COMMUNITY CHANGE IN OUR COASTAL OCEANS

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CLIMATE CHANGE IS DISRUPTING OUR ECOSYSTEMS

- Key Causes of rising atmospheric carbon
  - Fossil fuel use
  - Deforestation
  - Agriculture and land use practices
- Current atmospheric carbon is 50% higher than preindustrial conditions
- Worldwide ecosystem ramifications
  - Ocean acidification
  - Habitat destruction
  - Range shifts
  - Increasing temperatures

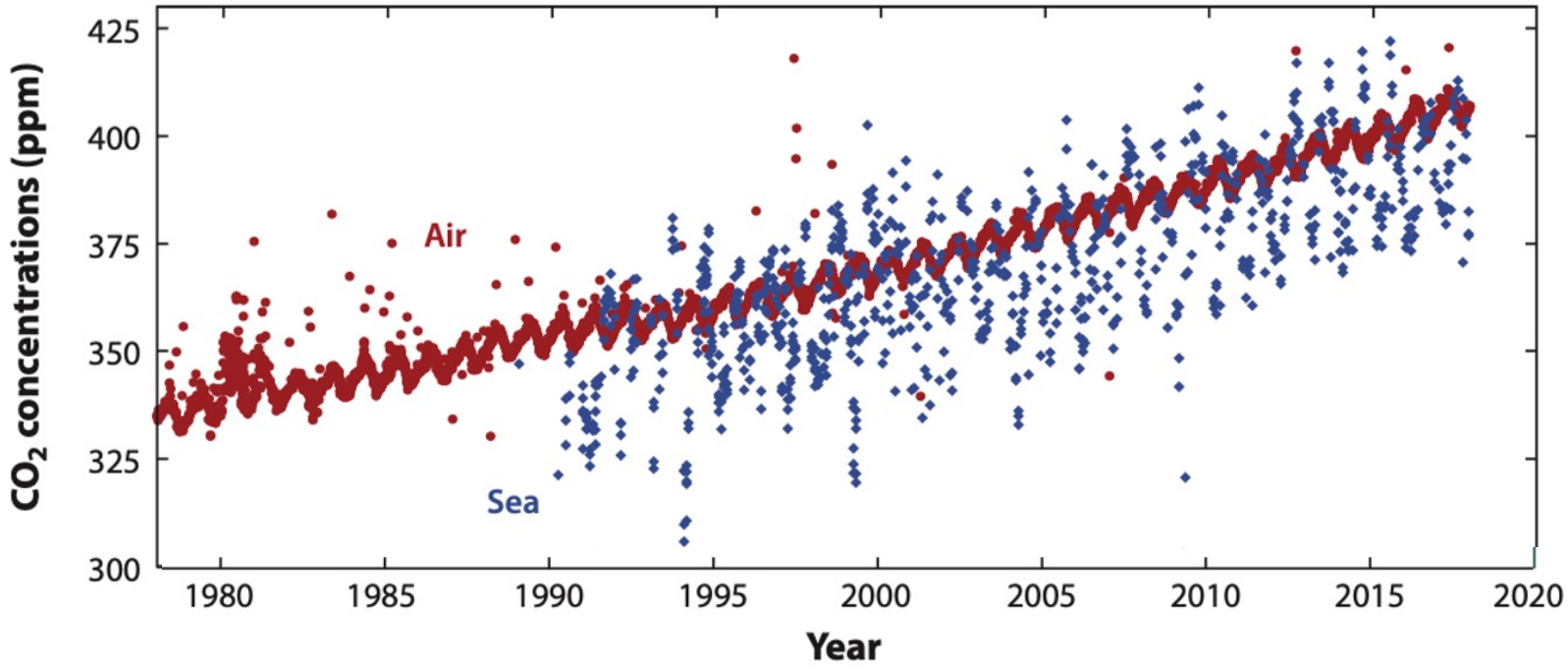
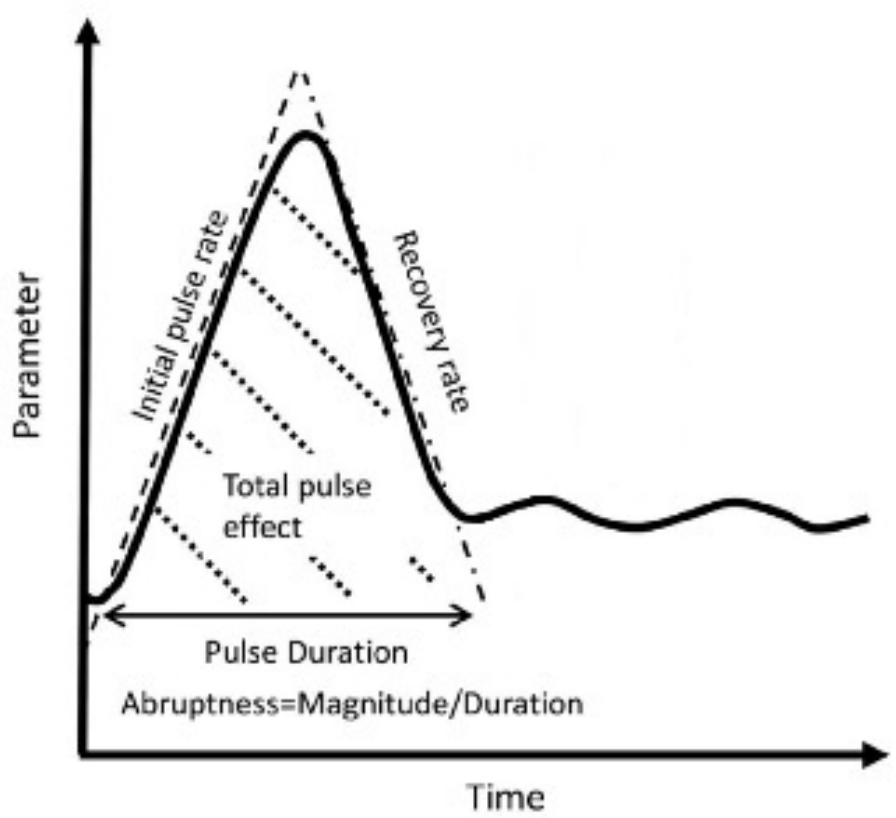


