Good afternoon, my name is Sue Mauger.

I'd like to comment on SCR #16 and the apparent interest by the sponsors to investigate the value of coal-powered energy for Alaskans. In my position as Science Director for Cook Inletkeeper, I've worked in salmon streams around Southcentral Alaska for the last 14 years. My focus in recent years has been on stream temperatures; specifically, how current stream temperature patterns in Cook Inlet might change in the future and how these changes might impact salmon.

Based on compelling evidence from the climate scientists of the world (see "evidence" attachment) and from Alaskan researchers (see "SNAP" attachment), we understand that future climate change will result in not just warmer summer temperatures in Southcentral Alaska but also warmer winter temperatures, resulting in more rain-on-snow events, and a reduced snowpack. With less water stored in our hills during the winter, our summer water levels will be lower. And since a little bit of water warms faster that lots of water, our summer water temperatures in non-glacial streams will rise that much faster in the years ahead. Based on our 5 years of research in Cook Inlet salmon streams, many Kenai Peninsula and Mat-Su streams are already at temperatures known to be stressful to salmon (see "Executive Summary" attachment).

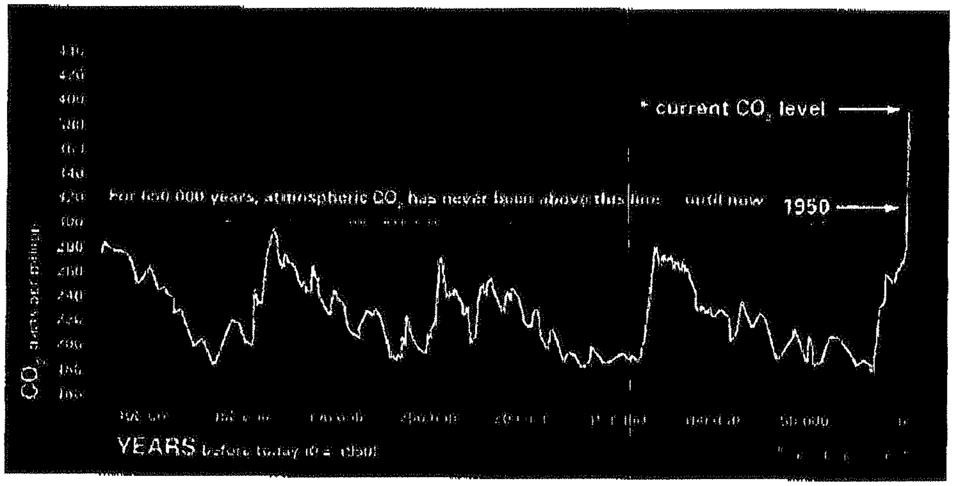
When I've talked about these climate change outcomes in the past, they have seemed a bit abstract, an eventuality for some future date. But as we sit here experiencing a remarkably warm winter, with record high temperatures, rain, ski races cancelled due to a lack of snow, the vagueness of climate change impacts are more tangible. As a scientific community, we know we have much to learn still about basic ocean dynamics and freshwater habitat requirements for salmon. And we must now add ocean acidification, and changing ocean and river temperatures into the challenge of attaining sustainable fisheries. But one thing is certain. The release of more carbon dioxide which will occur with new coal development will fast forward the timeline for the most drastic of climate change impacts. For Alaskans, living in the state disproportionately impacted by climate change, coal is a loser.

Please don't waste your time and Alaskans time exploring new fossil fuel development which will exacerbate climate change impacts in our salmon streams and salmon-based economies.

Sue Mauger

EVIDENCE

Climate change: How do we know?



This graph, based on the comparison of atmospheric samples contained in ice cores and more recent direct measurements, provides evidence that atmospheric CO2 has increased since the Industrial Revolution. (Source: NOAA)

The Earth's climate has changed throughout history. Just in the last 650,000 years there have been seven cycles of glacial advance and retreat, with the abrupt end of the last ice age about 7,000 years ago marking the beginning of the modern climate era — and of human civilization. Most of these climate changes are attributed to very small variations in Earth's orbit that change the amount of solar energy our planet receives.

