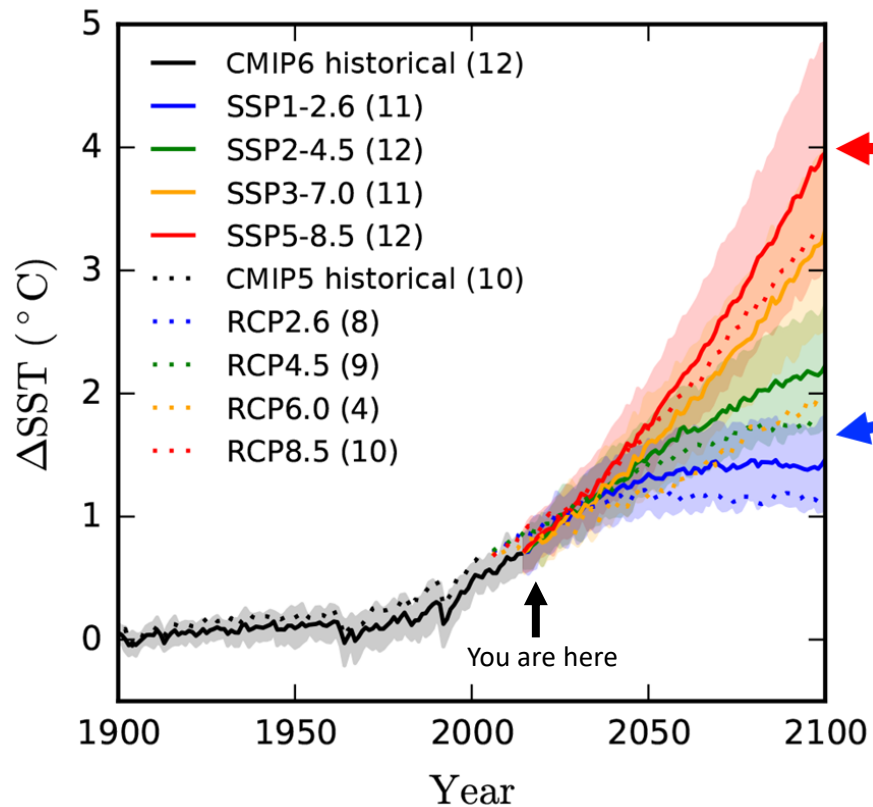


TOWARDS ESTIMATING MARINE ECOSYSTEM IMPACTS OF GEOENGINEERING

KELSEY ROBERTS &
CHERYL HARRISON



FUTURE CLIMATE SCENARIOS



High Emissions = SSP5-8.5

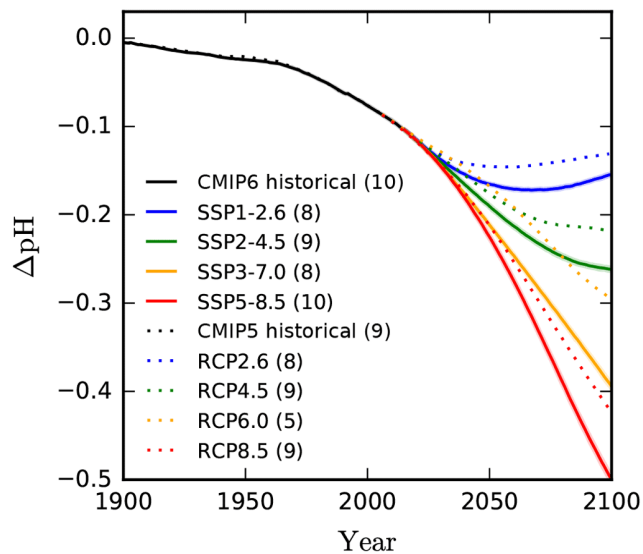
Burn all the fuels

< 2°C Warming = SSP1-2.6

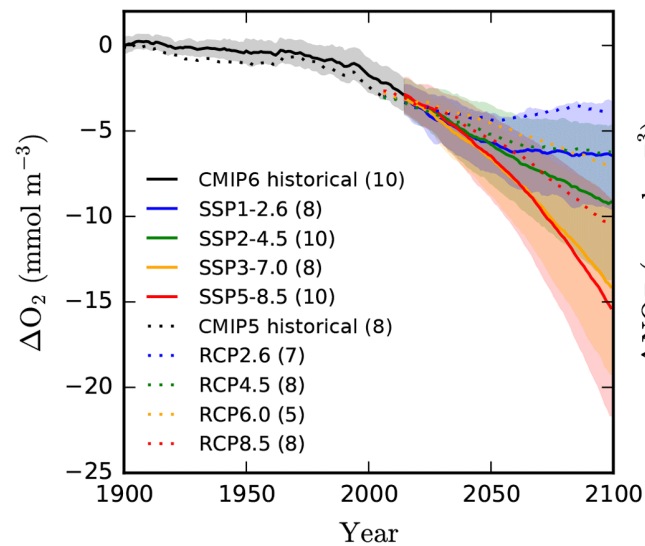
The global Green New Deal

- Best case scenarios require both stopping emissions and scrubbing carbon from the atmosphere with new technology
