Introduction

Ivan J. Fernandez, Co-Chair STS
School of Forest Resources, Climate Change Institute
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Island Institute

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Maine Geological Survey

Forests, Biodiversity & Agriculture | **May 29, 2024**

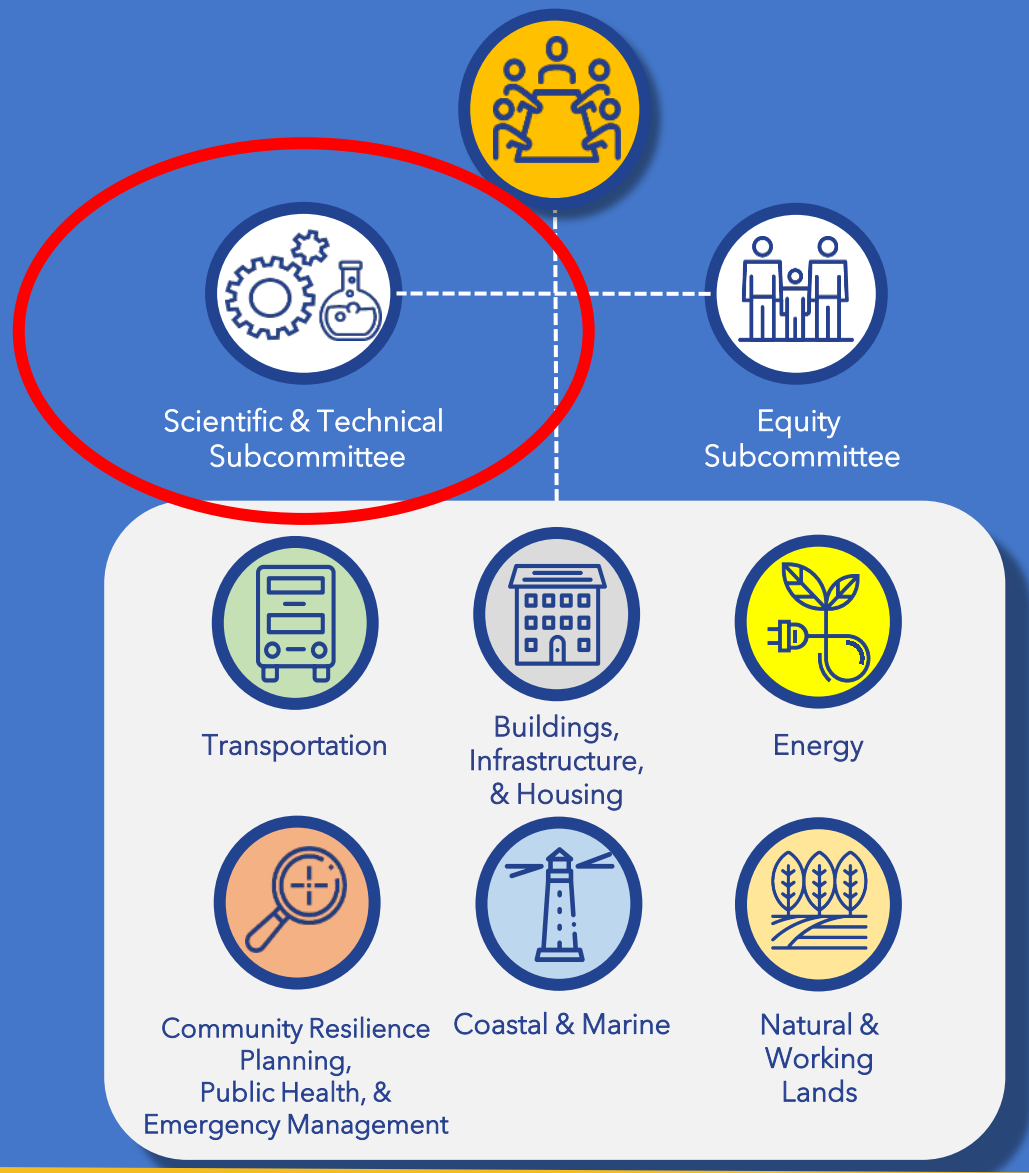
Maine Climate Council

The **39-member Maine Climate Council**, an assembly of scientists, industry leaders, bipartisan local and state officials, is responsible for **developing a Climate Action Plan** for Maine.

An expert **Scientific and Technical Subcommittee** is responsible for identifying the impacts of climate change in Maine.

An **Equity Subcommittee** will support planning and implementation of climate strategies to ensure benefits across diverse populations of Maine people.

Six working groups comprised of 230+ volunteer members recommend strategies to the Council for achieving Maine's climate goals.

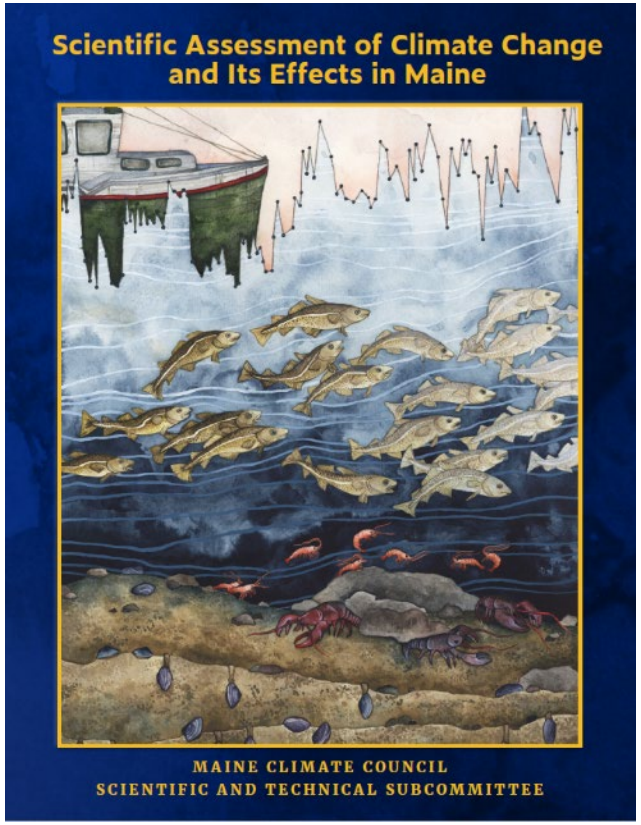


The Maine Climate Council Scientific and Technical Subcommittee

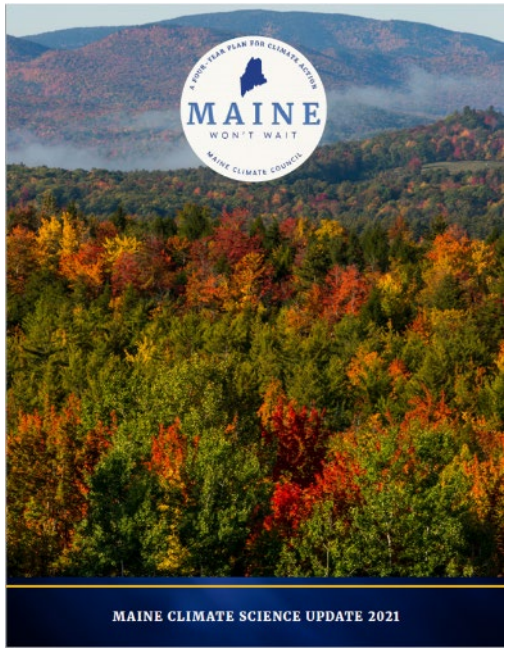
What do we do?

In 2019, Public Law Chapter 476 established the Maine Climate Council and the Scientific and Technical Subcommittee (STS) within the Council **"to identify, monitor, study and report out to the council and to the working groups…findings and recommendations related to climate change in the State and its effects on the State's climate, species, marine and coastal environments and natural landscape and on the oceans and other bodies of water."**

