Climate Change in **Nondalton**, Alaska

Strategies for Community Health

ANTHC Center for Climate and Health

Achieving wellness through awareness and adaptation

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SUMMARY

Climate change refers to change over time due to natural variability or as a result of human activity (IPCC, 2008). Alaska is experiencing a wide range of impacts from climate change and communities seek adaptive strategies that encourage wellness and sustainability. This report documents climate change impacts as described by local people and climate change effects or potential effects as interpreted through the lens of public health. It is the seventh report in a series describing climate change across Alaska, and the second report to focus on the Bristol Bay region, the first being in the community of Pilot Point.

In the Dena'ina community of Nondalton, residents report changes to the weather, the landscape, plants and wildlife with important implications for public health. Weather events with extreme precipitation, wind and temperatures have been observed in recent years and

Main street, Nondalton.
Photo by Mike Brubaker, 2013.

This report includes observations, experience and knowledge shared by a wide range of local experts. Predictions and projections are based on available information and limited by the quality of current scientific data and the uncertainties inherent in models. Research and model development is ongoing in Alaska and new information will be available in the near future.

there is a perception that these are occurring more intensely and more frequently. Understanding community impact of climate change is important for assessing negative and positive effects on health. Melting glaciers is improving flight conditions through Lake Clark Pass, but also changing lake conditions with uncertain impacts on fish and wildlife. Some subsistence resources such as caribou are more scarce while some types of salmon are being harvested with greater frequency. Rising temperature in summer raises concerns about heat illness and presents new challenges when preparing dry fish and other subsistence foods. Important health topics include food security, water security, heat related illness, and infrastructure vulnerability to damage and disruption from extreme weather events, and safety related to travel in increasingly unpredictable weather and changing seasons and landscape.

Figure 1.
Bristol Bay Native Association (BBNA) service area.

Understanding community impact of climate change is important for assessing negative and positive effects on health.

The climate change assessment process began at a workshop in Dillingham in 2011 with tribal environmental managers from throughout the region. An advisory team was established including the Bristol Bay Native Association (BBNA), Bristol Bay Area Health Corporation (BBAHC), the University of Alaska Fairbanks (UAF) Seagrant Program, the U. S. Fish and Wildlife Service (FWS), and the Alaska Native Tribal Health Consortium (ANTHC). In 2012, baseline information on climate change vulnerabilities were compiled and weighted, and three communities representing different regional biomes (river, coastal and lake) were selected for on-site assessments. Nondalton, a lake community, was identified as Priority Level 2 on a scale of 1 (high) to 5 (low) based on economic factors, vulnerability of water source, and past history of floods and erosion. Upon receiving a resolution of support from Nondalton Village (the tribal government), an assessment team was established consisting of Sue Flensburg from BBNA, Charlotte Balluta of Nondalton Village, Jennifer Skarada of BBAHC, and Mike Brubaker from ANTHC. A site visit was performed in June 2012 and in July of 2013. Survey and report preparation was based on guidance from Nondalton Village, and a multi-agency advisory team.

The assessment team visits Karen Evanoff's fish camp.
Photo by Sue Flensburg, 2013.

This report was prepared by ANTHC's Center for Climate and Health in partnership with Nondalton Village and members of the advisory team. Funding was provided by the Western Alaska Landscape Conservation Cooperative, and the United States Environmental Protection Agency. In-kind contributions were provided by project partners. Information sources for this report include the observations of local residents, reports from government agencies, and scientific findings gathered from published sources.

In the Dena'ina community of Nondalton, residents report changes to the weather, seasons, the landscape, plants and wildlife with important implications for public health.

Fireweed next to Six Mile Lake in Nondalton.
Photo by Mike Brubaker, 2013.

LANDSCAPE

Ecosystems are areas that share similar climate, geographic conditions and communities of plants and animals. Nondalton is part of the "Lime Hills," a subset of the larger Alaska Range Transition ecosystem between the continental boreal interior and the marine rainforst coastlands (Spencer et al. 2007). The climate here has shorter winters than the Interior and warmer, drier summers than the coastal rainforests. The higher elevations are defined by glaciers and glacially formed ridges and valleys that run east to west. The lower elevations are defined by boreal forest.

Soils in the area are generally thin, rocky, and cold, with scattered pockets of permafrost. The lakes are important headwaters for streams and rivers flowing into Kvichak Bay and Bristol Bay. The small streams are generally clear with narrow floodplains but the water becomes silty as it flows into larger glacial streams that are braided with broad, gravelly floodplains. Fish including the Arctic grayling, Arctic char and rainbow trout are common in clear mountain streams, and all five species of Pacific salmon migrate into these rivers.

The basins support white spruce and birch on higher ground; black spruce, low shrubs, sedges, and mosses in the wetlands. Stands of white spruce and balsam poplar can be found along the rivers. The lower mountain slopes are covered with dense thickets of alder that transition to low shrubs in the subalpine and blueberry rich alpine tundra. The areas above 4,000 feet are characterized by rock and ice and little vegetation.

The ecosystem supports many species of mammals and resident and migratory birds. Moose, caribou, grizzly and black bears, wolves, foxes, beavers, and various small mammals are common, and mountain lion have occasionally been sighted by residents. Birds, including a wide variety of waterfowl, nest in the wetlands, golden eagles in the mountains, ptarmigan in thickets. Ravens are found just about everywhere.

Computer models consider future "cliomes"; areas where temperature and precipitation reflect certain kinds of wildlife and vegetation. Bristol Bay's current cliome, "boreal forest with coastal influence and intermixed grass and tundra," is expected to shift north and largely disappear by 2090. It may be replaced by "prairie and grasslands," a cliome that does not currently occur in Alaska, and is characteristic of southeastern Alberta in Canada.

Nondalton may one day become one of the warmest climate regions in Alaska.

Aerial view of Nondalton.
Photo by Mike Brubaker, 2013.

"We notice in the fall how the shrubs are climbing up mountains. Someday these mountains will be all trees."

Ricky Delkittie, Sr.

COMMUNITY

Nondalton is a traditional subsistence community located on the west shore of Six Mile Lake, between Lake Clark and Iliamna Lake. It is situated about 116 miles northwest of Dillingham and 190 miles southwest of Anchorage. As of 2012, there were about 169 residents, mostly Alaska Native people of Dena'ina descent. The Dena'ina, part of the Athabascan language group, have occupied the region for at least one thousand years and the climate has more than once exacted huge environmental changes in the area, including the "Little Ice Age" from 1350 – 1900 AD. Today the Dena'ina are witness to a new chapter of history, characterized by warming and the demise of glaciers.

From early history the Dena'ina interacted frequently with the Alutiiq and Yup'ik peoples of Alaska. In the late 1700s a new influence emerged in the form of American, Asian, and European fur hunters, traders, settlers and clergy. The first American account of the area was by Charles Leslie MaKay in 1881. Within fifty years of MaKay's visit the first float plane landed on Lake Clark ushering a period of greater interaction with the outside world. Old village sites include "Kijik" located on the north side of Lake Clark. Kijik residents fell victim to an epidemic in 1902 and by 1909 was abandoned, except for fall fishing, camping and visiting the historic village site, which is still done today. In 1906, the village was moved to Six Mile Lake but at a different location, on the west shore, three miles north of Nondalton. The community relocated again in 1936

Mary Ann Trefon and her daughter Katie Trefon at the mouth of Walker's Slough located on the mouth of Chulitna River in the spring of 1927. In the foreground is their catch of white fish and pike. Katie is holding muskrat pelts that would have been sold.
Photo Courtesy Agnes Cuma (NPS Collection H-23).

"Our elders told us to be prepared for when there would be winter followed by winter, or summer followed by summer."

Ricky Delkittie, Sr.

Figure 2. Google view of Nondalton's location on Six Mile Lake.

because of lake and channel changes. The first post office was established in 1938. Nondalton was incorporated as a second class city in 1971 and today is part of the Lake and Peninsula Borough.