Figure adapted from Jewett & Romanou 2017 in Doney et al. 2020

PULSE DISTURBANCES ARE BECOMING MORE FREQUENT AND INTENSE



- **Pulse disturbances:** abrupt changes in the environment that alter ecological communities
- Abruptness = Magnitude / Duration
- Examples:
  - Heat waves
  - Marine upwelling events
  - Mass reproductive or mortality events
  - Storms
  - Floods
  - **Marine heat waves**

Figure modified from Jentsch and White 2019

PRESS AND PULSE DISTURBANCES MANIFEST DIFFERENTLY

PRESS

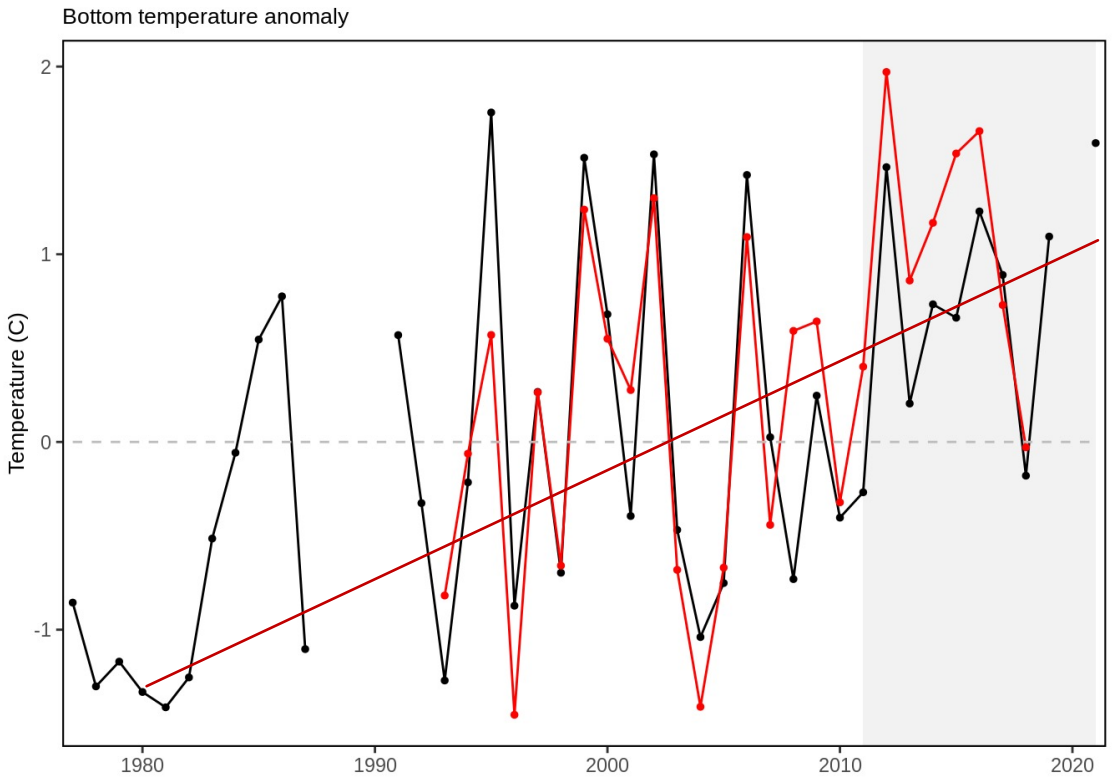
- Long term, multi-generational pressures on the community over time
- Examples:
  - Rising ocean temperatures
  - Fishing pressures
    - The first commercial fishing in Gulf of Maine began in 1600's

