

Linking Biological and Chemical Observations using Community Science

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Acknowledgements

Partners

Sara Beam (Chesapeake Bay Governor's School)

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Emily Beck (Gunston School)



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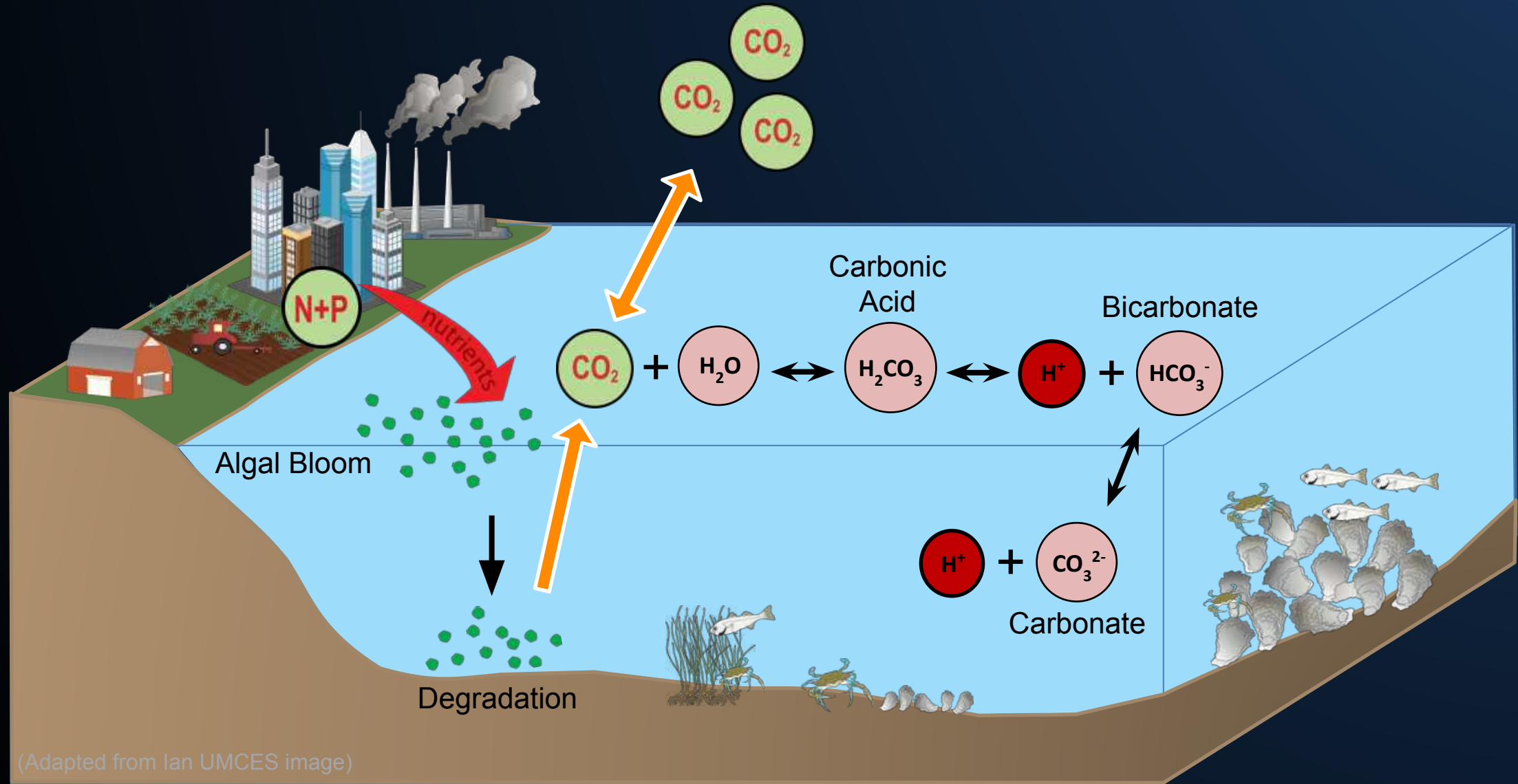
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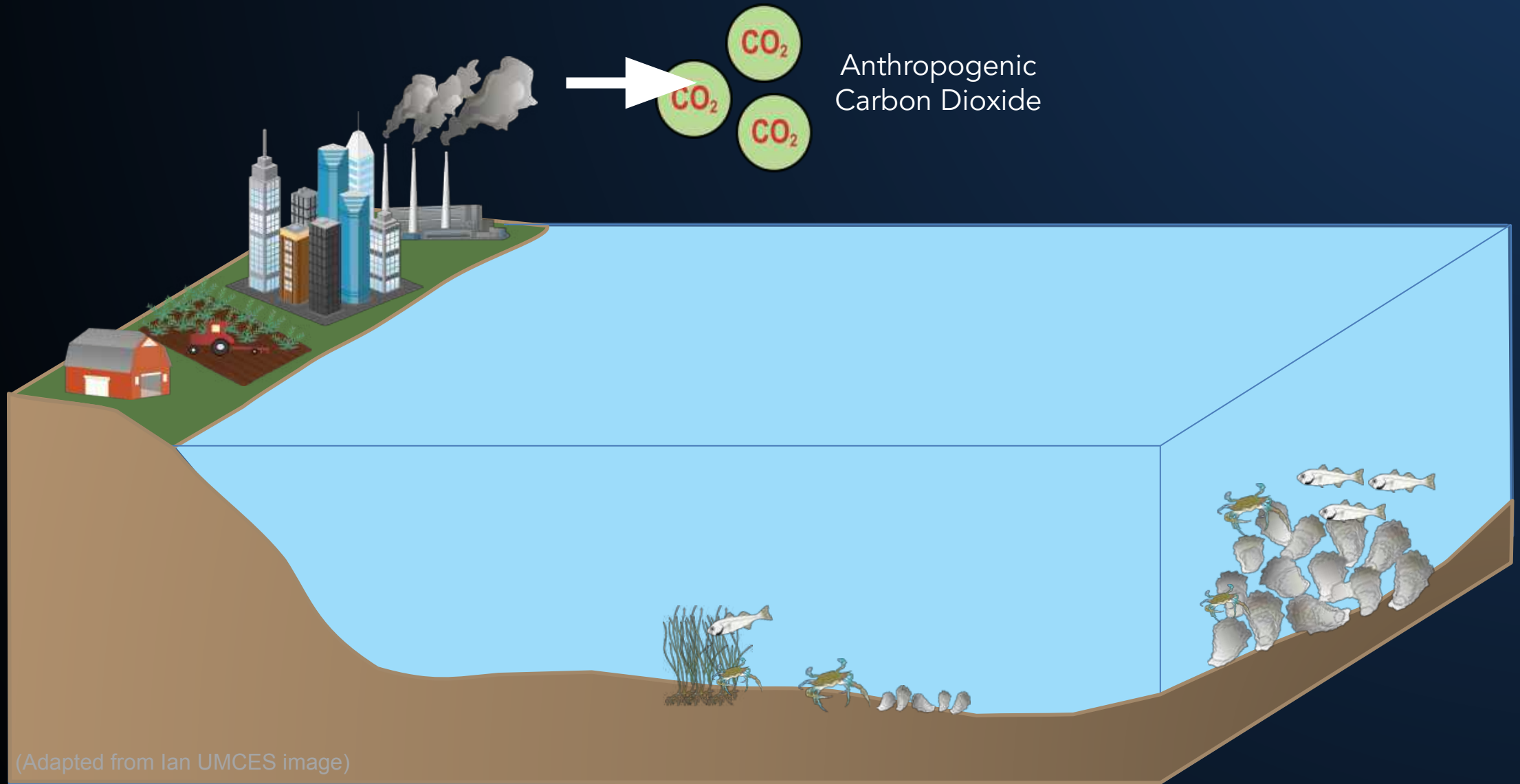
Lauren Wagner, Sarah Grace Lott, Jill Ashley, Sam Biddle, Charnaë Holmes, Natalie Batzel, Kiera Sears, Meredith Nolan, Emma McKee, Margaret O'Connor (W&M), Alexis Putney (ODU)

