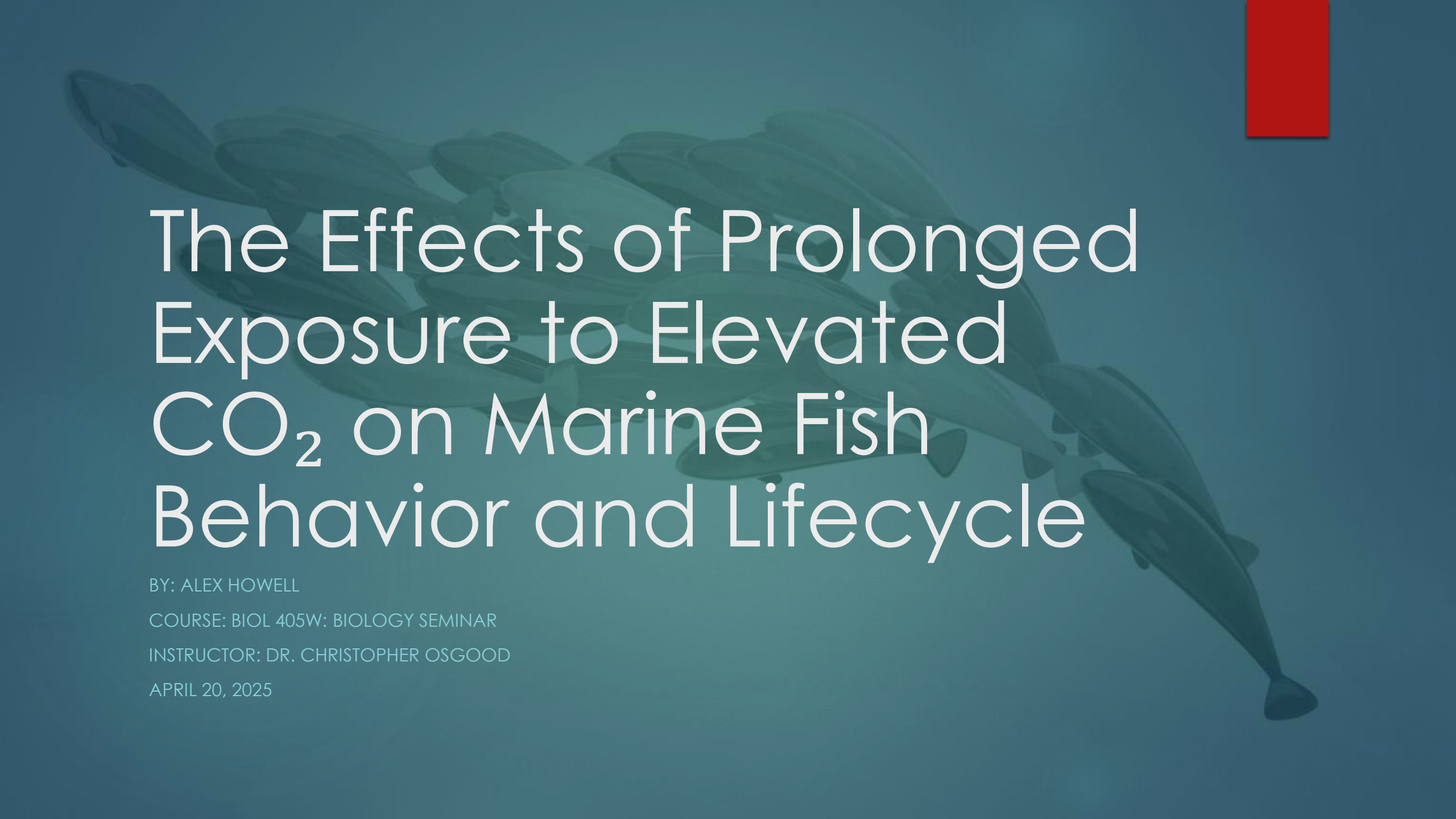

The Effects of Prolonged Exposure to Elevated CO_2 on Marine Fish Behavior and Lifecycle

