Second Council Meeting
January 29, 2020
9:00 am – 4:00 pm
SCIENTIFIC AND TECHNICAL SUBCOMMITTEE

PHASE I PRESENTATIONS ON THE EFFECTS OF CLIMATE CHANGE IN THE STATE OF MAINE
Presentation Outline

• Temperature
• Changing Season Lengths
• Precipitation and Drought
• Extreme Weather
• Snow and Hydrology
• Summary
• Annual increase of 3°F since 1895
• Overnight lows have risen more than daytime highs
• The six warmest years occurred since 1998
Warming of 2-10°F by 2100 depending on future scenario

Maine Annual Temperature Anomaly (°F)
NOAA Observations and CMIP5 Ensemble Mean Simulations
1901–2000 Baseline

- RCP 2.6
- RCP 4.5
- RCP 8.5
- NOAA
- Historical
Natural forcings cannot account for the observed warming since at least 1960

Meehl et al, 2012
• Summer is longer and winter is shorter than a century ago.

• Since 1950, the growing season has lengthened by ~16 days (Fernandez, 2020).

• Summer weather & growing season extension mostly into fall.

• Trends projected to continue, but some years will bring unexpected late spring or early fall frosts.

Fernandez et al. (2015)
Maine’s annual precipitation increased 6” since 1895. Largest increase last 20 years.

Trend expected to continue.

Drought occurrence has not increased, but rising temps can exacerbate droughts that develop.

Uncertain whether intermittent drought will be or more or less likely in the future.
Extreme Weather

- Extreme weather becoming more common around the Northern Hemisphere due to changes in atmospheric circulation.
- Increased likelihood of heat/cold waves, intense storms.
- Large increases (55%) in annual heavy daily precipitation across the USNE.
- In Maine, the last 10-15 years have seen the highest occurrence of 2”, 3”, and 4” precipitation events (Fernandez et al., 2020).
Temperature anomaly and Jetstream

Wind Storm
Nov 1, 2019
Summer in March, 2012

• Temperatures into the 80s across southern half of Maine 22-23 March with no historical equivalent.

• Farmington 83°F March 23rd – a daily high record set by 17°F!
Maine’s Snow is Melting Earlier

- Trend toward earlier winter-spring melt runoff
  - 7-14 days earlier than ca. 1950
  - Related to small increases in February–May air temps

- Trends projected to continue
  Hayhoe et al., 2007;
  Demaria et al., 2016b

Historical Changes in Snowmelt Related Streamflow Timing

Days Earlier (since ~1950)
- > 10
- > 5 and <= 10
- > 2 and <= 5
Ice-Out on Maine Lakes is Occurring Earlier

Hodgkins, 2013
Increasing Magnitude & Frequency of Small Floods

- 1941-2015 (75 yrs): average 29% increase
- 1966-2015 (50 yrs): average 19% increase

April, 2005, Hallowell, ME
USGS Photo

Blue triangles, increases
Brown triangles, decreases
Open symbols, < 25%
Light solid, 25-50%
Medium solid, 50-75%
Dark solid, > 75%

Hodgkins, Dudley, et al., 2019
100-year, 3-day Peak Flows are Projected to Decrease

• Likely linked to decreasing late winter snowpack
Summary

• Maine’s statewide annual temperature 3°F warmer since 1895.
• Models project additional warming of 2-10°F by 2100 depending future scenario.
• Warm season lengthened ~2 weeks since 1950, mostly into fall.
• Annual precipitation increased ~6” since 1895. Largest increase over the last 20 years.
• Drought has not increased in frequency, but rising temps could exacerbate droughts that emerge.
• Extreme weather has become more common across the Northern Hemisphere over recent decades.
• More frequent heavy precipitation, more intense storms, and greater tendency for heat/cold waves to develop.
• Trend toward earlier snowmelt and runoff by 1-2 weeks since ca. 1950.
• Magnitude & frequency of small floods increasing.
• 100-yr, 3-day peak streamflows projected to decrease, likely due to late winter snowpack.
Climate Impacts on Maine’s Coast and Marine Ecosystems

