Alaskan Arctic Coast Economic and Environmental Characterizations and Port Narratives

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Executive Summary

Introduction

The United States Coast Guard is initiating an Alaskan Arctic Coast Port Access Route Study (AACPARS) to ensure safe access routes for vessels proceeding to and from Arctic communities in light of declining sea ice extent in the Arctic Ocean, Chukchi Sea, and Beaufort Sea. The Coast Guard Office of Standards Evaluation and Analysis (CG-REG-1) has produced Alaskan Arctic Coast economic and environmental characterizations and port narratives to assist the Seventeenth Coast Guard District in its assessment of whether vessel routing measures are warranted for U.S. Arctic waters from the border between the United States and Canada to Cape Prince of Wales on Alaska's Seward Peninsula.

REG-1 has provided two high-level characterization. The economic characterization describes the prevailing economic conditions of the ports in the study area, including information on important economic activities, major employers and industries, and challenges to future growth. The environmental assessment outlines the climate conditions, wildlife, and habitat of the study area. Additionally, REG-1 has included port narratives that offer an in-depth look into the circumstances at each port while also outlining port characteristics and vessel activity.

The affected study area includes the entire Exclusive Economic Zone (EEZ) from the border between the U.S. and Canada to Cape Prince of Wales.

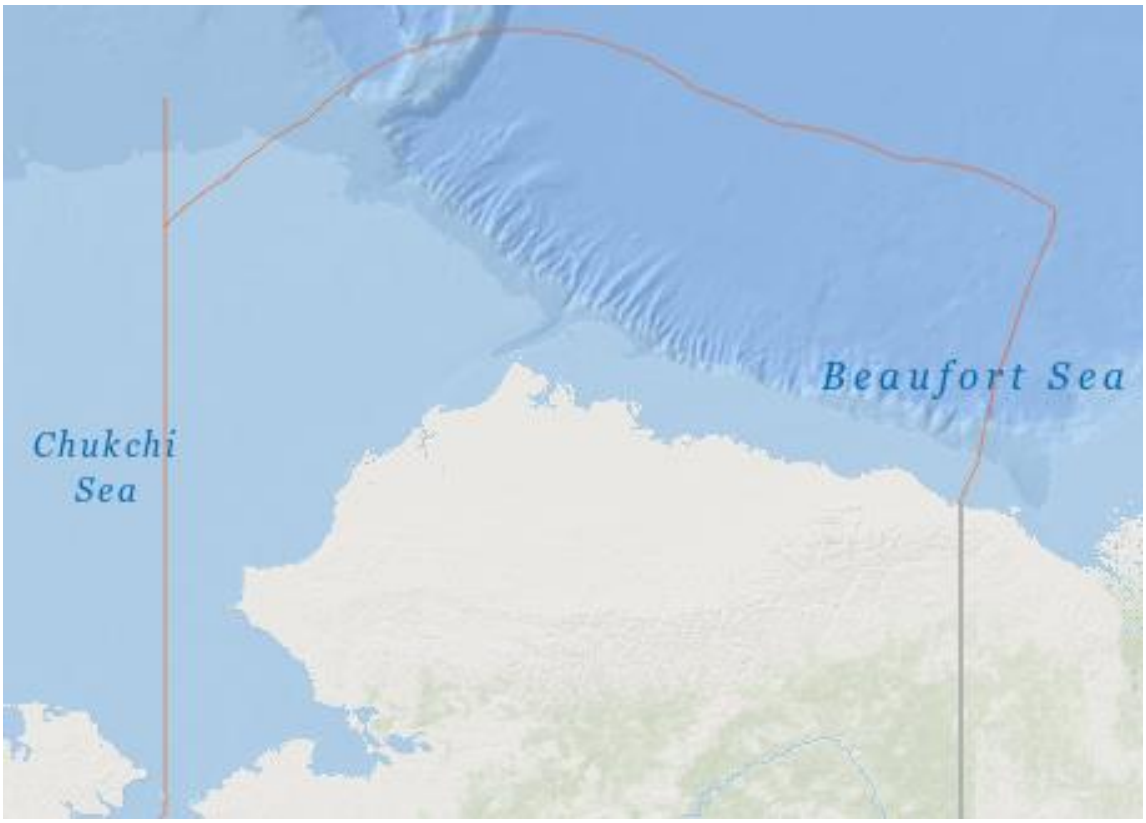


Figure 1. EEZ from the U.S.-Canadian Border to Cape Prince of Wales

Within the AACPARS area there are 20 port communities. The figure below shows the location of these ports.

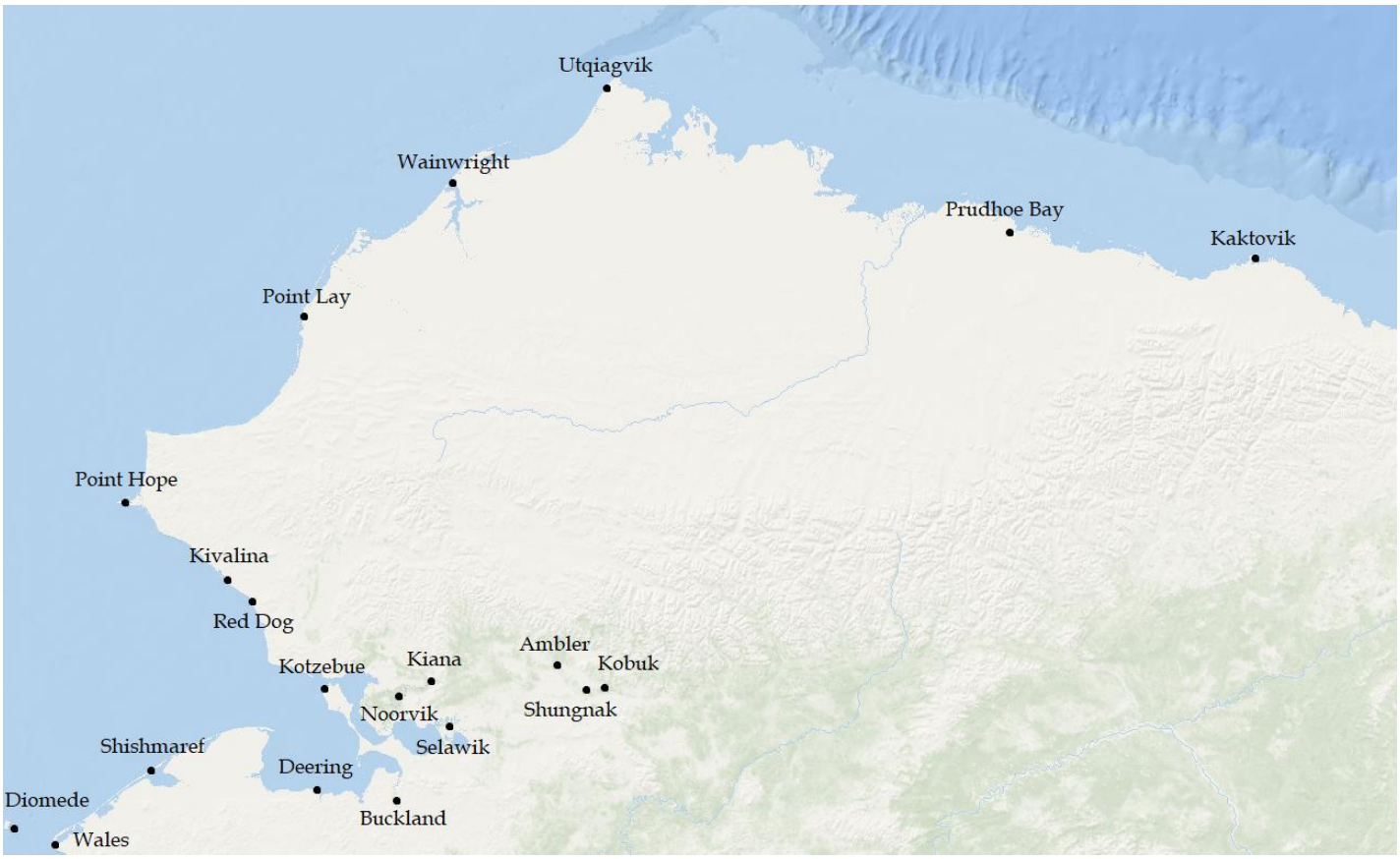


Figure 2. Ports in the Study Area

Key Findings

The key findings from this report are as follows:

- In general, these communities lack the port infrastructure to support marine services beyond beach landings, though some ports are equipped with marine headers to offload fuel, coastal protection measures, and moorings.
- Barge deliveries are still seasonal because of shore-fast ice along the coast, or in the case of inland ports because river depths are too shallow at other points in the year to be accessible by anything larger than small boats. Deliveries are also highly dependent on favorable weather conditions.
- Subsistence activities constitute the economic and nutritional foundation of these communities. A heavy reliance on hunting and fishing means that these communities are largely self-sustaining. Subsistence resources are also vulnerable to human activities, such as oil and gas exploration and extraction, and environmental changes.
- Residents often ascribe strong cultural and religious significance to subsistence activity.
- Many residents have voiced concerns over the preservation of their traditional culture, due in part to changing migration patterns of subsistence resources, decline of the native language, community relocation, or potential oil and gas development.
- Many of these port communities are facing the effects of a changing climate. Increased exposure to wave action and permafrost thaw has accelerated coastal and riverine erosion. This trend has damaged or threatened community infrastructure and property, and could jeopardize continued access to key subsistence areas.

Summary Table of Ports in the Study Area

Port Name	Latitude	Longitude	Pop.	Median Household Income	Transportation Service	Inland Road	Coastal	Port Characteristics	Imports	Subsistance Activities	Environmental Concerns
Kaktovik	70° 7′ 58″ N	143° 36′ 58″ W	246	$53,750	Airplane; barge	No	Yes (island)	Beach landing; marine header; tank farm	Fresh and non-perishable foods; fuel; mail; supplies	Bowhead and beluga whales; bearded and spotted seals; caribou	Increased polar bear presence; permafrost thaw; potential oil and gas development; receding sea-ice
Prudhoe Bay	70° 19′ 32″ N	148° 42′ 41″ W	2,174	$61,937	Airplane; barge	Yes (to Dalton Highway)	Yes	Beach landing; oil rig	Contruction materials; oil drilling equipment	Waterfowl; bowhead whales; polar bears; ringed seals	Pollution (oil spills)
Utqiagvik	71° 17′ 26″ N	156° 47′ 19″ W	5,256	$78,804	Airplane; barge	No	Yes	Beach landing; breakwater; coastal protection measures; small dock and boat launch; tank farm	Construction materials; equipment; fresh and non-perishable foods; fuel; furniture; household appliances; vehicles	Bowhead whales and beluga whales; bearded, ringed, and spotted seals; walrus; whitefish; sockeye salmon; cisco; grayling; char; cod; caribou; moose; arctic and red foxes;	Change in bowhead migration route; coastal erosion; drinking water contamination; flooding; receding sea-ice
Wainwright	70° 38′ 50″ N	160° 0′ 58″ W	555	$51,563	Airplane; barge	No	Yes	Beach landing; coastal protection measure; marine header	Construction materials; equipment; fishing supplies; food; fuel; household goods	Bowhead and beluga whales; bearded seals; smelt; geese; ducks; caribou	Coastal erosion threatening historic sites; flooding; potential oil and gas development; permafrost thaw; riverine erosion
Point Lay	69° 44′ 28″ N	163° 0′ 31″ W	287	$60,000	Airplane; ATV; barge	No	Yes	Beach landing (with gravel road)	Construction materials; heavy equipment and vehicles; grocery items; fishing supplies	Walrus; caribou; white beluga	Receding sea-ice; coastal erosion; walrus depletion; change in caribou migration route
Point Hope	68° 20′ 49″ N	166° 45′ 47″ W	749	$60,208	Airplane; barge	No	Yes	Beach landing	General supplies	Walrus; seal; whale	Coastal erosion; flooding
Kivalina	67° 43′ 38″ N	164° 32′ 21″ W	442	$59,063	Airplane; barge	No	Yes	Beach landing	General supplies	Caribou; seal; whale; walrus; salmon; whitefish	Coastal erosion; flooding due to storm surges; pollution (lead, zinc)
Red Dog	67° 34' 34" N	164° 4' 13" W	309	$61,937	Airplane; barge; truck	Yes (to Red Dog Mine)	Yes	Beach landing; mooring points	Construction materials; drilling equipment; general supplies; vehicles	N/A	Pollution (lead, zinc)
Kotzebue	66° 53′ 50″ N	162° 35′ 8″ W	3,121	$85,278	Airplane; ATV; barge; car	No	Yes	Dock (with 25,000 tn capacity); wharf and crane	Construction materials; durable household goods; equipment; fuel (heating oil, diesel, gasoline); vehicles	Caribou, sheefish, chum salmon, bearded seal	Coastal erosion; permafrost thaw; pollution (lead, zinc)

Port Name	Latitude	Longitude	Pop.	Median Household Income	Transportation Service	Inland Road	Coastal	Port Characteristics	Imports	Subsistance Activities	Environmental Concerns
Noorvik	66° 50′ 0″ N	161° 2′ 45″ W	629	$42,917	Airplane; barge	No	No	Beach landing; mooring points	Fuel; general supplies	Caribou; salmon; whitefish; moose; bearded seal; berries.	Air pollution; food insecurity (fewer caribou and fish); permafrost thaw; river bank erosion; thinner river ice
Kiana	66° 58′ 18″ N	160° 25′ 49″ W	421	$41,786	Airplane; barge	No	No	Beach landing	Fuel; general supplies	Caribou, salmon, whitefish, moose, sheefish, burbot, pike, berries.	Air pollution; food insecurity (fewer caribou and fish); permafrost thaw; river bank erosion; thinner river ice
Ambler	67° 5′ 6″ N	157° 51′ 37″ W	287	$41,429	Airplane; barge	No	No	Beach landing	Fuel; general supplies	Caribou,Geese, Ducks, Beavers, Musskrats, Bears, Sheefish, Moose,	Contaminated food supplies; environmental impact of subsistence hunting; permafrost thaw; riverine erosion; wildfires
Shungnak	66° 53′ 9″ N	157° 8′ 15″ W	274	$40,833	Airplane; barge	Yes (to Kobuk)	No	Beach landing	Fuel; general supplies	Caribou,Geese, Ducks, Beavers, Musskrats, Bears, Sheefish, Moose,	Contaminated food supplies; environmental impact of subsistence hunting; permafrost thaw; riverine erosion; wildfires
Kobuk	66° 55′ 3″ N	156° 54′ 25″ W	144	$48,750	Airplane; barge	Yes (to Shungnak)	No	Beach landing	Fuel; general supplies	Caribou,Geese, Ducks, Beavers, Musskrats, Bears, Sheefish, Moose,	Contaminated food supplies; environmental impact of subsistence hunting; permafrost thaw; riverine erosion; wildfires
Selawik	66° 35′ 49″ N	160° 0′ 49″ W	845	$53,750	Airplane; ATV; barge	No	Yes	Beach landing (with gravel access road)	Fuel; freight; equipment	Caribou; pike; sheefish; whitefish	Permafrost thaw; receding sea-ice; water contamination
Buckland	65° 59′ 5″ N	161° 7′ 47″ W	511	$44,750	Airplane; barge	No	No	Beach landing	Fuel, general supplies	Shellfish, Caribou, Bearded Seal, Berries, Eskimo Potato	Food insecurity; flooding; ice jams; permafrost thaw
Deering	66° 4′ 33″ N	162° 43′ 6″ W	168	$43,750	Airplane; barge	No	Yes	Beach landing; mooring point	Construction materials; fuel; groceries; household goods; vehicles	Beluga; spotted and bearded seal; walrus; caribou	Coastal erosion; flooding; water contamination

Port Name	Latitude	Longitude	Pop.	Median Household Income	Transportation Service	Inland Road	Coastal	Port Characteristics	Imports	Subsistance Activities	Environmental Concerns
Shishmaref	66° 15′ 20″ N	166° 4′ 20″ W	125	$30,000	Airplane; barge	No	Yes (island)	Beach landing	Construction materials; fuel; general supplies	Bearded seal	Coastal erosion; flooding
Diomede	65° 45′ 15″ N	168° 55′ 15″ W	99	$18,333	Airplane (winter only); barge; helicopter	No	Yes (island)	Beach landing; breakwater	Fuel; general supplies	Walrus; seal; polar bear; blue crab; whale; murre eggs; aucklets	Food insecurity (less consistent walrus, seal, and polar bear presence); permafrost thaw; receding sea-ice
Wales	65° 36′ 44″ N	168° 5′ 21″ W	165	$33,125	Airplane; barge	No	Yes	Beach landing	Food; fuel; general supplies; household goods	Bowhead and beluga whales; walrus; salmon; trout; tom-cod; white fish; herring; flounder; blue cod; clam; crab; moose; musk ox; caribou; duck; goose; ptarimagan; duck and murre eggs;	Coastal erosion; food insecurity

Economic Characterization of the Study Area

Introduction

Location

The Alaskan Arctic Coast study area encompasses ports from three Alaskan regions: the Nome Census Area, the Northwest Arctic Borough, and the North Slope Borough. The southernmost port studied is the village of Wales. The northernmost port is the city of Utqiagvik, formerly known as Barrow. There are five port communities in the study area that lie below the Arctic Circle (Diomede, Wales, Shishmaref, Deering, and Buckland). The remaining ports lie above the Arctic Circle.

The Nome Census Area is an unorganized borough with an area of 28,278 square miles, of which 22,962 square miles are land and 5,316 square miles are water. The population of the borough is around 9,800. Only the borough's northernmost communities are included in the study area, given that Cape Prince of Wales is the boundary. The borough's largest city is Nome, which has around 3,800 residents. Although Nome falls outside the study area, it nevertheless serves as a critical transportation link for cargo that is distributed to the ports that are in the study area.

The Northwest Arctic Borough has a total area of around 39,000 square miles, of which 35,898 square miles are land, and 4,863 square miles are water, and a population of 7,684. The region is bordered by the Chukchi Sea to the west, the Yukon-Koyukuk region to the east, the Nome Census Area to the south, and the North Slope Borough to the north. The borough is home to some of the most biodiverse lands on Earth and is home to the Noatak National Preserve, the Kobuk National Preserve, and the Gates of the Arctic National Preserve. It is also home to ecologically important water bodies such as the Kotzebue Sound and the Selawik Lake. The Northwest Arctic Borough has a transitional climate.

The North Slope Borough, is the northernmost borough in Alaska, and has a total area of 94,796 square miles, of which 88,695 square miles is land and 6,101 square miles is water. The land is characterized by tundra underlain with thick permafrost (permanently frozen sediment and rock). Only a shallow layer of ground thaws during the short summer, producing a vast number of thaw lakes. The borough is bordered by the Chukchi Sea to the west, up to Utqiagvik, and the Beaufort Sea along northern coast, all the way to the U.S.-Canada border, which defines the other boundary for the study area. The borough has approximately 9,832 residents, making it the fourth least dense county-level entity in the United States. The borough is home to Prudhoe Bay, the area in which the bulk of known oil in Alaska is located. A 400-mile-long road called the Dalton Highway connects Fairbanks to Prudhoe Bay. Other communities in the borough rely heavily on airplanes and barges for the importation of food, goods, equipment, and materials. The borough has an arctic climate with long, extremely cold winters, large quantities of snowfall, and high winds. It is also home to the Arctic National Wildlife Refuge, an ecologically important area of Alaska.

Socioeconomic Information

The ports are largely comprised of people of primarily Inupiat ethnicity, minus Prudhoe Bay, Red Dog, and to some extent, Utqiagvik. Utqiagvik has the highest population at 5,256 people and Diomede has the lowest population with 99 people. The average population in the communities is 878 and the median population is 421. The significant difference in the average and the median shows a skew of the population data towards the upper end of the distribution. Largely, the population

distribution is characterized by local economies and government employment. The regions with larger population sizes tend to have higher tourism, a larger job market, or a connection to the oil industry. The lower population communities tend to have more subsistence based economies, less tourist traffic, and less employment opportunities.

The highest median household income community is Kotzebue with $85,278 and the lowest is Diomede with $18,333. Community population and median household income appear to be relatively highly correlated. There is also a large spread of poverty in these communities. Some can be below 5 percent, and others are above 30 percent. Lastly, the populations in these communities lean younger, with the majority of the populations being under the age of 55.

An increase in vessel traffic in these communities may have an impact on population and median income levels. More vessel traffic could lead to an entry in new investments which would cause an increase in population growth. This could impact median household income for people in an upward direction by having more employment opportunities from new business. An increase in tourism could also be a side effect of the growth. If more people traveled through the towns, local businesses would be stimulated. These positives would have to be weighed against the negatives. Negative environmental impacts, such as pollution, would have to be taken into consideration as more vessels traveled through these communities.

Economic Activity

Cash Labor

The economies of the communities in this area are generally a mix of cash and subsistence activities. Residents pay for goods and services in cash and they are paid for work in cash. The local governments, schools, health clinics, mining, and other small businesses tend to pay their local employees in cash. The banking and internet infrastructure limited in most of these communities to process more complicated transactions or allow for non-cash financial transactions.

In addition to this more formal cash economy, an informal cash economy also exists in many places. These small villages and towns are often not large enough to sustain permanent service businesses such as vehicle repair and hair cutting shops. Residents compensate by exchanging services or paying cash to one another that is not going to a formal business and is usually not tracked by the IRS. Informal economies such as these are vital to these remote, rural communities.

An increase in vessel traffic could lead to an influx of new cash into the local economies by providing an increase in people traveling to the towns and using services. Similarly, additional oil and natural resource extraction development could lead to steady high paying jobs which would push more cash into these economies. However, these potential positive developments must be weighed against their disruption of the informal economies and the negative impacts that would have on the communities that rely on them for a source of services as well as a source of income.

Subsistence

Subsistence activities constitute the economic and nutritional foundation of these communities. A subsistence lifestyle is centered on year-round hunting, fishing, and gathering wild food and materials from the surrounding land, rivers, and sea. This allows these communities to be largely self-sustaining and to continue to survive when supply shipments are uncommon.

The main practitioners of the subsistence lifestyle in these communities are the Native Alaskan population. Subsistence activities have been passed through generations of the native communities that have lived in this region. These populations ascribe a strong cultural and religious significance to subsistence activity.

Subsistence activities provide benefits in addition to food and water harvests. Subsistence diets are very healthy, providing a wide range of essential nutrients as well as providing protection against diseases associated with a less healthy diet such as cardiovascular disease, hypertension, type 2 diabetes, stroke, obesity, osteoporosis, and some cancers. Additionally, subsistence activities provide significant mental health benefits and are the largest form of physical exercise for the communities.

The type of activities that communities practice can vary by their geographic location. Coastal communities rely on marine mammals such as bowhead and beluga whales, bearded seals, and walruses. Communities situated inland, such as those along the Kobuk River, rely more heavily on terrestrial mammals, especially caribou, but also others such as moose and bears, as well as river fish like salmon and whitefish.

Increased vessel traffic has the potential to put additional pressure on subsistence activities or threaten residents' continued reliance on subsistence. This is due to an increased likelihood of animal strikes, disturbing animals due to vessel noise, and oil spills, discharges, and pollution. Such factors could jeopardize the size, quality, and consistency subsistence harvests. Many residents have already voiced concerns over the preservation of their traditional culture, due in part to changing migration patterns of subsistence resources, decline of the native language, community relocation, or potential oil and gas development. Increased vessel traffic could accelerate some of these changes.

Bartering and Sharing

There is a deeply-ingrained culture of sharing within Inupiat society. The towns and villages of this region tend to be closely-knit communities with robust systems of bartering and sharing to supplement the cash economies and subsistence activities present. This type of bartering and sharing occurs in relation to services provided as well as food harvested. What is traded in these communities depends on the location of the ports. If they are located more coastally, more fish will be bartered than if the communities are located more inland. Neighbors will often trade services with one another, such as auto repair and haircuts. No money changes hands but both parties benefit.

Given the customary nature of sharing in these ports, individuals or crews who harvest animals are not the only ones who benefit. When a whaling crew, for instance, succeeds in hunting a whale it is a boon not just for the crew itself but for the entire community. While those who participate in the hunt may harvest more than their family can use (with the intention of sharing it with extended family or using it to barter or trade for other goods and services), catches are butchered and distributed among residents to help meet the nutritional needs of the population. Similarly, unsuccessful hunts are a detriment to the rest of the community.

An increase vessel traffic could affect bartering and sharing through its effect on subsistence activities. If pollution impacts local species that are harvested for subsistence, then bartering will be impacted as well. A decline in the population of local animals or change in their migration patterns in any specific community will cause a decline in the amount of animals that can be shared or bartered throughout that community. Additionally more visits from vessels may put pressure on the barter and sharing economy to change into a more formal economy with the influx of new cash.

Seasonality of Economic Activity

The ports in the study area share a similar degree of seasonality regarding economic activity, given the similar geographical characteristics. Economic activity ranges from services and subsistence activities to construction, mining, and oil and gas development and extraction. Every year Alaska experiences large swings in seasonal employment, notably in the fishing, construction and tourism industries. Year-round employment is more readily available in the larger cities, such as Utqiagvik and Kotzebue.

Major Employers and Industries

Government Employment

A relatively high proportion of residents in the study area work for the city governments, the local schools, or the boroughs. These offer full-time, year round positions with generally high incomes for the region.

Small Business

The ports in the study area typically have some form of crafting industry that uses non-edible subsistence harvest materials, such as ivory, whale bones, and caribou skins, to produce intricate clothing and crafts. These products, along with locally-produced art, reflect the rich history and traditions of the Inupiat culture. Some communities, such as Kaktovik, are developing a small but growing eco-tourism industry.

Natural Resource Extraction

The communities in this study are either directly involved with or are impacted by natural resource extraction. They are located on oil and mineral-rich land and work closely with corporations and local government to determine fair property evaluation and monetary compensation for extraction activities on their territory. Some of the most abundant resources are oil, zinc, lead, coal, and natural gas. Oil extraction is a growing industry in the state of Alaska, and the search for new sources of oil has led to multiple corporations claiming a stake in the development and continuation of oil rigs and pipelines. Similar activity can be observed in the mining industry.

Native communities are frequently shareholders in oil and mineral extraction projects, and contribute to the assigning of permits and to the discussions of the potential environmental repercussions of these endeavors. Corporations are accountable to native communities and work in tandem with them to ensure transparency and fairness. While measures are frequently taken to prevent excessive environmental damage, natural resource extraction comes with numerous risks that make eliminating all potential hazards nearly impossible. However, the economic benefits of industry growth in both oil and minerals have greatly benefitted these communities.

The anticipated increase in vessel traffic will allow for greater mobility in shipping extraction equipment and materials and also allow for new routes through which to transport extracted natural resources. Natural resource extraction industries have previously relied on inland routes to distribute material due to the sea ice, but are now expanding to marine vessels as a method to quickly and efficiently move material. As the sea ice recedes, the Chukchi and Beaufort seas become more navigable. Less sea ice will also create opportunities for exploration of new prospects. This can have the effect of increasing the demand for more sophisticated port infrastructure in key ports involved with these industries. Notwithstanding, the global perception of the Arctic as a pristine, snow-and-ice-covered region has strong public appeal, which may create resistance for industrial development.

Limiting Factors for Future Growth

Cost of Living

One of the most significant challenges to the Alaskan communities in the study area is the disproportionately high cost of living. These communities rely on airplane deliveries for the majority of food and household goods. As a result, the sticker price that residents must pay is greatly inflated by the transportation costs associated with bringing these items to such remote locations. (Given the nature of airplane deliveries, the prices also factors in the bulkiness and weight of these items.) As such, residents may pay two or three times as much for food items compared to someone living in the continental U.S. In Utqiagvik, it is not uncommon for a household to spend $500 every week on groceries. In addition to high prices, residents also have to sacrifice on the quality or freshness of some foods that are brought from the contiguous U.S. Non-perishable foods or those with a longer shelf life can be brought on barges.

The same exorbitant prices apply to equipment, construction materials, and vehicles, which can only be brought to these communities during the limited window in the summer when the sea ice recedes. There is the potential that with a longer summer season without shore-fast ice, these communities could receive an increase in barge deliveries. This could grant residents and local businesses more flexibility in importing items as well as reduce prices.

Environmental Challenges

Development and growth in the region is heavily influenced by weather and access to materials. Transportation infrastructure in the region is extremely limited. Few roads, limited airports, and vast distances between communities makes the movement of materials both challenging and expensive. Harsh weather conditions also create logistical and maintenance challenges. Pipe breakages are a recurring problem, thus making water relatively more scarce, expensive, and prone to outages. Permafrost thaw and coastal erosion are likely to place increased strain on the integrity of water and sewer lines as the region continues to feel the effects of climate change.

While an increase in temperatures could enhance navigability, significant obstacles to shipping would still remain. These include icing from sea spray, wind chill, polar lows and other challenges to the reliability of weather forecasts.