The lakeshore setting of Nondalton provides for excellent fishing, hunting, and berry and plant harvest in season. Snow machines are used for travel in the winter, small skiffs in summer. The Nondalton people are salmon people and the annual practice of harvesting salmon is an essential part of their lives and cultural identity. Most of the subsistence harvest is salmon caught during the summer and fall using beach seines. Fish camps form a small seasonal village less than a mile down lake from town, at the mouth of the Newhalen River. Here Nondalton residents and extended family gather every summer to harvest, dry, smoke and can fish that is used throughout the year. Beyond the importance of gathering food, the practice and teaching of traditions that occur at fish camp and the family and community social interactions emphasize the special importance of salmon as a resource and cornerstone for the Dena'ina way of life.

The Nondalton people are salmon people, and the annual practice of harvesting salmon is an essential part of their lives and cultural identity.

There are several miles of gravel road in Nondalton and a road on the west side of the Newhalen River leads 14 miles south to the community of Illiamna, where the airstrip can accommodate large jets. Nondalton has a 2,800 foot gravel airstrip with daily service. Residents rely upon road transport and air service for store-bought food, fuel, and other supplies. Seasonal fire fighting is a major source of income, but residents are also employed in construction, commercial fishing, tourism, guiding, mining, health care, education, traditional crafts, and other businesses and government services. Subsistence is also an important economy and a range of fish, birds, plants and wildlife are harvested.

Local facilities include the tribal and city administrative offices, a school, two stores, and a bulk fuel storage facility. The historic St. Nicholas Russian Orthodox Church was constructed in 1896 and moved with the village to the current site. There is a health clinic but residents travel to Dillingham or Anchorage for more advanced medical care. Homes are typically heated by fuel oil or wood stoves. Water is pumped from the lake, treated and distributed through a piped system to most homes. Sewage is piped and pumped to a storage and treatment lagoon and solid waste is taken to a landfill located south of the village. Electricity is provided by diesel power plant and fuel sales by the City of Nondalton.

June Tracy.
Photo by Mike Brubaker, 2013.

"I really love this lake. The way it changes in the spring and the different colors of the lake in seasons."

June Tracy

Nondalton fish camps.
Photo by Mike Brubaker, 2013.

At Fish Camp Nondalton residents and extended family gather every summer to harvest, dry, smoke and can fish that is used throughout the year.

TEMPERATURE

Observed change: *increases in temperature, weather variability and extremes, landscape change*
Community impacts: *season changes, travel conditions, subsistence harvest, wildfires*
Health concerns: *injuries, heat illness, mental health (positive & negative aspects), nutrition & dietary change*
Adaptations: *enhance systems for self-sufficiency & emergency preparedness, education, habitat conservation*

The climate is warmer than in the past

Nondalton is located in a transition between coastal and continental climate zones. The climate is characterized by long periods of cloudy, wet weather and strong consistent winds that mostly blow easterly. The mountains create lots of precipitation on the windward side, and rain shadows on the leeward. Average summer temperatures range from 42 to 62°F, and winter temperatures from 6 to 30°F. The record high temperature is 91°F, and the record low is -47°F. Average annual temperatures have been increasing and residents observe that extremely high summer temperatures have negatively affected their ability to dry fish, sometimes causing inadequate preservation or loss of harvest.

During the summer of 2013 temperatures hovered in the 70s and 80s for weeks, increasing the number of swim days for kids, but also raising concerns about sunburn, dehydration and heat illness. Nondalton homes are built to stay warm, not cool, and there were shortages of fans and reports of heat stress at the clinic. Dog yards are oriented for maximum sun not for shade and some pets suffered through the hot days. Infants are traditionally wrapped up tight to keep them warm and to protect from insects. However, these are behaviors adapted for cooler conditions, and during hot summers can result in over- heating and illness.

Drying racks for fish.
Photo by Neena Brubaker, 2013.

"We hang our fall fish to dry in the cold air, but last year it did not do well. It was too warm."

Charlotte Balluta

Annual average temperature based on measurements from the Illiamna regional weather station has been increasing since the early 1940s (Alaska Climate Research Center). Extreme temperature events have also been changing with more really hot days and fewer really cold days, especially in the spring and winter (Stewart 2011). Long-term weather records are limited for Nondalton, but records from the weather station in King Salmon (about 110 miles southwest of Nondalton) indicates that between 1949 and 2008, average annual temperatures increased by 3.8°F, with most warming occurring in winter (+8.1°F) and the least (+0.6°F) occurring in the fall.

The number of large wildfire years since 1940 has increased across Alaska, mostly in the Interior boreal forests (UAF 2013). Nondalton residents also report increases in wildfires, especially in tundra areas. In November 2012, an unusual winter tundra wildfire near Dillingham burned for days impacting important subsistence harvest areas (Bristol Bay Times). Longer summers and warmer temperatures will contribute to big fire years.

Over the past decade a climate system called the Pacific Decadal Oscillation (PDO) has changed the amount of warm air emerging from the North Pacific. The PDO is a cycle that

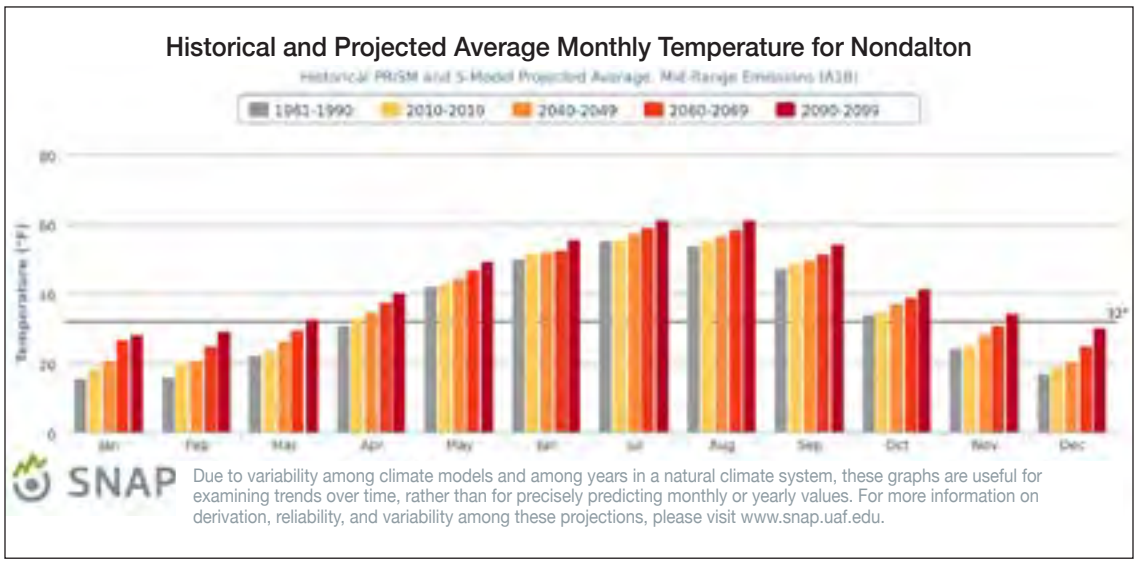


Figure 3. Historic & Projected Temperature, Nondalton, Alaska.
UAF, Scenario Network for Alaska Planning 2013.

"It can get very hot here. We are seeing cases of heat stroke in adults and more febrile seizures in infants."

Ron Loftfield, CHAP

changes from warm to cold every 20 to 30 years. The PDO exerts the most influence on Western Alaska and since 2000 areas south of the Brooks Range have actually been cooling (Wendler et al. 2012). King Salmon's average annual temperature dropped by a significant 2.9 degrees during this period. Because of the PDO, some areas of Alaska could temporarily cool and experience a period of relatively lower temperatures. The historical effect of the PDO can be seen in the King Salmon trend data (Figure 4), with cyclical periods of cold (1950s-1970s) and warm (1920s – 1940s, and 1980s – 2000) temperatures.