"Scientific evidence for warming of the climate system is unequivocal."

- *Intergovernmental Panel on Climate Change*

The current warming trend is of particular significance because most of it is very likely human-induced and proceeding at a rate that is unprecedented in the past 1,300 years.[1]

Earth-orbiting satellites and other technological advances have enabled scientists to see the big picture, collecting many different types of information about our planet and its climate on a global scale. Studying these climate data collected over many years reveal the signals of a changing climate.

Certain facts about Earth's climate are not in dispute:

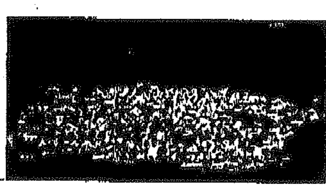
- The heat-trapping nature of carbon dioxide and other gases was demonstrated in the mid-19th century.[2] Their ability to affect the transfer of infrared energy through the atmosphere is the scientific basis of many instruments flown by NASA. Increased levels of greenhouse gases must cause the Earth to warm in response.
- Ice cores drawn from Greenland, Antarctica, and tropical mountain glaciers show that the Earth's climate responds to changes in solar output, in the Earth's orbit, and in greenhouse gas levels. They also show that in the past, large changes in climate have happened very quickly, geologically-speaking: in tens of years, not in millions or even thousands.[3]

Scientific Consensus

Ninety-seven percent of climate scientists agree that climate-warming trends over the past century are very likely due to human activities, and most of the leading scientific organizations worldwide have issued public statements endorsing this position.

Click here for a partial list of these public statements and related resources.

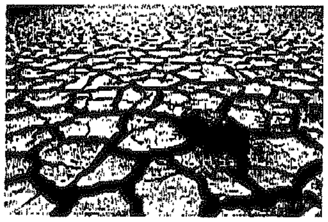
The evidence for rapid climate change is compelling:



Sea level rise

Global sea level rose about 17 centimeters (6.7 inches) in the last century. The rate in the last decade, however, is nearly double that of the last century.[4]

Republic of Maldives: Vulnerable to sea level rise

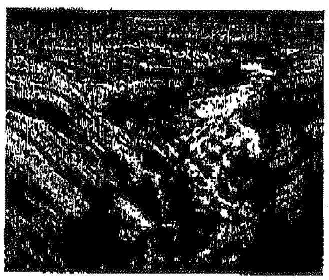


Global temperature rise

All three major global surface temperature reconstructions show that Earth has warmed since 1880.[5] Most of this warming has occurred since the 1970s, with the 20 warmest years having occurred since 1981 and with all 10 of the warmest years occurring in the past 12 years.[6] Even though the 2000s witnessed a solar output decline resulting in an unusually deep solar minimum in 2007-2009, surface temperatures continue to increase.[7]

Warming oceans

The oceans have absorbed much of this increased heat, with the top 700 meters (about 2,300 feet) of ocean showing warming of 0.302 degrees Fahrenheit since 1969.[8]



Flowing meltwater from the Greenland ice sheet

Shrinking ice sheets

The Greenland and Antarctic ice sheets have decreased in mass. Data from NASA's Gravity Recovery and Climate Experiment show Greenland lost 150 to 250 cubic kilometers (36 to 60 cubic miles) of ice per year between 2002 and 2006, while Antarctica lost about 152 cubic kilometers (36 cubic miles) of ice between 2002 and 2005.

Visualization of the 2007 Arctic sea ice minimum

Declining Arctic sea ice

Both the extent and thickness of Arctic sea ice has declined rapidly over the last several decades.[9]

The disappearing snowcap of Mount

Glacial retreat

Glaciers are retreating almost everywhere around the world — including in the Alps, Himalayas, Andes, Rockies, Alaska and Africa.[10]

Kilimanjaro, from space.