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COURSE: BIOL 405W: BIOLOGY SEMINAR

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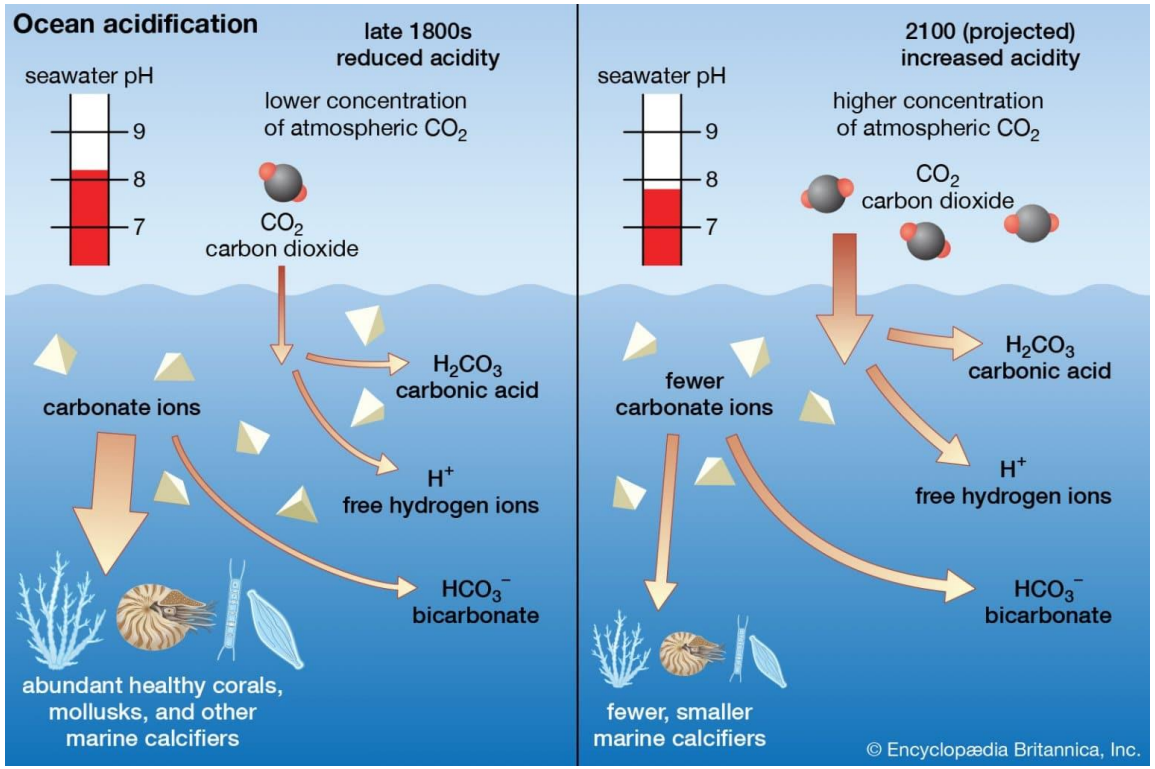
APRIL 20, 2025

Introduction

- Ocean acidification is driven by rising atmospheric CO_2
- Alters water chemistry and disrupts marine ecosystems
- Fish are particularly affected: behavior, physiology, lifecycle
- This study explores behavioral and physiological impacts, migration shifts, and adaptation