Recommendation: In the short term, Bristol Bay region may experience a temporary cooling period, the result of regional cycles rather than global climate trends. This may provide Nondalton with a break from some warming related impacts. Despite this, the long-term trend for Nondalton is for continued warming and seasonal change and variations in the timing of freeze-up, break-up and green-up are to be expected as are the increases in the onset, frequency and intensity of extreme weather and wildfires. Community disaster plans should by reviewed frequently to

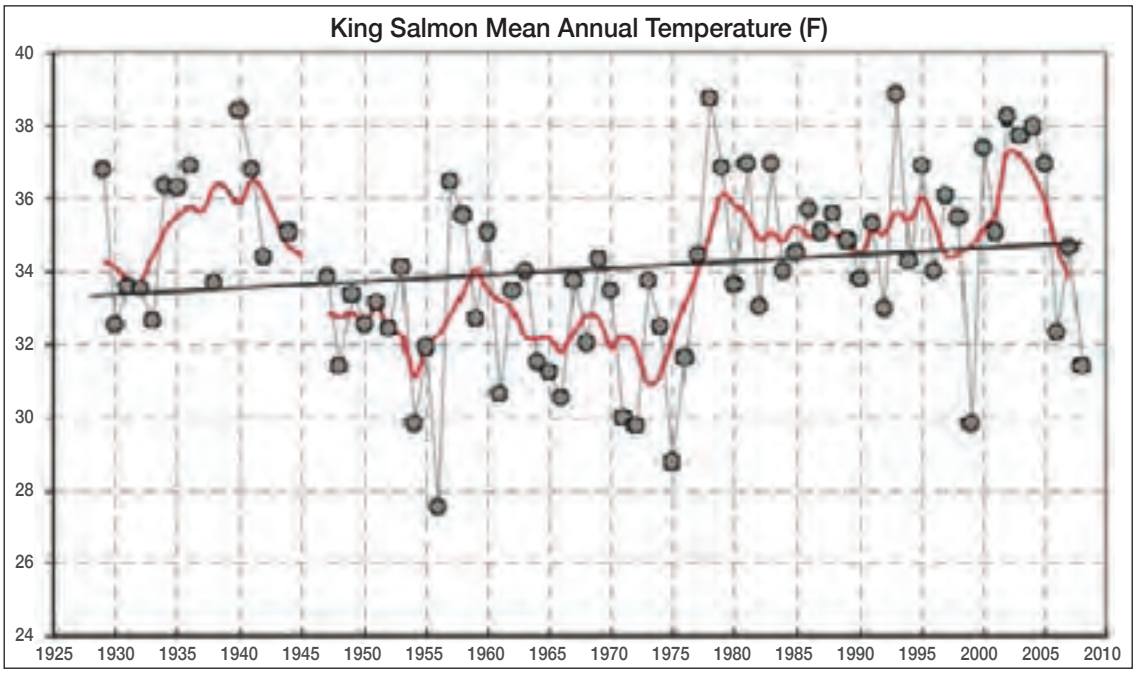


Figure 4. Mean Annual Temperature Trend in King Salmon.
Alaska Climate Research Center, Geophysical Institute, UAF.

"We have a lot of tundra fires."
Olga Balluta

incorporate changing risk conditions. Warm season public education on prevention of heat illness is recommended and could be performed through the tribal health system. Healthy housing discussions in the context of cooling homes engineered for Arctic environments, is also recommended. Nondalton would benefit from systems that ensure energy, water, medical, and food security in times of extreme weather or natural disaster that could interrupt transportation or cause shortages. Local environmental observers can help document and coordinate communication and response of unusual weather events. Key Contacts: City and Tribal Government, National Weather Service, Alaska Center for Climate Assessment and Policy, BBNA, BBAHC.

Kids escape the heat by swimming in Newhalen River.
Photo by Mike Brubaker, 2013.

"We need to teach people about how to stay cool."

Ron Loftfield, CHAP

PRECIPITATION

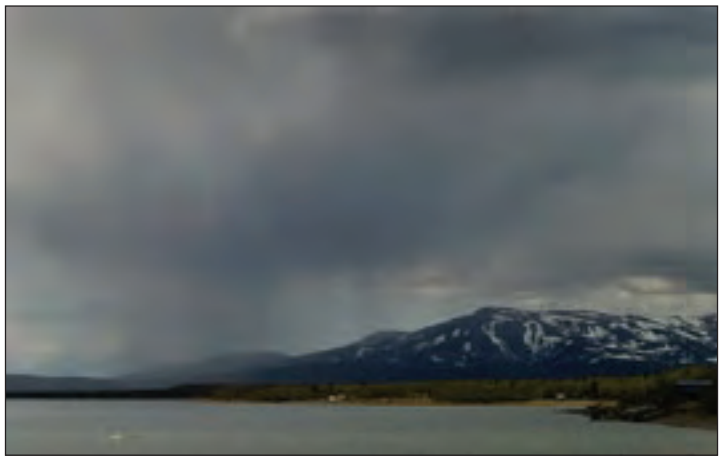
Observed change: *extreme precipitation events, less snow and more rain*
Community impacts: *weather delays; sewage lagoon overflow, submerged well head*
Health concerns: *mental stress, raw sewage and increased risk of waterborne illness*
Adaptations: *enhance systems for self-sufficiency & preparedness, sewage lagoon engineering study*

Extreme events threaten infrastructure

Over the past half century Nondalton has become wetter with increased precipitation in most months of the year (SNAP). In southwest Alaska, the frequency of extreme, three-day rain events in the summer has been increasing (Stewart, 2011). Nondalton residents observe very wet summers including 2011, when it was reported that rain occurred for 30 days without interruption. Increased variability is reported, including years with extremely high or low precipitation, including snow fall.

The majority of winter precipitation occurs in October through April. Annual average rainfall is 26 inches, mostly in the late summer and early fall. The wettest month is August and the driest is May. Snow fall has typically averaged about 64 inches per year, but sometimes with little accumulation. The snow day fraction (a measure of days of snow versus rain) was 30 to 40 in the 1990s. The projection for the future is for the winters to become increasingly rain rather than snow dominated, with snow day fractions of 20 to 40 (McAfee, 2013). This means less snow pack in the mountains and melt water for streams, and less snow on the land and the lake.

Comparing average precipitation from 1961 to 1990, with the period of 2010



Rainstorm in Nondalton.
Photo by Mike Brubaker, 2013.

"Last summer we had 30 days straight of rain."
William Evanoff

to 2012, the amount has increased in nine out of twelve months. Projections through 2040-2049 are for continued increases in every month except June, July and December (SNAP 2013). The frequency of extreme precipitation events is also expected to increase. Another change may be increases in the frequency of freezing rain. Western Alaska is among the most vulnerable areas of Alaska for "icing events" over the land or snow, with over seven of these events typical in a single year and mostly in the spring (Wilson, 2012).

Recommendation: Precipitation is projected to increase during the spring and summer and decrease in fall and early winter. Longer-term projections are for increases in almost every month. Warmer temperatures will likely mean more winter rain and wet snow conditions. Declines in snow pack or rapid thawing, extreme rain events and glacial melt all have implications for lake level, community water supply, and transportation as well as conditions for vegetation, birds, fish and wildlife. Improved precipitation data requires daily measurements, which could be coordinated through government partnerships. Key Contacts: City and Tribal Government, BBAHC, National Weather Service, National Park Service, Alaska Center for Climate Assessment and Policy, BBNA, ANTHC.