Ocean and Coastal Acidification

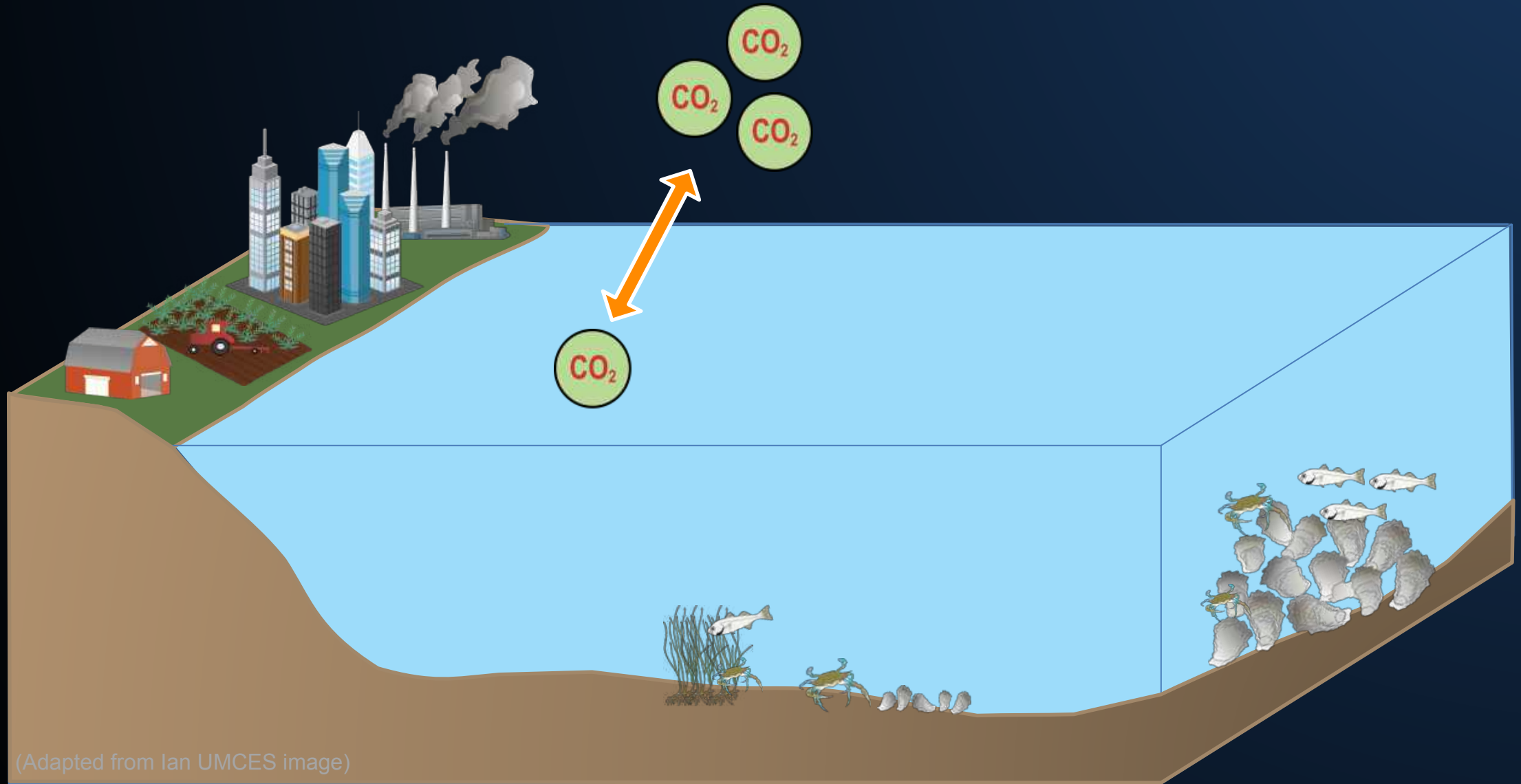


(Adapted from Ian UMCES image)

Ocean and Coastal Acidification

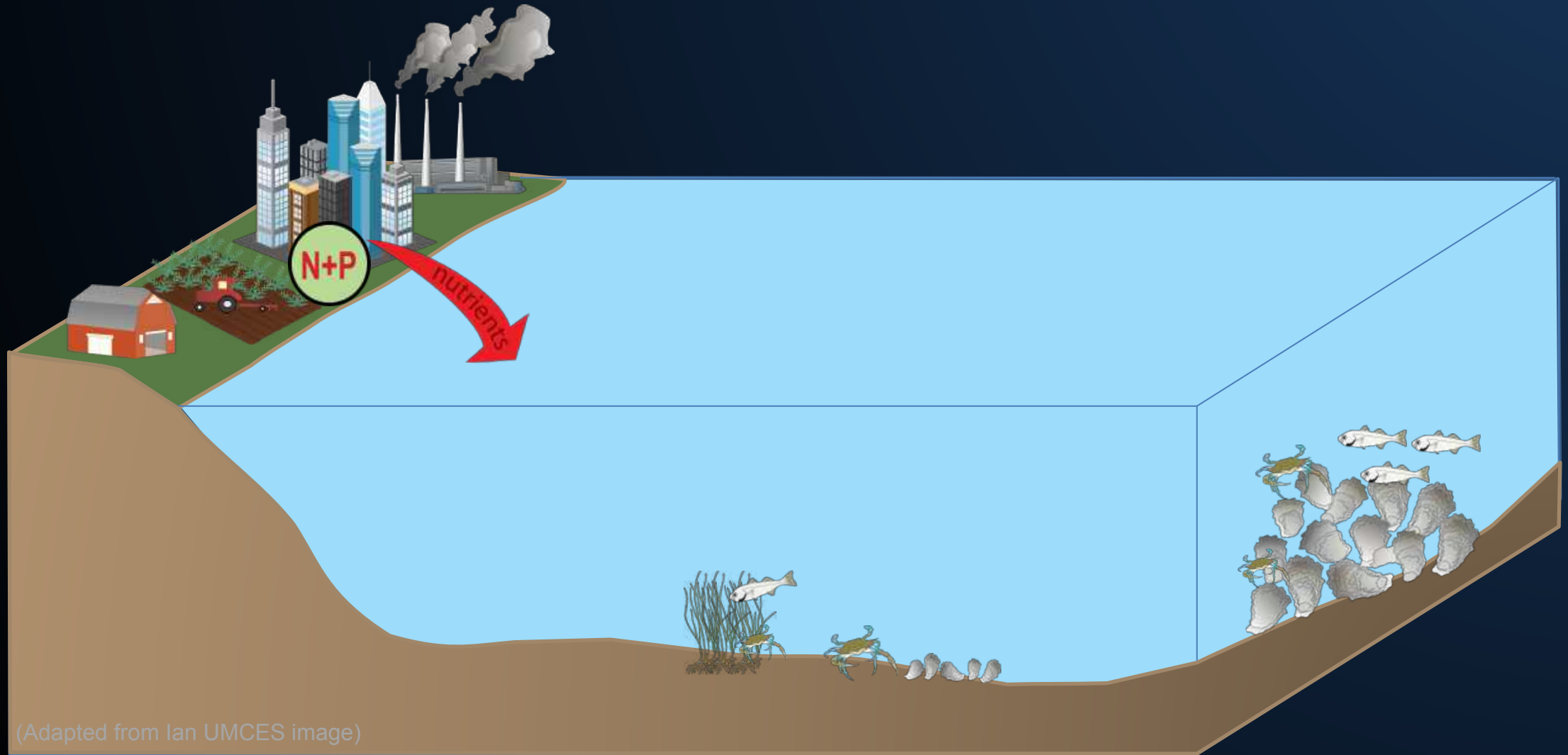


Ocean and Coastal Acidification



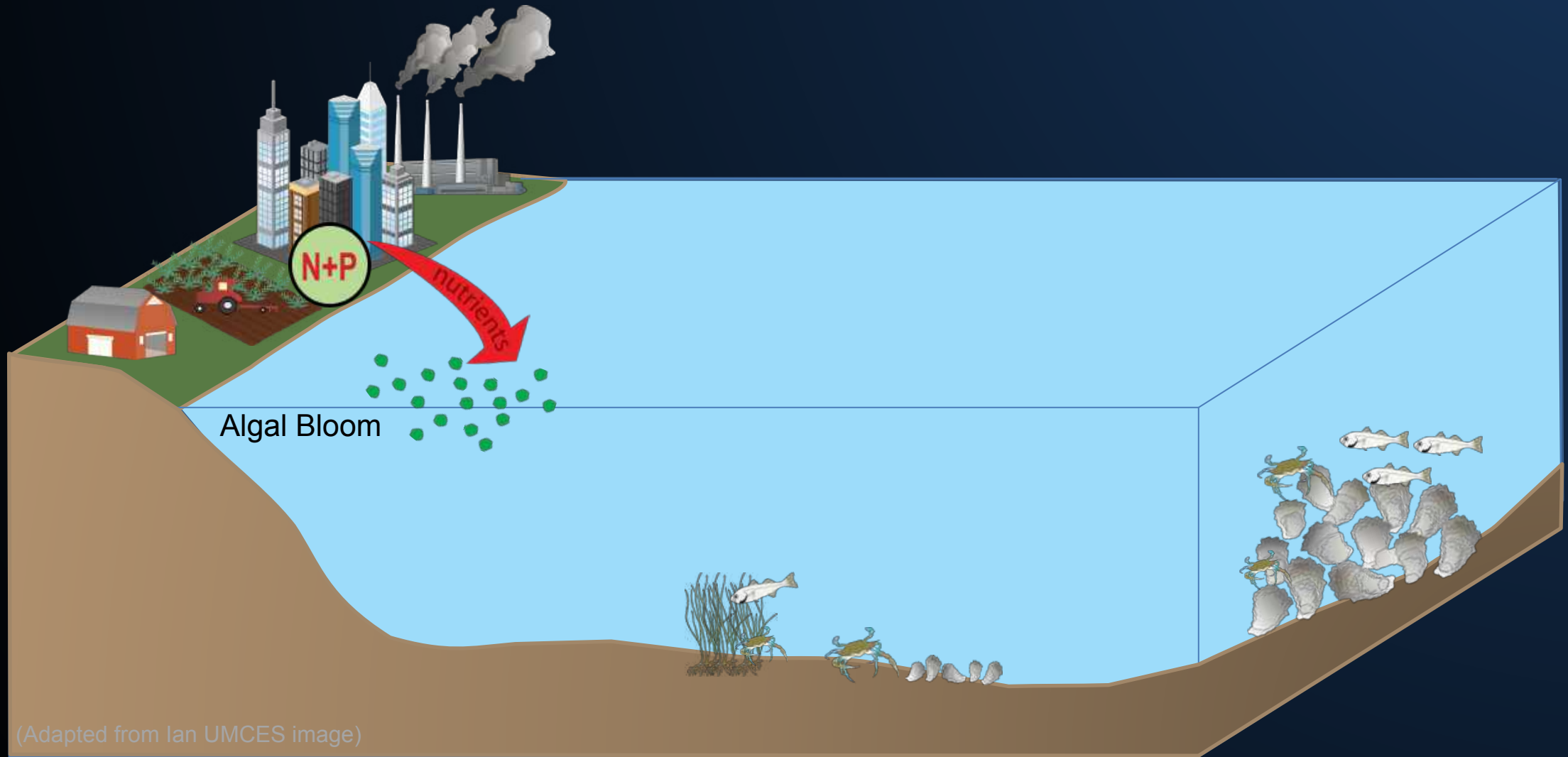
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Ocean and Coastal Acidification