Maine Climate Science Assessment



2020



2021

Scientific Assessment of Climate Change and Its Effects in Maine

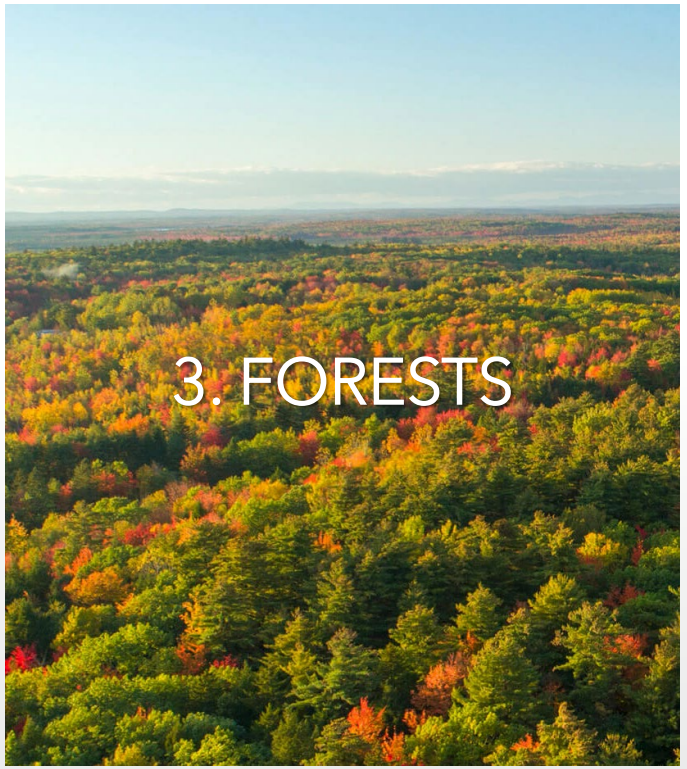
2024

www.maine.gov/future/climate/council/sts

climatechange.umaine.edu/climate-matters/maines-climate-future/


1. AGRICULTURE


2. BIODIVERSITY


3. FORESTS

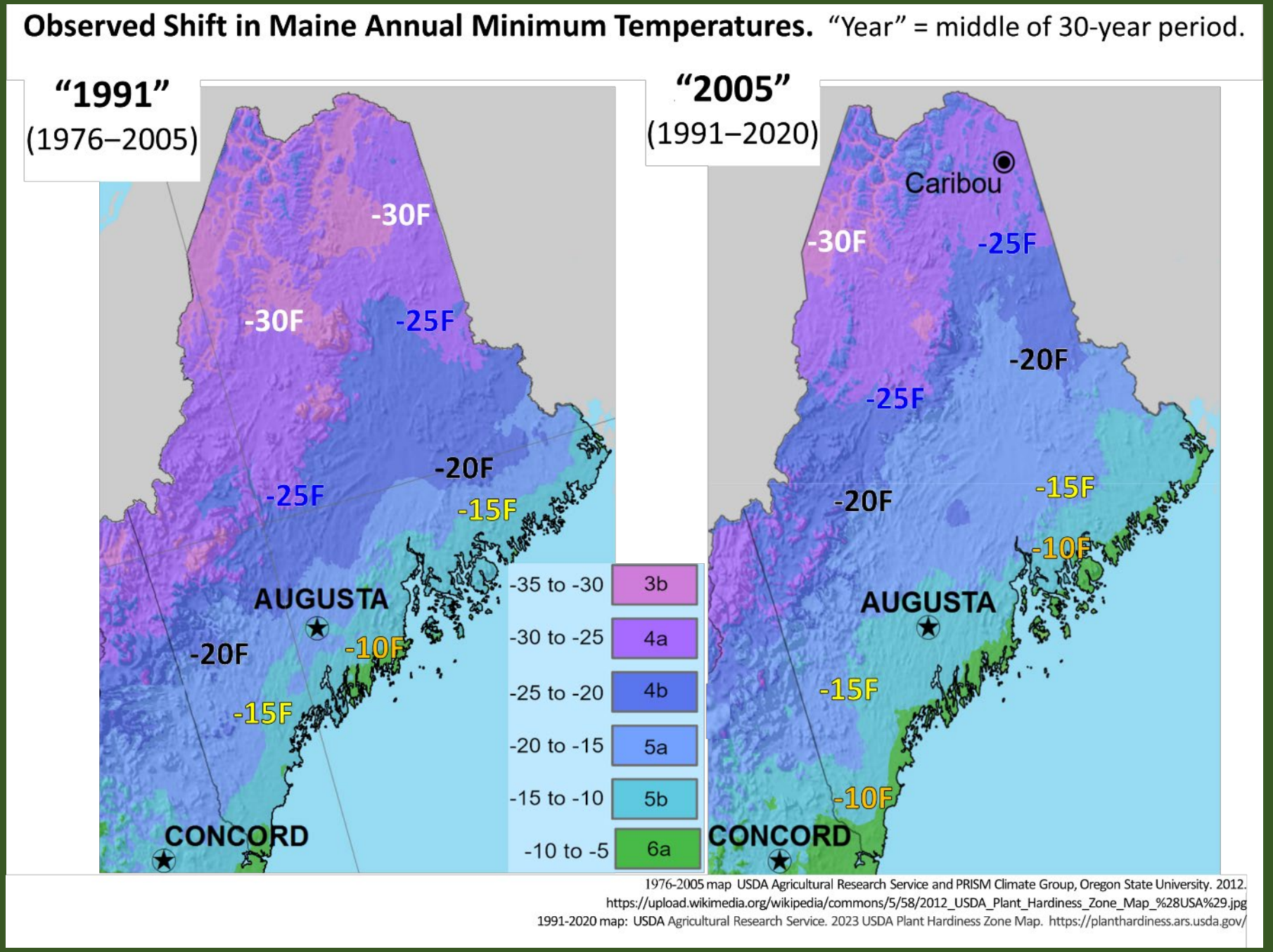
Agriculture & Food

Glen Koehler
University of Maine

Forests, Biodiversity & Agriculture

May 29, 2024

Annual minimum temperatures have increased, with slight northward migration of "Plant hardiness zones."

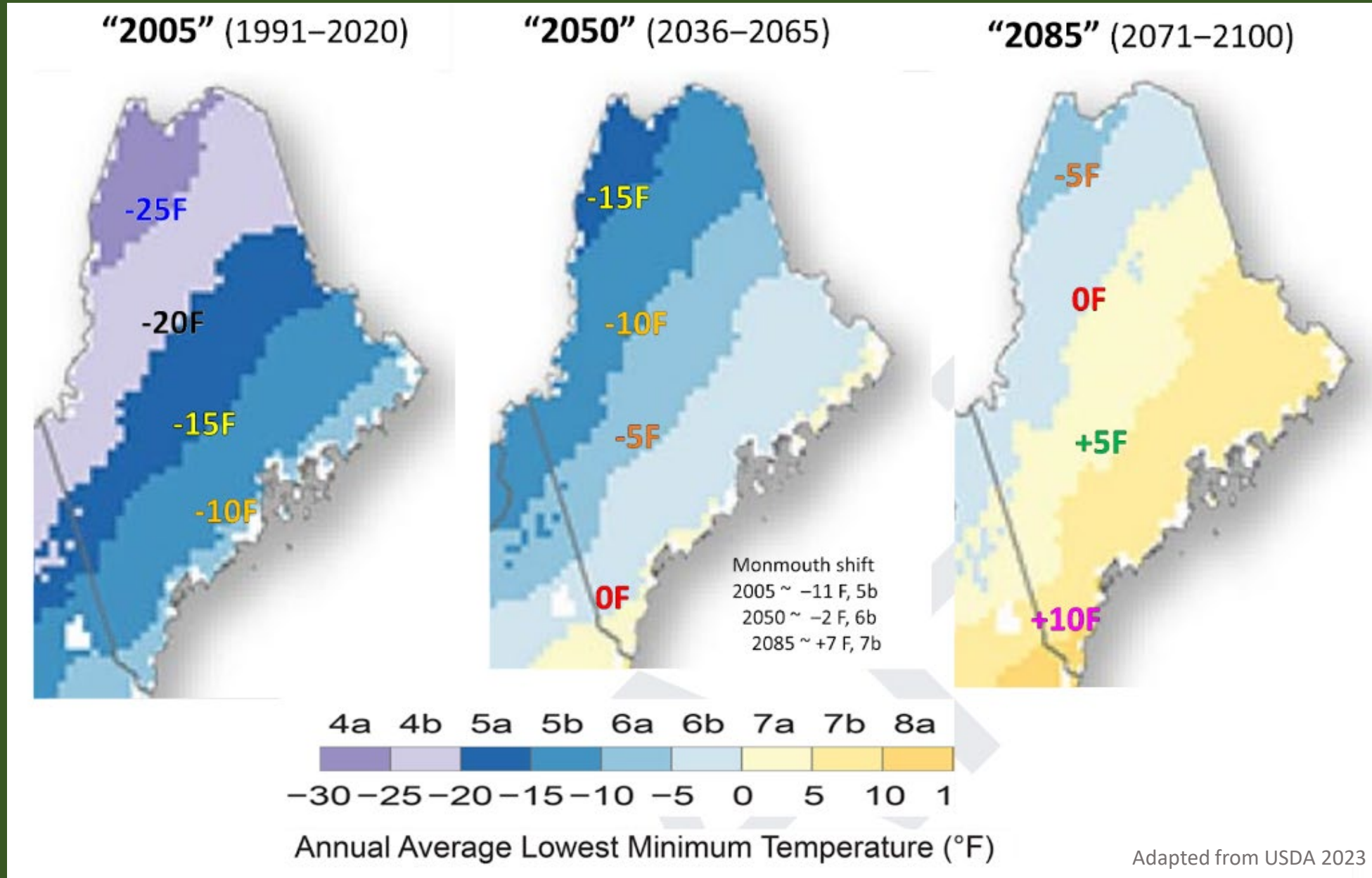


Adapted from USDA 2023

Warming brings both benefits and costs

The rate of minimum temperature zone migration is expected to increase. Perennial crop options will increase.

With increased winter survival of current and new insect, disease, and weed pests.

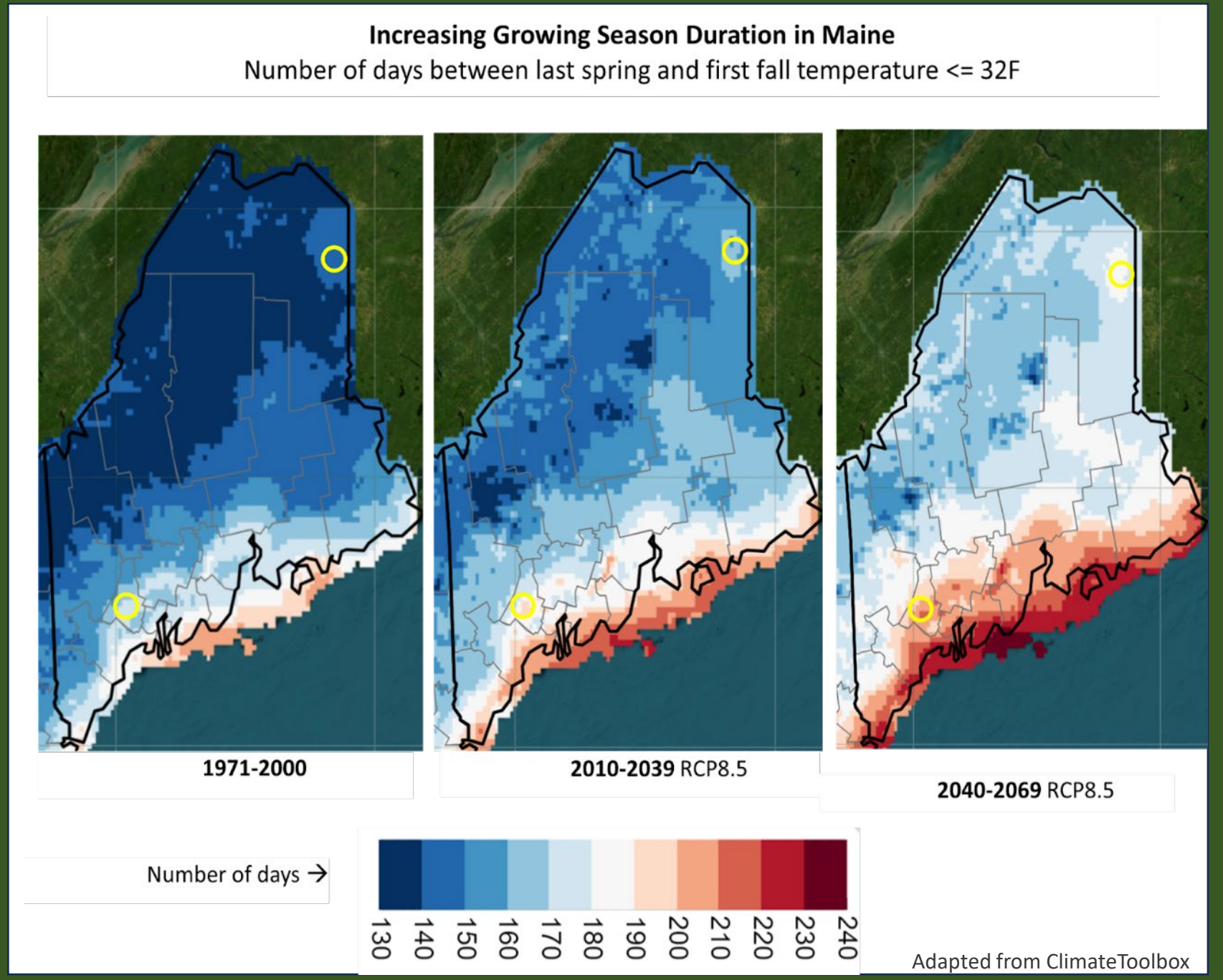


Adapted from USDA 2023

Longer and warmer growing seasons

allow for a wider range of crop options and potential for higher yields

Observed and projected growing season duration: RCP8.5 future emissions scenario (difference from 1971-2000)				
	1971-2000	**2010-2039**	**2040-2069**	**2070-2099**
PRESQUE ISLE	**145**	**161 (+16)**	**183 (+38)**	**196 (+51)**
LEWISTON	**176**	**195 (+19)**	**212 (+36)**	**223 (+47)**