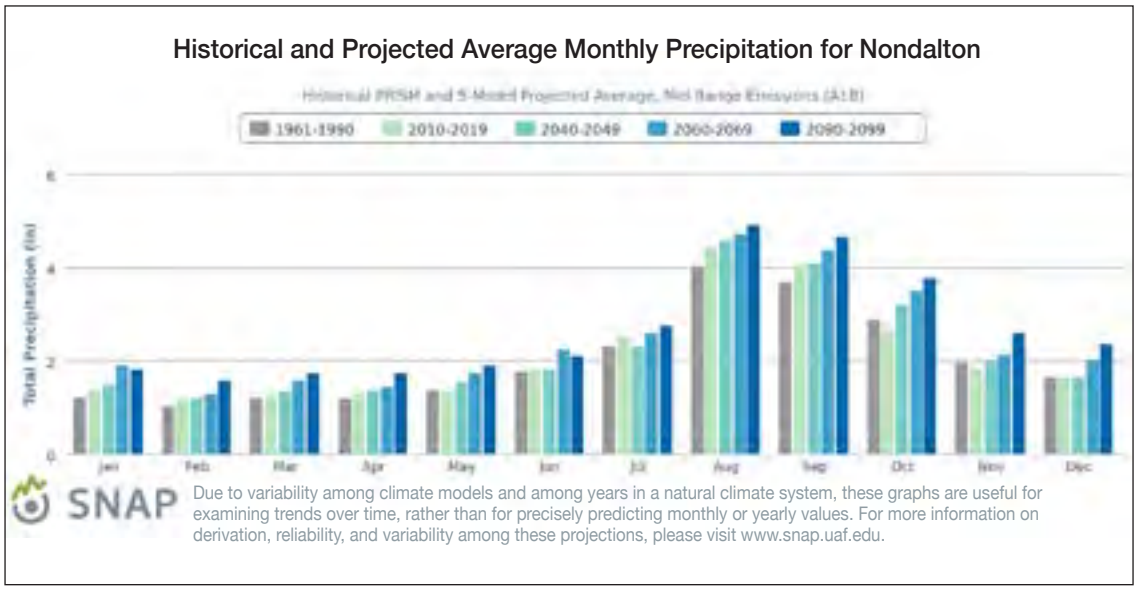


Figure 5. Projected Average Monthly Precipitation, Nondalton, Alaska.
UAF, Scenario Network for Alaska Planning 2013.

"When it rains a lot the berries spoil really fast."

Nancy Delkittie

MOUNTAINS

Observed change: *melting of glaciers, decrease in glacier elevation, more shrubs in mountains*
Community impacts: *plane flight at lower altitudes, species shift to higher elevation, less alpine berry habitat*
Health concerns: *increased air travel safety & decreased stress, potential changes for food harvest (berries)*
Adaptations: *monitor change & engage research & technical partnerships related to mountain change*

The glaciers are melting.

The mountains influence the day-to-day lives of Nondalton residents, affecting weather, travel, and water and food harvest. The Alaska Range was the origin for much of the glacier ice that carved the valleys and lakes of the region (Spencer et al, 2002). The remnants of these glaciers still define the mountains today but melting and glacial retreat is having profound effects: greening the slopes as vegetation climbs ever higher, reforming contours, and changing watershed conditions. Exposed ash from the previous volcanic eruptions blanket many glaciers (Giffen et al.). Once the snow melts in the spring, the glaciers present a dark surface that absorbs heat and contributes to glacial melt. Frequent wind events can redistribute the ash and impact both air and water quality. The water level in Six Mile Lake is connected to mountain conditions including precipitation and melting in the watershed. Nondalton has already relocated once in the past partly because of water level changes. Another watershed issue in areas of rapid glacial melt is the sudden release of water from glacial lakes. When ice dams release, a glacial lake outburst flood (GLOF) can occur and cause downstream flooding. Such an event from a GLOF on the Mendenhall Glacier flooded areas of Juneau in July of 2011.

Pilot's view over Lake Clark.
Photo by Mike Brubaker, 2013.

"The cameras now make it easier to know when weather is in the Pass."

Ronald Loftfield, CHAP

Receding glaciers in the Alaska Range.
Photo by Mike Brubaker, 2013.

By way of example, most glaciers in the Katmai Park region have receded and there was a reduction of about 45 square miles of glacier, a 7.7% decrease over a period of just 14 years (Giffen et al.). One benefit of glacier change is improvements in safety for aviation. Since the first float plane visits in the early 1930s, the mountains have presented a significant challenge for aviation. Lake Clark Pass at 1050 feet provides passage through the mountains for small aircraft and is the primary route between Southcentral Alaska and Bristol Bay. The narrow pass combined with frequent poor weather has spelled disaster for numerous pilots over the years. But melting ice has dropped the elevation of the glacier allowing aircraft to traverse the pass for the first time at elevations less then 2000 feet.

How climate change may affect future aviation, especially weather conditions is uncertain. Since the 1990s, safety has been improved through expanded use of GPS and the installation of webcams in Lake Clark Pass and other locations. Statewide these efforts have helped to reduce aviation accidents. But an unusually high number of fatal crashes occurred between January and August 2010 resulting in a State Department of Health epidemiological investigation. The fact that 2010 was one of the coldest and wettest summers on record may have been a contributing factor (DHSS, 2010).

Recommendations: The mountains are changing rapidly with both positive and negative effects for Nondalton. Continued local monitoring and participation in research is important to understand findings and share community perspectives and implications. An assessment to determine the presence or absence of glacial ice fall and outburst hazards for the lakes region is recommended. Due to increasing uncertainty and extreme weather, efforts to enhance weather monitoring and forecast systems is encouraged. Key Contacts: National Weather Service, City and Tribal Government, Lake and Peninsula Borough, National Park Service, Alaska Center for Climate Assessment and Policy.

"We used to worry about getting high enough to fly through the passes. We don't worry about that anymore. The glaciers have really receded."

June Tracy

LAKES

Observed change: *gradual water level drop, extreme flood events, changing water temperature*
Community impacts: *extreme change in water level, low water conditions and occasional flooding*
Health concerns: *damaged infrastructure, injury risk from navigation hazards, submerged well heads*
Adaptations: *monitor lake conditions; design infrastructure for extremes, monitor well conditions*

The conditions of lakes and rivers are changing

Six Mile Lake was carved by an ice age glacier and filled with the melt water of glacial streams. Climate change is continuing to shape the area through melting glaciers and changing lake conditions. The lakes are important headwaters for rivers flowing into Kvichak and Bristol Bay, and Nondalton residents are concerned because these lakes provide their food and water supply and connect them with other communities. With rapid environmental change occurring, attention to the conditions of lakes and rivers is important for community health.

Marvin Balluta enjoying a nice afternoon on Six Mile Lake.
Photo by Mike Brubaker, 2013.

"We travel along channels to go from Six Mile Lake to Lake Clark, because there are shallow areas. In the fall, you can see more and more sandbars which makes it harder to navigate."

Harry Karshekoff

Aerial view of Lake Clark.
Photo by Mike Brubaker, 2013.

Nondalton village was relocated in the 1940s partly because of water level change and expansion of the mud flats. Today the lake level is generally thought to be dropping, but extreme rain events have occurred recently and are expected to occur with increasing frequency in the future. In 2012, an extremely high snow-pack coupled with persistent rainfall throughout the summer resulted in the highest observed lake levels and coolest lake temperatures ever recorded.

Nondalton residents are concerned because these lakes provide their food and water supply and connect them with other communities.

Climate models project significant long-term changes in the freshwater conditions of Alaska. These are expected to alter distribution and population of freshwater fish (Clark et al, 2010). The Southwest Alaska Network Inventory and Monitoring Program (SWAN) is evaluating the long-term trends in water quality and surface hydrology in the large lake systems and the relationship between geologic and weather-related events. In Lake Clark, glacier-fed streams feed the upper lake making it more turbid than the lower lake. But in 2009, the eruption of Mt. Redoubt blanketed much of the watershed with a layer of volcanic ash. As the snow melted and runoff washed into the lake, the input of volcanic ash created turbid conditions lake-wide (Shearer, 2010). Ash layers from new and past eruptions may contribute to glacial melt, runoff and lake turbidity with uncertain outcomes.

Lake water temperature is another important factor effecting fish and other aquatic life, nutrient cycles and ice conditions. Hourly water temperature has been monitored in Lake Clark since 2006 at intervals down to a depth of 330 feet. Layering of water with different temperatures is limited in these lakes, because of mixing caused by frequent strong winds. Understanding the effects of wind on water temperature and biological productivity, including salmon, is one of the goals of current monitoring efforts (Shearer, 2010). Salmon spawn earlier in cool streams, so temperature change can affect the spawning time as well as the behavior and cycles of other plants and wildlife. Water temperature is important for salmon migration and health (Lisi & Schindler, 2013).