- There is still significant climate change in best case scenarios

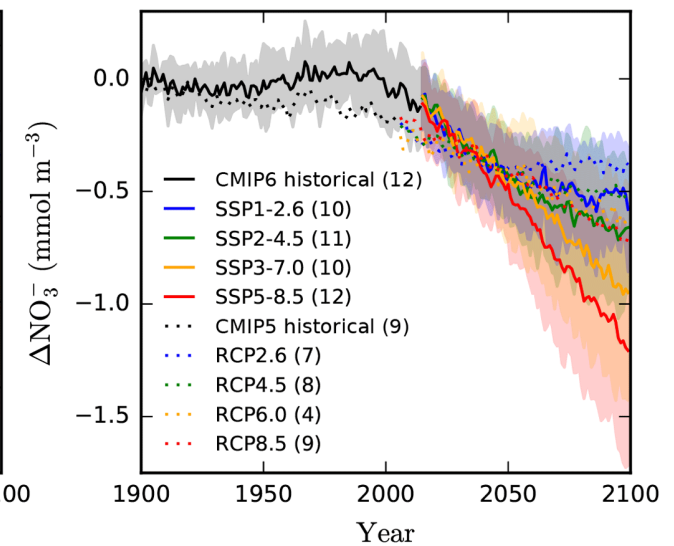
IMPORTANT CLIMATE DRIVERS FOR MARINE ECOSYSTEM IMPACTS



Acidification



Declining oxygenation



Declining surface nutrients

Bleaching

Health of coral reefs in jeopardy under 2 degrees warming

Sea level rise

Drowning wetland habitats and flooding coastal communities

Algal blooms

Larger and more frequent potentially toxic blooms affecting marine life and people