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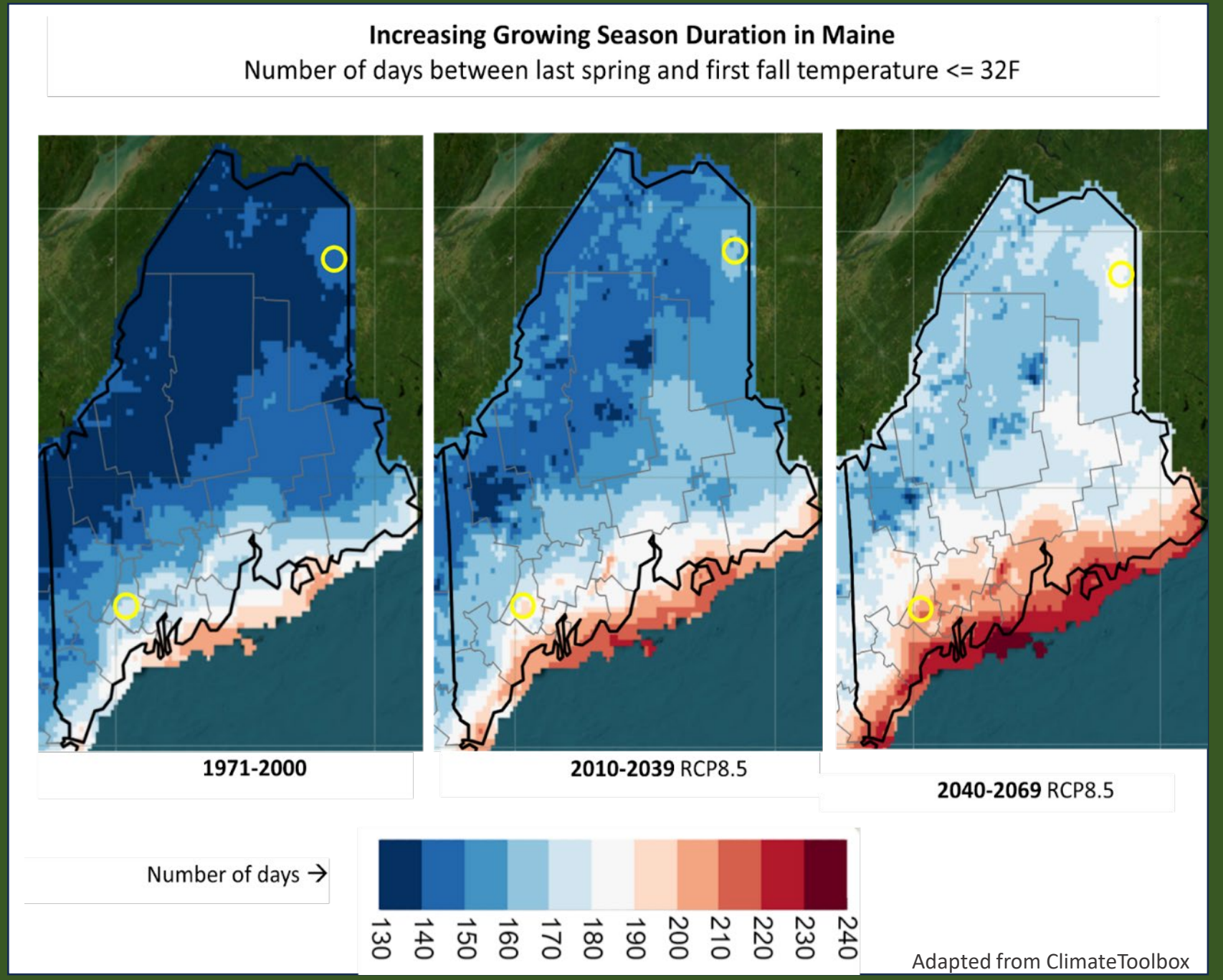
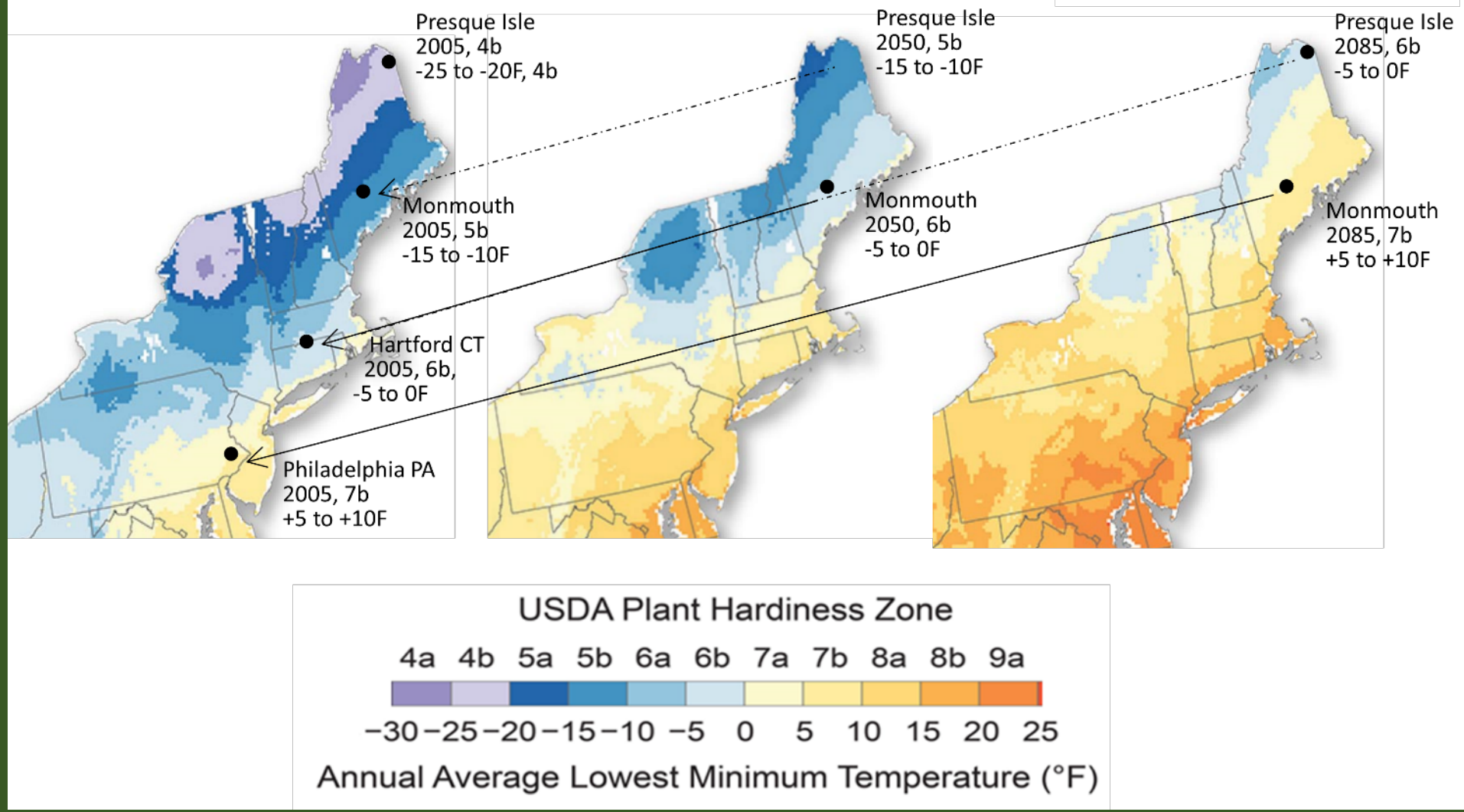


Central Maine temperatures transition to match current CT & MA in 2050, and southern PA & NJ in 2085.

But Maine sunlight & soils remain the same, so the net effects are ???

Observed and Projected Shift in Annual Minimum Temperature

"Year" = middle of 30-year period. Projections based on SSP5-8.5 scenario



Variable and Extreme Weather can counteract any Ag gains from warming

Apples made unsaleable by combination of an early bloom followed by unusually late frost on May 18, 2023