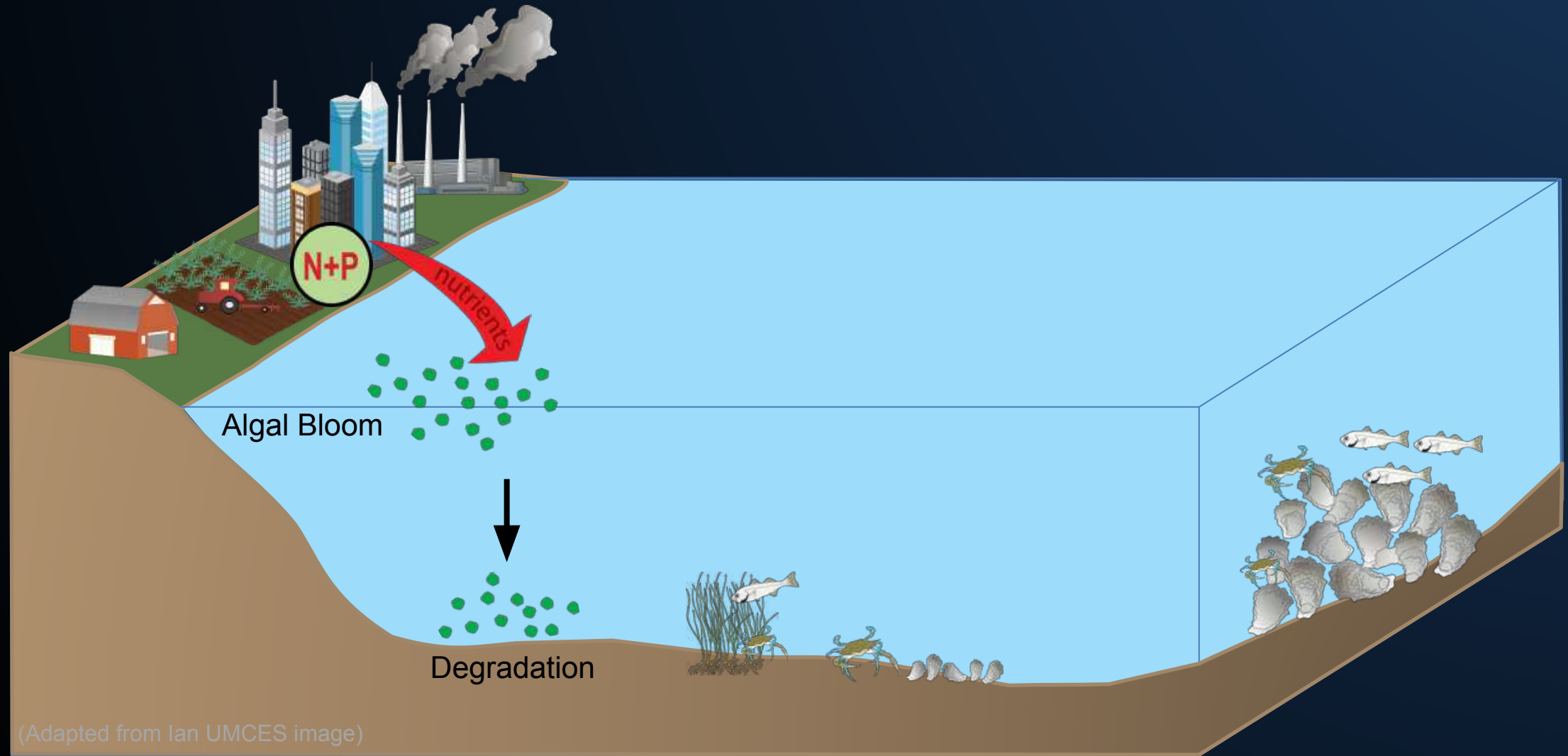
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Ocean and Coastal Acidification



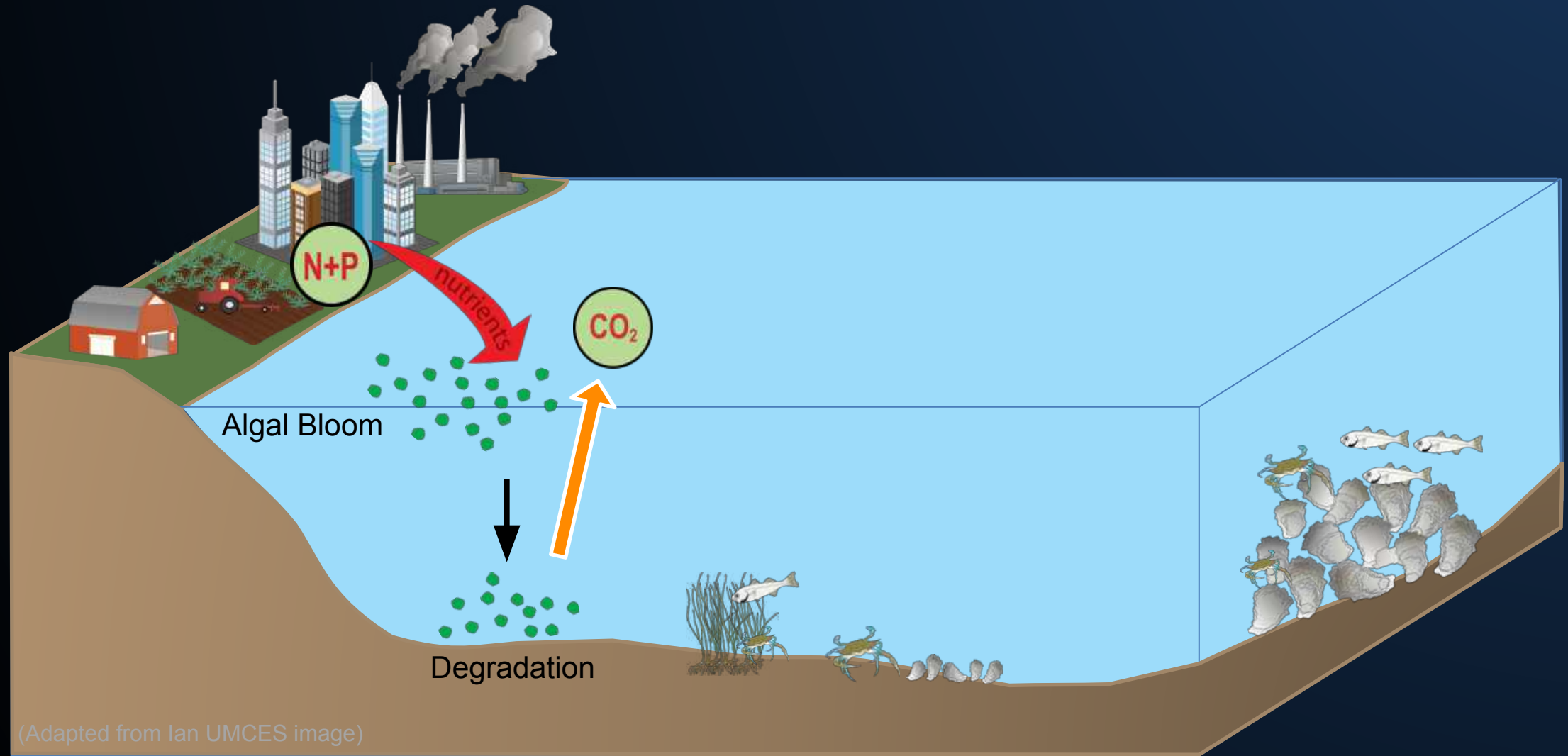
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Ocean and Coastal Acidification