TRANSLATION TO MARINE ECOSYSTEM IMPACTS

Fisheries

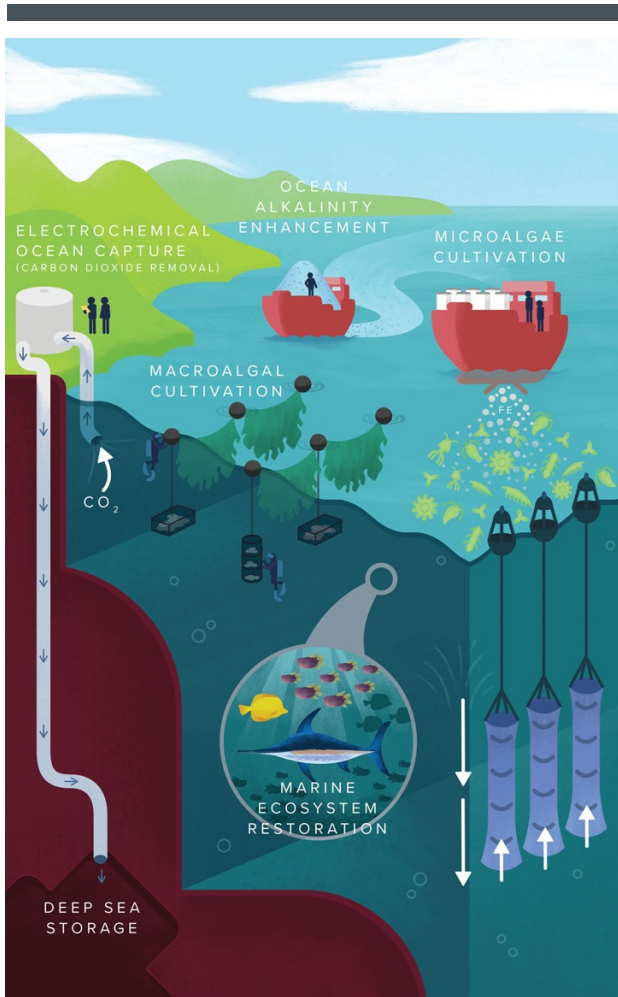
Disruptions impact the food web and global food security

Acidification

More acidic waters dangerous for calcifying organisms (i.e., corals, clams, oysters)

Habitat suitability

Lower oxygen levels shrinking habitats and shifting distributions

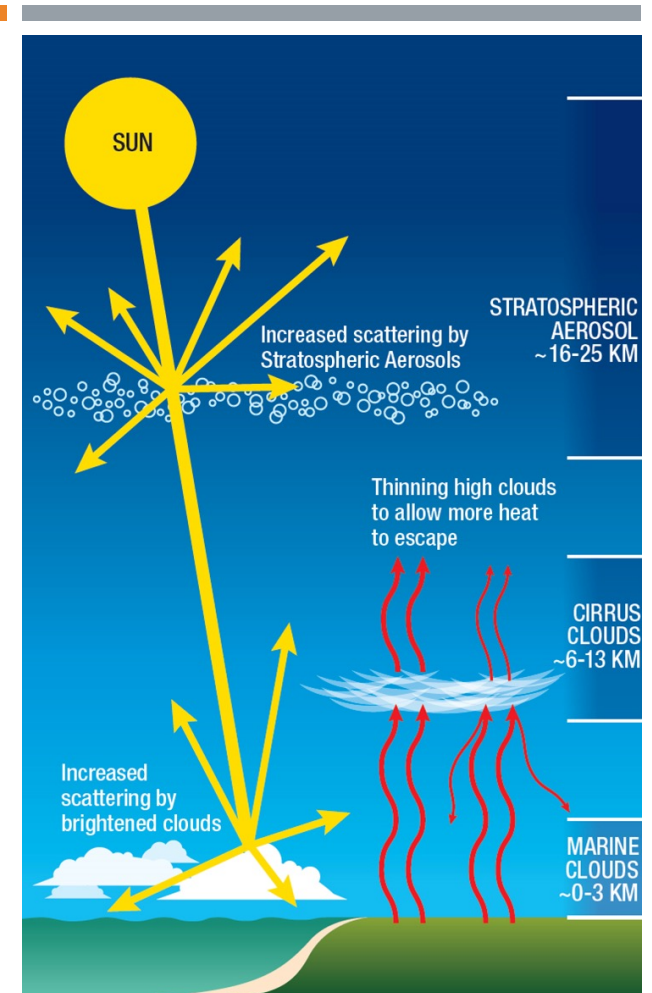


WHAT IS GEOENGINEERING?

