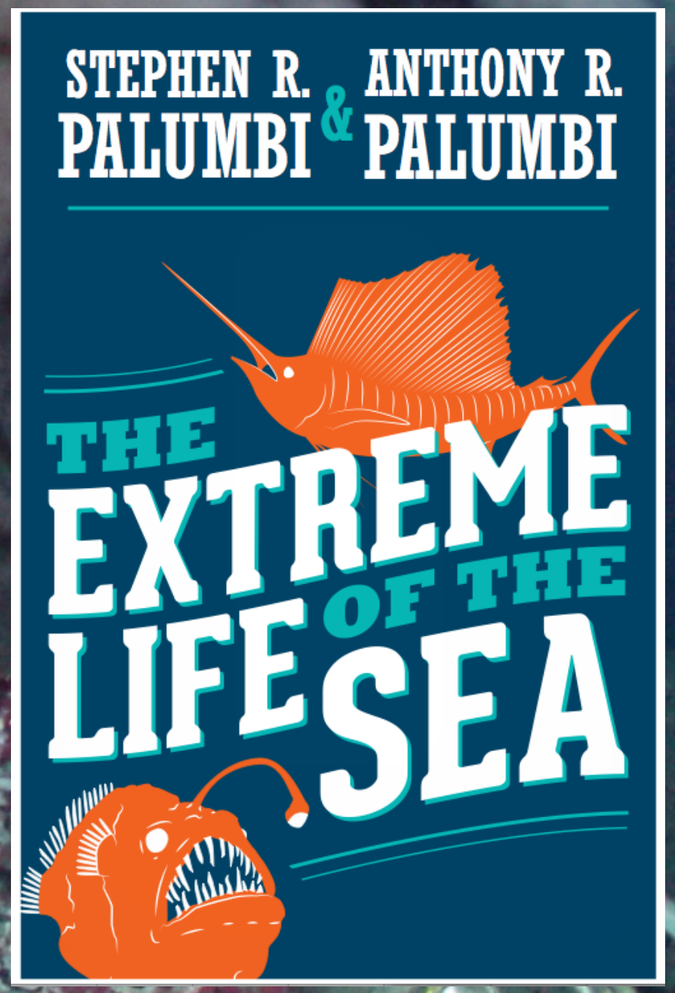
Ecological extinction: When a species beomes so rare that it no longer plays its normal ecological role.

Sea Otters were hunted so much in the 1800s that they could no longer control sea urchin herbivores. California kelp forests disappeared until sea otters recovered.

