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Ecosystem Modeling of Food Web Dynamics Explicitly Considering the Effects of Climate Change in a Macrotidal Coastal Estuary

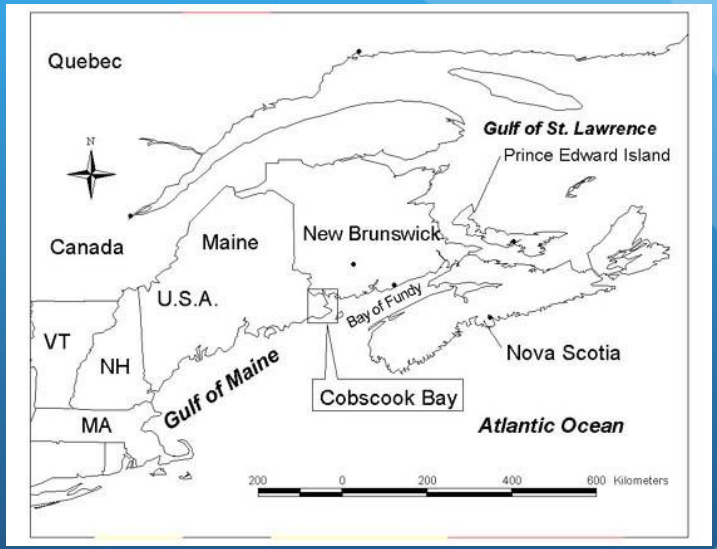
Kylee DiMaggio
University of Maine

Ecosystem modeling of food web dynamics explicitly considering the effects of climate change in a macrotidal coastal estuary