There's 2 main flavors:

- Solar radiation management: limiting radiation at the Earth's surface
 - In other words... 'turning down the sun'
- Marine carbon dioxide removal: removing carbon from the atmosphere and storing it elsewhere

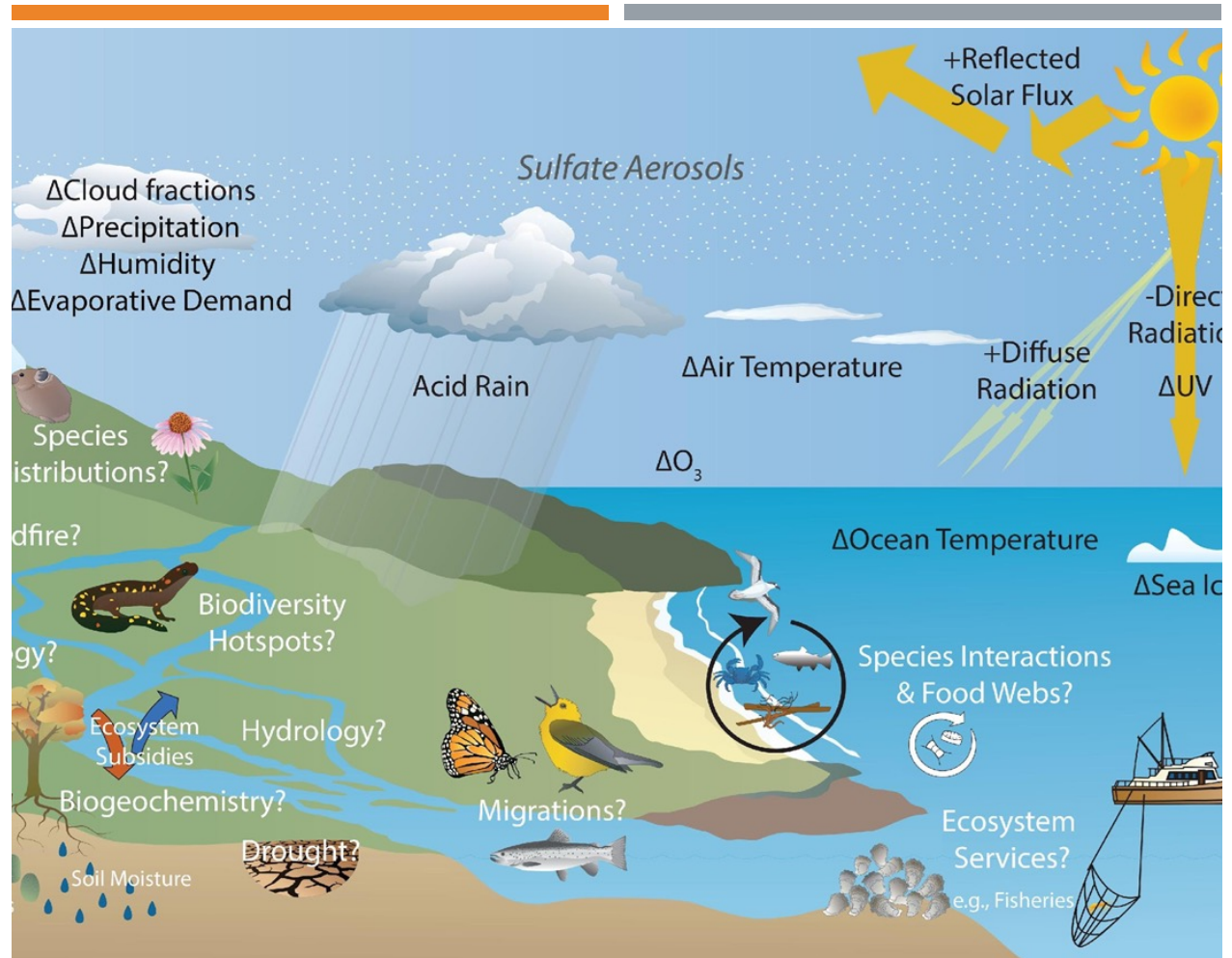
Research & implementation is moving forward whether we like it or not!