Despite Threats the Ocean Is Still Full of Incredible Life

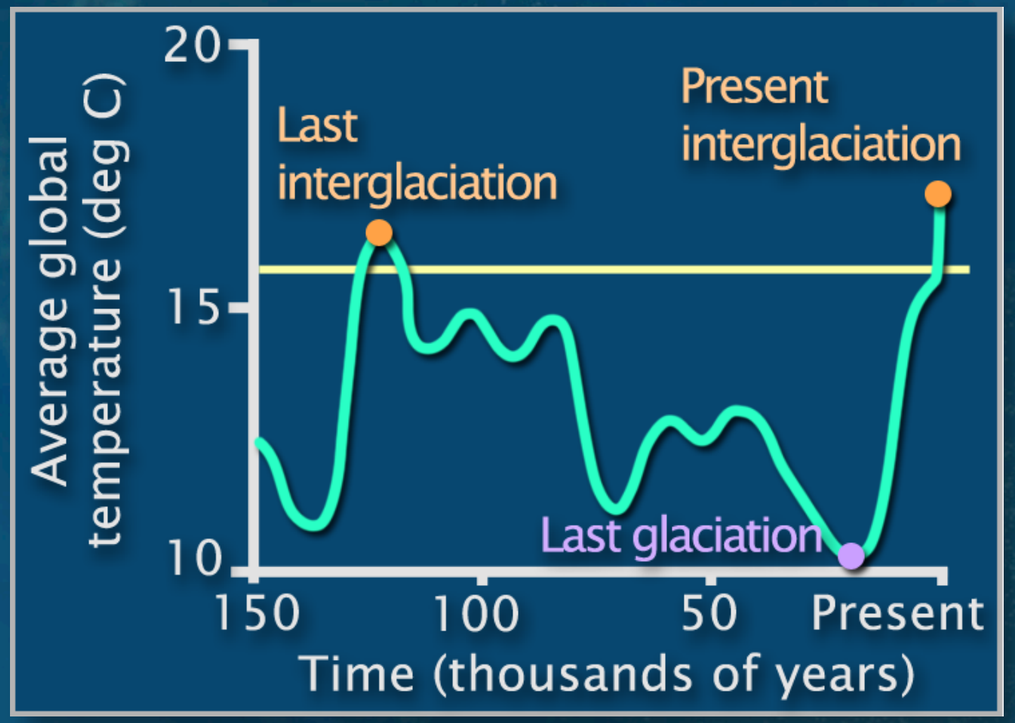


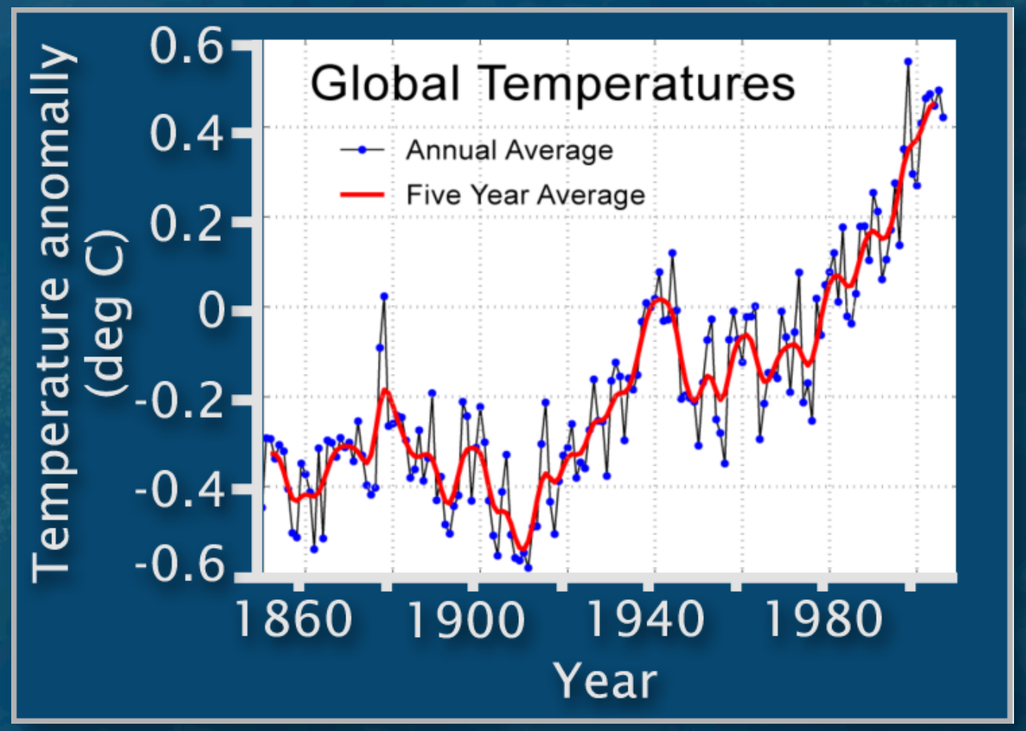
Extreme Life of the Sea is a fountain of valuable ideas for industry and human use