Environmental Characterization of the Study Area

Introduction

The Alaskan Arctic Coast Port Access Route Study (AACPARS) includes ports that extend from the Bering Strait to the Beaufort Sea. This is one of the areas most affected by climate change; temperatures here are increasing two times faster than the rest of the planet.[1] Because this area is dominated by ice, increased temperatures alter the extent and thickness of sea ice. As a consequence, these changes have brought an increase in industrial activity to the region, including the maritime transportation sector.[2] With the continued development of natural resources and tourism enterprises, areas with shipping-related infrastructure are expected to experience both social and economic changes.

Figure 1. Ports Included in AACPARS[3]

Location and Description of Habitat

Ecoregions were developed from the combined efforts of several state and federal agencies in order to provide a spatial framework for research, assessment, and monitoring of ecosystems and their biotic and abiotic characteristics. Ecoregions describe areas that have similar geology, landforms, soils, vegetation, climate, land use, wildlife, and hydrology.[4]

The ports in the AACPARS fall within five ecoregions: the Beaufort Coastal Plain, the Brooks Foothills, Kotzebue Sound Lowlands, Kobuk Ridges & Valleys, and Seward Peninsula (see Table 1 below).[5,6]

Beaufort Coastal Plain	*Brooks Foothills*	*Kotzebue Sound Lowlands*	*Kobuk Ridges & Valleys*	*Seward Peninsula*
Kaktovik Point Lay Prudhoe Bay Utqiagvik Wainwright	Kivalina Point Hope Red Dog	Diomede Kotzebue Noorvik Selawik Shishmaref Wales	Ambler Kiana Kobuk Shungnak	Buckland Deering

Table 1. Ports within the AACPARS Arranged by Ecoregion

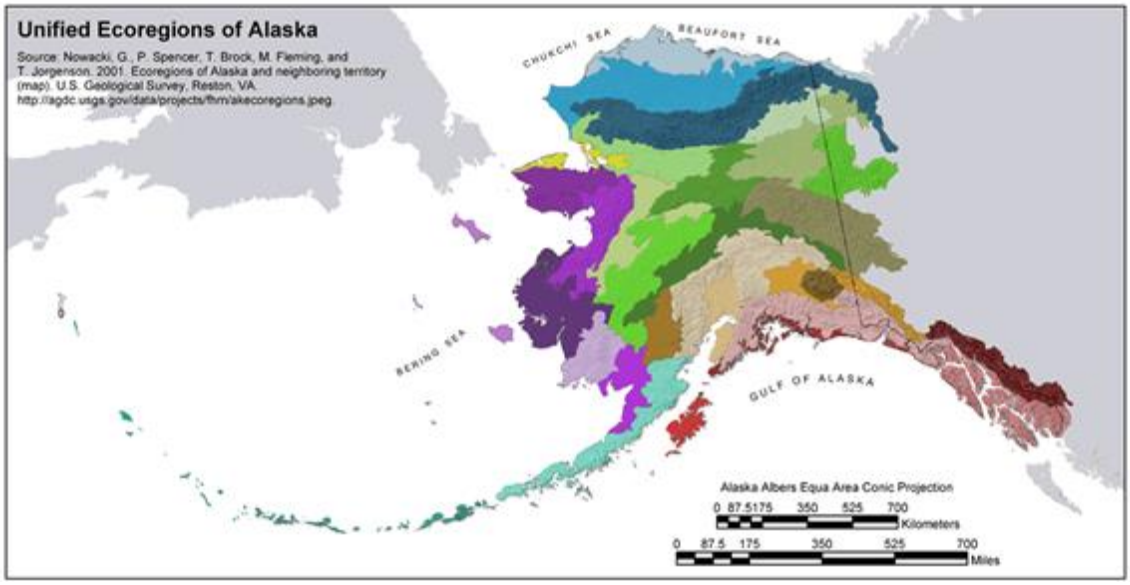


Figure 2. Unified Ecoregions of Alaska[7,8]

Beaufort Coastal Plain Ecoregion

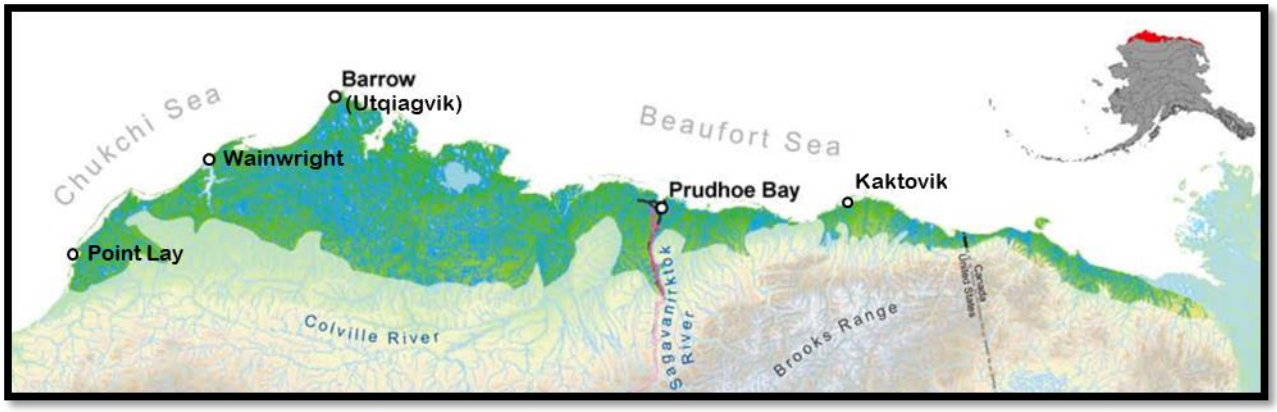


Figure 3. Extent of the Beaufort Coastal Plain Ecoregion[9]

Ports	Biome	Average Temperatures		Avg. Annual Precipitation
		Winter	Summer	
Kaktovik Point Lay Prudhoe Bay Utqiagvik (Barrow) Wainwright	Arctic Tundra	-30° to -21° C (-22° to -6° F)	1° to 8° C (34° to 46° F)	100 to 150 mm (4 to 6 in)

Table 2. Climate Characteristics of the Beaufort Coastal Plain Ecoregion[10]

The northernmost ecoregion in the United States, the Beaufort Coastal Plain, is bound on the north and the west by the Arctic Ocean and stretches eastward to the international boundary between Alaska and Canada. It was settled by Inuit (Taremiut) who traditionally depend on large marine mammals for food. This treeless ecoregion is comprised of smooth plains rising very gradually from sea level to the adjacent foothills. Small sand dunes irregularly occur along the coast. Permafrost-related features and thaw lakes also mark the terrain surface. As a whole, the Beaufort Coastal Plain is very poorly drained. Due to the abundance of lakes and saturated soils, over 82 percent of the ecoregion is considered wetland.[11]

A dry, polar climate produces short, cool summers and long, cold winters (see Table 2 above). Proximity to the Arctic Ocean and abundant sea ice contribute to the cool, frequently foggy, summers.

Brooks Foothills Ecoregion

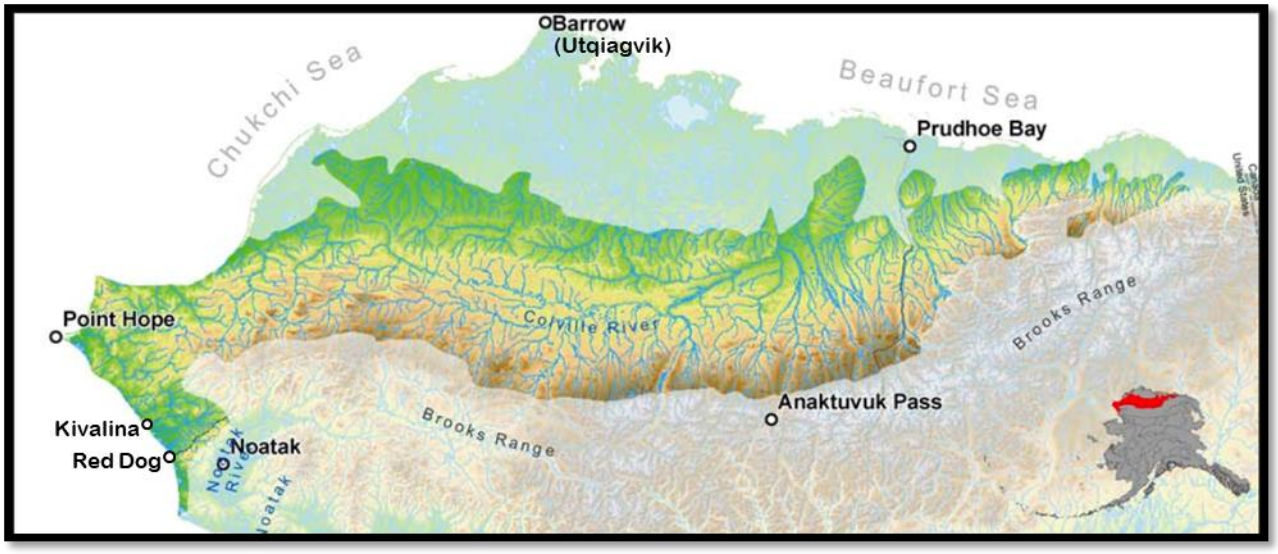


Figure 4. Extent of the Brooks Foothills Ecoregion[12]

Ports	Biome	Average Temperatures		Avg. Annual Precipitation
		Winter	Summer	
Kivalina Point Hope Red Dog	Arctic Tundra	-29° to -20° C (-20° to -4° F)	1° to 16° C (34° to 60° F)	120 to 250 mm (5 to 10 in)

Table 3. Climate Characteristics of the Brooks Foothills Ecoregion[13]

The Brooks Foothills ecoregion is composed of gently rolling hills and broad, exposed ridges. The hills and valleys of the region have better defined drainage patterns than those found in the coastal plain to the north and have fewer lakes. It is predominantly a treeless region, underlain by thick permafrost and ice-related features on the surface. The area was settled by Inuit (Nunamiut) who rely on caribou as their primary subsistence resource.[14]

A dry polar climate dominates this region, but it is somewhat warmer and wetter than the climate of the Beaufort Coastal Plain ecoregion to the north (see Table 3 above).

Kotzebue Sound Lowlands Ecoregion

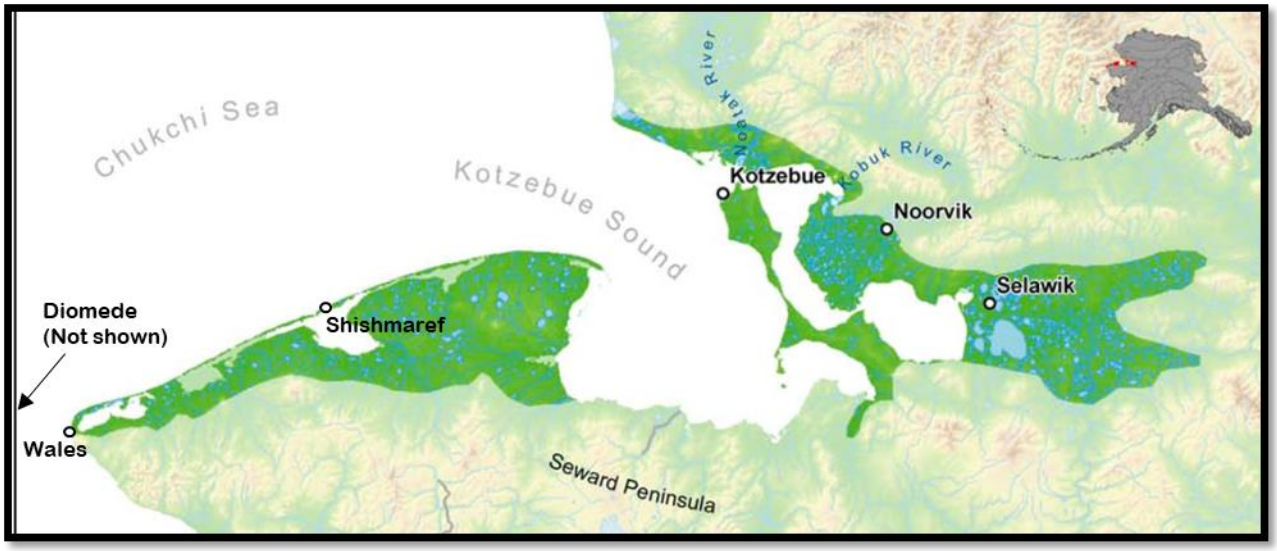


Figure 5. Extent of the Kotzebue Sound Lowlands Ecoregion[15]

Ports	Biome	Average Temperatures		Avg. Annual Precipitation
		Winter	Summer	
Diomede Kotzebue Noorvik Selawik Shishmaref Wales	Bering Tundra	-25° to -16° C (-13° to 3° F)	6° to 17° C (43° to 63° F)	100 to 300 mm (4 to 12 in)

Table 4. Climate Characteristics of the Kotzebue Sound Lowlands Ecoregion[16]

The Kotzebue Sound ecoregion mainly includes coastal plains of the Kotzebue Sound area and Chukchi Sea. This ecoregion tends to be flat and poorly drained, streams have very wide and serpentine meanders. Soils are wet, and permafrost is variable, deep under some areas and absent from others. A major regional disturbance is flooding of rivers; this can occur in the spring, during summer storms, or along the coast due to tidal inundation.[17]

The region is affected by both marine and continental climatic influences. A dry, polar climate produces short, cool summers and long, cold winters, though moister and warmer than in areas along the rest of the Chukchi Sea or the Arctic Ocean (see Table 4 above).

Small permanent and seasonal settlements occur throughout this region. The eastern portion of the region was settled by the Kotzebue Sound Inuit, who rely on small marine mammals, terrestrial mammals, fish, and migratory birds. The western portion was settled by the Bering Strait Inuit, who depend more on large marine mammals. The remainder of the region was settled by the Yupik who rely on marine mammals as a primary food source.[18]

Figure 6. Extent of the Kobuk Ridges & Valleys Ecoregion[19]

Ports	Biome	Average Temperatures		Avg. Annual Precipitation
		Winter	Summer	
Ambler Kiana Kobuk Shungnak	Boreal Forest	-18° to -11° C (-0° to 12° F)	9° to 20° C (48° to 68° F)	250 to 550 mm (10 to 21 in)

Table 5. Climate Characteristics of the Kobuk Ridges & Valleys Ecoregion[20]

The Kobuk Ridges & Valleys ecoregion represents a patchwork of characteristics. It consists of several large rivers (Kobuk, Noatak, Huslia, and Selawik), broad valleys, and numerous small mountain ranges south of the Brooks Range. The interplay of permafrost, surface water, fire, and local elevation relief produce a variety of vegetation communities. Region-wide unifying features include a continental climate, undifferentiated alluvium and slope deposits, a predominance of spruce and hardwood forests, and a very high frequency of lightning fires. Permafrost is almost continuous under this ecoregion, but varies in thickness from thin to moderate. Along the rivers, the presence of permafrost contributes to poorly drained soils and wet conditions.[21]

The dry, continental climate is characterized by long, cold winters and short, cool summers (see Table 5 above). Relatively dry summers combine with frequent lightning storms to make forest fires a common disturbance.

Native inhabits of this area have descended from a number of Athabascan groups. Upland dwellers rely on large terrestrial mammals (caribou and moose) as important subsistence sources. Riverine groups depend on salmon and freshwater fish, as well as smaller mammals as food sources.[22]

Seward Peninsula Ecoregion

Figure 7. Extent of the Seward Peninsula Ecoregion[23]

Ports	Biome	Average Temperatures		Avg. Annual Precipitation
		Winter	Summer	
Buckland Deering	Bering Tundra	-22° to -13° C (-8° to 9° F)	1° to 13° C (34° to 55° F)	250 to 510 mm (10 to 20 in)

Table 6. Climate Characteristics of the Seward Peninsula Ecoregion[24]

The Seward Peninsula ecoregion varies from coastal plains, to convex hills with broad valleys, to isolated groups of glaciated mountains reaching heights of 4,600 feet (1,400 meters). Streams occupy the larger valleys, and many small inland and coastal lakes exist. A continuous permafrost layer of varying thickness keeps most soils wet, shallow, and organic. Another predominantly treeless region with ice-related features across the landscape. Wildfires are a common occurrence in the summer after the grasses dry.[25]

The ecoregion is surrounded on three sides by water. The moist polar climate is characterized by cold and windy winter conditions and summer fog along the coastline (see Table 6 above).

Small settlements are scattered throughout the region. Bering Strait Inuit use the land for subsistence hunting and fishing. Populations nears the coast primary rely on large marine mammals, winter ice fishing, and summer ocean catches. Farther inland populations rely on salmon, freshwater fish, as well as variety of terrestrial mammals.[26]

Fish and Wildlife Values

Alaska is home to a large variety of animals adapted to living in harsh weather conditions and limited resources. In general, the ice-covered central Arctic Ocean has relatively low biological productivity. However, Arctic waters along the edges of ice are more productive; they host a large collection of fish, seabirds, marine mammals and invertebrates. There are also a number of species that migrate to the region for the high marine productivity during the summer season; hence areas along the Arctic Coast are considered to be regional hotspots of biodiversity.[27]

There are four species (see Table 7 below) within the AACPAR that are protected by the Endangered Species Act (ESA).

Table 7. Species within the AACPAR protected by ESA[28]

Common name	Scientific name	Status
Steller's eider	*Polysticta stelleri*	Threatened
Spectacled eider	*Somateria fischeri*	Threatened
Polar bear	*Ursus maritimus*	Threatened
Bowhead whale	*Balaena mysticetus*	Endangered

Birds

In total, more than two dozen shorebird and waterfowl species summer and breed within the AACPAR study area. Common species include Eiders, Turnstones, Loons, Black-legged Kittiwakes, Peregrine Falcon, and other raptors.[29] Over 6 million birds are estimated to breed on the National Petroleum Reserve-Alaska.[30] The Chukchi coast supports nearly a quarter-million breeding birds, some of which may forage more than 100 miles offshore.[31]

Fish

Waters within the AACPAR are host to numerous freshwater and anadromous fish species. Five Pacific salmon species occur in the study area, with pink salmon being the most numerous. Dolly Varden, cisco, and sheefish spawn and overwinter in larger rivers. The longest-lived and largest sheefish in Alaska are found in the Kobuk-Selawik river systems. Arctic char, lake trout, and whitefish are found in lakes; Arctic grayling are year-round residents in both lakes and streams.[32] [33]

Marine Mammals

Polar bears; ribbon, spotted, bearded, and ringed seals; bowhead, gray, beluga, killer, and minke whales; harbor porpoises; and walruses are all observed near the Arctic coasts and on adjacent ice floes.[34] Bearded and ringed seals haul out at the sea ice edge, as one proceeds north to south along the Chukchi Sea within the study area. Coastal waters along the Beaufort Sea and Chukchi Sea are an important feeding area of the endangered bowhead whale during the fall. The large lagoon systems of the Kotzebue Sound provide sheltered water and abundant prey for seals.

Terrestrial Mammals

Four caribou herds (Central Arctic, Porcupine, Teshekpuk Lake, and Western Arctic) fall within the AACPAR study area. Northern ecoregions are used as calving and summering grounds, and the herds spend winter in the southern portion of the Kobuk Ridges & Valleys ecoregion.[35] Other herbivores

include muskoxen, lemmings, barren ground shrews, singing voles, beaver, muskrat, tundra hares, and arctic ground squirrels. The main mammalian predators near the coast are arctic foxes and polar bears; other top predators include gray wolves, brown bears, and wolverines.

Impact Assessment

Proposed activities within the Arctic Coast have the potential to influence the Beaufort Sea, the Chukchi Sea, and the Arctic Ocean. During a proposed project, consider the potential effects on wildlife that depends on these waters for feeding, spawning, migration, or resting. Therefore, it is important to consider regulations at the federal and state level for all proposed projects.

Operating a vessel in the Arctic is challenging and brings potential risks to both human lives and the natural environment. An oil spill, for example, could have a catastrophic impact on the Arctic ecosystem and the indigenous communities that rely on subsistence activities. Damage is not limited to mortality of marine species, but can also have long-term persistent ecological impacts.[36] Arctic marine food webs are complex and diverse (see Figure 8 below); compared to temperate marine systems, they typically have fewer species which makes them more vulnerable to disruption. With relatively few species, each one plays an important role in the system, and adverse impacts on one (or several) species may trigger a cascading effect throughout the entire ecosystem.

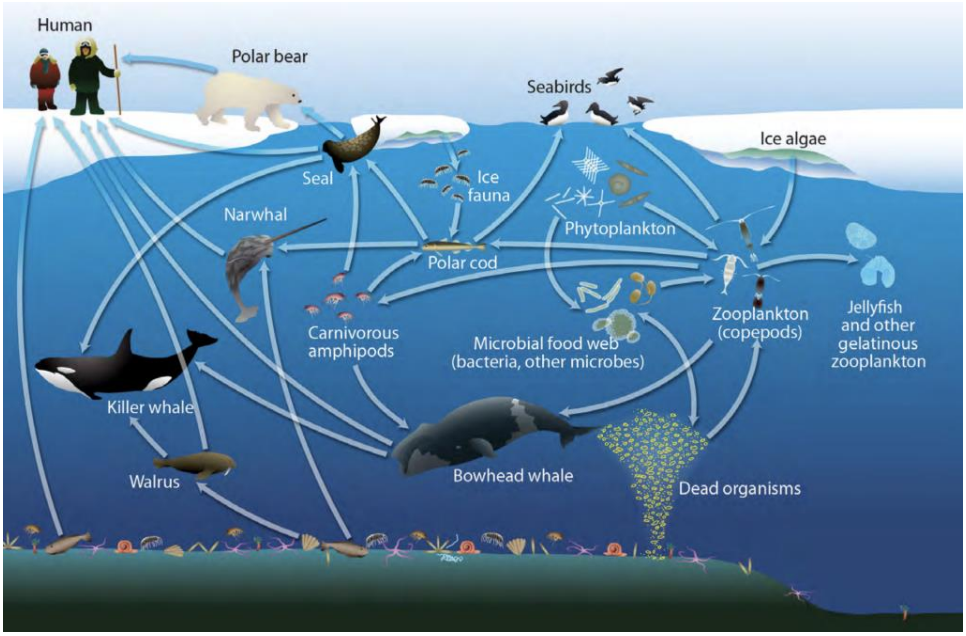


Figure 8. Arctic Marine Food Web[37]

Other negative impacts from vessel traffic include ship strikes of marine mammals, introduction of invasive species, and discharges of sewage and graywater.[38] It is important to follow state and federal regulations to minimize the impact of vessel traffic in these waters.

The release of toxic or hazardous material into the atmosphere and the Arctic Coast can have detrimental impacts to human health. The vast majority of commercial vessels are powered by diesel engines that run on heavy fuel oil, distillates, or fuel blends. These engines generate combustion exhaust, releasing long and short lived pollutants into the atmosphere. Many of these pollutants

contribute to global warming and negatively impact human and environmental health.[39] No part of the Arctic is currently included within an emission control area.[40] Fuel type and amount used by vessels are key data needed to estimate emissions by vessels operating in the Arctic.

Alaska's Coastal Management Program is a cooperative program between three agencies: Alaska Coastal and Estuarine Land Conservation Program, Kachemak Bay National Estuarine Research Reserve, and NOAA's Office for Coastal Management. It should be noted that Alaska withdrew from the National Coastal Zone Management Program in 2011.[41]

There are several fisheries with the AACPARS area which the Alaska Department of Fish and Game (ADFG) manages. Its Division of Commercial Fisheries manages commercial, subsistence, and personal use fisheries within the jurisdiction of the State of Alaska, in addition to the state's non-profit salmon hatchery and aquatic shellfish farming programs. It also operates three scientific laboratories specializing in fish genetics, fish pathology, and one in determining the age of fish. Waters that extend to the U.S. 200 mile limit—the Exclusive Economic Zone—are subject to federal jurisdiction, however, the North Pacific Fisheries Management Council has delegated authority to the ADFG's Division of Commercial Fisheries.[42] In 2018, the U.S. signed an international agreement to prevent unregulated high seas fisheries in the Central Arctic Ocean.[43]

Wetlands are a valuable resource and important habitat for many migratory and resident wildlife. Within the AACPAR study area there two designated areas with important ecological characteristics: Selawik National Wildlife Refuge[44] and Teshekpuk Lake wetlands.[45] Notwithstanding, the Arctic Coast is mostly comprised of estuarine and shallow water environments and is habitat for molting geese, threatened species, nesting shorebirds, and waterfowl. Arctic Coast wetlands support over six million shorebirds during summer breeding.[46] Proposed activities must avoid or mitigate detrimental effects to these important environments.

Any proposed port activities must also consider their proximity and potential impacts on historic property. There are close to 50 nationally registered historic places within the North Slope (15), Northwest Arctic (2), and Nome (29) boroughs.[47] The majority of the registered sites have archaeological and cultural significance to indigenous people. Proposed activities should also consider the potential impacts to historically important ship and aircraft wrecks as well.

In addition to English, Inupiaq is widely spoken throughout much of northern Alaska. Alaskan Inupiaq includes two major dialect groups: Northern Alaskan Inupiaq and Seaward Peninsula Inupiaq. The Northern Alaskan Inupiaq is made up of two dialects—the North Slope dialect is spoken along the Arctic Coast from Kaktovik (Barter Island) to Kivalina. The Malimiut dialect is primarily spoken around the Kotzebue Sound and the Kobuk River. Similarly, the Seaward Peninsula Inupiaq is comprised of two dialects— the Qawiaraq dialect is spoken in the southern part of the Seward Peninsula and along the Norton Sound. The Bering Strait dialect is primarily spoken in the villages surrounding the Bering Strait and on the Diomede Islands.[48] Translating materials into the appropriate Inupiaq dialect would help to ensure that local individuals are informed of proposed activities.

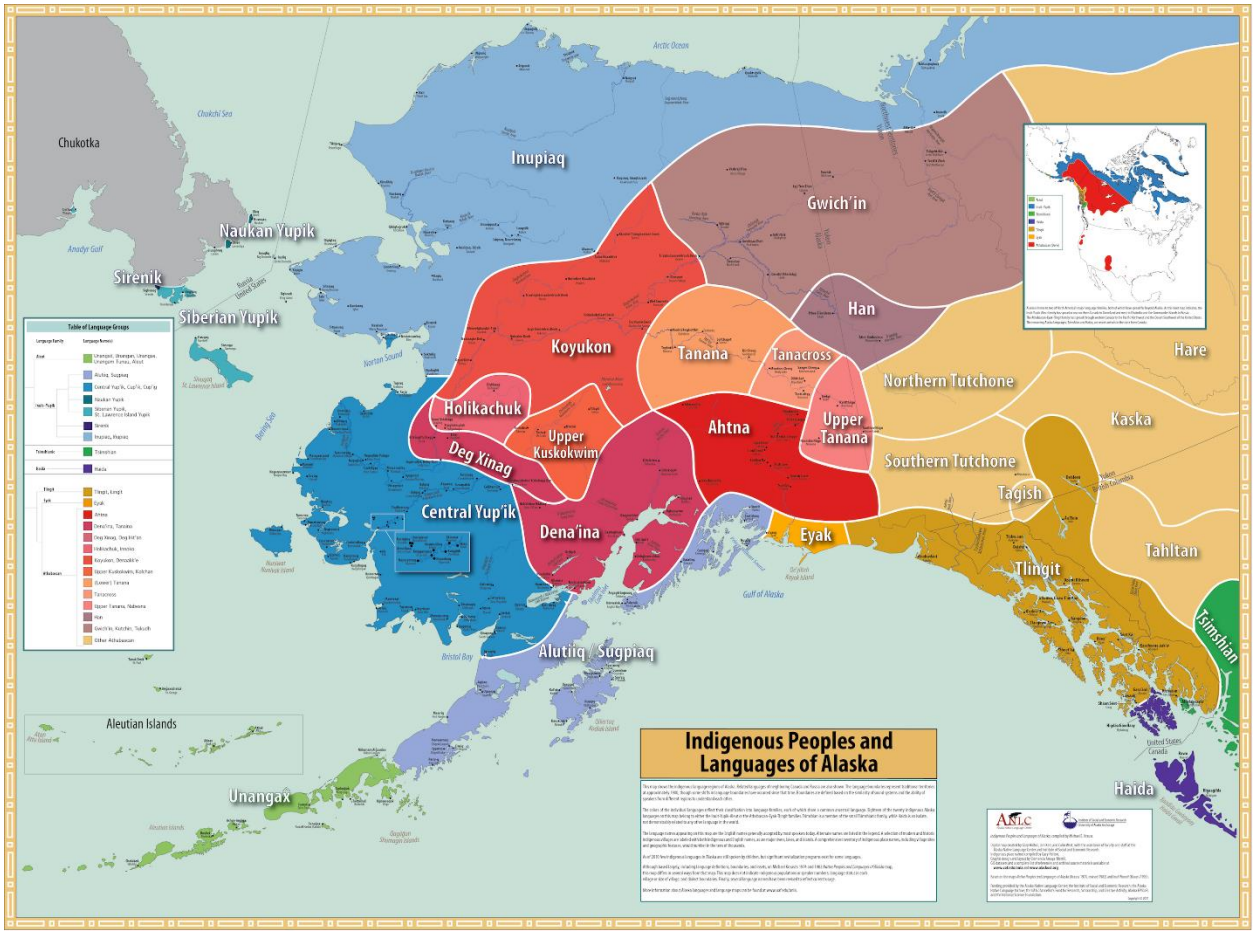


Figure 9. Indigenous Peoples and Languages of Alaska Map[49]

Proposed activities also need to be mindful of the impact on Alaska Native communities. These communities are usually comprised of low-income and minority populations and are more at risk to experience the negative consequences of global climate change and economic development. Changes to the geography have the potential to adversely affect subsistence, public health, and increase potential exposure to toxins.[50] Careful consideration needs to be made to ensure that proposed activities would not disproportionately affect low-income and minority populations.