National Academies, 2021

WHY ARE ECOSYSTEM IMPACTS IMPORTANT TO CONSIDER?

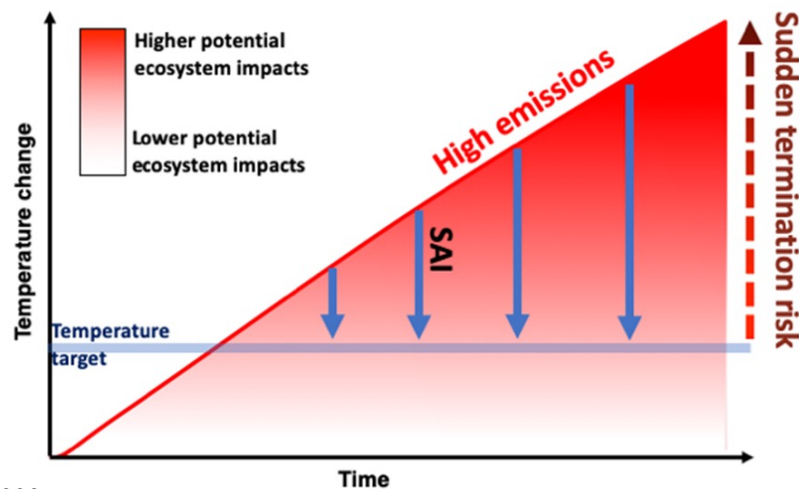
- **Very little literature on ecological impacts of SRM;** many unknowns
- **Scenario dependent**
 - Varying impacts based on scenario & associated geographic distribution of impacts
- Nature is complex, challenging to predict changes to biodiversity, ecosystem function
- Need more **collaboration** among Ecologists & Climate Scientists



Zarnetske et al. 2021 PNAS

MORE ON SCENARIO-DEPENDENCY

A) no climate change mitigation+ SAI deployment



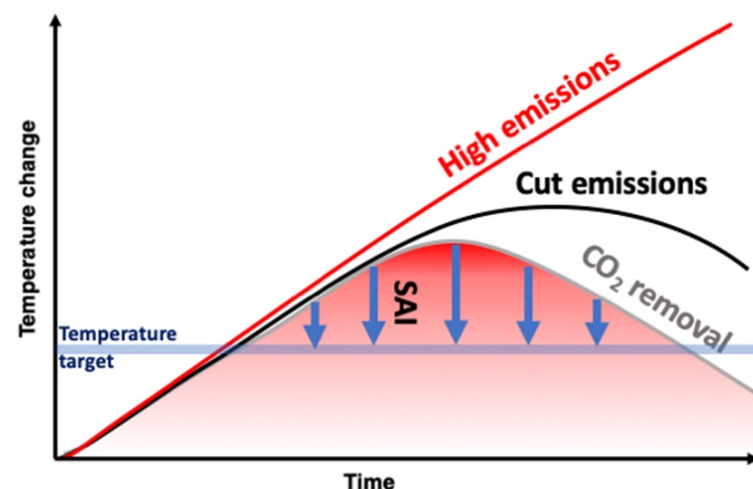
Zarnetske et al., 2021
Trisos et al., 2018

Business-as-usual = SSP5-8.5



*Cost to ecological systems? Substantial changes to hydrological cycle (regional and global), temperature shifts/extremes, increases in surface UV radiation to name a few...

