

Climate Change Impacts on Maine

Marine Resources Committee
January 11, 2022

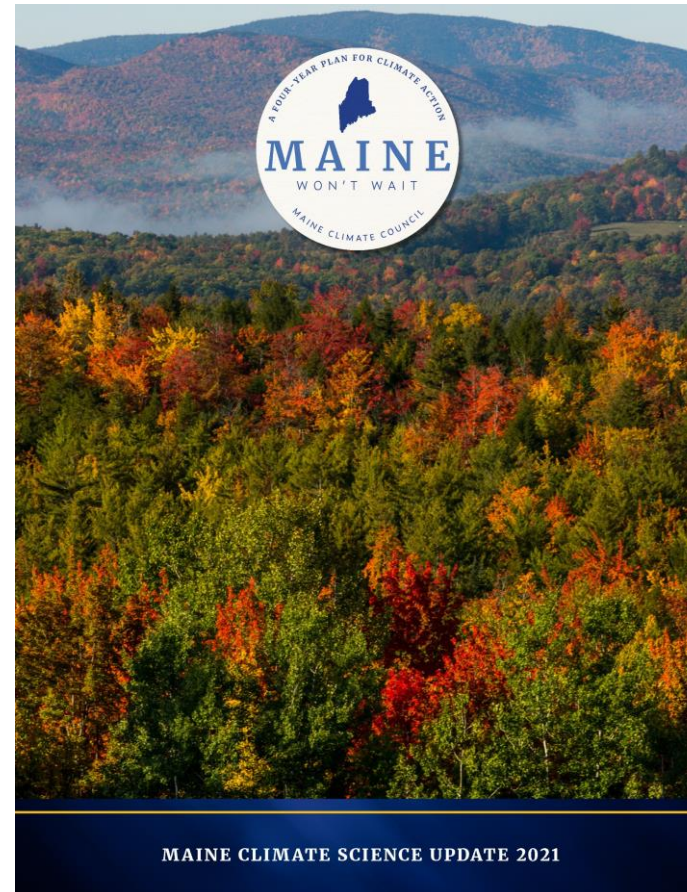
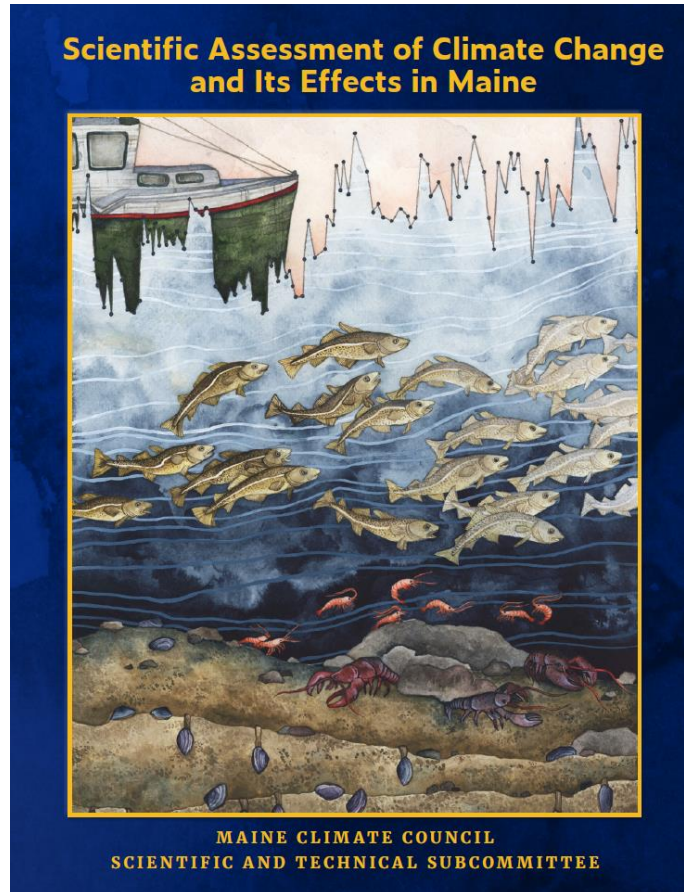
Dr. Susie Arnold, Island Institute
Dr. Cassandra Rose, Governor's Office of
Policy Innovation and the Future

Maine Climate Council's Scientific and Technical Subcommittee



LD 1679: an expert **Scientific and Technical Subcommittee** is responsible for identifying the impacts of climate change in Maine.

2020:
**Scientific
Assessment of
Climate
Change
(370 pgs)**



2021:
**Maine Climate
Science Update
2021
(20 pgs)**

Maine Won't Wait / Goal 1

To prevent the worst effects of climate change, we must drastically reduce the “greenhouse gases” that are emitted from burning fossil fuel.

CO₂, methane, and other greenhouse gases trap heat, raising earth's temperature.