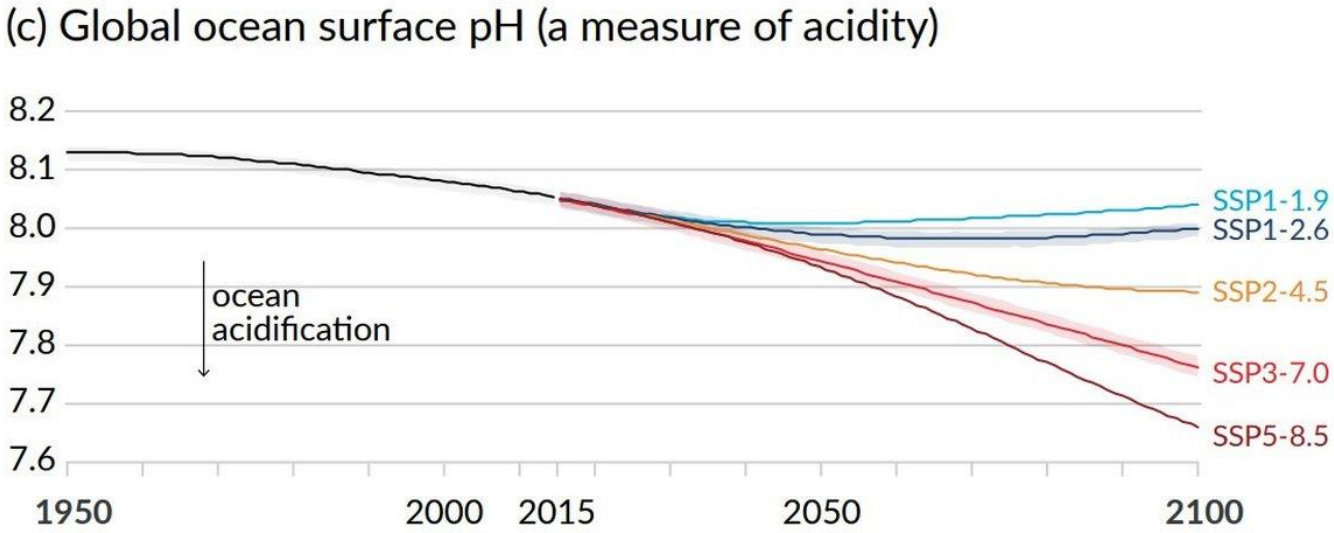
Mechanism of Ocean Acidification

- $CO_2 + H_2O \rightarrow$ carbonic acid $\rightarrow$ lowers pH
- Ocean pH has already dropped ~0.1 units; more decline expected
- Reduced carbonate ion availability affects calcifying organisms
- Disrupts food webs and ecosystem stability