Extreme events

The number of record high temperature events in the United States has been increasing, while the number of record low temperature events has been decreasing, since 1950. The U.S. has also witnessed increasing numbers of intense rainfall events.[11]

Ocean acidification

Since the beginning of the Industrial Revolution, the acidity of surface ocean waters has increased by about 30 percent.[12, 13] This increase is the result of humans emitting more carbon dioxide into the atmosphere and hence more being absorbed into the oceans. The amount of carbon dioxide absorbed by the upper layer of the oceans is increasing by about 2 billion tons per year.[14, 15]

This resource has been selected for inclusion in the CLEAN collection

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SNAP Scenarios Network for Alaska & Arctic Planning

Methods

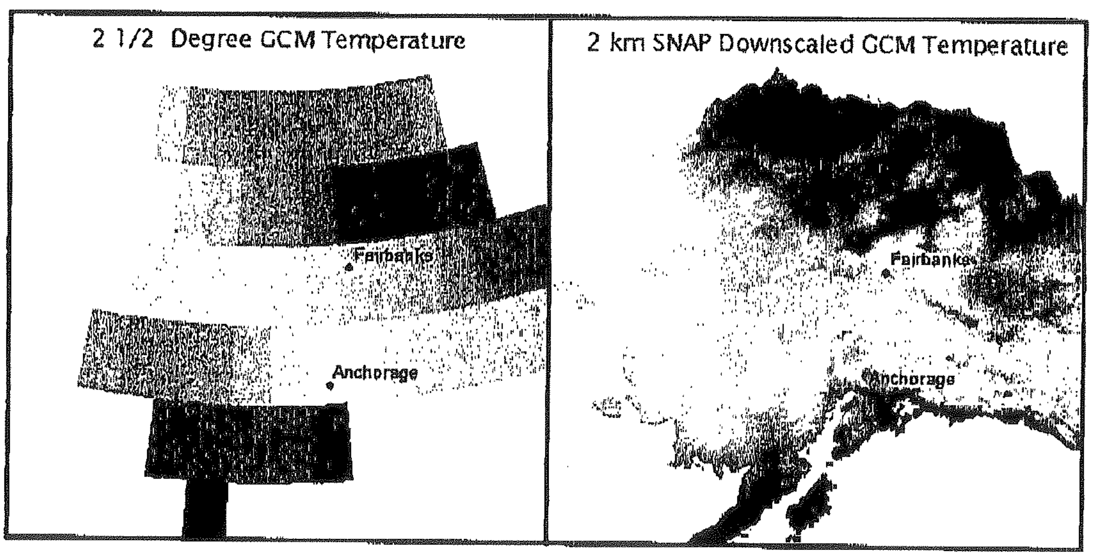
SNAP employs a variety of modeling and research methods that have been approved by the scientific community through large-scale research programs and peer-reviewed publications. In order to make global climate data useful for planning, SNAP downscales global model outputs to the local level.

SNAP selects the 5 Global Climate Models (GCM) that perform best in Alaska and the Arctic. Outputs from these models are then downscaled using PRISM data—which accounts for land features such as slope, elevation, and proximity to coastlines—as baseline climate data. This same downscaling procedure is applied to historical Climate Research Unit (CRU) data. The final products are high resolution monthly climate data for ~1901-2100 for Alaska and large regions of Canada. Where PRISM data are not available, GCM and historical data are downscaled to other baseline climate datasets such as CRU data products. Outputs are available for individual models and for a 5 model average, which reduces some types of errors associated with dependence on a single model. As new data become available, we continually update the SNAP climate datasets, applying these same methods to other areas of the Arctic and the world.

Our principal products are downscaled historical and projected monthly climate data, primarily temperature and precipitation. Projected data are produced for three emission scenarios (B1, A1B, A2). Additionally, SNAP produces derived data from the above base datasets through various modeling efforts. Derived data products include potential evapotranspiration, vegetation, fire, permafrost, day of freeze, day of thaw, the subsequent length of growing season, as well as decadal, seasonal and annual averages. For a full list of our available data, please visit the SNAP Data page. To explore the data with an interactive map, please visit the map tool.

