

Comparing the Impacts of Climate Change Upon Maine and Greenland

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WHO AM I...

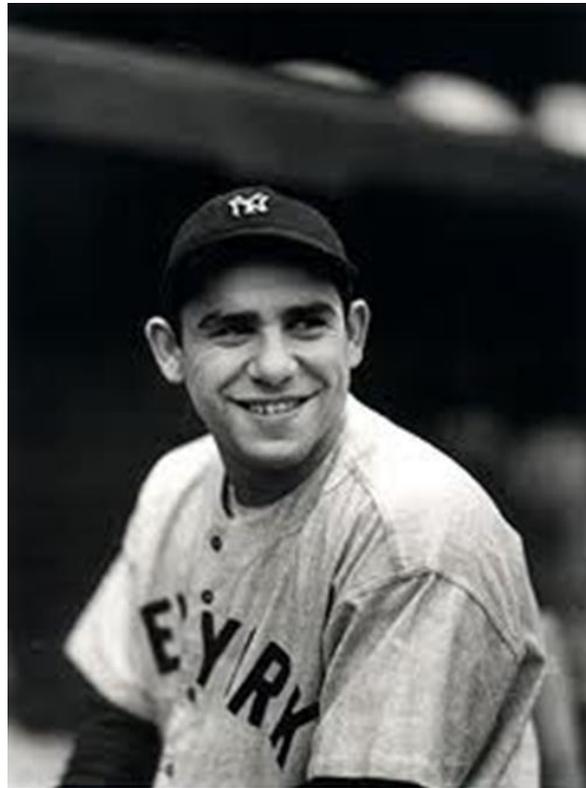


Jeff Thaler is a Professor of Practice at Maine Law School, Associate University Counsel, and Associate Faculty with the UMaine Climate Change Institute. Jeff has been a successful trial, environmental and energy lawyer in Maine for several decades, and taught from nursery school to graduate school.

He has been for the past 13 years the attorney for all of UMaine's floating deepwater wind projects and initiatives—handling all regulatory, permitting, contracting, and related issues at local, state and federal levels.

TO BEST MAKE SOUND ENERGY, CLIMATE & ENVIRONMENTAL
POLICY DECISIONS, YOU MUST FIRST PASS YOGI BERRA'S TEST...

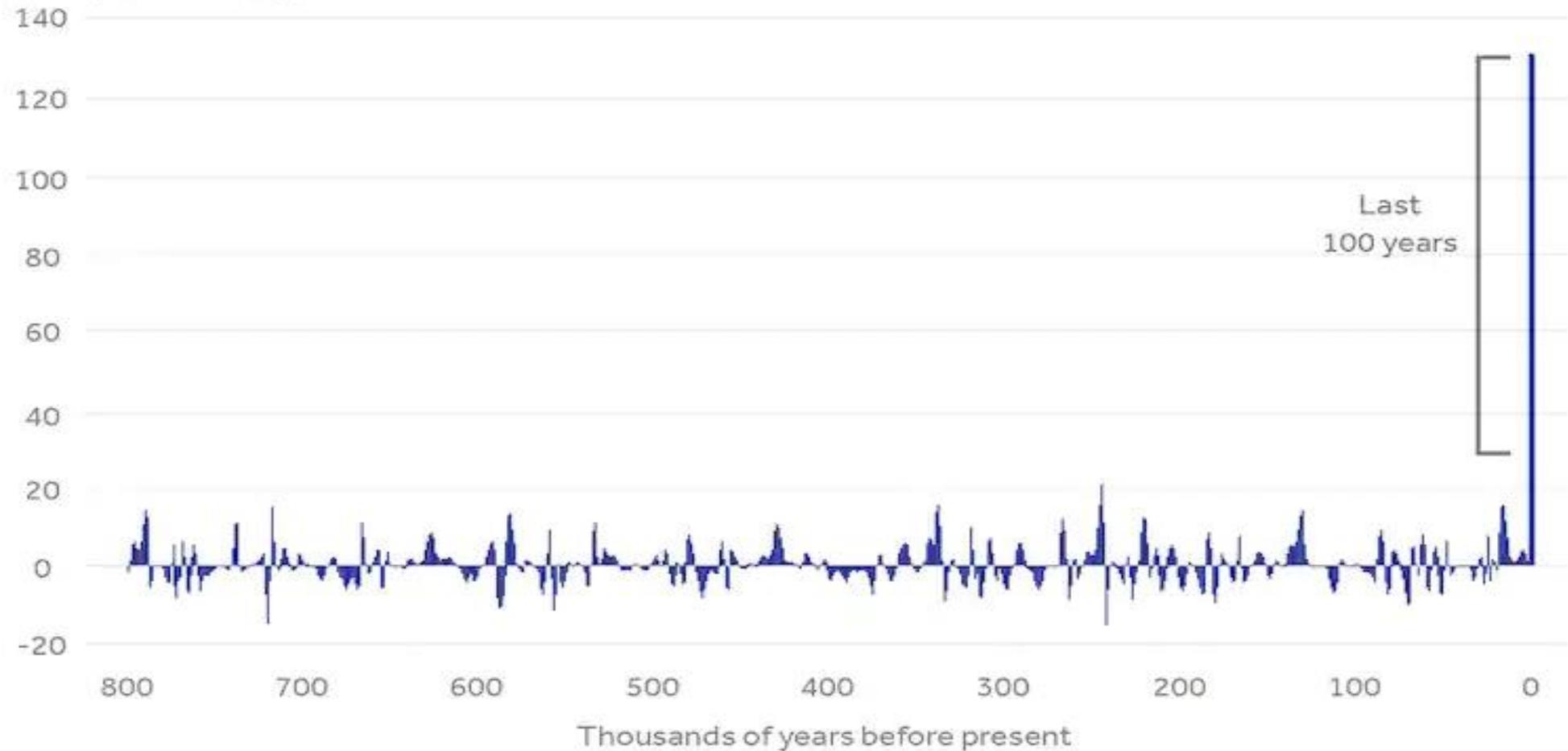
**If you don't know where you're going when
you get there you'll be lost.**



<https://www.washingtonpost.com/weather/2021/01/12/carbon-skyscraper-rapid-climate-change/>

Changes in carbon dioxide per 1000 years

parts per million change



GREENLAND, MAINE & US ENERGY CONSUMPTION

GREENLAND: 72% Fossil Fuels, 28% Renewables/Nuclear

UNITED STATES: 81% Fossil Fuels, 19% Renewable/Nuclear

MAINE: 60% Fossil Fuels, 40% Renewables (most reliant state in the US on oil for heating)

WHERE IN THE WORLD.....









Greenland and Maine

Maine 35,380 sq. miles 43 people per square mile
vs Greenland 836,300 sq miles = .1 per sq. mile

Alaska is 570,641 sq mi and Texas is 261,914 sq mi

Greenland has 660,000 sq. miles of ice

vs Alaska 16,000 sq. mile

Gr. coastline is over 27,000 miles—4th in world to
Canada, Norway, Indonesia; Maine is 228 miles as a
crow flies, or 3,478 up and down the inlets

Populations

Greenland: 56,000 people

Maine: 1,350,000 people

Nuuk: 18,000

**Portland-South Portland Metro Area:
538,000**

What is Greenland?

Greenland is an autonomous part of the Kingdom of Denmark, with limited self-government. Its people are Danish citizens. Denmark provides 2/3 of the budget revenue.

Greenland has the right to elect its own parliament and government, the latter having sovereignty and administration over the areas mentioned in the 2009 Self-Government Act such as education, health, fisheries, environment and climate.