Photos: Glen Koehler

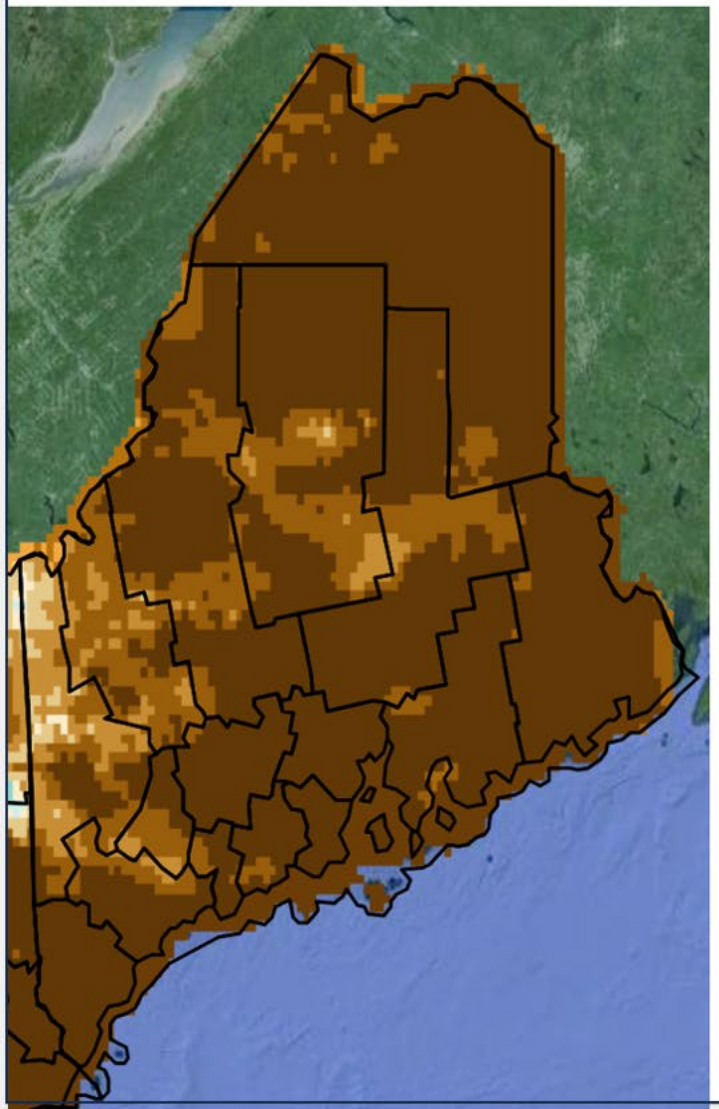
A tale of two seasons

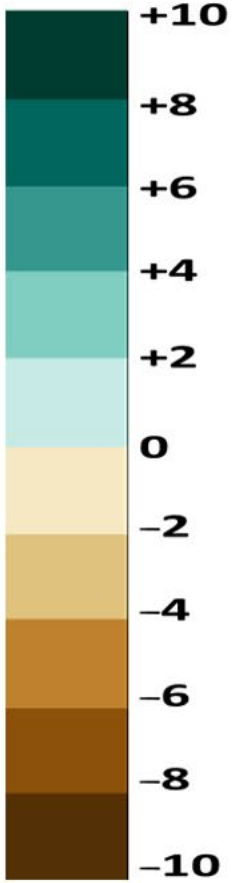
June 1 to September 30

Inches Precipitation minus Evapotranspiration

vs. 1990 – 2019 average

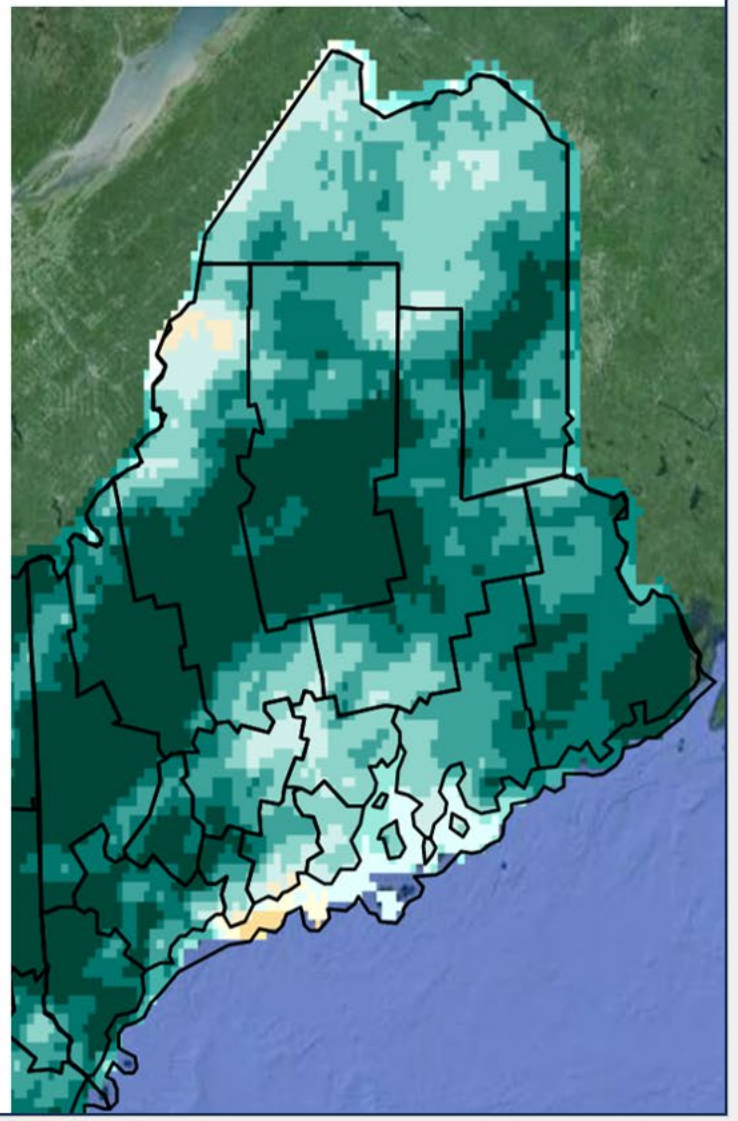
2020





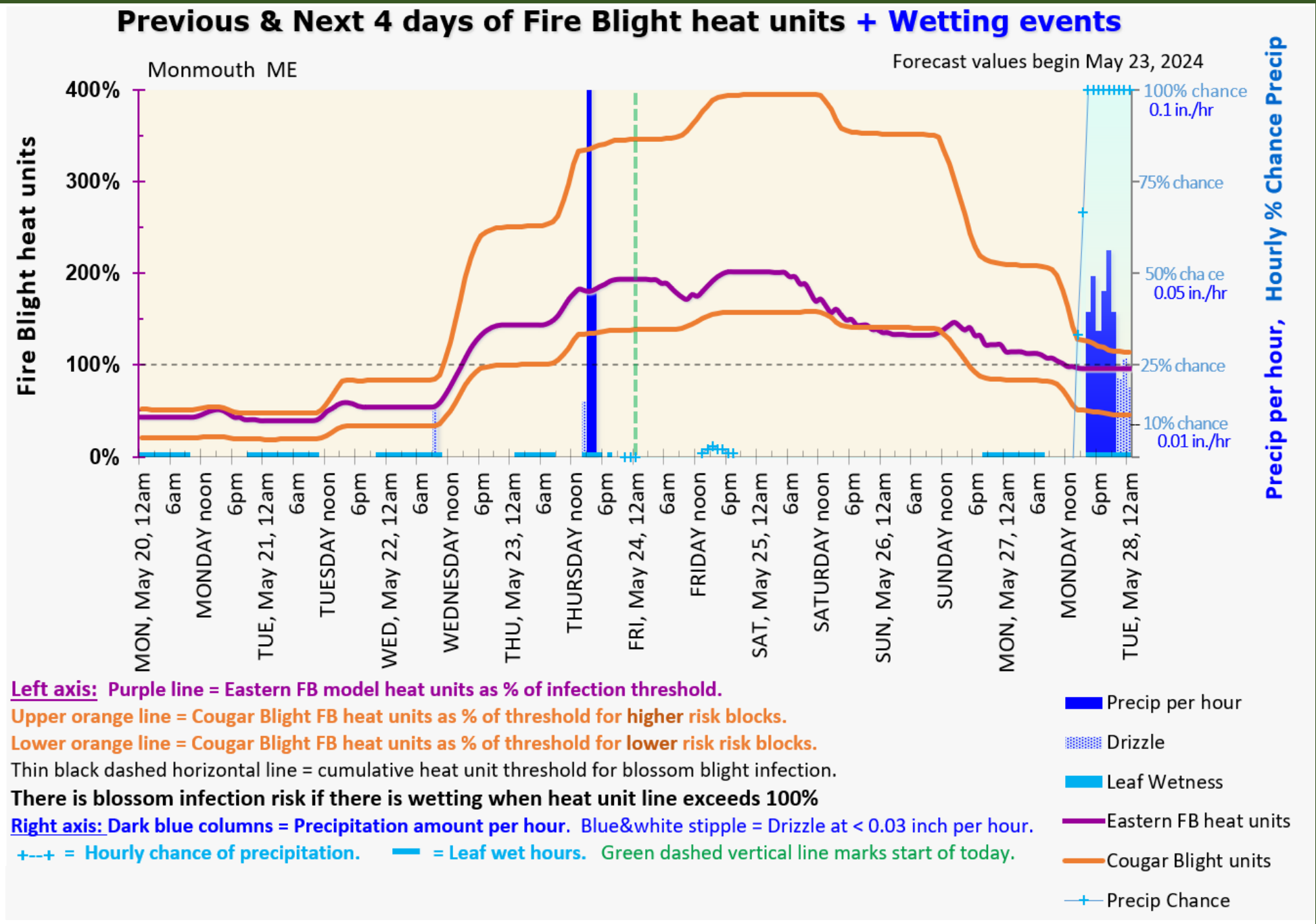
Inches rain vs. average

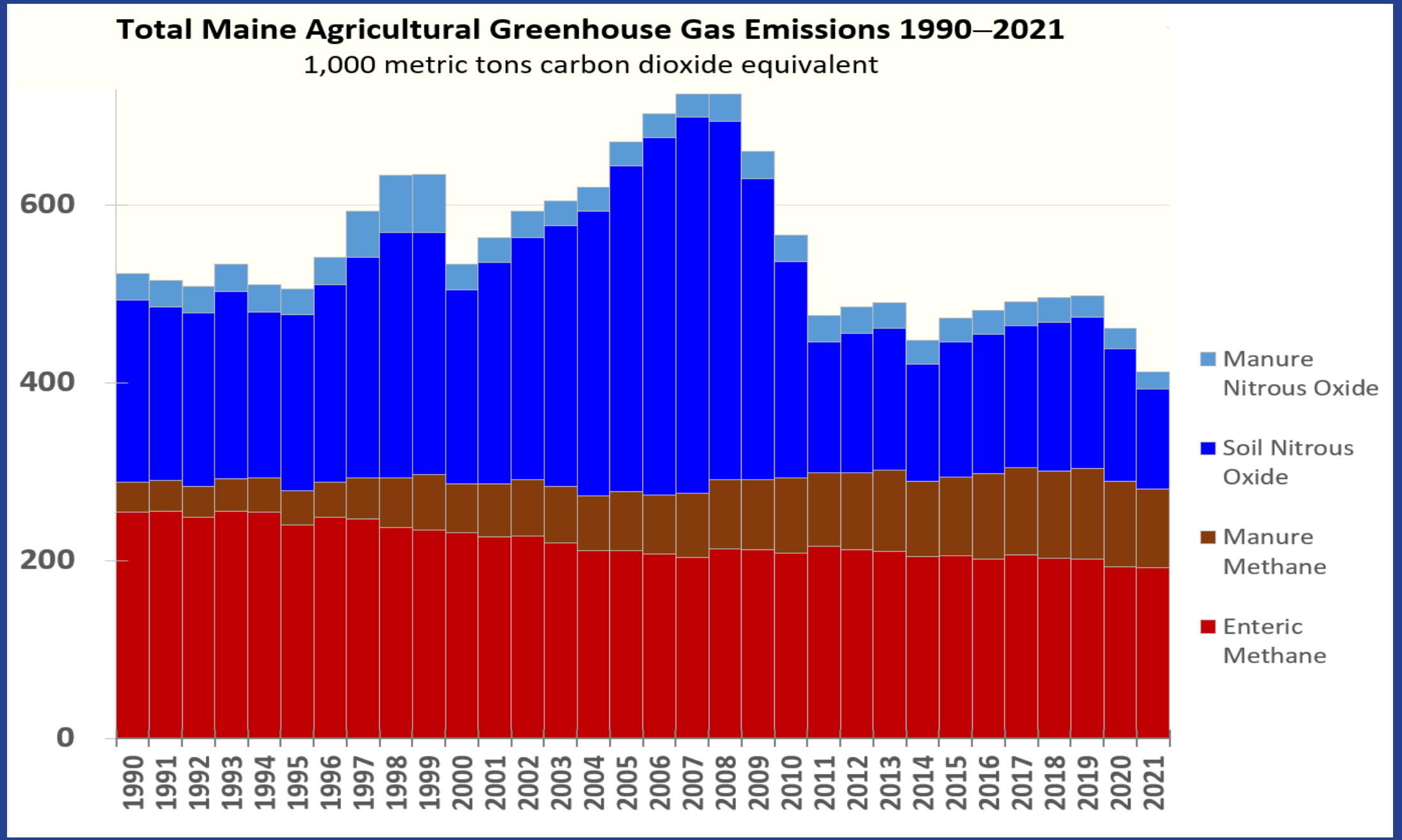
2023



Adapted from ClimateEngine.org, 2024.