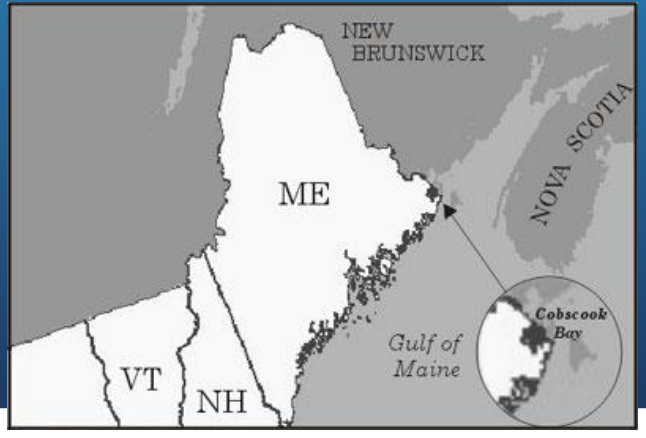
By Kylee DiMaggio

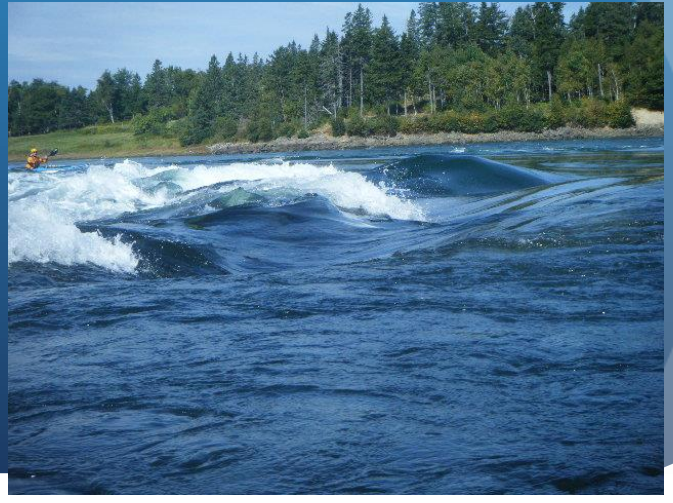
The purpose


CLIMATE CHANGE
AHEAD

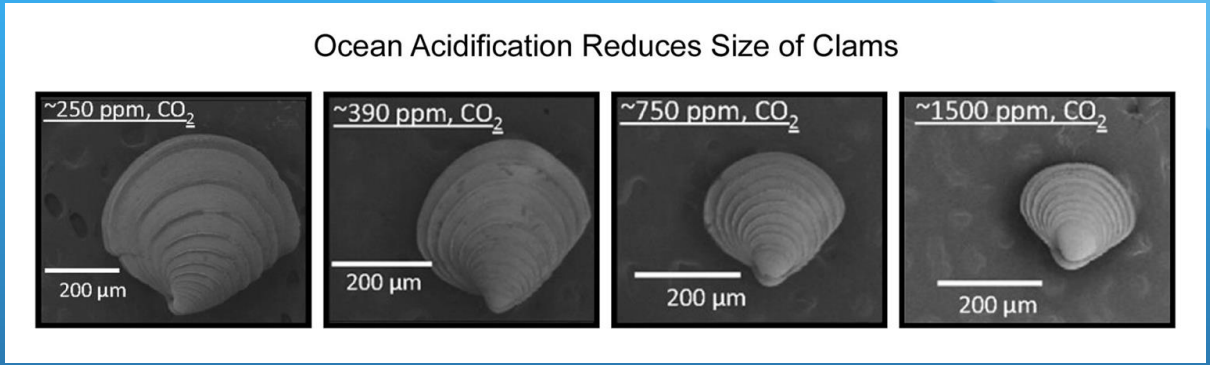

Quebec
N
Gulf of St. Lawrence
Prince Edward Island
Canada
Maine
New Brunswick
U.S.A.
Bay of Fundy
VT
NH
Nova Scotia
Gulf of Maine
Cobscook Bay
MA
Atlantic Ocean
200
0
200
400
600 Kilometers

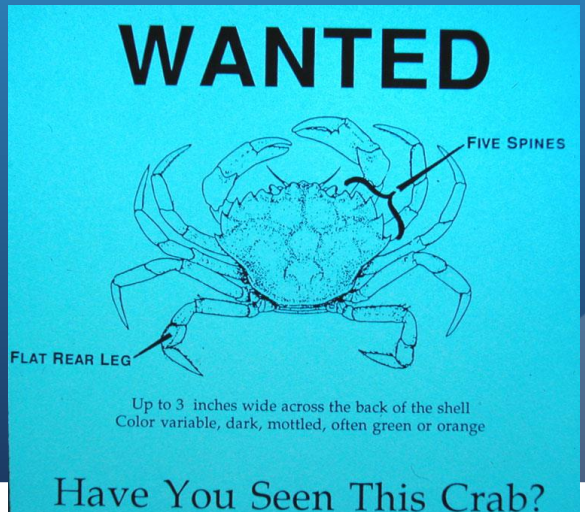
About Cobscook Bay





Effects of climate change on the system





What we are testing

Ocean Acidification: How would a decrease in the biomass of shell forming organisms due to ocean acidification affect the Cobscook Bay ecosystem?
Ocean Warming: How would a decrease in zooplankton due to increased ocean temperature affect the Cobscook Bay ecosystem?
Species Shifts: How would an increase in green crabs as an invasive species affect predators in Cobscook Bay?

How the model works

BOBLME Training Workshop slides

Ecopath Master Equation (I)