There is the opportunity for Greenland to become an independent state.

These areas are still under Danish jurisdiction:

Justice affairs, including police, criminal procedures and the courts of law

Defense and National security

Financial sectors and monetary system e.g. the currency used in Greenland is Danish Kroner DKK

Civil rights law e.g. family and succession, citizenship matters etc.

Foreign affairs

WHAT DO GREENLANDERS THINK ABOUT CLIMATE CHANGE?

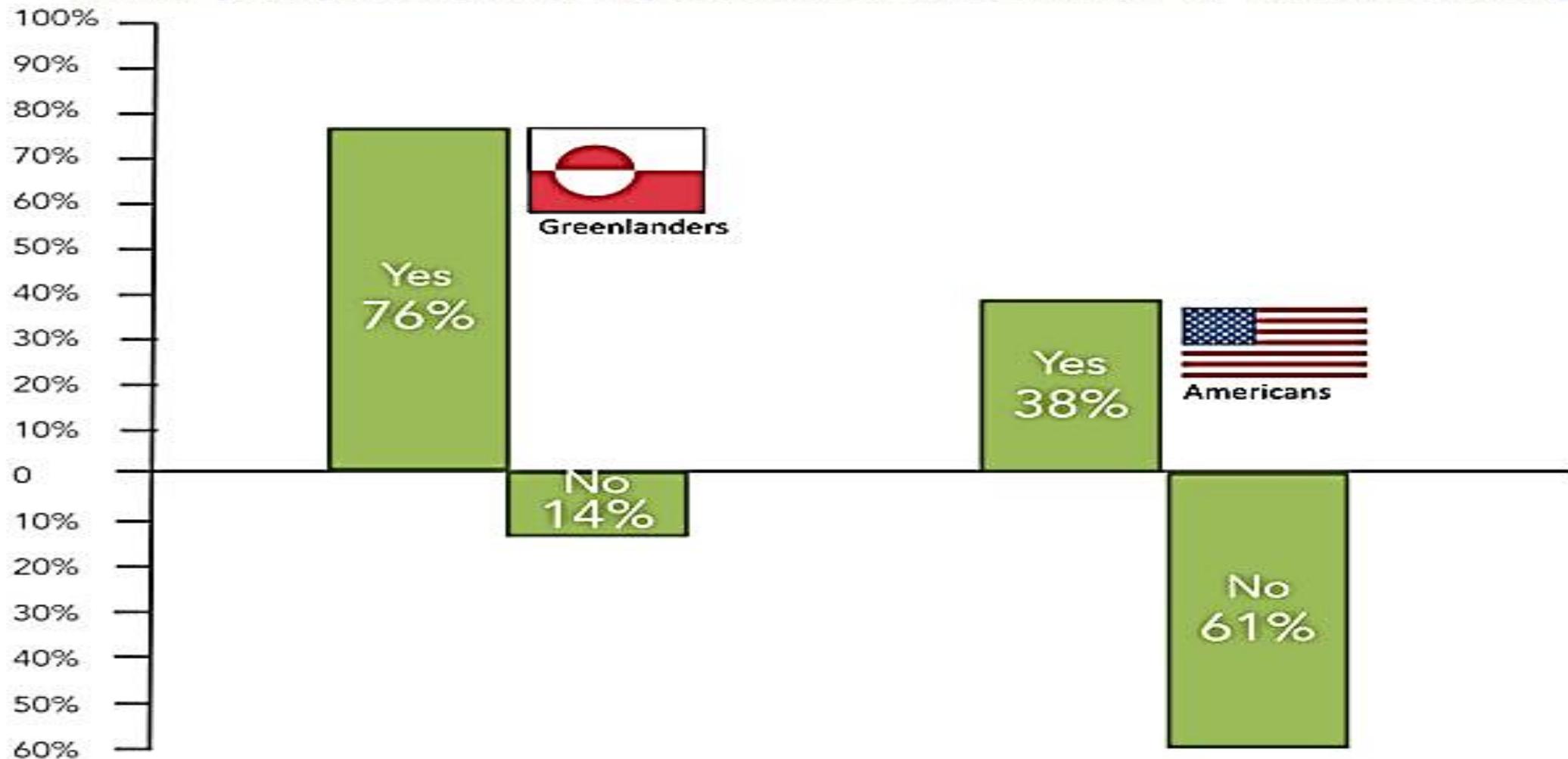
Late 2018: 79% said that they'd experienced the effects of climate change first-hand.

Nearly half believe climate change is detrimental to the living condition of themselves or their families, while 9% said they think climate change will improve their living conditions.

Some 71% want Greenland to increase its investment in energy from sustainable sources, such as from sun, wind and rain, while 59% wanted more regulation of greenhouse gases emitted from industry.

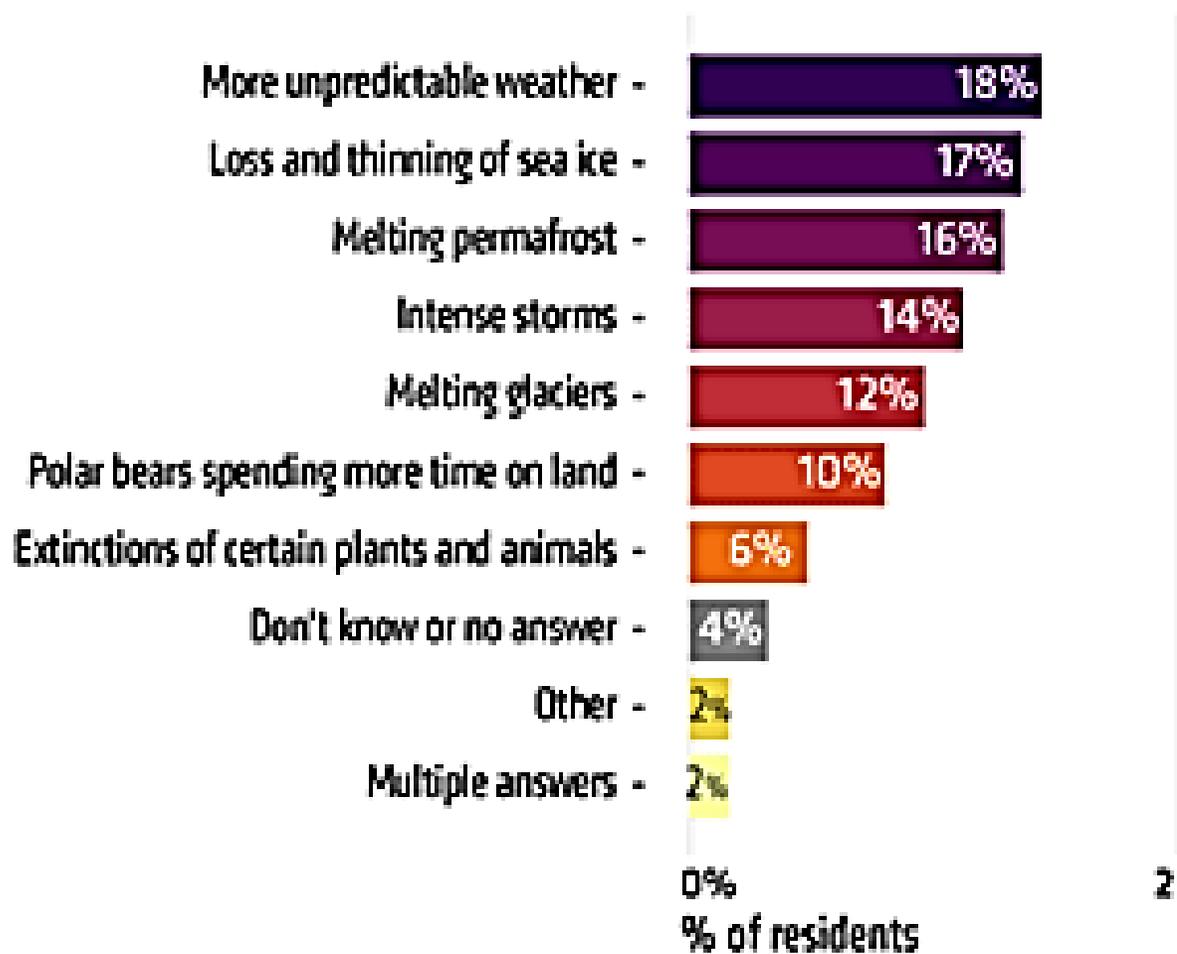
2nd survey, taken summer/fall 2018 (before 2019 heat wave)

Have you personally experienced the effects of climate change?