Team Leads:
Andrew Pershing
Stephen Dickson
Susie Arnold
Nichole Price
Climate Change & the Ocean

- CO₂
- Warming
- Ocean Acidification
- Ocean Warming
- Sea Level Rise
- Melting Ice
- Ocean Circulation
- Precipitation & Coastal Pollution
Maine’s Sea Level is Rising Now and into the Future

Figure by P.A. Sloviksky, MGS

After Sweet et al. (2017)
Maine’s Sea Level is Rising Now and into the Future

0.6 feet over past 100 years

Figure by P.A. Slovinsky, MGS

After Sweet et al. (2017)
Observed Impacts on Natural and Built Environments
Maine’s Sea Level is Rising Now and into the Future

0.6 feet over past 100 years

Figure by P.A. Slovinsky, MGS
After Sweet et al. (2017)
Maine’s Sea Level is Rising Now and into the Future

- 0.6 feet over past 100 years
- 1 foot + over next 30 years

Figure by P.A. Slovinsky, MGS
After Sweet et al. (2017)
Sea Level Rise Impacts – Nuisance Flooding

**PORTLAND HISTORICAL INUNDATION FREQUENCY**

Avg. Inundation Frequency (1912-2019) = 3.4 hours/year
Avg. Inundation Frequency (1999-2019) = 11.9 hours/year
Sea Level Rise Impacts – Nuisance Flooding

PORTLAND HISTORICAL INUNDATION FREQUENCY (+ 1 ft SLR)

Avg. Inundation Frequency (1912-2019) = 54.3 hours/year
Avg. Inundation Frequency (1999-2019) = 129.5 hours/year

Hours above 12’ with additional 1’ of sea level rise
Maine’s Sea Level is Rising Now and into the Future

- 0.6 feet over past 100 years
- 1 foot + over next 30 years

After Sweet et al. (2017)
Maine’s Sea Level is Rising Now and into the Future

Sea level rise will continue beyond 2100

- 0.6 feet over past 100 years
- 1 foot + over next 30 years

Figure by P.A. Slovinsky, MGS

After Sweet et al. (2017)
Ocean Temperatures

- Recent marine heatwaves provide a preview of average conditions in 2050
- Southern coast will have a climate similar to today’s Rhode Island
- High emissions will threaten temperatures Downeast
Ecosystem Impacts of Warming

- Gulf of Maine is becoming less subarctic
Ecosystem Impacts of Warming

- Gulf of Maine is becoming less subarctic
- Warm water species & diseases are moving in

butterfish

green crab

[Haplosporidium nelsoni (MSX disease)]

Ecosystem Impacts of Warming

- Gulf of Maine is becoming less subarctic
- Warm water species & diseases are moving in
- Expect declines in lobster productivity

Le Bris et al. 2018
Ocean and Coastal Acidification

Atmospheric CO₂ at Mauna Loa Observatory

Global surface ocean pH over time with future IPCC scenarios

Data from Jiang et al. 2019

Deb Dawson, Friends of Casco Bay
Ecosystem Impacts of Acidification

• Observed impacts on oyster larvae
Ecosystem Impacts of Acidification

• Observed impacts on oyster larvae
• Lab studies show impacts on other mollusks and crustaceans
Ecosystem Impacts of Acidification

- Observed impacts on oyster larvae
- Lab studies show impacts on other mollusks and crustaceans
- May be possible to buffer some impacts locally
Climate Change & the Ocean

- CO₂
- Warming
- Ocean Acidification
- Ocean Warming
- Sea Level Rise
- Melting Ice
- Ocean Circulation
- Precipitation & Coastal Pollution
Forest Ecosystems, Forestry, and Biodiversity