Pompeii Worm: Tail = Hot Tea
Head = Ice Water

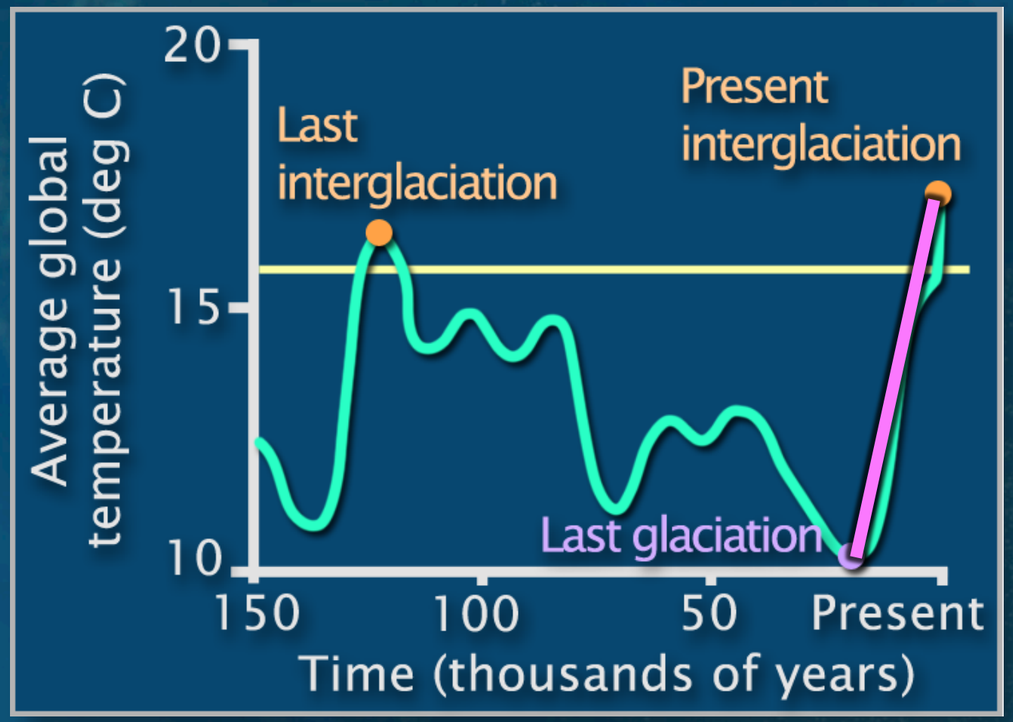
We Are Causing High Rates of Environmental Change

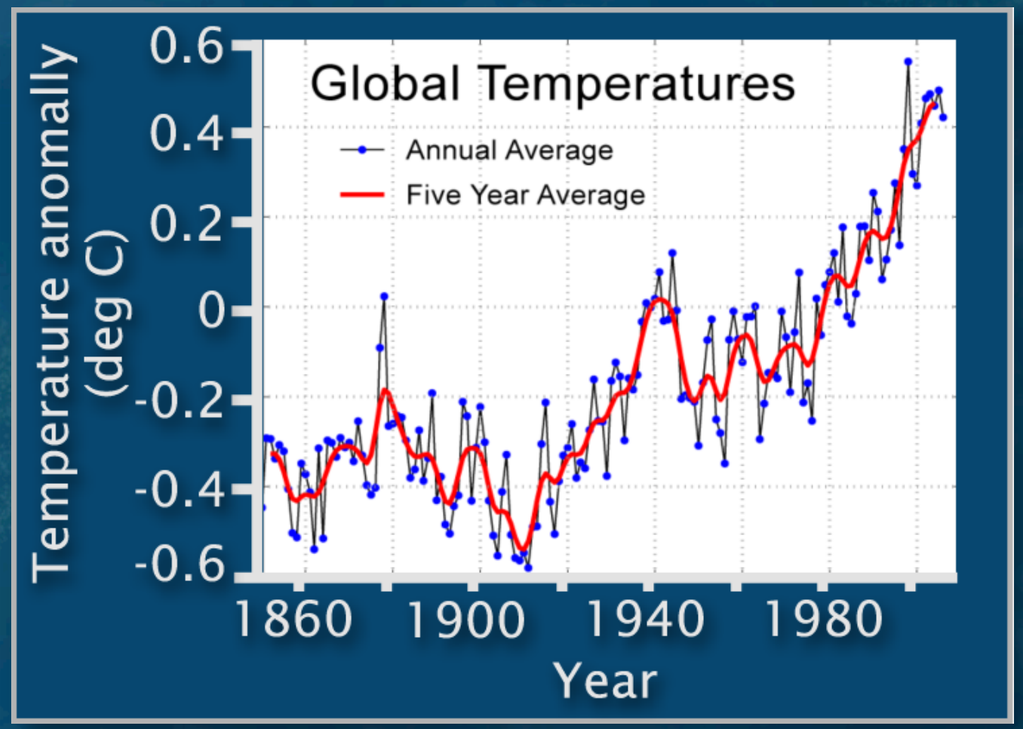




What were the rates during the last Ice Ages?