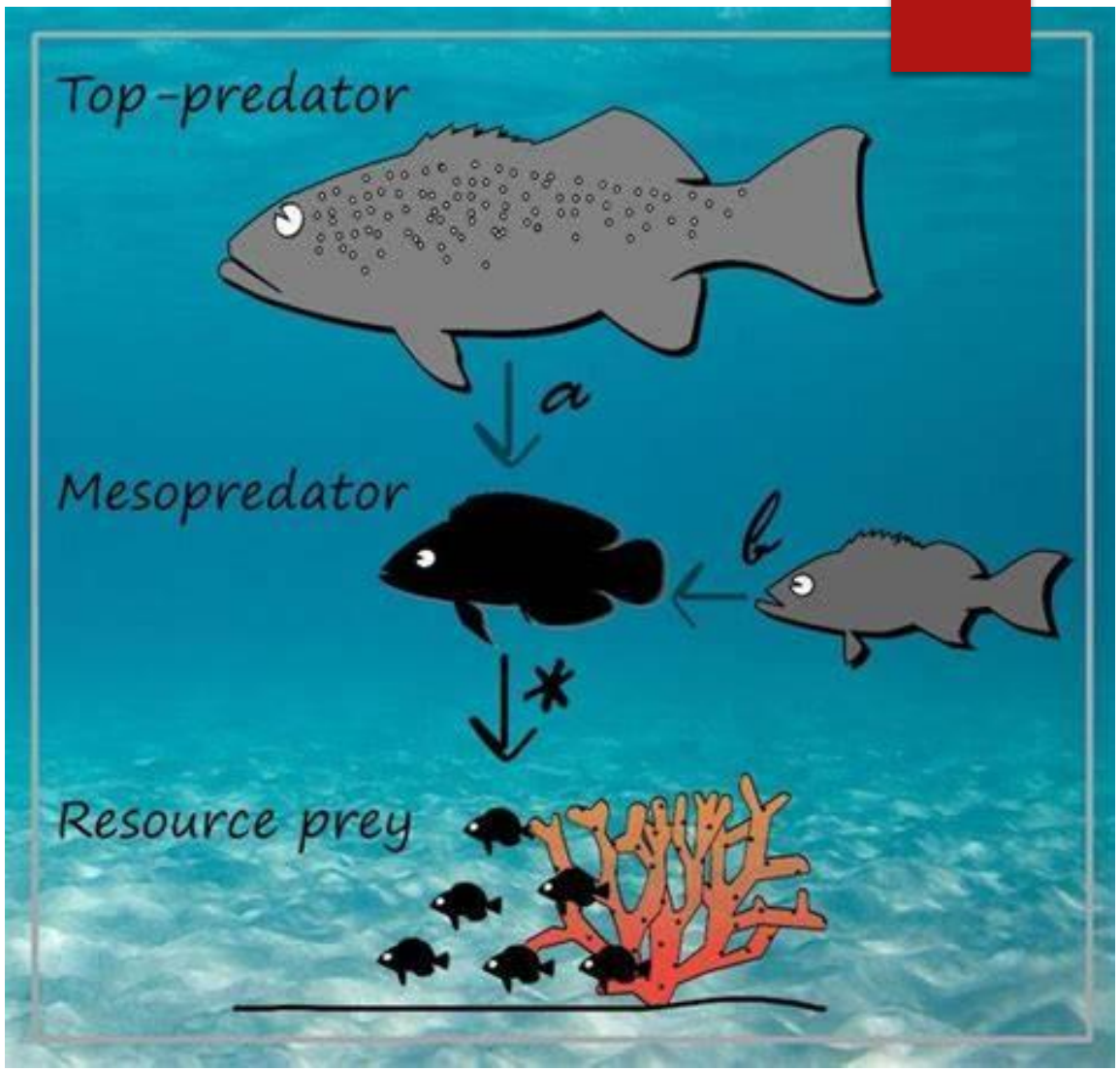
Ecological Implications

- Species-level to ecosystem-level disruptions
- Affects gene expression, survival rates (Mandal & Baag, 2022)
- Predictive modeling suggests major future shifts