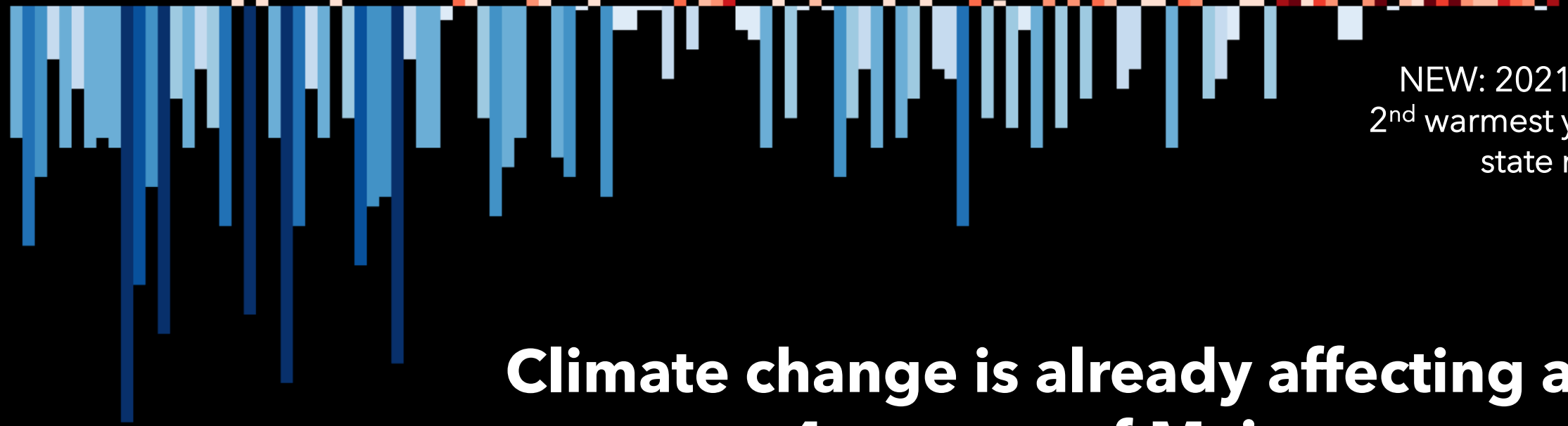


Temperature change in Maine

+3.2°F on average since 1895

1895

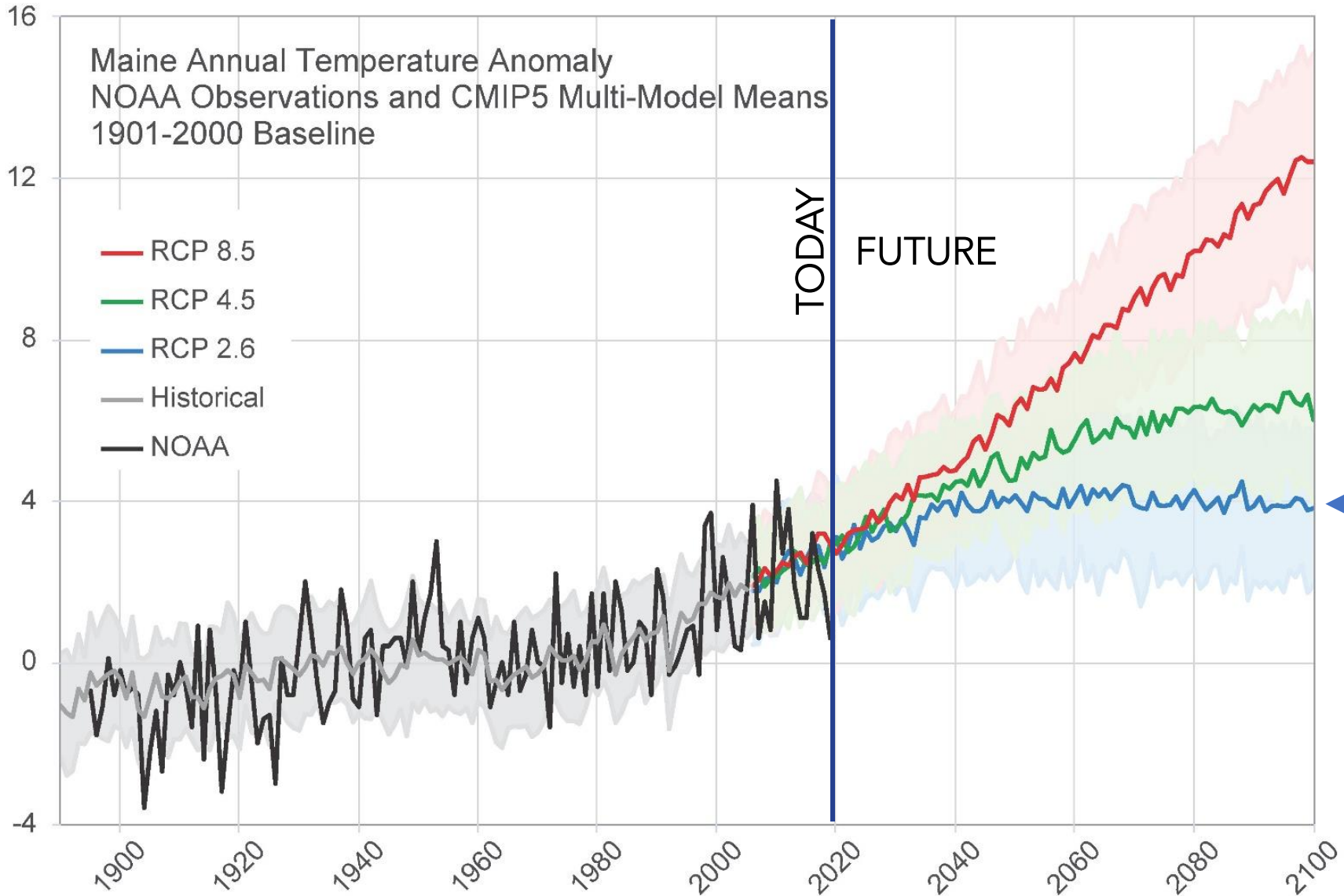
2020



NEW: 2021 is the 2nd warmest year in state record

Climate change is already affecting all 4 corners of Maine

Amount of Future Warming Depends on Curbing Emissions in Maine and Globally

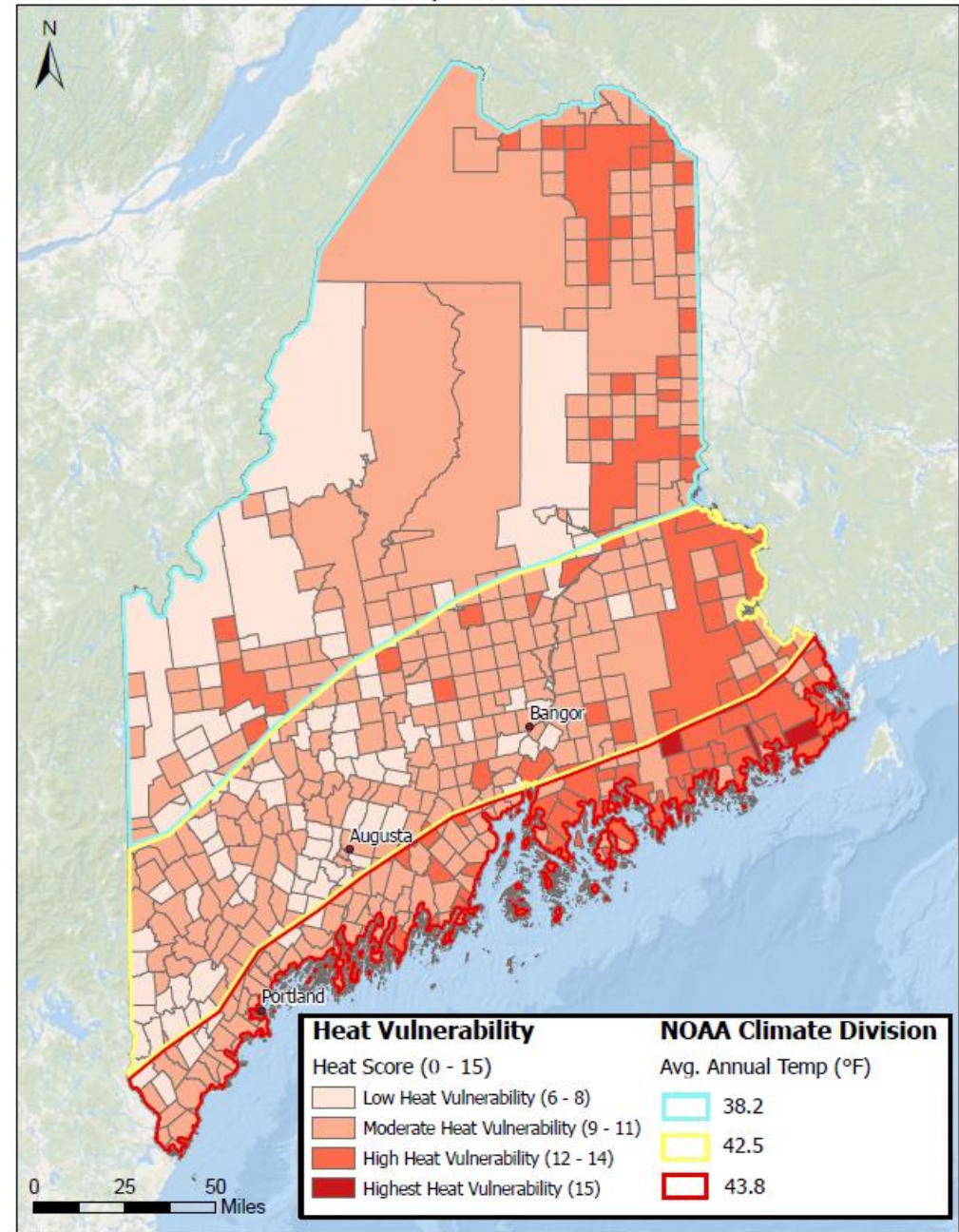




Increasing high heat days disproportionately impact vulnerable Mainers

- High heat index days 2 - 4 times more frequent by the 2050s
- Direct and indirect costs from heat-related emergency and hospital visits will rise with hotter temps

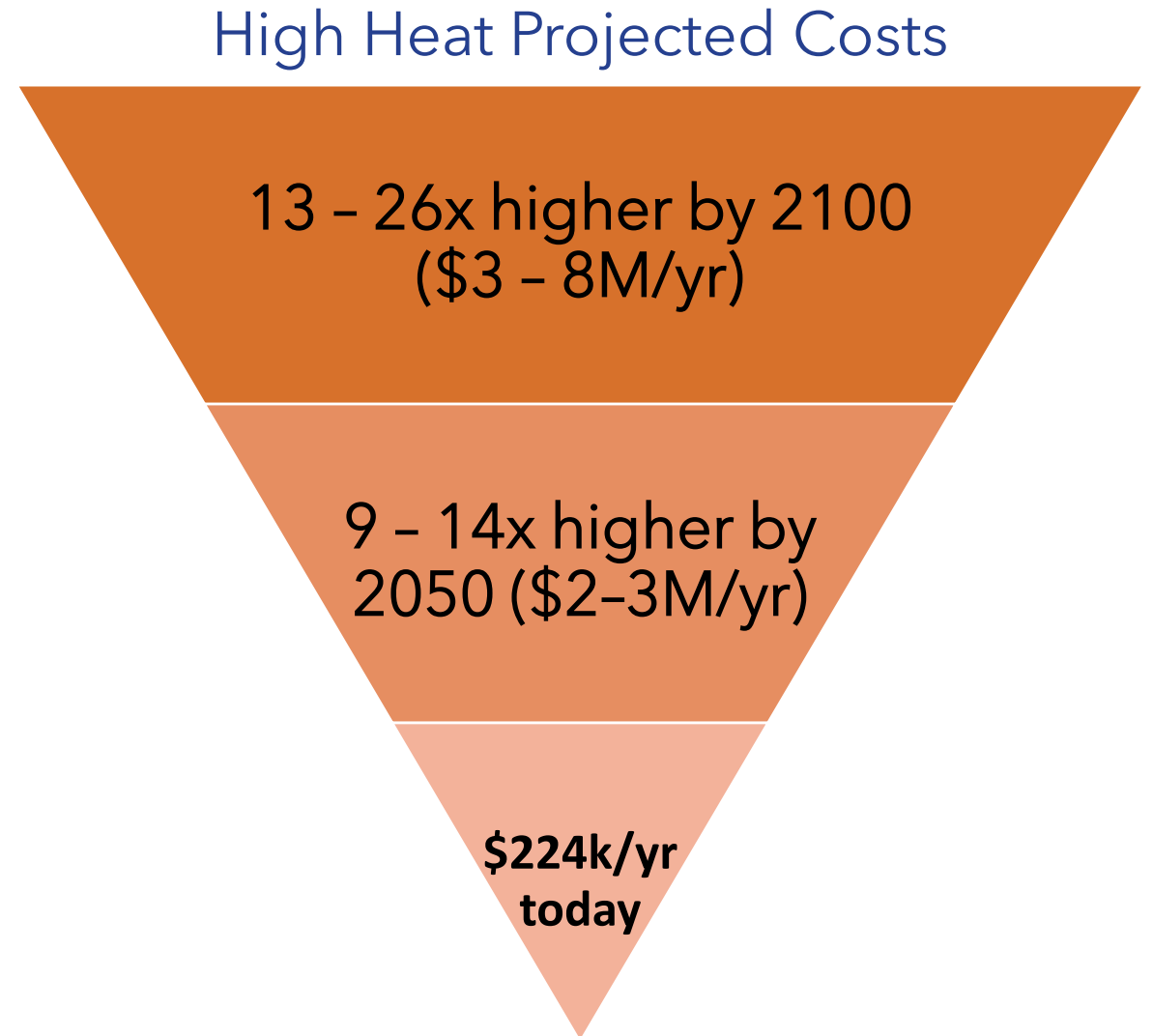
Heat Vulnerability
County Subdivisions





Increasing high heat days disproportionately impact vulnerable Mainers

- High heat index days 2 - 4 times more frequent by the 2050s
- Direct and indirect costs from heat-related emergency and hospital visits will rise with hotter temps





"Maine's annual precipitation (rain and snowfall) has increased more than 6 inches since 1895, and extreme precipitation events (1" to 4" or more) are becoming more frequent."