Residents in Greenland Are Worried About Several Different Climate Change Impacts

-Overall, residents are most concerned about more unpredictable weather, the loss and thinning of sea ice and melting permafrost-



-Top 3 Concerns By Region-

AVANNAATA

10% loss and thinning of sea ice
17% melting glaciers
16% more unpredictable weather

QEQTALIK

24% loss and thinning of sea ice
22% melting permafrost
15% intense storms

QEQQATA

22% melting permafrost
18% more unpredictable weather
16% intense storms

WEST SERMERSOOQ

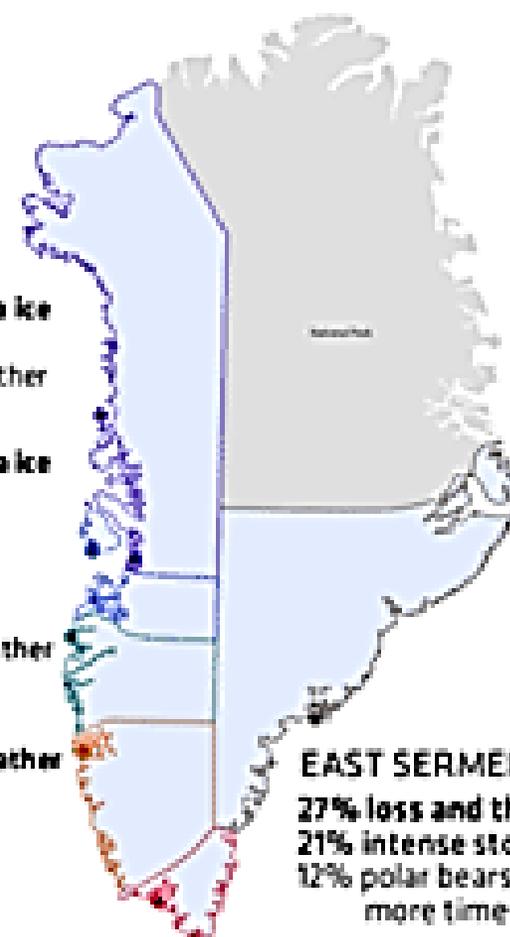
23% more unpredictable weather
13% intense storms
13% polar bears spending more time on land

KUJALLEQ

18% intense storms
18% melting glaciers
16% melting permafrost

EAST SERMERSOOQ

27% loss and thinning of sea ice
21% intense storms
12% polar bears spending more time on land



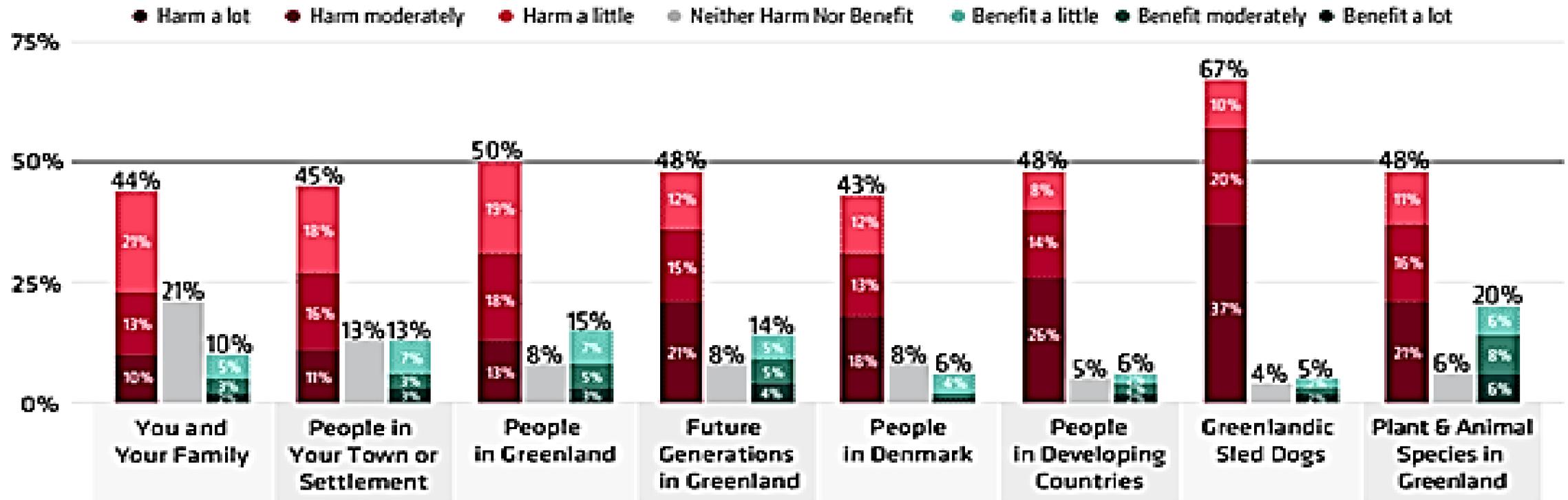
● Sampled locations

Which one of the following climate change impacts are you the most worried about?

Greenlandic Perspectives Survey (GPS) | July 2018 - Jan 2019 | n=646 Adult (18+) Residents in Greenland

Half of Residents Think Climate Change Will Harm People in Greenland A Majority Think That It Will Harm Greenlandic Sled Dogs

-Residents are more likely to think that it will harm, rather than benefit, themselves and others-



Overall, how much do you think that climate change will harm or benefit each of the following...