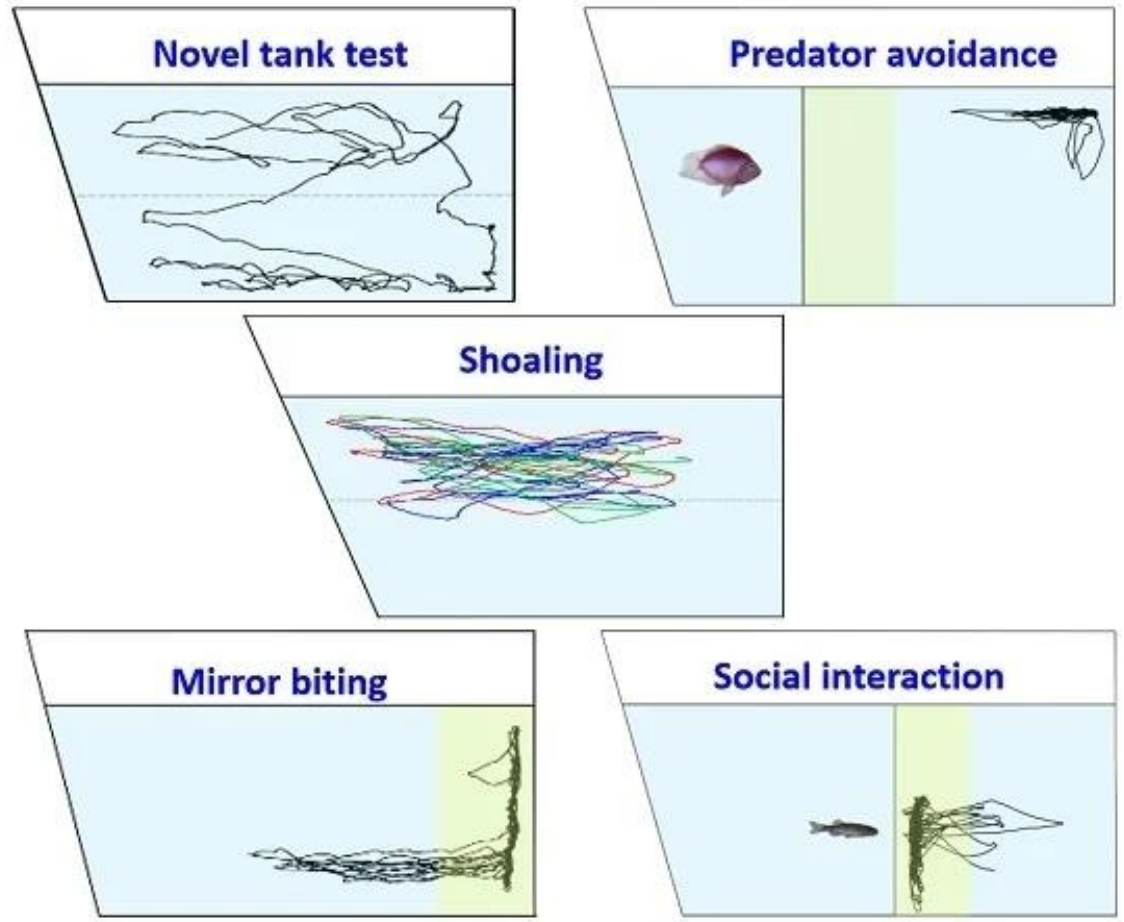
Behavioral Changes in Marine Fishes

- Observed behaviors: boldness, impaired predator detection, altered foraging
- Linked to neurotransmitter function disruption under CO_2 exposure
- Initial findings now moderated by recent analyses



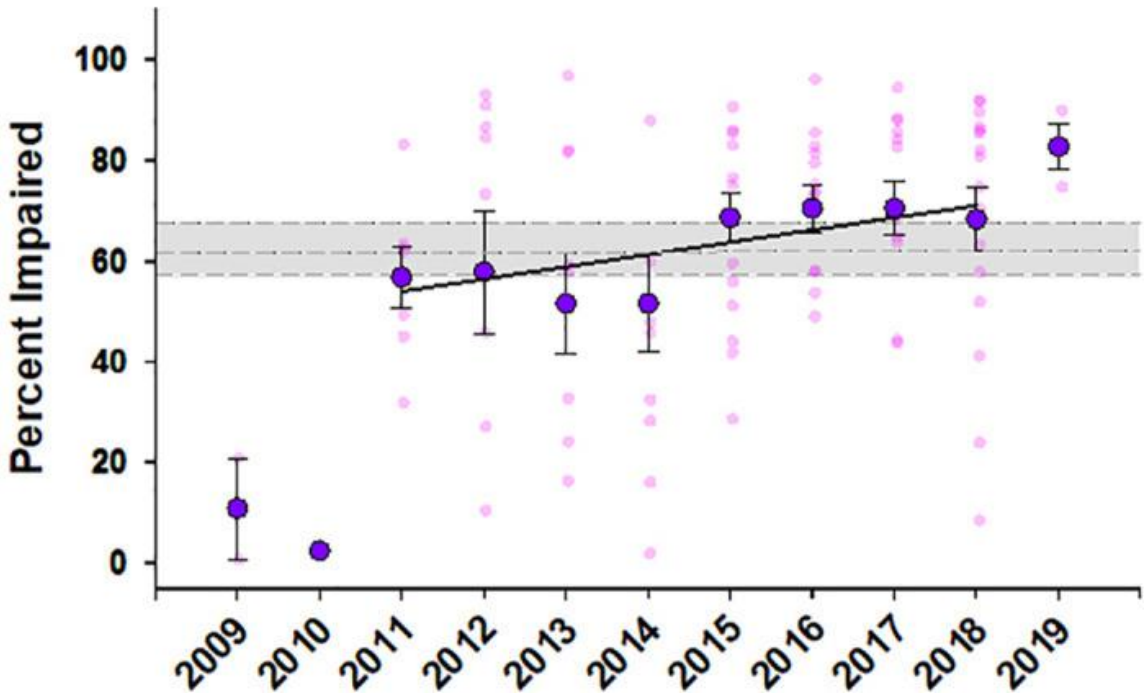
In-Lab Behavioral Studies

- Radford et al. (2021): Auditory cues under high CO_2, reduced predator response
- Spatafora et al. (2022): Goby behavior largely stable under chronic exposure
- Results vary by species; long-term studies needed