Amanda Cross¹, Adam Daigneault², Erin Simons-Legaard², Sally Stockwell³, Aaron Weiskittel²

¹Maine Department of Inland Fisheries & Wildlife
²University of Maine, Center for Research on Sustainable Forests
³Maine Audubon Society
Maine: An Ecological Transition Zone

Fish and Wildlife Species

- Invertebrates (33,000)
- Amphibians (18)
- Birds (423)
- Fish (291)
- Mammals (85)
- Reptiles (23)

Other Taxa Groups

Plants (2100), Phytoplankton (310), Macrophytes (271), Fungi (3500)
What makes a species vulnerable to climate change?

1. Habitat specificity
2. Edge of range
3. Narrow environmental or physiological tolerance
4. Species interactions
5. Limited mobility
6. Sensitivity to pathogens, exotic species

Whitman et al. 2014, adapted from Foden et al. 2008 and Young et al. 2010
Maine’s Forest Overview

- 89% of state’s land area
  - 16.6 million acres

- Transitional ecosystem
  - South: temperate hardwoods
  - North: boreal softwoods

- Part of the Acadian Forest Ecoregion, which covers ~60 million acres
Maine’s Forest Industry Overview

- $8-10B in annual direct economic contributions
- Diverse yet integrated across sectors
- Additional economic benefits
  - Recreation
  - Wildlife habitat
  - Aesthetics
<table>
<thead>
<tr>
<th>Carbon Pool</th>
<th>% of State’s Annual Fossil Fuel Emission</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forest carbon stocks + annual growth</td>
<td>60%</td>
</tr>
<tr>
<td>Forest products</td>
<td>15%</td>
</tr>
<tr>
<td>Total forestry sector</td>
<td>75%</td>
</tr>
<tr>
<td>Net Land Sink</td>
<td>78%</td>
</tr>
</tbody>
</table>
Some areas may see **higher growth** due to *longer growing seasons*, other areas may **decline** due to greater *droughts* and pest occurrence. **Forest management** has a strong influence of future trends.
Impacts of Climate Change on Biodiversity

Global declines
- 3 billion fewer birds in North America since 1970
  - 1 in 4 birds lost
- 75% decline in flying insects in protected areas in Germany over the past 27 years

Future projections
- 34-58% species faced with extinction if unable to shift ranges
- 11-33% lost if able to shift
Climate Change Affects Maine’s Most At-Risk Species

MAINE'S WILDLIFE ACTION PLAN
Prepared by
Maine Department of Inland Fisheries Wildlife
in collaboration with
Maine’s Conservation Partners
September 2015

Action Plan: 378 At-Risk Species

One-third affected by climate change

Images by USFWS, Audubon, NH Fish and Game
Winter Ticks and Moose

Up to 70,000 ticks/calf

70% annual calf mortality 2014-2016
Outbreaks in 5 out of 10 years

Jones et al. 2019, NH Fish and Game, UNH Pete Pekins, MDIFW – Lee Kantar
Piping Plovers and Salt Marsh Sparrows

Amanda Reed
Eastern Brook Trout

North woods are the last stronghold for wild brook trout in the U.S.

Warmer summer temperatures and more storm events = less suitable habitat, more stress
Red Bellied Woodpeckers are Moving North
Key Recommendation: Conserve and Connect Diverse Landscapes

Anderson and Ferree 2010; Beier, Hunter, Anderson, and many others; Conservation Biology 29(3) 2015
Summary & Conclusions

- Many *species and habitats at risk* of significant decline, degradation, or extinction with climate change.

- Forests likely to shift towards *more hardwood* species with *greater variability* in future productivity.

- Carbon in growing *forest & wood products* currently *offset about 75% of ME’s fossil fuel emissions* → potential for more via management shifts.