S. Bristol, 2020



Gouldsboro, 2021



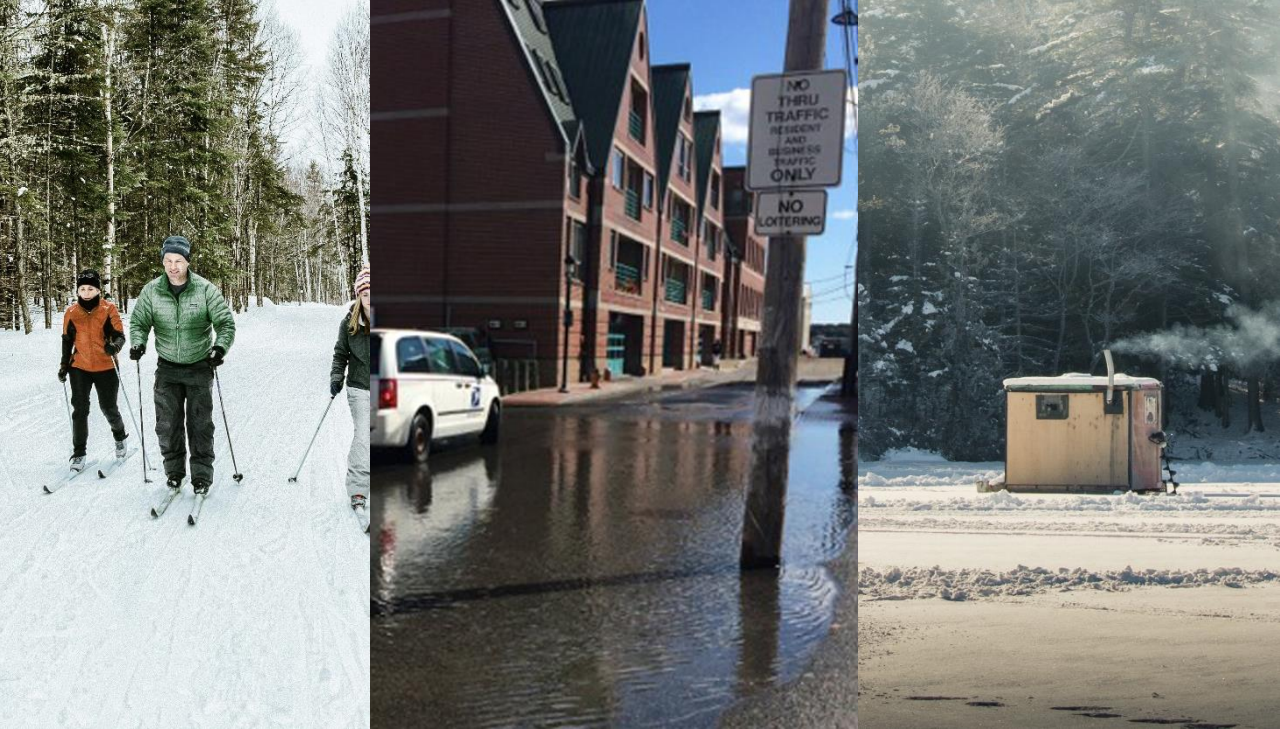
Camden, 2021



Acadia NP, 2021



Camden, 2021

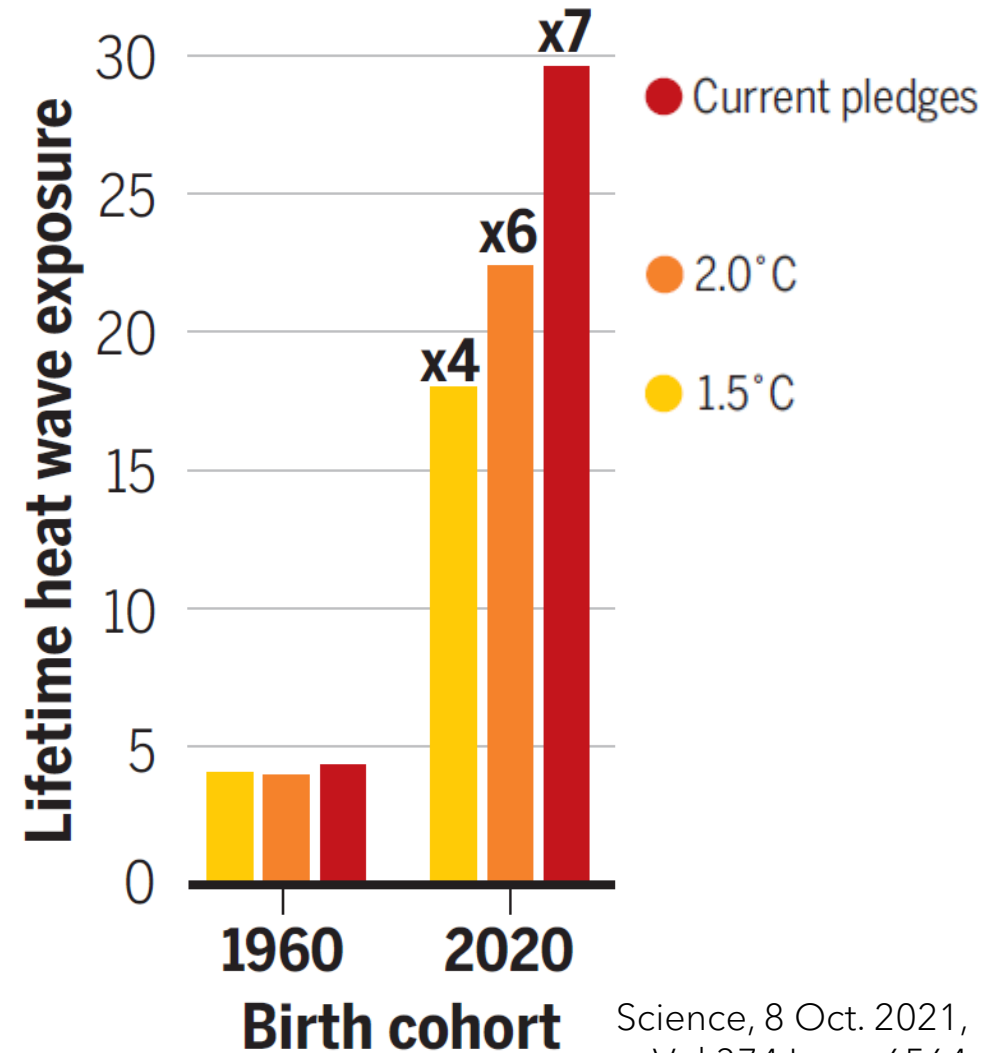


"All sectors of Maine's economy -- from energy to agriculture, forestry, fishing, and tourism -- will feel the effects of climate change, such as warmer temperatures, more rain and overall extreme weather, and rising sea levels. Sea-level rise will increase the incidence of flooding and damage to property and infrastructure."



Learn more at MaineWontWait.org

Younger generations will experience far more frequent extreme climate events than previous ones



Science, 8 Oct. 2021, Vol 374 Issue 6564

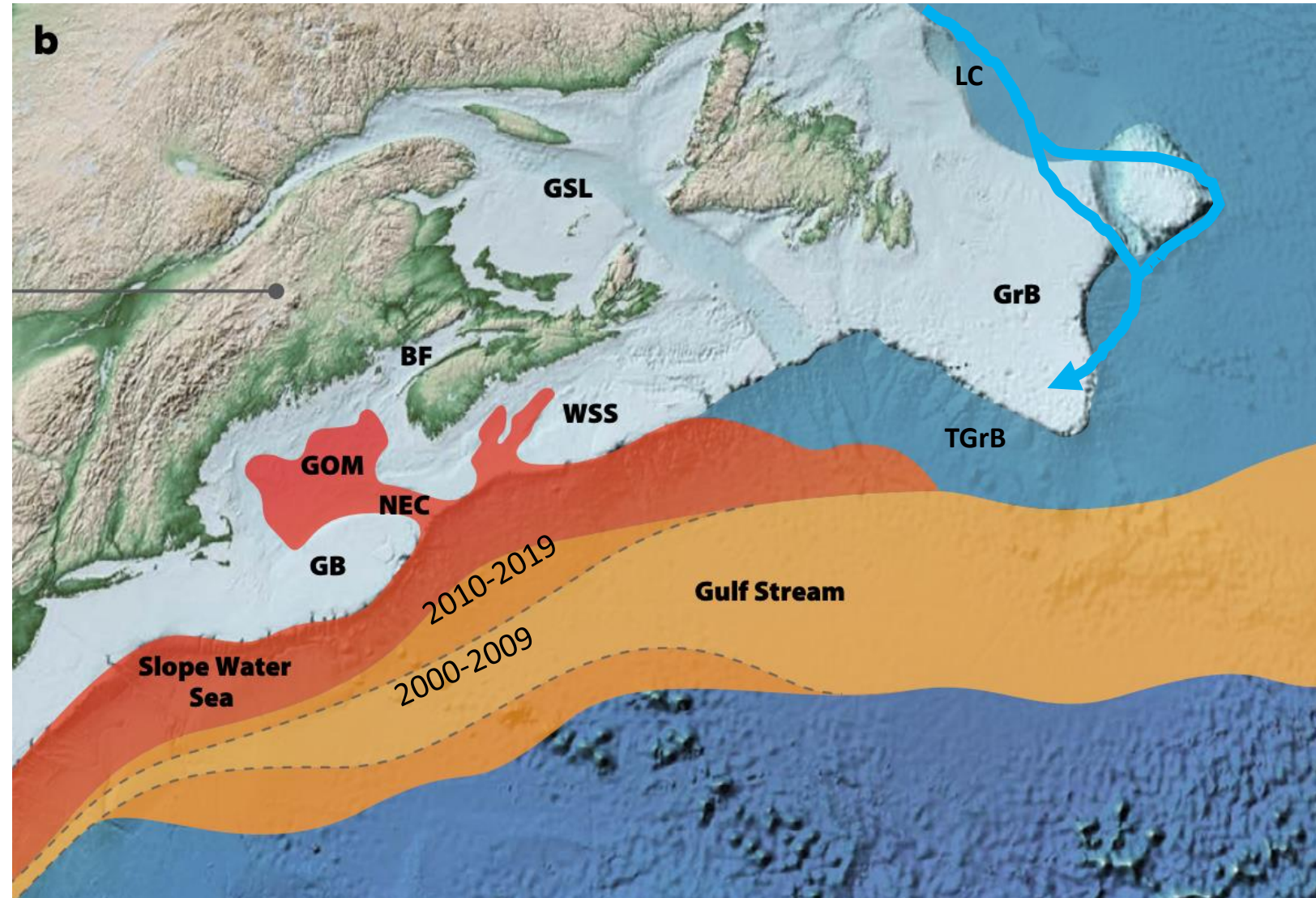
Changes in Ocean Circulation

Background-

- Arctic warming and accelerating ice melt from Greenland weakening AMOC
- weakening of AMOC linked with a northward shift of Gulf Stream and retreat of the Labrador Current, resulting in warmer water entering GOM through NEC