The “Decline Effect”

- Clements et al. (2022): Meta-analysis revealed overestimated behavioral changes
- Importance of using larger datasets and refined methodologies
- Critical reevaluation strengthens future findings

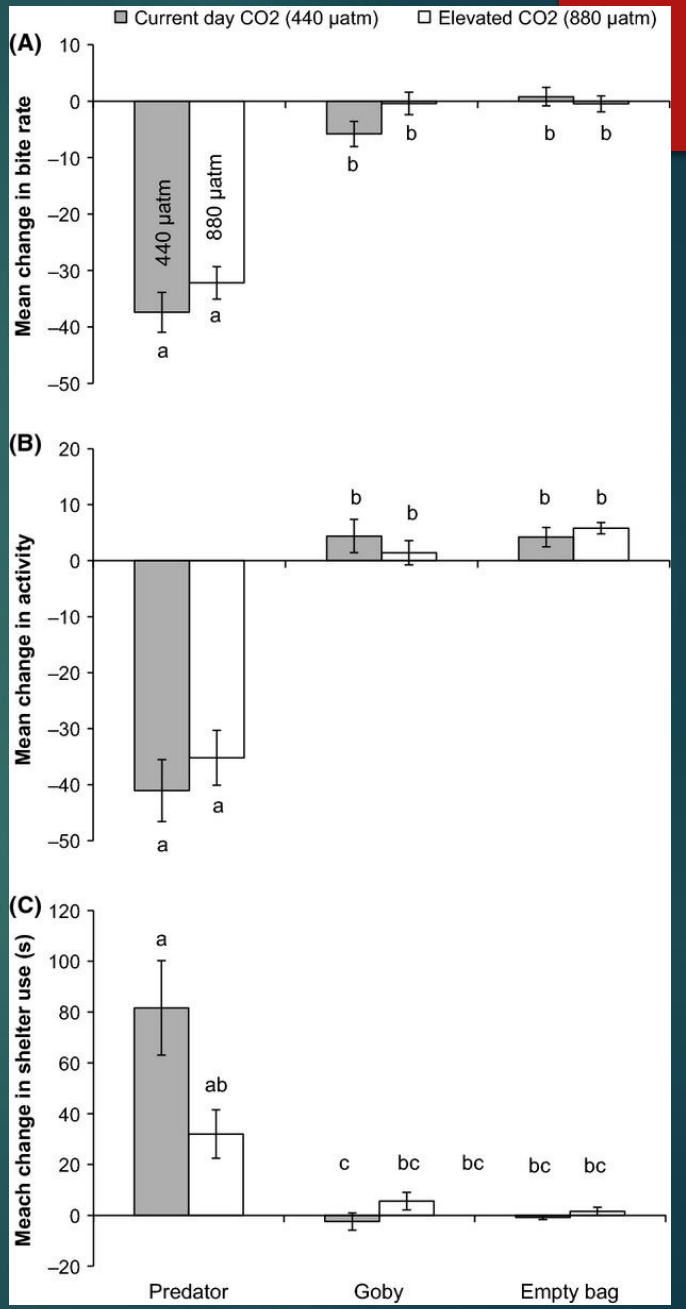


Sensory and Physiological Impairments

Impaired smell, hearing, and communication reduce survival

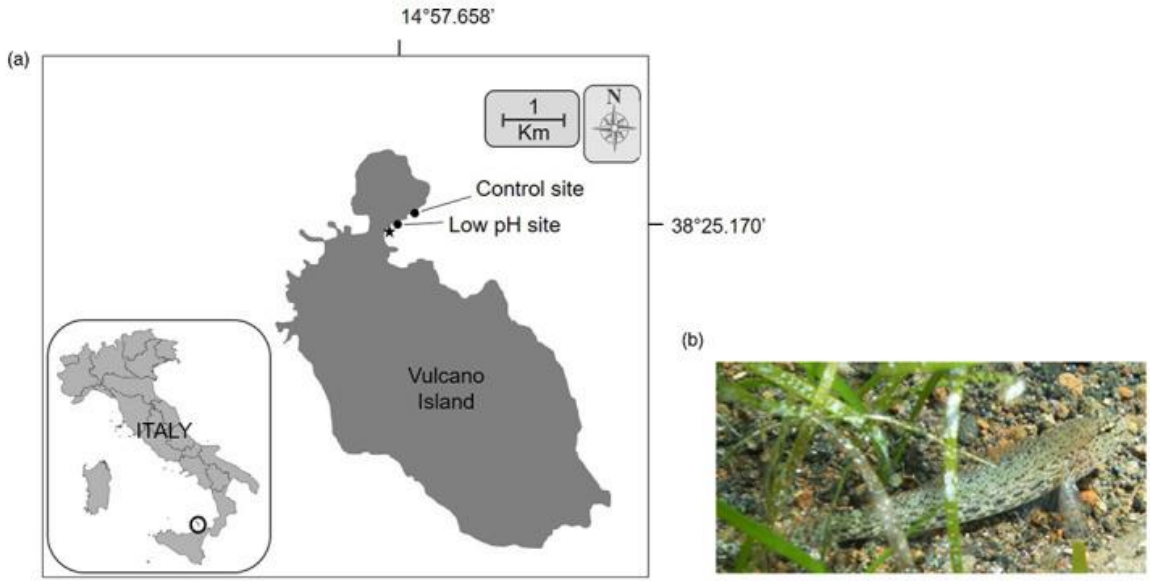