- *Conserving and connecting* geologically *diverse landscapes* is key to allowing species to shift and respond to climate change.
Priority Information Needs for Maine’s Forests

- **Forest Impacts**
  - Improved monitoring of key indicators
  - Greater integration of remote sensing technologies
  - More studies on human adaptation component (i.e., management, harvest)

- **Forest Management & Operations**
  - Develop and revise existing Best Management Practices, particularly as it relates to roads, water-crossing, and culverts
  - Complete a full environmental cycle analysis for forest and forestry products
  - Evaluate alternative suite of forest management strategies at a landscape-level
Additional Recommendations for Maine’s Biodiversity

- **Research and monitoring**
  - Snowpack and changing winters
  - Water quality and aquatic communities
  - Changing seasons and phenology
  - Invasive species and food webs

- **Adaptation**
  - Reduce impervious surfaces
  - Replace failing structures with StreamSmart designs
  - Manage and plan for diverse future landscapes, including migrating marshes, dynamic coastlines, riparian areas, and maturing forests

- What is good for biodiversity is often equally good for people
- Local and traditional knowledge needs to be incorporated
Acknowledgements

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References


Maine Department of Inland Fisheries and Wildlife and Conservation Partners. 2015. Maine’s Wildlife Action Plan (SWAP). Maine Department of Inland Fisheries and Wildlife, Augusta, ME.


Agriculture and Food Systems

Glen Koehler\textsuperscript{1}, Richard Kersbergen\textsuperscript{1}, Senator Russell Black\textsuperscript{2}

\textsuperscript{1}University of Maine, Maine Food and Agriculture Center, Cooperative Extension

\textsuperscript{2}Maine State Legislature
Reduced number of “Field Work Days” constrains farm work
(days with soil dry enough to support tractor, allow tillage etc.)

Fewer Field Work Days in Maine

\[\downarrow \text{0.4 days per week since 1996}\]
What a lost field work day looks like, and an adaptation response

Hoop houses proposed
Climatic conditions are likely to become less favorable for Lowbush blueberry.
Livestock-Based Methane Emissions

3.9% of U.S. greenhouse gas emissions come from animal agriculture.

**Methane emissions vary within same species by production method**

- Methane emissions from cattle production are a significant contributor to global greenhouse gas emissions.
- Methane is produced by microbes in the cow's stomachs, which break down feed into usable sources of energy and protein and produce methane.
- Manure collection ponds generate about a tenth of all U.S. methane emissions.

**Methane Emissions per Gram of Protein**

- Global estimates in grams, CO₂-equivalent:
  - Buffalo: 404g
  - Beef: 295g
  - Milk from cows: 87g
  - Pork: 55g
  - Chicken: 35g

Adapted from: Paul Horn. Infographic: Why Farmers Are Ideally Positioned to Fight Climate Change. Inside Climate News. Oct 24, 2018

Enhancing soil health and Carbon storage

Cover Crops
Crop Rotations
No-Till

Compost
Crop-Livestock & Agroforestry systems

A 0.5% increase in soil organic matter across all tilled crop acres in Maine would sequester ~ 1 million tons carbon.

Adapted from Paul Horn. Infographic: Why Farmers Are Ideally Positioned to Fight Climate Change. Inside Climate News. Oct 24, 2018
Nitrogen fertilizer threats

- Runoff into waterways, conversion to CH$_4$
- Nitrate leaching in groundwater
- Manufacture of N fertilizer releases CO$_2$ & N$_2$O
- Microbial conversion of N to N$_2$O

Adapted from Paul Horn. Infographic: Why Farmers Are Ideally Positioned to Fight Climate Change. Inside Climate News. Oct 24, 2018
Food insecurity in Maine

- 13.6 percent of households, or nearly 200,000 Mainers, are food insecure. Maine ranks 1st in New England in terms of food insecurity.

- Food insecurity refers to "both the dietary quality and also the dietary quantity."

- 1 in 5 Maine children are food insecure.

- 16 percent of Maine seniors (≥65) are either food insecure or at risk of becoming food insecure.