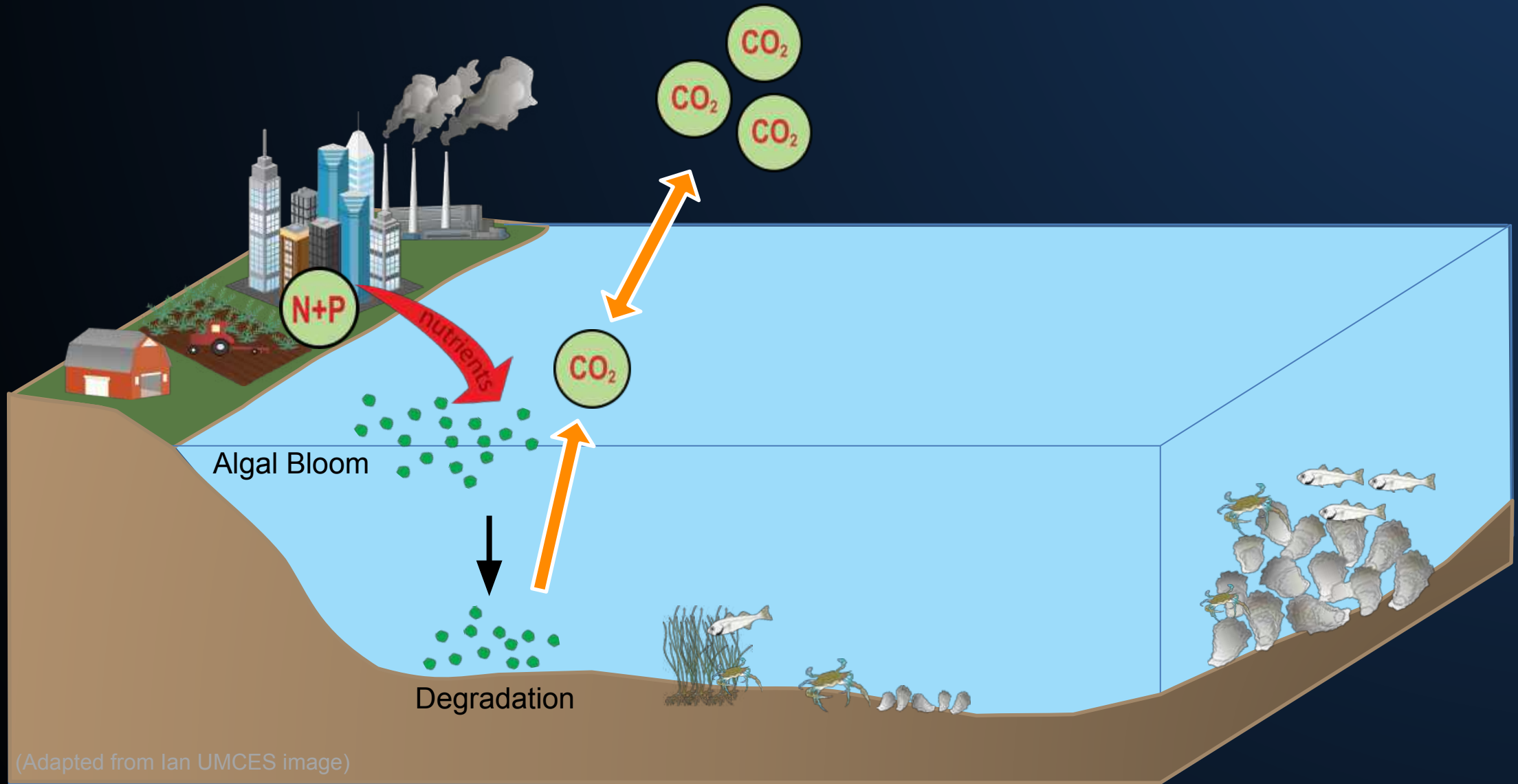
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Ocean and Coastal Acidification



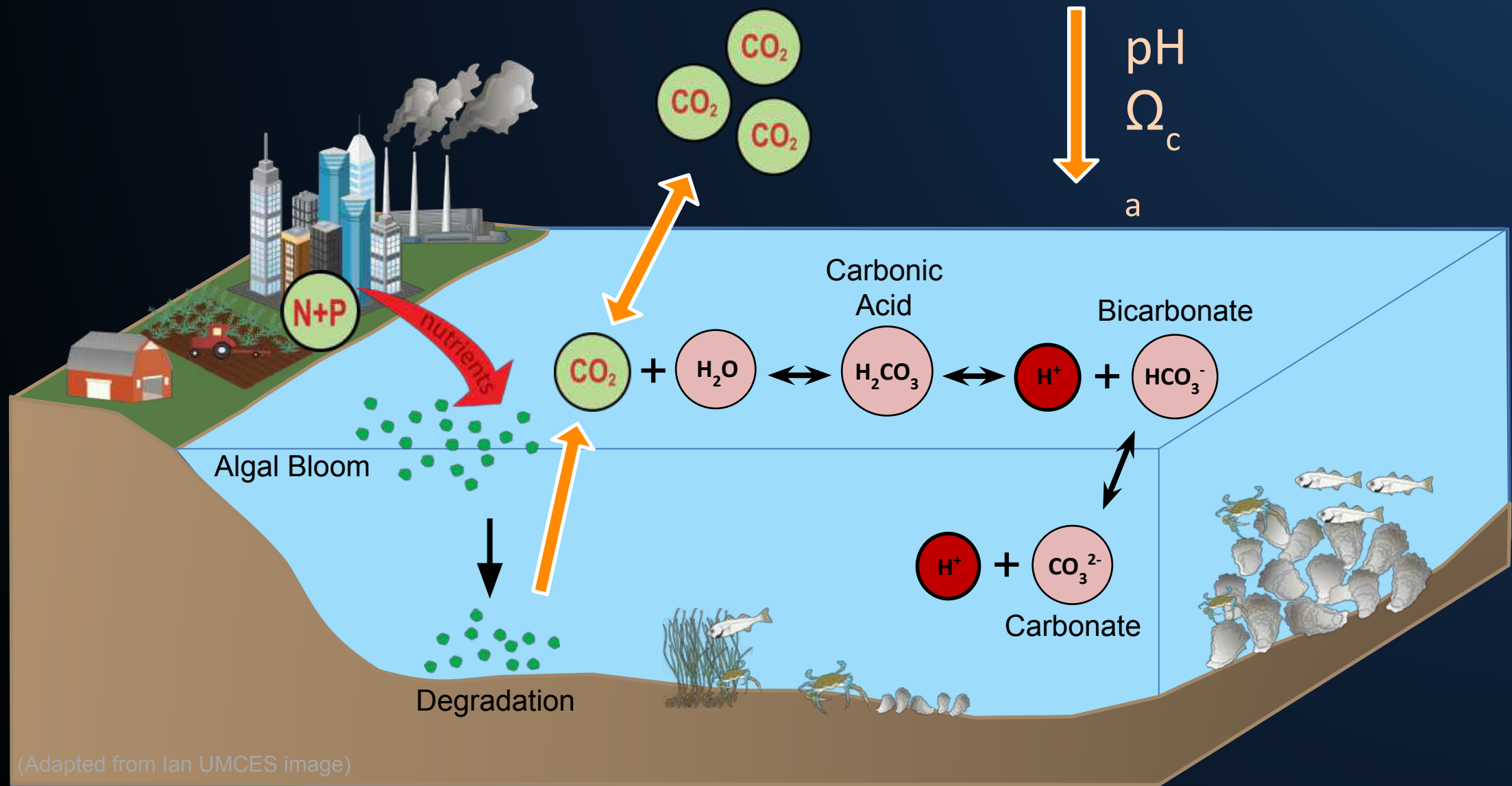
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Ocean and Coastal Acidification



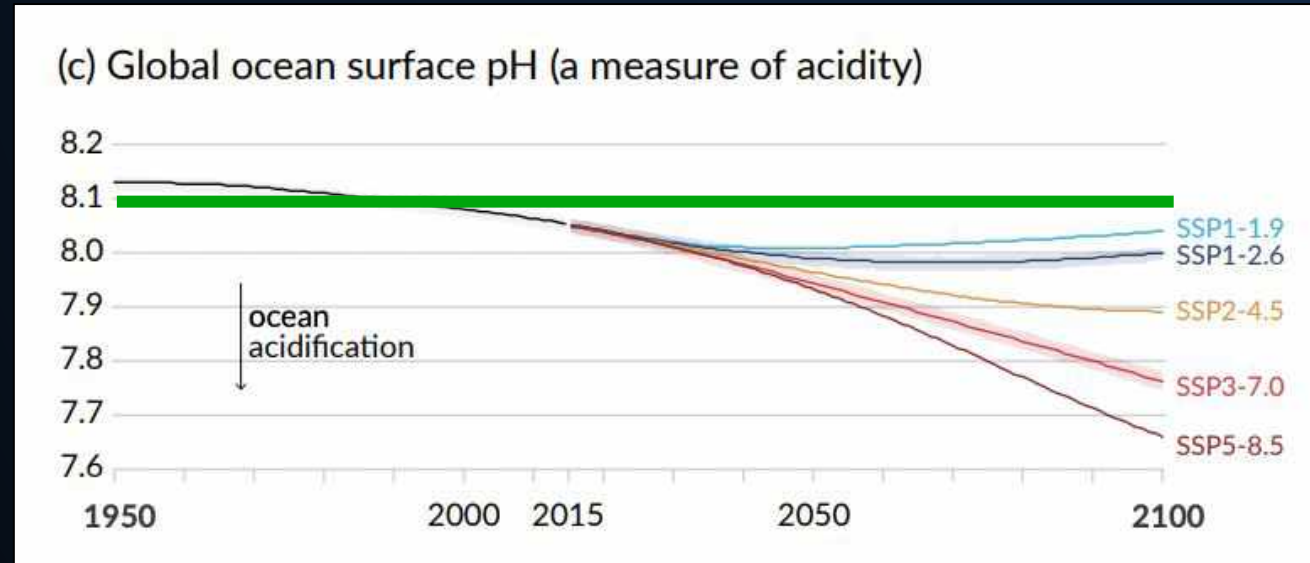
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Ocean and Coastal Acidification