Production = Predation

+ Fishery

+ Biomass accumulation

+ Net migration

+ Other mortality

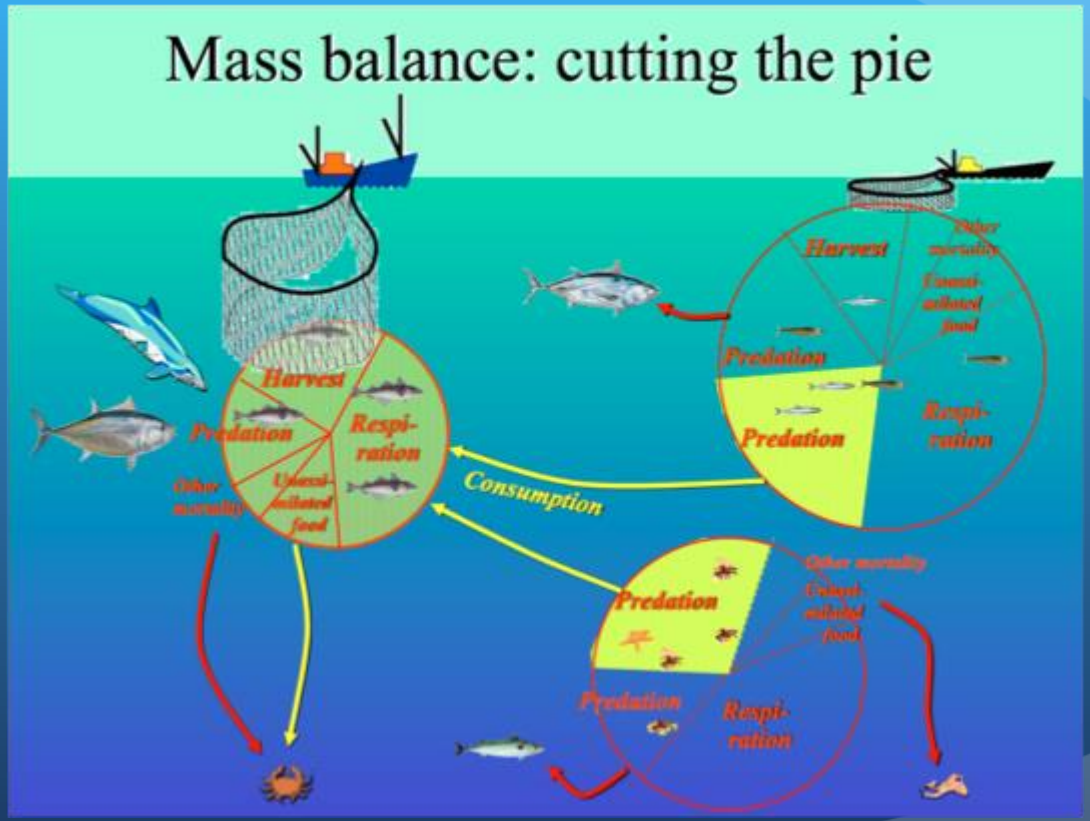
Ecopath Master Equation (II)

Consumption = Predation

+ Unassimilated food (= excretion + egestion)