PULSE

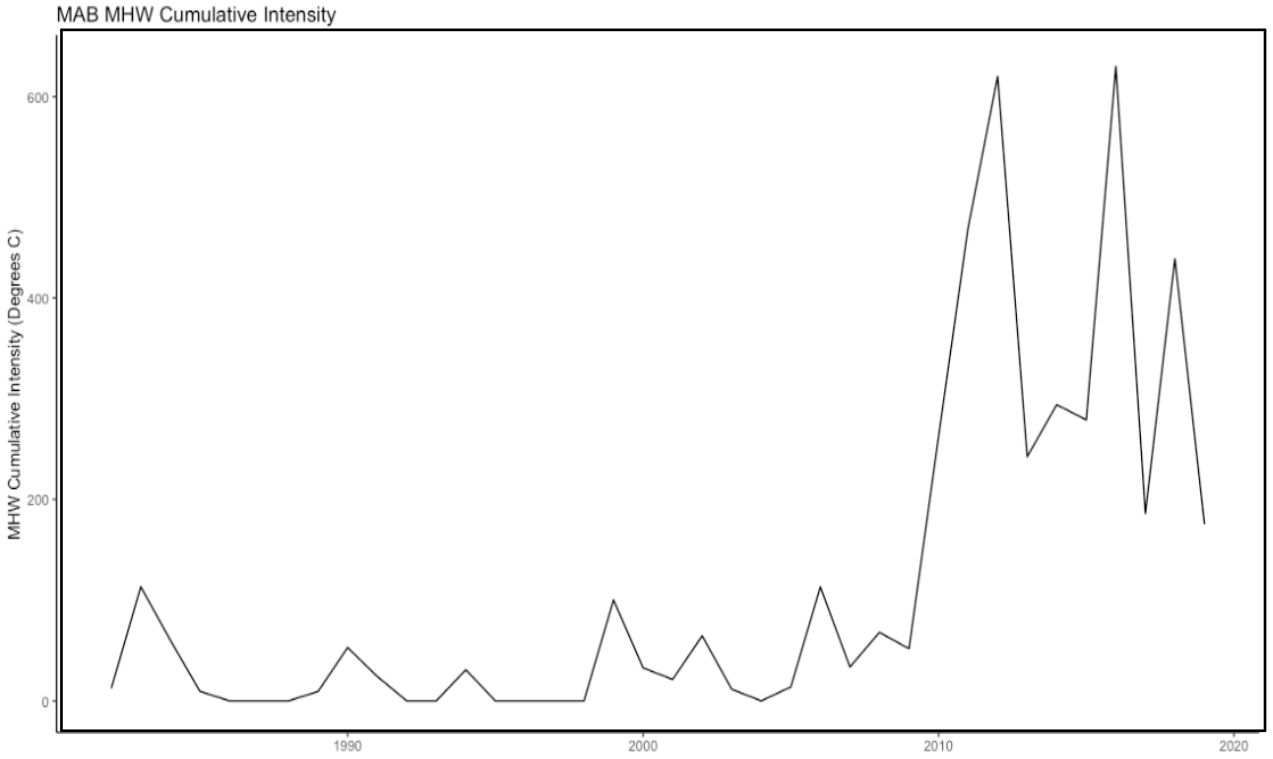
- Rapid change in ecosystem conditions
  - can have cascading effects across trophic levels
  - Globally – 33% reduction in space with no MHW
  - In 2012 the Gulf of Maine had a 132 day long MHW