Mitigation of weather impacts by information tools




Total Maine Agricultural Greenhouse Gas Emissions 1990–2021
1,000 metric tons carbon dioxide equivalent
600
400
200
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
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2002
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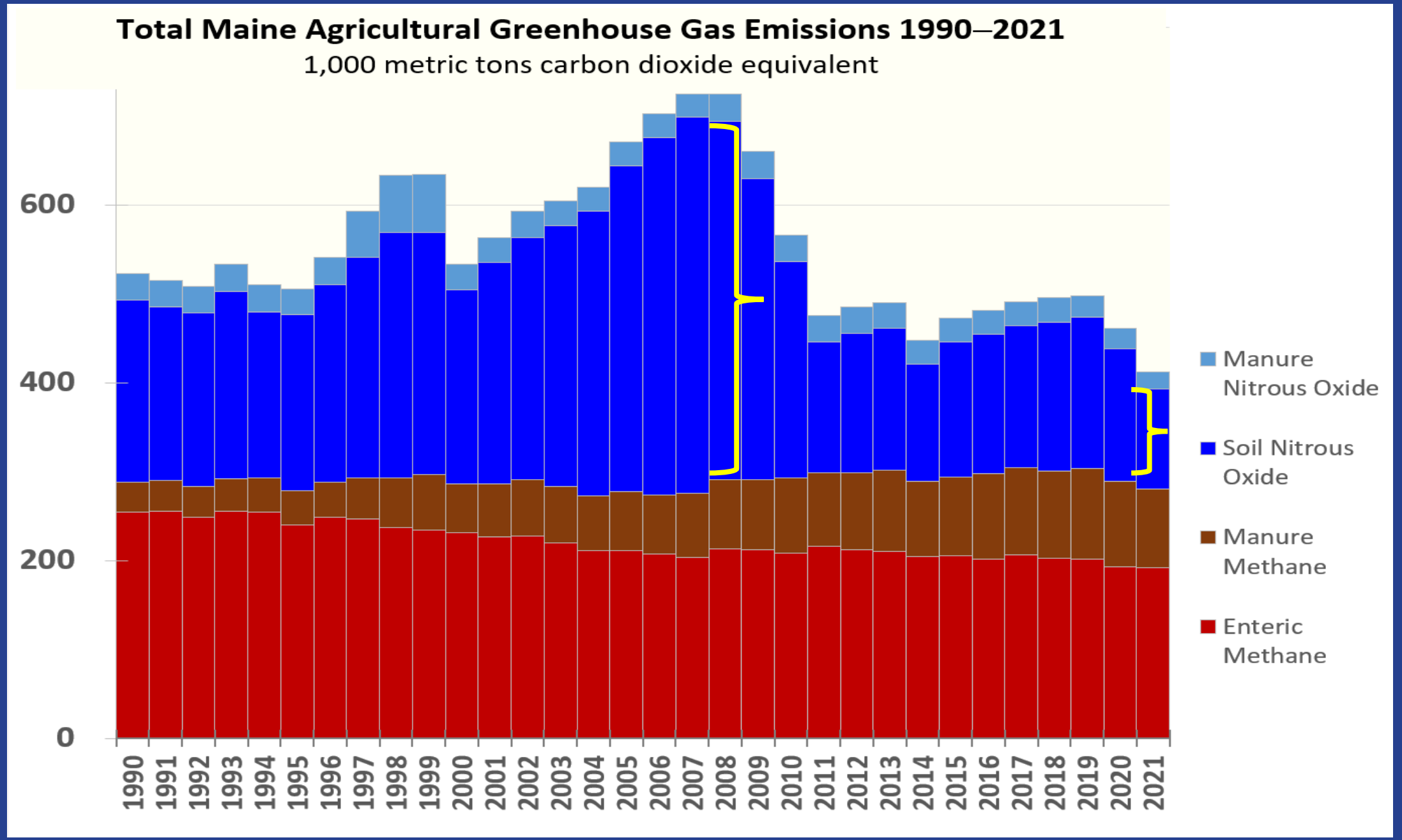
2019
2020
2021
Manure Nitrous Oxide
Soil Nitrous Oxide
Manure Methane
Enteric Methane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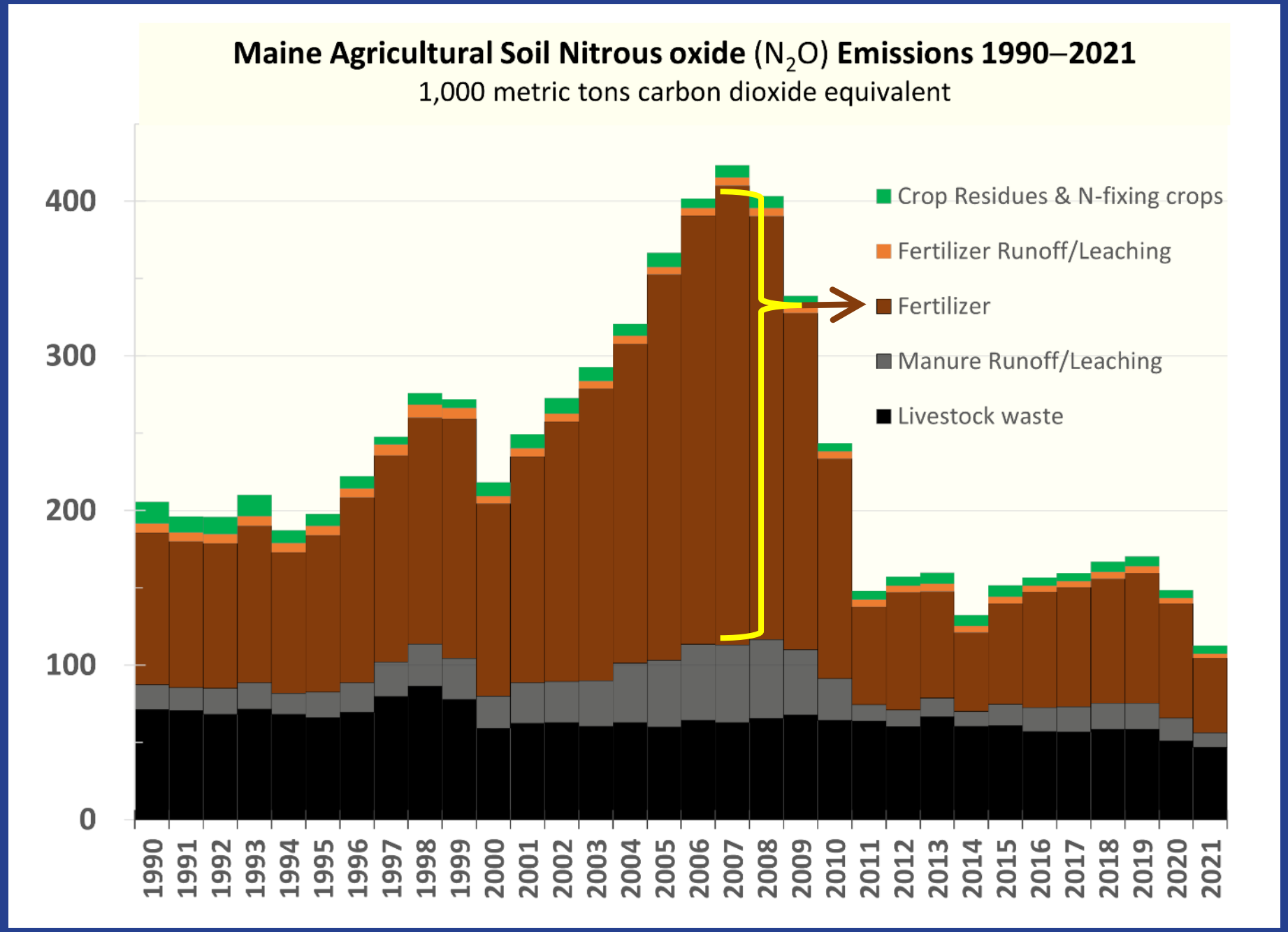
Maine Agricultural Soil Nitrous oxide (N_2O) Emissions 1990–2021
1,000 metric tons carbon dioxide equivalent
400
300
200
100
0
Crop Residues & N-fixing crops
Fertilizer Runoff/Leaching
Fertilizer
Manure Runoff/Leaching
Livestock waste
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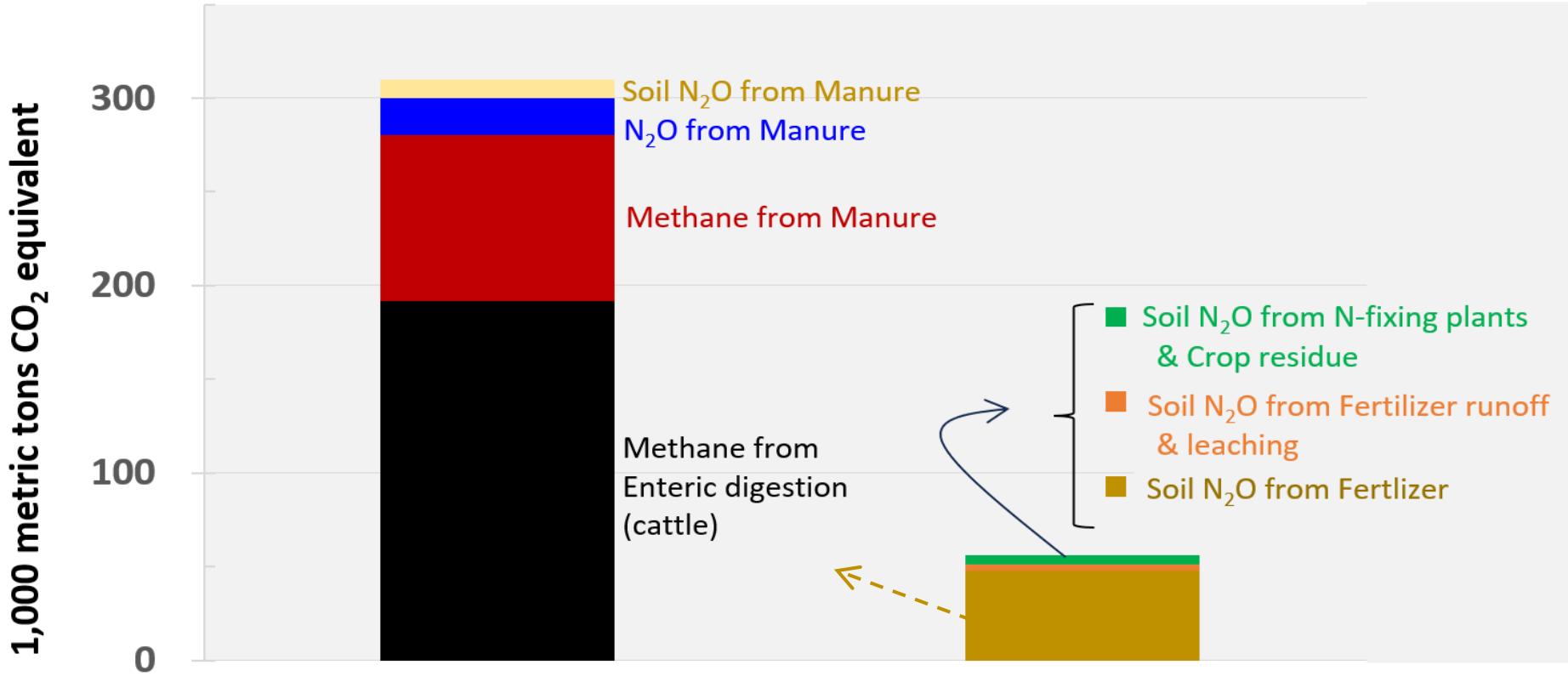
2021

CONTEXT:
Agricultural production accounts for ~2% of Maine total GHG emissions

Maine 2021 Agricultural Greenhouse Gas Emissions: Livestock-only vs. Other Agricultural sources

1,000 metric tons carbon dioxide equivalent

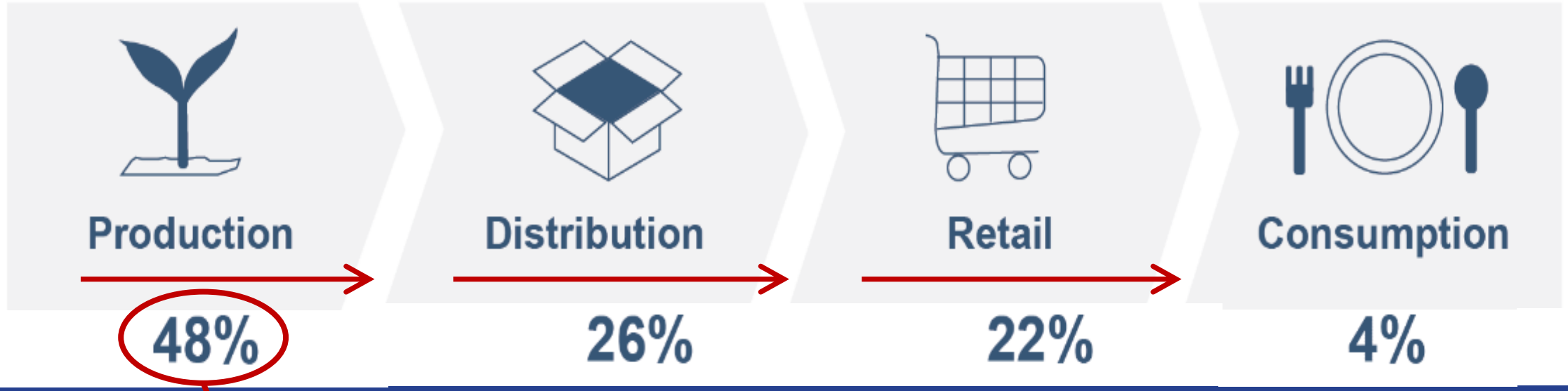


Livestock-only
- includes emissions directly from livestock animals and manure management.

Other Ag sources (including livestock feed)
Hay, pasture, and livestock forage account for ca. 75% of Maine crop acreage, so a large portion of fertilizer use is also livestock-related. CO_2 emissions are 1.1 metric ton from urea fertilizer and too small to display.