We Are Causing High Rates of Environmental Change





Slope of change: 7 degrees/10,000 yr

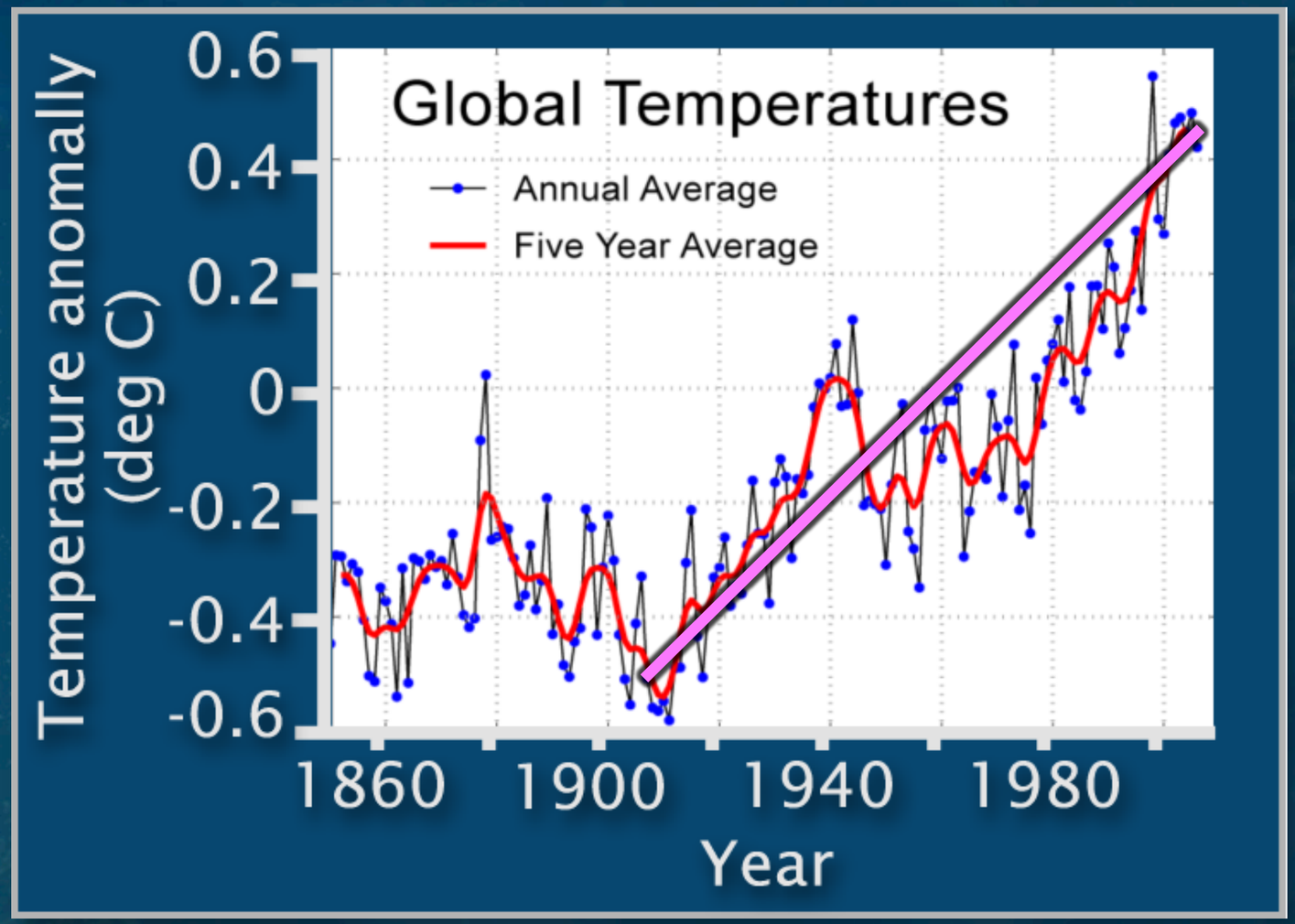
= 0.07 deg/century

Slope of Climate Change

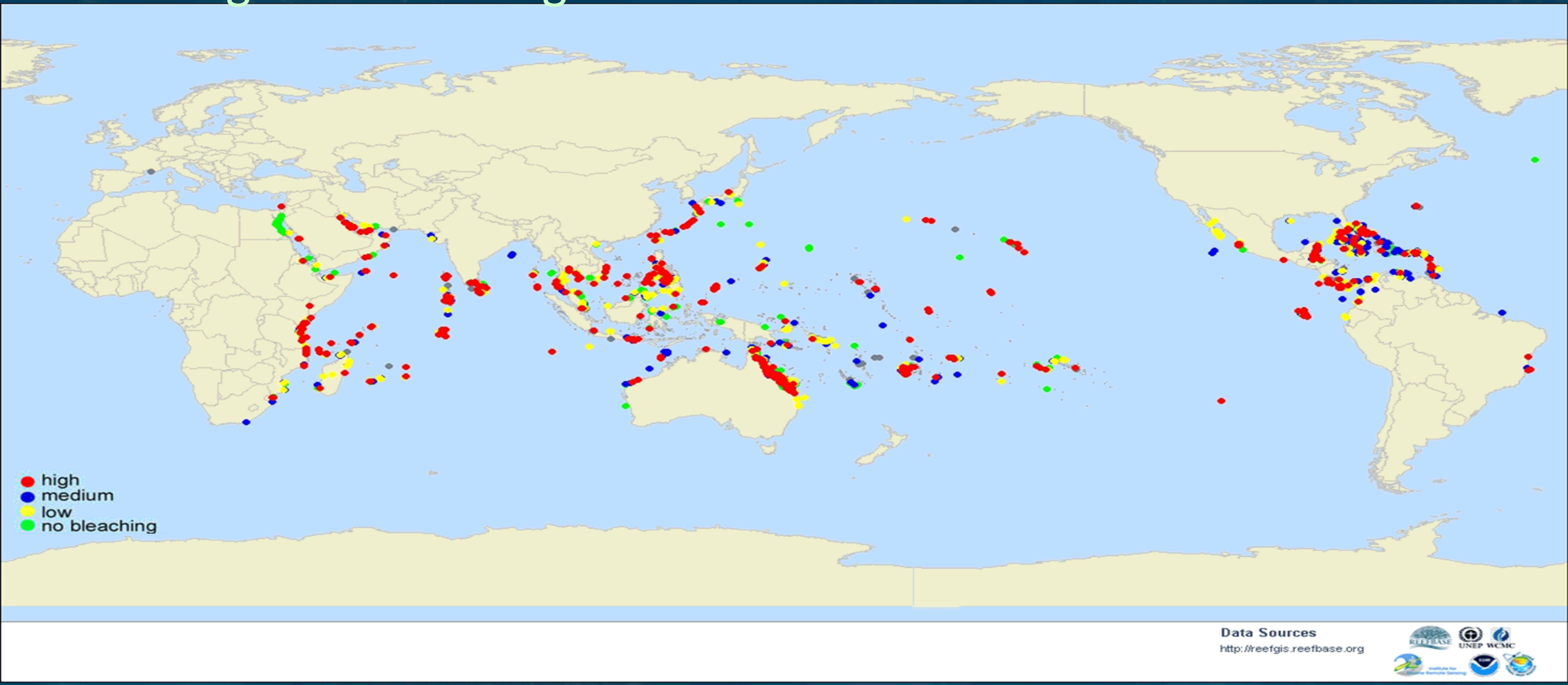
How does this compare to rates today?