+ Respiration

Mass balance approach

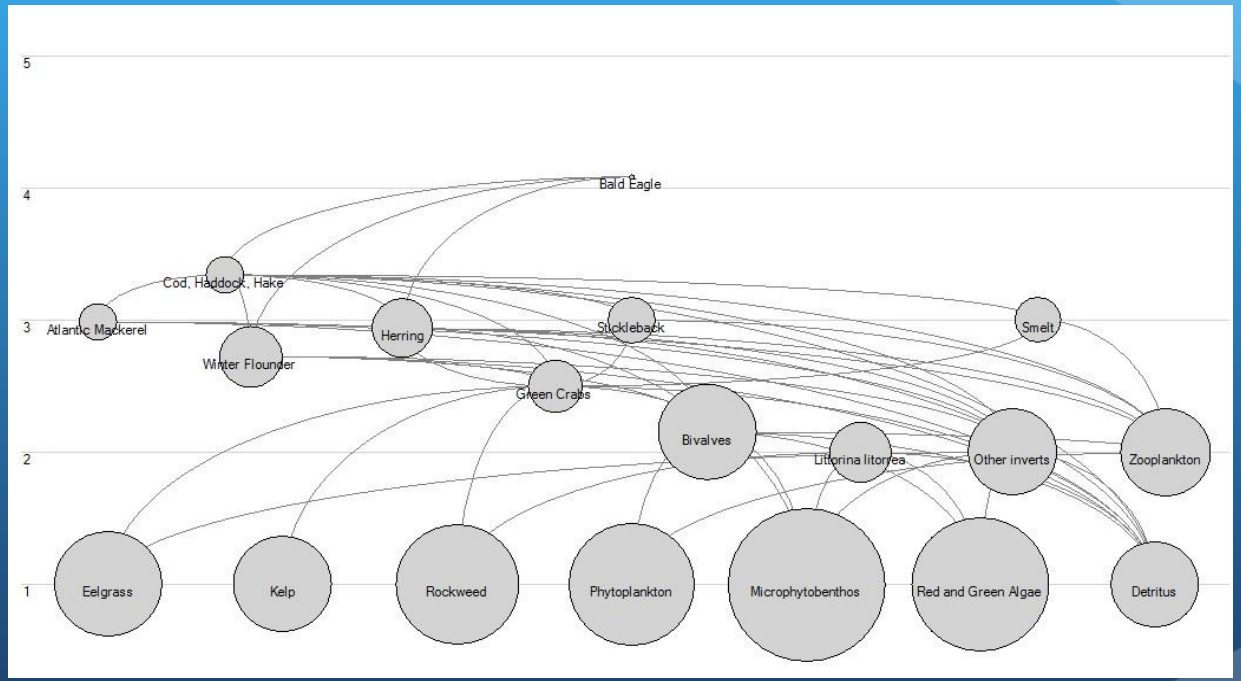


BOBLME Training Workshop slides

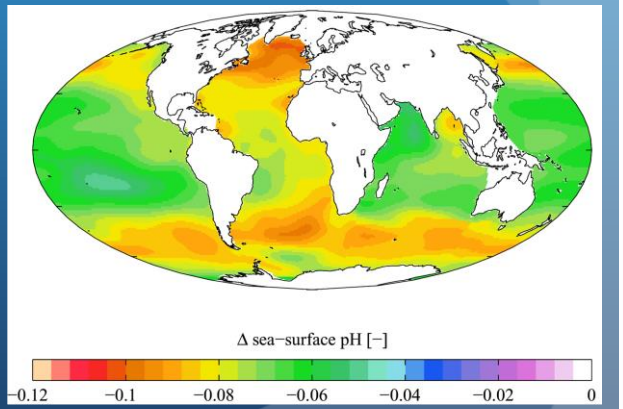
About the model

	Group name	Trophic level	Habitat area (fraction)	Biomass in habitat area (t/km²)	Biomass (t/km²)	Production / biomass (/year)	Consumption / biomass (/year)	Ecotrophic efficiency	Production / consumption
1	Bald Eagle	4.086	0.667	0.0260	0.0173	0.200	0.750	0.000	0.267
2	Cod, Haddock, Hake	3.344	0.667	1.971	1.314	0.380	2.580	0.480	0.147
3	Atlantic Mackerel	2.988	0.667	2.000	1.334	0.190	4.400	0.924	0.043
4	Winter Flounder	2.727	0.667	12.47	8.318	1.900	3.800	0.015	0.500
5	Stickleback	3.000	0.667	4.056	2.705	0.540	9.700	0.442	0.056
6	Herring	2.938	0.667	10.70	7.133	0.600	10.10	0.153	0.059
7	Smelt	3.000	0.667	3.600	2.400	0.350	3.600	0.770	0.097
8	Green Crabs	2.500	0.333	13.74	4.580	1.400	3.000	0.236	0.467
9	Bivalves	2.150	0.333	305.7	101.9	0.700	4.000	0.072	0.175
10	Littorina litorrea	2.000	0.333	22.46	7.486	0.483	18.00	0.000	0.027
11	Other inverts	2.000	1.000	50.00	50.00	2.000	14.00	0.232	0.143
12	Zooplankton	2.000	1.000	56.25	56.25	50.00	200.0	0.059	0.250
13	Eelgrass	1.000	0.667	300.0	200.1	0.391		0.922	
14	Kelp	1.000	0.667	157.4	105.0	3.543		0.004	
15	Rockweed	1.000	0.333	1814	604.6	0.546		0.069	
16	Phytoplankton	1.000	1.000	675.0	675.0	125.0		0.135	
17	Microphytobenthos	1.000	1.000	6750	6750	125.0		0.000	
18	Red and Green Algae	1.000	0.333	4632	1544	8.000		0.027	
19	Detritus	1.000	1.000	46.80	46.80			0.000	