New insights (Goncalves Neto et al. 2021)-

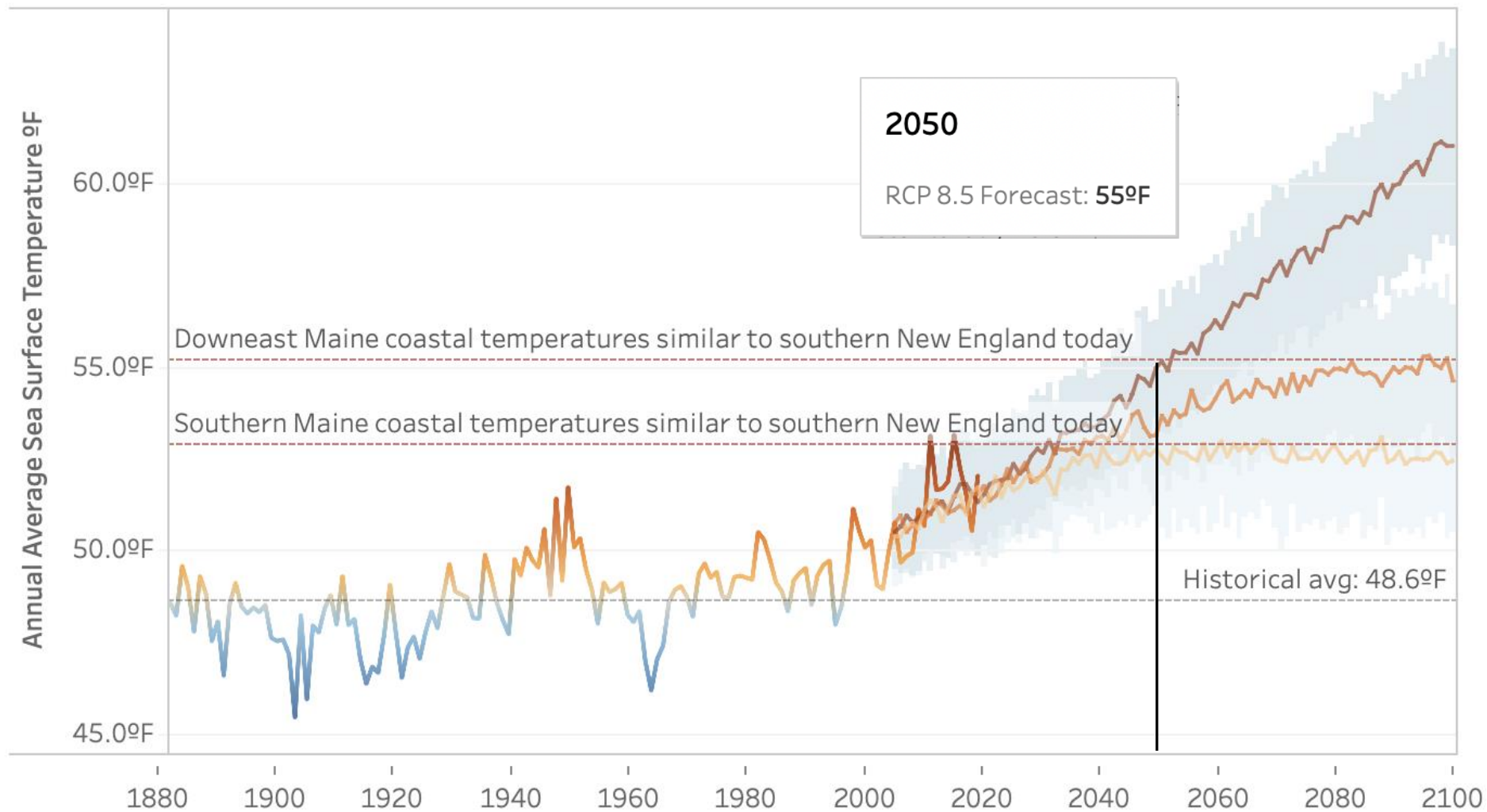
- beginning in 2008 GS migrated closer to TGB, reducing input of Labrador Current; within one year of that warm salty water at the TGB, subsurface warming progressed in GOM
- help interpret rapid temperature change
- ability to simulate the Gulf Stream-Labrador Current interactions enhances the predictability of future warming



Ocean Temperature Trend

Long-term Temps and Projections ▾

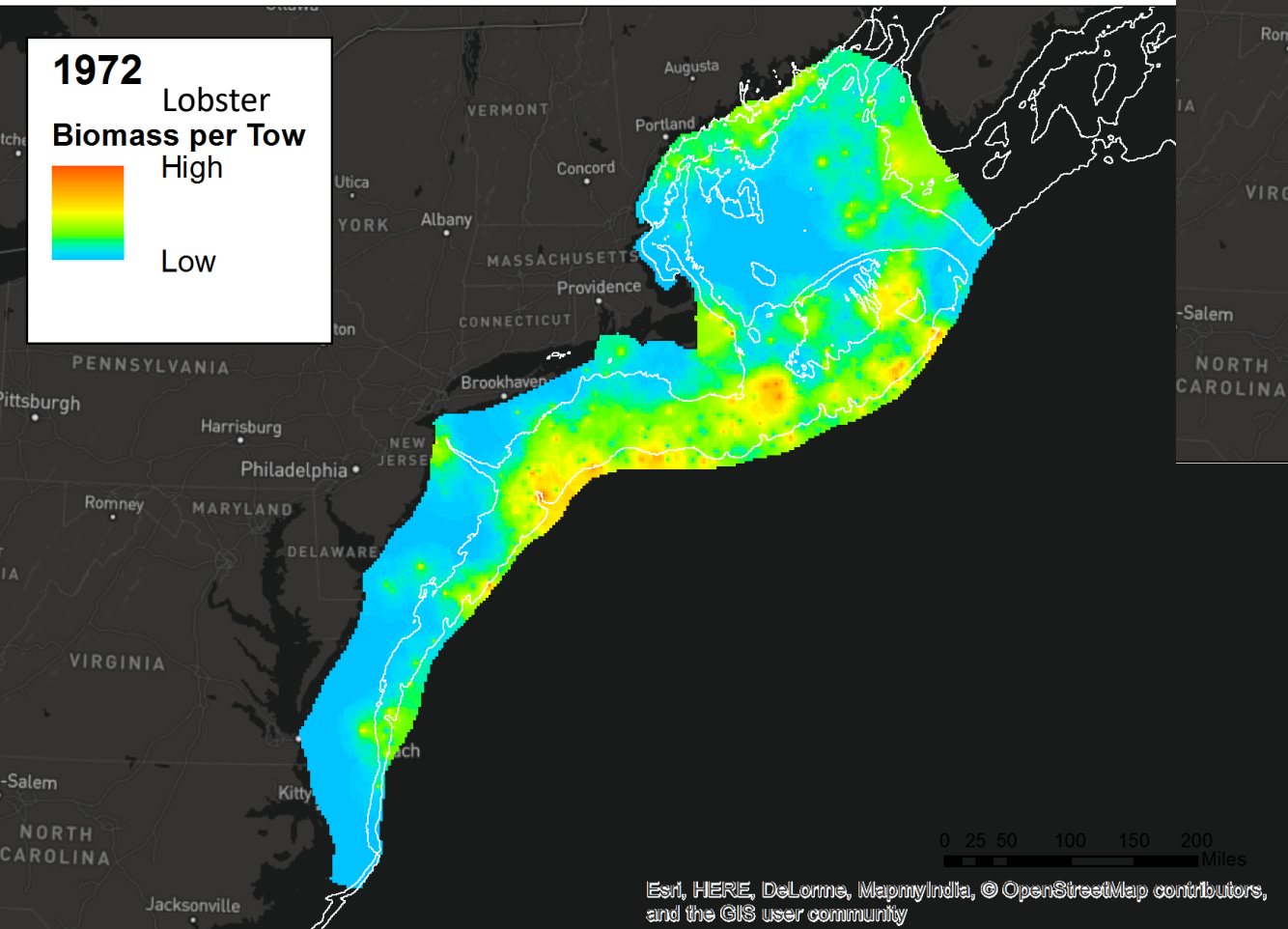
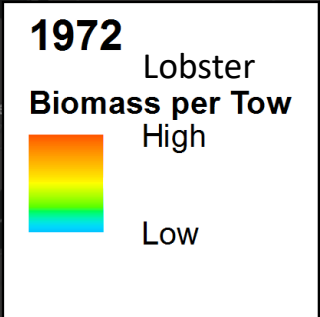
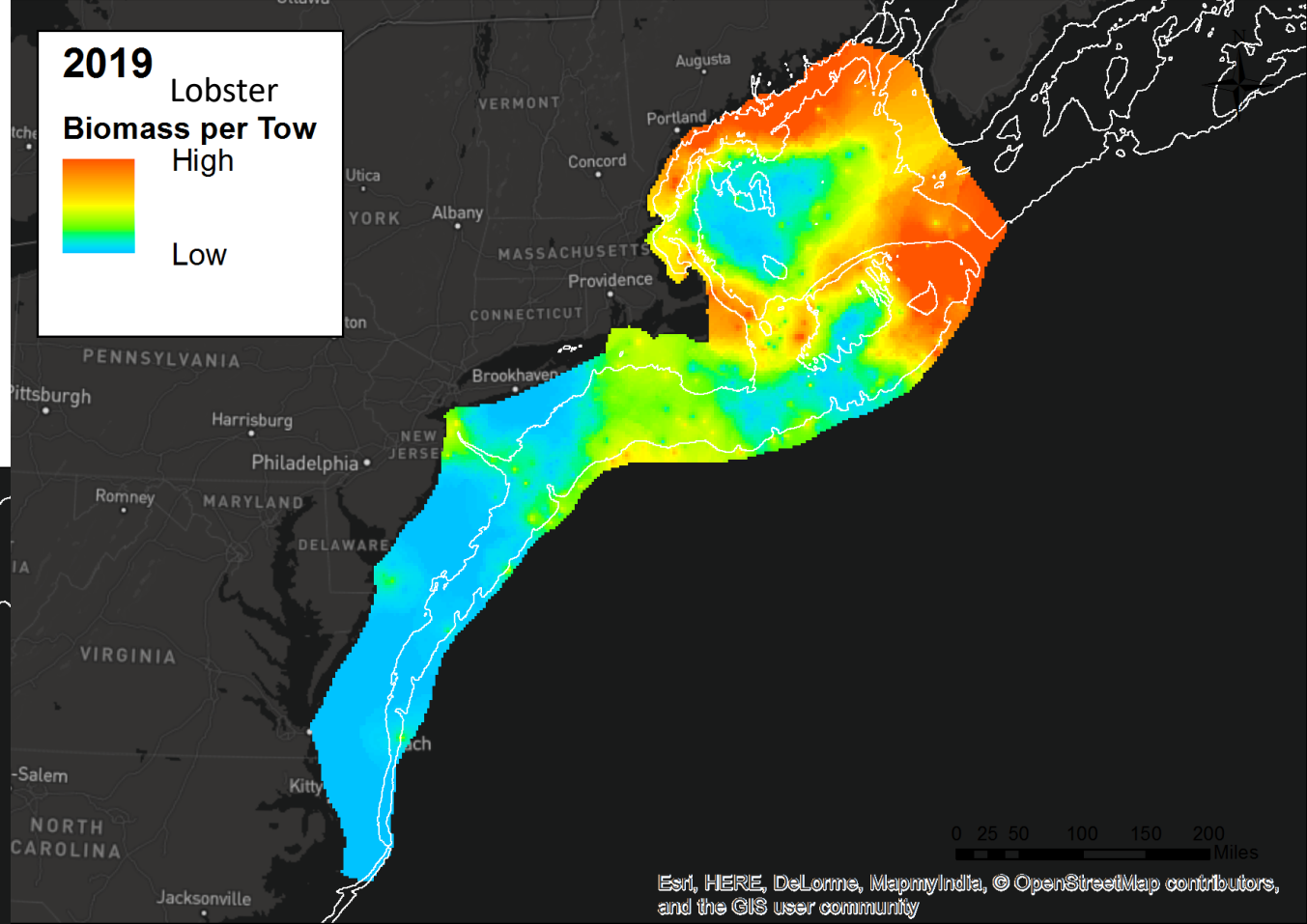
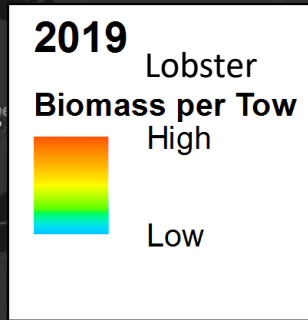
Use your cursor to drag and select a comparison period in the map and bars to the right. Click away to reset the selection.