0.8 deg/century

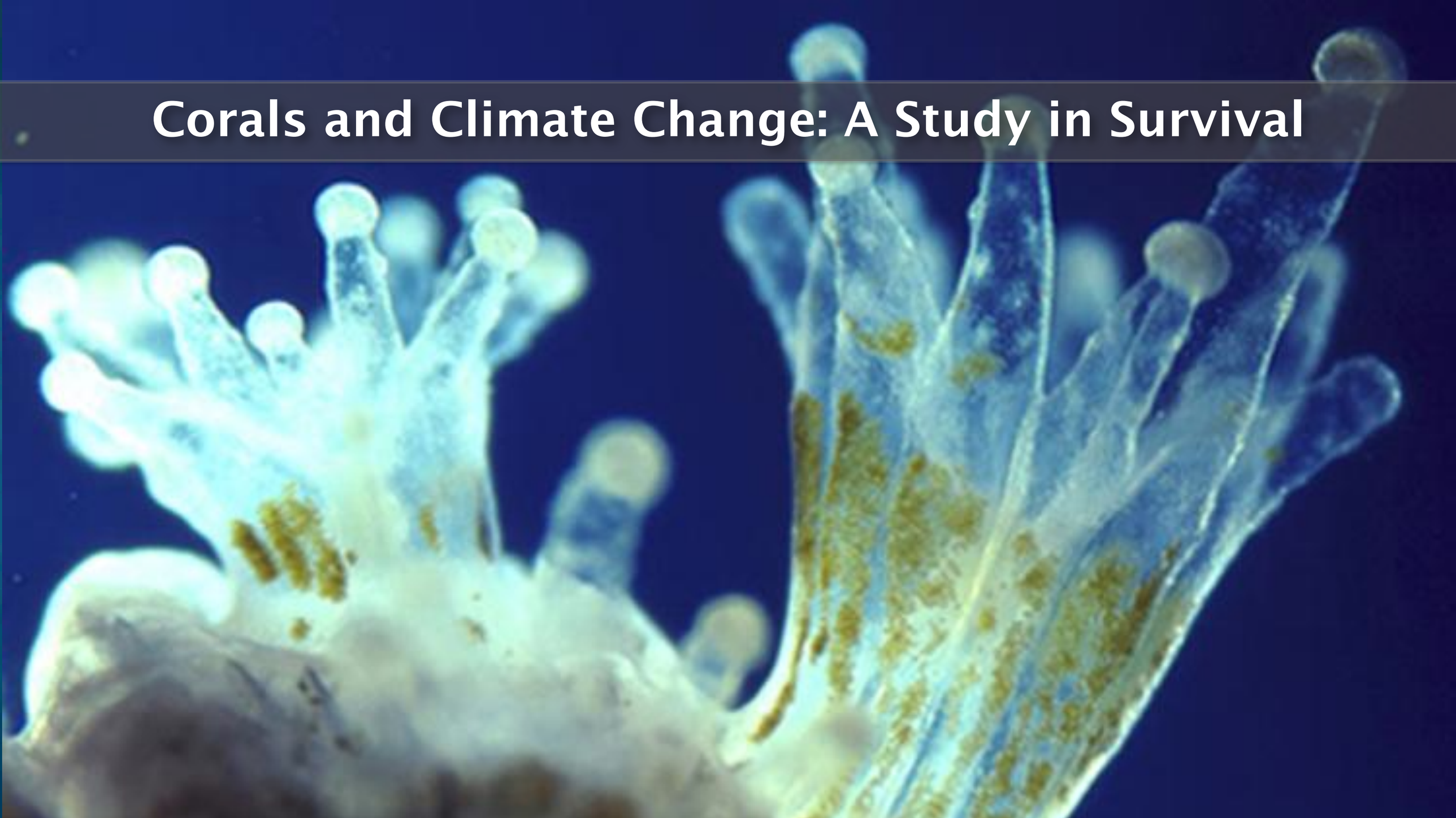
Eleven times faster



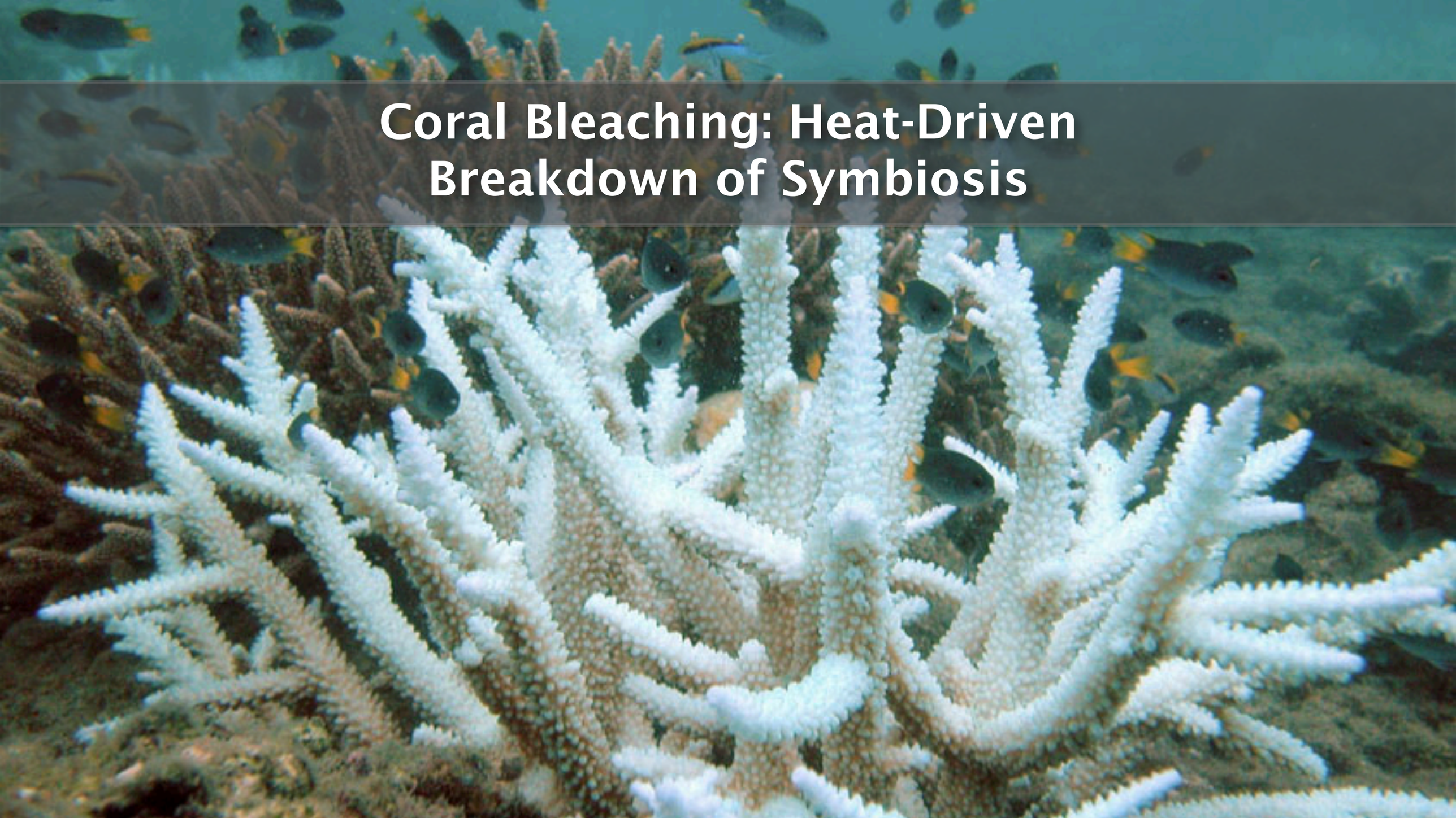
Coral bleaching – one of the most visible, global impacts of increasing climate change