Ocean and Coastal Acidification

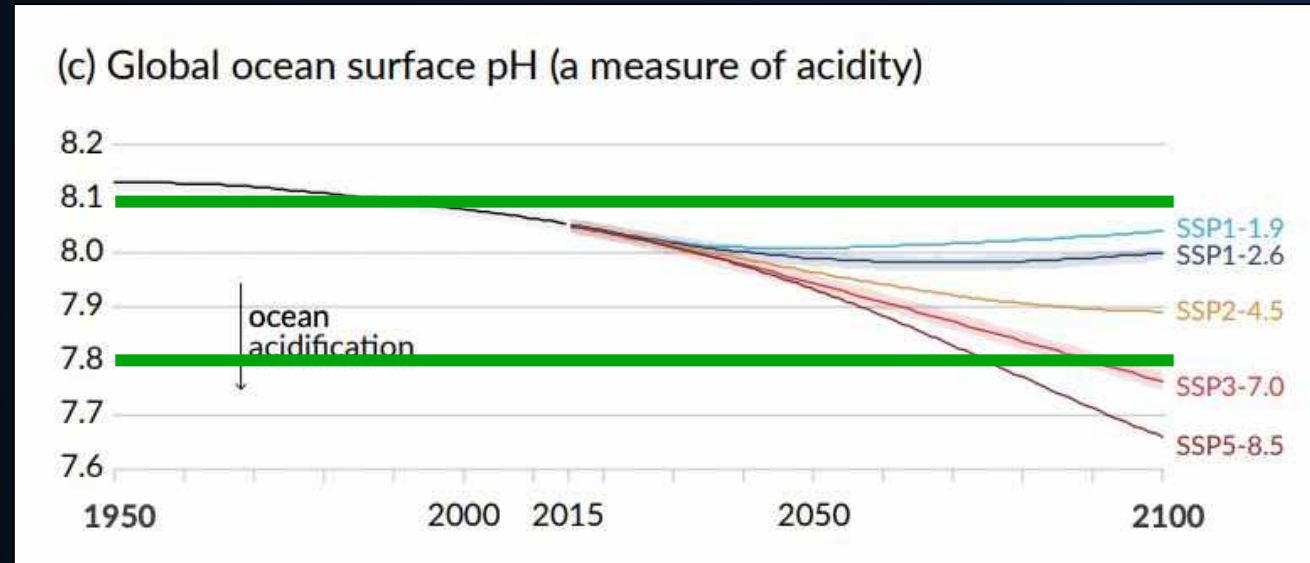
Intergovernmental panel on climate change (IPCC) 2021 report



Average Ocean pH = 8.1

Ocean and Coastal Acidification

Intergovernmental panel on climate change (IPCC) 2021 report

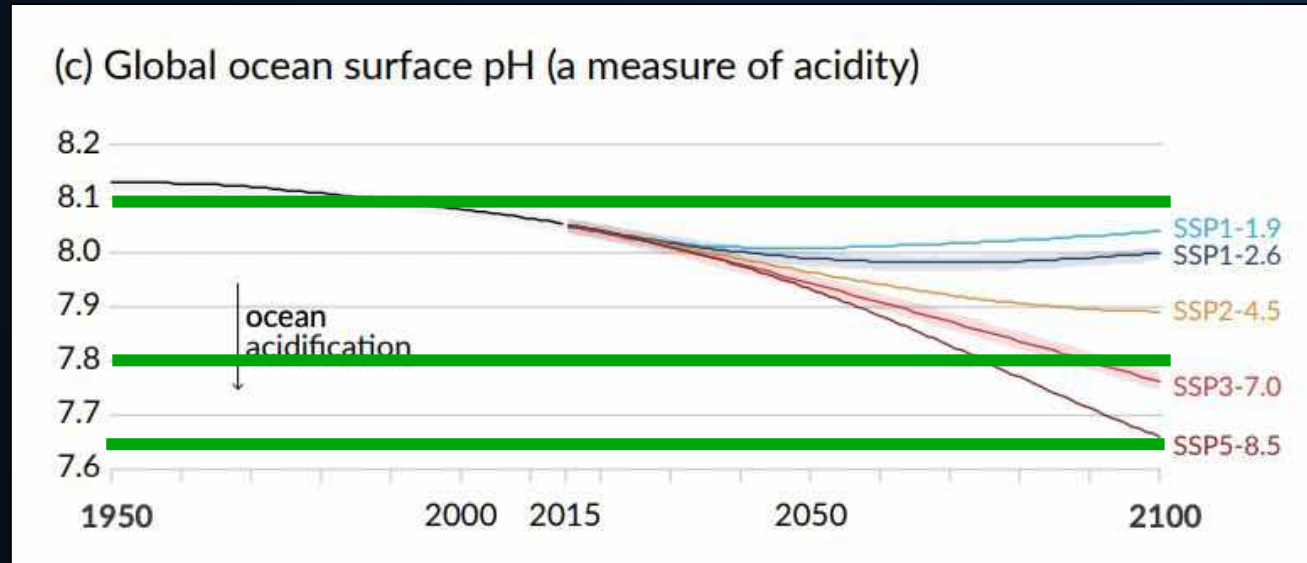


Average Ocean pH = 8.1

Average pH in Chesapeake Bay = 7.8

Ocean and Coastal Acidification

Intergovernmental panel on climate change (IPCC) 2021 report



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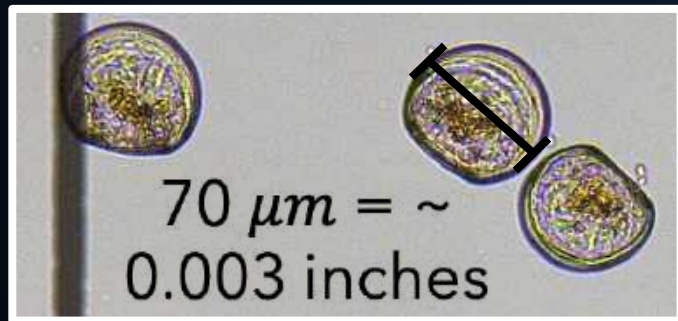
Average pH in Chesapeake Bay = 7.8

Predicted Ocean pH by 2100 = 7.65

Effects of Ocean and Coastal Acidification on Oysters

2-day-old oysters (larvae)

Normal conditions

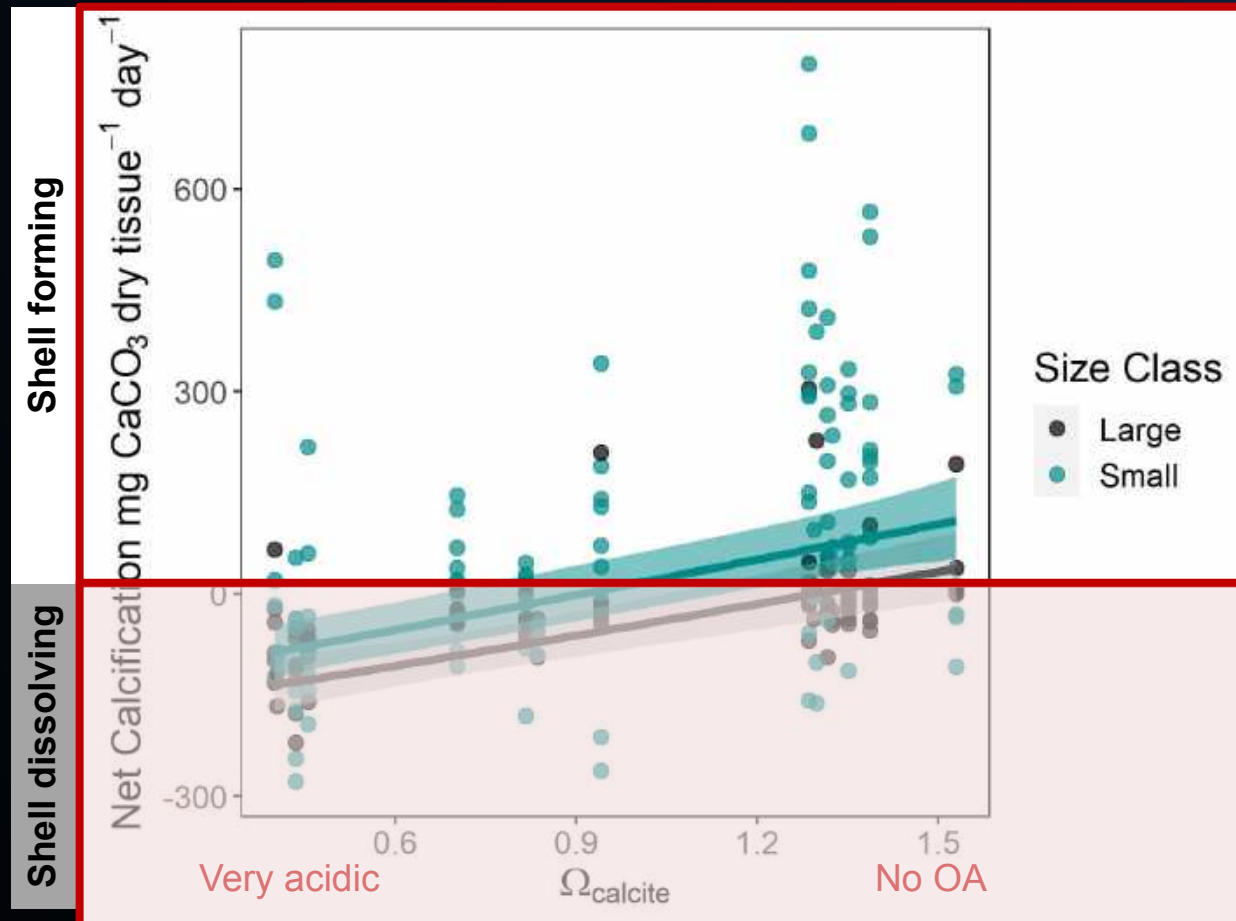


Acidic conditions



Even as early as 2 days-old, we found oysters in acidic waters had smaller and more deformed shells