For additional information or specific questions, refer to the resources identified in the summary table (below) or contact the local U.S. Coast Guard sector within District 17.

Table 8: Environmental Characteristic Summary Table*

Subject	Presence	Contact
Chemical Spill	Possible	NOAA's Office of Response and Restoration (scientific support) U.S. Coast Guard (response operations)
Coastal Zone Management	No	N/A
Dredging (channel)	Yes	U.S. Army Corp of Engineers, Alaska District
Emission Control Area	No	N/A
Endangered Species	Yes	*Federally-listed species*: U.S. Fish and Wildlife Service and NOAA National Marine Fisheries *State-listed species*: Alaska Department of Fish and Game
Essential Fish Habitat	Yes	NOAA Fisheries
Fisheries	Yes	North Pacific Fishery Management Council
Historic Property	Yes	National Register of Historic Places
Invasive Species	Yes	Alaska Department of Fish and Game U.S. Fish and Wildlife Service
Marine Mammals	Yes	NOAA National Marine Fisheries Service U.S. Fish and Wildlife Service
Migratory Birds	Yes	National Audubon Society U.S. Fish and Wildlife Service
Nonattainment Zones	No	Alaska Department of Environmental Conservation; Division of Air Quality U.S. Environmental Protection Agency
Oil Spill	Possible	NOAA's Office of Response and Restoration (scientific support) U.S. Coast Guard (response operations)
Superfund sites	No	Environmental Protection Agency
Wetland	Yes	The National Wetlands Inventory U.S. Fish and Wildlife Service

***This table is not an exhaustive list of subjects or references.**

Port Narratives

Nome Census Area

Diomede

Overview

Location

Diomede is a city situated on the west coast of Little Diomede Island, 135 miles northwest of Nome in the Bering Strait between Alaska and Russia. The island is only 2.5 miles east of Big Diomede Island, Russia, and the international boundary lies between the two islands. The city of Diomede is located at latitude 65° 45' 32"N and longitude 168° 57' 5"W, and encompasses 2.8 square miles of land.

Demographics

Diomede has a population of 99. The median household income in Diomede is $18,333. Ninety-five percent of the population of Diomede is Alaska Native; the rest of the population identifies as two or more races. The population is young, with 47 percent of the population under 20 years old and only 2 percent above the age of 55.[51]

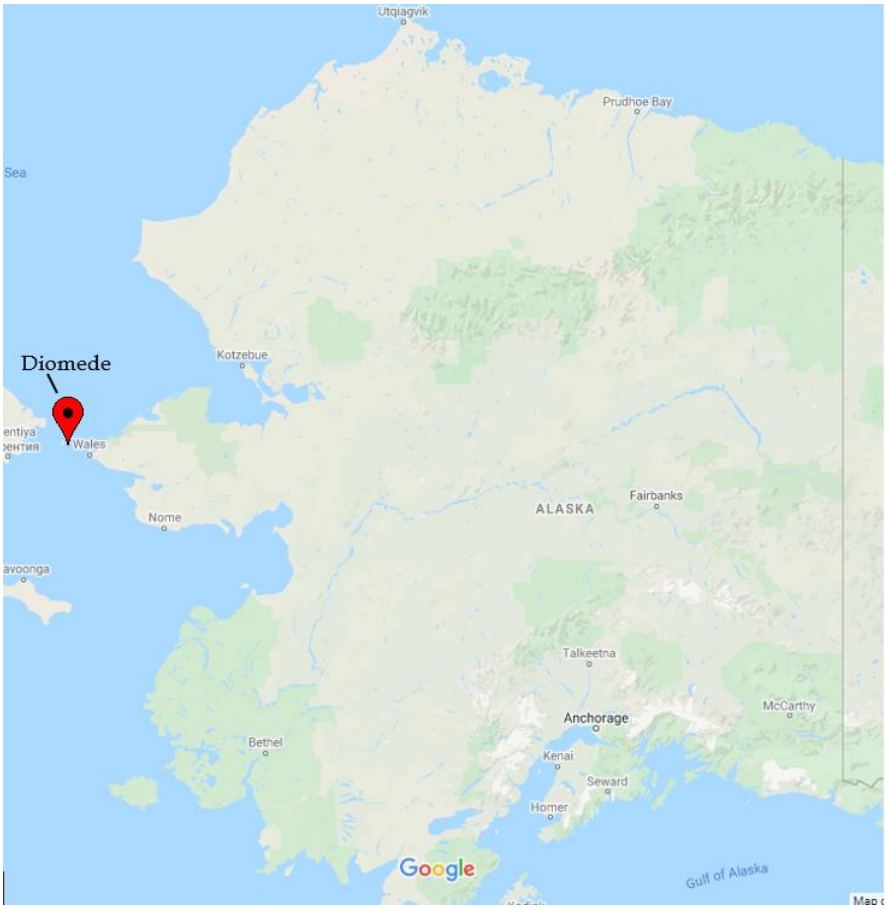


Figure 1. Diomede

Historically, villages existed on both of the Diomede Islands, and these villages were closely related. Residents travelled between the villages regularly, intermarried, and shared traditions and customs.

The cultures of the two islands were indistinguishable, however, during the Cold War, the Soviet Union relocated the native population of Big Diomede Island to mainland Russia. Contact between the communities became limited and residents of Little Diomede Island who traveled too closely to Big Diomede Island were captured by the Soviet Union. Even today contact between the two communities is rare.[52]

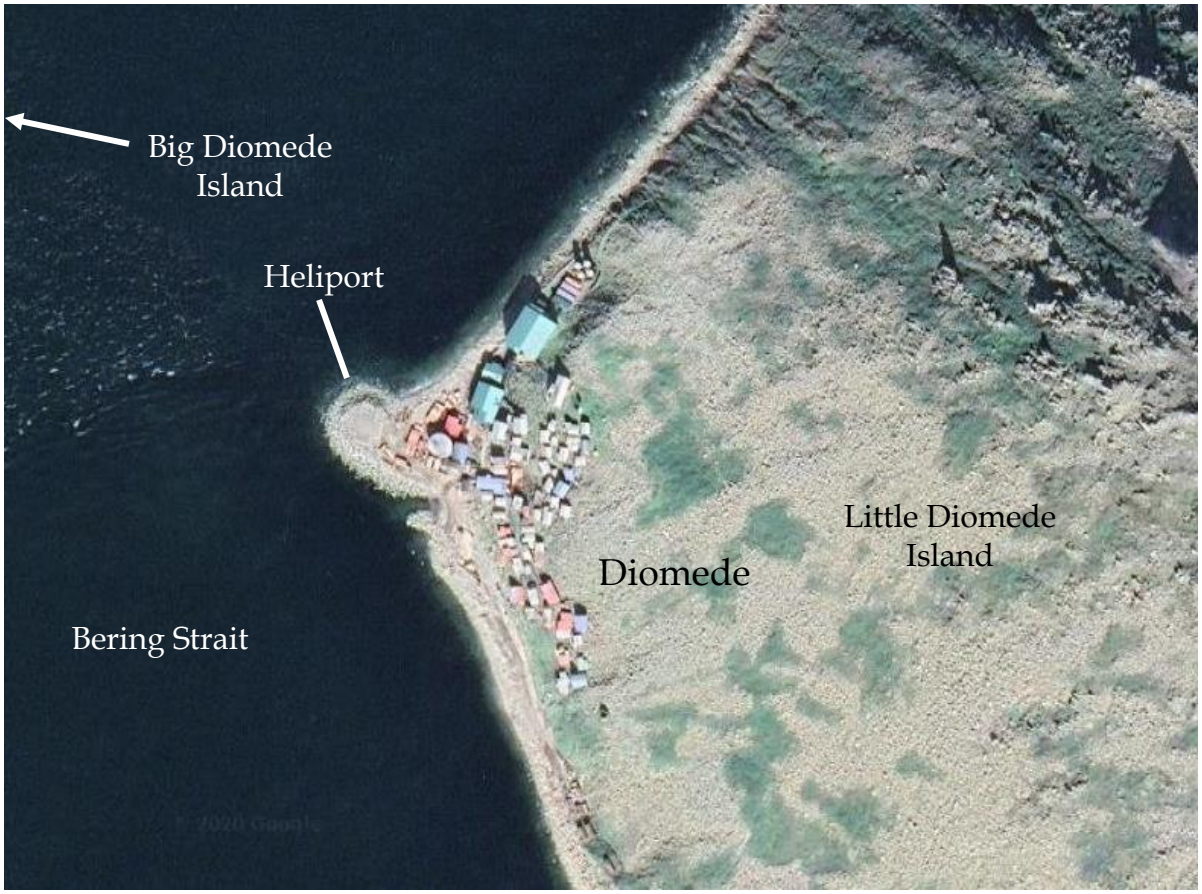


Figure 2. Port of Diomede

Climate/Weather

Diomede resides in the transitional climate zone, which is characterized by tundra interspersed with boreal forests, and weather patterns of long, cold winters and shorter, warm summers. Summer months are marked by cloudy skies and fog. Diomede is subject to strong winds from the north consistently averaging 15 miles per hour with gusts up to 60 to 80 miles per hour. The Bering Strait is usually frozen over between mid-December and mid-June.[53] Average summer temperatures range from 40 to 50 degrees Fahrenheit, while average winter temperatures range from -10 to 6 degrees Fahrenheit. Annual precipitation is 10 inches, and producing approximately 30 inches of snowfall.[54]

Municipal Utilities & Services

Diomede receives its power from a diesel generator located in town. Water is provided by a natural spring on the island.[55] Additionally, the island is home to one small tribal store and a post office. The geography of the island has prevented construction of a more extensive water system, a sewer system, and a landfill.[56]

Accessibility

Transportation Links

A state-owned heliport provides access to mainland Alaska; it allows for weekly mail delivery and travel year round.[57] Diomede is applying to be a beneficiary of the Federal Aviation Administration Essential Air Service Program (FAA EAS), which improves regular passenger and freight service to the community. Inclusion in the FAA EAS will increase the number of helicopter flights to more adequately address the needs of the community.[58] Erickson Incorporated[59] and Pathfinder Aviation[60] provide helicopter flights to Diomede.

Airplane access is limited. The steep slopes and rocky terrain of Little Diomede Island do not allow for an airstrip on the island. Float planes can attempt to land on the rough, often foggy seas in summer.[61] No roads exist inside Diomede or connecting Diomede to any other city or town. Transportation within the community and around the island is primarily on foot. Boardwalks link buildings in the city and trails travel around the island. Skin boats are also a popular method of sea travel to cover the 28 miles to Wales, Alaska.[62]

No road, bridge, or tunnel currently connect Diomede to the mainland of either Alaska or Russia. There have been proposals to create an inter-continental connection in order to link Alaska to Russia. The Diomede Islands would be used as stepping stones for either a bridge or tunnel; this would increase accessibility and potentially bring more people to the islands.[63]

Seasonal Constraints

During winter, travel to Diomede becomes even more difficult with ice and severe winds blocking travel from barges and helicopters. To mitigate this impact, residents plow the ice on the Bering Strait outside the town to create a runway for ski planes to land.[64]

Port Characteristics

Port Infrastructure

Accessibility to Diomede by the sea is limited. The island has a rocky shoreline; sea currents, tidal swells, fog, and wind making landings especially difficult. Diomede has a breakwater and a small boat harbor. Boats and barges can land on either side of the breakwater depending on the sea conditions. While annual deliveries occur, variable sea and ice conditions cause the timing of cargo barge deliveries to be irregular. Barge operators are hesitant to commit to Diomede deliveries due to the difficulty of the landings. Cargo deliveries can only land during a small window of safe weather conditions. Freight barges must wait offshore near the breakwater for favorable weather; it can take up to two weeks to land. Large rocks prevent fuel barges from landing onshore—to unload fuel, barges remain offshore and float the hose into nearby fuel tanks.[65]

Figure 3. The City of Diomede Looking East

Local Economy

Major Employers

Diomede is a predominantly subsistence-based community, supplemented by few local jobs and some seasonal employment. The city government and school offer the only year-round employment. Seasonal employment can be found in mining, construction, or commercial fishing, but these jobs have been on the decline. Additionally, a number of ivory carvers live in the city and the city acts as an ivory wholesaler.[66] Residents also use the seal, walrus, and polar bear hides from their hunting to make hats, parkas, mukluks, furs, and skins which they trade.[67]

Diomede has five active business licenses; they are for 1) the city council, 2) the utility company, 3) the Native Store, 4) a retail store, and 5) the Native Village of Diomede.[68]

Subsistence Activities

Diomede is a traditional Ingalikmiut Eskimo village with a subsistence lifestyle. Seal, walrus, polar bear, blue crab, and whale meat are the preferred foods of the community. Residents use all parts of these animals to make parkas, hats, mukluks, furs, and skins for trading.[69]

To support their diet, residents will gather materials they can find around the island. Residents will search the far side of the island for fresh greens, search the small spaces in the rocks for murre eggs, and catch aucklets out of the sky with homemade nets. The most important and most desired harvest, however, is the walrus. The walrus hunt is a community affair. When walruses swim or float by, they look for a place to haul-out and rest along the rocky shore of the island. The community attempts to attract walruses to shore with deep-throated grunts, and when successful, lure them towards the helipad. Men take rifles and attempt to kill the walruses, and use hooks attached to ropes to bring the dead walruses in closer.[70]

Planning and Future Growth

Some discussion has also taken place among residents about relocating the community. Life on the island is hard and presents a number of difficulties that would be lessened by relocating the

community off the island. The island's rocky slopes and lack of usable land reduce the availability of housing and restrict the community's ability to construct essential infrastructure such as a water and sewage systems, a landfill, or an airport.[71]

Environment

Environmental Justice

Proposed activities also need to be mindful of the impact on Alaska Native communities. These communities are usually comprised of low-income and minority populations and are more at risk to experience the negative consequences of global climate change and economic development. Climate issues such as those discussed above have an outsized impact on these communities. Changes to the geography have the potential to adversely affect subsistence, public health, and increase potential exposure to toxins. Careful consideration needs to be made to ensure that any proposed activities would not disproportionately affect low-income and minority populations.

Additionally, the relocation of communities comes with a steep price tag, and this poses a large financial burden for individuals of the port. There are few communities where mitigation of erosion and flooding is the solution rather than adaptation to crumbling landscapes. Displacement of communities is not only a burden to individuals during the process, but can also further erase important cultural aspects and traditions for these communities.

Water/Air Quality

There is no readily available information on water or air quality in Diomede.

Effects of Climate Change

Recent years have seen climate change begin to dramatically affect the island and its community. Residents of the island have noticed the temperatures slowly creep upward with some noting the occasional day with temperatures that reach 70 degrees Fahrenheit. Warming temperatures have had a number of negative effects on the community, such as the two to six centimeters of permafrost thawing each year. The sea ice that forms on the shore of the community every winter has been coming later, leaving earlier, and is consistently thinner when present. Less consistent ice puts the ice runway in jeopardy and makes contact with the mainland more difficult. The lack of ice has also led to more damaging storms. The ice can blunt turbulent weather and seas, but when it is gone, communities are exposed to storms that used to pass over an ice region.[72]

Climate change has also affected the hunting patterns of the island community. Walruses come by the island less regularly, seal hunting season is becoming shorter, and polar bears are becoming scarcer. The animals that the community relies on for survival are dwindling, and the environment is becoming less predictable.[73]

Shishmaref

Overview

Location

Shishmaref is a village on Sarichef Island, located along the Chukchi Sea at latitude 66° 15′ 20″ N and longitude 166° 4′ 20″ W. The majority of the island is comprised of the Bering Land Bridge National Reserve. The reserve is 2.6 million acres in size, and is part of the Beringian National Heritage Park. It is north of the Bering Strait and 5 miles offshore of the mainland. Shishmaref has an excellent harbor, and in 1900 it became a supply center for gold mining activities to the south. The village was named after the inlet, and a post office was established in 1901. The city government was incorporated in 1969.

Figure 1. Shishmaref

Demographics

It is a traditional Inupiat village with a fishing and subsistence lifestyle.[74] There are approximately 125 inhabitants. Per capita, the average income in 2010 was $10,203 and almost twenty-seven percent of all residents live below the poverty line. Ninety-five percent of residents are Inupiat.

Shishmaref has frequently experienced severe erosion. The most severe occurrence happened in 1997, where a storm eroded over 30 feet of the north shore, requiring massive relocation. An average of 3 to 5 feet have been eroded every year. In July 2002 residents voted to relocate the community.[75]

Accessibility

Transportation Links

Shishmaref Airport (SHH) is the only means of transportation to the rest of Alaska.[76] Three main roads exist through the community: Main Street-Airport Road, Housing Trail and Clinic Road. Roads through the village are not paved, and vehicles owned by residents are mostly ATVs with some private vehicles and motorcycles. No permanent roads exit or enter the community. There are winter snow trails to Wales.

Seasonal Constraints
When it is free of ice, residents will use wooden vessels to travel by water around the island.

Port Characteristics

Port Infrastructure
Investment in Shishmaref led to the installation of 1,380 feet of shoreline barriers. A rock barrier protects the community along areas where the coast directly impacted infrastructure. However, much of the infrastructure in residential parts along with the airport are vulnerable. The Shishmaref Landfill Road is currently being considered for reconstruction due to heavy storm damage. Despite ongoing projects and discussions, Shishmaref's native community is still actively seeking another place for relocation due to the extent of the damage on the village.

The current estimate for relocation is $180 million, provided by the U.S. Army Corps of Engineers in a 2004 study. A study of potential relocation sites was conducted in 2016, along with a planning and environmental linkages study that identified environmental concerns that obstruct community building. Much of the building material used in Shishmaref, along with other small communities, is made from local material, which is endangered as well by coastal erosion.[77]

Figure 2. Coastal Erosion in Shishmaref

Vessel Characteristics
Given Shishmaref's relocation efforts, vessel activity is very likely to be affected over the next decade. Currently, a barge delivers materials and goods to the community when the coast is ice-free.[78]

The study mentioned above (the planning and environmental linkages study) may require vessel activity in and around the Sarichef Island to conduct surveys. Otherwise, most vessel activity will be directed towards re-building efforts, such as the single barge required to bring equipment and supplies for the re-construction of the Shishmaref Landfill Road. In the event that relocation of the Shishmaref community comes to fruition, it is anticipated that the annual load of supplies and equipment will require 2-3 barges for the duration of at least 3 years. However, due to the uncertainty of the relocation decision, there is some doubt cast on whether this scenario is plausible. [79]

Local Economy

Major Employers

Inupiaq art work makes up significant sector of the economy. Shishmaref specializes in sculptures, jewelry, masks, and carvings made of bone, antler, or ivory. The art work is frequently exported across Alaska and the world.

Subsistence Activities

The local economy is subsistence based, and supplemented by part time wage earnings and local sales of arts and crafts. Job sectors on the island include service positions associated with the tribe, the education system, and medical care. Forty-six percent of adults are not in the labor force and employment opportunities are scarce, and most part time employment goes toward supporting subsistence based activities.

Shishmaref is also the only village in the Bering Strait region to rely heavily on the bearded seal or ugruk. Each home in the village has a white bucket containing panaaluk, which is dried ugruk meat along with other cuts of the ugruk.[80]

Environmental

Water/Air Quality

There is no readily available information on natural resources in the immediate vicinity of Shishmaref.

Natural Resources Available

There is no readily available information on water or air quality in Shishmaref.

Effects of Climate Change

Among the islands in the region, erosion at Shishmaref has been uniquely pronounced due to its exposure to high winds and wave action. As a result, Shishmaref implemented more robust infrastructure and multiple shoreline defense structures. [81]

Permafrost thaw and general erosion of the sandy shores is worse on Sarichef Island's front than along its sides. To a degree, infrastructure has contributed to increased erosion rates. Solutions to coastal erosion are being heavily vetted, the most extreme of which is leaving the island.

Environmental Justice

Due to ongoing issues with coastal erosion and environmental damage due to storms and high winds, the community has channeled its resources into intense rebuilding. Ultimately the community is seriously considering moving the village altogether.[82]

Wales

Overview

Location

Wales is a small city located at the westernmost tip Alaska's Seward Peninsula at latitude 65° 36′ 44″ N and longitude 168° 5′ 21″ W. The town lies immediate north of Cape Prince of Wales, the designated boundary of the study area and the westernmost point on the North American mainland. It is also located 111 miles northwest of Nome and 26 miles east of Diomede. Although incorporated in 1964, it is one of the oldest communities in the Bering Strait region.

Demographics

The town occupies 2.8 square miles of land and has 165 inhabitants.[83] The median household income is $33,125 and the median property value is $62,000.[84,85] The median age is 25.5 years old.[86] The population is 93.5 percent Alaska Native and 6.5 percent identify as two or more races.[87] The local economy largely depends on native arts and crafts and subsistence activities, though some residents rely on income from mining.

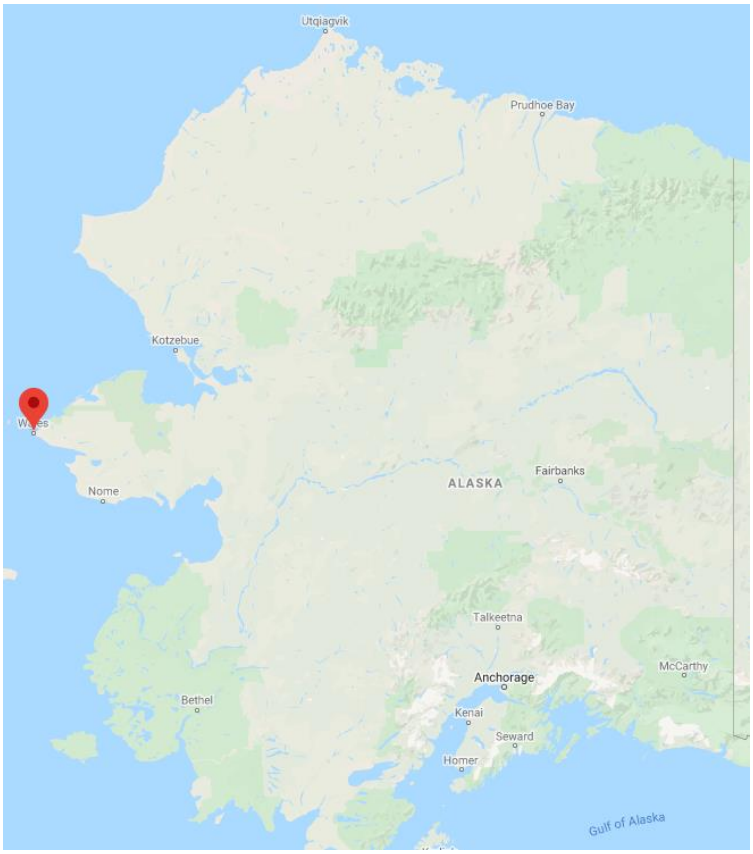


Figure 1. Wales

Climate/Weather

Wales has a maritime climate during the ice-free months, typically from June to November. Once the ice arrives in the Bering Strait, however, the climate transitions to a cold continental climate with harsh weather conditions, including frequent wind, fog, and blizzards, which can limit access to the community.[88] Temperatures range from -10 degrees Fahrenheit in the winter to 50 degrees Fahrenheit in the summer. The town receives 10 inches of precipitation, including 35 inches of snow every year.[89]

Municipal Utilities & Services

Wales has a school, health clinic, city government building, post office, native store, and a washeteria. More than three-quarters of residents have digital subscriber line (DSL) internet access.[90] The City of Wales provides water and sewer services, firefighting, search and rescue operations, and health services, and maintains the roads. It also manages two a washeteria and a local store.[91] The washeteria charges $3 per load of laundry and $3 for a 15-minute shower. Potable water costs 25 cents per gallon.[92]

There is a 500,000 gallon water storage tank and two new groundwater wells. The town collects water from the Gilbert and Village creeks (some of it untreated). Wales also has a diesel-fired generator that provides electricity, which is managed by the Alaska Village Electric Cooperative (AVEC) and the City of Wales. In 2001, a joint effort between the federal and state governments and local authorities installed two wind turbines north of town to supplement the town's power plant. However, this system is no longer functional. Nearly all residents use a honeybucket haul system for wastewater disposal, although a few houses have plumbing. (A honeybucket is usually a five gallon bucket lined with a plastic bag and fitted with a toilet seat. While inexpensive, residents are required to haul their waste to a disposal site, which can be inconvenient, unpleasant, and possibly unsanitary in the event of spillages.) The school, clinic, and City building all have piped water and septic systems. The monthly charge for honeybucket waste haul is $20.[93]

Figure 2. Port of Wales

Accessibility

Transportation Links

Wales is accessible year-round by plane. Wales Airport (WAA) is a state-owned gravel airstrip immediately northwest of the community that is 3,900 feet long and 75 feet wide. It has no aircraft repair facilities, nor does it have a passenger shelter. The largest aircraft that perform regular flight operations at Wales is the Cessna Caravan and Grand Caravan.[94] There are approximately 435 annual flights from Nome to Wales.[95]

There are regular scheduled and charter flights available to and from Wales via Nome, which also serves as the community's mail hub. The two main air carriers for Wales are Ravn Air and Bering Air. In 2017, Wales enplaned 1,361 passengers and roughly 52,000 pounds of cargo including mail and household items and deplaned 1,433 passengers and 550,000 pounds of cargo.[96] The typical roundtrip cost to fly between Wales and Nome is between $345 and $459.

Residents travel between Wales and Diomede in aluminum or traditional skin boats and skiffs, particularly in the summer, and residents from Diomede travel to Wales by boat for supplies.[97] Wales has a road to Tin City that is six-and-a-half miles long, but there are no road connections to other communities.

Seasonal Constraints

Residents access inland subsistence areas with all-terrain vehicles in the summer and snow machines in the winter. There are winter trails east to Brevig Mission and northeast to Shishmaref.[98]

Port Characteristics

Port Infrastructure

Wales has no formal port facilities. The waters near the beach are shallow, so it is much more efficient for freight barges to land at Tin City, an abandoned mining settlement less than six miles east of Wales that serves as a minimally-manned Long Range Radar Site for the U.S. Air Force. Trucks haul cargo from Tin City to Wales, and then distribute the cargo within the community. Most heavy goods are offloaded in Tin City, but on occasion cargo can be lightered half-a-mile offshore from Wales.