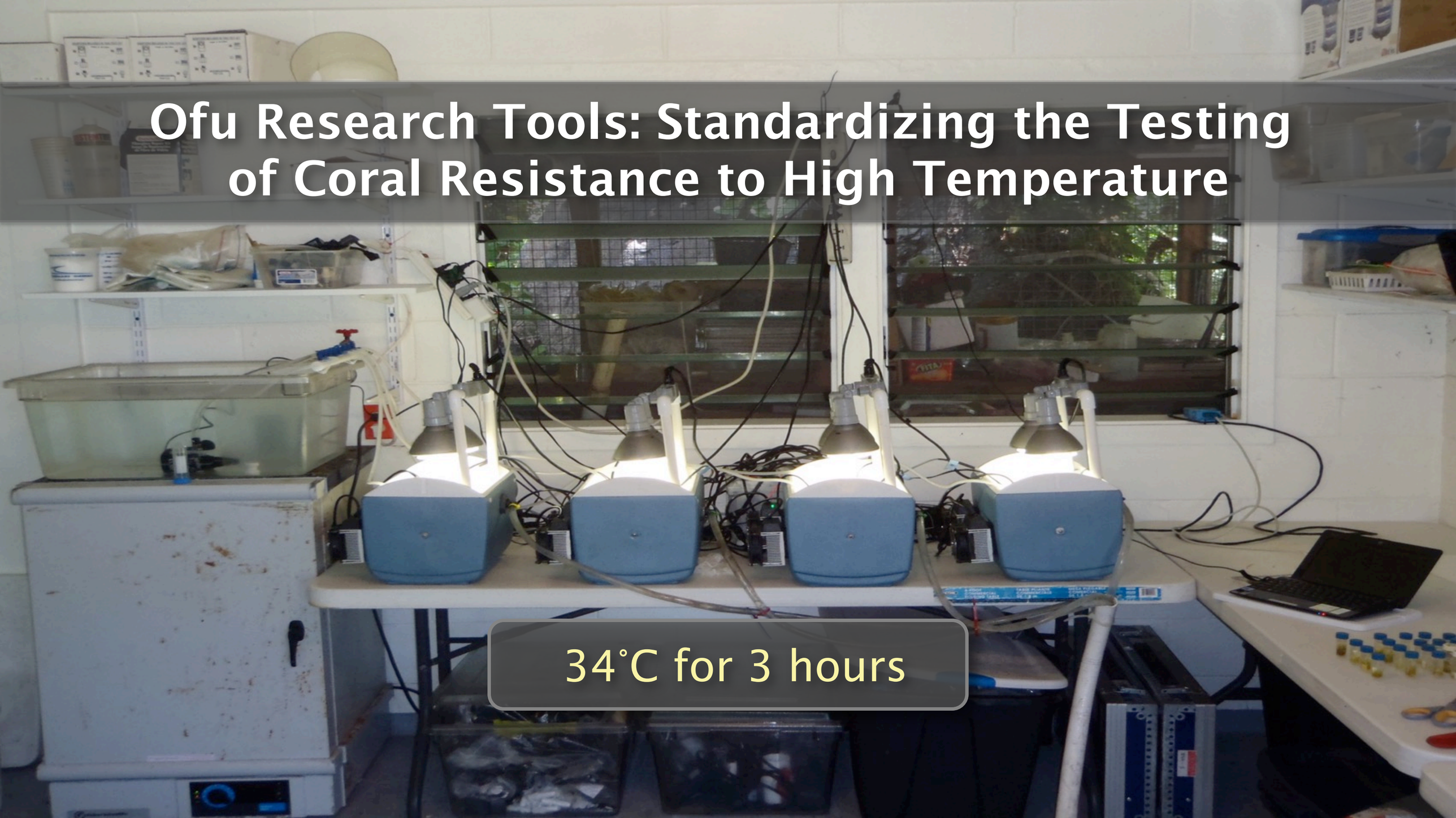


Corals and Climate Change: A Study in Survival



Coral Bleaching: Heat-Driven Breakdown of Symbiosis



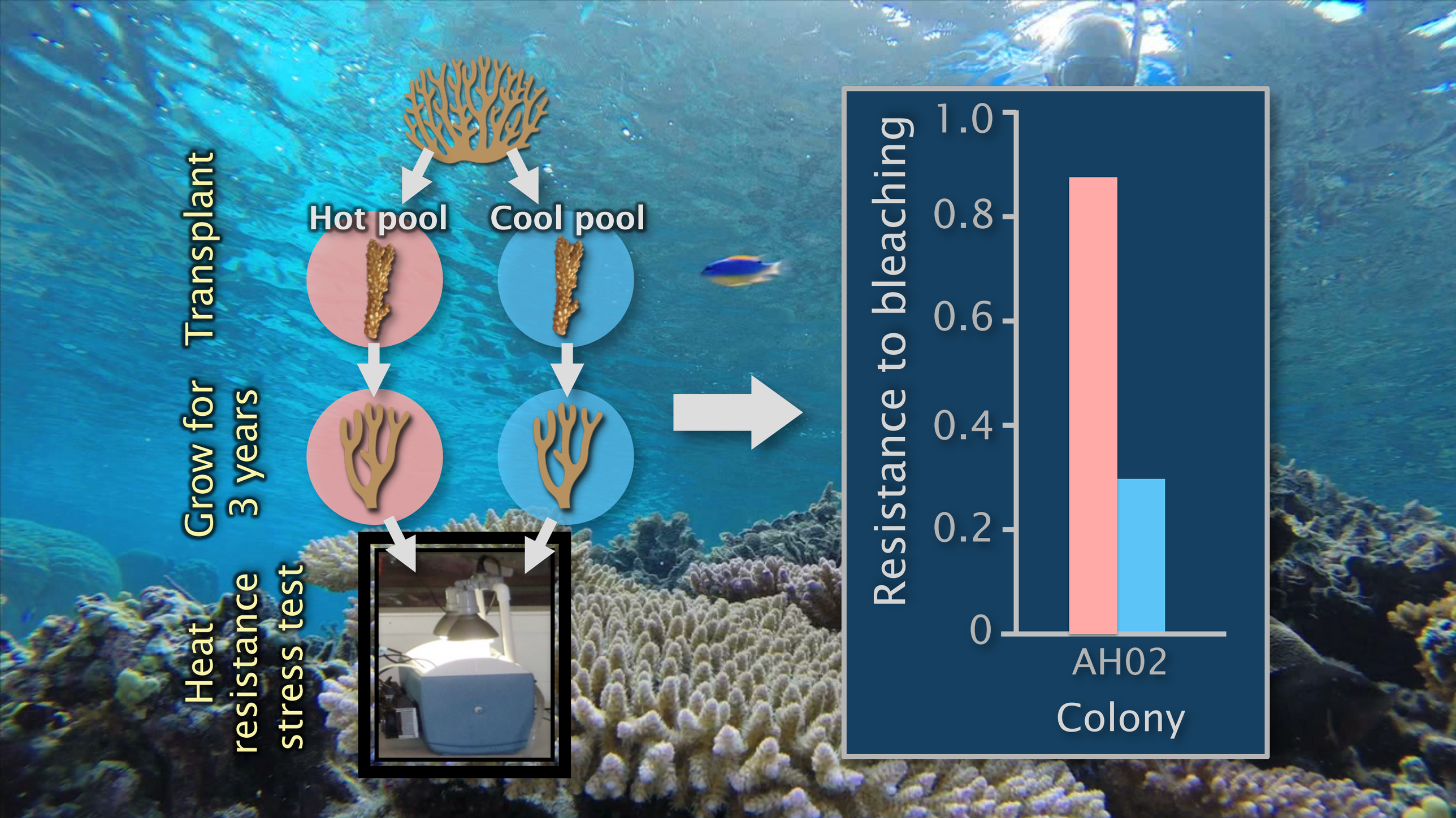

Ofu Research Tools: Standardizing the Testing of Coral Resistance to High Temperature
34˚C for 3 hours

Stress Tank Results: Some Corals Bleach (Lose Color, Lose Chlorophyll)

Coral from the cooler
Pool 400 bleach more

Same species from the warmer
Pool 300 does not bleach

How Do Heat-Resistant Corals Become Heat Resistant?


Transplant
Grow for 3 years
Heat resistance stress test
Hot pool
Cool pool
Resistance to bleaching
1.0
0.8
0.6
0.4
0.2
0
AH02
Colony

What about genetic differences between pools?

Sample 29 colonies at noon on the same day across Pools.