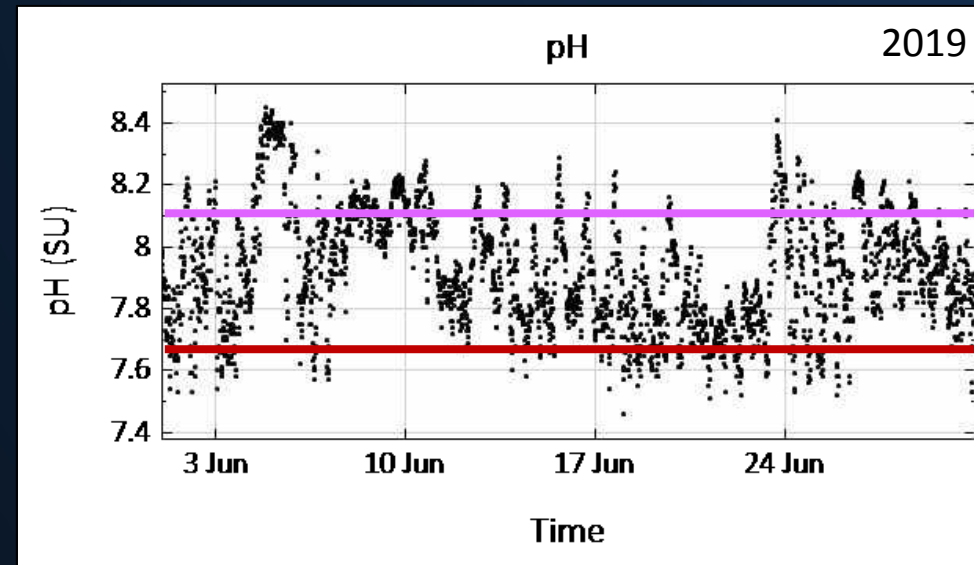
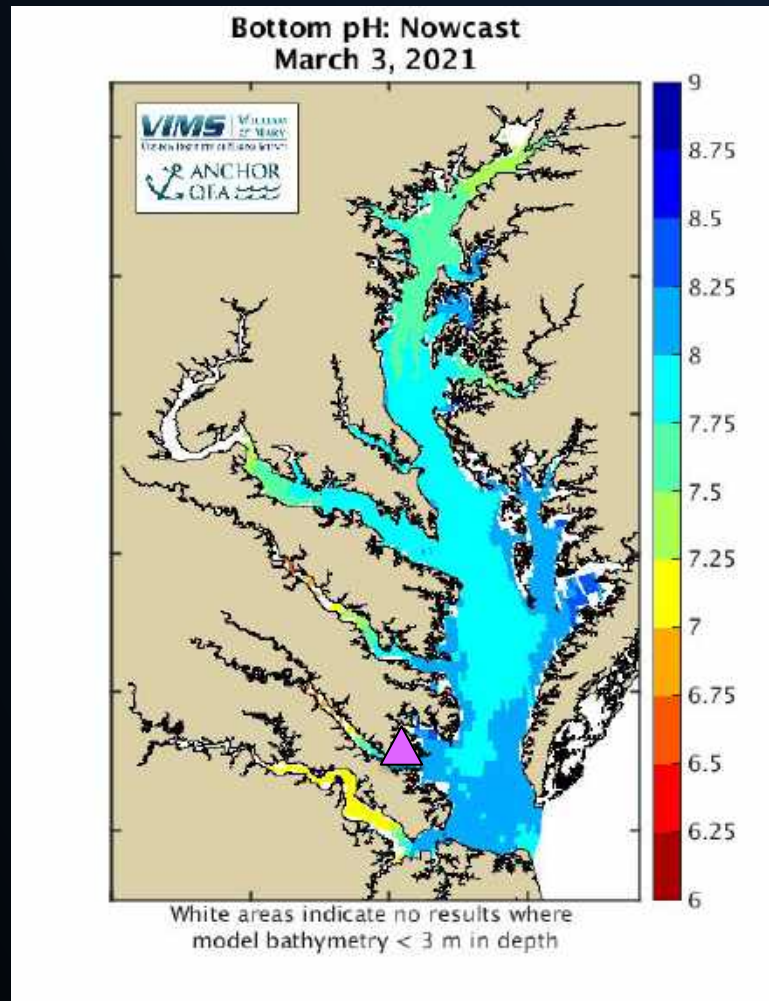
Effects of Ocean and Coastal Acidification on Oysters



As Ω_{ca} decreases, oyster calcification slows, and their shells start to dissolve

Controlled laboratory experiments provide metrics to measure in the field

The challenge: Acidification occurs across a mosaic of natural conditions



Virginia Estuarine and Coastal Observing System, VIMS

How can we best monitor OA and its impacts across this diverse seascape?

Linking Biological and Chemical Observations

Critical needs

- What water conditions do organisms and communities actually experience?
- How variable is the natural environment? What kind of data do we need to detect OA and its impacts?
- What biological metrics can allow us to separate impacts of OA from impacts of other environmental variables?
- Of these metrics, which can be easily measured by a variety of data collectors?
- *BONUS: are these metrics predictive or representative of community or ecosystem-level impacts?*

The opportunity of community science

Many hands make light work to:

- Collect data in more locations
- Sample more distant sites
- Survey a wider range of environmental conditions
- Engage more people in OA research!



Expanding the footprint of understanding

A community science program for building understanding about the relationship between ocean acidification and oyster ecology

Expanding the footprint of understanding

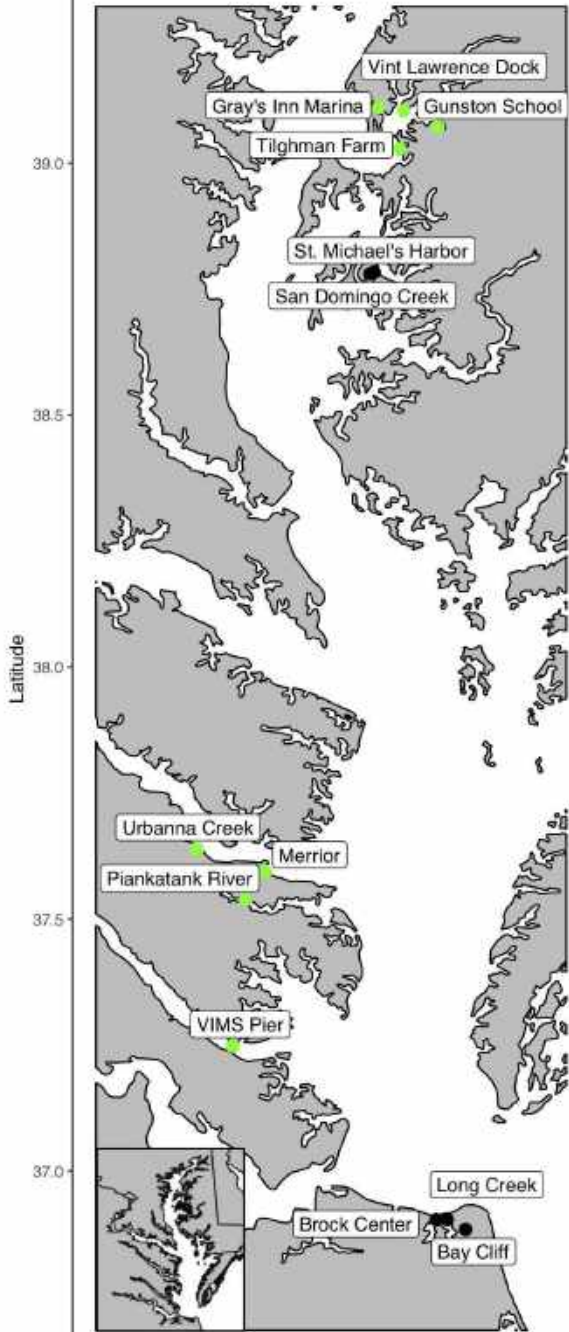
A community science program for building understanding about the relationship between ocean acidification and oyster ecology

Community Science Initiative - Oyster (CSI Oyster)

- High school students and their teachers
- Purpose: Monitor impacts of water quality variations on oyster growth over time



CSI Oyster



DOMINION ENERGY



Sara Beam



- 1) Deepen high school students' understanding of the scientific process and its role in addressing complex ecological problems
- 2) Advance environmental literacy and public awareness about OA
- 3) Improve a community science data collection program that integrates water conditions and oyster ecology data