SOURCE: NOAA (sea surface temperatures); Maine State Climate Office (CMIP5 model forecasts).

<https://www.maine.gov/climateplan/climate-impacts/climate-data>

Changing Distribution and Abundance of Species



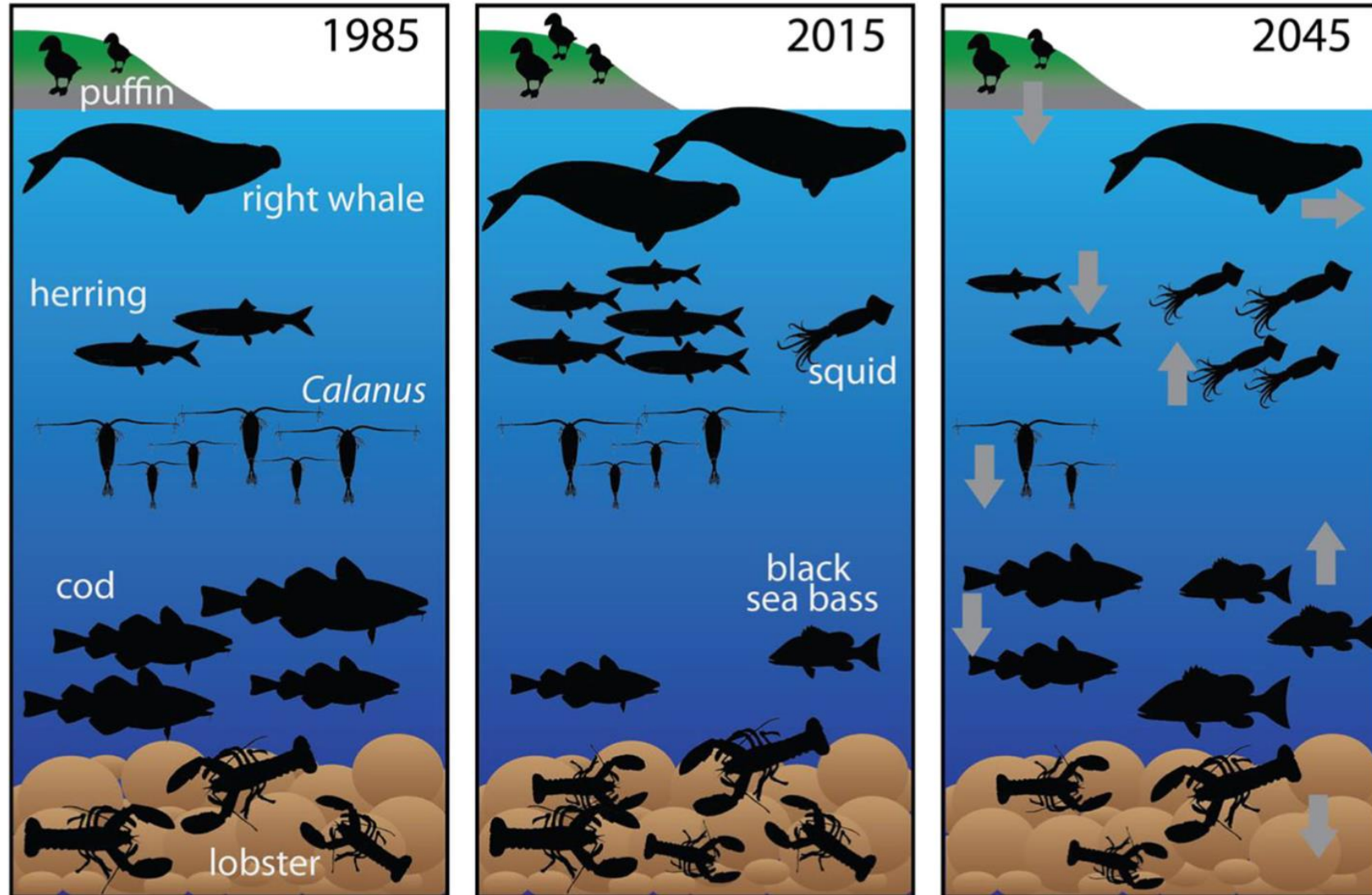
Disruptions in Predator/Prey Dynamics

REVIEW

Climate impacts on the Gulf of Maine ecosystem:
A review of observed and expected changes in 2050
from rising temperatures

(Pershing et al. 2021)

- marine species have higher sensitivities to warming and faster rates of colonization than terrestrial species
- local extirpations related to warming have been twice as common in the ocean as on land and species turnover is faster in the ocean



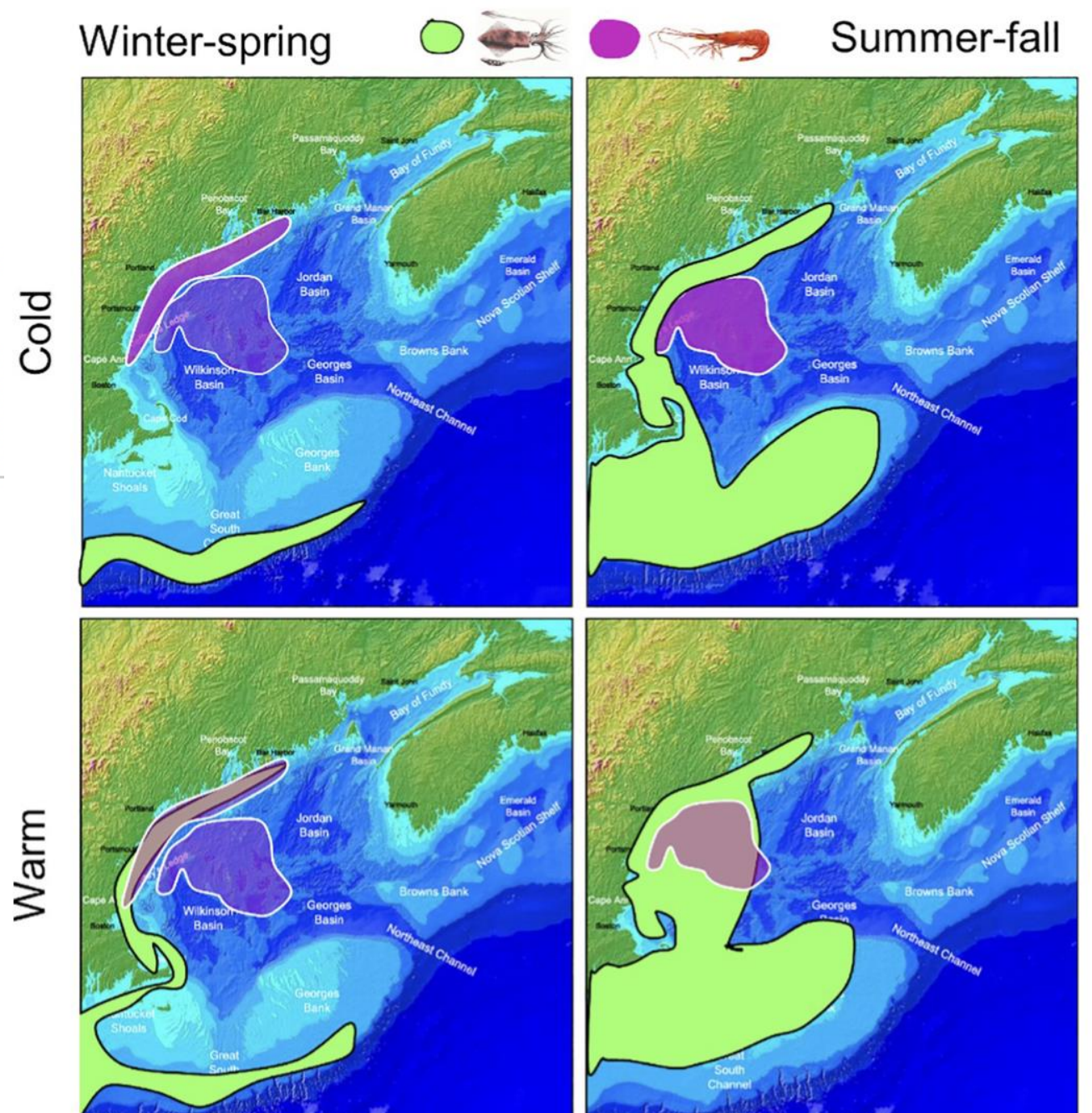
Changing Predator/Prey Relationship Impacting Northern Shrimp