PRESS AND PULSE DISTURBANCES IN MARINE SYSTEMS

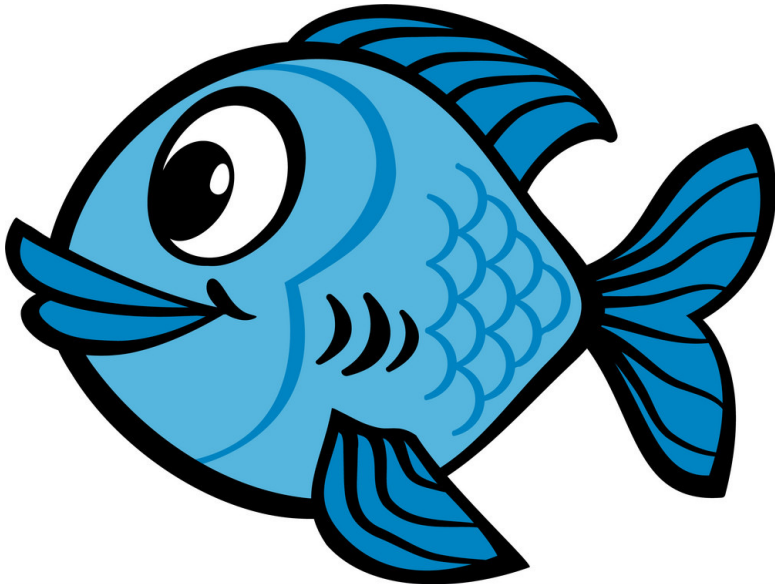
PRESS



PULSE

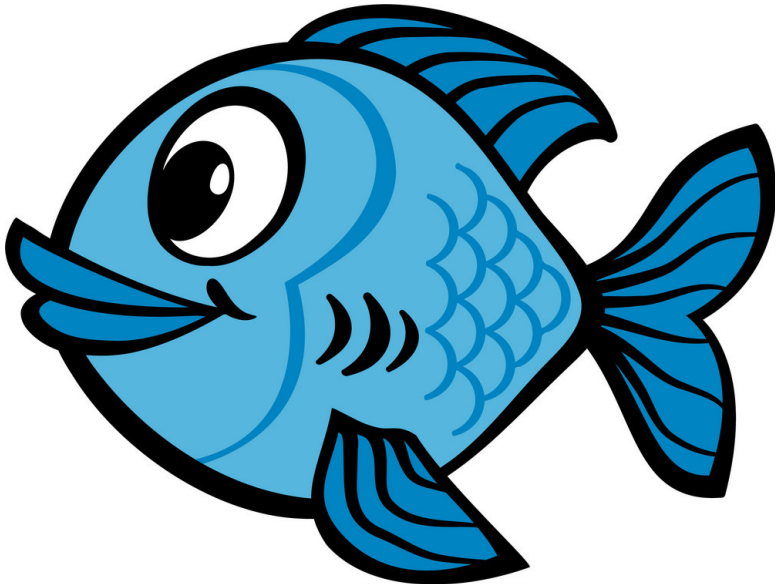


EXPANDING BEYOND OUR SINGLE SPECIES FRAMEWORKS



How is THIS species responding to these changes?

EXPANDING BEYOND OUR SINGLE SPECIES FRAMEWORKS



How is THIS species responding to these changes?