B) climate change mitigation + SAI peak shaving



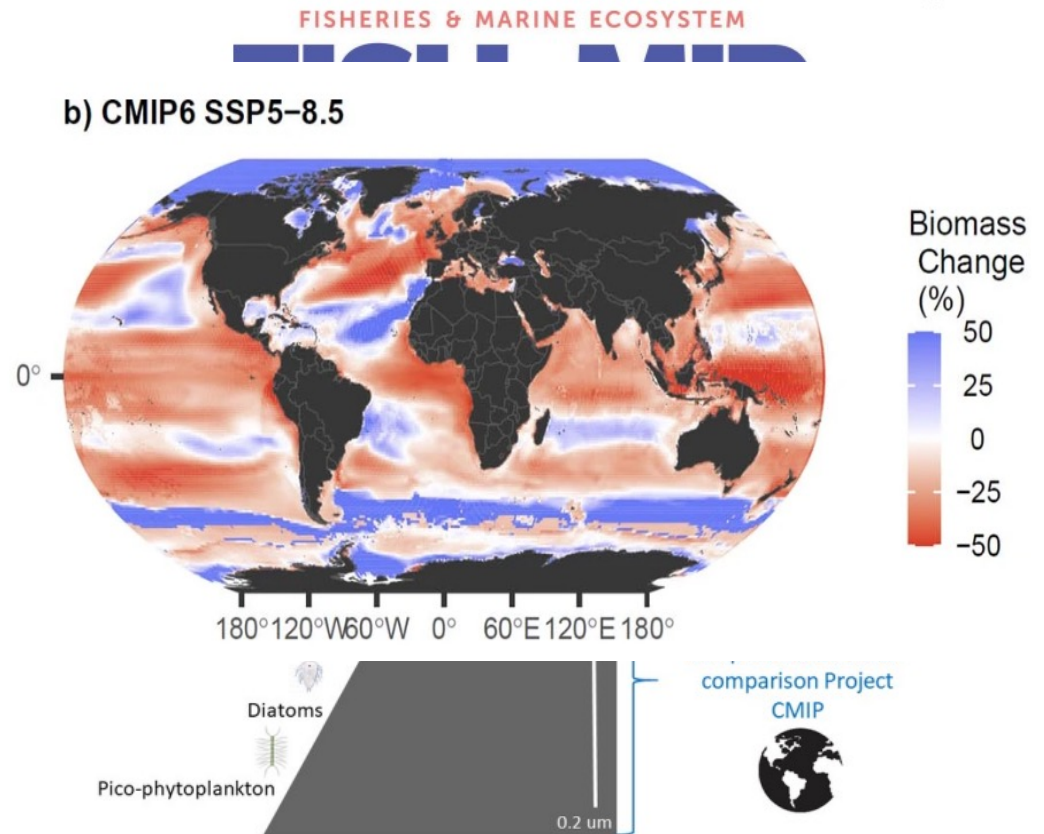
Overshoot = SSP5-3.4 OS



*Mitigation + SAI = potential reduction of risks to species and ecosystem processes BUT might not be enough for some areas (e.g., biodiversity loss in the poles)

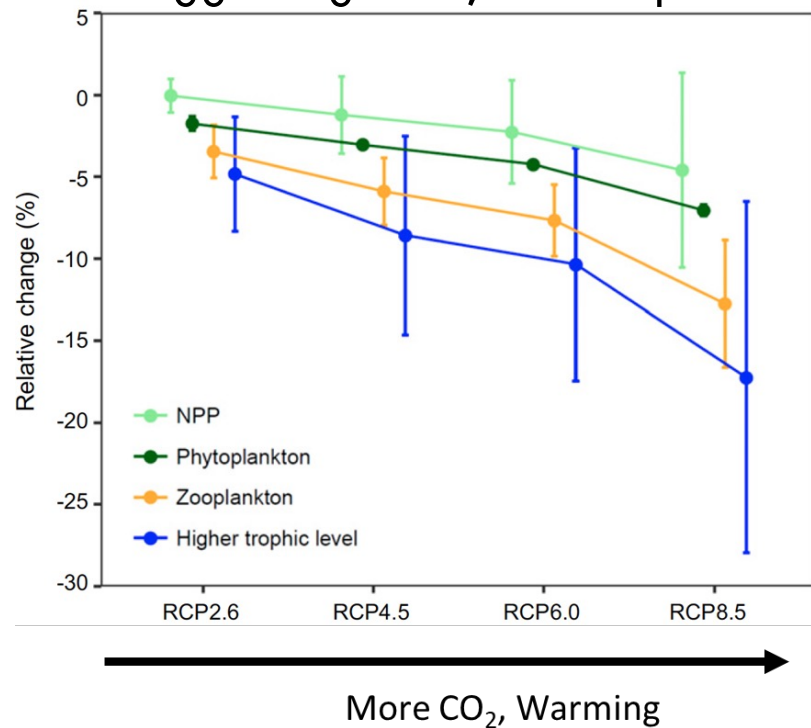
HOW DO WE MODEL MARINE ECOSYSTEM IMPACTS?