Figure 3. Tin City Infrastructure

Fuel deliveries still occur in front of the community, and the town's various bulk fuel storage facilities hold a total of more than 222,000 gallons of fuel.[99] Given the shallow conditions near the beach, barge operators unload fuel by holding offshore and floating long hoses to nearby fuel tanks. However, harsh weather conditions and nearby shoals make the fueling process a challenge. Barge operators require as many as three stops in order to deliver fuel to the town's various tank farms.[100] A 2009 report by the U.S. Army Corps of Engineers (USACE) showed that barge operators had expressed the need for a centralized tank farm with a single marine header.[101]

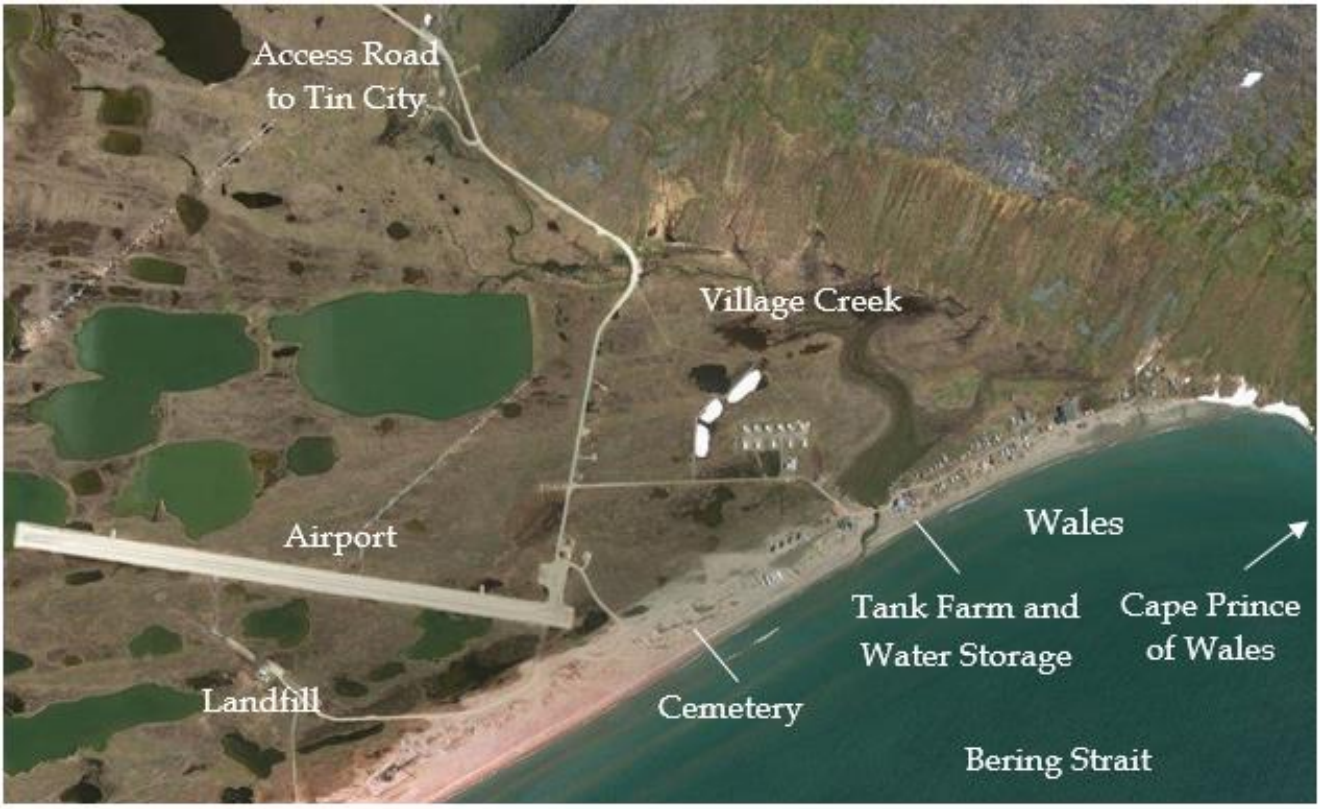


Figure 4. Wales Port Infrastructure

Vessel Count

There is no easily obtainable vessel count information for Wales.

Vessel Characteristics

Shallow draft fuel and freight barges provide marine services for Wales.

Barge Operators

Barge deliveries occur once a year during the summer. A report listed Crowley Marine,[102] Alaska Logistics,[103] and Northland Services as service providers.[104] Lynden, the parent company of Alaska Marine Lines (a key barge carrier in the region), provides marine support services to Wales.[105]

Main Imports/Exports

Wales imports food, fuel, supplies, and materials by barge. The electric company purchases diesel fuel through a bulk fuel purchasing program. Heating fuel is also imported through bulk fuel program and

sold at the Wales Native Store at a price of $6.25 per gallon (as of September 2019).[106] Household goods are flown in.

Local Economy

Major Employers

The population relies heavily on subsistence activity, usually supplemented with part-time wage work, as year-round employment opportunities are uncommon. There are seven active businesses in Wales. There is the Wales Native Corporation which operates a general merchandise store, a commercial and residential leasing company, and a vehicle rental company. The other registered businesses are the Native Village of Wales, which also owns the local native store, and two private businesses: a hotel and a device repair shop.[107] As of 2018, Wales is a designated distressed community, according to the Denali Commission's Distressed Communities Report.[108]

The median individual income in Wales is $17,679 [109] and the unemployment rate is 10.7 percent.[110] The largest industries in Wales are educational services, and health care and social assistance (37.3 percent); public administration (26.9 percent); and transportation and warehousing, and utilities (20.9 percent).[111] A private reindeer herding provides some employment for the community.

Subsistence Activities

As a traditional Kingikmiut whaling community, Wales depends heavily on subsistence activity, and the nearby waters are a productive habitat for a variety of fish, marine mammals, and waterfowl. The town's location at the tip of the Seward Peninsula makes it particularly conducive to catching beluga and bowhead whales, since both species migrate through the Bering Strait each spring and fall. The community also makes use of subsistence harvests from other marine mammals, including walrus and polar bear.

Residents also harvest a number of fish and shellfish, including salmon, trout, tom-cod, white fish, herring, flounder, blue cod, clam, and crab. Hunted land animals and birds include moose, musk ox, caribou, duck, goose, and ptarimagan. They also harvest duck and murre eggs, plants, and berries. A reindeer herd is managed in the vicinity and provides employment for some of the town's residents.[112] Residents will use small boats and skiffs to access hunting and foraging areas. There are no critical habitat areas, refuges, or sanctuaries, nor any known endangered species habitats nearby.[113]

Port Planning and Future Growth

In a 2019 report, the community recommended the construction of a seawall and small boat harbor.[114] Residents report frequent damage to small boats since there is no dock or protected moorage, and are instead required to drag their boats up onto the beach when they are not in use. Residents also expressed interest in a docking facility for barges and cruise ships.[115] It is unclear whether any construction activity has taken place. According to the USACE, Wales is expected to receive full water and sewer system upgrades.[116]

In Wales's comprehensive economic development plan from 2012, Kawerak, the regional non-profit native corporation, argued that coastal protection measures, such as a breakwater, seawall, or rock revetment would protect the community from coastal erosion.[117] With only seasonal barge access, the airport is a critical lifeline for the community. However, a number of flight operations for Wales are cancelled because of heavy winds, so the addition of a crosswind runway would likely help reduce this issue.[118]

Environment

Environmental Justice

Environmental Justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.[119] Consequently, proposed activities need to be mindful of the impact on Alaska Native communities. These communities are usually comprised of low-income and minority populations and are more at risk to experience the negative consequences of global climate change and economic development.

Wales has a strong Kingikmiut Inupiat whaling culture and still practices traditional songs, dances, and other customs. A town report indicated that resident felt the community was struggling to preserve its traditional culture, their native language, and their subsistence lifestyle.[120]

Changing climate conditions and sea ice extent has changed access to certain subsistence foods. After a poor walrus harvest in 2015, Wales, along with three other communities in the Bering Sea region, made economic disaster declarations due to shortages of food.[121]

These issues can be discussed with residents and representatives of the Wales community. The contact information for the Native Village of Wales can be found at https://kawerak.org/our-region/wales/.

Water/Air Quality

Residents retrieve treated water from the water storage tank at the washeteria, though some practice traditional water sourcing and retrieve untreated water from Village Creek.

Natural Resources Available

There is no readily available information on natural resources in the immediate vicinity of Wales, although nearby Tin City was a tin mining site in the early 1900s. The mine appears to be inactive. According to the Alaska Department of Environmental Conservation, however, there is an active contamination site (linked to diesel fuel) at Tin City. The extent of contamination is unknown.[122]

Effects of Climate Change

The natural barrier of sea ice that has protected the community in the past has diminished. Storm surges and wave action from strong winds are the main sources of flooding for Wales. And with the exception of a few outlying buildings near the Cape, the entire community lies within a 100-year floodplain.[123] Coastal erosion due to storm and tidal surges is also a concern for Wales.

Northwest Arctic Borough

Ambler, Shungnak, and Kobuk

Overview

Location

Kobuk, Shungnak, and Ambler are all located along the Kobuk River. Kobuk is located on the right bank of the rivers, Shungnak on the west bank, and Ambler on the north bank. Kobuk is the smallest village in the Northwest Arctic Borough.[124] All three ports are a part of the Northwest Arctic Borough.

Kobuk encompasses 16.1 square land miles and 0.7 square water miles.[125] Kobuk is about 7 miles northeast of Shungnak and 128 air miles northeast of Kotzebue.[126] Kobuk is in the Kotzebue recording district at latitude 66°55′3″N and longitude 156°54′25″W. Shungnak encompasses 8.4 square land miles and 1.3 square water miles. Shungnak is located on the west bank of the Kobuk River, about 150 miles east of Kotzebue. The original settlement was 10 miles further upstream at Kobuk.[127] It is located at latitude 66°53′9″N and longitude 157°8′15″W. Ambler encompasses 9.5 square land miles and 1.3 square water miles. Ambler lies 45 miles north of the Arctic Circle, in a Transitional Climate Zone (TCZ). It is 138 miles northeast of Kotzebue, 30 miles northwest of Kobuk, and 30 miles downriver from Shungnak.[128] It is located at latitude 67°05′06″N and longitude 157°51′37″W.

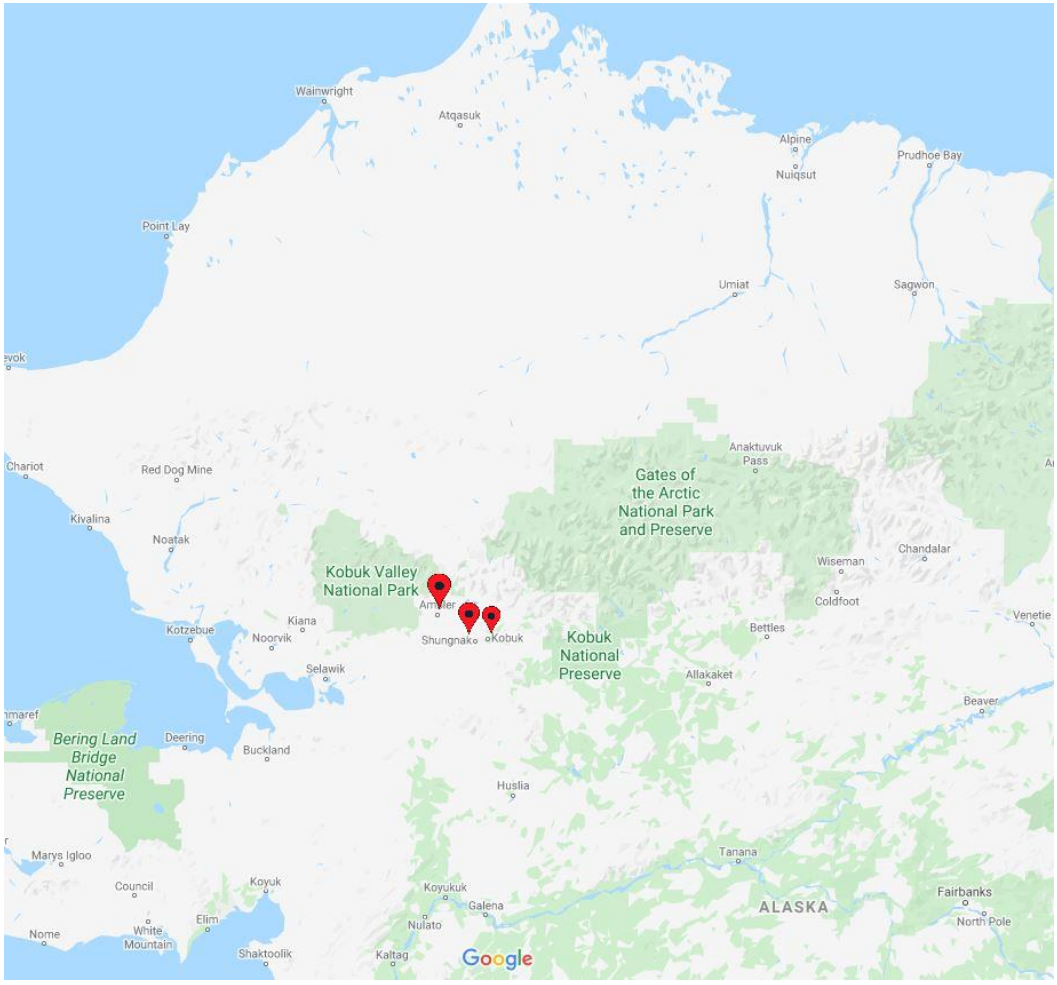


Figure 1. Ambler, Shungnak, and Kobuk

Demographics

The population of Kobuk, Shungnak and Ambler are 144[129], 274[130] and 287[131], respectively. Median household income in Kobuk port is $48,750 and 97 percent are American Indian or Alaskan Native.[132] Median household income in Shungnak is $40,833 and 85 percent are American Indian or Alaskan Native. Median household income in Ambler is $41,429 and 95 percent of the residents are American Indian or Alaskan Native.[133]

	Ambler	Shungnak	Kobuk
Location	67°05′06″N 157°51′37″W	66°53′9″N 157°8′15″W	66°55′3″N 156°54′25″W
Area (mi²)			
Land	9.5	8.4	16.1
Water	1.3	1.3	0.7
Demographics			
Median Income	$41,429	$40,833	$48,750
Population Size	287	274	144
Native Alaskan	95%	85%	97%

Table 1. Ambler, Shungnak, and Kobuk Summary Table

Figure 2. Port of Kobuk

Figure 3 Port of Shungnak

Figure 4. Port of Ambler

Climate/Weather

All three have similar climates, with temperature averages of -10 to 15 degrees Fahrenheit during the winter and 40 to 65 degrees Fahrenheit in the summer.[134] Kobuk is located in the transitional climate zone. Snowfall averages 56 inches, with 17 inches of total precipitation per year. The Kobuk River is navigable from the end of May through October, if the water levels are high enough.[135]

Shungnak temperature extremes have been recorded from -60 to 90 degrees Fahrenheit. Snowfall averages 80 inches, with 16 inches of total precipitation per year. The Kobuk River is navigable from the end of May to mid-October.[136]

Ambler receives up to 80 inches of snowfall, and the river is free of ice from early July to mid-October. Ambler falls within the arctic climate zone, characterized by seasonal extremes in temperature. Winters are long and harsh, and summers are short but warm. The Kobuk River is navigable from early July to mid-October.[137]

Municipal Utilities & Services

A 30-foot well provides water, which is treated and hauled from the self-serving laundry business, which has its own septic tank. Kobuk Valley Electric Co-op purchases power from Alaskan Village Electric Corporation (AVEC) over a power line that connects Kobuk with nearby Shungnak. Shungnak has water pumped from a reservoir to a 200,000-gallon storage tank. Piped water and sewer is provided to approximately 60 percent of homes, the clinic, school and community building. A new city waste site and landfill has recently been completed. Ambler's main source of water comes from a well near the Kobuk River. Water is pumped 940 feet to the treatment facility and stored in a 210,000-gallon insulated tank, then piped to 57 homes currently served by the water and sewer system.[138]

Accessibility

Transportation Links

There are no main roads through the towns, other than the one road connection from Kobuk to Shungnak. Local transportation is also achieved with all-terrain vehicle (ATV) and snow machines. Most services, including shipments and transportation, are done by flight.

Kotzebue is the hub for the Northwest Arctic borough, where daily flights are offered to and from Kotzebue to the ports. With a paved primary runway, an unpaved crosswind runway, and an unofficial float pond, Kotzebue accommodates commercial, general aviation, and military aircraft.[139] The main airliner used is RavnAir Group, which services all three airfields. Bering Air also services these towns. From Kotzebue, typically the aircraft to perform routine flights to and from the three ports are the Cessna (light).[140]

The three towns have individual airports. The characteristics of each airport are similar in size and each have gravel runways. The airports provide a necessary service due to low water levels for most of the year. Kobuk has two airports in the town's vicinity.

Kobuk airport (OBU) is located right outside the town, with a runway of 4,020 feet by 75 feet. Dahl Creek Airport (DCK) is located approximately 4 miles north of Kobuk with runway of 4780 feet by 75 feet. The airfields are state-owned and has lightly graveled airstrips. It is accessible by Dahl Creek Road traveling north from Kobuk.[141] Shungnak Airport (SHG) is located directly outside of Shungnak.[142] Its runway is 4001 feet by 60 feet. Ambler Airport (AFM) is locate just outside of

Ambler[143], and has a runway of 4000 feet by 60 feet. Float planes can access the Kobuk River when necessary.

Seasonal Constraints

Barge operators have stated they can only access these ports when the water level on the river is at an above average level. Small boats, however, can travel whenever the river is not frozen over.

Port Characteristics

Port Infrastructure

Barge landings are not found on any of the three ports. Any barge that wants to land must do so on the beach. Reaching these ports proves difficult and often are only accessible during specific times of the year, when the river is at an above average water level. Small boats are usually launched from the beach for travel.[144]

Kobuk

The primary barge landing area in Kobuk is on the upriver end of the community, where the airport road intersects the town. Other landing areas are on a wide beach about 1000 feet downriver. Reports from barge operators state that the sites appear to be in decent condition. However, the upriver landing site could be widened and mooring points are needed.[145]

Figure 5. Aerial Perspective of Kobuk

Shungnak

There is a 70-foot cliff along much of the shoreline of the Shungnak community, except at the barge landing areas. The landing areas floods each year. Upriver, there is a marine fuel header, which marks the primary barge landing area. There is another barge landing at the downriver end of the community, where there is a gravel ramp that extends out into the river. This area has a sand bar in front of it, and can only be accessed during very high water periods. Barge operators indicate that mooring posts and dedicated staging area are needed in this community.[146]

Figure 6. Aerial Perspective of Shungnak

Ambler

Ambler has a landing area on the beach. A cliff drops 30 to 40 feet down to the beach, and then changes from low lying beaches to the water gradually. The landing areas flood each year. The fuel barge landing is downriver, near a marine fuel header.[147]

Figure 7. Aerial Perspective of Ambler

Vessel Count

There is no available information about vessel count in these communities.

Vessel Characteristics

Barge operators have reported difficulty servicing these communities. Reports have stated barges can

only access upper parts of the Kobuk River when the water is above average in level. Typically, they can commute up there once every year or two, using barges operated by Crowley Marine Services. Crowley operates two river class tugs: Aku and Toolik River as well as six river barges: Riverways 8, Napamute, Oiler 1, Eek, 120-1, and 120-2.[148]

Barge Operators
Crowley Marine Services operates in these communities.

Main Imports
Crowley Marin Services mainly transport fuel and supplies whenever they have the ability to reach these communities.[149]

Local Economy

Major Employers
The economy of these three communities are limited. The economy of Kobuk is based on subsistence hunting. Whitefish, caribou and moose provide the majority of meat sources. Cash employment in Kobuk is limited to the school, city government, and Maniilaq clinic. Seasonal construction and Bureau of Labor Management (BLM) firefighting provide some income.[150]

Shungnak subsists mainly on fishing, seasonal employment, hunting, and trapping. Subsistence food sources include sheefish, whitefish, caribou, moose, ducks, and berries. Most full-time employment is with the school district, city government, Maniilaq Association, two stores, and the Kobuk River Lodge. BLM provides seasonal employment in firefighting, hiring over 30 residents each year. Shungnak also has a handcraft industry where residents make and sell finely-crafted baskets, masks, mukluks (boots), parkas, hats, and mittens. The community wants to develop a visitor center, mini-mall, post office, and health clinic complex at Dahl Creek.[151]

In Ambler, cash employment is limited to the school, city clinic, local stores, and some mining which include copper, zinc, silver, gold, and lead. Subsistence is a major part of the local economy. Birch baskets, fur pelts, jade, quartz, bone and ivory carvings are exported and sold in gift shops throughout the state. Ambler's major means of transportation are by barge, plane, small boat and snow machine. Boats are used for inter-village travel and subsistence activities. ATVs and snow machines are commonly used in winter.[152] Two stores sold groceries, clothing and other necessities.[153]

Subsistence Activities
Depending on the season, subsistence activities may vary because of timing of the resource availability. In spring, residence largely hunt caribou, especially in the months of March and April, because caribou become much less populated once spring passes. From April, residents hunt mainly birds, especially geese and ducks. Historically, residents harvested eggs from these birds, but that trend has declined in current years. In May, hunters may combine hunting birds, beavers and muskrats as well. Bears are hunted after they emerge from their dens in the spring.[154]

Once spring progresses into summer, river ice begins to breakup and fishing becomes a main focus because of the river breakups. Whitefish is the first to be sought. Sheefish arrive in July, and they are harvested with rod and reel as well as set nets and seines. Salmon don't begin to populate the river until late July or early August. In the late months of summer, focus shifts to vegetation as the salmonberries (*rubus spectabilis*) begin to ripen.[155]

In the fall months, hunters target large game including caribou, moose, and bears. Once the ice hardens over, residents place nets under the ice to target broad whitefish, while others set burbot traps for ice fishing. The latter months of the year are prime months for jigging through the ice. Jigging is a practice of fishing with a special type of fishing lure, a jig. Jigging is one of the main subsistence activities in late winter and early spring. Hunters will also target wolves in the winter and some none migratory birds.[156]

Port Planning and Future Growth

Shungnak and Kobuk have a road connection to each other, but Ambler is isolated.[157] There has been a push to develop a road that would access the Ambler mining district, home to several known large prospective mining companies including Arctic, Bornite, Sun and Smucker and enable further exploration and development of the area's resources, providing economic development.[158] The Alaska Industrial Development and Export Authority (AIDEA) proposed to construct a 211-mile long gravel access highway in the southern Brooks Range foothills to provide industrial access to Ambler mining district.[159] This road would be available all seasons, but primarily intended to facilitate for transportation for the mining industries.

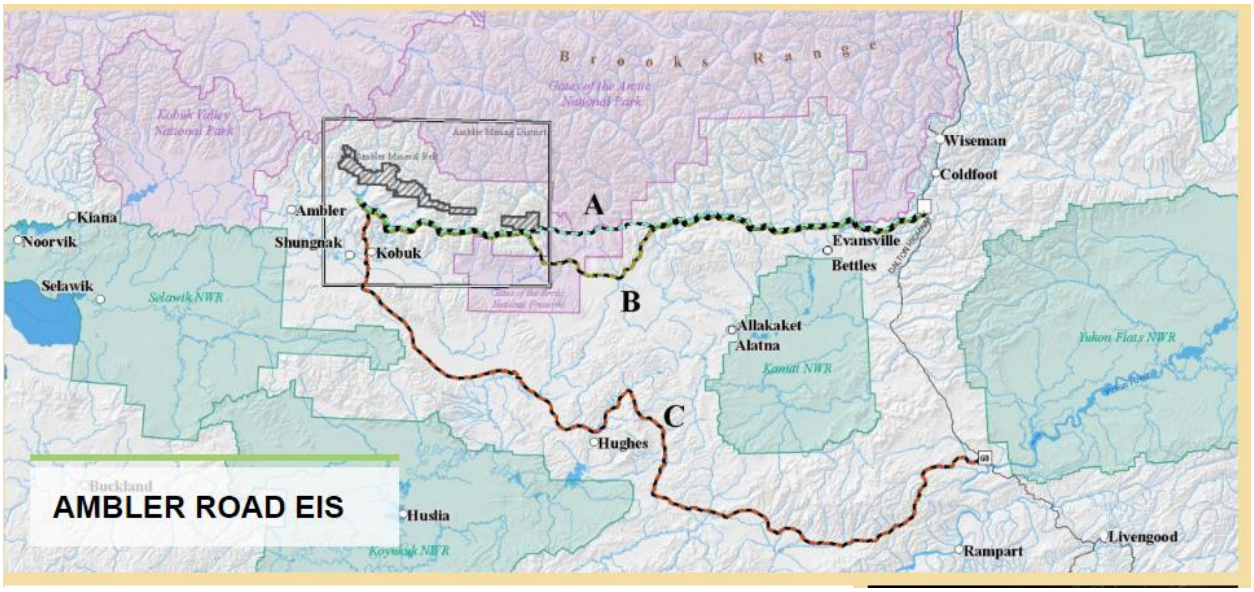


Figure 8. Ambler Road

Environment

Environmental Justice

Evidence suggests that native Alaskans are adversely impacted by the threat of climate change due to their location geographically and their poverty rates. Climate change and pollution put their food supplies, travel routes, supply routes, culture and life at discriminatory risk. Any proposed activities or future growth planning should take these issues into account. These issues should be further discussed by natives and representatives of the Kobuk, Shungnak and Ambler communities. Miles Cleveland Sr. is the current representative on Seat D of the communities can be contacted via the website www.nwabor.org/assembly/members.[160]

Natural Resources

There is no readily available information on natural resources in these three communities.

Water/Air Quality

In an article from Alaska Public Media, the author writes these communities have trouble keeping their water tanks clean and unfrozen. The Community Utility Assistance Program (CUAP) was put in place in 2018 to help alleviate these issues. Reducing water system emergencies and ensuring local operators are well trained are the main goals of this program. "The program is a partnership between the borough, Alaska Native Tribal Health Consortium and Maniilaq Association to bring local communities in compliance with state criteria for water utilities," the author explains. Most of the villages have said they have little trouble complying with the new requirements of the program.[161]

Effects of Climate Change

These three communities are a part of the NANA Regional Corporation (NANA). NANA is entitled to 2.2 million acres. These regions are remote, and have higher costs for goods and services such as fuel. There has been a desire to introduce alternative energy resources, both renewable and non-renewable. These regions seek a 10 percent reduction of imported diesel fuels by 2020, 25 percent by 2030, and 50 percent by 2050, and will accomplish their goals by receiving grants from the Department of Energy (DoE) to install solar arrays.[162] These developments have been awarded $1M to install these arrays in Deering, Buckland and Kotzebue.[163] NANA also received a High Energy Cost grant for $1.6M, in order to install storage batteries and controls.[164]

Other environmental concerns involving the ports revolve around the effects of climate change on the Kobuk River. The river is a valuable resource for these communities and provides transportation and subsistence activities. Residents have hunted, fished and lived along the Kobuk River for at least 12,500 years. Warming temperatures have caused various issues for the river, which impacts these communities.[165] Warming weather makes ice travel more hazardous, causing the ice traveling season to shorten.

There has also been more permafrost thawing. These increased temperatures will lead to more erosion and sediment load. Reduced water clarity and increased fine-grain material could make the river less favorable as a spawning ground for sheefish.[166]

Warming also impacts the river characteristics. The river is becoming wider and more turbid. A study predicted substantial impacts to fish and invertebrate populations because the breakups have been more severe in recent years. Thawing is causing bank erosion. In 2011, severe erosion near a camp lost an estimated 30 feet of river bank. This can effect barge landing and docking areas.[167]

Wildfires related to hot summers have also increased in nearby communities along the river. This causes and increase in risk of repertory ailments. The wind carries the smoke throughout these communities, which increases the range of wildfire risk.[168]

Caribou is an important subsistence species, and the warming of the climate is directly impacting hunting habits. There has been an increase in hunting costs, as hunters need to spend more time by travel further to meet their needs. Traditional sources of food may become contaminated with disease –causing pathogens and climate-driven invasive species. Boiling or use of filters are recommended to treat such risks.[169]

Buckland

Overview

Location

Buckland is located on the west bank of the Buckland River, about 75 miles southeast of Kotzebue. Buckland is in the Cape Nome Recording District, part of the Northwest Artic Borough. Buckland is at latitude 65°59′5″N and longitude 161°7′47″W. Buckland encompasses 1.2 square land miles and 0.2 square water miles; 97 percent its population are Alaska Native.[170]

Figure 1. Buckland

Climate/Weather

Buckland is in the arctic climate zone, where seasons are characterized in extreme temperatures, from -60 to the 85 degrees Fahrenheit. Winters are long and harsh and summers are short but warm. The annual precipitation averages 9 inches, and the annual snowfall averages 40 inches.[171] Crosswinds can restrict flying during the winter.[172]

Demographics

The population of the town is around 511.[173] The median household income is $44,750.[174]

Municipal Utilities & Services

Water is pumped from the Buckland River through a 300-foot insulated transmission line, treated in the washeteria, and stored in a 100,000-gallon insulated tank. A flush haul system is currently under construction in Buckland, which includes household water, waste holding tanks, and complete plumbing. As of this writing, 36 homes have new flush haul systems, 46 homes still use honeybuckets, and 5 homes are connected to the school's piped system. Honeybucket bunkers are emptied once a week by the city. The school is connected to the washeteria system and has full plumbing. Residents dispose of refuse in dumpsters placed around Buckland. City workers periodically empty the dumpsters in an Alaska Department of Environmental Conservation approved landfill. The Kotzebue Electric Association supplies Buckland with electrical power via diesel generators.[175]

Figure 2. Port of Buckland

Accessibility

Transportation Links

Buckland has a state-owned gravel airstrip known as BVK, which serves a number of flights to Kotzebue. The Buckland runway has dimensions of 3200 feet by 75 feet and is managed by Alaska Department of Transportation. Pilots remark in the summer crosswinds create challenging turbulent conditions. Planes also require an altitude correction when temperatures fall below -33 degrees Fahrenheit, so flights can also be limited in the winter.[176]

When flying to BVK, the most common direct connection is to Ralph Wien Memorial Airport in Kotzebue, about a 30 minute flight, and RavnAir Group and Bering Air are the most commonly used airlines. These flights operate regular passenger and cargo flights to the village of Buckland.[177] BVK airport averages 81 flights per week.[178]

There are no main roads that connect Buckland to other nearby communities. There are, however, a series of trails that connects Buckland to Deering (40 miles), and Buckland to Selawik (50 miles).[179] Residents will also travel overland to reach subsistence hunting grounds by vehicle or snow machine, depending on the season.[180]

Seasonal Constraints

Access to Buckland is limited. Barges can only access the town at high tide. Barge operators pointed out there are big rocks in the water, and some will hire a local pilot to help navigate around them. Landing at the community is made more difficult because barge operators have to wait for local boat owners to relocate their boats, which are moored all along the beach at the landing site. According to freight barge operators, a dedicated landing site and staging area would help increase operational efficiency.[181]

Figure 3. Port of Buckland

Port Characteristics

Port Infrastructure

The port has a marine fuel header. However, barge operators avoid landing in front it because of nearby hazards. Instead operators land upstream where there is a bend in the river. Long hoses are run up the beach to access the header. The upstream area is also difficult to navigate because the river is narrow; a 250-foot barge almost takes up the entire width of the river. Barge operators say installing mooring points would be helpful, but otherwise, they had no recommendations for improving the landing facilities at Buckland.[182]

There have been proposed locations for gravel ramps and two possible upland staging area options. Before development, a site assessment will be needed to confirm existing site conditions prior to a final design. Potential hazards include rock hazards that can't be easily removed. If these proposed sites are not feasible, mooring points should be installed at the existing landing area and relocating the marine header should be considered.[183]

Vessel Count

There is no available information on vessel count in this community.