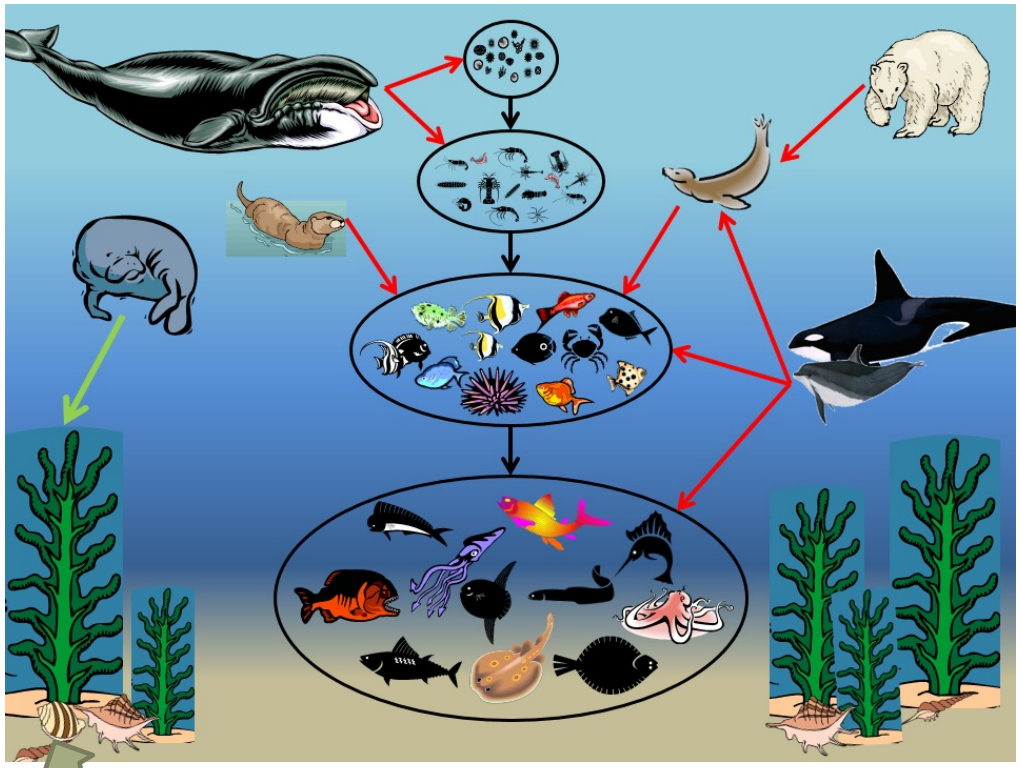
Nothing happens in isolation

INTERACTIONS SHAPE SPECIES RESPONSES

Communities : interacting group of species in a common location

Factors that impact species response

- **Predators**
- **Food sources**
- **Habitat viability**
- **Temperature preference**