Recommendation: Navigation by boat is vulnerable to drought, because the lake is shallow in some areas. Nondalton is also vulnerable to flooding from extreme rain; an event in 2012 resulted in flooding that inundated homes and other community infrastructure. Monitoring lake conditions is recommended for understanding community water resources as well as habitat conditions for salmon and other fish. A time lapse camera installed by ANTHC in 2012 is helping to document environmental conditions at Six Mile Lake. Local participation in research activities will help to enhance understanding about the practical implications of lake change, impacts on community water, navigation, and subsistence resources. Key contacts: City and Tribal Government, National Park Service (NPS), BBAHC, BBNA, ANTHC.

"Our water is going away. The last time we had a flood was 1960. The reason is because the glaciers are going away. It affects the water level and temperature."

Ricky Delkittie, Sr.

Six Mile Lake in Nondalton.
Photo by Mike Brubaker, 2013.

VEGETATION

Observed change: *plant growth at higher elevation, invasive plants; infestation in trees downriver*
Community impacts: *loss of tundra to woodlands, increased browse for moose*
Health concerns: *potential for new or increased allergens, variability in success of plant & berry harvest*
Adaptations: *monitor changes, inform clinics on emerging environmental concerns, manage invasive plants*

Plant range and growth and species types are changing

Nondalton residents describe more trees and shrubs in the mountains and the emergence of new types of plants they have not seen before. These changes raise questions about impacts on local vegetation and food harvest: potential benefits such as increasing browse area for moose and problems such as declining habitat for alpine berries. It also raises questions about air quality as Alaska records increases in pollen events and pollen related allergies.

The spruce bark beetle turns trees into dangerous tinder for forest fires.
Photo by Mike Brubaker, 2013.

"We are seeing more spruce bark beetle kill trees around the horseshoe bend on the Newhalen River. Ten years ago we did not see any."

Harry Karshekoff

There are publications describing the impacts of changing climate on vegetation in the area. For example, the Shamrock Glacier near Lake Clark has receded over a mile since 1928, and older portions of the glacier moraine are now colonized by cottonwood and alder. The alder-dominated tall shrub thickets have expanded to higher elevations (Jorgenson, 2006). The rate of growth of White spruce trees has increased during the last 30 years, likely related to warming. This contrasts with the decreases in growth rate seen in drought-stressed trees in interior Alaska (SWAN 2012). A 2012 aerial survey identified spruce bark and/or Ips beetle infestations to the northeast and near Port Alsworth. In 2013, Nondalton residents reported additional outbreaks of spruce bark beetle and aphids on the Nushagak River.

Cache of birch firewood.
Photo by Mike Brubaker, 2013.

Changing climate is also impacting plant phenology, or the timing of plant growth and other processes. For example, a longer growing season combined with high levels of carbon dioxide encourages rapid growth of fungi, which produce spores, and of trees and grasses, which produce pollen. Most trees release their pollen in the early spring, while grasses do so in late spring and early summer. Alaska has some of the highest birch pollen levels in the world (Demain J., personal communication) and with increases in allergy-causing events in Alaska there is potential for more people to develop asthma and allergies, and for clinics to see more patients seeking treatment for respiratory problems.

Plant "Watch List" includes species that are vulnerable to encroachment as well as invasives. Historically Alaska's cold climate prevented non-native plants from becoming established. However, in recent years there has been an influx of meadow hawkweed, Canada thistle, and spotted knapweed; all now have localized populations in Alaska. Other species such as reed canary

"We used to have a hard time finding birch. Now you look out there and there is a lot of firewood."

June Tracy

grass and white sweetclover are very widespread (Carlson et al. 2007). The invasive plants watchlist for Nondalton includes orange hawkweed, yellow toadflax, and oxeye daisy which have already taken hold along the road system in Dillingham and Aleknagik (BBNA). In Nondalton there is a small infestation of Melilotis alba or sweet white cover (Jennifer Robinette, 2013). Species documented during a July 2013 site visit include Leontodon autumnalis, or fall dandelion.

Recommendation: Climate models predict that Bristol Bay region will experience rapid ecological change during the next 100 years. This may mean higher susceptibility to diseases and pests along with competition from invasive species. Residents reported spruce bark beetle and aphid infestation downstream on the Newhalen River. An aerial survey request may be submitted to the U.S. Forest Service (FS) to assess these conditions. Local environmental observers can assist with monitoring and connecting to technical resources. Management plans for controlling and limiting the expansion of invasive plants is recommended. Key contacts: BBNA, UAA, ADF&G, FWS, NPS, U.S. FS, AACD.

Dandelions at the school.
Photo by Neena Brubaker, 2013.

"We didn't have dandelions years ago. I think someone has transplanted them. We also have pretty purple flowers all along the road to Iliamna."

William Evanoff

Fall dandelion, Leontodon autumnalis.
Photo by Mike Brubaker, 2013.

Another invasive is Fall dandelion, Leontodon autumnalis, which can be found all along the road to the airport.

WILDLIFE

Observed change: *increasing negative encounters wolves and bears, new bird species*
Community impacts: *increased caution with children and pets, concerns about invasive species;*
Health concerns: *food security, public safety, anxiety and related mental health concerns*
Adaptations: *monitor wildlife changes and events, assess wildlife change causes*

There are changes in abundance and behavior and there are new species

Climate change is impacting the landscape and the ecosystem in the Nondalton area and has the potential to affect the fish and wildlife resources including subsistence species that the community relies upon. There are thirty seven species of land mammal and 160 species of birds that have been documented in the Lake Clark area (Mammals List - National Park Service). Nondalton residents expressed concern about large invasive species and about changes in predators, including wolves and bears. Community health concerns related to wildlife include

Wolves near Lake Clark.
Photo by Buck Mangipane, NPS.

"I notice that the wild animals, bears and wolves, are not afraid anymore and come right into the village. We had a wolf kill a dog on a chain. They are hungry for caribou."

Olga Balluta

food harvest, public safety, mental health concerns (e.g. wildlife interactions, subsistence challenges and success), and zoonotic diseases such as rabies, which can be transmitted from wildlife to people. Also of concern is the increase in insects that has occurred in recent years, in particular wasps. Warming climate is thought to have contributed to increases in wasp populations and related injury throughout Alaska (Demain et al. 2009).

Residents reported increasing interactions with predators, as well as anxiety and fear for the safety of children and pets. A chained dog was killed by a wolf recently in Nondalton and concerns have been high in the Bristol Bay region since 2010 when a Chignik Lake school teacher was killed and eaten by pack of wolves within two miles of the village. The wolves were later killed, examined and found to be neither food stressed nor rabid. Lake Clark Park biologists are studying wolves to determine population dynamics, movement patterns and predation rates. The average pack size in Lake Clark Park is five animals. Territory depends on how much prey is available and Lake Clark wolf packs have territories of greater than 750 square miles.

Unusual sightings of wolves and bears have been reported in other areas of Bristol Bay and residents wonder whether changes in caribou or other prey species may be a source of stress on predators. Climate change is thought to be changing behavior and the range of Arctic predator species. By way of example, a five-year study is currently underway in thirteen communities in Nunavut, Canada looking at wolf, wolverine and bear behavior and the effects of climate change on human-wildlife interactions. The Alaska Department of Fish and Game killed 89 bears in southwest Alaska in May of 2013 with the intent of reducing the harvest pressure on moose (APRN June 2, 2013).

Residents also reported sightings of unusual wildlife such as mountain lion, suggesting changes to wildlife range. Invasive species are plants or wildlife that move into a new region and adversely

The timing of salmon spawning effects the timing and behavior for other fish, wildlife, birds and plants that are dependent on salmon, e.g. bears will visit the cold streams first and warmer streams later.

affect the habitat. Mountain lions or cougars are occasionally reported in southern Alaska. In 1989, a mountain lion was killed near Wrangell in Southeast Alaska and reports of sightings were thought to be increasing, possibly due to the numbers of mule deer (Alaska Geographic, 1996). Cougars are not currently included in the mammals list for the Lake Clark National Park.