Decision coming on whether to allow Maine shrimp fishing

AP by The Associated Press
November 15, 2021

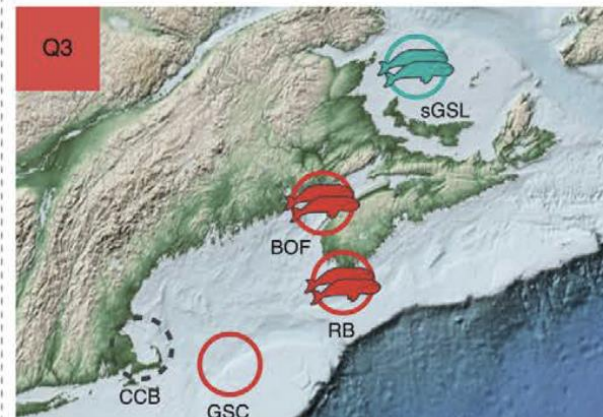
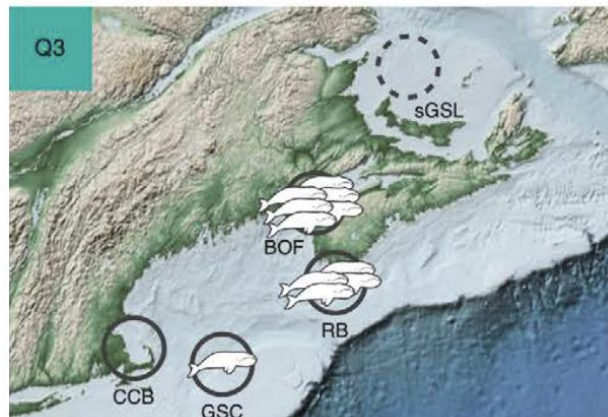
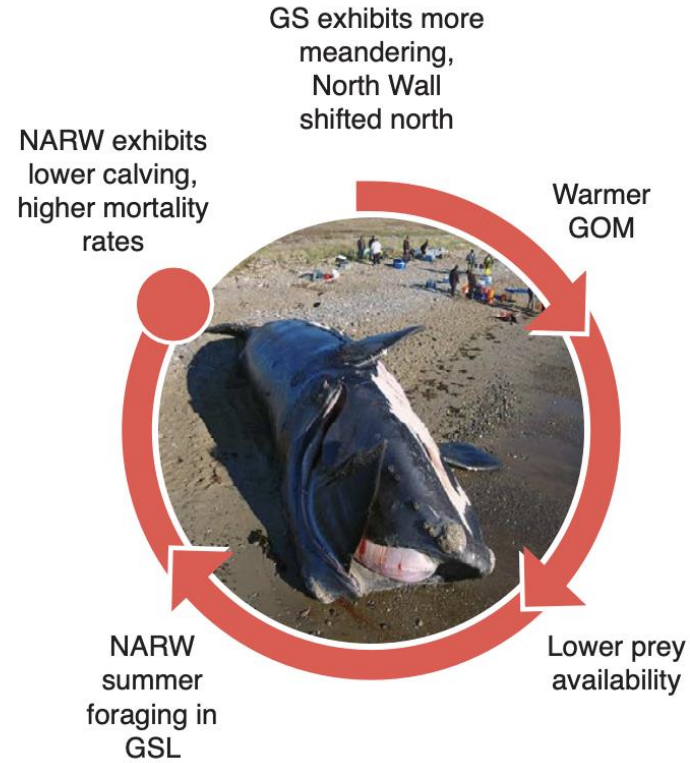
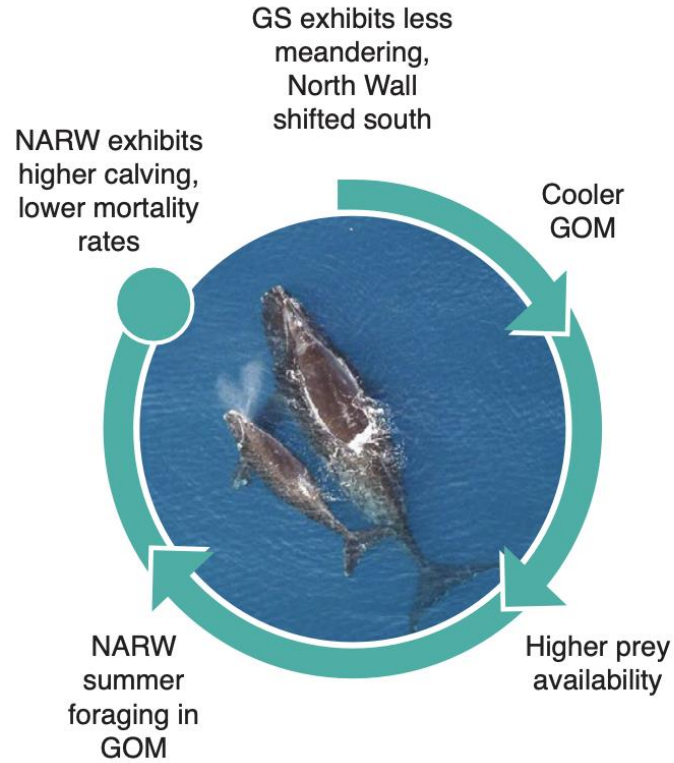


In this Jan. 6, 2012 file photo, northern shrimp, also called pink shrimp, lay on snow aboard a trawler in the Gulf of Maine. Credit: Robert F. Bukaty / AP



Conceptual model of seasonal distribution patterns of northern shrimp and longfin squid. (from Richards and Hunter, 2021)

Impacts of Changing Ocean Conditions on the North Atlantic Right Whale



Preparing for Sea Level Rise

The State of Maine is planning for the intermediate scenario of 1.5 feet of relative sea level rise (SLR) by 2050 and 4 feet of SLR by 2100.