Radford et al. (2021): Controlled playback experiments show auditory loss

Lab-measured metabolic stress and growth changes



Molecular-Level Documentation

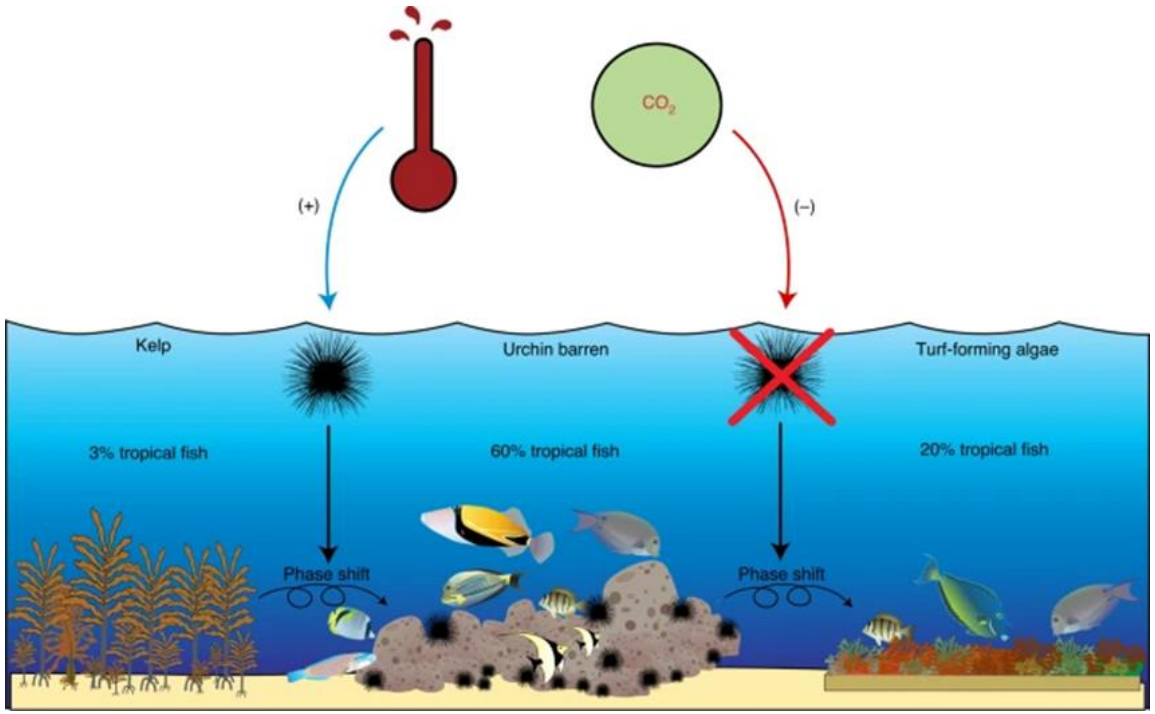
- Suresh et al. (2023): Transcriptome analysis in gobies from CO_2 seeps
- Changes in gene expression linked to stress response and neural function
- Demonstrates physiological adaptation at the molecular level