Recommendation: A regional study of predator species in Bristol Bay should be considered, due to public concern and the number of interactions with bears and wolves reported in Nondalton and other communities. Health implications include food security, injury and fear and stress that can impact mental health. Measures to detect and control invasive species is recommended along riparian corridors and entry points such as airports and docks. A Local Environmental Observer (LEO) in Nondalton can help monitor these occurrences and coordinate technical assistance as appropriate. Key contacts: City and Tribal Government of Nondalton, ADF&G, Lake and Peninsula Borough, ANTHC (LEO Network), Lake Clark National Park, Alaska Association of Conservation Districts, science and research priorities, Western Alaska LCC.

Mountain Lion.

"We had a sighting of a mountain lion up at Turner Bay at the mouth of the Chulitna River. The lodge owner saw 7 to 8 caribou come running out at full tilt followed by a lion."

Ricky Delkittie, Jr.

Rufous hummingbird.

"We have begun to see hummingbirds in our village."

Ricky Delkittie, Sr.

SUBSISTENCE

Observed change: *decline in caribou harvest, variable berry harvest, change in fish species*
Community impacts: *dietary change; increased dependence on moose, fish and waterfowl*
Health concerns: *food security, nutrition, depression related to subsistence lifestyle change*
Adaptations: *regular harvest survey, encourage healthy foods, protect subsistence habitat & activities*

Changing conditions and changing harvest

Nondalton residents expressed concerns about changes to subsistence food harvest and questions about the possible relationships with climate change. A wide variety of healthy, nutritious wild foods have traditionally been harvested in Nondalton (ADF&G 1972), the most important being salmon (78,401 lbs harvested per year), followed by large land mammals (33,912 lbs), non-salmon fish (6,241 lbs), small land mammals (4,817 lbs), and birds (871 lbs.) Plants, eggs, and berries are also recognized as important food resources.

Between June and September, all five pacific salmon species spawn in the major rivers and streams of the Kvichak drainage. Residents report that the harvest of kings and silvers have

"We have not been able to successfully harvest caribou from the Mulchatna herd in six years."

Ronald Loftfield, CHAP

Reduced berry harvests has been attributed to climate change.
Mike Brubaker, 2013.

been increasing in recent years. Other important fish species include arctic char, arctic grayling, Dolly Varden, northern pike, lake trout, and rainbow trout. In winter burbot and whitefish are caught through the ice (NPS). Effects of climate change including changing water conditions can stress salmon and other fish species. Climate driven stress has in some cases been shown to exceed tolerance levels for salmon (Grah and Beaulieu, 2013) and increasing water temperatures and turbidity are among the lake dynamics that are raising concerns. Research is underway evaluating the effects of changing turbidity on salmon fry and other forage fish (Shearer, 2010). A 2011 risk analysis ranked climate change as a high threat to all of the watersheds in the Bristol Bay region, including Lake Illiamna and the Kvichak River (SWASHP, 2011). As glaciers, snowpack and the waters they produce decline, a decrease in aquatic habitat is expected in many large river systems impacting fish species that utilize these rivers for spawning (Clark, 2010).

In 1972, the second most important subsistence resource was caribou, but there has not been a successful harvest in years. The size of the Mulchatna herd is down from an estimated 200,000 animals in 1999 and is now about 30,000 animals (NPS). The reasons are uncertain, but one possible contributing factor is the effect of icing events on caribou forage areas. The highest frequency of icing events in Alaska occurs in the southwest, especially at low elevations adjacent to the coast. Some areas have experienced as many as seven events per winter (Wilson et al. 2012). Climate-driven changes in vegetation may optimize conditions for other wildlife, such as moose. However, populations in Lake Clark Park have been on the decline since the late 1990s (NPS). With a lack of current harvest data it is difficult to determine what may be filling the harvest void left by caribou declines, and the implications for food security and nutrition.

Berries are another important food resource, and residents observe increased variability in berry harvest. Case in point was the failure of the blueberry harvest in 2012, followed in 2013 by an unusual abundance in salmon (cloud) berries. Berry bushes are extremely sensitive to temperature, rain and snow and soil conditions, and declining harvest has been attributed to climate change in other northern regions (Zubov L, 2012). USGS is performing a survey

"In 2010 there was no snow and we only got black berries, no blueberries."

Charlotte Balluta

in collaboration with the Local Observer (LEO) Network, to help monitor berry harvest. Nondalton Village Council is a participant in LEO and a participant in the survey. Locally harvested species include low bush cranberry, cloud berry (called salmon berry), nagoon berry, crow berry, and high bush and low bush cranberry. In 2013, there was an unusual abundance of cloud berries, perhaps related to the late spring followed by hot temperatures.

Recommendation: Climate change will likely have significant impacts on salmon throughout Southwest Alaska. Combined with stresses from other threats, the impact could be very negative and severe, although beneficial changes may also occur as new habitat is opened (SWASHP, 2011). For now, high temperatures in Nondalton have in some years affected the conditions for the preservation of salmon. Change in seasonality may also occur, such as the early salmon run of 2013. Changes in timing and adaptive strategies for drying fish and game may be necessary to prevent spoilage and conservation strategies are recommended to protect salmon habitat. Loss of the primary subsistence resource and the increasing cost of store bought foods raise concerns about food security. An updated comprehensive subsistence harvest survey is recommended. Local environmental observers can assist in monitoring the condition of subsistence resources. Key Contacts: icing (Wilderness Society) berries (USGS), harvest surveys (ADF&G), shorezone mapping (FWS), nutrition (BBAHC), local observers (ANTHC), salmon (SWASHP), science and research priorities (Western Alaska LCC).

Fishermen check the nets for salmon.
Photo by Mike Brubaker, 2013.

"Once in a blue moon we used to get King Salmon up here. Now we get more King salmon and also silvers. We never used to get silvers."

June Tracy

Smoking salmon at fish camp.
Photo by Mike Brubaker, 2013.

"The salmon run in 2013 came in really early—the middle of June. We usually don't get fish until after the 4th of July. Normally we try to get the first fish because they are the best dry fish. This year they went by too fast."

Charlotte Balluta

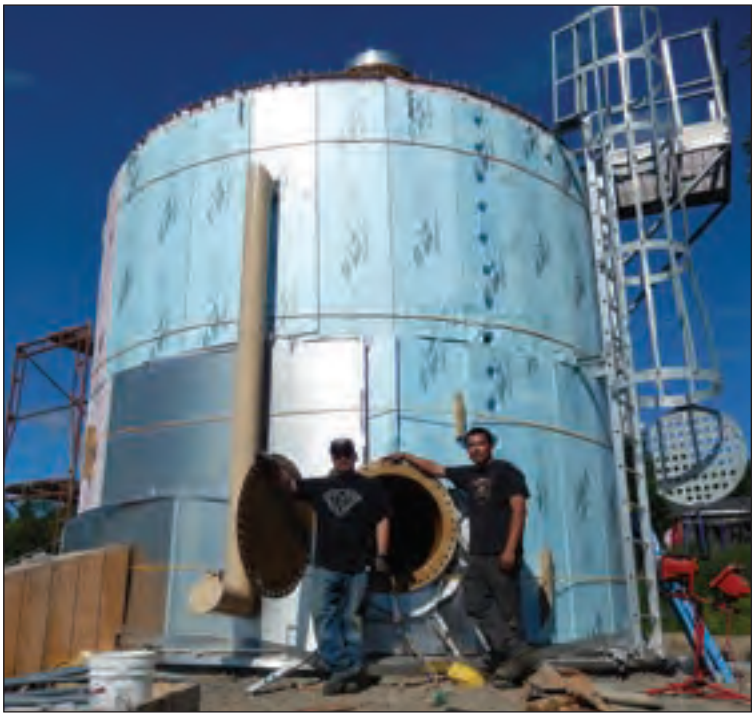
SANITATION

Observed change: *gradual lake water level drop, extreme precipitation events*
Community impacts: *low water conditions, flooding, overflow of sewage lagoon*
Health concerns: *damaged infrastructure, risk of waterborne illness*
Adaptations: *monitor wells, design infrastructure for emerging climate, perform sewage lagoon study*

Water and waste water systems are vulnerable to extremes

The lakes are important headwaters for rivers flowing into Kvichak and Bristol Bay, and Nondalton residents are concerned because these lakes provide their food and water supply and connect them with other communities. With rapid environmental change occurring, attention to the conditions of lakes and rivers is important for community health.

