Climate Science of Kachemak Bay and the Kenai Peninsula[1]

Local science to inform local decisions

Coastal communities on the Kenai Peninsula are already coping with a variety of challenges related to a changing environment, particularly because communities depend on coastal resources for their economic and cultural livelihood. The effects of a warming climate in this region are dramatic and forecasted to become even more so in future years. Agencies, small businesses, and communities on the Kenai Peninsula have responded to these signs of rapid climate change in varying ways; however, these efforts to date have not resulted in many tangible recommendations or a long-term strategy for adaptation.

Increased awareness and understanding of climate change science and vulnerabilities among decision-makers would help these communities adapt and increase resilience to environmental change. To start address this issue, Kachemak Bay National Estuarine Research Reserve (KBNERR) collaborates with researchers to synthesize and distribute the best available science around climate change impacts projected for the Kenai Peninsula.

Climate Science and Impacts

Local Climate

Temperatures will increase, especially in the winter.
Alaska is warming at twice the rate of Lower 48, with winters warming more than summers and nights have warmed more than days. Since 2014, KBNERR System Wide Monitoring Program has measured temperature anomalies in Kachemak Bay air and estuary water temperatures that have been above normal. Warmer air temperatures influence freshwater inputs to the estuary by changes in precipitation patterns and the rapid melting of overwinter snow pack and coastal glaciers.

Precipitation will increase overall, with more precipitation falling as rain rather than snow.
One of the most difficult to forecast trends on the Kenai Peninsula is the form, timing, and magnitude of increasing precipitation. Scenarios Network for Alaska and Arctic Planning predictions indicate a shift in precipitation from snow to rain, which impacts water storage capacity and surface water availability. Impacts include changes in storm water runoff, groundwater infiltration and water storage. Snow may increase at higher elevations but decrease along coast.

Many locations will be dryer in the summer as evaporation rates increase.
Research by Kenai National Wildlife Refuge documents wetland drying and encroachment of woody vegetation into peatlands. KBNERR has found that these peatlands are important sources of organic carbon, vital for stream productivity, and support on anadromous fish. The Western Kenai has warmed and dried in last 50 years with respect to available water (60% loss since 1968), wetlands (6 – 11% per decade), and glaciers (5% surface area, 21 m elevation). Glacial systems provide cold water during warm months but at higher stream flow and will likely contribute to increased turbidity.

Coastal & Marine

Storm intensities and frequency will increase.
Sea level rise is likely to be offset by land level rise from glacial rebound and tectonic uplift according to a joint study between KBNERR and UAF Geophysical Institute. Oceanographic monitoring in Kachemak Bay and lower Cook Inlet done collaboratively with KBNERR and Kasitsna Bay Lab indicates a lack of ocean cooling in the winter is important. Wave height, period, and direction are important factors in sediment transport; wave dynamics are being monitored with an IOOS wave buoy supported by KBNERR and KBL in outer Kachemak Bay. A 2016 study by KBNERR indicates erosion rates on Eastern shores of Cook Inlet are 1 foot per year, and 2.3 feet per year on the western Homer area.

Oceans will become warmer and more acidic.
Increase in carbon in the atmosphere will affect ocean carbonate chemistry, leading to ocean acidification. Shell formation of important zooplankton is most at risk and a source of food for many harvested fish stocks in the region. Ocean acidification will damage vital nurseries for many fish stocks. Alutiiq Pride Shellfish Hatchery tests water samples from

[1] KBNERR hosted a Climate Adaptation for Coastal Communities workshop in March 2016 in Homer, AK. The climate science and impacts summarized in this document are a result of the presentations and discussions during this workshop. NOAA Office for Coastal Management trainers presented basic influences on the climate system, as well as climate's impact on coastal communities and the natural environment. Regional experts presented local data and monitoring, impacts on coastal and watershed resources, and landscape level vegetation and wildlife change. Through facilitated discussion, regional environmental experts, coastal decision-makers, and community members were able to understand synergistic and land-scape level impacts that are occurring on the land and in the estuary. Coastal and community impacts were identified utilizing local research and monitoring, and observations from our network of partners, including the National Estuarine Research Reserve System's (NERRS) System-Wide Monitoring System (SWMP). Presentations:

- *Regional Data, Trends, and Impacts*, Jessica Shepherd, Kachemak Bay NERR
- *Alaska's Salmon Streams in a Changing Climate*, Sue Mauger, Cook Inletkeeper
- *Early Responses of Kenai's Wildlife and Vegetation to Rapid Climate Change*, John Morton, USFWS Kenai National Wildlife Refuge

numerous communities near coastal villages and communities in south-central Alaska to assess vulnerability with the emphasis on shellfish health. NOAA Kachemak Bay Habitat Focus Area research is currently being conducted to promote native shellfish population recovery through pH monitoring, habitat modeling and clam spawning sanctuaries.