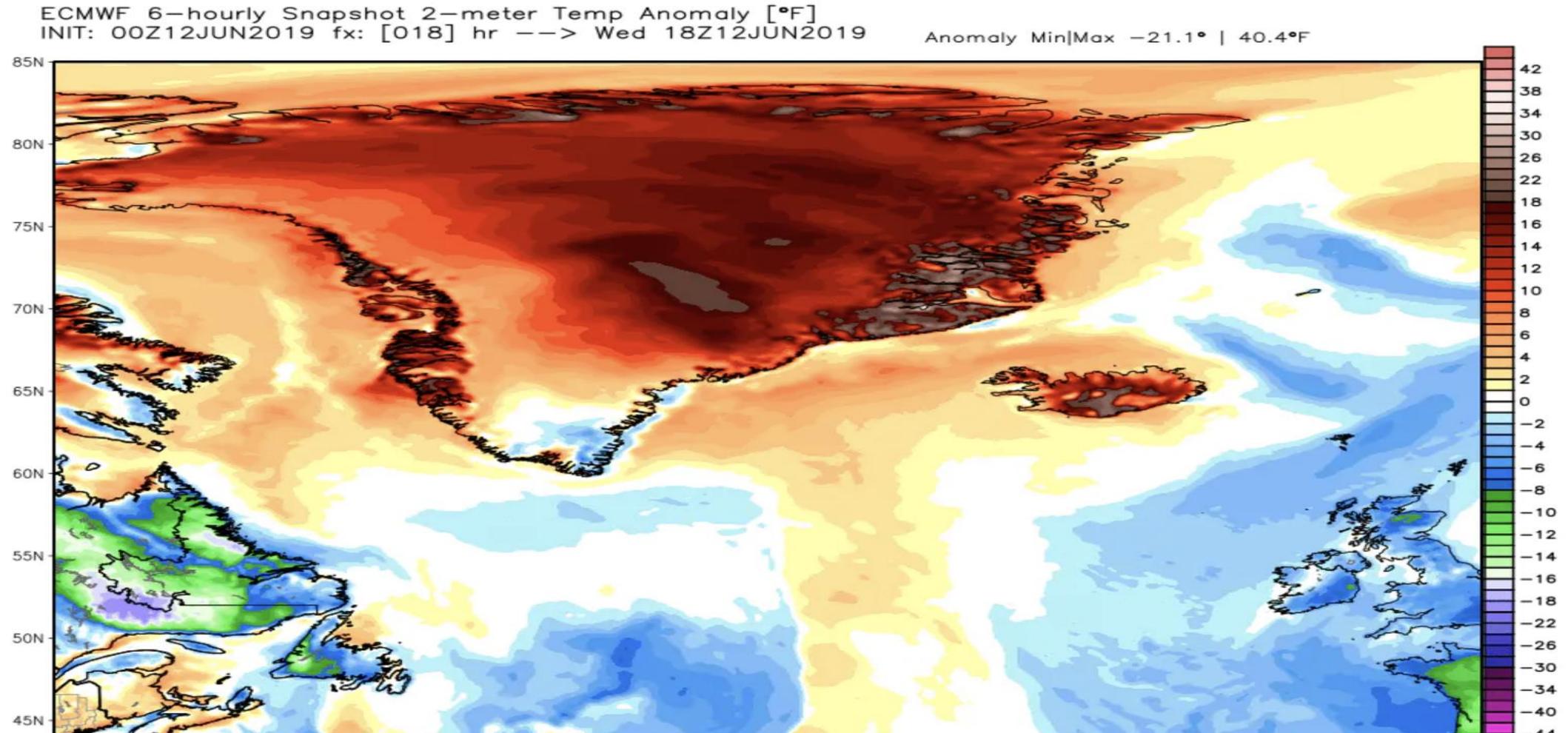
Greenlandic Perspectives Survey (GPS) | July 2018 - Jan 2019 | n=646 Adult (18+) Residents in Greenland



The Arctic is warming at a rate that is almost twice the global average

Temperature difference from normal over Greenland on June 12, 2019.

<https://www.sciencealert.com/greenland-was-40-degrees-hotter-than-normal-this-week-and-things-are-getting-intense>



Shrinking Margins of Greenland: At Least 200 Coastal Glaciers Have Retreated Over the Past 20 Years Jan. 2, 2021 NASA Earth

About **80 percent** of Greenland is blanketed by an ice sheet, also known as a continental glacier, that reaches a thickness of up to 3 kilometers (2 miles).

“The coastal environment in Greenland is undergoing a major transformation,” said Alex Gardner, a snow and ice scientist at NASA’s Jet Propulsion Laboratory and co-author of the study. “We are already seeing new sections of the ocean and fjords opening up as the ice sheet retreats, and now we have evidence of changes to these freshwater flows. **So losing ice is not just about changing sea level, it’s also about reshaping Greenland’s coastline and altering the coastal ecology.**”

<https://scitechdaily.com/shrinking-margins-of-greenland-at-least-200-coastal-glaciers-have-retreated-over-the-past-20-years/>

LOSING ICE

Greenland's ice sheet saw a record net loss of 532 billion tons in 2019, raising red flags about accelerating sea level rise = to an additional three million tons of water streaming into global oceans every day, or six Olympic pools every second.

Greenland's ice melt is the single biggest source of global sea level rise in 2019 and accounted for 40% of the total, If all of Greenland's ice sheet were to melt, it would lift global oceans by 23 feet. It also would impact the North Atlantic circulation, a current that keeps northwestern Europe 5 to 10C degrees warmer than similar latitudes elsewhere. Climate models show this circulation can be switched off by adding fresh water to the North Atlantic.

BUT GAINING ELEVATION?

Two processes combine to cause sea levels around Greenland to fall as the ice continues to melt. The first is caused by a reduction in the weight of the ice sheet that has for thousands of years been pushing down on the land. As the weight is removed, the land slowly rises back up and coastlines pull up out of the water, a geologic process called isostatic rebound.

The second effect is caused by the ocean's attraction to the large ice sheet. The ice pulls the water towards it with a gravitational tug that raises sea level around Greenland's coast, but as the size of the ice shrinks, so does this attraction, causing the ocean to fall away and sea level to lower. For both of these reasons, Greenland's coastlines will rise.

FISHING IS KING, BUT...

The vast majority – **more than 90%** – of Greenland's export income is from fish, and as seas warm, an increasing number of southern fish species find their way into Greenland's oceans, creating new opportunities for fishing.

Cod stocks are getting bigger; while Greenland's "pink gold", cold-water shrimp, is moving further north, new fish species – such as mackerel, herring, cod and Atlantic bluefin tuna – are entering the country's waters.

Warming temperatures also mean that fishermen can extend their seasons, allowing them to catch more fish. They're harvesting tens of thousands of tons of warm-water fish like mackerel and blue fin tuna, that only appeared off Greenland seven years ago. Mackerel fishing is expected to become Greenland's largest fishing activity.

Greenlandic shrimp fishing will be significantly limited as recruitment of the stock has been poor for several years and there is yet no biological basis for replacing it with fishing for cod. Despite new fishing opportunities, the overall profit from fishing faces major challenges as the shrimp fishing comprises such a considerable part of the sector's income. A reduced shrimp stock or even a collapse of this as a result of climate change will have considerable consequences for Greenland's economy.

WHAT HAPPENS ON THE ICE

Previously, ice fishing lasted from October to May, but now the ice period is shortened from December to March. Recently, there was no possibility for ice fishing at all.

Many ice fishermen have, however, been able to adapt to the new conditions, which is why they fish from small boats – dinghies – instead. During the period the ice is melting, ice fishing is dangerous. At the same time, the ice cannot be used for ordinary inshore fishing either since the ice is still too thick for the small boats to launch. The sea ice freezes later, the ice is thinner and it breaks up earlier.

According to a survey done among the polar bear hunters in North-Western Greenland, there have been almost precisely the same observations of similar changes in the ice conditions.

In southern Greenland, polar bears are thinner and are seen more frequently near villages, scavenging for food. Some hunters are no longer able to store their meat in caches on the ice, as they once did, because hungry polar bears may steal it.

Over the last 10 years, it has become increasingly hard to reach usual hunting grounds with sled dogs due to unpredictable weather, thinning ice or no ice at all.

Seal hunting, which has helped sustain Greenland natives for thousands of years, has crashed.

AGRICULTURAL IMPACTS

In South Greenland climate change has, over the past 5 years, resulted in less rainfall. And some farmers have been struggling with drought.