Data: Stacy Knapp, Graph: Glen Koehler

Greenhouse Gas Emissions by Food Supply Chain Stage



Nationally, more than half of food GHG emissions are off-farm

and in the end…
30+% of food is lost as waste

Data and graph adapted from 5th National Climate Assessment

Biodiversity

Kristen Puryear
Maine Natural Areas Program

Forests, Biodiversity & Agriculture | **May 29, 2024**

Photo: K. Puryear

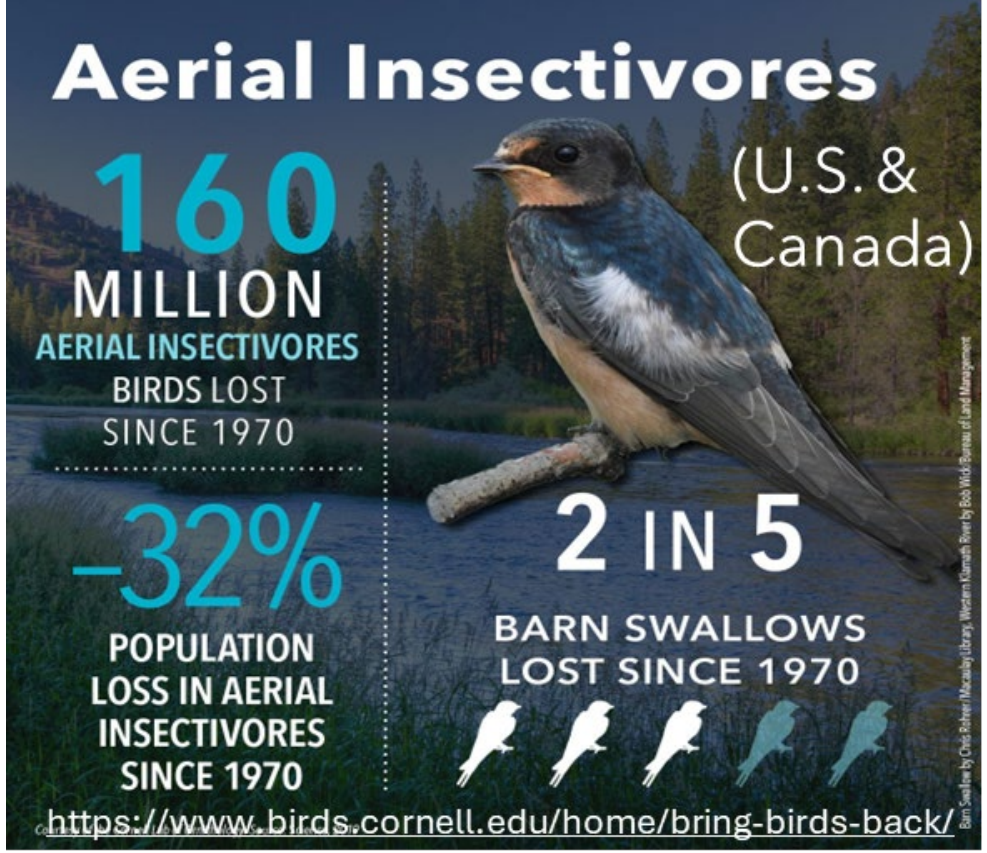
Status of Biodiversity

Broad Trends

- An unprecedented 50 years
- Climate change exacerbating worldwide declines
- Local extinctions and range shifts

Habitat impacts

- Seasonal mismatch, parasites, diseases
- Interruptions to food webs & ecosystem structure
- Invasive plants and animals



Kelp forest (photo: Shane Farrell)

Status of Biodiversity

Species impacts

- 8 wildlife species added to Maine's Endangered and Threatened Species List (in 2023)
- 21% of Maine's butterflies are listed rare/threatened/endangered/extirpated (25% due to climate change)
- With 3°C warming, range shifts predicted for 100 North American bird species (including Loons)

Spotted salamander egg mass (photo: K. Puryear)

Japanese stiltgrass (photo: MNAP)

Katahdin arctic butterfly (Mark McCollough)

Saltmarsh sparrow (photo: B. Bienvenuti)

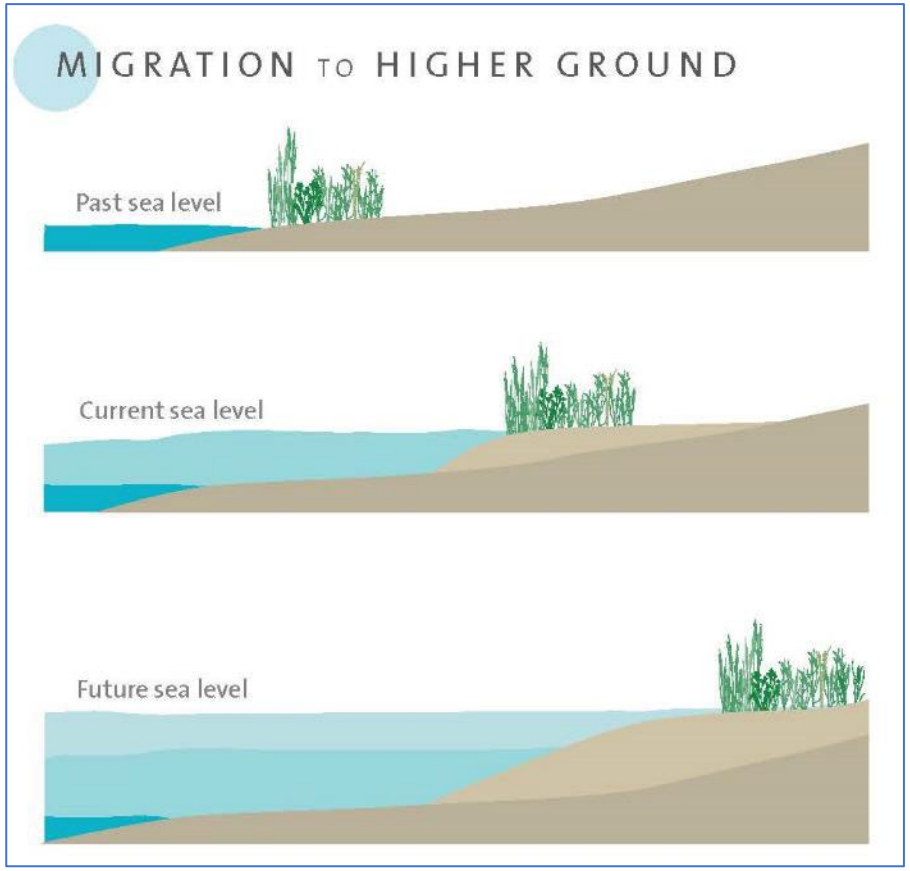
Tri-colored bat (photo: USFWS)

Emerging and Compounding Threats

Habitat loss is still the primary driver of species loss

Direct and compounding climate-related effects are increasing, including:

- Invasive species - new and expanding
- Stream temperature increases
- Sea level rise
- Stream flooding
- Habitat fragmentation



Tidal Marsh Migration inland (NROC)


Black spruce


Brook trout


Spring salamander (photo: T. Parsons)

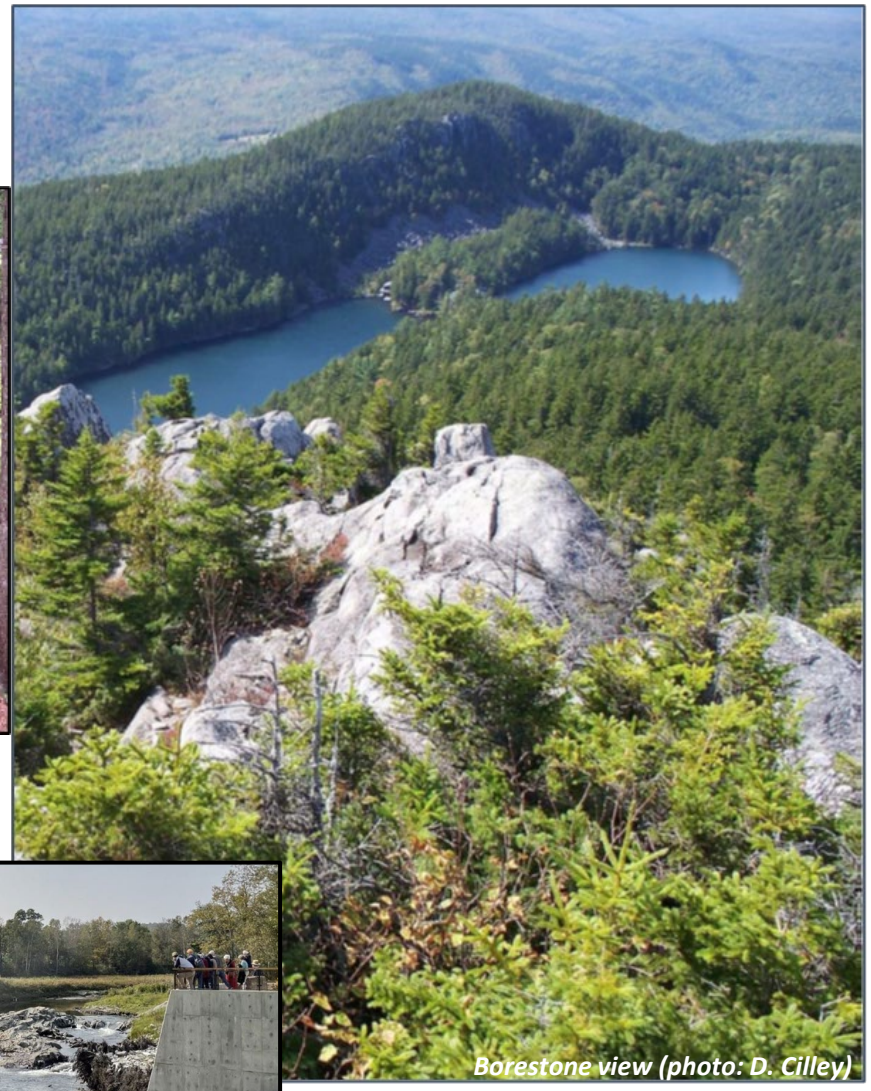
Opportunities and Considerations

Diverse landscapes support species diversity

Connected landscapes and corridors buffer climate impacts

Biodiversity protection yields nature-based solutions


Photo: MNAP


Borestone view (photo: D. Cilley)


Saltmarsh (photo: MNAP)


Riparian area (photo: MNAP)


Walton's Mill dam removal (photo: B. Emerson)

Summary

- Climate change exacerbating worldwide declines
- Local extinctions, extirpations, and range shifts expected
- Thoughtful, strategic, conservation, restoration, and management can boost resiliency and help mitigate impacts to species, habitats