About the model

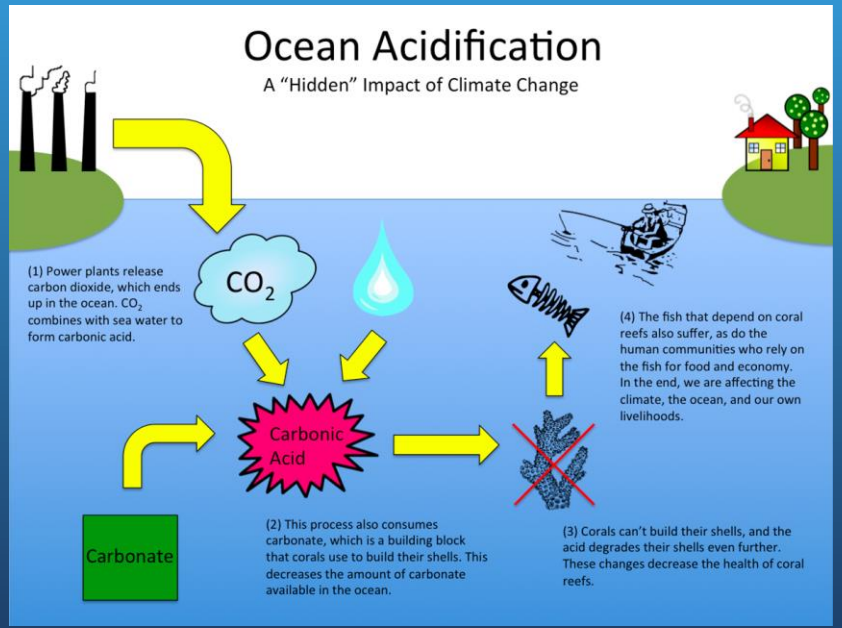


What is climate change?



Scenarios and questions: Ocean acidification

How would a decrease in the biomass of shell forming organisms due to ocean acidification affect the Cobscook Bay ecosystem?