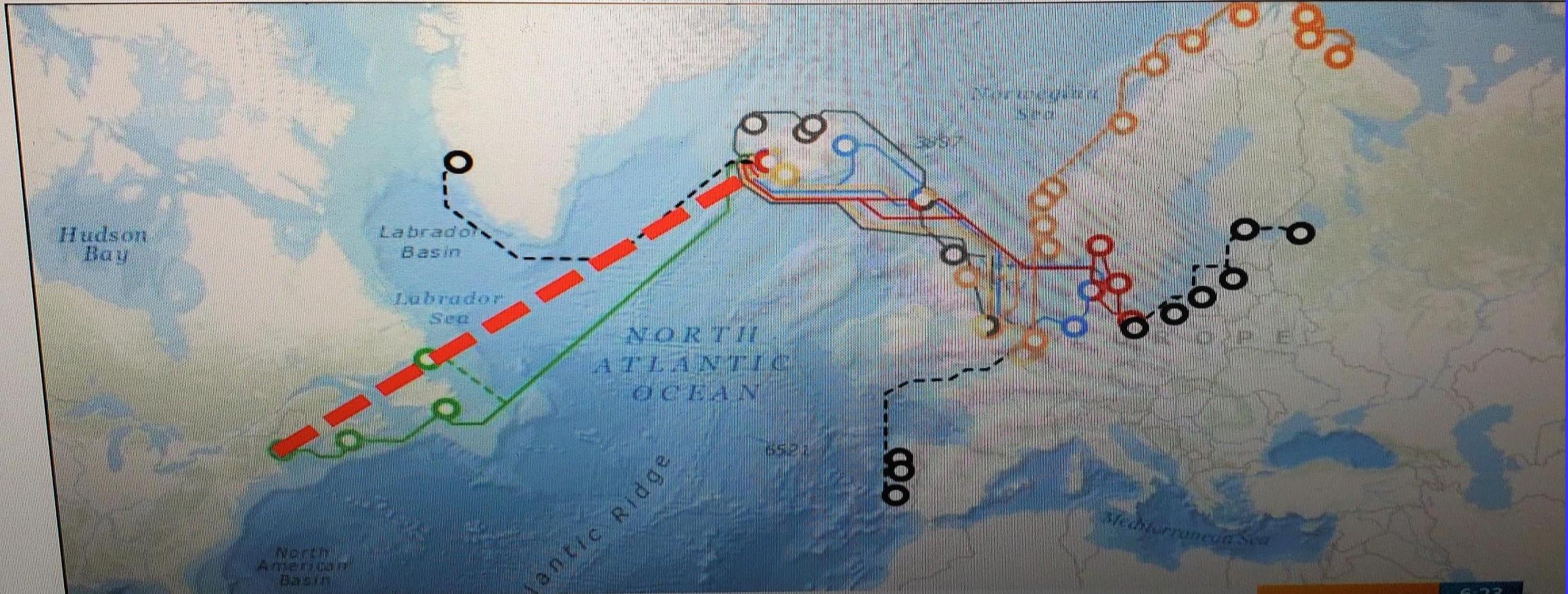
Sheep farmers are experiencing that lambs are born smaller and grass yield decreases. Smaller lambs, combined with the fact that you have to import feed from abroad, results in poorer economies for sheep farmers.

The grass harvest has been reduced due to dry summers, and annual yields fluctuate more than in the past. A farmer from Qassiarsuk explained that in 2018, he harvested 200 tons of grass in the same fields where he harvested 400 tons in 2008. Farmers use the grass for fodder for the sheep during the winter season, and a smaller harvest necessitates importing extra fodder.

Shipping Opportunities in the Arctic



Every day, goods are shipped from the Eimskip USA on the Portland waterfront to Iceland, and then to the biggest ports in the world.



The Arctic is the region of the world most dramatically transformed by the effects of a warming climate, caused by the burning of fossil fuels for energy. As the Arctic Ocean's sea ice thaws, bordering nations are preparing to tap vast energy resources held beneath the Arctic Ocean: about 22% the world's undiscovered fossil fuels.

Which creates national security issues given a potential race to control such fuel and other Arctic resources

Eye on the Arctic

Summer Sea Ice

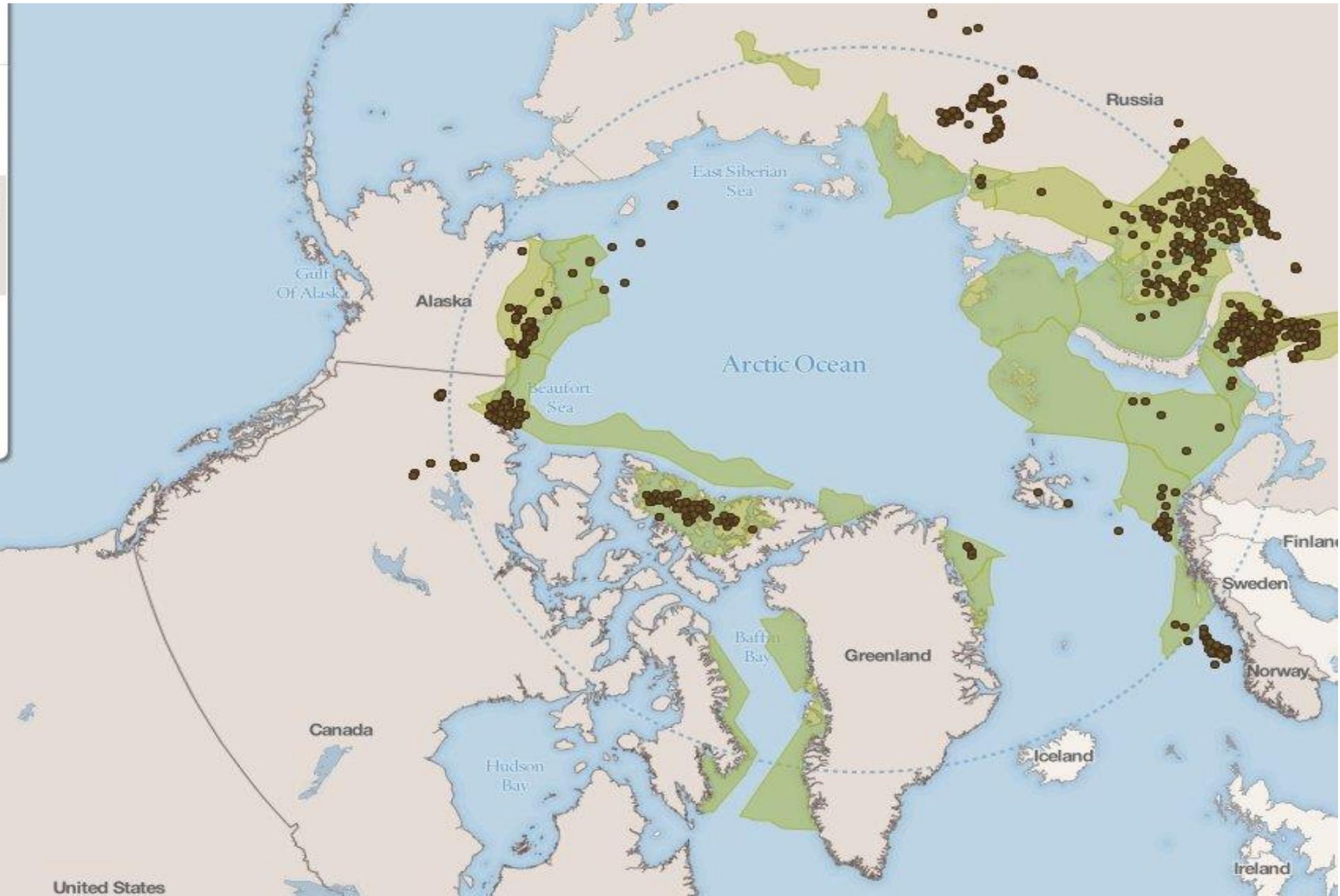
Shipping Routes

Oil and Gas

- Points: Existing fields
- Shaded: At least 50% chance of large undiscovered reserves

The Arctic Ocean Five

- Points: Disputed areas
- Shaded: Territorial waters & EEZs
- Outlined: Potential continental shelf





The Kuannersuit mountain at Narsaq, 600 meters high, holds one of the largest known deposits of rare earths in the world. Rare earths, which contain 17 different minerals. Scores of crucial technological inventions are highly dependent on rare earth minerals. These minerals, with names like neodymium, praseodymium, terbium and dysprosium, are indispensable in electronic appliances, self-driving cars and other electronics that are to communicate through the internet.