Photos: K. Puryear

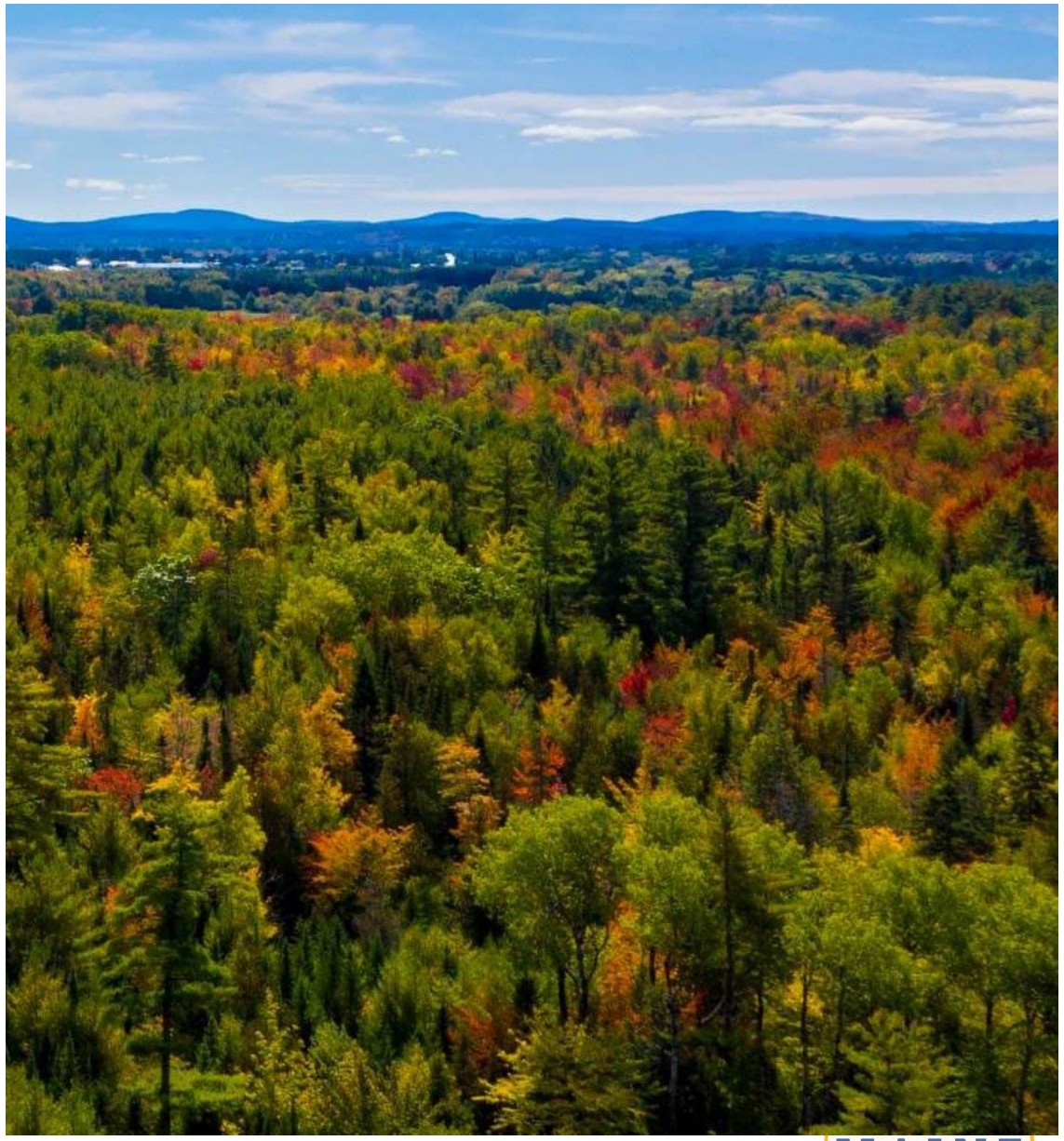
Forests & Forestry

Adam Daigneault
University of Maine

Forests, Biodiversity & Agriculture | **May 29, 2024**

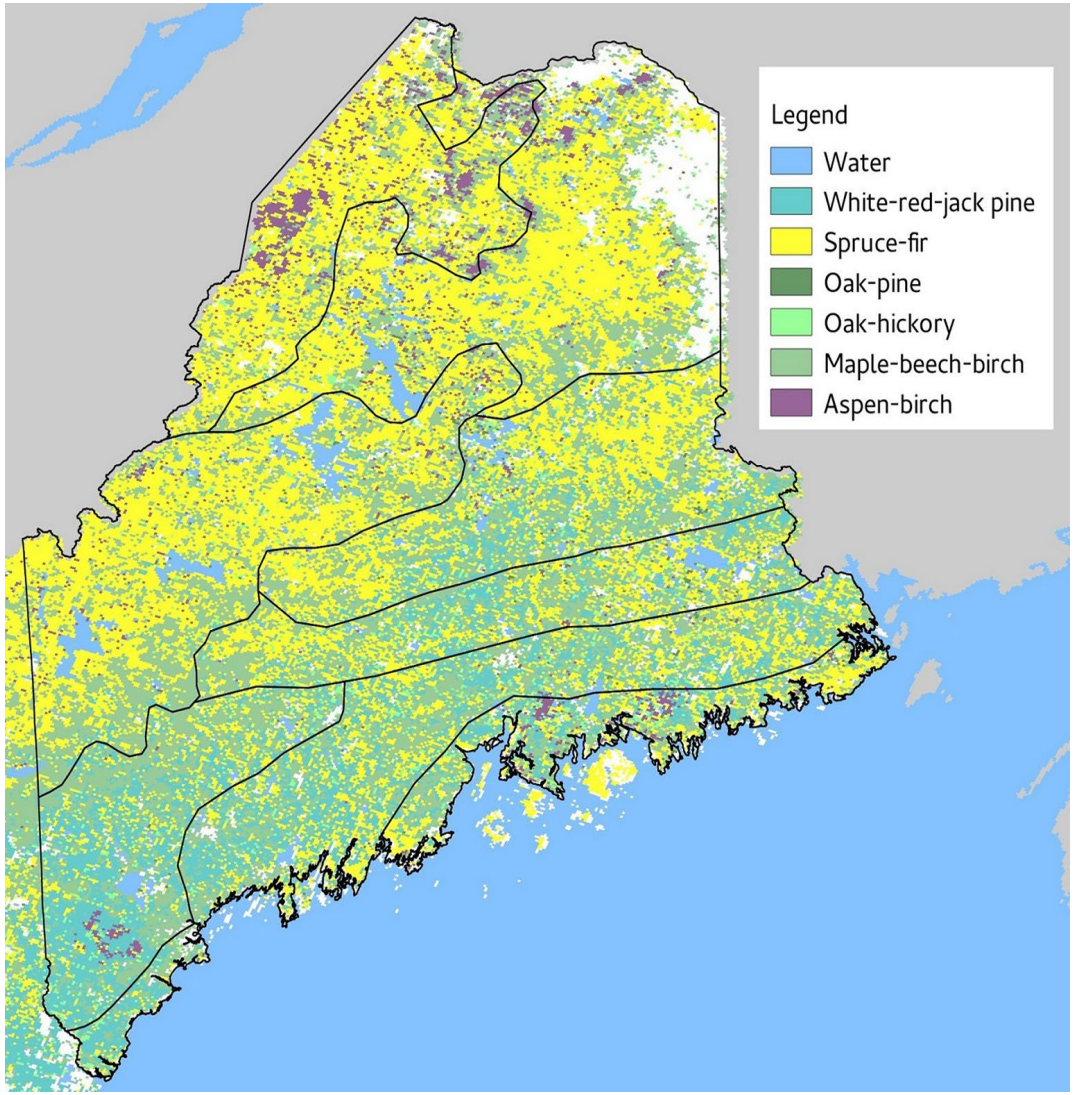
Chapter Highlights

- Maine's forests & wood products currently offset nearly all of Maine's fossil fuel GHG emissions
- Climate change has mixed effects on forest growth, yield, and ecosystem health
- Maine is becoming more vulnerable to wildfires, pest, and disease
- Active & passive adaptation measures can enhance, maintain, and restore forest values.



Forests Overview

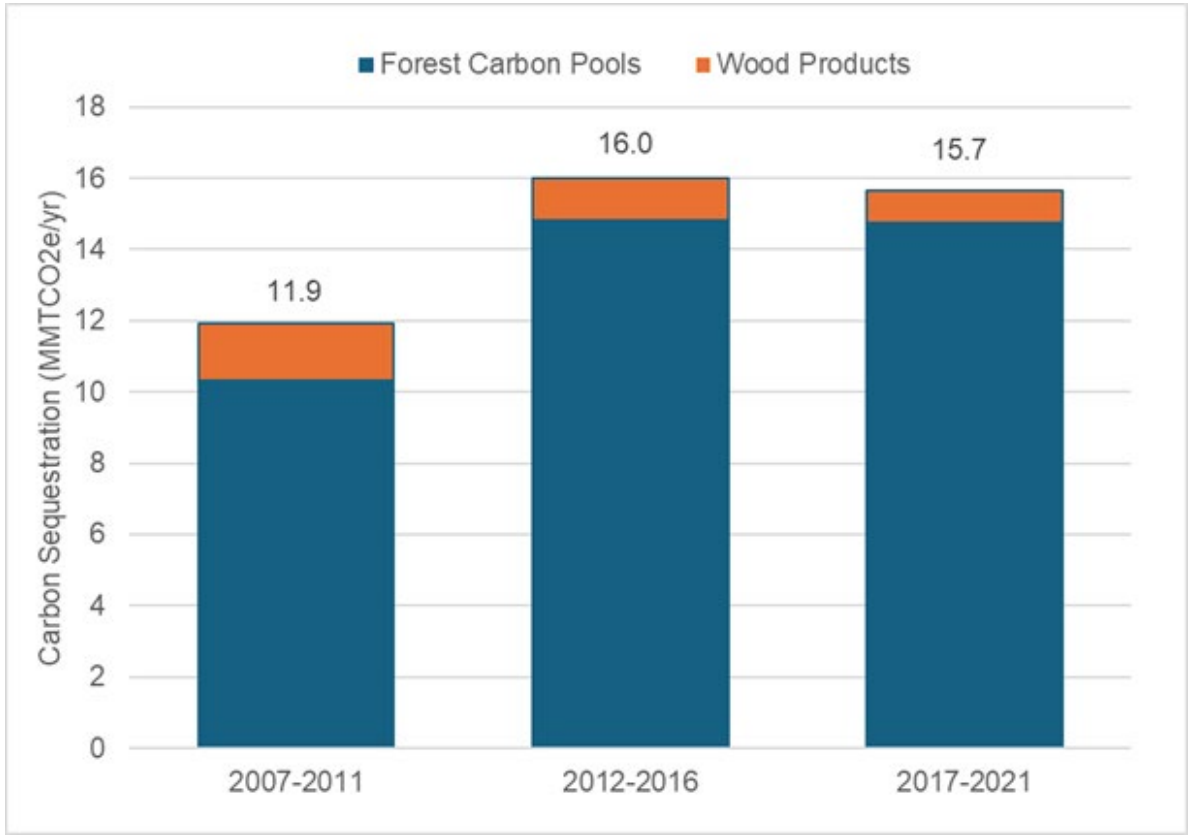
- 89% of state's land area
  - 17+ million acres
  - 90%+ privately owned
- Transitional ecosystem
  - South: temperate hardwoods
  - North: boreal softwoods
- Forest sector contributes $8+ bil/yr to state's economy



Maine's distinct climate zones and primary forest types

Maine Forest Carbon

Maine forest ecosystem and harvested wood product annual average carbon stock change for the last three FIA inventory periods (MMTCO2e/yr)