Maine Climate Council
Scientific and Technical Subcommittee
Phase I Update: Human Health

Rebecca Lincoln, ScD, Maine Center for Disease Control
Susan Elias, PhD, Maine Medical Center Research Institute

January 29, 2020
Scientific & Technical Subcommittee Report: Human Health

• Direct Impacts of Climate and Weather
  • Extreme Temperatures
  • Extreme Storms

• Ecosystem-Mediated Impacts of Climate Change
  • Vector-borne diseases
  • Food- and water-borne illnesses
  • Air quality (pollen)

• Indirect (Downstream) Impacts of Climate Change
  • Mental health impacts
Extreme Temperatures: Heat

- Heat is the leading weather-related cause of death in the U.S.
- Average of >600 heat-related deaths per year
- Heat waves can cause massive excess mortality
  - Chicago (1995) – 700 excess deaths
  - Europe (2003) – 40,000 excess deaths
  - New England (1911)
    - Temperatures in 90s and 100s for 11 days in July
    - 2,000 excess deaths
Mainers are Vulnerable

- Physiologically not adapted
- Older population
- Higher rates of chronic diseases
- Rural population, outdoor occupations
- Limited AC in homes, businesses, institutions
  - State average: 50% of homes (25%-70% by county)
  - Rest of Northeast/U.S.: 85%+

Source: Maine Tracking Network: www.data.mainepublichealth.gov/tracking
More Heat in Maine’s Future

• “Extreme” heat days will increase by two- to four-fold by the 2050s.

• As Maine’s climate warms, we will experience more heat-related illnesses and deaths.

Source: Maine’s Climate Future: http://climatechange.umaine.edu/research/publications/climate-future
Mainers are Vulnerable

All-Cause Emergency Department Visits

Health Effects of Extreme Storms: Floods

- Floods caused by extreme precipitation events OR storm surge
  - Injuries, deaths
  - Waterborne disease outbreaks
  - Displacement, mental health effects

- Extreme precipitation events have increased, are predicted to continue increasing – especially in winter/spring

- Extreme storms have increased since 1950s – but unclear if this will continue
Flooding: Waterborne Diseases

↑ Precipitation leads to:

• Urban areas: Overwhelmed sewer systems
  — Runoff, mixing of bacteria/waste/drinking water

• Rural areas: Flooded wells
  — Bacterial/chemical contamination of well water
Health Effects of Extreme Weather: Storms

• Winter / wind storms
  → Injuries
  → Power outages: CO poisonings, foodborne illnesses, effects on healthcare infrastructure
  → Displacement, mental health effects

• Extreme storms have increased since 1950s – but unclear if this will continue
Tickborne diseases increasing exponentially in Maine

- Lyme, anaplasmosis, babesiosis – transmitted by deer tick
- Powassan virus – less common, also transmitted by deer tick
- Increases expected to continue
- Health impact can be significant

Tickborne Disease Cases in Maine: 2001-2018

Source: Maine Center for Disease Control, Maine Tracking Network
Ecosystem-Mitigated Impacts: Vectorborne Diseases

- Warmer, shorter winters, more humidity allow tick survival and range expansion
- Climate only part of the problem
- Expect arrival of new vectors as Maine warms
  → Lone Star tick (ehrlichiosis, ‘alpha-gal’ red meat allergy)
Medium-Risk Impacts: Pollen

• Earlier springs, warmer temps, higher CO$_2$
  ↑ pollen, longer pollen season
  ↑ hay fever, asthma

• Rates of allergic diseases high
  — 7.9% of adults report hay fever in northeast
  — 12% of adults report asthma in Maine

• Currently, no pollen monitoring stations in Maine
Medium-Risk Impacts: Mental Health

• Exposure to extreme weather events, disruption, displacement, and loss can cause significant mental health impacts:
  — Anxiety, depression, PTSD, suicidality

• Exposure to extreme heat associated with significant mental health impacts:
  — Reduced cognitive performance, aggression, violence, suicide