Suresh et al. (2023)

Migration and Ecosystem Shifts

- "Tropicalization" of temperate waters disrupted
- Acidification limits reef habitat availability
- Coral degradation reduces support for diverse reef fish
- (Coni et al., 2021; Hill & Hoogenboom, 2022)



Coni et al. (2021)

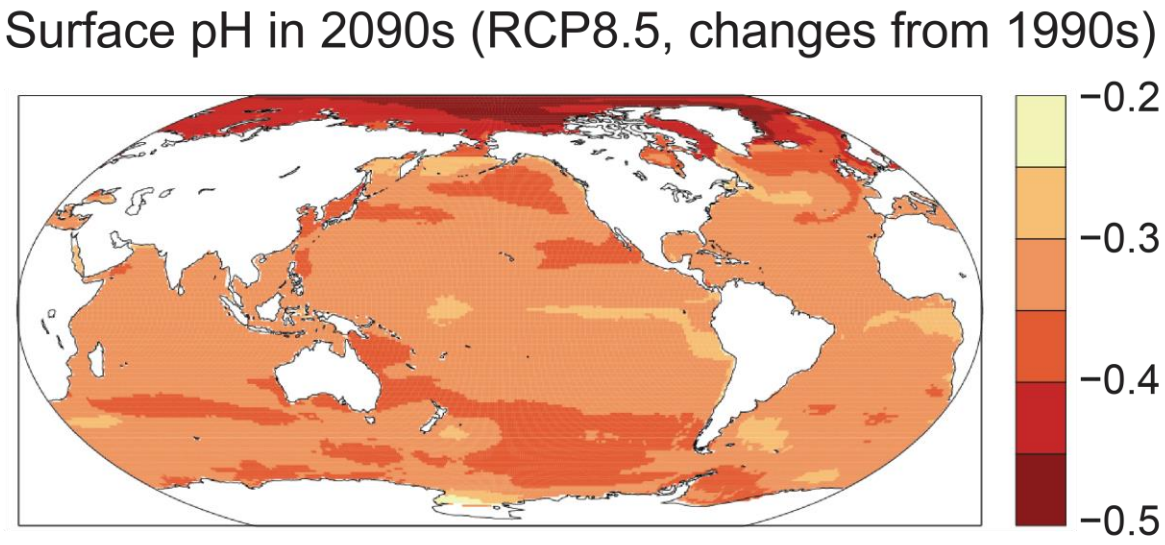
Natural CO_2 Seeps and Adaptation

- Fish in seeps exposed to high CO_2 over generations
- Adaptive traits observed: reduced behavioral change, altered gene expression
- Spatafora et al. (2022), Petit-Marty et al. (2021)

Hill et al. (2022)

Predictive Modeling and Long-Term Outlook

- Mandal et al. (2022): Modeling population responses and food web dynamics
- Timmers et al. (2021): Coral reef biodiversity shows structural change but not decline
- Need for proactive ecosystem management



Conclusion

- Ocean acidification disrupts fish behavior, physiology, and ecosystem roles
- In-lab experiments and molecular studies reveal mechanisms
- Some species show resilience—key to future biodiversity
- Interdisciplinary research is crucial for conservation planning

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