Vessel Characteristics
Crowley Marine Services barges in fuel and various lighterage companies deliver cargo and supplies each summer.[184] Crowley operates two river class tugs: Aku and Toolik River as well as six river barges: Riverways 8, Napamute, Oiler 1, Eek, 120-1, 120-2.[185]

Barge Operators
Crowley Marine delivers cargo and supplies to these communities.[186]

Main Imports
The main imports in these communities are food, fuel and other general supplies.

Local Economy

Major Employers
Buckland is an Inupiat village, and has a small economy based around subsistence lifestyle. Their top employers are the Buckland School, Buckland Clinic, Maniilaq Association, and Buckland Council City Office. Buckland also has nine active business licenses. Buckland has two stores, a village clinic, community hall, city council, city administrator, police officer, magistrate, a volunteer fire department, and a school serving grades K-12.[187] Buckland School, built in 2004,[188] is a part of the Northwest Arctic Borough school system, and has 189 students.

Buckland employs 133 people, the largest industries which are educational services, public administration and health care, and social assistance. The highest paying industries are utilities, construction, and transportation. The median household income in Buckland is $41,932, and in 2017, full-time male employees in Alaska made 1.35 times more than female employees. The average male salary was $68,424, and the average female salary was $50,667.[189] There is also a school that employs around 14 teachers and combines elementary, middle, and high school.[190]

A herd of over 2,000 reindeer are privately managed, and employees are paid in meat. The village is also interested in developing a Native food products and crafts manufacturing facility to produce reindeer sausage, berries, ivory, wood carvings, and Labrador tea.[191]

Buckland is a part of the NANA Regional Corporation, a for-profit corporation that serves 11 villages and more than 7,500 people to manage the surface and subsurface rights of approximately 2.2 million acres of land.[192]

Living in this region is four times more expensive than living in Anchorage. Transporting diesel fuel by flight increases the cost by $2 per gallon. One suggestion to cut diesel fuel costs would be to tap into renewable resources for energy production. While reducing the cost of fuel is the primary driver, developing renewable resources can also create more jobs for the community.[193]

Subsistence Activities
The population of Buckland relies heavily on a subsistence lifestyle, as most households in Buckland use and harvest at least one kind of subsistence food. The most common subsistence foods are fish and plants; the least common subsistence food is shellfish, due to the limited availability. Hunting marine mammals is a specialized trait that usually requires a considerable amount of skill. Only about one-third of households harvest marine mammals.[194]

Unlike most other communities in northwest Alaska, who rely on whitefish and salmon, Buckland harvested mainly rainbow smelt. Buckland also harvests multiple Pacific salmon species: fall chum salmon, Chinook and Coho salmon are most harvested. Seines and dip nets accounted for most used gear to harvest fish. Shellfish are harvested by a very small number of households, and of that, king crab was the most harvested shellfish.[195]

Caribou and bearded seal contributed the most subsistence food than any other category.[196] Muskoxen, furbearers, wolves, wolverines, beaver, snowshoe hare, arctic hare, and porcupine were also harvested. Of the marine mammals hunted, bearded seals were by far the most harvested.[197]

Birds and eggs are harvested, but not in large quantities. Migratory birds like white-fronted geese and resident birds like willow ptarmigan are harvested by the community to add to their diet.[198]

The community also harvests vegetation, and the most commonly harvested foods include berries, Eskimo potato, and other greens.[199]

Port Planning and Future Growth

Not much is known on future plans for the community. If the community grows, a dedicated barge landing and upland staging area would be considered necessary according to barge operators.

Environment

Environmental Justice

Evidence suggests that native Alaskans are adversely impacted by the threat of climate change due to their location geographically and their poverty rates. Climate change and pollution put their food supplies, travel routes, supply routes, culture and life at discriminatory risk. Any proposed activities or future growth planning should take these issues into account. These issues should be further discussed by residents and representatives of Kobuk, Shungnak and Ambler communities. Kirk Oviok is a representative on Seat E of the Northwest Arctic Borough council and can be contacted via the website www.nwabor.org/assembly/members.[200]

Water/Air Quality

In an article from Alaska Public Media, the author writes these communities have trouble keeping their water tanks clean and unfrozen. The Community Utility Assistance Program (CUAP) was put in place in 2018 to help alleviate these issues. Reducing water system emergencies and ensuring local operators are well trained are the main goals of this program. "The program is a partnership between the borough, Alaska Native Tribal Health Consortium and Maniilaq Association to bring local communities in compliance with state criteria for water utilities," the author explains. Most of the villages have said they have little trouble complying with the new requirements of the program.[201]

Natural Resources Available

The Koopuk Creek Gold Mine is near Buckland and is a part of the Selawik Mining District but has been closed indefinitely.

Effects of Climate Change

Climate change has been impacting Buckland and the surrounding area. In 2007, the U.S. Army Corps of Engineers (USACE) wrote an assessment of the erosion surrounding Buckland, and found that in part due to melting permafrost, natural river flow, flooding, and ice jams, the banks of the Buckland River have also been quickly eroding three and a half to five feet of bank erodes every year according

to the report. Estimates say that within 30 years, starting from 2002, erosion would impact the town post office, several homes, and the access road to a subdivision of the town.[202]

Climate change has also put pressure on the food security of the Buckland community. Caribou is an important resource for the subsistence lifestyle practiced by the people of the region. Major herds of caribou have been in decline, making them scarcer and harder to find for the people who rely on them as a food source. From 2011 to 2013, one major caribou herd lost about 27 percent of its caribou, and the decline is thought to be the result of winter thaws, rain, and ice.[203]

Deering

Overview

Location

Deering is a small city along the northern coast of Alaska's Seward Peninsula. Located at latitude 66° 4′ 33″ N and longitude 162° 43′ 6″ W, the town occupies a flat, narrow spit half-a-mile long and 300 feet wide between Kotzebue Sound to the north and the Inmachuk River to the south. The town is 57 miles southwest of Kotzebue.

Demographics

The town was established in 1901 as a supply station for inland gold mining operations. Today, Deering has 168 inhabitants.[204] The median household income is $43,750, the median property value is around $62,000, and the median age is 27.3 years old.[205,206,207] The population is 92 percent Alaska Native.[208] The local economy depends on cash income and subsistence activities.

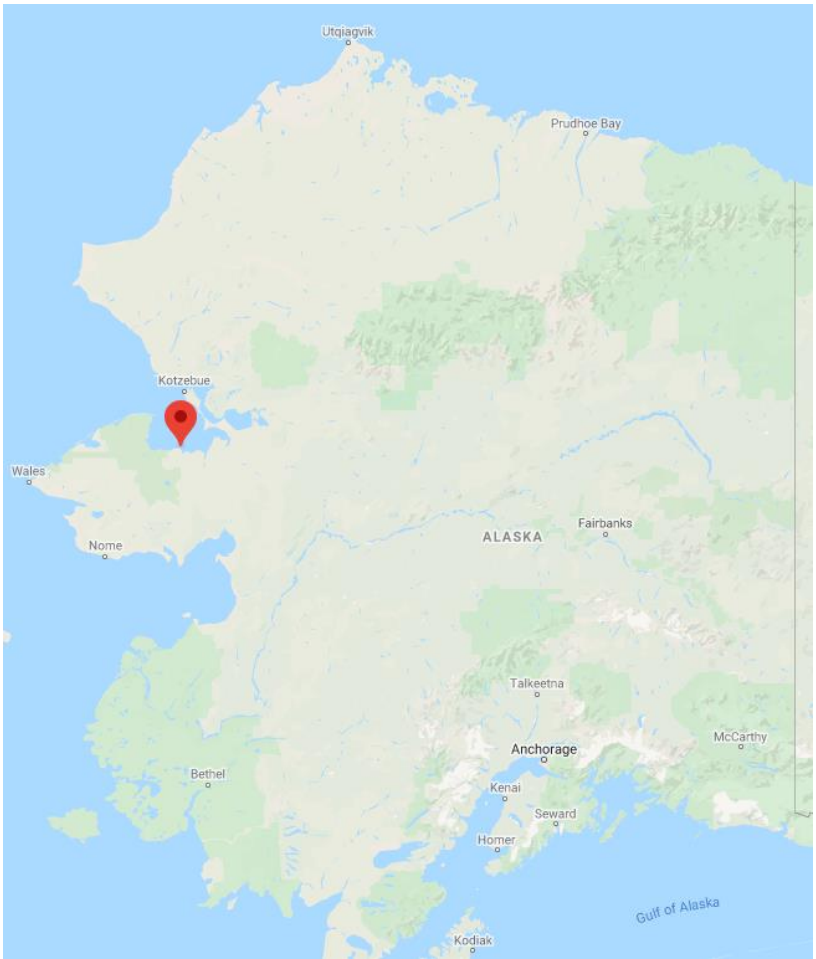


Figure 1. Deering

Climate/Weather

Deering has a transitional climate with long, cold winters and cool summers, with temperatures ranging between -18 and 63 degrees Fahrenheit[209], and prevailing westerly winds. The community averages 9 inches of precipitation, including 36 inches of snow per year. The sea around the town is usually free of ice from early-July through mid-October.

Municipal Utilities & Services

A state-owned gravel airport a mile southwest of Deering provides year-round access to the community. Residents have access to a watering point and water delivery. There is a diesel-fueled power plant, a water treatment facility and potable water storage tank with a capacity of 400,000 gallons.[210] In 2013, the water treatment plant was outfitted with photovoltaic (PV) arrays to harness solar energy.[211] The village also has a landfill and sewage lagoon northwest of town and a vacuum sewer line system to draw wastewater into the sewage lagoon.[212] The vast majority of residents do not have internet access.[213]

Figure 2. Port of Deering Looking East

Accessibility

Transportation Links

Deering is only accessible year-round by plane via Deering Airport (DEE). The airport has two airstrips, one 3,320 feet long by 75 feet wide, and the other 2,660 feet long by 75 feet wide. There are roughly 67 weekly flight operations.[214] In 2017, the airport enplaned and deplaned 1,536 and 1,558 passengers, respectively, and residents sent 71,897 pounds and received 367,351 pounds of freight and mail air cargo.[215]

The two main air carriers that provide flights to and from Deering are Ravn Air[216] and Bering Air.[217] These flights go through Kotzebue, which serves a transportation hub for the region. A typical roundtrip between Kotzebue and Deering (despite being a short one-way distance of 57 miles) costs between $257 and $342.

Local transportation options include small boats, ATVs, and snow machines.

Seasonal Constraints

Deering only has seasonal land transportation access. There are winter trails connecting the village to Candle and Buckland.

Port Characteristics

Port Infrastructure

Deering has no port and only seasonal access to marine services. There are annual fuel and cargo deliveries from Kotzebue.[218] Residents use the beachfront for a variety of activities, such as launching and landing small boats, processing harvested foods, and for community and cultural events.[219] There is a shallow shelf below the surface that restricts landings along portions of the shoreline. Barge operators have remarked that waters near the shore along the southeastern part of town are deeper and therefore more conducive to offloading cargo. Barges land at high tide and have to offload quickly or wait for high tide to return in order to leave, depending on the amount of cargo to be offloaded. With no tank farm, fuel deliveries cannot be completed in one high tide.[220]

In the summer of 2017, the Denali Commission partnered with the U.S. Army Corps of Engineers (USACE) to install mooring points at a number of Northwest Arctic Borough (NAB) communities, including Deering, to allow for safer and more efficient offloading of cargo and fuel.[221] USACE also constructed two revetments behind the community along the airport access road near the banks of the Inmachuk River.[222] In 2017, these revetments were reported to be in good condition.

Figures 3 and 4. Revetments Along Airport Road

Vessel Count

There is no easily obtainable vessel count information on Deering.

Vessel Characteristics

Shallow draft fuel and freight barges provide marine services to Deering.

Barge Operators

- Alaska Marine Lines (AML) provides marine support services to Deering.[223]
- Crowley Marine delivers fuel to Deering.[224]

Main Imports

Deering imports a number of commodities by barge, including:

- Fuel;
- Groceries;
- Construction materials;
- Vehicles; and
- Household goods.

Delivery costs for an automobile is $7,017; household goods, $14,735 for a 20 foot container with a minimum weight of 10,000 pounds; and groceries, $1,690 for a 1,500 pound pallet.[225]

Figure 5. Deering Port Infrastructure

Local Economy

Major Employers

Like most other communities in the study area, residents in Deering depend largely on cash income and subsistence activities. The town has a Native Store, a post office, health clinic, K-12 school, community hall, and washeteria. The community's largest employers are the Ipnatchiaq Electric Company, the local school, the health clinic, and the Maniilaq Center. There are six active registered businesses.[226] The largest share of employment takes place in the following industries: educational services, health care, and social assistance (41.3 percent); transportation and warehousing, and utilities (17.4 percent); public administration (15.2 percent); followed by retail trade (8.7 percent) and other services, except public administration (8.7 percent).[227]

The unemployment rate is approximately 19.3 percent[228], and roughly 14.9 percent of the city's population live below the poverty level.[229] The median individual income in Deering is $30,000,[230]and the Alaska Permanent Fund payments makeup a significant portion of unearned income.[231] The cost of a gallon of gasoline and heating oil is $4.38 and $3.35, respectively.[232]

Subsistence Activities

According to NWABOR's Subsistence Mapping Project, harvested marine mammals include bearded and spotted seals, beluga whales, and walruses. Residents also fish for burbot, char, cod, grayling, salmon, sheefish, smelt, trout, and whitefish. Harvested terrestrial animals include caribou, brown bear, fox, lynx, moose, muskox, river otter, reindeer, wolf, and wolverine.[233] Residents also hunt a number of species of birds and waterfowl along the coast from east of the Kiwalik Lagoon to the northernmost part of the Seward Peninsula and inland at Imuruk Lake, including brant, duck, specklebelly goose, ptarmigan, and swan. Residents identify fish, caribou, berries, and seals as the most important subsistence resources for the community.[234]

Subsistence harvesters will travel farther from shore during the spring and summer months to hunt for beluga whales, walruses, and bearded and spotted seals throughout the Kotzebue Sound region. During the fall and winter, residents will only harvest seals and walruses close to Deering. In the winter especially, this activity is limited to the area between the Kiwalik Lagoon in the east and the mouth of the Goodhope River in the west.[235]

Figure 6. Important Subsistence Areas near Deering

Caribou hunting occurs year-round but is most prevalent during the winter months. In the winter, hunters may travel as far as 70 miles inland to hunt caribou. A 2011 study found that in a one-year period from June 2007 to May 2008, Deering residents harvested 24,000 pounds of caribou meat, or approximately 162 pounds of meat per resident.[236]

Residents in Deering adapt to changes in harvests by relying on an extensive network of sharing and reciprocity within and between extended families. The dynamic exchange process helps mitigate the risks from uncertainty regarding subsistence harvests.[237]

Figure 7 depicts Deering's subsistence area and concentration of harvest activity for marine mammals, fish, terrestrial animals, and birds. Nearby areas important to subsistence throughout the year are the waters between Deering itself and the Eschscholtz Bay, especially near Kiwilik Lagoon, and the mouth of the Nugnugaluktuk River to the west.[238]

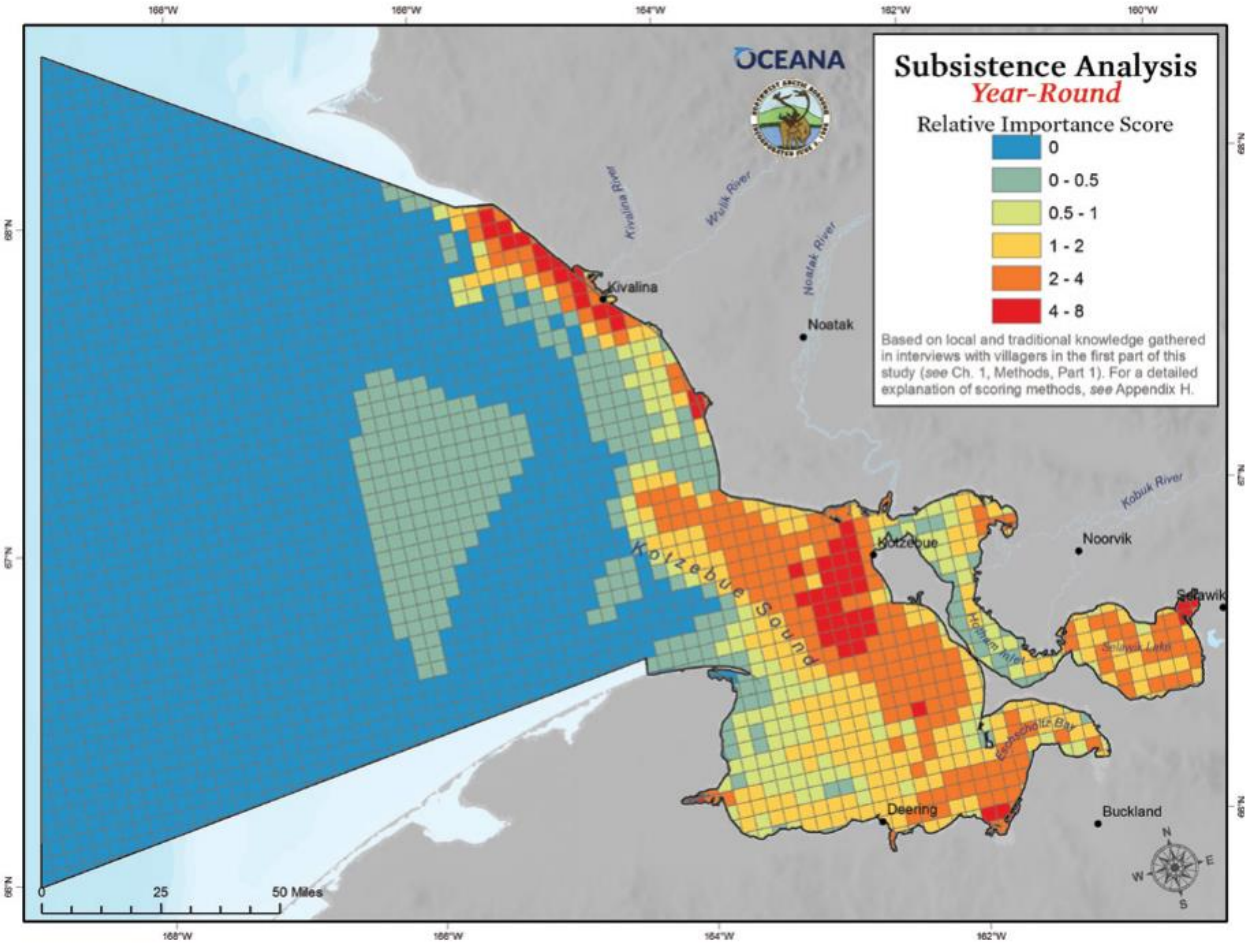


Figure 7. Important Subsistence Areas in Kotzebue Sound (Year-Round)

Port Planning and Future Growth

There are no population projections for Deering specifically. In a 2009 USACE report, barge operators suggested that the community needs a larger staging area. A small area of 5,000 square feet exists near the mouth of the Inmachuk River, which is close to the preferred landing site. However, most of the surrounding area lying above the high tide line is private property.[239] These operators also recommended a rock and gravel causeway to allow barge access for a longer period of time. However, USACE felt such a structure would be undesirable unless there were coastal protection measures in place, like a breakwater, to shield the causeway from wave action. USACE suggested a gravel or concrete ramp could make it easier for loaders to haul offloaded cargo up the beach and into the community.[240] However, no such improvements appear to have taken place.

The NANA* Regional Corporation (NANA), a native for-profit corporation based in Kotzebue, set energy goals to reduce the region's reliance on diesel fuel by 50 percent by 2050. To do so, the regional communities would shift power generation to a hybrid system that runs on wind, solar, battery, and diesel power. In 2016, the U.S. Department of Energy (DOE) gave a $1 million grant to co-fund a project that would bring containerized solar PV arrays to Deering, Buckland, and Kotzebue.[241] Deering used the Village Economic Development Committee (VEDC) funds and contributions from NANA to cover its share of the project. The installation of these solar arrays in Deering was scheduled for September and October of 2019.[242] It is unclear, at this time, whether the solar array installation has been completed. Additionally, the State of Alaska (SOA) funded the construction of a wind turbine in the village. The U.S. Department of Agriculture (USDA) gave Deering and its sister village Buckland a $1.6 million grant to install a battery and control systems to optimize their use of alternative energy.[243] Deering experiences flooding during spring thaw and during fall storm surges, and the airport access road is subject to yearly flooding. Deering's residents have voiced concerns that the south side of the community adjacent to Smith Creek and the Inmachuk River lacks protections against riverine erosion.[244] The community identified beach landing areas that are eroding, and that there may be need for additional coastal protection.[245]

Environment

Environmental Justice

Environmental Justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.[246] Consequently, proposed activities need to be mindful of the impact on Alaska Native communities. These communities are usually comprised of low-income and minority populations and are more at risk to experience the negative consequences of global climate change and economic development.

There is the former Utica gold mine located 18 miles upriver from Deering along the Inmachuk River that is an active contaminated site. There is a gravel road that connects the town to the mining camp. Deering residents use the Inmachuk River for drinking water and for subsistence fishing. In 2005, the Alaska Department of Environmental Conservation (ADEC) conducted an assessment of the area and found elevated levels of metals in the soils at the site, including mercury, lead, silver, cadmium, barium, chromium. ADEC found other toxic chemicals, such as Diesel Range Organics (DRO), Residual Range Organics (RRO), arsenic and selenium at the site. There are also drums containing unknown substances.

In June 2020, ADEC held a teleconference with representatives from the Maniilaq Association regarding the Utica site's history, current status, and to discuss steps for moving forward. The steps forward included "continuing stakeholder coordination, updating the status of site cleanup records, and evaluating and prioritizing any ongoing protectiveness concerns associated with any remaining contamination."[247]

* The NANA Regional Corporation is one of 13 Alaska Native Regional Corporations. Its predecessor organization was known as the Northwest Arctic Native Association, but NANA is not an acronym today.

Figure 8. Utica Mining Camp, 2005

This issue can be further discussed with residents and representatives of Deering. Kirk Oviok is a representative on Seat E of the Northwest Arctic Borough council and can be contacted via the website www.nwabor.org/assembly/members.

Water/Air Quality

There has been a growing interest in recent years regarding the level of toxic chemicals in the waters of the Kotzebue Sound released from mining operations from Red Dog Mine. Contaminated waters in the Sound would have a negative impact on Deering because the community is located along the Sound and residents utilize the area for subsistence activities.

No specific, readily available information on the air quality in Deering.

Natural Resources Available

Mining has been a common activity on the Seward Peninsula since the early 1900s. As previously mentioned, Deering was founded in order to support inland mining operations. There are two areas with gold, silver, zinc, and lead deposits in relatively close proximity to Deering. One is the Independence Mine along the Kugruk River (the mouth of which lies a few miles east of town) which operated between 1918 and 1922; the other is the Utica Mine which was founded in 1903 and operated for 75 years. Both areas have seen some exploration activities in recent history.[248]

Effects of Climate Change

In the 2019 Statewide Threat Assessment, a report funded by the Denali Commission and carried out by the U.S. Army Corps of Engineers and the University of Alaska, identified Deering as an environmentally threatened community. Environmentally threatened communities are those that are most vulnerable to erosion, flooding, permafrost thaw, or a combination of factors. Using a combined score, the report showed that Deering had tied for the 14th most environmentally threatened Alaskan community.[249]

Kivalina and Red Dog

Overview

Location

The port of Red Dog is a shallow-water, private port located northeast of the Bering Strait. It is located at latitude 67° 34' 34" N and longitude 164° 4' 13" W. Red Dog exports 75 percent of the country's global zinc exports annually. The Red Dog Mine, for which the port is named, is a lead and zinc mine located in northern Alaska in the Northwest Arctic Borough. It is found in the Delong Mountains in the Brooks Range, and is 80 miles north of Kotzebue.

Figure 1. Port of Red Dog and Red Dog Mine

Kivalina is a village located close to the port of Red Dog in the Northwest Arctic Borough at latitude 67° 43′ 38″ N and longitude 164° 32′ 21″ W.

Figure 2. Kivalina

Demographics

As a private port to support the mining operations at Red Dog, the population of the port is undetermined. Kivalina has a median household income was $59,063, and the median property value is $91,300. The Inupiat whaling community of Kivalina, home to around 442 people, is facing imminent relocation due to rising sea-levels.[250]

Municipal Utilities & Services

Kivalina has a Native Store, which sells everyday necessities.

Accessibility

Transportation Links

A 55-mile-long haul road connects the Red Dog mine to the mine's port site on the Chukchi Sea. The region is accessible only by air, served by the Red Dog Airport, except during the 100-day shipping season. Mine workers from remote villages in the region are transported to the mine on small aircraft.

In Kivalina, the village can be accessed only by plane and boat, as there is no inland transportation. The closest airport is the airport at Red Dog.

Seasonal Constraints

The port at Red Dog is only ice free for 3 months out of the year.

Figure 3. Aerial Perspective of Red Dog

Figure 4. Aerial Perspective of Kivalina

Port Characteristics

Port Infrastructure

Red Dog was first discovered in the 1950s after USGS geologists found metal deposits in the area. The NANA Regional Corporation, a for-profit Alaska Native corporation, owns the land, which is operated by the mining company, Teck Mining Corporation. These corporations signed an agreement to

develop the mine in 1982, and in 1986, were granted permission by the Alaskan government to construct a shallow-water port on the Chukchi Sea and a road connecting the port to the mine site. Construction on the port, road, and mine began officially in 1987, before becoming fully operational in 1989.

The Red Dog mine reaches 1600 m x 915 m x 122 m deep. It is powered by a series of diesel generators that total over 40 MW in capacity. The buildings on site are powered through the waste head produced by these generators. The mine uses conventional mining techniques to extract an average of 9,800 tons of ore per day. 200 tons of cyanide are used to separate the zinc and lead from the pure ore. The resulting components are then trucked through a 55-mile road to the Red Dog port, where they are kept until the 3 month shipping season begins in the summer (June – August). The port does not allow access to large ships so the ore is ferried out by barges.

Vessel Count

Vessel tonnage, while not widely available to the public, is provided exclusively by Fednav Int Ltd.

In Kivalina, ships are unable to refuel, and most unique ships identified at the port are small barges that also service the Red Dog Mine, as well as privately-owned vessels operated by locals.

Vessel Characteristics

The port primarily deals with tugs and barges. Vessels at the port of Red Dog are anchored about 3 miles off shore and the ore concentrates are brought out to the ship by self-unloading barges. This is a compulsory pilotage area and the pilot station is located approximately 12 miles from the loading anchorage. Water depth at the anchorage varies from 50 ft. inshore to 72 ft. offshore. Although the anchorage can accommodate more vessels, usually only three vessels will be anchored at a single time.

Barge Operators

- Foss Maritime of Seattle is the operator of the barges and tugs, and provides shuttling and transshipment of the cargo. Seagoing vessels are not allowed to dock at Red Dog.
- Crowley Marine Services delivers supplies to Kivalina bi-annually.[251]

Main Imports/Exports

The port of Red Dog is capable of handling up to 1.4 million tons of zinc and lead concentrates annually. The cargo is typically exported during the summer shipping season, which lasts from June to August. The terminal itself is operated by the Teck Company, which ships the cargo. Teck is the operator of the Red Dog Terminal, and is the shipper of the cargo.