As with any data, analysis or interpretation, multiple sources of uncertainty are always present. Understanding the uncertainty inherent in the input and output data can help in determining how these climate projections are best utilized and interpreted.

For additional details on SNAP Methods, please explore our Downscaling, Modeling, Planning, and Uncertainty sections.



STREAM TEMPERATURE MONITORING NETWORK FOR COOK INLET SALMON STREAMS 2008-2012

EXECUTIVE SUMMARY

Despite the importance of salmon resources to Alaska's economy and links between warm water temperature and reduced salmonid survivorship in other regions, long-term stream temperature datasets in Alaska are limited. We implemented a Stream Temperature Monitoring Network for Cook Inlet salmon streams to describe current water temperature profiles and identify watershed characteristics that make specific streams more sensitive to climate change impacts. Beginning in the summer of 2008, we collected continuous water and air temperatures in 48 non-glacial salmon streams during open-water periods. This report presents a summary of five years of data (2008-2012) from this collaborative project.

Maximum stream temperatures varied broadly among sites: 11.9 – 24.5°C, with average summer temperatures across all five years ranging from 6.9 – 16.2°C. The vast majority of streams exceeded Alaska's water temperature criteria set for the protection of fish especially in 2009, the warmest year, when stream temperatures exceeded the criteria of 13°C at 47 sites, 15°C at 39 sites, and 20°C at 17 sites. We recorded frequent exceedances (> 30 days/year) of the 13°C criteria at 27 sites (56%) and of the 15°C criteria at 13 sites (27%). Thirty sites (63%) had maximum weekly averages above 15°C over the five year period. Our modeling efforts indicate that large watersheds with low slope and low elevation are inclined to have the warmest temperature profiles and are the most sensitive to increasing air temperature.

Based on our assessment of current stream temperature profiles and sensitivities in Cook Inlet streams, average July water temperature in 27% of the streams will increase by at least 2°C and may result in a greater incidence of disease, poor egg and fry incubation survival, low juvenile growth rates, and more pre-spawning mortality for salmon by 2099. Thermal impacts will be more moderate in 23% of the streams, with no significant impacts to salmon health for 50% of the streams.

The Stream Temperature Monitoring Network has proven to be a successful collaborative regional monitoring effort coordinated by Cook Inletkeeper, with fifteen different partnering entities involved. Project challenges over the five year study period included: 1) coordination of partner schedules and turnover; 2) loss of data from high flow events; 3) management of 6.8 million data points; and 4) lack of available high resolution GIS layers (land cover, NHD+, stream flow) for data analysis. This regional network can be a template for coordination, data management and analysis to facilitate expanded water temperature monitoring throughout Alaska.

To read the entire report, please go to:
http://inletkeeper.org/resources/contents/stream-temperature-synthesis-report/view

TESTIMONY ON SCR 16 – COAL FIRED POWER PLANTS
MARGO REVIEL – JAKOLOF BAY OYSTER COMPANY

My husband and I are small business owners who own an oyster farm in Kachemak Bay.

We are deeply concerned about changes due to Ocean Acidification. Ocean acidification is directly linked to increased carbon pollution in our atmosphere; as more carbon enters our atmosphere, our oceans absorb more carbon, which then forms acids that eat away at shellfish. Our spat - the early life stage of oysters – are especially vulnerable to increased acidity levels.

Spending money to study more coal fired power plants strikes me as a very bad idea, because coal is a leading source of carbon pollution. Even developing countries, suffocating from pollution, are backing away from coal.

The greatest threat to me and my family is not energy costs; shaving a few dollars off our energy bill will not vastly improve our quality of life. But ocean acidification directly threatens our livelihood.

For example, upwelling of acidic water off the coast of the Pacific Northwest is having a direct negative impact on the growth of small oysters, making it incredibly difficult for Alaska farmers to acquire enough spat to get shellfish farming going in Alaska. As recently as last week, ocean acidification has been implicated in a die-off of 90% of the mature stock of scallops at a BC shellfish farm.