They pulsate in your computer and cell phone, and in navigation systems for nuclear missiles. They are used in solar panels, and are essential in magnets for the pumps, windmills and electrical vehicles that are paramount for the fight against global warming. BUT-- uranium is a by-product from the potential mine that will inevitably be unearthed as the rare earths are excavated.

Chinese-Australian partnership as developer

Requires \$1.2 billion investment

Jobs vs Environment and culture debate...

Just like we have seen in Maine

Maine....The Way Life Will Be?



CLIMATE CHANGE IMPACTS UPON MAINE

Maine's annual temperature has increased 3.2 degrees since 1895, and extreme heat days are expected to be two to four times more frequent by 2050.

Increasing land and ocean temperatures, rising sea levels, more frequent severe storms, increased environmental damage, and public health maladies are all involved.

<https://climatecouncil.maine.gov/maines-climate>

THE OCEAN

Recent “ocean heat waves” have occurred in the Gulf of Maine, which is warming faster than 99 percent of the world’s oceans and is beginning to lose its subarctic characteristics.

Sub-Arctic and boreal marine species are disappearing from the Gulf of Maine’s traditional fishing grounds as they move northward with ocean warming, while temperate species from the south invade.

Ocean acidity levels have already risen 30 percent and will continue rising alongside growing greenhouse gas levels. Scientific data indicate that the rate of ocean acidification is at least 100 times faster at present than at any other time in the last 200,000 years and may be unprecedented in Earth's history.

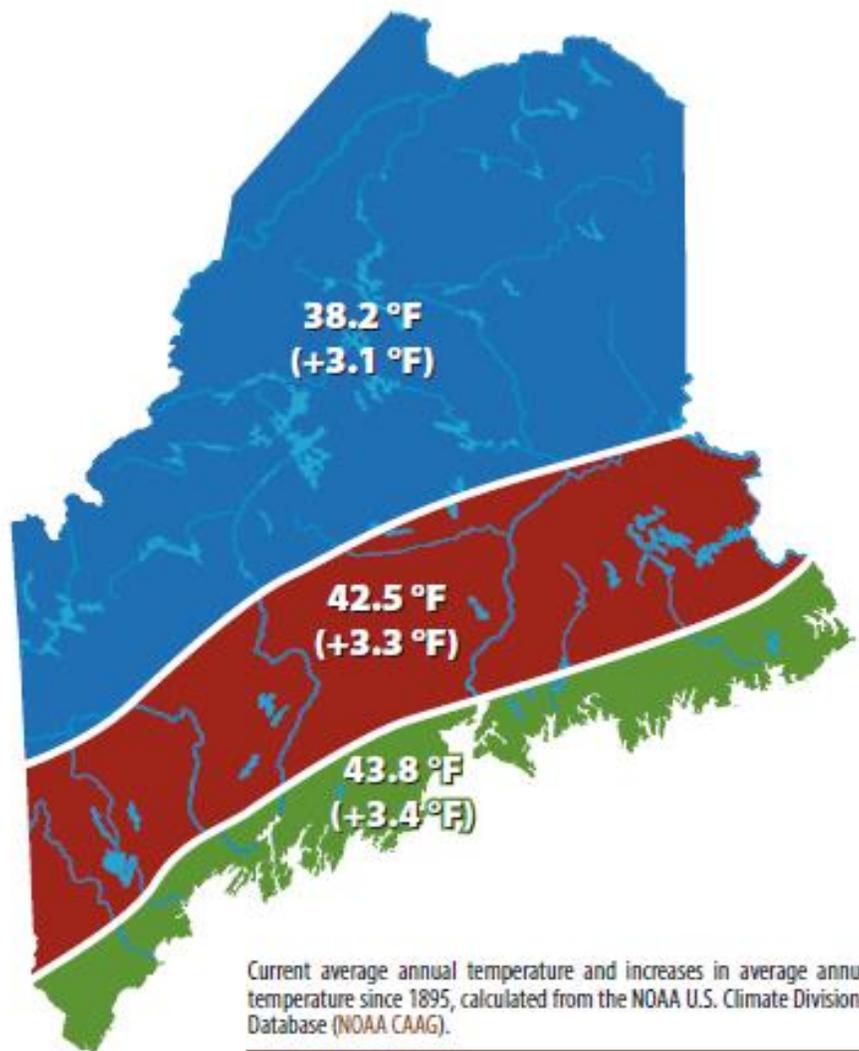
Ocean acidification has already impacted some aquaculture operations in Maine and will increasingly affect marine organisms that produce calcium carbonate to build shells, such as oysters, scallops, clams, mussels, and sea urchins.

ON LAND

Warming has shortened Maine's winters and lengthened the summers by two weeks on average over the last century, a trend that's expected to continue as temperatures increase.

Warmer, shorter winters from climate change have played a role in the increase of tick-borne illnesses in Maine, such as Lyme disease, *anaplasmosis*, *babesiosis*, and *Powassan encephalitis virus*.

Annual Temperatures by Climate Division



Changes in Winter Indicators

Over the last 100 years, the winter season in the Northern Forest region that includes Maine has changed, as shown by

Decreased days of:		Increased days of:	
Ice (max temp < 32)	5 fewer days	Thaw	5 more days
Frost	13 fewer days	Bare ground	9 more days
Snow	10 fewer days	Mud	10 more days
Snowmaking	12 fewer days	Insect pest survival	4–12 more days

From Contosta et al. (2019).

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.