Local Economy

Major Employers

The mine employs around 475 people full-time and creates several dozen temporary jobs each year for a total payroll of around $50 million. The mine is the sole taxpayer in the Northwest Arctic Borough and, in 2007, paid $230 million in state and federal taxes. Red Dog is also an important purchaser of goods and services in the region, and over half of the mine employees are NANA shareholders. The NANA Corporation had set a goal of 100 percent shareholder employment at Red Dog but high turnover and jobs requiring extensive post-secondary education have kept this from becoming a reality.[252]

According to a section under the Alaska Native Claims Settlement Act[253], 70 percent of net profits received by a regional native corporation for mining operations must be divided among other native corporations in the state. This money is distributed to the other regional corporations, which then distribute half of it to the village corporations in their region. In 2008, NANA paid $122 million of Red Dog royalties to the other Native corporations. As a result, profits from Red Dog are a significant revenue source for native corporations across the state, and form the largest single contribution of income to many village corporations.

In Kivalina, the school district, city, village council, airlines, local stores, and Maniilaq Association provide year-round jobs.

Subsistence Activities

In Kivalina, the economy revolves around subsistence activities, specifically the harvest of caribou and a variety of marine wildlife such as seal, whale, walrus, salmon, and whitefish.

Port Planning and Future Growth

In 2018, the mine proposed a new road in a bid to find more ore, with projections suggesting that the mine will run dry in less than 15 years. State and federal permit applications submitted by Teck ask for permission to build a 10-mile road that accesses even more remote areas of Northwest Alaska, such as Anarraq and Aktigiruq. Surface-level drilling has been conducted in these areas, but deeper drilling has yet to be attempted. The road would provide a transportation network for heavy equipment.

Local elders in Kivalina were flown in by helicopter to observe the land and beginning stages of drilling. Teck assured communities that it has its best interests in mind, though communities remain fearful that the expansion of the mine will lead to contamination of the Willuck River, which is their main water source.

Currently, plans are being evaluated to build a transmission line between Kivalina and the Red Dog Mine, given that its current power plant is at risk due to rising sea levels. The transmission line will provide Kivalina with an electrical energy source and access to other villages. As a traditional village, Kivalina is heavily reliant on its subsistence lifestyle, so protecting their resources is a top priority. While Kivalina is at risk of relocation, the community and its supporters are looking for ways to preserve the village and its culture.

Environment

Environmental Justice

Environmental Justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.[254] Consequently, proposed activities need to be mindful of the impact on Alaska Native communities. These communities are usually comprised of low-income and minority populations and are more at risk to experience the negative consequences of global climate change and economic development.

According to the Environmental Protection Agency (EPA), the Red Dog Mine produced 517 million pounds of waste material during 2008. The high metal content of waste rock that is generated during the mining process causes this toxicity. Because these rocks contain zinc, lead, and other toxic metals, they are released into the environment any time they are moved or processed. The Teck Company insists that this does not qualify as pollution, but environmentalists continue to point out that

fracturing the rock leads to toxic compounds leaching into the environment. Waste rock at Red Dog results in acid and increases soluble metal levels, which require water treatment. A series of ditches exist to divert waste water downstream, which is treated before it is discharged.

Additionally, metal-laden dust that is released at the mine site or during transport has been an ongoing issue at the mine. According to an EPA report in 2008, the mine released 138 tons of "fugitive dust," which can be toxic to surrounding flora and fauna and can accumulate in the food chain. The National Park Service, in 2001, released a study on the levels of lead, zinc, and cadmium found along the road leading to and from the mine. After assessing the situation, the risk was found to be low, though environmental groups continue to question the quality of the assessments. A management plan has been developed by the Teck Company to address this, but only slight improvement has been found since the assessment.

Water/Air Quality

In Kivalina, residents are concerned about toxic compounds in their drinking water, and in 2003, sued the Teck Company for polluting their water source. After settling out of court, Teck provided residents with reverse-osmosis water purifiers. The company was fined again in 2009 for more water-related violations, which included two spills. Little progress has been made for the residents of Kivalina, who also blame the mine for fish kills downstream.

Natural Resources Available

The mine at Red Dog is the second largest producer of zinc in the world, and is a major revenue source for native corporations across Alaska. The mine itself is smaller than other mines, but the richness of the ore found at Red Dog allows it to produce a similar amount of finished metal. The main pit is almost out of ore, but an adjacent pit was drilled into and is expected to last until 2031.[255]

Kotzebue

Overview

Location

Kotzebue is an Alaskan city located approximately 30 miles above of the Arctic Circle[256] and 549 air miles northwest of Anchorage.[257] Much of the borough's 36,000 square land miles and 4,900 square water miles are above the Arctic Circle, with the borough extending from the northern coast of the Seward Peninsula in the south to the Brooks Mountain Range in the north. The precise coordinates of the city of Kotzebue are latitude 66°53′50″N and longitude 162°35′8″W.

Demographics

With an estimated population of 3,121[258], of which approximately 70 percent[259] are Inupiat, Kotzebue is the service and transportation center for all villages in the northwest arctic region of Alaska, with a healthy cash economy, a growing private sector, and a stable public sector.[260] The median household income is estimated at $85,278[261] and a median property value of $214,900.[262] With an unemployment rate of 6.9 percent, Kotzebue has the third smallest unemployment rate among neighboring towns and villages.

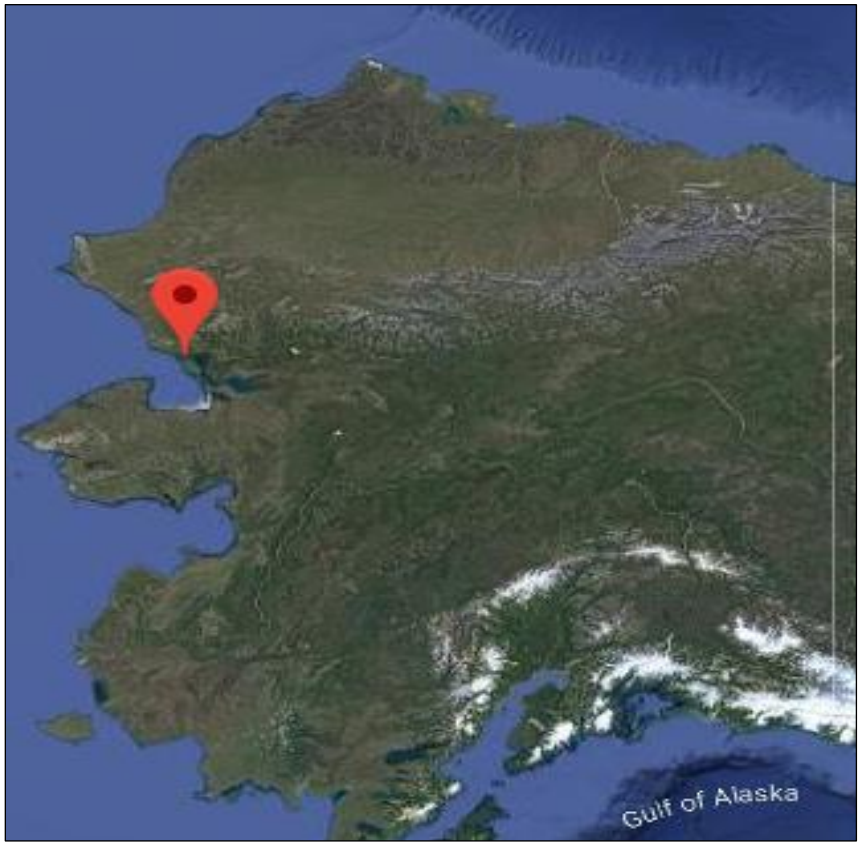


Figure 1. Kotzebue

Climate/Weather

The borough's climate is characterized by long, cold winters with average low temperatures ranging from -7 degrees Fahrenheit to -12 degrees Fahrenheit, while the average winter high temperatures range from 2 to 9 degrees Fahrenheit. In summer, average low temperatures range from 25 to 48 degrees Fahrenheit, with high temperatures ranging from 50 to 60 degrees.

Temperature extremes have been measured from 52 degrees below zero to 85 degrees above. The daily low temperature dips below freezing 250 days per-year,[263] with inland communities (Ambler, Kobuk, and Shungnak) often experiencing warmer summer temperatures.[264]

Municipal Utilities & Services

As the largest village of the Northwest Artic region of Alaska, the city of Kotzebue provides most of the utilities and services you will find in a similar sized city in the US, such as electricity, water and wastewater system, landfills, and seasonal barge access. The city also has a police, fire, public works and park and recreation departments for the benefit of its residents.[265]

Formal education in Kotzebue is provided by two schools: the June Nelson elementary school, which accepts students from kinder to fifth grade the Kotzebue Middle/High School, which accepts enrollment from sixth to twelfth grade. The Nelson elementary school currently has an enrollment of 397 students, while the high school has an enrollment of about 323 students.[266]

Last but not least, Kotzebue is also home to the Maniilaq Health Center.[267] The Maniilaq Health Center is considered the primary, most important health care provider to the residents of the Northwest Artic region. This facility was built in 1980 and was formally inaugurated in 1981. It provides a comprehensive catalog of health services such as an emergency room with helicopter and ambulance access, ambulatory, eye, dental and specialty care.

Accessibility

Transportation Links

Kotzebue is home to the Ralph Wien Memorial Airport (OTZ), which is the only airport in the Northwest Arctic Borough with regularly scheduled large commercial passenger aircraft services to and from the cities of Anchorage and Nome, as well as daily jet service and air taxis to local villages.[268] Given the weather experienced in the city of Kotzebue, year-round supplies of goods are normally brought by air transportation.

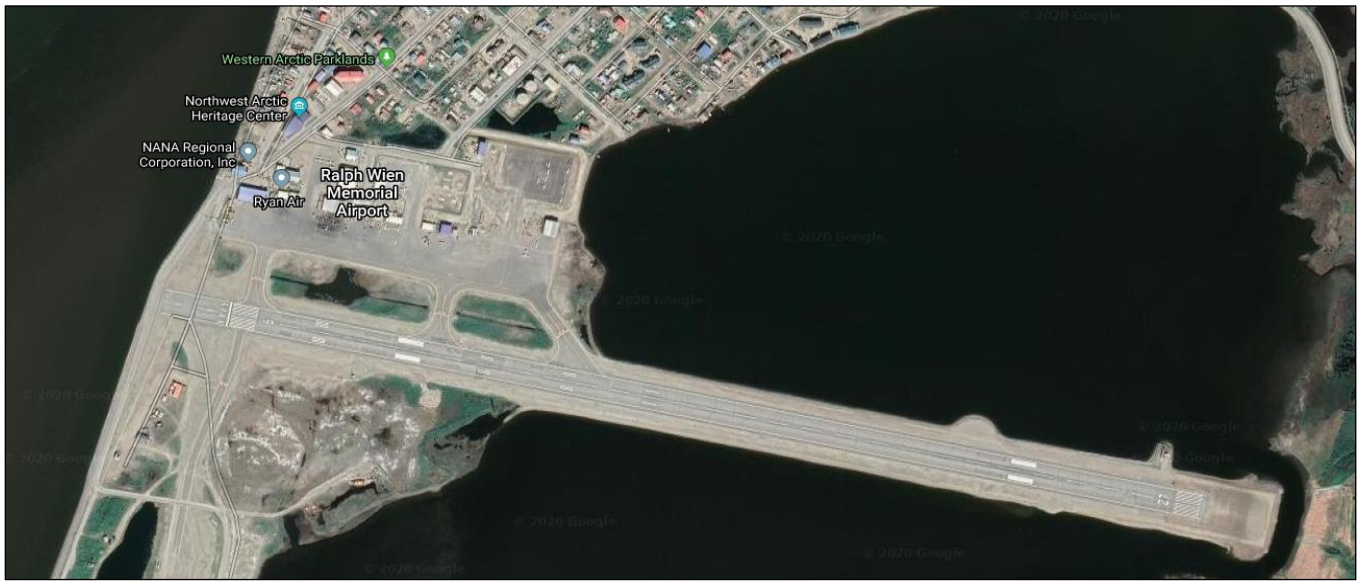


Figure 2. Port of Kotzebue

Lack of deep-water port facilities means deep-draft vessels carrying goods and fuel must lighten their contents 12 to 15 miles offshore. Maritime service is only available during the three months where Kotzebue Sound is ice free because there is no natural harbor.[269] The shipping season lasts 100 days from early July to early October, when the Sound is ice-free. Freight and fuel may be transported from Kotzebue to villages in the region using river barges. Due to river sediments deposited by the Noatak River four miles above Kotzebue, the harbor is shallow, and Crowley Marine Services operates shallow draft barges to deliver cargo to area communities.[270]

The Northwest Arctic Borough has no roads connecting it with the rest of Alaska, and no roadways connecting any of the villages with each other. However, in the winter, once the Kotzebue Sound and the Kobuk River freeze, a road is plowed through the snow on top of the ice connecting Kotzebue with the Noorvik and Kiana rivers along the Kobuk River allowing transportation over them via snow machines and all-terrain vehicles (ATVs).[271]

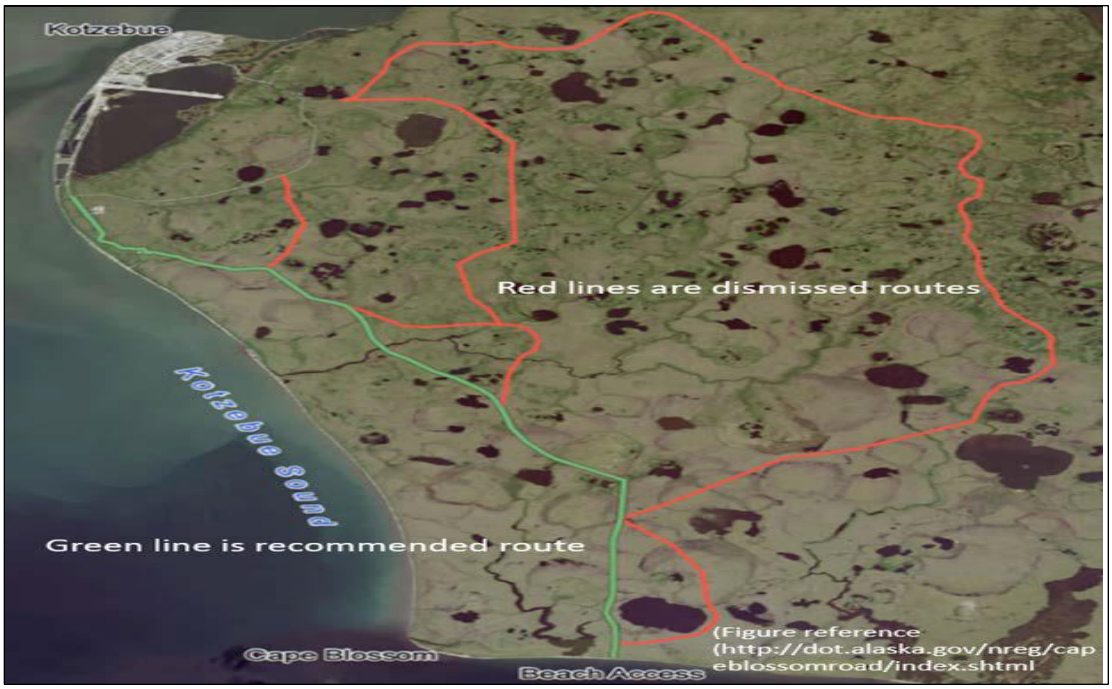


Figure 3. Kotzebue-Cape Blossom Road Route

The U.S. Army Corps of Engineers completed a harbor feasibility study[272] for the Cape Blossom deep water port project in early 2019 with the primary purpose of "decreasing the endemic navigational inefficiencies associated with delivery of fuel and freight," and recommended one that calls for a 10-mile road connecting Cape Blossom to Kotzebue and includes significant uplands development.

Seasonal Constraints

Similar to the rest of the villages in the Northwest Artic region, the waters surrounding Kotzebue are largely frozen during the non-summer months, making it only accessible through the local airport, and ATVs. There are no road access to the rest of the villages year-round, therefore transportation between NWB villages are either through air or the Kotzebue sound, the Hotham Inlet, and the Noorvik and Kiana rivers.

Port Characteristics

Port Infrastructure

The Port of Kotzebue is located approximately 90 miles from the Port of Red Dog[273] and 180 miles south of Point Hope,[274] and is the regional center for boat and air traffic (Port of Kotzebue Airport), commerce, service and health care industries for the northwestern Arctic region. The University of Alaska has a campus located near the port. Two important non-profit Native groups, the NANA Regional Corporation and the Maniilaq Association are stationed at the port. The government is the largest employer, but the tourism and fishing industries play a significant role in the area's economy.[275]

In the Port of Kotzebue, Crowley Marine Services, Inc. owns and operates the Kotzebue Wharf. The wharf receives and ships containerized and conventional general cargo and petroleum products. Seven six-inch pipelines connect the wharf to 15 steel storage tanks with capacity for over 146,000 barrels of oil. There are also three unpaved open cargo storage areas at the rear of the Port of Kotzebue wharf, covering a total of 1.6 acres. Located about two kilometers (1.2 miles) north of the Port of Kotzebue Airport, the wharf has berthing distance of about 122 meters (400 feet) with alongside depth of three meters (10 feet).

The Port of Kotzebue Dock is owned by Drake Construction, Inc. and is operated by the company jointly with Crowley Marine Services. Inc. The dock receives sand and gravel and provides mooring for maintenance and repair of vessels. Cargo handled at the dock includes sand, stone, gravel, rock, soil, limestone, and dredged materials. About 1.5 acres of open area is adjacent to the Port of Kotzebue Dock for repair of hauled-out vessels.

Figure 4. Tug and Barge Docking

Drake Construction also has open storage area at the rear of the dock with capacity for about 25,000 tons. Located about 2.5 kilometers (1.5 miles) north of the Port of Kotzebue Airport, the dock affords berthing space of about 7 meters (24 feet) with alongside depth of 1.2 meters (4 feet).[276]

Vessel Count

This section describes the quantity and characteristics of the boats that have entered or left the port of Kotzebue for the past 10 years. This data can be found through the U.S. Army Corps of Engineers Waterborne Commerce Statistics Center (USACE WSCS).[277]

Vessel Type	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Cargo Barge	20	46	27	10	10		16	30	14	5	
Liquid Barge	14	23	29	16	27	35	29	27	75	56	32
Towboat	5	16	10	6	8	2	14	6	21		7
Products Tanker								2	6	2	11
Cruise Vessel							2				
Landing Craft							2			2	

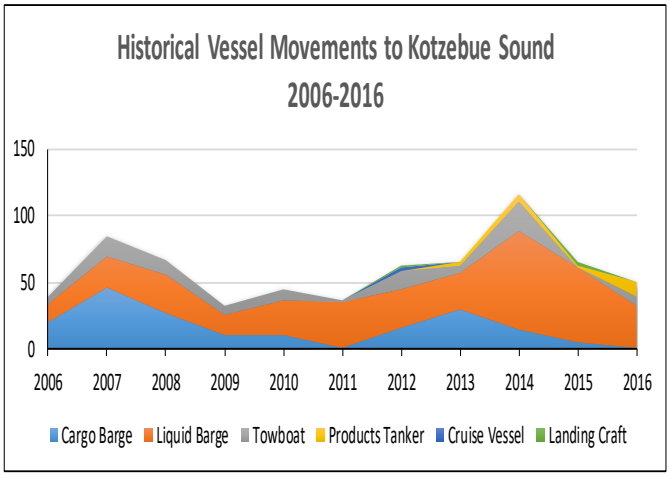


Table 1. Historical Vessel Movements to Kotzebue Sound, 2006-2016

Vessel Characteristics

Tanker vessels hauling bulk fuel may come up the outer west coast of Alaska, paralleled by a coastal barge. Vessels involved in this type of operation range in size depending on the distribution contract awarded by the local governments to provide fuel. Since 2013, line ships have ranged between 400-600 feet long, 66-106 feet wide, 27-42 feet deep, and had capacities between 11,000-48,000 deadweight tons.

Barge Operators

Many firms and barge operators serve the Kotzebue region.[278] Some of the most important firms are:

- Alaska Marine Lines (AML) provides marine support to Kotzebue.[279]
- Alaska Logistic provides services to western Alaska, mostly transporting equipment and other supplies from Seattle.[280]
- Drake Construction manages a fleet of four barges: Koyuk, Barge 156, Lil' Toot, Barge 80-1.[281] Drake's primary business is to transport construction equipment along Alaska's western coast.
- Crowley mostly delivers fuel to the region, with an annual average of 50 million gallons of fuel delivered to the region.[282] Two of their most important barges are *The Sesok* and *The Aku*. Fuel delivery only takes place during the non-ice forming period, which is up to 180 days per year.

There are no formal cruise trips to Kotzebue, or making stops at Kotzebue, although some cruises along the western passage route would occasionally stop, mostly due to emergencies, as reported by the Anchorage Daily News.[283] In September, 2015, a group of 120 foreigners were transported from the German cruise MS Hanseatic to shore because of deteriorating weather conditions in Nome. According to the US Coast Guard, traffic along the Bering Sea has doubled since 2007, averaging 400 trips, as of 2015.

Main Imports/Exports

Lightering barges and tugs bring fuel, freight, and construction material into Kotzebue. The focus group interviewee reported transporting 80,000 to 90,000 barrel of crude oil (bbl), of fuel a year (3.36 to 3.78 million gallons). Another operator claimed that they deliver 1 to 2 million gallons of fuel to the region annually, and includes some propane. They don't deliver a significant amount of commodities. According to the USACE port development study at Cape Blossom, the actual cost of lightering is about $44,000 per day and takes 3-5 day per voyage. This could be reduced to 12-18 hours with proper facilities at Cape Blossom.[284]

Heating oil, diesel, gasoline, other energy sources, construction materials (i.e. materials for the road construction, rock and armor rock), and equipment (including gravel, vehicles used specifically for construction, and commercial building materials), residential construction materials (including pre-fabricated homes), durable goods and household furnishings, private vehicles (including boats), non-perishable foods and dry goods, and mining equipment (and vehicles for mining). Also, according to the USACE study, lightering freight items was estimated at a rate of $20,000 per day.[285]

Local Economy

Major Employers

The majority of income is directly or indirectly related to government employment, such as the school district, the Maniilaq Association, the city, and the borough. The Teck Alaska Red Dog Mine is a significant regional employer. Commercial fishing for chum salmon provides some seasonal employment, and 112 residents hold commercial fishing permits. Most residents rely on subsistence hunting to supplement income.[286] The estimated percentage of population living below the poverty rate is 17.5 percent, which is the 4th smallest percent of people earning less than the poverty level of all the other places in the area. The highest paying industries are construction and extraction ($123,571); life, physical and social sciences ($116,250); and health diagnosis and treating practitioners ($113,571).[287] As of 2019, there were 124 active business licenses.[288]

Tourism is also an important industry in Kotzebue, which has several of the infrastructure assets needed to support a tourism industry, including the 78-room Nullagvik Hotel, a NANA property built in 2011, the Suilianich Art Center, which provides opportunity for visitors and residents to purchase art made by residents throughout the region and the Northwest Arctic Heritage Center. Finally, Kotzebue's natural attractions include stunning views of Kotzebue Sound, the Chukchi Sea, local wildlife, five nearby national parks, monuments, preserves, and several resident dog teams. While visitor statistics specific to Kotzebue are unavailable, the Alaska Visitor Statistics Program includes the borough in its profile of visitation to Alaska's Far North communities, which had an estimated 33,000 visitors in 2016 (the latest year for which data were available). On average, visitors to the Far North spent $826 per person in the region. Kotzebue is the gateway city to nearby parks such as the Noatak National Preserve, Kobuk Valley National Park and Cape Krusenstern National Monument.[289]

Figure 5. Midnight Sun in the Chukchi Sea

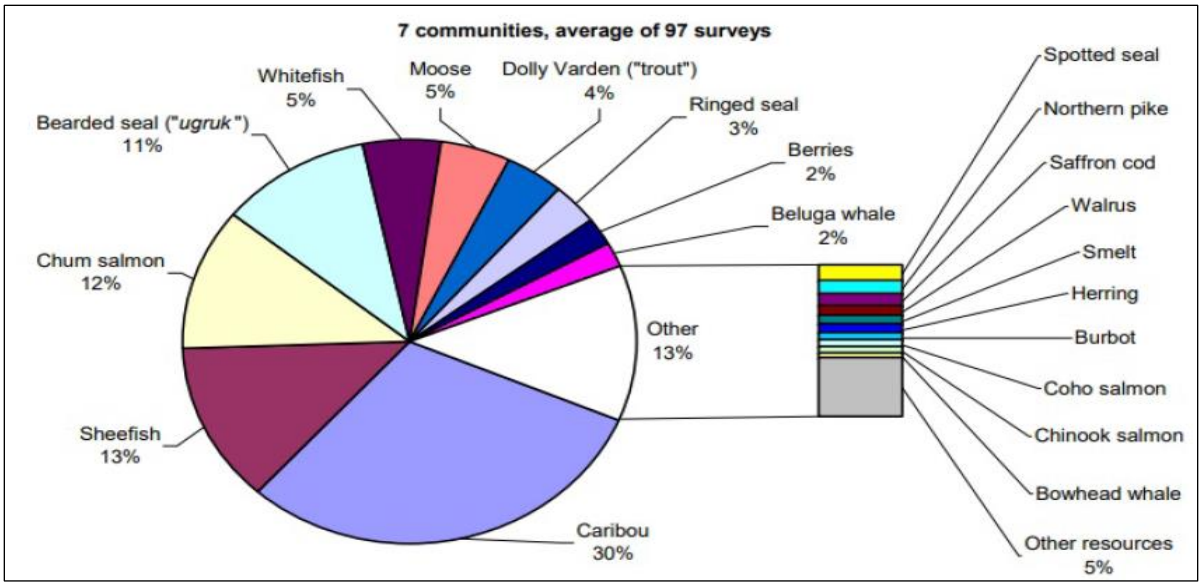


Figure 6. Subsistence Averages by Edible Weight, 1964-2007 (Kotzebue, Kivalina, Noatak, Deering, Shungnak, Buckland, and Kiana)

Subsistence Activities

Subsistence hunting is an important part of local culture, where approximately 500 pounds of locally hunted and gathered food is acquired per person per year.[290] These regional subsistence practices include a number of different resources, which focus heavily on the taking of caribou. Previous studies have found that on average 2.2 caribou are taken per household per year.[291]

Port Planning and Future Growth

Among the six alternatives studied, the Corps recommended one that calls for a 10-mile road connecting Cape Blossom to Kotzebue. Development of the Cape Blossom port may allow for shipment by river barge 10 to 15 days earlier than freight brought into Kotzebue, when rivers are at their normal maximum depth and most navigable.[292] The impacts of a warmer climate include coastal erosion, one of the most critical issues in the region, permafrost melt, and sea ice retreat. These trends will negatively affect the region's built infrastructure and are projected to increase maintenance costs. Climate change is also affecting subsistence resources, an important aspect of the region's economy.[293]

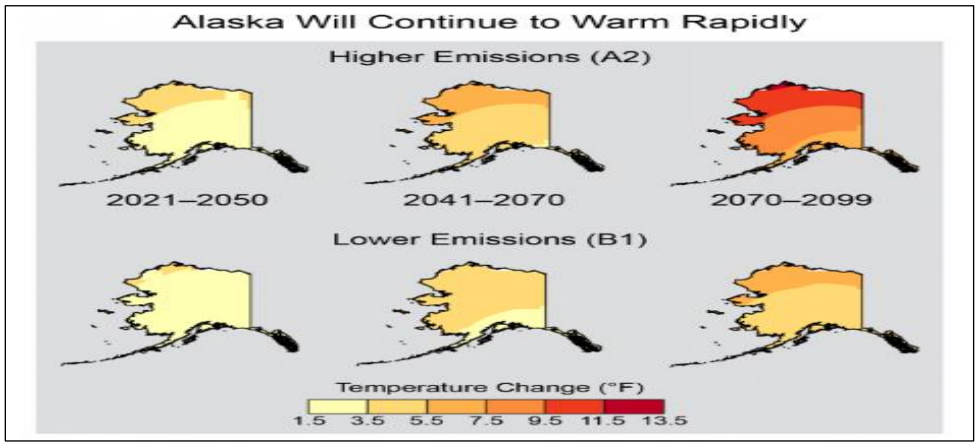


Figure 7. Projected Temperature Changes across Alaska for the Rest of the Century

However, receding sea ice may open new business opportunities in the region as marine traffic increases and could foster development of offshore resources. The region is likely to experience additional opportunities as the U.S. Department of Defense (DOD) explores an increased presence in the Arctic.[294]

The Northwest Arctic Borough (NAB), which Kotzebue is part of, is seeking to position itself as a strategic Arctic location for defense installations and maritime safety. With climate change, new transportation routes and increased[295] maritime traffic present new opportunities to create new infrastructure for the region.