Two Responses to Environmental Change

Acclimation: The adjustment of an individual's physiology to new conditions

Adaptation: Natural selection for the individuals that have the right genes for new conditions

Two Responses to Environmental Change

Acclimation: The adjustment of an individual's physiology to new conditions

The individual changes quickly

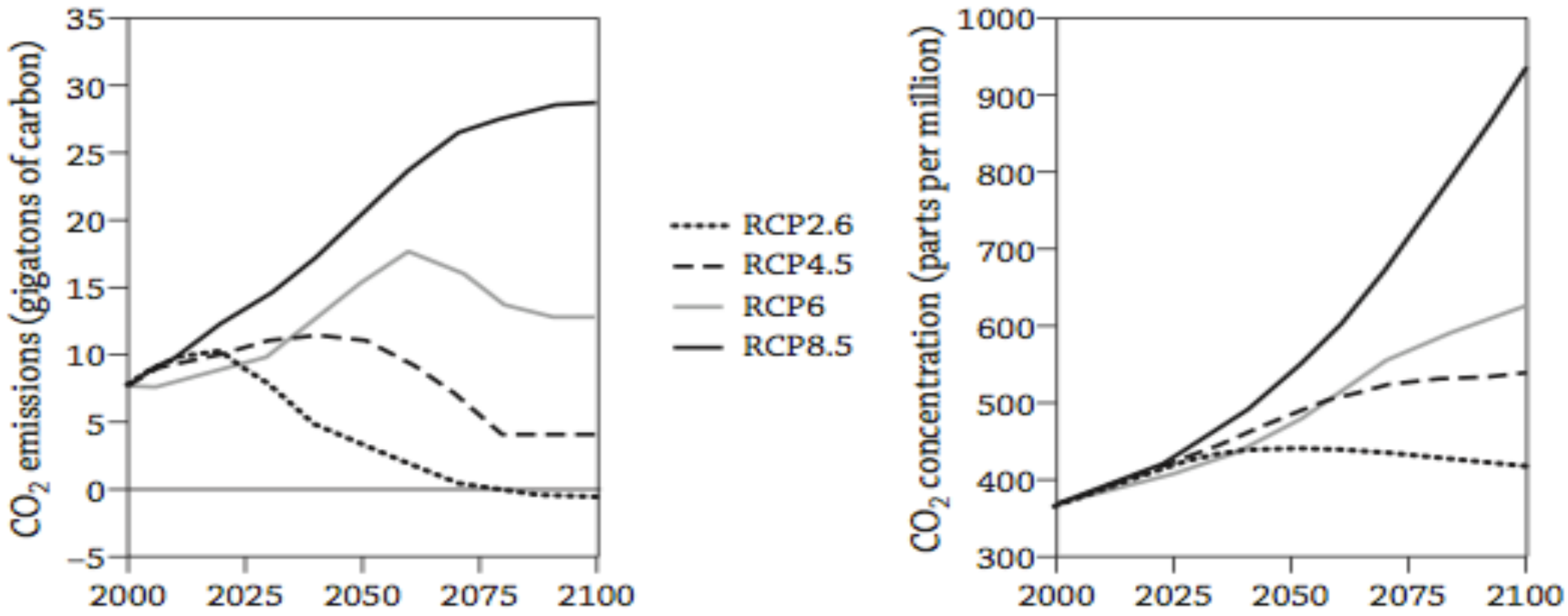
Adaptation: Natural selection for the individuals that have the right genes for new conditions