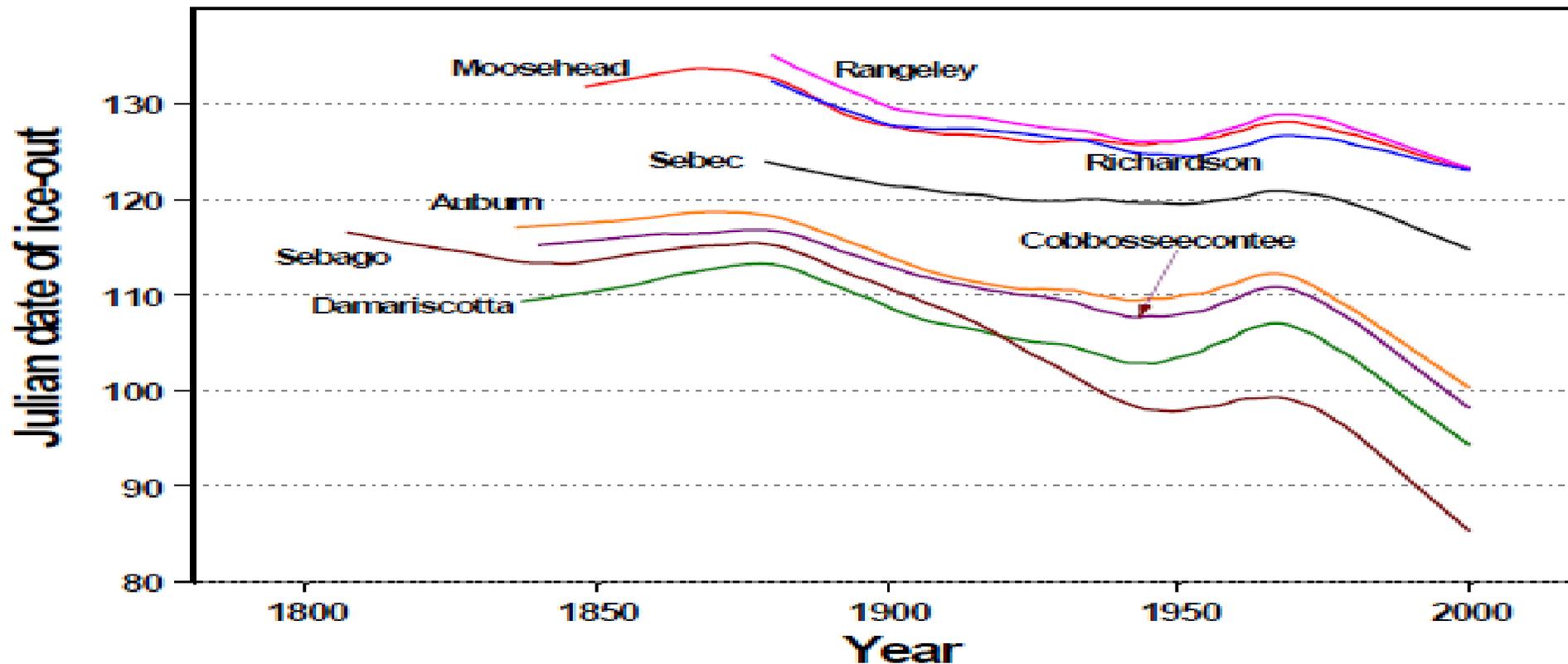
Recurring blooms of harmful blue-green algae in Maine lakes are expected to become frequent as temperatures warm, potentially impacting human, animal, and ecosystem health.

Surface temperatures of lakes in northern New England increased 1.4°F (0.8°C) per decade from 1984-2014 – faster than the worldwide average – with smaller lakes warming more rapidly than larger lakes. Maine lake surface temperatures have warmed on average by nearly 5.5°F (3°C).

Warming winters reduce snowpack and change snowmelt, river, and lake ice-out dates, causing ripple effects through Maine's biodiversity, agriculture, inland lakes and streams, and winter-based recreation.

When Frozen Water Melts: Maine Lake Ice-Out Dates

Smoothed ice-out dates for 8 selected lakes in New England



Source: "Historical Ice-Out Dates for 29 Lakes in New England, 1807–2008," U.S. Geological Survey Open-File Report 2010-1214, by Glenn A. Hodgkins

<http://pubs.usg.gov/of/2010/1214/>

Where is Maine Likely Heading?

Maine at 4.5: Moderate change is still major change



With moderate controls on greenhouse gas emissions, warming in Maine still results in a 5°F increase by 2050, and 6.5 °F by 2100. Maine cities experience 14–23 more high heat index days, when it feels like 90 °F or hotter (Dahl et al. 2019). Warm-climate insects and pathogens spread, with hundreds of more cases of West Nile Virus each year (EPA 2017). Precipitation continues to increase in frequency and intensity, and to shift from snow to more rain. The snowpack will likely be reduced by 50 percent by 2100 for the southern half of the state, or one-third fewer snow days; northern Maine experiences 12 percent fewer snow days. The majority of the losses in the snowpack will occur at the beginning of the spring season, which might have direct impacts on spring streamflow peaks (Demaria et al. 2016).

The Gulf of Maine in 2050 is 1.5 °F warmer, which is similar to conditions in 2010. In this climate, 2008 would be a cool year, and 2012 would be warm, but not extreme (Gulf of Maine 2050). Sea level rises at least 1 foot by 2050, leading to a tenfold increase in flooding to 98 events per year in Portland; by 2100, sea level could rise between 3.6 and 6.5 feet (Slovinsky 2019; Sweet et al. 2017), the latter being the recommended scenario for planning purposes, given uncertainty in the contributions of melting ice sheets to global sea levels (Bamber et al. 2019).

If Maine continues to experience more intense rainfall events as in recent years, then stormwater transport of nutrients and pollutants to fresh waters will increase. Increasing nutrients will shift biota in rivers, streams and lakes to less-desirable species including nutrient-loving invasive species, cyanobacteria and possibly toxin-producing harmful algal bloom species.

Multiple studies on Maine lakes have shown that shoreline property values decrease when water clarity is reduced due to the deterioration of lake trophic state. This causes a domino effect with respect to property taxes by shifting the tax burden from shoreland properties to upland properties. These studies estimated that our lakes generate annual revenue of approximately \$4 billion (amount adjusted for inflation).

WHAT ABOUT SEA LEVEL RISE?

Over the last century, sea levels along the Maine coast have risen at about 0.6 to 0.7 feet/century, or two times faster than during the past 5,000 years. Over the past few decades, the rate has accelerated to about 1 foot/ century, or three times the millennial rate. About half of the last century's sea level rise in Maine has occurred since the early 1990s and it is likely that sea level in Maine will rise between 3 and 5 feet by the year 2100 based on an intermediate sea level rise scenario, although scenarios of higher rise are physically plausible.

By 2050, Maine will likely see between 1.1 and 1.8 feet of relative sea level rise, and potentially between 3.0 and 4.6 feet of sea level rise by the year 2100. A 1-foot increase in sea level in the future will lead to a 15-fold increase in the frequency of “nuisance” flooding.

Nuisance flooding in Portland in the last decade was about 4 times more frequent than the 100-year average. A 1-foot increase in sea level, which could occur by 2050, would cause a “100-year storm” flood level to have a probability of occurring once in every 10 years. Not accounting for changes in storm intensity or frequency, this would result in a **10-fold** increase in coastal flooding in Maine in the next 30 years. Sea level rise will cause high tides to regularly inundate coastal lowlands with salt water and may cause limited salt contamination of groundwater aquifers.

Coastal beaches, dunes, salt marshes, and bluffs are likely to experience increased erosion, landward movement, land loss and sediment redistribution due to long-term sea level rise. A 1.6-foot sea level rise will submerge two thirds of Maine’s coastal sand dunes and reduce the dry beach area by 43%, which may happen by 2050 or earlier depending on the amount of sea level rise and available natural sand supply.

Possible Legal Issues Arising from SLR?

- Property Boundary Changes (hard vs rolling?)
- Intertidal Zone Changes, and Public Access Thereto
- Changes in Availability of Flood Insurance, and FEMA Zone Maps
- Changes in Dimensions of “Submerged Lands” for purposes of the Submerged/Intertidal Lands Leasing law, 12 MRS §§1801(9), 1862
- Changes in Coastal Wetland and Sand Dune locations and protections, see Natural Resources Protection Act, 38 MRS §§480-A et. seq.
- Changes in Shoreland Zoning Areas, 38 MRS §§435-49
- Increase in Insurance Claims and Disputes

ALSO OCEAN ACIDITY

Scientific data indicate that the rate of ocean acidification is at least 100 times faster at present than at any other time in the last 200,000 years and may be unprecedented in Earth's history

Approximately one-third of the 442 plants and animals, 21 habitats, and Species of Greatest Conservation Need found in the state are affected by climate-change related threats, including habitat shifts and alterations, droughts, temperature extremes, and storms and flooding, and are therefore highly vulnerable to climate change. Another one-third are moderately vulnerable.