In May 2017, the U.S. Army Corps of Engineers published the Kotzebue Small Boat Harbor Integrated Feasibility Report[296] which studied "the feasibility and Federal interest of constructing navigation improvements that would increase efficiency of navigation at Kotzebue." This report concluded that "deepening the entrance… will provide beneficial economic effects by allowing deeper draft ships to utilize the channel", with an estimated present value cost of $99.1 million and will allow vessels of up to 380 feet in length, 96 feet in width, and drafts 20 feet deep.

Specifically, the Upland and In-Water Local Service Facilities (LSF) upgrades are listed as follows:

Upland LSF

- Bulk fuel storage facility with a capacity of approximately 197,000 barrels (8,274,000 gallons);
- Fuel transfer equipment:
    - Dual fuel pipeline, 8-inch diameter extending to and from dock;
    - General fuel transfer equipment – pumps etc.; and
    - Truck fueling rack.
- Boat ramp to support increased subsistence and marine safety;
- Gravel pad area prepared for future upland LSF features that may include:
    - Lay-down yard for incoming and outgoing cargo;
    - Parking areas;
    - Warehouses, maintenance shops; and
    - Fuel pipeline to Kotzebue.

In-Water LSF

- A bridge from uplands to a trestle that leads to a dock located at -12 ft. Mean Lower Low Water (MLLW), approximately 1,100 ft. from the shoreline;
- The bridge and trestle with a road deck are supported by gravity-filled structures (e.g., caissons);
- Marine fueling head and associated 8-inch diameter pipeline extending to and from the bulk fuel storage facility;
- Pass-pass facilities (ship to pier); and
- Miscellaneous features such as lighting.

Environment

Environmental Justice

The Northwest Arctic Borough encompasses a large area unaffected by development. Most of the lands within the area are managed by the National Park Service (NPS), the Bureau of Land Management (BLM), the U.S. Fish and Wildlife Service (U.S. FWS), and the State of Alaska. The major private land owners include the Northwest Arctic Native Association (NANA) and the Kikiktagruk

Inupiat Corporation.[297]

Red Dog Mine, the world's largest zinc and lead producer in the United States (583,200 metric tons of zinc and 98,400 metric tons of lead in 2018)[298] is situated approximately 90 miles west of Kotzebue. Because of its proximity to the Red Dog Mine, Kotzebue is considered the most polluted town of America, according to data by the Environmental Protection Agency (EPA)[299] and articles published by National Geographic[300] and Science Alert.[301] In 2018 the Red Dog Mine released 885.7 million pounds of toxic chemicals which includes the release of methanol, zinc, ammonia and cadmium compounds.[302]

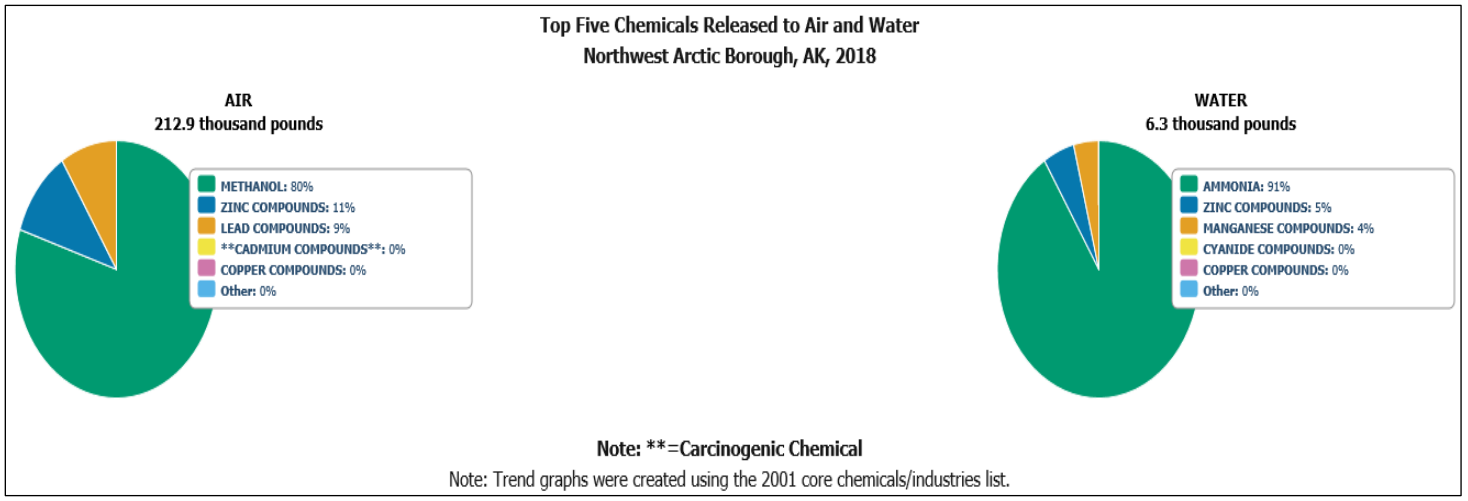


Figure 8. Top Five Chemical Releases to Air and Water, Northwest Arctic Borough

Water/Air Quality

According to the 2018 Kotzebue Water Quality Report,[303] water supplies are considered generally safe. For instance, this report highlights the fact that it was tested for 50 contaminants and it met the EPA guidelines in all but two contaminants. Water quality is continuously monitored, and each month samples are collected and tested for Total Coliform Bacteria.

Kotzebue's drinking water is pumped from Devil's Lake about 2 miles east of the city. Vortac Lake is also a source of water during the summertime. An important violation to the EPA standards occurred when the city exceeded permissible levels of haloacetic acids, which are disinfection by-products and are the result of the reaction of chlorine with natural organic material such as humic and fluvic acids.

Natural Resources Available

There are no oil or gas fields in Kotzebue or in its proximity. According to a US Geological Survey fact sheet,[304] Kotzebue lays in an area of low petroleum and natural gas potential probability (less than 10 percent), hence, there are no current or future oil exploration plans in this area. However, according to the Kotzebue Electric Association, a local, non-profit utility company dedicated to the generation and transmission of electricity through a mix of conventional and renewable resources. It generates over 18 million kilowatt hours per year by employing 19 turbines installed approximately 4 miles south of the city, and can generate 2.9 megawatts per hour at full capacity.[305]

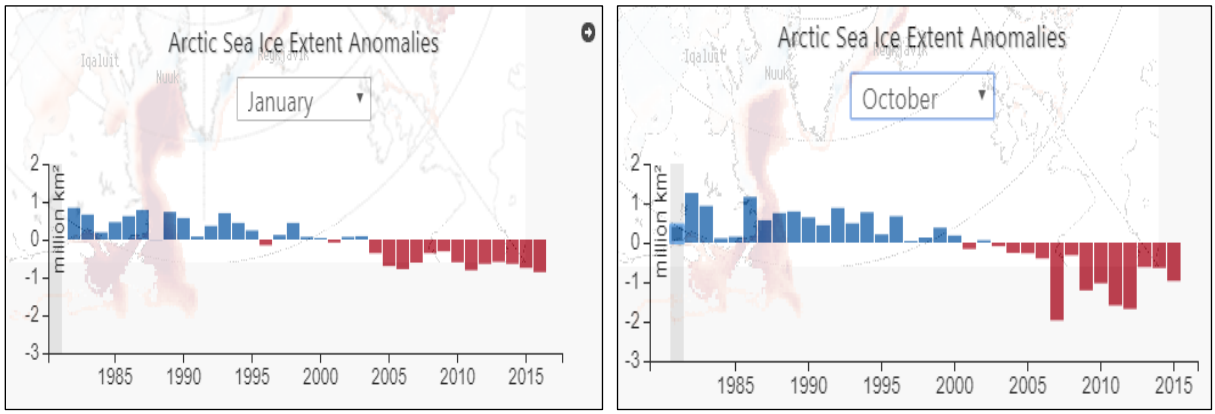
Effects of Climate Change

The predicted warmer weather in the arctic region is also expected to exacerbate some of the already challenging environmental conditions in the area, such as:

- a) Tourism and recreation. A projected increase in rainy weather would discourage marine trips and hiking expeditions (negative effect);
- b) Fuel consumption. Warmer days reduces the demand for heating as measured by the heating degree days (HDD) (positive effect);
- c) Agricultural production. Growing season has already increased by 45 percent over the 20th century and this trend is expected to continue (positive effects); and
- d) Industry and public infrastructure. The U.S. Army Corps of Engineers have already identified 31 communities (including Kotzebue) requiring partial or complete relocation.

Ice coverage in Kotzebue Sound has been shrinking steadily since the 1950s, with acceleration in recent years. A working paper published by economists Francis Diebold and Glenn Rudebush conducted a probability based projection of Arctic sea extent for the rest of the century, and concluded there is a 60 percent chance of an effectively ice-free Arctic Ocean sometime during the 2030s, in contrast to the gradual slowing of Arctic sea loss projected by CMIP5 global climate models.[306]

The National Snow and Ice Data Center compiles data and images provided by the National Aeronautics and Space Administration (NASA) and other agencies in order to create interactive maps. For instance, the following images represent the Arctic Sea Ice Extent Anomalies, which measures the growth (or decay) of sea ice extension relative to an index based on the average ice extension from 1979 to 2015, measured in millions of squared kilometers.[307]



Figures 9 and 10. Projected Sea Loss during the 1st and 3rd Quarters, Respectively

Scientists estimate there are roughly 300,000 bearded seals in the Bering Sea breeding population and an unknown number of others that breed in the Chukchi and Beaufort seas in Alaska. As the sea ice patterns change, there could be changes in the places where the animals spend time. Historically, Kotzebue's population relied heavily on beluga whales, but since the 1980s, belugas stopped coming into Kotzebue Sound.[308]

The Baldwin peninsula is also part of the Western Arctic Caribou Herd (WAH) which, despite the recent decline in caribou counts, is still large.[309] In addition, Kotzebue Sound is also an important winter hub for ringed and bearded seals.

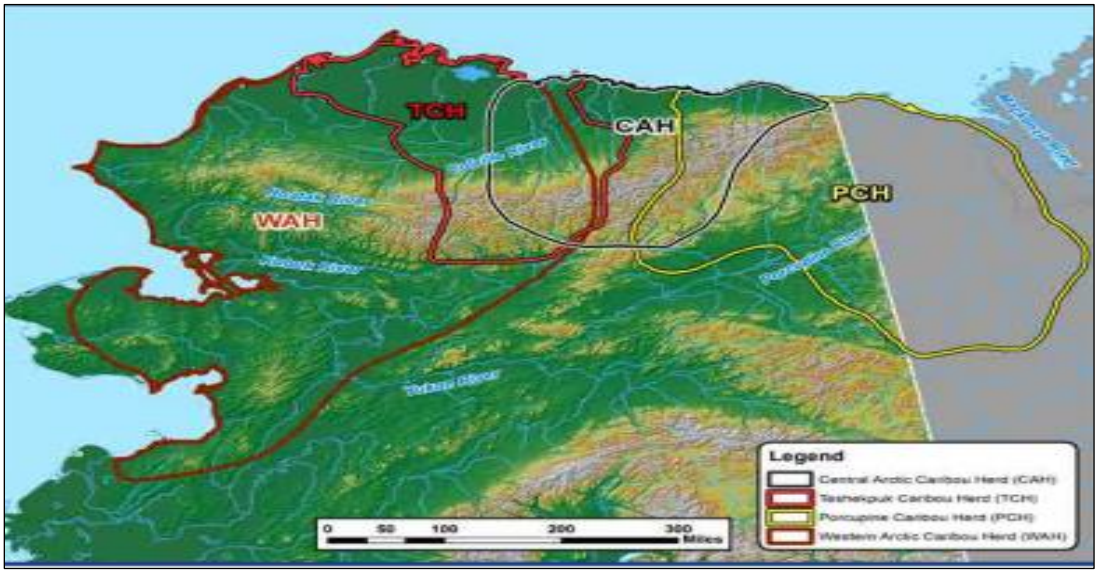


Figure 11. Herd Ranges and Overlap of Caribou

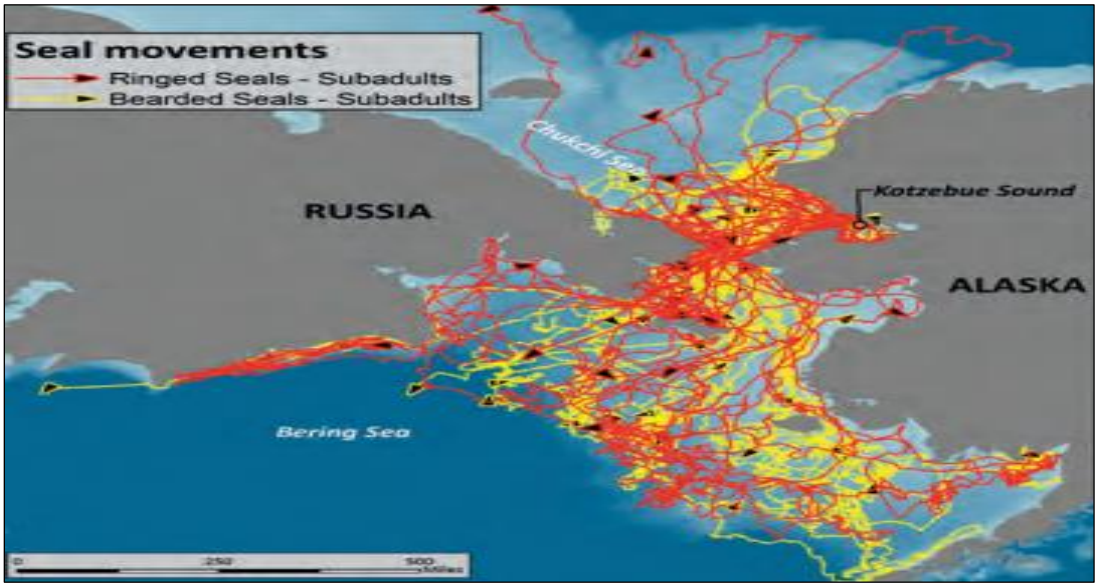


Figure 12. Sub-Adult Ringed and Bearded Seal Movements, 2004-2009

Noorvik and Kiana

Overview

Location

Noorvik and Kiana are cities in the northwest of Alaska along the Kobuk River and its channels. Noorvik is situated on the right bank of the Nazaruk Channel of the Kobuk River[310], while Kiana is further upstream and situated on the north bank of the Kobuk River, where two channels of the Kobuk River and the Squirrel River meet.[311] The cities are down stream of the Kobuk Valley National Park. Noorvik is located at latitude 66° 49' 58"N and longitude 161° 2' 37"W.[312] Kiana is located at latitude 66° 58' 18"N and longitude 160° 26' 14"W.[313]

Demographics

Both cities are in the Northwest Arctic Borough. Noorvik is larger and more populous, covering one square mile of land and 0.4 square miles of water with a population of 629.[314] Kiana covers 0.2 square miles of land, no water area, and has a population of 421.[315] The median household income is similar between Noorvik and Kiana, with $42,917[316] and $42,188,[317] respectively. The majority of the population is Alaska Native (92 percent in Noorvik and 88 percent in Kiana), and both cities have a large under 20 age group.[318]

	Noorvik	Kiana
Location	66°49′58″N 161°2′37″W	66°58′18″N 160°26′14″W
Area (mi²)		
Land	1	0.2
Water	0.4	n/a
Demographics		
Median Income	$42,917	$42,188
Population Size	629	421
Native Alaskan	92%	88%

Table 1. Noorvik and Kiana Background Information

Figure 1. Noorvik and Kiana

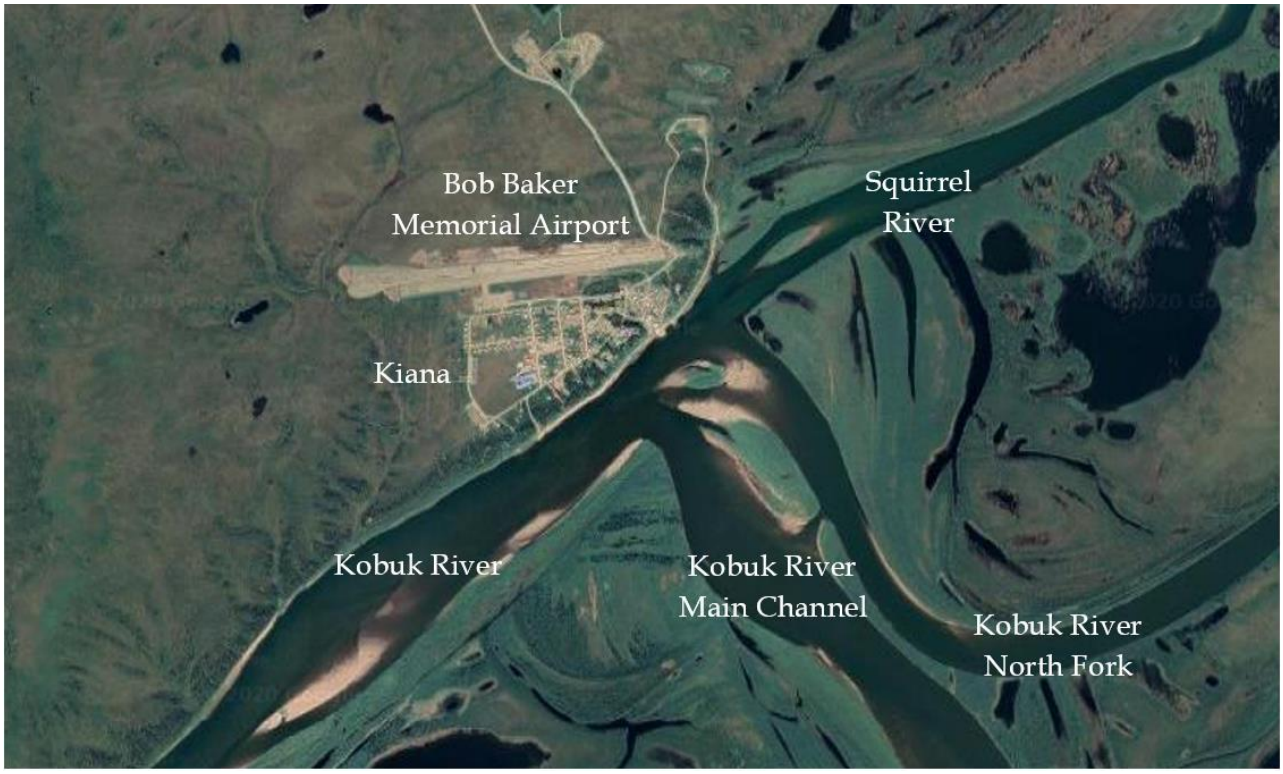


Figure 2. Port of Kiana

Figure 3. Port of Noorvik

Climate/Weather

Noorvik and Kiana are both in the transitional climate zone and have very similar climates. Average winter temperatures range from –10 degrees Fahrenheit to 15 degrees Fahrenheit, while average summer temperatures range from 40 degrees Fahrenheit to 60 degrees Fahrenheit. Annual precipitation is 16 inches and produces approximately 60 inches of snowfall. The Kobuk River (and its channels) are navigable (i.e. ice-free) from the end of May of early July to early October.[319]

Municipal Utilities & Services

Electricity is created by a diesel generator in each city and provided to the residents by Alaska Village Electric Cooperative. In Kiana, fuel is provided by the city, and in Noorvik, fuel is available at the Noorvik Native Store. Each city also has their own water treatment and water distribution system. Noorvik gets its water from the Navuruk channel, while Kiana uses wells to tap groundwater sources.

Accessibility

Transportation Links

Like most small Alaskan cities, Noorvik and Kiana each have one local airport. Airports provide transportation access to residents who would otherwise be unable to reach nearby towns when the river is non-navigable. These airports allow for flights to nearby communities and to Kotzebue, which allows for connections to farther destinations.[320]

Noorvik has the Robert (Bob) Curtis Memorial Airport (ORV) is a 4,000 feet long by 100 feet wide gravel runway about one mile south of town. The airport is state-owned for public use, has a lighted runway, a light beacon, and a lighted wind indicator.[321]

Two airlines operate commercial flights out of Robert (Bob) Curtis Memorial Airport: RavnAir Alaska and Bering Air. RavnAir flies from Noorvik to Kotzebue, where connections are available to nearby small towns, and to Anchorage, where additional connections are available.[322] Bering Air operates flights from Noorvik to both Kiana and Kotzebue. From Kotzebue, flights are available to other regional airports.[323]

Kiana has the Bob Baker Memorial Airport (IAN) is a 3,400 feet long by 100 feet wide gravel runway on the north edge of town. The airport is state owned for public use, has a lighted runway, a light beacon, and a lighted wind indicator.[324]

Two airlines operate commercial flights out of Bob Baker Memorial Airport: RavnAir Alaska and Bering Air. RavnAir flies from Kiana to Kotzebue, where connections are available to nearby small towns, and to Anchorage, where additional connections are available.[325] Similarly, Bering Air operates flights from Kiana to both Noorvik and Kotzebue. From Kotzebue, flights are available to other regional airports.[326]

No roads connect Noorvik or Kiana to each other or to any other city. Local transportation is achieved with all-terrain vehicles (ATVs) and snow machines. Boats are also commonly used by residents of both towns.[327]

Seasonal Constraints

During the summer months when the river has no ice, residents of the cities use boats to travel between the cities, further inland, or out to Kotzebue. During winter, when the river is frozen, it acts as an ice road for residents using snow machines and ATVs.[328]

Port Characteristics

Port Infrastructure

Neither Noorvik nor Kiana have substantial port facilities or infrastructure. In both cities, barges land on the shore and are offloaded onto the beach. Residents also use the beaches for their small personal boats which can be problematic when unloading barges; boat owners must be located to move their vessels and make space on the beach.[329]

Port Infrastructure (Noorvik)

Noorvik is considered to have relatively good access when the river is not frozen because the water levels allow barge access. There are multiple landing sites for barges on the Navuruk Channel, all consisting of low-lying beaches. Nevertheless, beach landings here can prove difficult. Frequent spring floods cause the ground to be soft and muddy, which leads to poor traction during cargo offloading. The main barge landing area is at the downriver end of the community, on a wide section of beach. This site gives the best area of beach for staging equipment, which occurs along the brush as far back on the beach as possible. Multiple stops are required for fuel barges to fill the community's fuel tank farms.[330] In the summer of 2017, the Denali Commission working with the Army Corps of Engineers (USACE) installed mooring ties at Noorvik.[331] The mooring ties increase stability for barges during mooring operations.

Figure 4. Aerial Perspective of Noorvik Looking South

Port Infrastructure (Kiana)

Kiana is situated on a bluff above the Kobuk River which makes barge access inconsistent. Shallow and narrow river access means that barges can only reach Kiana about half of the time. One popular freight offloading site is on the main channel of the Kobuk River, where the Squirrel River and the two channels of the Kobuk River meet. This is challenging for barge operators who then have to contend with the currents of the three rivers intersecting. The road that runs up to town is steep and narrow, and cannot facilitate cargo transport. Two stops are required to offload fuel, the first is at the location listed above, and the second is downriver at the end of an access road.[332]

Figure 5. Aerial Perspective of Kiana Looking South

Vessel Count
There is no readily available information on vessel count.

Vessel Characteristics
Shallow draft river barges service both communities. Barges operated by Crowley Marine Services are used to bring supplies such as fuel and general cargo to the community. Crowley operates a fleet of barges, including two river class tug boats and six river class barges that service Noorvik, Kiana, and a number of other Alaskan localities. River barges that Crowley operates range in length from 70 feet to 165.4 feet with a cargo capacity ranging from 814 barrels (BBL) to 5281 BBL.[333]

Barge Operators
Crowley Marine services operates barges that service Noorvik and Kiana as well as many other cities and towns in Alaska.[334]

Main Imports
Barges bring in bulk items to both communities. Items imported are food, supplies, heating fuel and gasoline.[335]

Local Economy

Major Employers
Noorvik and Kiana are subsistence communities, which are supplemented by a cash economy. Most of the year-round jobs in Noorvik and Kiana come from the school district, city government, and Maniilaq Association, which operates health clinics in both towns. Each town also has a set of stores for the community (two in Noorvik and three in Kiana). Residents find seasonal employment in Kotzebue, firefighting for the Bureau of Land Management (BLM), or mining at Red Dog Mine.[336] Noorvik has four active business licenses for the store, the trading post, a Bible and gift shop, and a gravel sales company. Kiana has seven active business licenses for the trading post, the city, a consulting firm, two passenger air businesses, a firearms store, and a rental shop.[337]

Subsistence Activities

Both Noorvik and Kiana are traditional Inupiat villages that practices subsistence hunting and gathering lifestyle, which is centered on year-round hunting, fishing, and gathering wild food and materials from the surrounding land, rivers, and sea. The most important species that support the subsistence lifestyle are caribou, moose, blueberries, and bearded seal, with caribou being especially important. The most important riverine species that support the subsistence lifestyle are chum salmon, whitefish, sheefish, burbot, pike, and coho salmon. The river is particularly important for subsistence activity because it provides access to fish and fresh water, as well as serving as a transportation link to hunting and fishing grounds and surrounding communities through the use of boats during the summer, and snow machines and ATVs on the ice during the winter.[338]

While at hunting and fishing camps, residents often use traditional surface water sources. Water is gathered from streams, lakes, or the Kobuk and Squirrel Rivers; it is untreated and consumed directly. While especially common at camps, this practice also occurs to a lesser extent in the villages themselves.[339]

Subsistence activities provide benefits in addition to food and water harvests. Subsistence diets are very healthy, providing a wide range of essential nutrients as well as providing protection against diseases associated with a less healthy diet such as cardiovascular disease, hypertension, type 2 diabetes, stroke, obesity, osteoporosis, and some cancers. Additionally, subsistence activities provide significant mental health benefits and are the largest form of physical exercise for the communities.[340]

Planning and Future Growth

Kiana has also been making strides at developing an eco-tourism industry. Primarily, this would consist of guided trips up the Kobuk River to the Great Kobuk Sand Dunes. Additionally, there has been interest in Kiana in constructing a whitefish and turbot processing plant.[341] This plant would provide additional jobs and income for the local community but could also put strain on local fish populations as well as the current subsistence lifestyle.

Environment

Environmental Justice

Proposed activities also need to be mindful of the impact on Alaska Native communities. These communities are usually comprised of low-income and minority populations and are more at risk to experience the negative consequences of global climate change and economic development. Climate issues such as those discussed above have an outsized impact on these communities. Changes to the geography have the potential to adversely affect subsistence, public health, and increase potential exposure to toxins. Careful consideration needs to be made to ensure that any proposed activities would not disproportionately affect low-income and minority populations.

Water/Air Quality

As noted above, some residents practice traditional water sourcing, where they drink untreated river water while at hunting and fishing camps. Warmer temperatures have allowed new species to move into the area, which puts these traditional sources at risk. New trees and warmer temperatures have attracted species such as beaver to the region. Beavers in particular are dangerous for residents practicing traditional water sources, because they can carry giardia, which is transferred to the water through the beaver's feces. Giardia can be an unpleasant and sometimes dangerous infection in humans. Treated water can prevent the spread of giardia, but residents are at risk when they drink raw river or stream water.[342]

There are two main sources of respiratory danger for the communities of Noorvik and Kiana: smoke and dust. Drier, warmer summer months in combination with more frequent lightning strikes have led to an increased number of wildfires in the northwest of Alaska. These fires have not threatened Noorvik and Kiana specifically but have had a negative side effect. Exposure to these pollutants increase the risk of respiratory ailments, incite asthma and acute bronchitis, and compromise people with current respiratory diseases.[343] Increased wildfires have increased the level of smoke pollution in the communities. Residents have expressed worry about the negative effects of smoke on the respiratory health of the communities. Additionally, longer dry periods have increased the amount of dust in the air. The roads in these towns are gravel and when it is dry, ATVs and the wind can kick up dust from the road into the air. The Environmental Protection Agency (EPA) tested dust levels in Noorvik, Kiana, and other surrounding communities, and found that they exceed the EPA national standard for particulates. These particulates can contain pollutants which can be inhaled into the lungs.

Natural Resources Available

There is no readily available information on natural resources in the area.