The population changes between generations

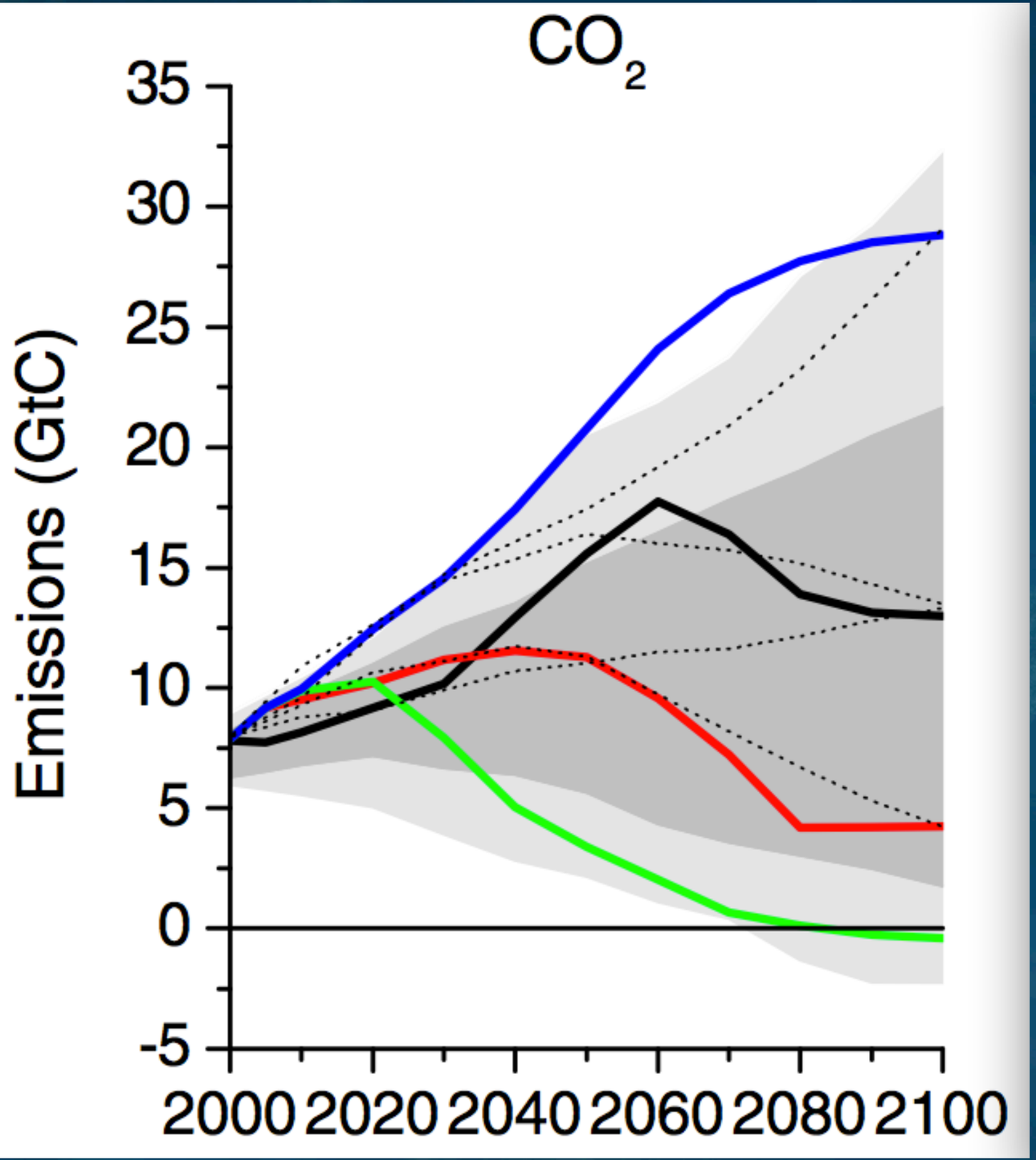

Coastlines are in a delicate balance between
storm erosion and biological construction

Species acclimation and adaptation both help – but only for a short while

Need to reduce emmision levels to low levels by 2050



Predictions of CO_2 emissions (left) and atmospheric concentrations of CO_2 (right) based on various future scenarios of global response to climate change. The RCP 8.5 scenario (left figure, black solid line) is currently the most likely, as it represents no future controls on emissions. This scenario would lead to an exponential increase in oceanic CO_2 (right figure, black solid line) with serious impacts on ocean life from the year 2100 onward. Only if CO_2 emissions were to begin to decline by 2020 (for example, under the RCP 2.6 scenario, left figure dotted line) would CO_2 in the oceans begin to decrease by the year 2100. Intermediate scenarios (RCP 4.5 and RCP 6.0) would still see CO_2 in the oceans increasing for the foreseeable future



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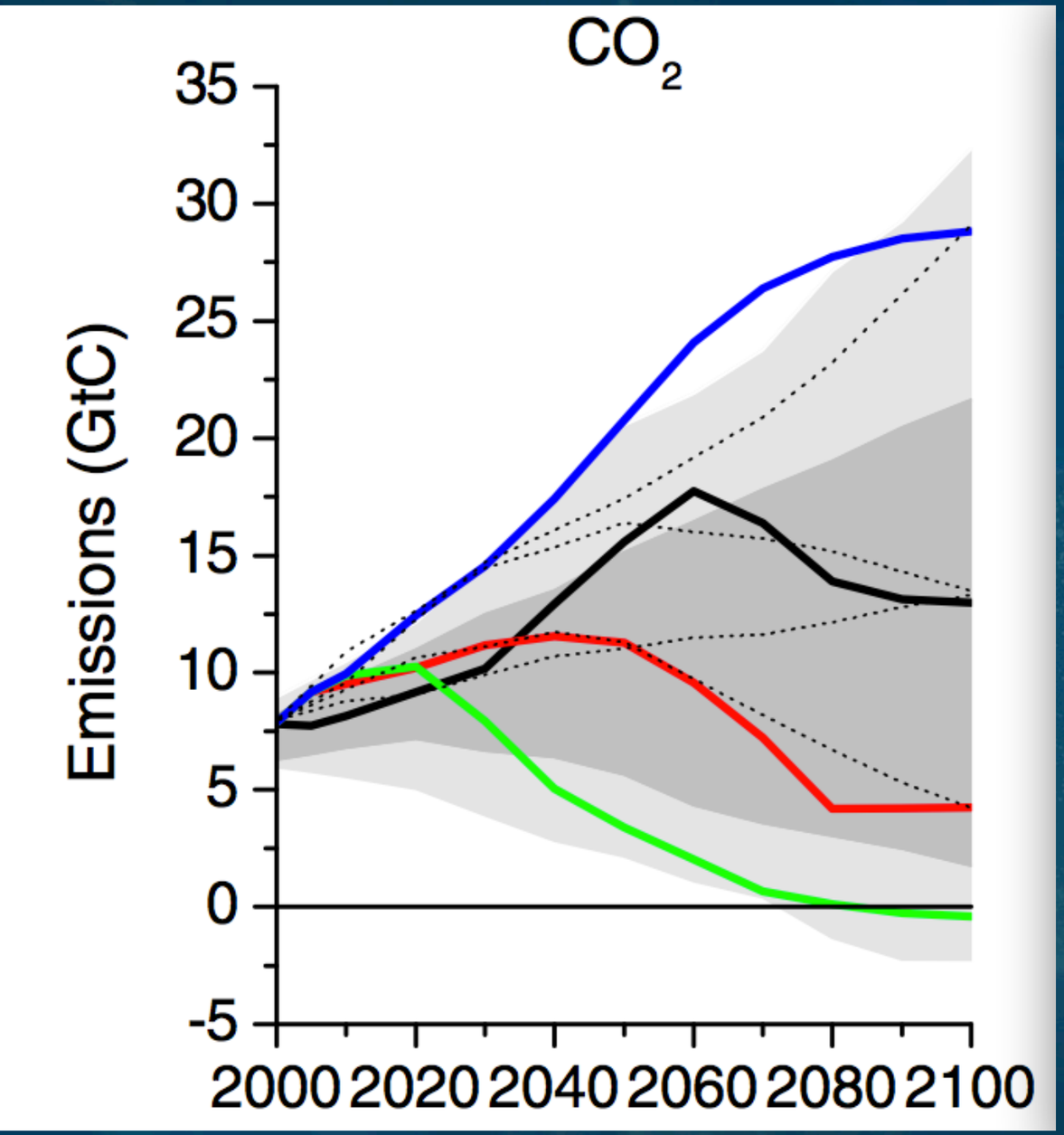

A grand bargain –society reduces emissions (green line) so CO2 begins to drop by 2100

Science and conservation saves as much of productive ecosystems as possible so that they can begn to recover when global climate improves.