Participation

- 100 high school students
- 5+ undergraduate students
- 2 graduate students
- 3 faculty members
- Summer students/volunteers



Water quality measurements

- YSI handheld instrument – temperature, salinity, dissolved oxygen, pH
- Bottle samples, preserved – pH, total alkalinity



Oyster size measurements

Measure shell height using:



Calipers



Photo bucket

Oyster growth in just 4 months



Patterns in water conditions

	Temperature (°C)	Salinity (psu)	Dissolved Oxygen (%)	pH (total scale)	Total Alkalinity ($\mu\text{mol kg}^{-1}$)	Calcite Saturation State
Gray's Inn	15.1 \pm 1.9	7.7 \pm 0.3	85.4 \pm 4.2	7.8 \pm 0.1	1131 \pm 34	0.6 \pm 0.1
Vint Lawrence Dock	14.6 \pm 1.8	7.6 \pm 0.3	81.2 \pm 3.7	7.6 \pm 0.1	1087 \pm 31	0.5 \pm 0.1
Tilghman Farm	15.4 \pm 2.0	9.3 \pm 0.4	78.6 \pm 5.1	7.8 \pm 0.1	1225 \pm 33	1.0 \pm 0.2
Piankatank River	18.9 \pm 2.6	8.4 \pm 0.7	83.1 \pm 4.5	7.6 \pm 0.1	1128 \pm 67	0.5 \pm 0.1
Urbanna Creek	17.3 \pm 1.8	11.3 \pm 0.3	89.9 \pm 3.2	7.9 \pm 0.1	1343 \pm 30	1.1 \pm 0.1
VIMS Pier	17.5 \pm 1.7	17.3 \pm 0.5	100.9 \pm 3.8	7.9 \pm 0.0	1565 \pm 31	1.6 \pm 0.1
Merroir	17.9 \pm 2.6	13.7 \pm 0.3	84.1 \pm 4.8	7.8 \pm 0.1	1410 \pm 36	1.0 \pm 0.1

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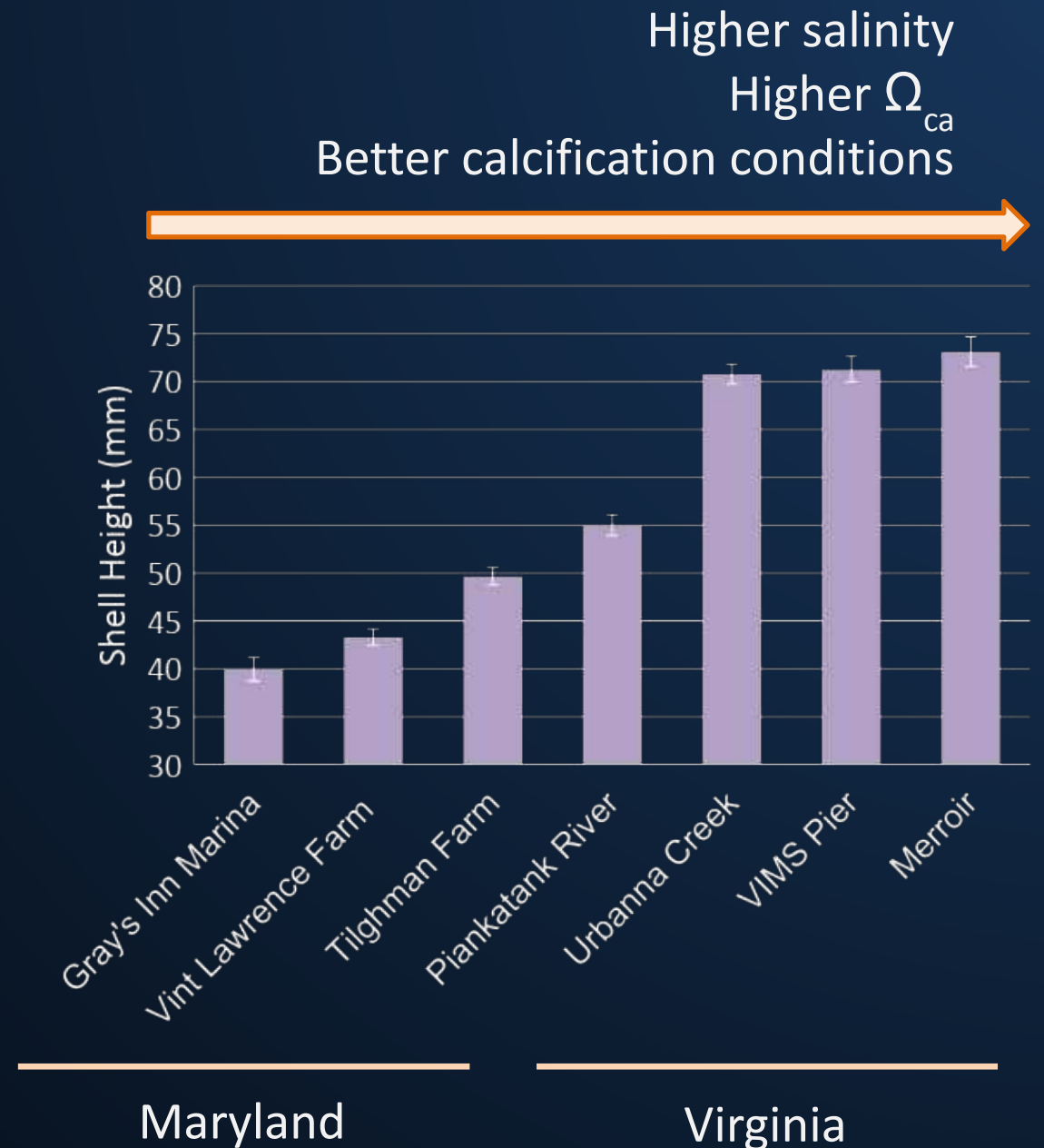
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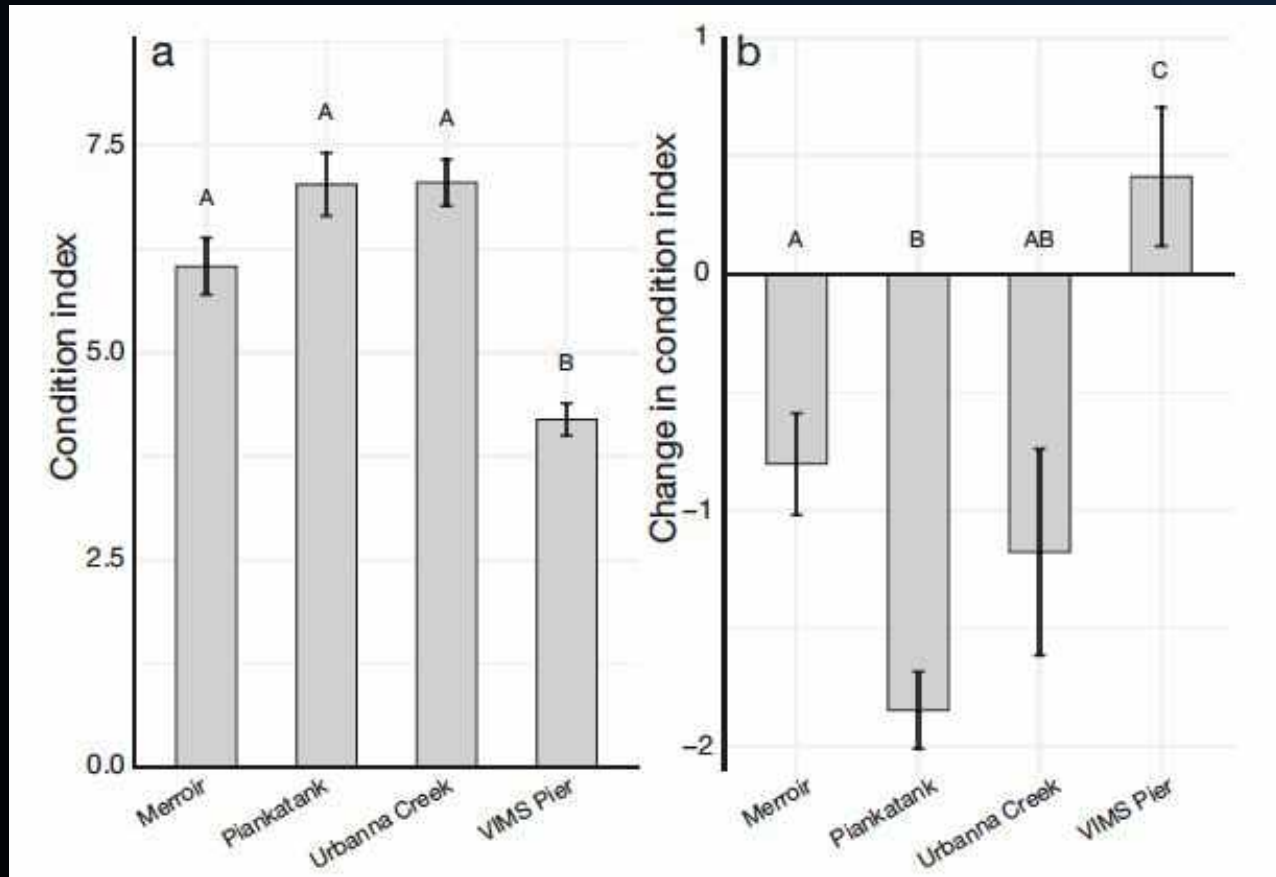
Relative
influence of
salinity and
carbonate
chemistry