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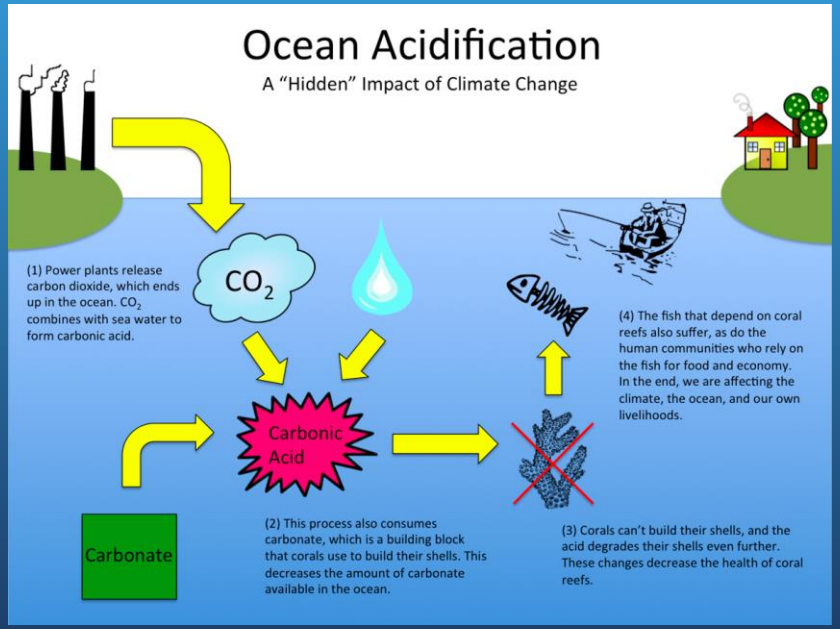
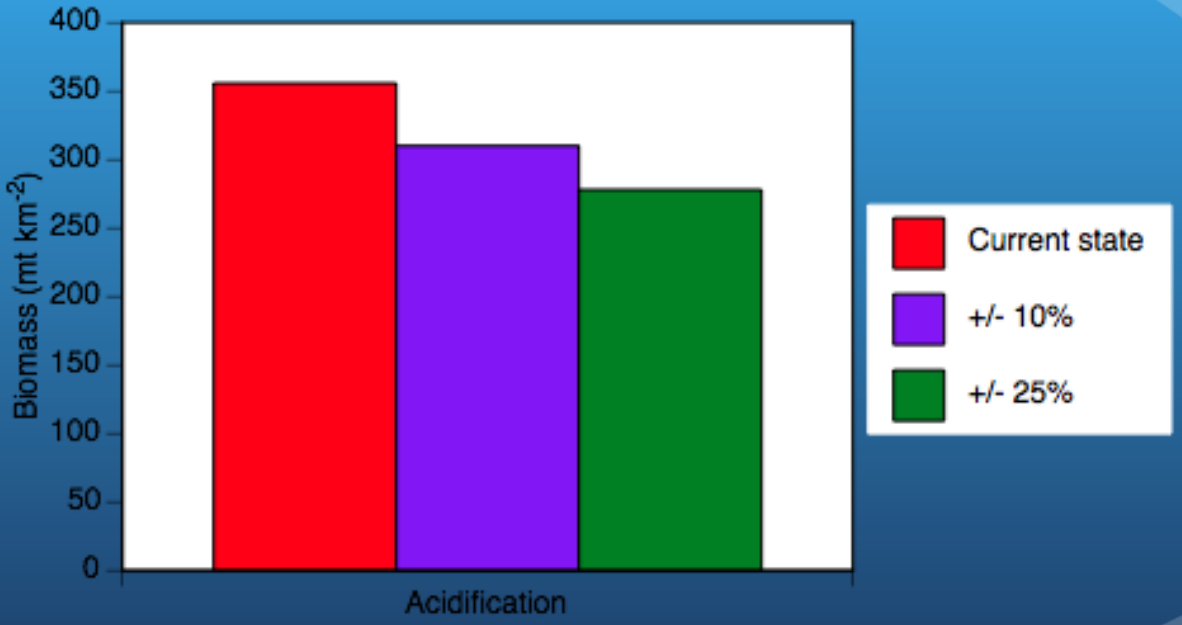