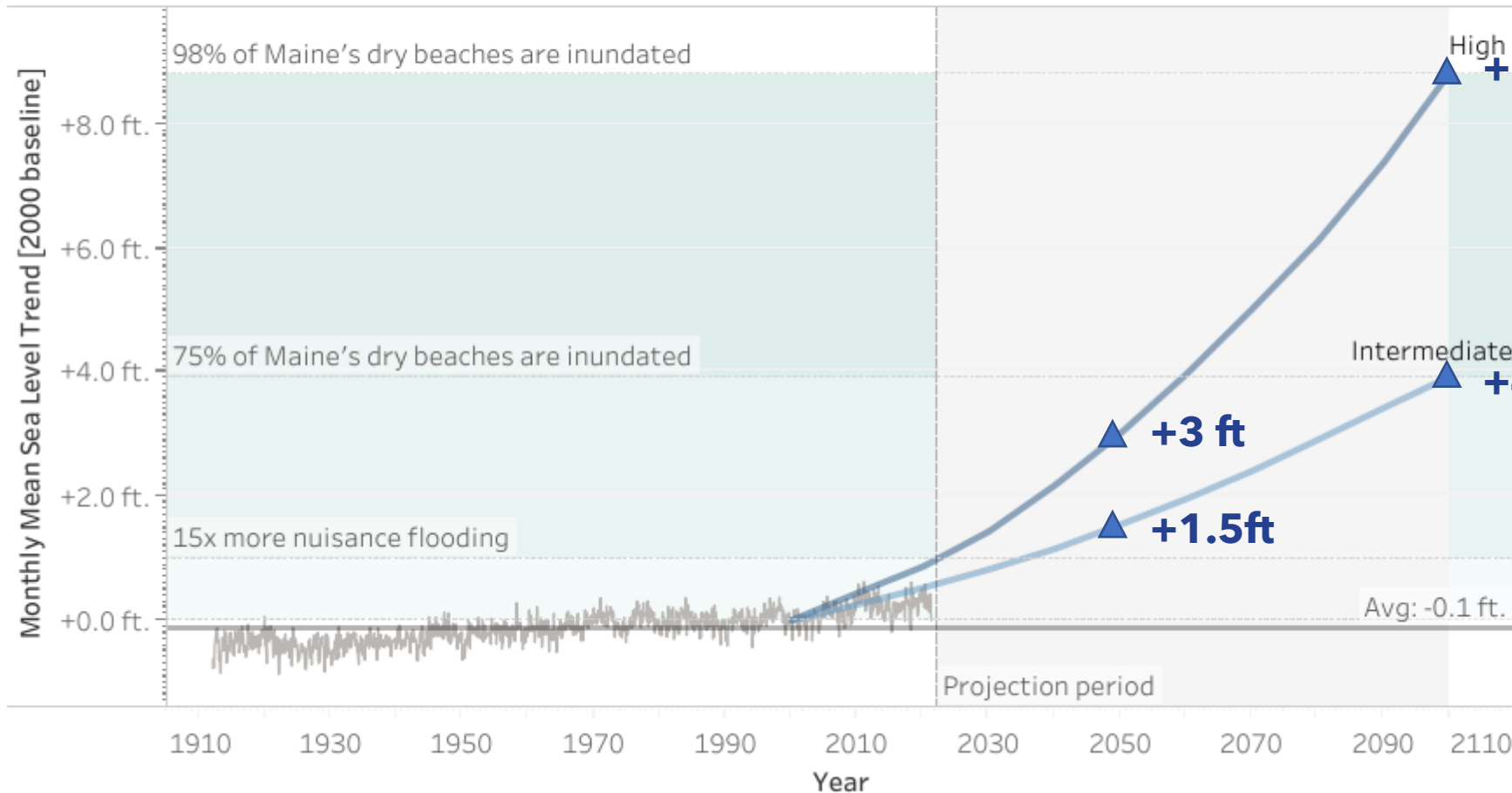
Sea Level Rise Trend vs. 2000 baseline

Tide gauge: All

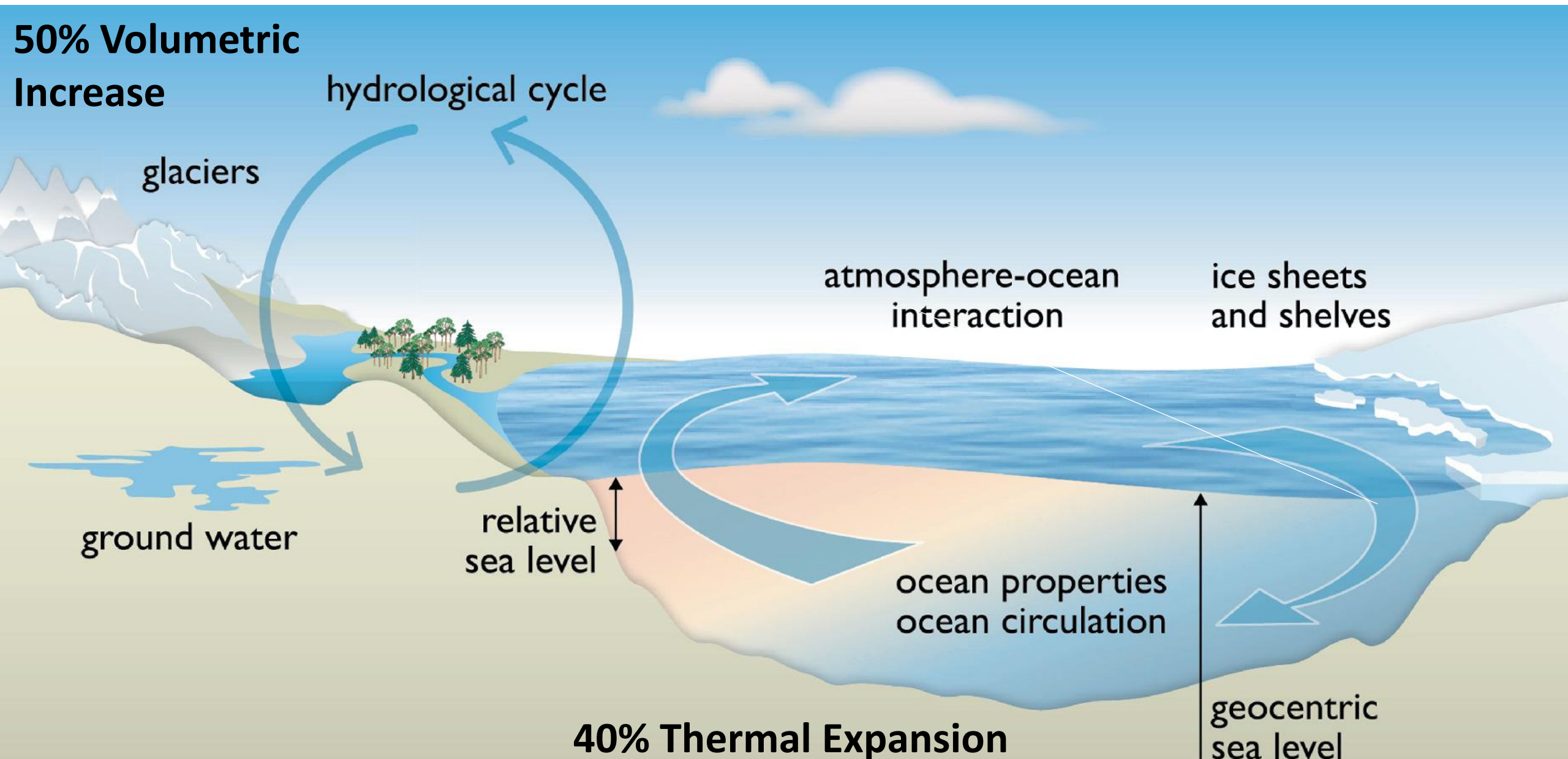
Use your cursor to drag and select a comparison period in the bars to the right. Click away to reset the selection.

Projection End of century

Tide gauges
Click to filter



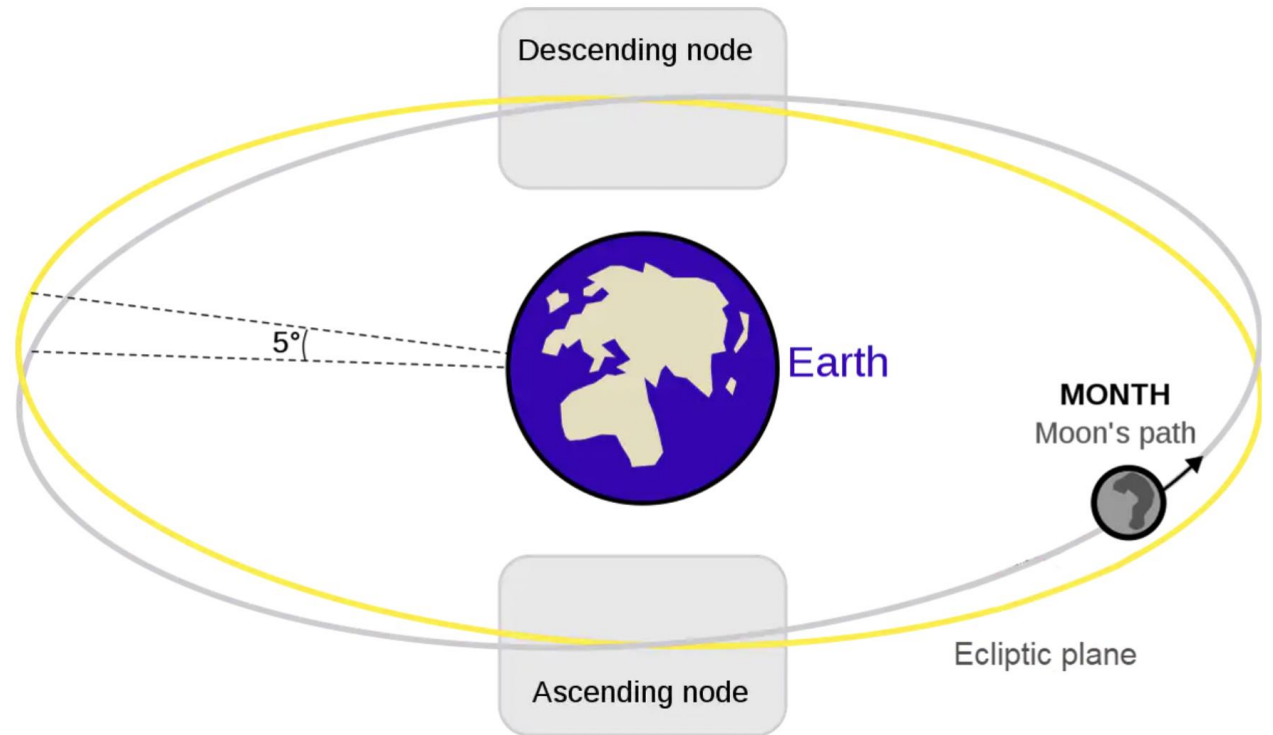
Causes of Sea Level Change



(IPCC, 2001)

Atmosphere-Ocean Interaction

18.6 year **Lunar Nodal Cycle**- a natural cycle of the orbits of the Earth and the moon that exaggerates and mutes tides on Earth, and thus enhances or suppresses the effects of sea level rise



- currently in a downward phase of the lunar nodal cycle, reducing the impact of SLR over the next few years
- after 2025 will start the upward phase, and by 2030 or sooner, the rate of SLR will likely rise significantly over the linear trend for over a decade

Possible temporary reprieve should not mask the fact that it will be replaced by an even faster rate

Month	Highest Average Monthly Sea Level (through November 2021)					
	Seavey Island	Wells	Portland	Bar Harbor	Cutler	Eastport
	1930-2021*	2005-2021	1912-2021	1947-2021	2011-2021	1929-2021
January	2021	2021	2010	2010	2021	2019
February	1978	2010	2010	2010	2020	2010
March	1958	2018	2010	2018	2018	2018
April	2021	2020	2020	2020	2020	2020
May	1960	2017	2017	2017	2017	2017
June	1998	2012	2012	2012	2018	2011
July	2020	2019	2009	2019	2019	2011
August	2021	2021	2011	2011	2011	2011
September	2021	2021	1996	2021	2021	2010
October	2021	2021	2021	2021	2021	2021
November	2021	2021	1970	2021	2019	2019
December	2020	2012	2010	2010	2019	2010

** Seavey Island, ME tide gauge was added to MGS SLR Ticker in December 2021; it has data gaps from 1987-1998 and 2001-2019*

SEA LEVEL RECORDS SET IN 2021:

- Eastport: 2nd highest November since 1929 (and 2021 so far is 3rd highest average annual sea level)
- Cutler 2nd highest November since 2011 (and 2021 so far is highest average annual sea level)
- Bar Harbor: 1st highest November since 1947 (and 2021 so far is 2nd highest average annual sea level)
- Portland: 5th highest November since 1912 (and 2021 so far is 3rd highest average annual sea level)
- Wells: 1st highest November since 2005 (and 2021 so far is highest average annual sea level)
- Portsmouth: 1st highest November since 1930 (and 2021 highest average annual sea level, realizing there are a few gaps in the record)

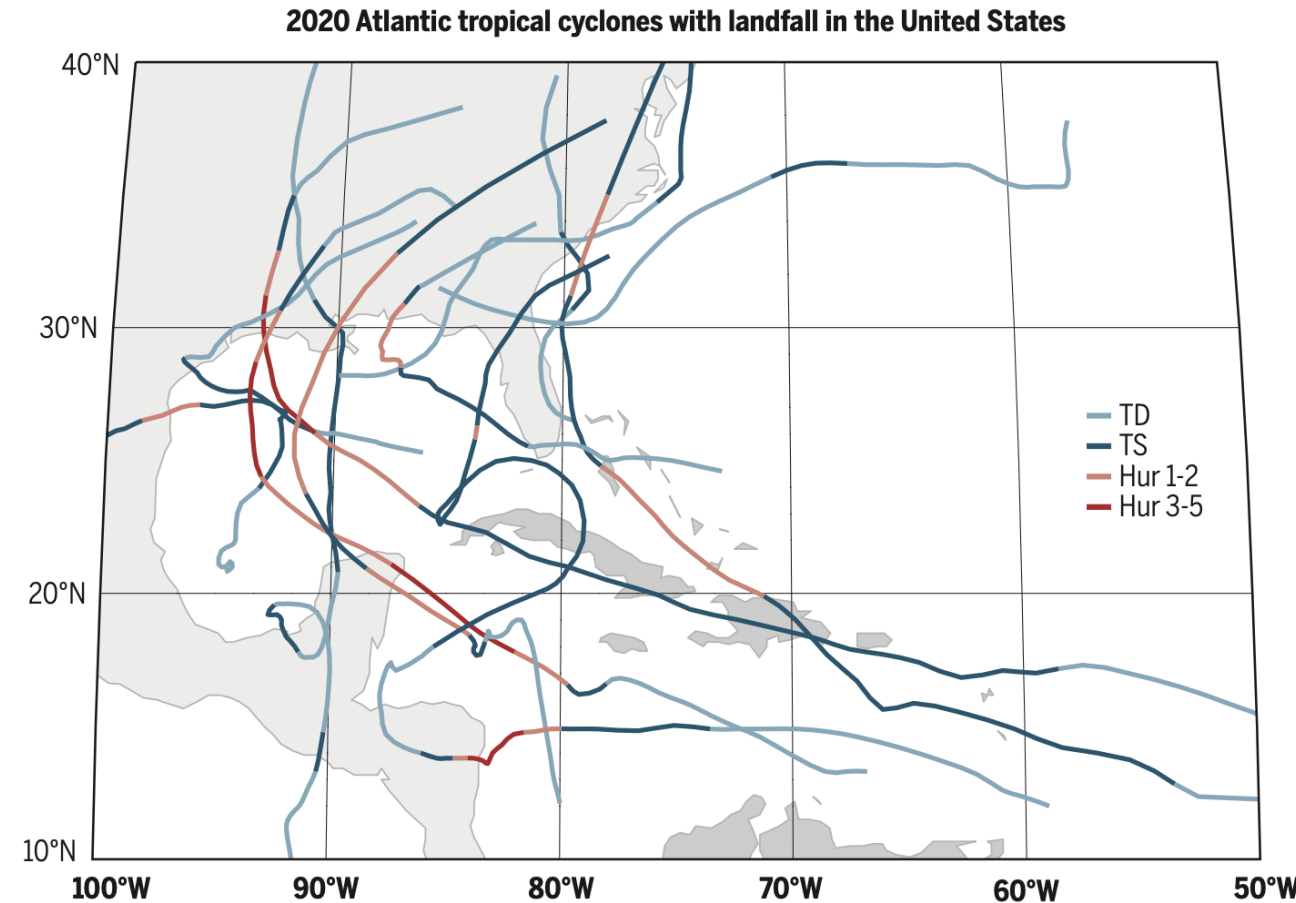
Changes in Storm Tracks and Activity

Background- Tropical Cyclone (TC) activity with warming

- ↑ occurrence and intensity of most intense TC
- ↑ precipitation associated with TC
- ↑ storm surge flooding