Oysters at VA sites grew larger than oysters at MD sites

Water chemistry, as well as temperature, salinity, and dissolved oxygen, affects oyster growth



Coupled datasets – teasing apart relative influences



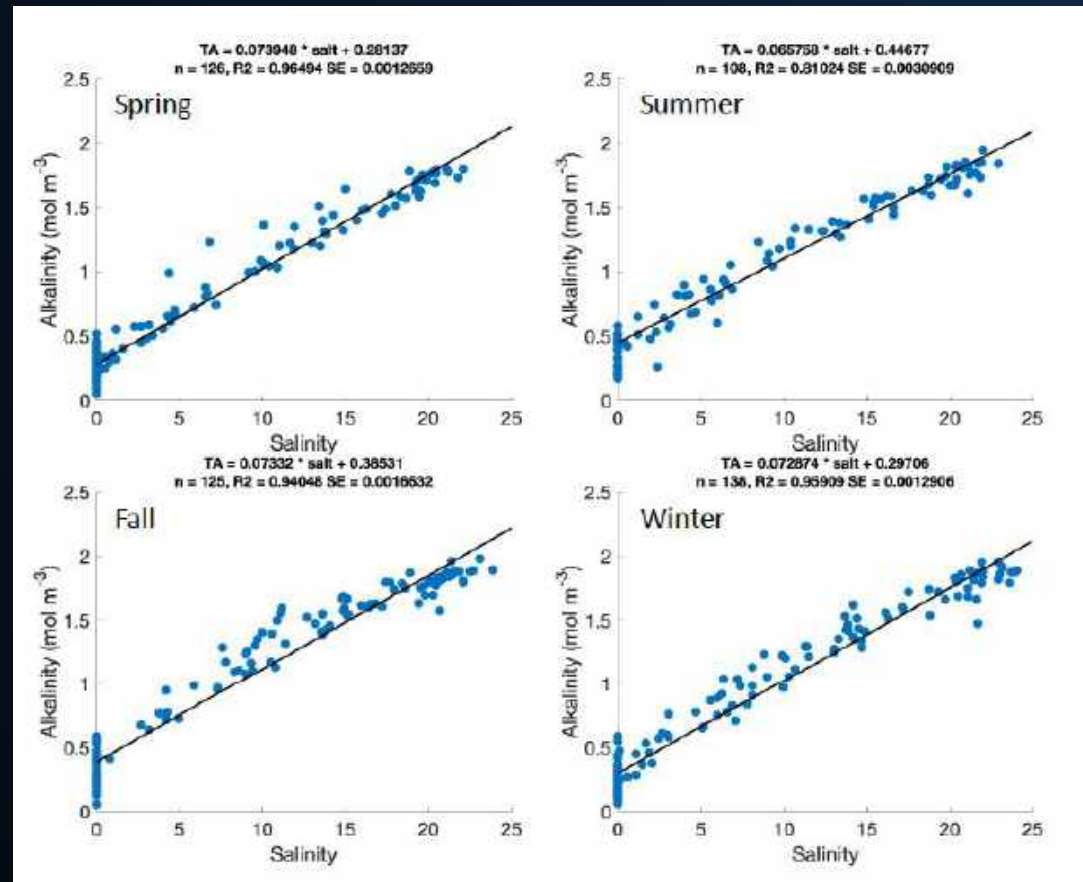
CSI Oyster

After 1 mo. common garden

- Ω_{ca} , salinity, and temperature
- **Salinity** was the only significant predictor of change in condition index

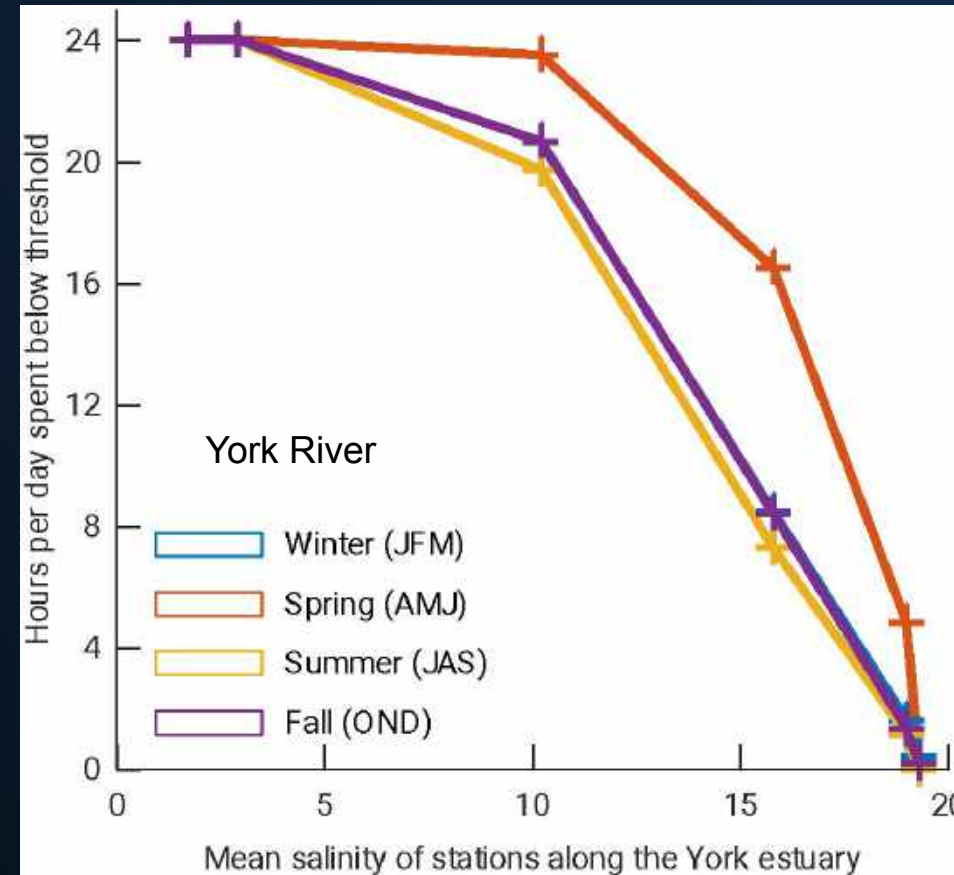
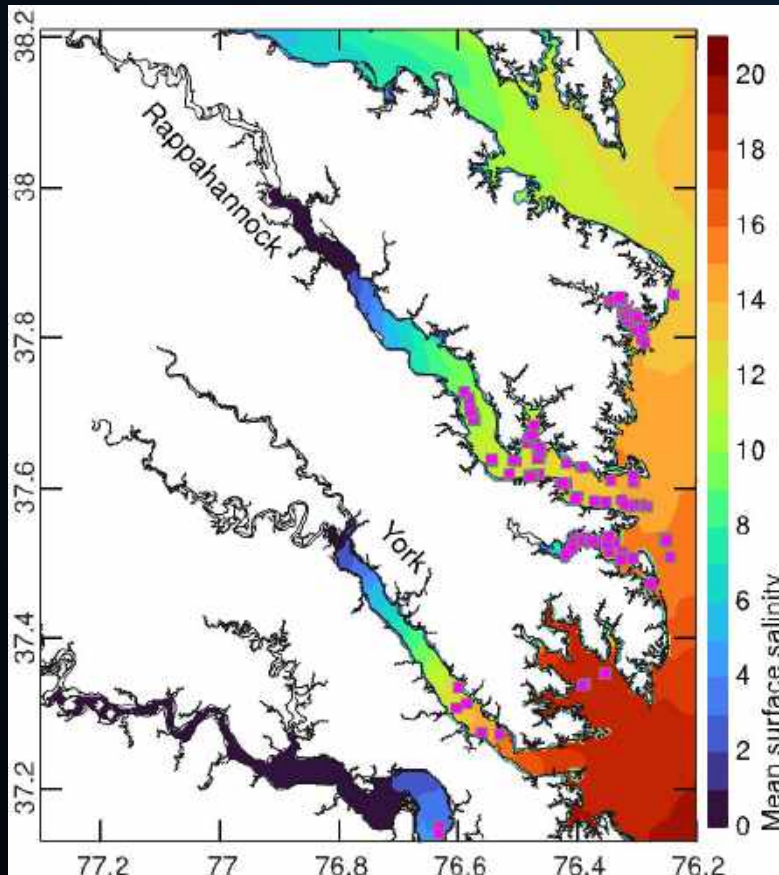
Coupled datasets – integrative modeling

1. Extend use and value of existing limited time series



Coupled datasets – integrative modeling

2. Predict when and where OA thresholds occur



Linking Biological and Chemical Observations using Community Science

Critical contributions

- Diversity of habitat conditions (spatial and temporal)
- Documentation and prediction of emergence of impacts
- When and where OA is a defining ecological driver
- Identification of bio-indicators that are reliable *in situ*

Engagement with community members

- Enhance OA literacy
- Capture more spatial and temporal data
- Understand bio-indicators in different settings (e.g. restoration, aquaculture)