- **Step 1:** hack the Earth System Model (ESM) outputs to drive ecosystem models
 - ESMs designed to simulate ocean carbon cycle
 - We can look at what is simulated directly and infer higher trophic level impacts
- **Step 2:** simulate marine ecosystems with ESMs
 - Project long term impacts; global and regional perspectives
 - Answers questions about the future of fisheries, seafood supply, marine biodiversity, and marine ecosystem functioning

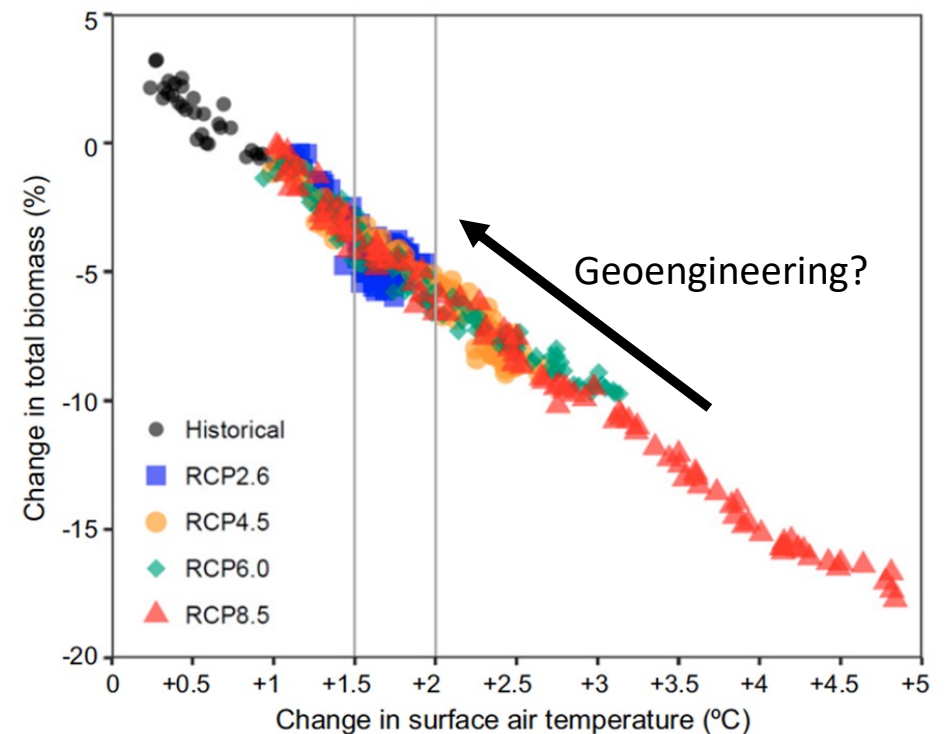


WHAT ARE THE GLOBAL FISHMIP FINDINGS SO FAR?