What keeps me up at night, what hurts my quality of life, is the real and present danger that these risks are unfolding in Alaska's waters. We are fortunate to have one of the world's leading researchers on ocean acidification – Dr. Jeremy Mathis – in our state, and I am attaching a short paper he wrote on the issue.

The State of Alaska has been incredibly supportive of shellfish farming and ~~aquaculture~~ mariculture, and we are truly appreciative. The ability to grow oysters in Alaska hatcheries where acidity levels can be controlled during those delicate early life stages, is critical to the future of our industry. But oysters and other shellfish are the canaries in our ocean coal mine, and they are showing strong indications that it's past time to back away from coal.

I can think of a long list of resolutions that would improve our quality of life, this is not one of them.

Attached article: http://www.arcus.org/witness-the-arctic/2014/1/article/20438

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Ocean Acidification Along the Rapidly Changing Alaskan Coast

By: Jeremy T. Mathis, Supervisor of Oceanography at NOAA Pacific Marine Environmental Laboratory

Jeremy T. Mathis, PhD, is also the Director of the Ocean Acidification Research Center at University of Alaska Fairbanks. Photo courtesy of Jeremy Mathis.

Since the pre-industrial era, human activities have increased atmospheric carbon dioxide (CO_2) concentrations by about 40% to values near 400 ppm, which is higher than at any point during the last 800,000 years. During this rapid loading of the atmosphere, the ocean has absorbed more than 25% of the total emitted anthropogenic CO_2, helping to offset atmospheric warming, but fundamentally changing ocean chemistry. The uptake of CO_2 triggers a series of well-understood reactions in the surface ocean called ocean acidification (OA) that has already reduced the global surface ocean pH by about 0.1 units, making the ocean 30% more acidic than in pre-industrial times. During this process, biologically important carbonate minerals are diminished, which makes it more difficult for organisms like mollusks to create and maintain their shells, especially during early life stages.

High-latitude oceans, like those around Alaska, have naturally low carbonate ion concentrations due to low sea surface temperatures and increased solubility of CO_2 and are thus considered to be more vulnerable to the impacts of OA on shorter timescales. Accordingly, the uptake of anthropogenic CO_2 further reduces carbonate ion concentrations, pushing the high-latitude waters closer to the threshold where shell dissolution can occur.

Waters that are potentially corrosive to carbonate shells in the western Arctic Ocean and the Bering Sea are found in the central Canada basin, on the Chukchi and Beaufort Sea shelves, in outflow waters on the Canadian Arctic Archipelago shelf, and across the expansive northern and southern Bering Sea

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began to fund the development of an ocean acidification-monitoring network (see Figure 2) in key regions around the state. Data from each location can be found at http://www.pmel.noaa.gov/CO (http://www.pmel.noaa.gov/CO)$_2$/story/Coastal+Moorings.

This network is made up of fixed buoys, oceanography research cruises, and unmanned vehicles; along with a citizen-monitoring program where fisherman, school children and concerned citizens collect water in their own regions for scientific analysis. By monitoring sensitive areas and the keystone species that inhabit these environments it will be possible to detect the detrimental consequences brought on by OA before a complete collapse of a fishery occurs.

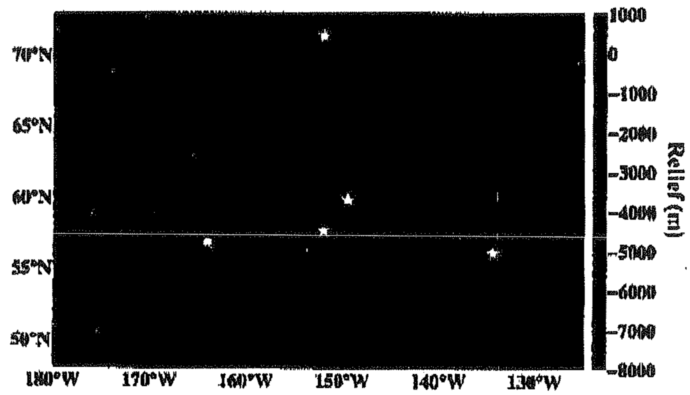

Figure 2. Map showing the location (yellow stars) of the buoys around Alaska that are measuring ocean acidification parameters in real-time. Image courtesy of Jeremy Mathis.