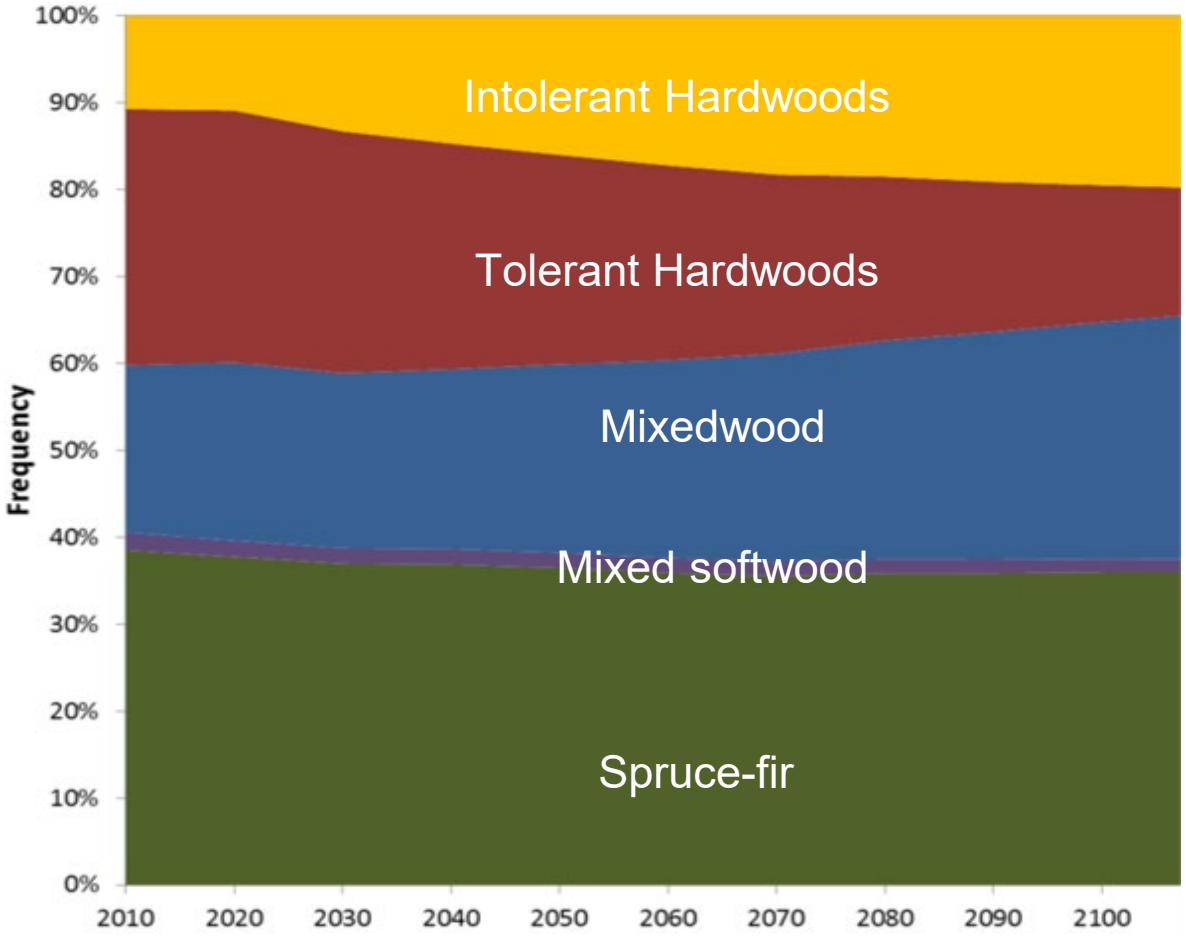
Maine's forests currently sequester nearly 15 million metric tons of CO2-equivalent per year (MMTCO2e/yr)

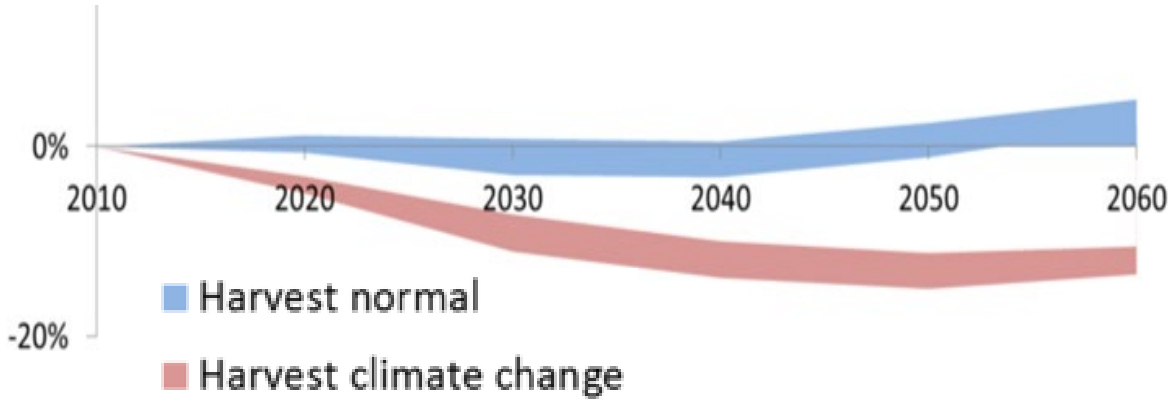
Harvested wood products ~1 MMTCO2e/yr

Together, forests + products offset nearly all of Maine's fossil fuel GHG emissions

Persistently high rates over 10+ years, but emerging threats of pest, disease, fire, etc. could reverse this trend.

Variable Forest Productivity

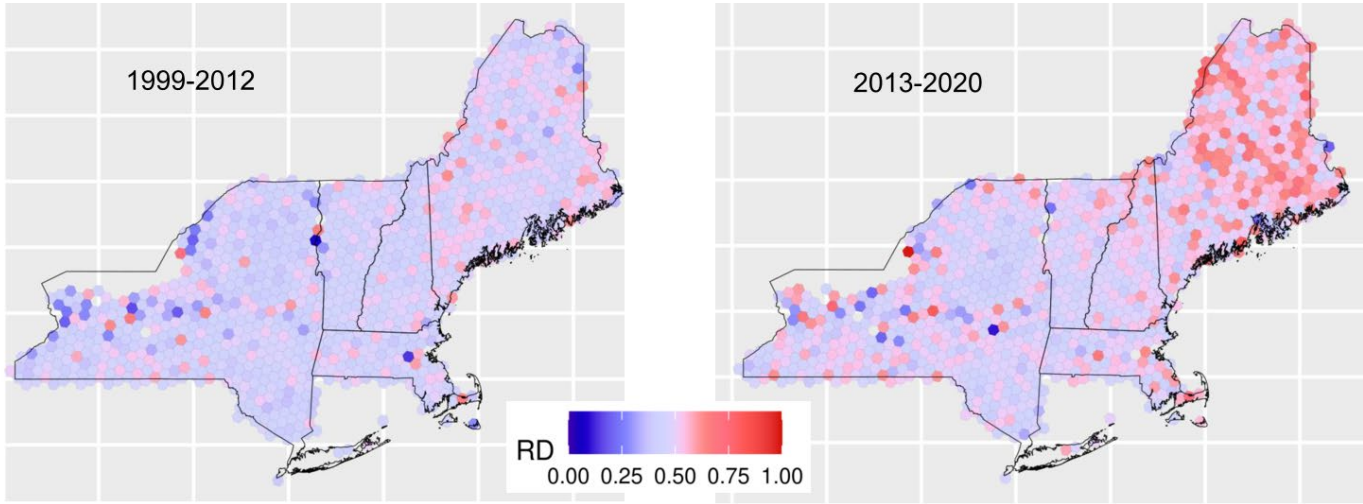




- Some areas may see higher growth due to ***longer growing seasons***,
- Other areas may decline due to greater ***droughts*** and ***pest*** occurrence
- ***Forest management*** a strong influence of future trends

Persistent and Emerging Threats: Forests

Forest Relative Density (RD)



Maine's forest at a biological tipping point with ongoing threats from climate change, natural disturbances (e.g. wind, fire), and invasive species

Wildfire Threat

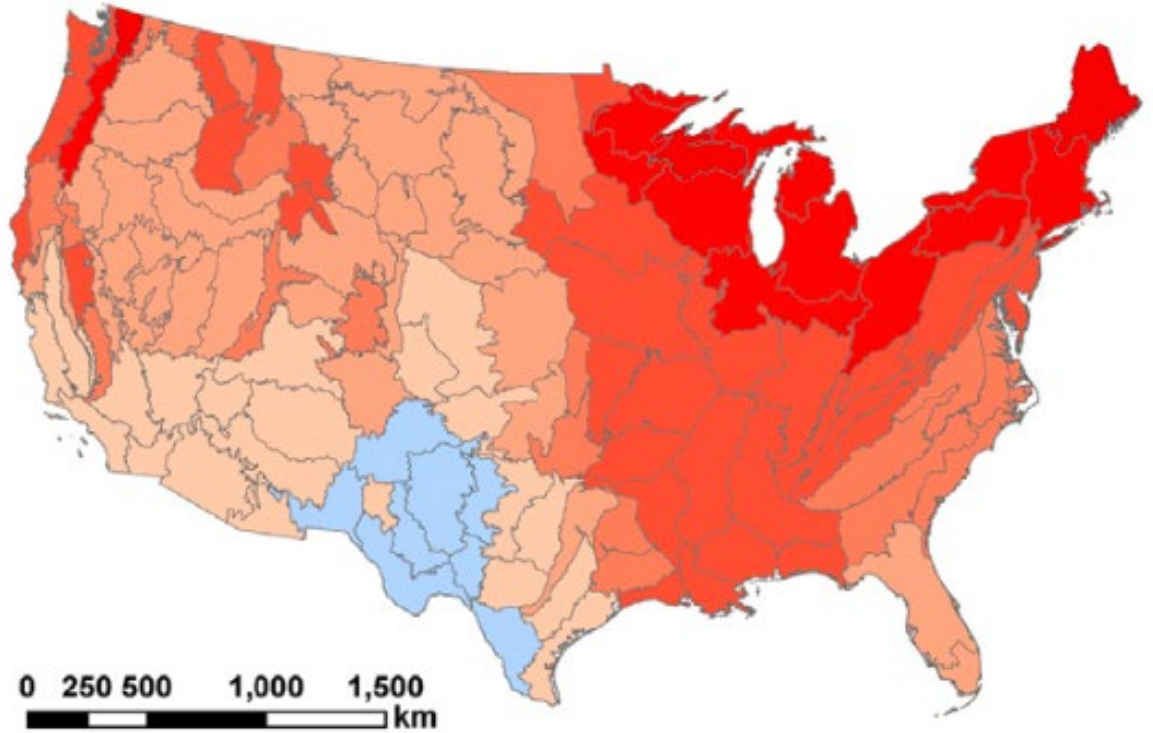
Despite its low fire risk, serious wildfires occurred in Maine, especially during droughts (e.g., 1947)

2023 Nova Scotia wildfires burned 60,000 acres, similar ecosystem

Risks: dense forest fuels, houses in forest interface, lack of wildfire fighting capacity

Relatively low, but increasing wildfire probability in Maine due to CC

For the most pessimistic emissions scenario, northeastern fire risk is expected to more than double



Projected changes (%) in annual fire probability from baseline (1971-2000) to late century (2070-2099) based on Greenhouse Gas Emissions Scenario RCP 8.5.

Opportunities and Barriers to Adaptation

Active & passive adaptation can enhance, maintain, and restore the mitigation value of forests.

Foresters were concerned most with warming winters and declining tree vigor; urban foresters cite extreme weather and safety hazards from storm-damaged trees as highest concerns.

Many forest managers believe adaptation is a priority, however there are many barriers that they face:

- Increased public use on conserved lands
- Public opposition to harvesting
- High costs of treatments & limited timber markets
- Information at relevant spatial scales
- Determining appropriate on-the-ground management

Additional Highlights

- Tree lines, the growing season, and foliage timing are all shifting up/out.
- Peak fall foliage nearly 2 weeks later than 1950, month later by 2050
- Shifts in forest management could increase carbon sequestration by 20%+
- Socioeconomic factors likely to be larger driver of future forest change than climate

Maine Climate Council – Climate Science Webinars

Climate & Human Dimensions

Thursday, May 16, 12-1PM

Registration link: https://mainestate.zoom.us/webinar/register/WN_7f8ZI003Qlm837-gQdvyrA#/registration

Forests, Biodiversity & Agriculture

Wednesday, May 29, 12-1PM

Registration link: https://mainestate.zoom.us/webinar/register/WN_Wb_wvsIeTVWK11TsfeZCFw#/registration

Sea Level Rise & Marine Systems

Wednesday, June 5, 12-1PM

Registration link: https://mainestate.zoom.us/webinar/register/WN_96fV4Zj6RLuEmgJfLLU52w#/registration