Trophic Amplification:
bigger organism, more impact

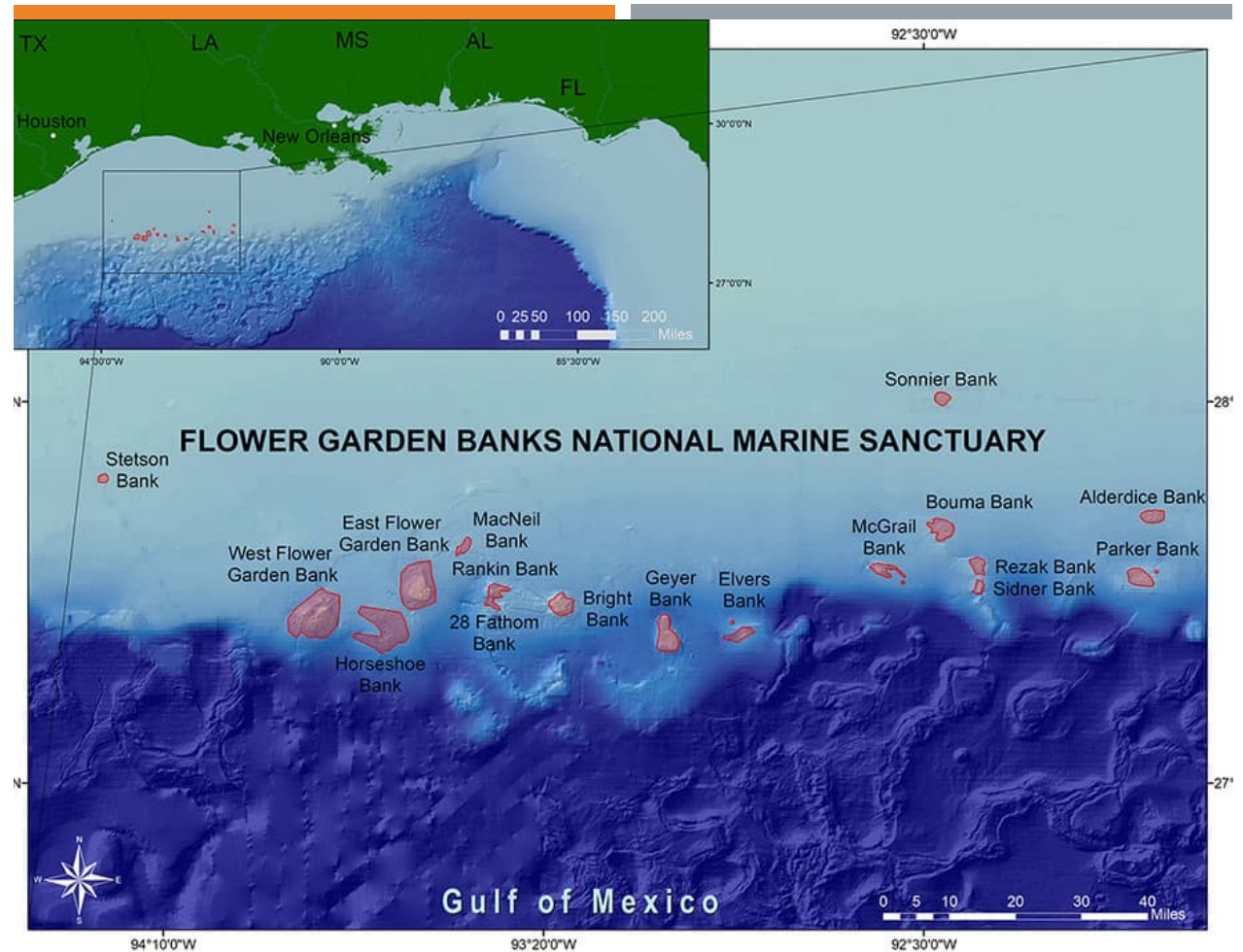


5% decline in fisheries biomass
for every 1°C of warming



MOVING TOWARDS REGIONAL APPLICATIONS

- Engage with policy and management specifically US NMSS and fisheries closures
- Sanctuary response to geoengineering?
- Drive marine ecosystem models with SRM simulations
- Can we assess sanctuary design & effectiveness through a climate intervention lens?



THANK YOU!



KROBERTS3@LSU.EDU