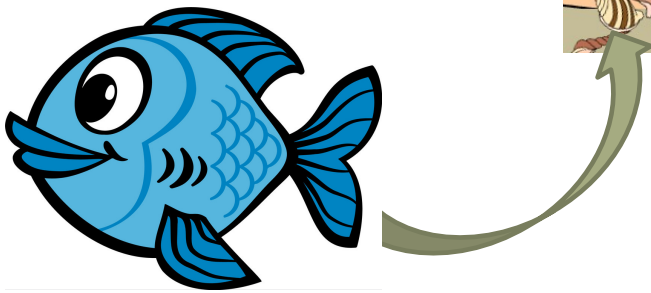
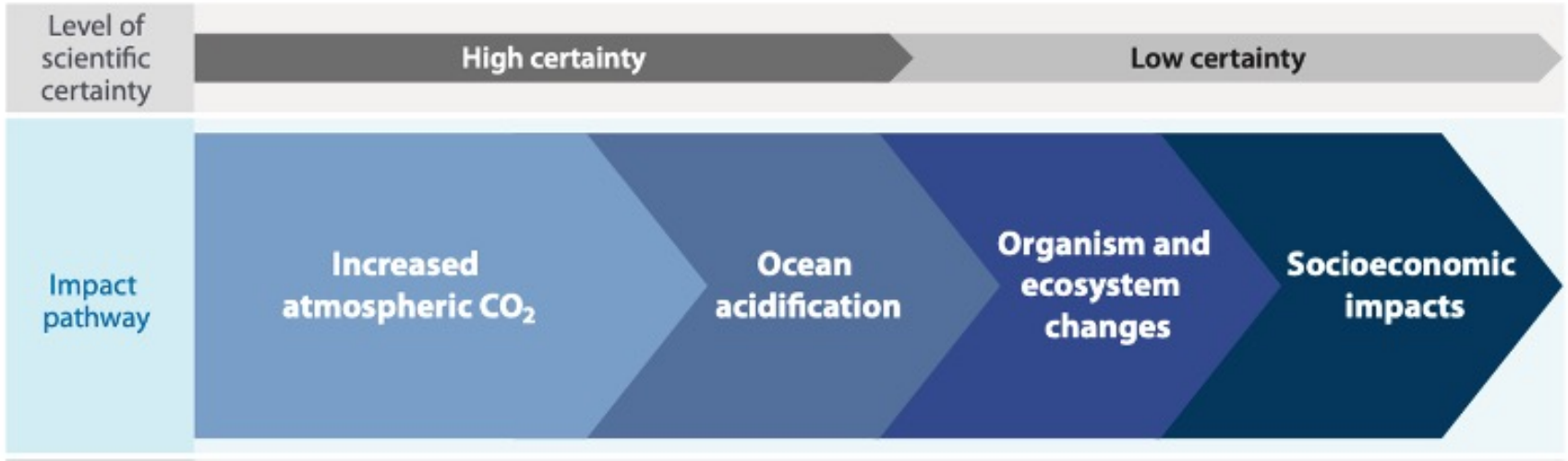


Image courtesy of Woods Hole Sea Grant

ECOSYSTEM CHANGE INFORMS ADAPTIVE CAPACITY



Adaptive capacity:
just-in-time measures, disaster risk reduction, planning for uncertainty

Figure modified from Gatusso et al. 2014 and Doney et al. 2020

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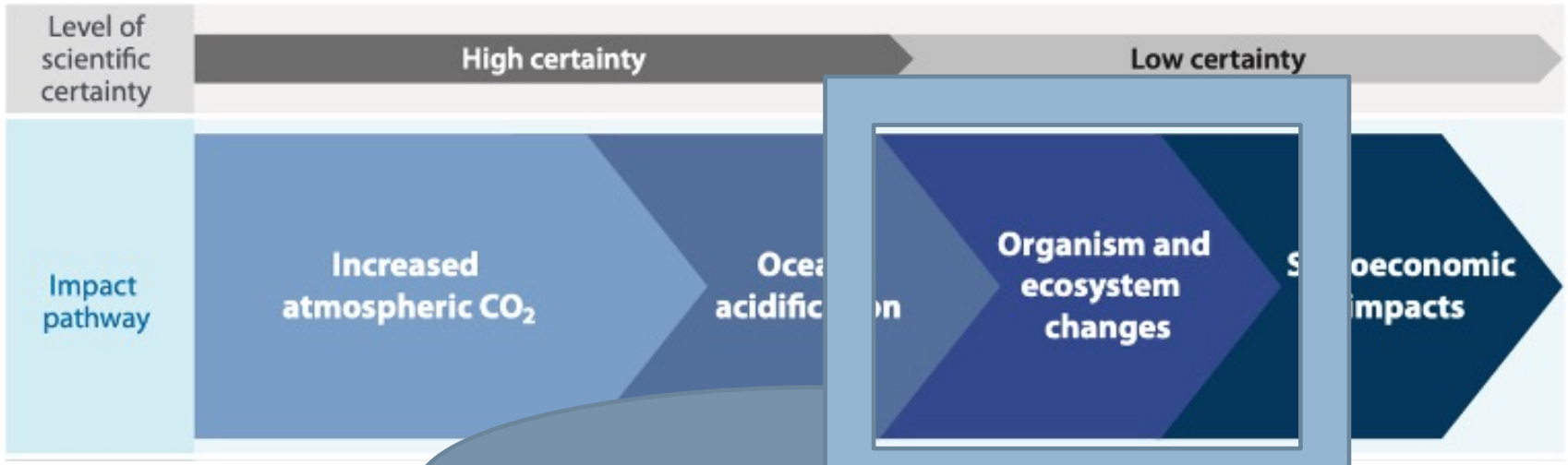
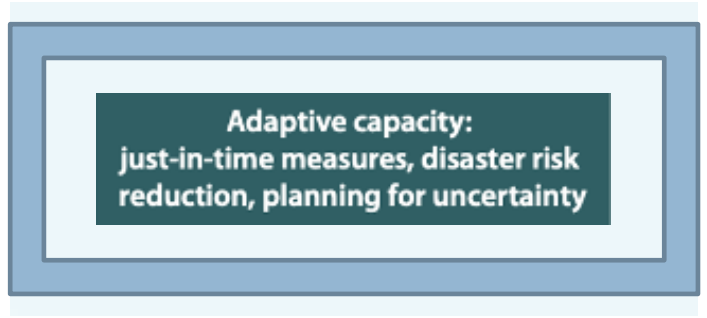