Nondalton relies on the lake for their water source. Two shallow (~ 30') groundwater wells are located at the lake side (BBAHC 2010). Too much or too little water is a problem. Nondalton village was relocated in the 1940s partly because of lake water level change and expansion of the mud flats. Today the lake level is generally thought to be dropping, but extreme rain events have occurred recently and are expected to occur with increasing frequency in the future. In 2012 an extremely high snow-pack coupled with persistent rainfall throughout the summer



New water storage tank under construction in Nondalton.
Photo by Mike Brubaker, 2013.

Extreme rain events can affect water quality and availability as well as the community waste water system.

resulted in the highest observed lake levels and coolest lake temperatures ever recorded. Extreme rain events, such as occurred in 2012, could breach and contaminate the wells. (BBAHC 2010).

The community sewage lagoon was constructed in 1984 and designed to service 62 homes (DHSS 1984). Today Nondalton has 59 homes (DCCED 2013) but the lagoon is over capacity and extreme rain events in 2012 resulted in overflow. Contaminnation of the access road to the sewage lagoon is a concern as well as adjacent down gradient areas near the lakeside and the road to nearby fish camps. The community is in the process of building a new water storage tank and treatment plant which will address many water system related deficiencies. However, there are no current plans for upgrades to the sewage lagoon.

Suspected sewage lagoon overflow.
Photo by Neena Brubaker, 2013.

Recommendations: Installation of instruments to monitor well water level is recommended to better understanding groundwater conditions. Engineering design should take into consideration revised extreme event estimates, in particular those related to intake and quality of community water, and wastewater storage capacity. Given the size of the sewage lagoon and evidence of recent overflow, an engineering study is recommended to explore options for expansion and overflow prevention. When overflow is suspected, water testing should be performed to determine health risk and appropriate signage should be posted to prevent access to flooded areas. Contacts: Norton Sound Area Health Corporation.

"The sewage lagoon is overflowing and we can smell it when the wind is blowing the right way."

Nancy Delkittie

FINDINGS

It is becoming warmer with a gradual increase in average annual air temperature.
There are also increases in extremely warm days and a decrease in the number of extremely cold days. Warmer temperatures have a broad range of impacts both positive and negative.

Hot summers temperatures have resulted in health illness.
Education is recommended to raise awareness about the dangers of heat illness and strategies for staying cool. Healthy homes discussions with regional housing associations is also recommended to explore strategies for keeping arctic-designed homes cool.

It is becoming wetter with the amount of precipitation having increased in nine out of twelve months.
The number of extreme precipitation events is expected to increase. In 2011, it rained 30 days without interruption.

Nondalton is vulnerable to flooding from extreme rain events and to drought.
A rain event as recently as 2012 resulted in flooding that impacted homes and community infrastructure.

Improve monitoring of community water wells.
The wells may be vulnerable to lake change including flooding or drought. Installation of instruments to monitor well water level is recommended.

Overflow of the sewage lagoon has occurred during rain events.
Engineering should take into consideration revised extreme event estimates. Given the size of the sewage lagoon and evidence of recent overflow, an engineering study is recommended to explore options for expansion and overflow prevention.

Glacial melt is improving aircraft flight conditions in Lake Clark Pass.
This is allowing pilots to fly their aircraft at lower altitudes than in the past. However, the frequency of extreme weather events may present new challenges.

"If you know how to survive out here, we have everything we need."

June Tracy

Water quality change raises concerns about the impacts on salmon and wildlife.
Understanding the relationships between climate change and salmon health and success is a priority. Effective management strategies will be necessary to promote salmon health, survival and harvest.

The water level of the lake has been gradually dropping.
This has resulted in access problems but has also opened new shore areas for development. Extreme rain events have caused flooding.

The shrubs are climbing higher on the mountains.
This raises questions about impacts on food harvest: benefits such as increasing browse area for moose and problems such as declining habitat for alpine berries.

Community members are concerned about subsistence harvest change.
Some important subsistence resources including caribou and some types of berries are thought to be declining.

Changing wildlife behavior is a safety concern.
Residents report increasing numbers of and changes in the behavior of wolves and bears. A research partnership to look into these reports is recommended for Nondalton and other Bristol Bay communities. Warmer winters may have resulted in increases in summer wasp numbers and related insect stings.

There are new species of plants, insects, birds, and mammals.
Residents report a variety of unusual wildlife sightings including mountain lions and humming birds. There are increasing numbers of silver and king salmon. Care must be taken to manage invasive plants that can result in environmental and health problems.

Climate models project rapid change.
Residents should expect that some plants and wildlife will be stressed during a period of rapid environmental change. This may mean higher susceptibility to diseases and pests, out-competition by species from further south, and heat-shock from more extreme summer temperatures and lessened water availability.

A wide variety of healthy, nutritious wild foods are harvested in Nondalton, but there have been no comprehensive harvest surveys since 1972.

CONCLUSION

Public health considers climate change based on effects to mental health, injury, disease, and food and water safety and security. In Nondalton, climate change is increasing vulnerability to infrastructure as a result of changes in the lake conditions, increases in extreme weather and flooding. Climate change is altering subsistence systems with potential effects both positive and negative. Periods of extreme heat, by Alaska standards is raising concerns about heat illness and adapting homes for cooling as well as staying warm. An example of positive impact includes melting glaciers improving flight safety conditions in Lake Clark Pass, and warm weather encouraging more lake play days for children. This report raises awareness about current, emerging, and potential future climate change. It is hoped that this will help Nondalton make informed planning decisions, find community appropriate development strategies, and pursue a safe, healthy, and sustainable future.

For more information, contact the Center for Climate and Health by e-mail at akaclimate@anthc.org or by phone (907) 729-2464.

Midnight sun in Nondalton.
Photo by Mike Brubaker, 2013.

It is hoped this report will help Nondalton make informed decisions and find community appropriate adaptation strategies.

Figure 6. Climate Change Health Assessment Findings, Nondalton, Alaska

Topic	Observed Change	Community Impacts	Health Concerns	Adaptations
Temperature	Increases in temperature, variability and extremes	Travel disruptions, infrastructure damage, timing of seasons	Supply shortages, accident and injury, mental stress	Enhance systems for self-sufficiency and emergency preparedness
Precipitation	Extreme weather, increased precipitation, less snow	Travel challenges and disruptions due to extremes and marginal weather	Supply shortages, accident and injury, mental stress, depression	Enhance systems for self-sufficiency and preparedness, encourage social activities
Mountains	Change: more storms, extreme and poor weather and less winter shore ice	Damage to infrastructure, travel challenges and disruptions	Supply shortages, accident and injury, mental stress, depression	Engineer for extremes, phased relocation, encourage social activities
Lake	Less shore ice and storms and flooding are increasing erosion	Damage to roads and associated utilities, bulkhead, and fish camps	Damage or disruption to critical health infrastructure	Shore hardening activities, engineer for extremes, phased relocation
Vegetation	Rapid tree growth, new coastal wetlands, invasive plants	New waterfowl habitat, loss of tundra to woodlands, loss of berry plant habitat	Food security, potential for new or increased pollen allergens, mental health	Monitor changes (LEO); inform clinics on emerging environmental concerns; manage invasive plants
Wildlife	Increasing encounters with bears and wolves, new bird species	Increased caution with children and pets, concerns about invasive species	Food security, public safety, anxiety and related mental health	Monitor wildlife changes and events (LEO); assess wildlife change causes
Subsistence	Decline in caribou harvest, variable berry harvest	Dietary change; increased dependence on moose, fish and waterfowl	Food security, depression and related mental health issues	Monitor subsistence events (LEO); perform comprehensive harvest survey; encourage healthy food
Sanitation	Lake water level change, extreme weather	Flooding around well head, sewage lagoon overflow	Potential service disruption, contamination, waterborne illness	Monitoring, improve well head seal, feasibility study for lagoon improvements

Aerial view of Newhalen river.
Photo by Mike Brubaker, 2013.