How ocean acidification is predicted to affect shell forming biomass

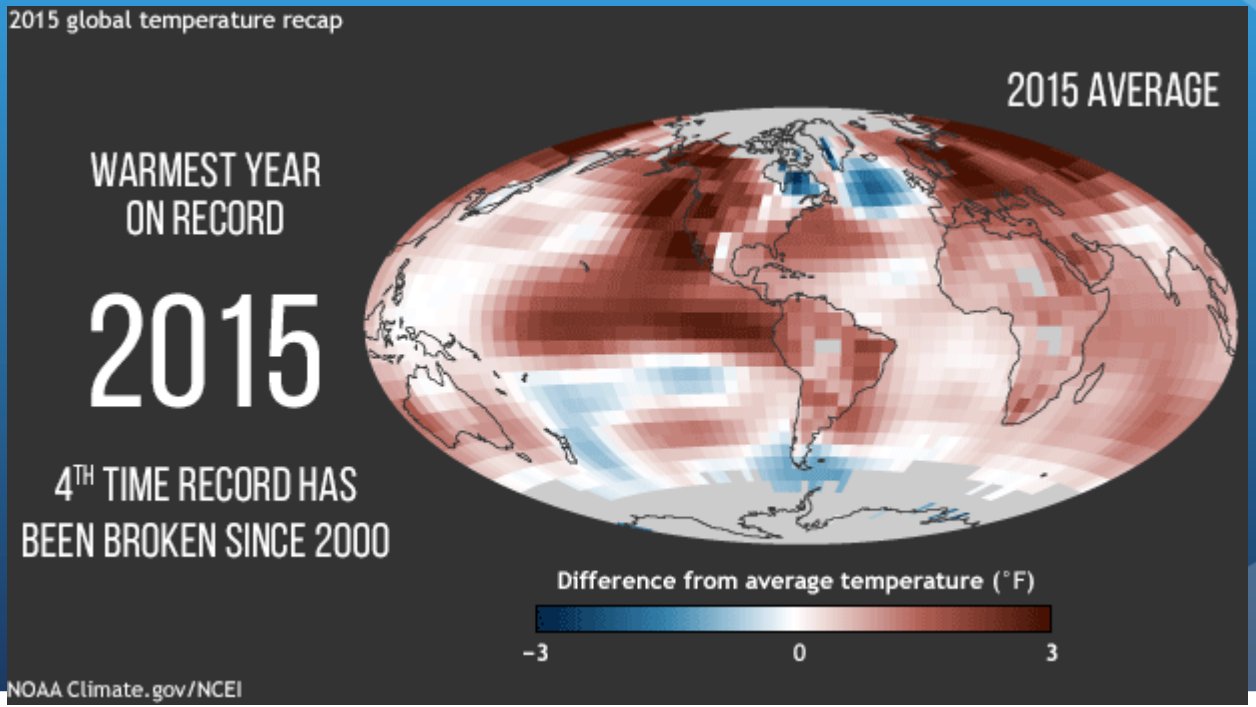


Results: Ocean acidification

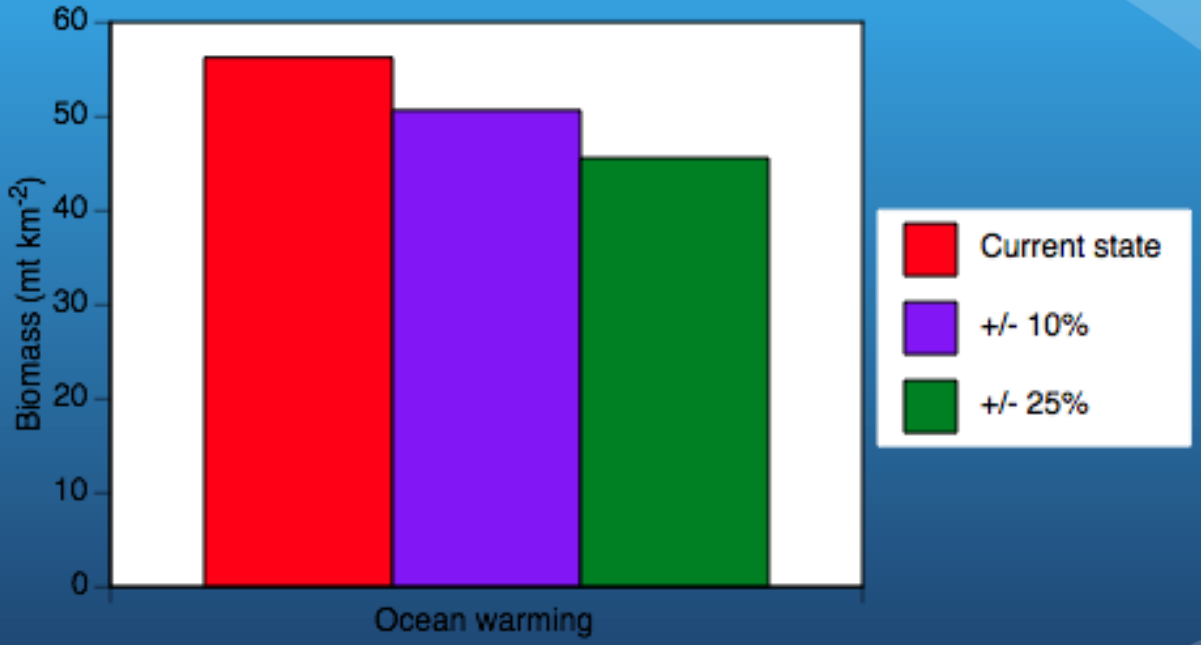
No effect at <95% decrease

Scenarios and questions: Ocean warming

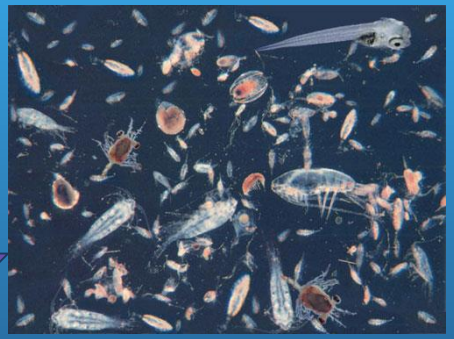
How would a decrease in zooplankton due to increased ocean temperature affect the Cobscook Bay ecosystem?



How ocean warming is predicted to decrease zooplankton biomass



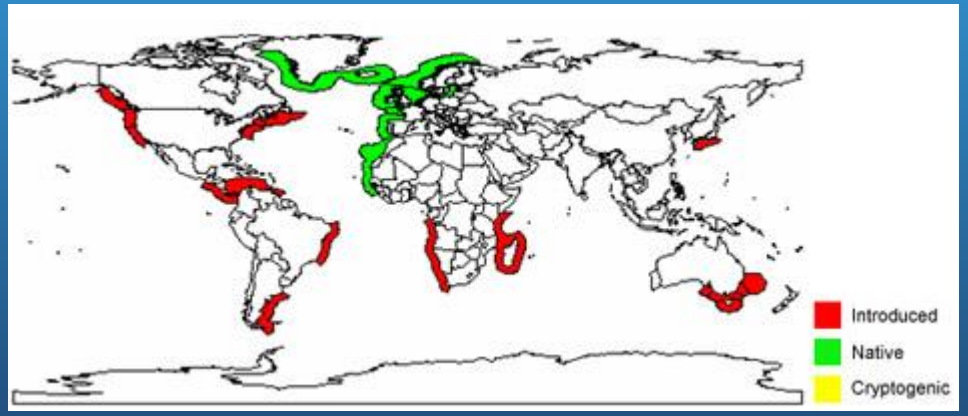
Results: Ocean warming



No effect at a 95% decrease

Scenarios and questions: Species shifts

How would an increase in green crabs as an invasive species affect predators in Cobscook Bay?



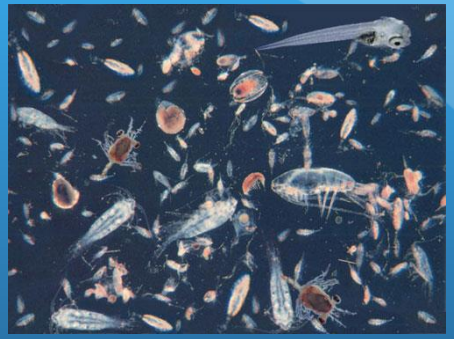
Results: Species shifts

Hypothesis

We hypothesized that:

Ocean warming and ocean acidification would have the biggest impact on ecosystem biomass while species shifts would have a lower impact on ecosystem biomass.

How this study has surprised us



In summary

- Ecopath can be used successfully as a simulation tool
- Species shifts are more impactful in the Cobscook Bay ecosystem as both ocean warming and ocean acidification

How this study can be furthered

- Researching the effects of different species shifts
- Effects of ocean warming and ocean acidification on different species in the model
- Explore vital rate ratios
- Explore effects on the Cobscook Bay ecosystem when there is more than one shift in the food web

Acknowledgements

Thank you so much to Dr. Carrie Byron and Dr. Eric Chapman for giving me this amazing opportunity and all of their help and guidance on this project.

Questions?

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