I. Quantifying and visualizing community change

II. Exploring the drivers of change

III. Investigating application to community dynamics

Figure modified from Gatusso et al. 2014 and Doney et al. 2020

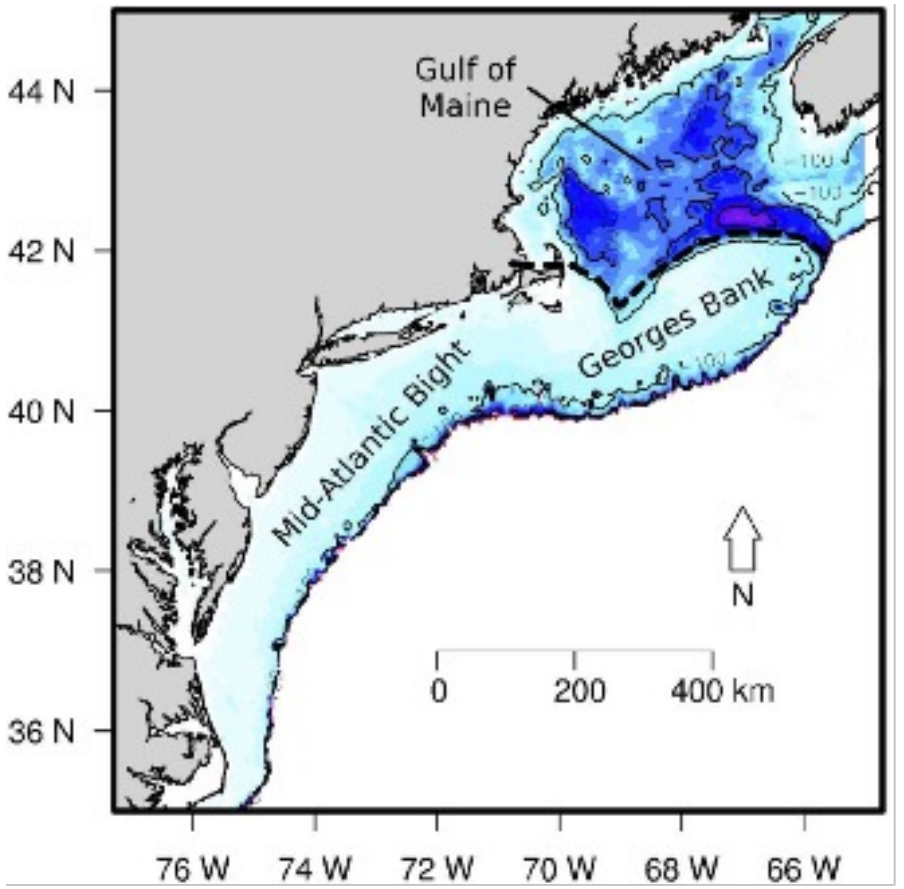
OUTLINE OF RESEARCH

Exploring drivers of community change

How does the effect of pulse and press disturbances differ?

STUDY SYSTEM: NE US LARGE MARINE ECOSYSTEM

- Ocean warming hotspot
- High variability in oceanographic conditions
  - EPU's defined by variables in 3 categories:
    - Physiographic
    - Oceanographic
    - Biotic
- Long term coverage of data
- 76 species included in analysis to create annual community observation



Exploring drivers of change

Press disturbances: Do long term pressures shape community structure?

Pulse disturbances: Are short term intense events impacting community change?