APPENDIX A

Community and Regional Contributors

Anecdotal data was collected on observations and experiences from local experts in health, wildlife, Dena'ina culture, weather, subsistence, education, sanitation, local governance, law enforcement, and emergency services.

	Name	Position	Association
1	Charlotte Balluta	Environmental Coordinator	Nondalton Tribal Council
2	Olga Balluta	Elder	Resident
3	Marvin Balluta	Youth	Resident
4	Tara Balluta	Youth, Invasive Plant Observer	Resident
5	Janice Chambers	Elder	Resident
6	Nancy Delkittie	Council Member	Nondalton Tribal Council
7	Rickie Delkittie Sr.	Former Tribal Council President	Nondalton Tribal Council
8	Rickie Delkittie Jr.	Youth	Resident
9	Karen Evanoff	Researcher	National Park Service
10	William Evanoff	President	Nondalton Tribal Council
11	Gladys Evanoff	Elder	Former Nondalton Resident
12	Nathan Evanoff	Youth	Resident
13	Jeremy Jeffries	Community Health Aide	Bristol Bay Area Health Corporation
14	Harry Karshekoff	Elder	Nondalton Tribal Council
15	Sue Flensburg	Environmental Planner	Bristol Bay Native Association
16	Ron Loftfield	Community Health Aide	Bristol Bay Area Health Corporation
17	Jeremy Jeffries	Community Health Aide	Bristol Bay Area Health Corporation
18	Gary Martilas	Water Operator	City of Nondalton
19	Tracy Rickteroff	Clerk	Nondalton Store
20	Jennifer Skarada	Environmental Health Specialist	Bristol Bay Area Health Corporation
21	Bob Tracy	Mayor / Business Owner	City of Nondalton
22	June Tracy	Pilot / Business Owner	Chada + Chida B & B
23	Paul Brendemuhl	Pilot	Business Owner
24	Chuck Trefon	Water Operator	City of Nondalton
25	Jesse Trefon	Water Operator	City of Nondalton
26	Terra Trefon	Invasive Plant Coordinator	National Park Service
27	Betty Wilson	Council Member	Nondalton Tribal Council

APPENDIX B

Nondalton Climate and Health Web Resources

Topic	Resource	Location
Climate / Health Study	Center for Climate and Health-	www.anthc.org/chs/ces/climate/links.cfm
Community Profile	State of Alaska Community Database	http://www.commerce.state.ak.us/dca/commdb/CF_BLOCK.htm
Regional Climate Data	Alaska Climate Research Center, UAF	http://climate.gi.alaska.edu/Climate/Location/TimeSeries/KingSalmon.html
Temperature Charts	Scenario Network for Alaska Planning	http://www.snap.uaf.edu/charts.php
Precipitation Charts	Scenario Network for Alaska Planning	http://www.snap.uaf.edu/charts.php
Extreme precipitation	NOAA Atlas 12	http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_ak.html
Weather Spotters	NWS Extreme Weather Spotter	http://www.weather.gov/skywarn/
Precipitation Monitor	Collaborative Snow, Rain, Hail Program	http://www.cocorahs.org/
Erosion Data	USACE Community Report, 2009	www.poa.usace.army.mil/AKE/Home.html
Flood Data	USACE Flood Hazard Database	http://66.223.166.160/usace_disclaimer.html
Coastal Observations	National Weather Service	www.nws.noaa.gov/om/coop/index.htm
Season Observations	USGS Phenology Network	www.usanpn.org/
Local Environment Observers	LEO - ANTHC	http://www.anthc.org/chs/ces/climate/leo/
Regional Health Profile	Alaska Native Tribal Health Consortium	http://www.anthctoday.org/epicenter/assets/data/bristol_bay/bristolbay_data.html
Regional Climate Studies	Western Alaska LCC	http://www.arcus.org/western-alaska-lcc
Food Harvest Data	Alaska Department of Fish and Game	http://www.adfg.alaska.gov/sb/CSIS/index.cfm?ADFG=harvInfo.harvestCommSelComm

APPENDIX C

Resolution of Support – Nondalton Tribal Council

Nondalton Tribal Council
P.O. Box 49
Nondalton, AK 99640
Tel. 907-294-2257/Fax 907-294-2271

RESOLUTION 05-25-12-1

A RESOLUTION REQUESTING THAT ANTHC, BBNA, BBAHC AND MAP WORK WITH THE NATIVE VILLAGE OF NONDALTON IN THE PERFORMANCE OF A CLIMATE CHANGE HEALTH ASSESSMENT

WHEREAS: the environment is changing as demonstrated by warming temperatures, diminished ice, thawing permafrost, increased erosion, dropping river levels, and invasive species; and

WHEREAS: the effects of these changes on public health are not well understood; and

WHEREAS: local observations provide evidence of climate change, and Arctic projections suggest that the effects are expected to accelerate in coming years; and

WHEREAS: local government and health entities need to be aware of changes that can effect infrastructure, mental health, injury and disease, so as to plan appropriate responses actions; and

WHEREAS: the Alaska Native Tribal Health Consortium (ANTHC) have resources to perform a Climate Change Assessment, working with Bristol Bay Native Association, Bristol Bay Area Health Corporation, and Marine Advisory Program; and

WHEREAS: the ANTHC Center for Climate and Health has demonstrated capacity monitoring health indicators, interpreting epidemiologic data, and assessing potential impacts from climate change; and

WHEREAS: the Native Village of Nondalton would benefit from the technical assistance related to climate impacts to develop adaptive measures for protection of community health;

WHEREAS: the Native Village of Nondalton through our environmental department has staff who could work with ANTHC in performing an assessment;

WHEREAS: the products from this assessment would be of value to the Native Village of Nondalton to develop adaptation plans for climate change and to acquire needed resources;

NOW, THEREFORE, BE IT RESOLVED: The Nondalton Tribal Council hereby requests that the Alaska Native Health Consortium, Center for Climate and Health, perform a Climate Change Assessment in Kokhanok.

Certification

We, the undersigned, do hereby certify that the Nondalton Tribal Council is comprised of __ members, of whom 7 were present at a duly constituted meeting held this 25th of May, 2012 and that Resolution 05-25-12-1 was adopted by an affirmative vote of 7.

William Ernest
President

Kristy Ilutsin
Secretary

05-25-12
Date

APPENDIX D

Glossary

AACD	Alaska Association of Conservation Districts
ACCAP	Alaska Center for Climate Assessment and Policy
ACRC	Alaska Climate Research Center
ANTHC	Alaska Native Tribal Health Consortium
ADF&G	Alaska Department of Fish and Game
ADEC	Alaska Department of Environmental Conservation
BBNA	Bristol Bay Area Native Association
BBAHC	Bristol Bay Area Health Corporation
CAHM	Climate and Health Measure
CCH	Center for Climate and Health
CCHA	Community Climate and Health Assessment
CCHRC	Cold Climate Housing Research Center
CDC	Centers for Disease Control
CSIS	Community Subsistence Information System
CVI	Climate Vulnerability Index
DHSS	Department of Health and Social Services
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
GIS	Geographic Information System
GLOF	Glacier Lake Outburst Flood
HIA	Health Impact Assessment
HVA	Hazard Vulnerability Assessment
IPCC	Intergovernmental Panel on Climate Change
L&PB	Lake and Peninsula Borough
LEO	Local Environmental Observer
NTC	Nondalton Traditional Council
NOAA	National Oceanographic and Atmospheric Administration
NPS	National Park Service
NWS	National Weather Service
SNAP	Scenario Network for Alaska and Arctic Planning
SWAN	Southwest Alaska Network Inventory and Monitoring Program
SWASHP	Southwest Alaska Salmon Habitat Partnership
UAA	University of Alaska, Anchorage
UAF	University of Alaska, Fairbanks
USFWS	United States Department of Fish and Wildlife Service
USG	United States Geologic Service
WALCC	Western Alaska Landscape Conservation Cooperative

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June Tracy's fish camp.
Photo by Mike Brubaker, 2013.

The shoreline of Six Mile lake in Nondalton.
Photo by Mike Brubaker, 2013.

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For more information please contact:
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