Wildfires

Wildland fire season will shift in timing and vegetation types.
Official fire season is now April 1 instead of May 1. In the aftermath of spruce bark beetle-induced deforestation, grassland fires have burned in April on the southern part of the Peninsula in recent years. Lightning caused the 2005 Irish Channel fire that burned 1,100 acres of mountain hemlock, an event so rare in this forest type that charcoal evidence of a historic fire regime has not been detected.

Agriculture & Fisheries

Length of growing season will increase.
Homer's growing season has increased from 100 days to 130 in the past 30 years. Homer has jumped 2 USDA plant zones, and season extension and mechanisms that improve plant health and vigor (high tunnels) has increased local agriculture opportunities. Southern Kenai Peninsula NRCS offices are the highest grantor of Equip grants in the nation.

Salmon stream viability will be stressed.
Several of our Kenai Lowlands streams have been measured by Cook Inletkeeper that fall into temperature categories that put salmon at risk. Warmer temperatures will cause reduced survivorship of salmon egg and fry, reduced growth rates due to increased rates of respiration and metabolism. Premature smolting and shifts in emigration timing reduce marine survival and some organic chemicals and metals, including mercury, can increase in toxicity with temperature, causing greater vulnerability. Juvenile salmon may respond positively to increased stream temps as long as their habitat and food sources are intact.

Habitats, Wildlife, & Plants

Land cover types will change.
Temperature and precipitation regimes indicate we are in the edge of three biomes- boreal forest, temperate rainforest and grassland savanna. Kenai National Wildlife Refuge has detected woody shrub encroachment into 8000 year-old Sphagnum peatlands, and conversion of spruce forests to savannah. Eastern Kenai Peninsula is predicted to undergo afforestation in alpine (hemlock) and coastal (Sitka spruce) areas, while the Western side will undergo deforestation (white and black spruce), expanding grasslands.

Animals, insect species, and plant communities will shift their ranges.
Changing bird migration windows and birds that are more common in winter have been documented through E-bird. In the marine environment, changes in food web dynamics likely influenced mortality events for large whales in the Gulf of Alaska and common murres. COASST Citizen Scientists recorded the die-off of thousands of common murres in fall, 2015. Sea otter strandings increased to record numbers for Kachemak Bay during 2015 according to the Marine Mammal Stranding Network. Baseline vegetation mapping in four salt marshes (Beluga Slough, Fox River Flats, Sadie and China Poot) has been done through KBNERR to measure plant community dynamics in response to sea level change.

Changing conditions will enhance the likelihood of invasive and harmful species.
KBNERR Harmful Species Program works with oyster growers and community volunteers for early detection of harmful algal blooms and invasive species. A toxic *Pseudo-nitzschia* bloom in Kachemak Bay was seen September 2015 and a Kachemak Bay oyster farm tested positive for saxitoxins, which can cause Paralytic Shellfish poisoning from *Alexandrium*. As marine water temperatures increase, Southcentral Alaska is vulnerable to invasions from marine invasives, including European Green Crab and Invasive Tunicates. Alaska Center for Conservation Science tracks all non-native plants known to occur in Alaska. Spruce forests have been hit by eruptive species such as Spruce Bark Beetles, and more recently Spruce Aphids, causing defoliation around Kachemak Bay in 2016.

Where can I learn more?

- Kachemak Bay NERR Long Term Monitoring and Research Programs http://accs.uaa.alaska.edu/kbnerr/research-program/
- Alaska's Climate Change Strategy: Addressing Impacts in Alaska https://climatechange.alaska.gov/aag/docs/aag_all_rpt_27jan10.pdf
- Climate Change Impacts in the United States: Alaska Chapter https://www.epa.gov/climate-impacts/climate-impacts-alaska

Kachemak Bay Research Reserve

National Estuarine Research Reserve System