• Those with existing mental illness are vulnerable:
  — Limited resilience, inability to protect from exposures
  — Social isolation, co-occurrence with homelessness
  — Medications that inhibit temperature regulation
Thank You

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Vulnerability

Varies depending on exposure/outcome

• Kids & older adults
• Those with pre-existing health conditions
• Those in rural areas
• Low-income Mainers
• Those with less social engagement/access to community resources
  - Those experiencing homelessness
  - Socially isolated
  - Refugees
  - Limited/no access to healthcare/insurance
Mainers are Vulnerable

All-Cause Deaths

Direct Impacts: Cold-Related Illness

Number of Heat and Cold-Related Hospitalizations
Maine 2001-2014

# Cold Illness NCDM Hospitalizations
# Heat Illness Hospitalizations
Extreme weather events

↑ Air Temps/Water
↑ Temps/Atmospheric moisture →
  ↑ Hydrologic extremes: droughts, powerful storms, extreme precipitation events
  ↑ Flooding, mudslides, drought, forest fires...
  ↑ Wind storms?
  ↑ Winter storms?
Extreme weather events
Waterborne diseases

↑ Precipitation →

Urban: Overwhelmed sewer systems
  ↑ Runoff, mixing of bacteria/waste/dinking water

Rural: Flooded wells
  ↑ Bacterial/chemical contamination of well water

↑ Temperature →

↑ Growth of pathogens (including HABs) in recreational/drinking water sources/fisheries
  Cryptosporidium, Giardia, E. coli,
  Camplyobacter, Salmonella, enteric viruses,
  noroviruses, rotaviruses, hepatitis A/E,
  Leptospira, Leptonema
Ecosystem-Mitigated Impacts: Vector-borne Diseases

- Mosquito-borne disease – medium priority
  - Tree-hole mosquitoes vector of Easter Equine Encephalitis virus, associated with wet summers
  - Climate change -> more extreme precipitation
  - Mitigated through management of larvae, emergency response to adults in case of outbreak
  - Impact of precip/drought on vectors of West Nile virus difficult to predict
Medium-Risk Impacts: Air Quality

• Air quality
  
  → Pollen - medium priority; Earlier springs, warmer temps > asthma/hay fever, but 3 former pollen counting programs in Maine discontinued
  
  → Ozone, PM – unknown priority; 30-year decline due to national/regional standards, if maintained expect standards to be exceeded locally
Resilience, Adaptation

• Resilience
  • Community-driven planning
  • Vulnerable and impacted groups included
  • Developing institutional readiness

• Adaptation
  • Individual, local, and state-level
  • Developing comprehensive response plans
  • “Climate-proofing” healthcare infrastructure
  • Improving surveillance
  • Improving wastewater management

→ Important to ensure that mitigation and adaptation steps recommended by other groups take public health into account – co-benefits vs. added harm
STS: Maine’s Economy & Climate Change

Jonathan Rubin
MCS Policy Center & School of Economics, University of Maine

Adam Daigneault
School of Forest Resources, University of Maine
Overview

Climate change expected to impact all sectors of Maine’s economy

Sectors of particular concern

- Energy
- Transportation
- Tourism & Recreation
- Agriculture
- Forest Products
- Marine Fisheries & Aquaculture
Maine’s real GDP has been relatively constant since 2004, while GHGs have been declining. Maine’s economy is transitioning to lower GHGs per dollar of output.
Energy

• Nearly 2/3 of Maine households use fuel oil for home heating

• Petroleum products ~50% all energy used in state

• Net Electricity ~75% renewable
  • Hydro, wood & wind

• Opportunities:
  • Fuel switching: heating and transport
  • Renewable energy generation

Maine Net Electricity Generation by Source (2017)

- Hydroelectric, 30.08%
- Wind, 20.71%
- Wood, 22.45%
- Other Biomass, 1.55%
- Petroleum, Natural Gas, and Coal, 22.42%
- Solar, 0.05%
Maine Energy Expenditures (2017)