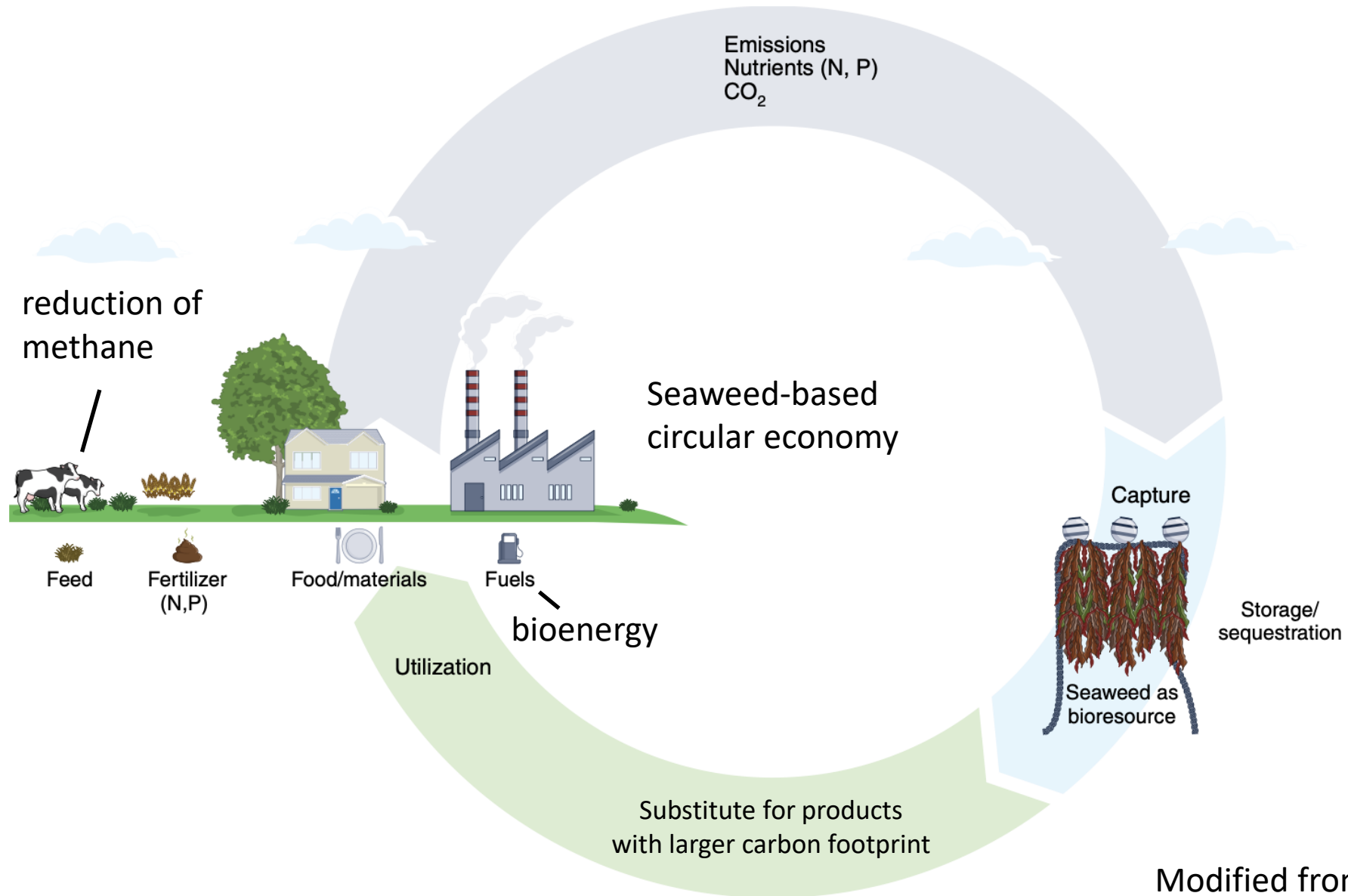
New insights-

- Tracks shifting poleward and westward, potentially impacting unprepared regions not typically affected by intense TCs
- TC activity close to land is increasing, and seeing increased stalling of Atlantic TCs- with a substantial increase in risk to coastal regions (Wang & Toumi 2021)



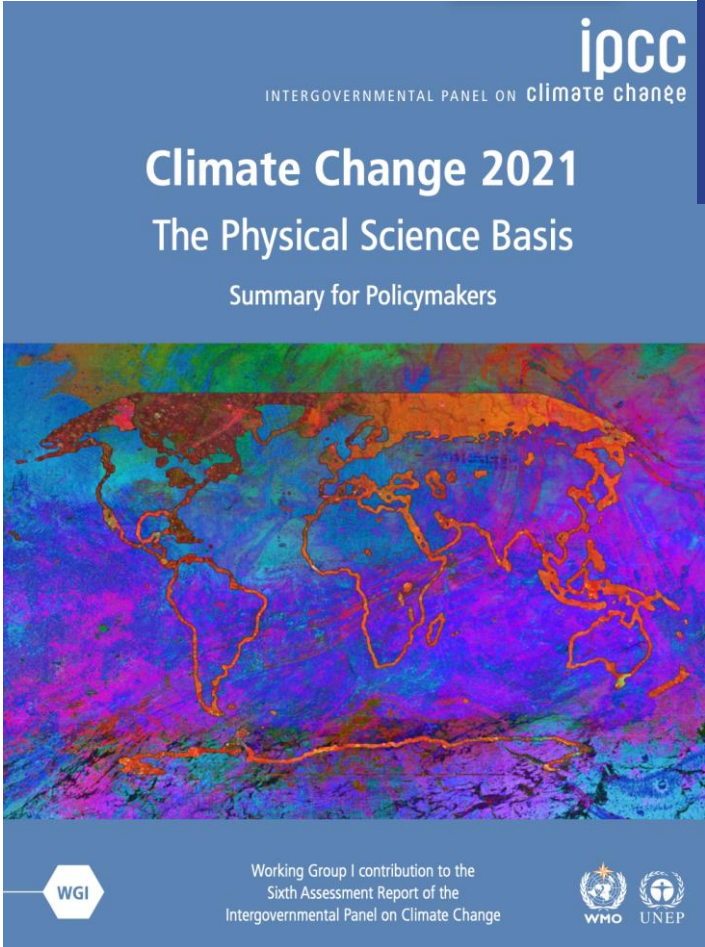
Advances in Climate Services of Farmed Seaweeds

-potential for climate action in Maine

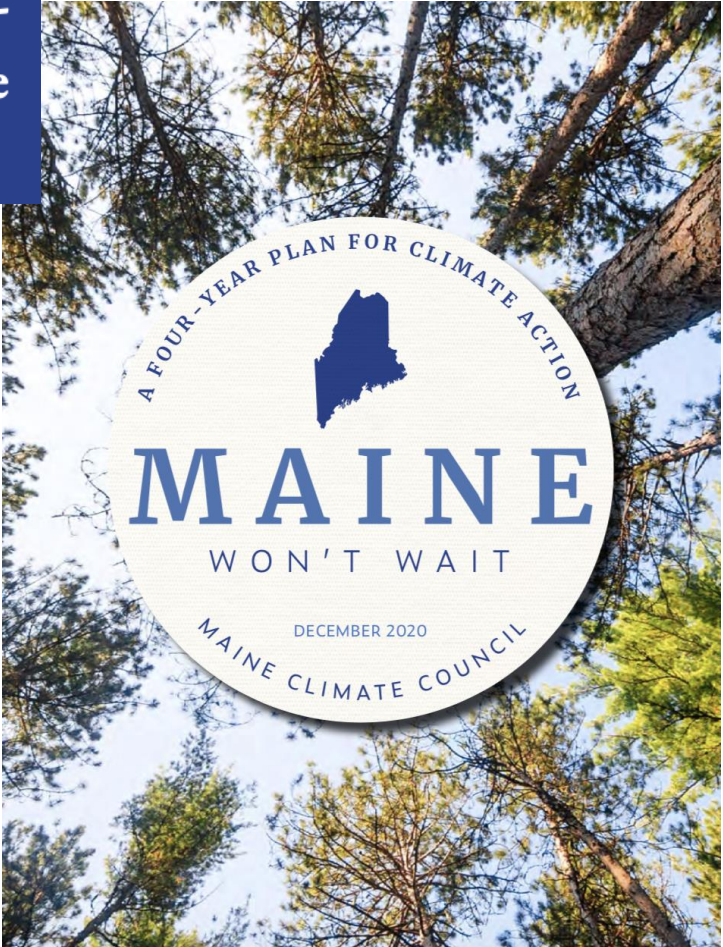


In Conclusion

This is the last IPCC report that will be released while the world still has time to avoid the worst of our possible climate futures beyond 1.5°C (2.7°F) global warming after 2050. However, that requires society to immediately cut greenhouse gas emissions to be able to achieve carbon neutrality by around 2050.



...but *rates* of continued change can be decreased or reversed for *all* indicators of climate change with deep reductions in greenhouse gas emissions



Extra Slides

CO₂ emissions in World Energy Outlook scenarios from 2000-2050 and the corresponding rise in global temperatures in 2100