BACK ON LAND

Forests currently cover nearly 89% of Maine's area and sequester over 60% of the state's annual carbon emissions, while the forest industry sector is statewide, multi-faceted, and provides between \$8-10B in direct economic impact. However, both the natural forest and industry expect significant challenges in the decades to come. For example, the state has some of the highest densities of non-native forest pests in the US, linked to changes in both climate and human behavior, which are expected to continue to increase in the coming decade.

From Maine Audubon Society:

In Maine, species that are most threatened by a combination of climate change and additional climate-related threats under 3°C of warming include Chestnut-sided Warbler, Black-throated Blue Warbler, Eastern Whip-poor-will, Pine Warbler, Purple Finch, White-winged Crossbill, Tree Swallow, Hermit Thrush, Bobolink, Dark-eyed Junco, Yellow Warbler, Northern Parula, and Black-throated Green Warbler. Blackburnian Warbler, Canada Jay, Blue-headed Vireo, and Boreal Chickadee are also considered vulnerable to climate change, but were not assessed for climate-change related threats. Black-capped Chickadee faces multiple climate-change related threats despite having low range-shift based vulnerability. For information on threats for individual species in Maine, see Table 2.

ARE THERE BENEFITS?

State Report 2020: Economic opportunities from the response to climate change include the growing renewable energy industry including land and ocean-based wind power, solar, and biofuels. Growing renewable energy production and use also means fewer imports of fossil-based energy supplies of which Maine has none.

Warmer temperatures may extend seasons for tourism activities such as cruise ships and boating while reducing the seasons for skiing and snowmobiling. Longer growing seasons will permit farmers to expand the range of crops and animals in Maine agriculture.

The forest products industry, which has been adapting to changing species mix and market demand, will experience more variable impacts due to a longer growing season but increased occurrence of drought.

Other Economic Opportunities for Maine

Ice-free Arctic could shorten distances between East Asia and North Atlantic by almost 40%

Maine's 3 ports competitively located to support increased trade from Arctic changes

Maine's renewable energy, ocean, composites and maritime sectors can lead innovation domestically and globally, creating more jobs and opportunities for Mainers, especially young people and entrepreneurs

April 2017 report: Maine 7th in clean energy momentum; 3rd in CO2 emissions reductions from 2011 – 2015 (32%)

<http://www.ucsusa.org/clean-energy/increase-renewable-energy/momentum%23.WPotP1MrIkg>

Maine's Opportunity and the Arctic

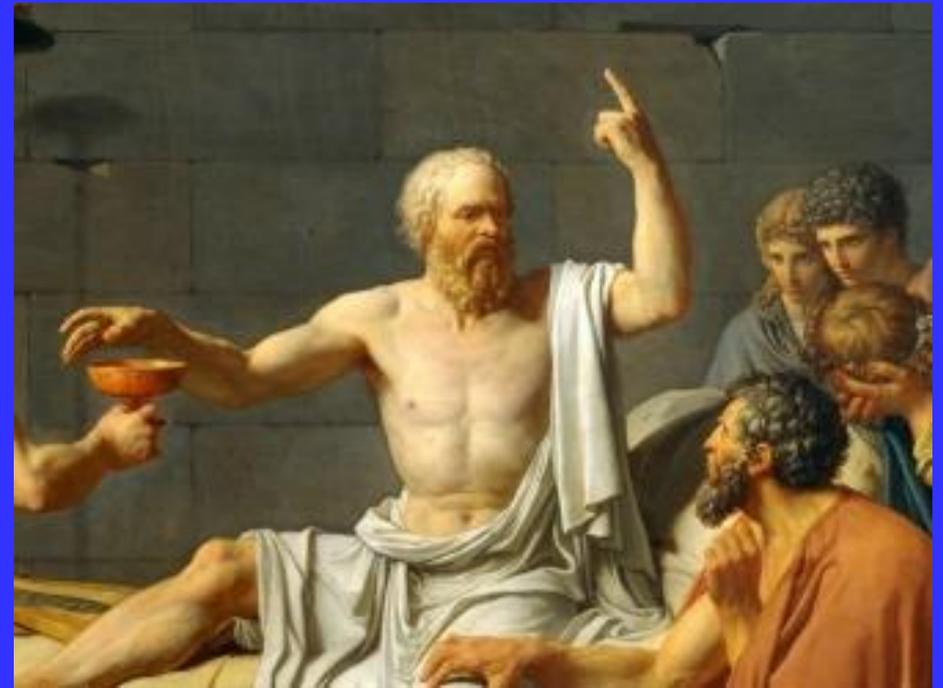


SOME GENERAL TAKE-AWAYS

- 1. Greenland and Maine have much in common:
“Vacationland”, Tourism, Fisheries...Jobs “vs”
Environment and Locals’ Conflicts**
- 2. Greenland and Tropical Rain Forest commonalities:
Global vs Local views of impacts and changes (What
happens in Greenland, Brazil, Indonesia does not stay
there); Leads to...**

BUT— WHY CAN'T EVERYONE BETTER CONFRONT “CLIMATE CHANGE”?

Climate Change is an existential threat on the scale of nuclear war—threats to our sense of place, identity, way of life, expectations of the future, protection of our children and to defend our tribe...BUT it is getting worse, not better—WHY??



The Human Mind: Cognitive Barriers

Climate Change is not concrete, immediate, visible

Dealing with CC requires short-term costs and reductions in living standards to mitigate against higher but uncertain losses far in the future

There are no pressing deadlines, so it gets pushed to the future

Uncertainty justifies inaction

CC challenges our innate wiring: it is complex, unfamiliar, slow moving, invisible, intergenerational

CC is not caused by an external enemy—we are all personally responsible for increases ie emissions, which leads to denial

"PLEASE READ THIS BOOK AND THEN ASK YOURSELF: WERE YOU SET TO WORK?" — BILL BRU

DON'T
EVEN
THINK
ABOUT
IT

WHY OUR
BRAINS
ARE WIRED
TO IGNORE
CLIMATE
CHANGE

GEORGE MARSHALL

Copyright © 2011

MIKE BERNERS-LEE

"You can't even enjoy the fact that I had a book that was done
for me and I was able to enjoy it all at the same time."

— BILL BRU



How Bad Are
Bananas?

THE CARBON FOOTPRINT
OF EVERYTHING

Copyright © 2011

A GOOD READ

AN EPIC JOURNEY INTO GREENLAND'S
BURIED PAST AND OUR PERILOUS FUTURE

THE ICE AT THE END OF THE WORLD

JON GERTNER

NEW YORK TIMES BESTSELLING
AUTHOR OF *THE IDEA FACTORY*



For more, see my articles at:

“The Seas Are Changing: It’s Time to Use Ocean-Based Renewable Energy, the Public Trust Doctrine, And a Green Thumb to Protect Seas From our Changing Climate”

<https://digitalcommons.maine.edu/oclj/vol19/iss2/4/>

“Fiddling as the World Floods and Burns: How Climate Change Urgently Requires a Paradigm Shift in the Permitting of Renewable Energy Projects”

<http://law.lclark.edu/live/files/13156-thalerready-for-websitepdf>