Exploring drivers of change

Press disturbances significantly impact community dynamics

Pulse disturbances do not restructure community as expected

Exploring drivers of change

Press disturbances significantly impact community dynamics

Pulse disturbances do not restructure community as expected

- Long term press stressors have a significant influence on community structure and dynamics
  - Fishing pressures
  - Rising temperatures
- Species are responding and adapting to multi-generational stress over time
  - Cumulative impacts shifting in favor of some species over others

Lucey & Nye 2010, Jentsch & White 2019, Brander 2010, Jennings & Brander 2010

Exploring drivers of change

Press disturbances significantly impact community dynamics

Pulse disturbances do not restructure community as expected

- Analyses do not demonstrate significant influence of MHW events on community-level variability
- The immediate ecosystem restructuring impacts of MHW pulse disturbances anticipated were not seen
- The connectivity of the marine system can contribute to higher levels of functional redundancy → higher opportunity for recovery of system services and interactions

Hillebrand & Kunze 2020, Yachi & Loreau 1999, Cottingham et al. 2001, Hautier et al. 2014

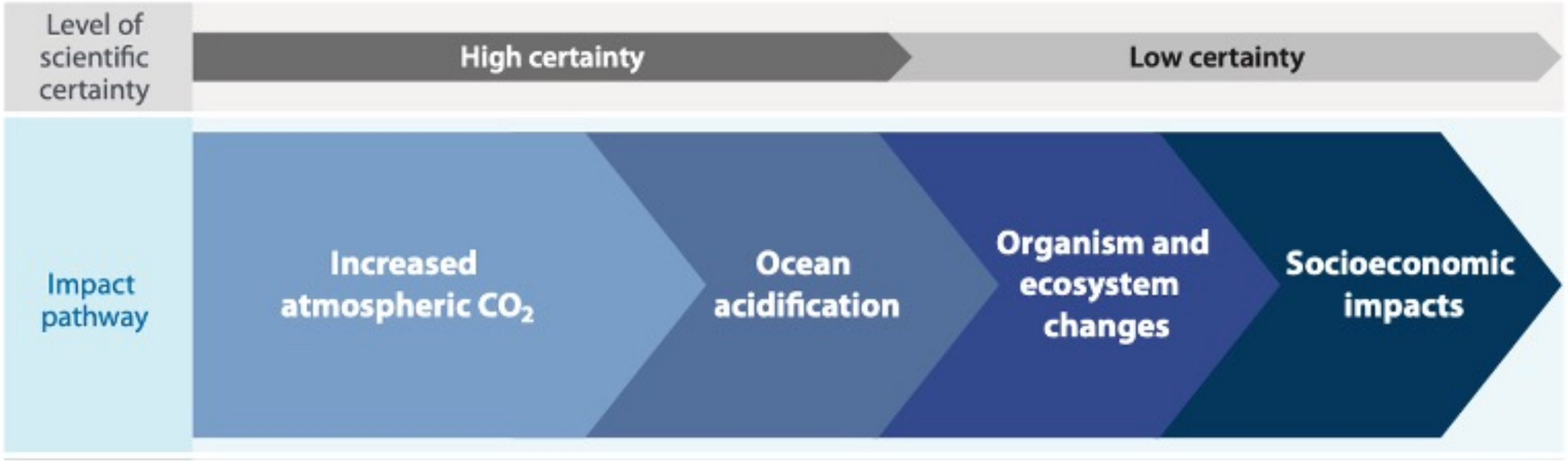
Functional recovery > compositional recovery

Leads to overall resilience

- Connectivity of system
- Scale of analysis

Resource consumer interactions may drive community interactions

- Mobile consumers
- Generalist behaviors
- “tolerator strategy”



IMPROVING OUR MANAGEMENT STRATEGIES REQUIRES ECOSYSTEM CHANGE

- Empirical applications to detect and understand abrupt shifts are limited
- Improve our predictive models with better understanding of community change
- Moving forward → Explore application similarly in multiple ecosystems

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  - Micah Floyd

"If I have seen further, it is by standing on the shoulders of giants."

To my village, my mentors, my friends – my many giants – thank you for your endless support in this endeavor. I would not be here without you.

QUESTIONS?

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