Source: EIA SEDS 2017
Transportation Sector

- Maine’s GHG emissions, \(50+\%\)
- Maine transport energy, \(~94\%\) oil
- \textit{Per-capita}, Maine’s transportation GHGs \(~\text{average nationally}\)
- Climate impacts on infrastructure
  - Pavement life
  - Bridge fatigue & culvert washouts
  - Coastal roads & infrastructure – severe weather
- Opportunities
  - Electric Vehicles
  - Locally-produced biofuels
  - Better public health: air quality, mobility, etc.

Source: Maine Climate Future, 2009
Transportation - Opportunities

Benefits
• Active transportation
• Better air quality
• Less congestion
• More access & mobility
• Economic development

Solutions
• Electric Vehicles
  ▪ Available/affordable
  ▪ Across Maine
• Biofuels
• Vehicle fuel efficiency
• System efficiency, multimodal
• Reduced carbon intense travel activity
• Reduce GHGs from construction maintenance
• Mobility options: ride hailing & pooling

Top 10 EV Towns in Maine
1. Portland
2. Brunswick
3. Falmouth
4. South Portland
5. Bangor
6. Cape Elizabeth
7. Scarborough
8. Cumberland
9. Freeport
10. Saco
Tourism & Recreation

• $6 billion/year direct expenditure

• Primarily outdoor and recreational activities

• Climate change will likely:
  • Increase time for summer activities
  • Decrease availability for winter activities
  • Directly impact spending by activity

• Opportunities:
  • Tourists push/pull northward
  • New recreation ventures

Source: Maine Climate Future, 2009
Forest Products

• $8 billion/year industry

• Diverse species and product mix

• Climate change likely to:
  • Shift species mix towards hardwoods
  • Affect forest productivity
  • Increase risk of pest and disease
  • Have more variable & costly harvests

• Opportunities:
  • Mitigation via improved forest management
  • Emerging wood products and C storage

Source: Maine Climate Future, 2009
Agriculture

• Largest and most diverse agricultural economy in New England ($1+ billion)

• Climate change is likely to:
  • Lengthen growing season
  • Increase need for irrigation and other infrastructure
  • Affect confined livestock due to higher temps

• Opportunities:
  • Mitigation via soil health and manure management
  • New crops and products

Source: Bauer, S., Maine Climate Future, 2009
Marine Fisheries & Aquaculture

- $600+ million in commercial harvests/year
  - 2/3 attributed to lobster fishery

- Climate variability & warming waters likely to have a negative impact on landings and sector-level employment

- Opportunities
  - New aquaculture ventures
  - Capitalize on new markets

Source: Lilieholm, Maine Climate Future, 2009
Critical Issues

• Maine’s economy not just affected by climate change impacts, but climate mitigation policy as well – *our choices matter*.
  – Performance standards v. technology winner
  – Build in flexibility, update as science and data evolves

• Need to *consistently* assess sources of mitigation and potential tradeoffs/impacts for major sectors of the economy across all working groups

• Where can *Maine* have the most impact?

• Who is entering the workforce? What industries are growing? Who will be most affected by policy?
Context: Employment Change (%) Since 1990

Source: Maine Department of Labor
**Recommendations for MCC and WGs**

- All MCC analyses should use consistent **discount rates** to quantify costs and benefits of climate change impacts and mitigation.

- Suggest using the US Government Social Cost of Carbon (SCC) analysis rates of **2.5%**, **3%** and **5%**, but...

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**Source:** Rff, Social Cost of Carbon 101
Summary & Conclusions

• Climate change impacts several sectors of Maine’s economy, but not all equally

• Maine’s GDP and GHG emissions diverging, in the ‘right’ way

• Mitigation and adaptation efforts can also create economic opportunities

• Economic assumptions for MCC policy analysis needs to be consistent across working groups