In the meantime, Alaskans, particularly those in the most vulnerable areas must work to diversify their regional economies so that they are not solely dependent on a few commercially important marine species. Alaskan commercial fisheries have a long history of opportunistically switching to different species based on availability and marketability. This suggests that the socio-economic system may have some ability to adapt to future conditions. However, every effort should be made to develop other industries and resources (e.g., fur seals, gold, timber) so that if a worse case OA scenario occurs, the consequences can be managed in a way that leaves both coastal communities and the state on sound financial footing.

For further information contact Jeremy Mathis (jeremy.mathis@noaa.gov (mailto:jeremy.mathis%40noaa.gov)).

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shelf. In the Chukchi Sea and Bering Seas, waters that are potentially corrosive to carbonate shells occur seasonally near the bottom due to the combination of natural respiration of large quantities of organic matter transported from the surface and the intrusion of anthropogenic CO_2 from the atmosphere. These processes are creating an ever-expanding environment where the intensity, duration, and extent of low-pH events are increasing in one of the most productive and diverse ecosystems on Earth (see Figure 1).

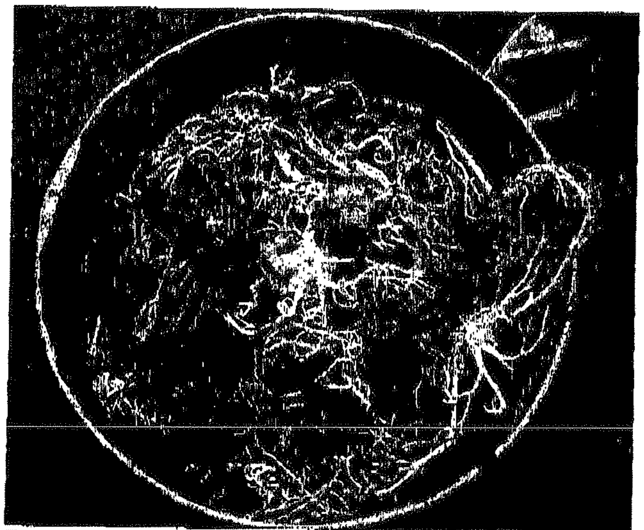

Figure 1 – Benthic grab from the bottom of the Bering Sea showing the diversity of organisms, many of which are calcifiers that could be impacted by ocean acidification. Photo courtesy of Jeremy Mathis.

While there have been few comprehensive studies, OA appears to act more strongly on certain species, but lower pH environments can fundamentally alter ecosystem composition toward dominance by non-calcifying organisms. Mollusks, such as oysters and clams, appear to be the calcifying group most negatively affected by OA. However, crustaceans such as the red king crab and tanner crab species exhibit negative responses that included slower growth and lower survival rates when they are exposed to high-CO_2, lower-pH water.

Alaska's heavy dependence on marine organisms for both commercial and subsistence activities implies that ecosystem services based on these species could change as OA continues to progress. As this happens over the next 50 to 100 years, the region could be impacted through changes in food security or shifts in livelihoods. In many communities around the State, large portions of the economy are tied directly to the extraction of living marine resources. Alaska's western and southern rural areas are likely at the highest risk from OA due to a confluence of factors, including: subsistence fishing for near-shore species like clams and crabs, more rapid projected OA, lower industry diversity, economic dependence on fishery harvests, lower income, and higher food prices.

While the only way to mitigate the impacts of OA is through the reduction of CO_2 emissions to the atmosphere, there are some adaptive strategies that can be implemented in the near-term to help managers and policymakers deal with any disruptions in marine ecosystem services. Careful monitoring of coastal marine environments, particularly in regions of societal and economic importance is a critical first step in addressing the challenges of OA. Beginning in 2012, a number of Federal and private agencies as well as the state of Alaska