Effects of Climate Change

Permafrost is soil that does not thaw over the summer months. Permafrost is generally found deeper in the soil as the top few layers thaw and freeze annually. As average temperatures increase, the layers that thaw are getting deeper while the permafrost is decreasing and disappearing.[344]
Permafrost melting has negative and in some cases dramatic effects on the surrounding area. Thawing permafrost has caused hundreds of "thermokarsts" to appear, which are areas where the thawing permafrost has caused land to collapse, slide away, or create gullies. This is a symptom of a more fragile ecosystem caused by permafrost thaws. Permafrost thawing may also be responsible for lakes in the area that are showing signs of drying or draining.[345]

Land fragility is especially an issue for infrastructure in and around Kiana. Drainage ditches built to hold overflow storm water and runoff are particularly vulnerable to land erosion. Ravines caused by erosion have developed on the southwest end of the runway in Kiana. Some homes have thaw ponds that have emerged underneath them and the homes require regular leveling. The area around the sewage lagoon north of Kiana has also been vulnerable to erosion because a ravine has emerged to its north. Other sewer mains in town have sagged due to permafrost thaw and have been replaced.[346]
Permafrost is an important part of the Kobuk River bank. Permafrost strengthens the banks, slows channel migration, and reduces erosion. Due to the permafrost melting, the positive effects are lessening, which is causing the Kobuk to be a wider, more turbid river. This could also have an effect on river depth and the sustainability of river organisms. Large portions of the river bank are falling into the river. Houses in Kiana that sit on the bluff are increasingly in danger of falling off the bluff as the ground collapses. The barge landing and dock area in Kiana are especially vulnerable to bank erosion.[347]

The Kobuk River is an important transportation link for Kiana and Noorvik. In the months without ice, boats are used to travel up and down the river, while in the months where the ice on the river is thick enough, residents use snow machines to travel atop the ice. Warmer average temperatures mean that there is less time that the ice is thick enough to travel on. Ice-on is occurring later and ice-off is occurring earlier. Ice breakup is also occurring differently. Ice used to break up in large chunks and was a fairly dynamic process. In recent years however, the breakup has been more thermal, with ice

becoming soft and dissipating slowly. Thin ice can be very dangerous for residents.[348]
Residents have also had recent trouble traveling the river by boat, and noted that the river has become shallower, especially upstream of Kiana. Residents recall being able to travel to Kiana without trouble but now need to take special precautions.[349]

Caribou is the most important food resource of these communities, but a wide range of food is harvested by the community. Climate change has been threatening these food harvests, which has put pressure on the communities and harmed food security in the region. For example, caribou harvests have become less reliable. In more extreme cases of caribou being unavailable, residents have turned to other food sources such as moose and whitefish. The most common reasons for the lack of available caribou are distance from the community, scarcity, and changing migration patterns, all of which are worsened by climate change.[350]

A warmer climate also puts pressure on the section of the local diet that is filled by fish. Different types of fish are being caught near the community. A high population of pink salmon is replacing chum salmon in the community. This change is believed to be due to the warming river temperature, which puts pressure on species like chum salmon while benefiting others such as pink salmon. Additionally, warmer temperatures are putting pressures on traditional preparation and storage techniques. Warmer temperature are shortening the window of time that the residents can dry their whitefish. The warmer temperatures are also causing fish left out to age to spoil. This all results in less food security for the communities.[351]

Selawik

Overview

Location

Selawik is an Alaskan town located at the mouth of the Selawik River, approximately 90 miles southeast of the city of Kotzebue, in the northwestern region of Alaska, incorporated in 1977.[352] The village spans three riverbanks linked by bridges, and it's considered one of the largest villages in the region. Selawik is located in a biologically and ecologically important area, near the Selawik National Wildlife Refuge, a key breeding and resting sport for migratory waterfowl.[353] The total area is approximately 3 square miles with an additional square mile of water. The precise coordinate of Selawik are latitude 66°35′49″N and longitude 160°0′49″W.

Demographics

As of 2020, the population of Selawik is 865. Similar to most western villages in Alaska, the demographics of Selawik is predominantly Alaska native (96.1 percent), and it is considered the 32nd largest city in Alaska. According to the most recent census from 2010, the population has increased 4.34 percent.[354] The average household income in Selawik is estimated at $43,893 with a poverty rate of 46.6 percent. The median rental costs is approximately $800 per month, and the median house value is $75,000. The median age in Selawik is 24 years.

Climate/Weather

Selawik is located in the transitional climate zone, which is characterized by long, cold winters and mild summers.[355] Temperatures in Selawik averages -10 to 15 degrees Fahrenheit during winter, and 40 to 65 degrees Fahrenheit during summer. However, temperatures as low as -50 degrees and as high as 85 degrees have also been reported. The Selawik River surrounds the city, and it is only navigable during the months of June to mid-October.[356]

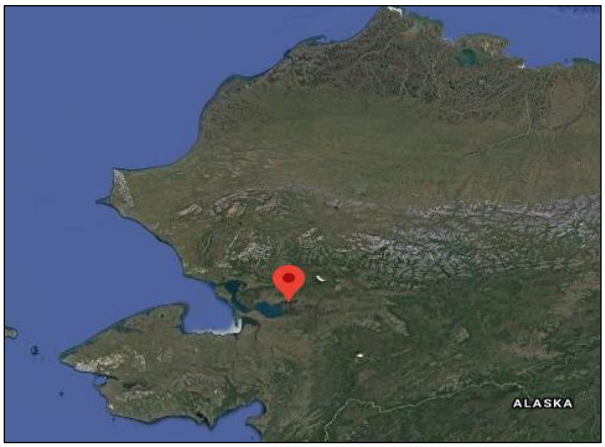


Figure 1. Selawik

Municipal Utilities & Services

Electricity is provided by the Alaska Village Electrical Cooperative.[357] Power is mostly produced by a 1,686 kW diesel power plant and a 200kW derived from wind turbines. According to the Northwest Artic Strategic Plan, the current usable fuel storage capacity in Selawik by tank farm owner: AVEC (272,834 gallons); IRA Store (258,100); Northwest Arctic Schools (92,900); HUD Housing (26,000); Rotman Stores (9,800), Army National Guard (8,500); Alaska Dept. of Transportation and Public Facilities (2,500).[358] Given the costs associated to the transportation and consumption of energy in the

Selawik area, alternative methods have been studied[359] such as the viability of geothermal or hydroelectric production. However, it was concluded that heating oil and diesel would likely remain the primary source of fuel for Selawik. Wind energy production could be expanded, and a possible intertie line between Selawik and Kiana is also viable according to the study.

Water and sewing system is managed by the Alaska Rural Utility Collaborative (ARUC), a non-profit consortium. Because the pipes were built above ground, frozen pipes have become a chronic, costly problem for the village of Selawik.[360] The Davis-Ramoth Memorial School, operated by the Northwest Artic Borough School District (NAB) serves the community and enrolls 270 students, teaching grades from kinder to 12th, and employs 20-49 people.

Other remarkable infrastructures in Selawik includes the Selawik City Office, the Police Department and the US Fish & Wildlife Service office, all employing between 10-19 people at any given point.[361]

Figure 2. Exposed Water Pipes Can Be Seen Throughout the Village

Figure 3. Students and Faculty Member at the Davis-Ramoth Memorial School

Accessibility

Transportation Links

The Selawik Airport (WLK) is a state-owned airport with two runways available; a smaller gravel runway measuring 2,659 feet long and a larger gravel runway measuring 3,002 feet long. As of December 2016, there was an average of 110 aircraft operations per week at WLK, all for civilian purposes.[362] This airport has been in operation since 1958, and is primarily served by the airline companies Bering Air[363] and Ravn Alaska[364], with the city of Kotzebue being the primary destination.

Figure 4. Selawik Airport (WLK)

According to the American Community Survey (ACS 5-year estimate), 49.65 percent of Selawik's residents walk as their primary method of transportation, followed by other (47.6 percent), which includes All-Terrain Vehicles (ATVs), boats, and snow machines. The mean travel time to work was estimated at 10.1 minutes.[365]

Selawik's residential area is basically divided in three sections;[366] the "school side," the "church side," and the "airport side." All three areas are connected through board roads which is used by pedestrians and ATV's drivers. In addition, there are two large bridges in Selawik: the Rainbow Bridge and Airport Bridge, which were built in the 1980's.

The primary transportation route for Selawik is the Selawik River, which is navigable with boats in summer, and use of snow machines in winter is encouraged. However, the receding ice makes traveling through the river more difficult and hazardous and locals must adapt to these changes. Subsistence activities patterns have also changed with the amount of harvested fish. Residents report a shorter season for drying fish and increasingly having to discard fish because of warming related spoiling.[367]

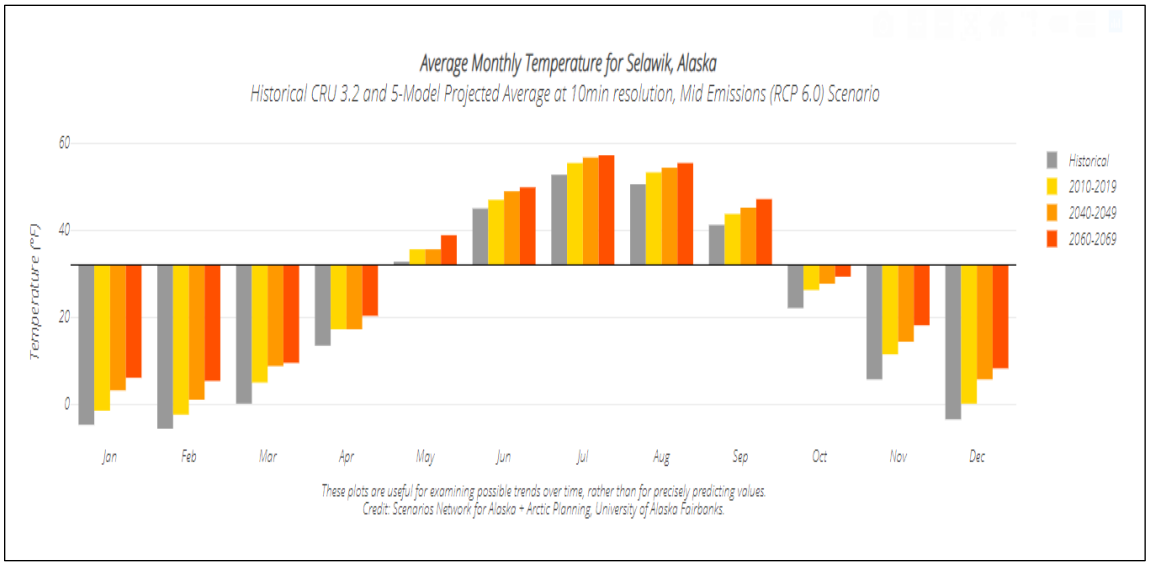


Figure 5. Average Monthly Temperature in Selawik, AK: Historical (2010-2019) and Projected (2040-2069)

Seasonal Constraints

Staked winter trails link Noorvik with Selawik, Kiana, Kotzebue, and points beyond. In some years, a winter road is plowed on the ice between Noorvik and Kotzebue, enabling residents to drive vehicles between the two towns.[368] Contrary to most other villages in western Alaska, Selawik does not have a system of roads; instead, it relies on boardwalks, making it impossible to drive cars or trucks within the community[369].

Port Characteristics

Port Infrastructure

There are no formal ports in the city of Selawik. Imported freight and fuel are first lightered 15 miles from the shore of Kotzebue, then shipped to Selawik's Barge Landing Area[370] on the Selawik River. The landing area is located approximately 1,400 feet north-northwest of the David-Ramoth School, and features a gravel pad of about 100 feet by 200 feet for staging materials, along a 3,000-foot-long gravel-surfaced access ramp.[371] Fuel and equipment are typically barged each summer.

The Selawik River is shallow at the mouth, but sufficiently deep in the main part of the river. The primary barge landing area consists of a gravel access road that leads to the river and a 60-foot-wide beach landing area.[372]

Vessel Count

No official or reliable data could be found related to the count of vessels arriving or departing the village of Selawik.

Vessel Characteristics

No official or reliable data could be found related to the characteristics of vessels arriving or departing the village of Selawik.

Barge Operators

The main barge operators in Selawik are Alaska Marine Lines, which mostly transports freight from Seattle and Kotzebue into the region[373], and Crowley Marine, which delivers fuel to Selawik. However,

sometimes fuel is delivered by airplane due to the extreme shallow waters surrounding Selawik, greatly increasing the cost of fuel[374], up to $5 per gallon.[375] It is common for electric rates to be more than $0.50 per kWh, four times higher than urban residents.

Main Imports/Exports

No specific data related to the amount or characteristics of exports or imports could be found for the Selawik village. However, the main barge operator in the region, Alaska Marine Line is dedicated to the transportation of construction, heavy machinery, perishable and other goods. Given its proximity to Kotzebue, it can be inferred that many of the goods imported by the city of Kotzebue are also imported by the regional villages in the Northwest Artic Borough.

Figure 6. Selawik's National Wildlife Refuge

Local Economy

Major Employers

Selawik's economy is a mix of cash and subsistence activities.[376] The primary employers in the community include the school, the City, the IRA, Maniilaq and three grocery stores. Handicrafts are made and sold locally and at gift shops in larger cities. According to the ACS 2012-2016 5-year estimate, the median age was 23 years old; the median income was $53,750, with a population of 494 people working and 281 persons in families in poverty. At the time of the survey, the primary occupations for residents were educational services (35), public administration (31), and retail trade (21).[377]

Selawik's tourism is primarily based on their Wildlife Refuge, which is not accessible by road but by boats, snowmobiles, dogsleds or small aircrafts. The majority of tourist visit the Refuge during the fall hunting season, typically late August to late September, when non-local hunters visit to pursue caribou, moose and brown bears. The Selawik Hot Springs can also be visited during early spring.[378]

Subsistence Activities

Similar to other western towns in Alaska, the population of Selawik relies heavily on subsistence activities such as fishing and hunting; their diet consists mostly of whitefish, sheefish, caribou, moose, ducks, ptarmigan, and berries. Occasionally, seals and beluga whales will also supplement their diet. Residents are primarily employed by the local school, the City and three grocery stores, as well as the production of handicrafts which is sold locally and to larger cities. In addition, some residents choose to work on a seasonal basis outside of Selawik in places such as the Red Dog Mine.[379]

Climate change is affecting food availability and traditional preservation practices. The most important subsistence species in Selawik are large land mammals and fish. Over 50 percent of the annual harvest is composed of large land mammals, mostly caribou. The rest is non-salmon fish species including pike, sheefish and white fish. In 2006 fish harvest for Selawik exceed 115,000 pounds, comprising over 40 percent of the total wild food harvest (ADF&G 2006). The high cost of market foods underlines the economic importance of subsistence. As of April 2012 a box of milk in Selawik costs $3.69, a dozen eggs is $4.09, a loaf of Wonder bread is over $2.00 and a large container of Tang is $20.00.

The high costs related to imported food underlines the importance of economic subsistence in the area; hence, subsistence activities and local economy are closely related in Selawik.
Over 50 percent of the annual harvest is made up of large land mammals such as caribou.
The rest of the annual harvest of residents comes mostly from non-salmon fishes such as the pike, sheefish and white fish. An excess of 115,000 pounds of fish meat was harvested in 2006, comprising well over 40 percent of the total wild food consumed by residents at Selawik.[380]

Planning and Future Growth

In 2011, Alaska's Environmental Conservation agency published a report[381] detailing the state of the landing area, which was classified as inadequate and potentially dangerous for environmental purposes. During inspection, "limited screening and sampling did not suggest that large releases of contaminants have occurred, but several potential sources of contaminants are present at the Barge Landing. Improvements to facilities are requested on a continuous basis.[382]

Environment

Environmental Justice

Similar to other villages along the western coast of Alaska, the city of Selawik is also vulnerable to climate change, which disproportionally affects the northern and northwestern region of Alaska.

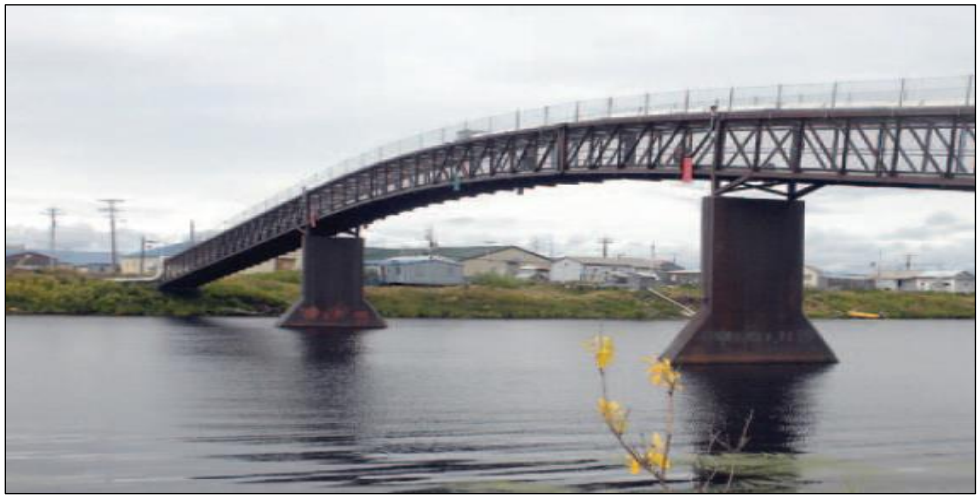


Figure 7. Rainbow Bridge is Gradually Sinking into the Selawik River

Water/Air Quality

The community is concerned about their overall health as Selawik continues to warm.
For instance, warming and thawing of permafrost is also associated with vegetation change,

as well as to rupture of pipes and other vital infrastructure, making them vulnerable to waterborne disease vectors, such beavers which can carry the parasite *Giardia lamblia*. To prevent potential illnesses, residents have resorted to boiling water before its use. According to the Scenarios Network for Alaska (SNAP), warmer, drier spring weather may also be an indicator for increased fire risk. Warmer winters may favor growth of species that are less cold-hardy (including desirable crops and invasive species), or it may decrease snowpack and increase the frequency of rain-on-snow events that impact wildlife.[383]

Natural Resources Available

The Selawik Refuge is a vast complex of wetlands and lowlands that provide rich habitat for many plants and animals. At over two million acres, the Selawik Refuge is geographically located where the boreal forest meets Alaska's tundra, thus providing a unique ecology.

The National Wildlife Refuge contains more than two million acres of land and hosts over 244,000 animals, such as bears, moose and muskoxen[384], and some on a seasonal basis, such as the caribou herd.[385]

During the spring, birds migrate to the Selawik Refuge to nest including the ptarmigan, jays, and snow buntings. The Refuge is also home to the Kobuk River, as well as the lower portion of the Selawik River, where fish population are abundant. The predominant species are sheefish, salmons, the northern pike, and the whitefish. It is also important to note that the ability of many large animals to thrive in this region is only possible by the small animals such as dragonflies and other invertebrates, including insect larvae and zooplankton, which is found in the water and feeds many small fishes and birds.[386]

Effects of Climate Change

The specific threats of climate change to the city of Selawik could be summarized under the following five broad categories:[387]

- Permafrost thaw**:** as seasonal warming continues to increase over time, there is less permafrost in the ground, causing damages to home dwellings, utilities and other critical infrastructure. As an example, the Rainbow Bridge, one of the handful of bridges in Selawik, had sunk about 2.5 feet since its construction in 1981.
- Riverbank erosion: As of 2011, there was an estimated 36 homes deemed at high risk of erosion, with some areas losing several feet each year. According to the American Community Survey (ACS). Some of the main contributors to the river erosion are the natural river flow, flooding, ice jams, spring break-up, vehicles, barges and boat traffic, and melting permafrost. The shoreline also experiences erosion, mostly naturally, from storms, winds, waves, and melting permafrost. Some of the potential damages from this erosion includes, but is not limited to, dwellings, water tanks, fuel tanks, food storage areas, roads and boardwalks, which residents rely upon heavily to walk around town. An extensive erosion assessment was conducted by the US Army Corps of Engineers (USACE) in 2007.[388]
- Pollution motion and river contamination: Residents are concerned that, as riverbanks continue to thaw and erode, natural pollutants (i.e. mercury) and non-natural pollutants (i.e. dump waste) can make its way to the Selawik River, which is the community primary source for fishing and drinking water.
- Travel hazards: Resident's method of transportation varies according to the season in Selawik. For instance, during summer, the Selawik River serves as an important mean of transportation.

During winter, the same river is traveled by snow-machines. As the ice-season becomes shorter and warmer, it is becoming more dangerous to use these routes as the ice becomes less thick and less predictable.

- Potable water contamination: The possibility of contamination on Selawik's streams and springs continue to worry residents. To avoid waterborne illnesses, residents rely on appropriate filters and treatment systems if available, in addition to the constant boil of water before its consumption is deemed safe.

There are some benefits to the receding ice in the area surrounding Selawik nonetheless.
For instance, less ice accumulation and longer ice-free waters increases the potential for new food resources, a longer boating season, and less ice jam flooding, which in turn contributes to less erosion, and warmer summer days.

North Slope Borough

Kaktovik

Overview

Location

The city of Kaktovik is a small and isolated Inupiat village on the northeastern shore of Barter Island, a six square mile tundra plateau along the Beaufort Sea coast. The village encompasses 0.8 square miles of land and is located at latitude 70°7′58″ N and longitude 143°36′58″ W. It is roughly 70 miles west of the Canadian border and 310 miles southeast of Utqiagvik. The village also lies along the northern edge of the Arctic National Wildlife Refuge (ANWR).

Demographics

The population of Kaktovik is approximately 246.[389] The median household income is around $53,750 and the median property value is roughly $100,000.[390,391] About 90 percent of the population is Alaska Native.[392]

Figure 1. Kaktovik

Climate/Weather

Kaktovik is located in an arctic environment with an average temperature of around 10 degrees Fahrenheit. In an area classified as a polar desert, Kaktovik receives little precipitation throughout the year. On average, Kaktovik receives roughly 6.4 inches of precipitation, including 35 inches of snowfall every year.[393] Annual wind speeds in Kaktovik average 17 miles per hour.[394]

Municipal Utilities & Services

The North Slope Borough (NSB) provides electricity, water, sewer, and trash services. The town relies on diesel-fired generators to provide electricity, and diesel is also the main source of fuel for heating residences and buildings. The village encompasses 8.4 miles of gravel road.[395] It has a school, fire station, health clinic, post office, and local store that sells groceries, clothing, first-aid, hardware, and sporting goods.[396]

Figure 2. Port of Kaktovik

Accessibility

Transportation Links

Kaktovik is accessible year-round by plane. There are airline and air taxi services to and from Utqiagvik and Fairbanks. The airport at Deadhorse (about 100 miles to the west) provides many of the connections to and from Kaktovik. In the 2017 calendar year, Kaktovik emplaned 3,212 passengers and 85,595 pounds of cargo (freight and mail) and deplaned 3,392 passengers and more than 1.2 million pounds of cargo.[397]

There are no road connections to the mainland or to other communities on the North Slope. In 2015, the NSB proposed a road linking the village to Prudhoe Bay and Deadhorse to the west, connecting the village to the Alaska road system.[398] No such connecting road currently exists.

The U.S. Air Force owns the Barter Island Long Range Radar Service Airport (BTI), an airstrip immediately northeast of the village that is roughly 4,800 feet long. Although owned by the Air Force, the Barter Island airport is managed by the NSB. The largest aircraft to undergo 500 annual flight operations (250 flights) at Kaktovik is the Beechcraft 1900.[399] The airstrip lies roughly two feet above sea level and experiences recurring flooding, which has led Kaktovik to construct a 4,500 foot gravel airstrip on higher ground south of town.[400]

Seasonal Constraints

In the winter of 2018, the NSB created 300 miles of seasonal roads connecting two North Slope communities to the Dalton Highway, but Kaktovik was not among them.[401]

Port Characteristics

Port Infrastructure

Kaktovik does not have a formal port facility, so vessel landings occur on the nearby beach in front of the village's tank farm.[402] The village has a marine header where barge operators can offload fuel. Cargo is offloaded on the beach, and then hauled into the village. Frequent strong winds, strong currents, and the presence of polar bears in the area can make landings difficult. The lack of infrastructure to help manage these challenges can make deliveries time-consuming and hazardous.[403]

Vessel Count

Kaktovik is a highly isolated community and barge access is limited. There were 32 vessel arrivals between nine unique vessels from January 2017 through September 2018.[404] This is likely due to the village's location on the Beaufort Sea, which makes it more susceptible to the colder Arctic waters than other communities in the study area because it is not influenced by the warmer currents of the Chukchi Sea. As a result, Kaktovik experiences shore-fast ice roughly nine months a year.

Vessel Characteristics

Between late summer and early fall, when weather conditions are favorable, shallow draft vessels with roll-on/roll-off capability are beached in front of village.

Barge Operators

- Alaska Marine Lines (AML) provides marine support services to Kaktovik.[405] AML's main barge service comes once a year from Seattle, WA, and Anchorage, AK, and delivers 3,000 to 5,000 tons to communities along the Alaskan coast, including Kaktovik. This service usually takes place in July.[406]
- Bowhead Transport Company (BTC), a subsidiary of the Ukpeagvik Inupiat Corporation (UIC), has been providing marine support services to the North Slope for more than 30 years.[407]
- Crowley Maritime provides small barge service to Kaktovik.[408]

Main Imports

Kaktovik imports food, fuel, supplies, and materials by barge. The fuels available in Kaktovik include marine gas, diesel, propane, and unleaded gas. Mail and fresh food items arrive by plane from Prudhoe Bay. While Kaktovik has both air and marine transportation access, for most of the year the village is solely dependent on air transportation services, which come at a disproportionately high cost to residents.

Local Economy

Major Employers

Government jobs account for 68.9 percent of the jobs in Kaktovik. The largest share of employment takes place in the following industries: public administration (32.8 percent); educational services, health care, and social assistance (14.8 percent); transportation and warehousing, and utilities (14.8 percent); and professional, scientific, and management, and administrative and waste management services (11.5 percent). The unemployment rate is approximately 16.4 percent[409] and 6.9 percent of the village population is below the poverty level.[410]

Residents rely on a variety of sources to support their way of life. In addition to subsistence activities and standard wage work and wage labor, villagers depend on bartering or sharing food and services with other members of the community. They also rely on dividends from the Alaska Permanent Fund, the Kaktovik Inupiat Corporation (KIC), and the Arctic Slope Regional Corporation (ASRC).[411] There has been an increase in small-scale ecotourism businesses. Changing ice conditions has led to an increase of polar bears appearing on shore in and around Kaktovik. Polar bear viewing is most popular between August and October when whale remains are brought ashore. In 2017 alone, Kaktovik had more than 2,000 visitors.[412] This has provided new work opportunities for residents to serve as tourist guides.[413] Kaktovik is also a common stopping point for visitors going to and from the ANWR.

Subsistence Activities

Kaktovik rely on a number of subsistence resources, either for sustenance, clothing, tools, and crafts. Bowhead whaling season in Kaktovik is from late summer to early fall, usually peaking in September. One of the two essential feeding areas for bowhead whales is the waters between Barter Island and the border with Canada. Beluga whales are also a main food source. Residents use ringed[414] and bearded[415] seals for supplemental food, clothing, equipment, and crafts. The community also relies on caribou, which locals can hunt year-round but are most plentiful from July through September. According to a 2015 NSB census report, 96.6 percent of Inupiat households used subsistence food.[416] Most of what is harvested stays in Kaktovik. About 97.9 percent of food obtained from local harvesting is shared locally, with only 2.1 percent being shared outside of the village.[417]

Port Planning and Future Growth

Kaktovik's population is projected to grow to anywhere between 289 and 320 inhabitants by 2035.[418] The cost to extend infrastructure in Kaktovik is the lowest among North Slope communities, since Kaktovik has already extended residential roads to a new subdivision. The town has also constructed a new landfill and sewage lagoon. There are roughly 129 lots available for development at an average cost of $317,203 per lot, which includes the cost of installing road, water, sewer, and electrical infrastructure.[419] The average subdivision development cost for the North Slope as a whole (including Kaktovik) is $562,439. A wind project design has been funded to evaluate the cost effectiveness of harnessing wind energy, and the NSB has identified solar power as another potential candidate to help meet the village's energy needs.

The main source of fresh water comes from a 9-foot-deep lake roughly 0.7 miles from the village called Fresh Water Lake. Water is pumped into a treatment facility in the summer and then sent to storage tanks. The village has a water storage capacity of 3.5 million gallons, but the NSB has identified the need to upgrade or replace the storage tanks to accommodate 5 million gallons for year-round access.[420] Some residents have expressed concern over potential water contamination from the new airport and from other development activities. The local government has sought to prevent the use of the land around the lake because of these concerns.

Environment

Environmental Justice

Environmental Justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.[421] Consequently, proposed activities need to be mindful of the impact on Alaska Native communities. These communities are usually comprised of low-income and minority populations and are more at risk to experience the negative

consequences of global climate change and economic development.

In 2017, Congress passed and President Donald Trump signed a tax overhaul bill that included a provision to open up the 1002 Area of the ANWR to energy development by authorizing oil and gas lease sales, which would allow drilling to take place in relatively close proximity to Kaktovik. As a result, oil and gas exploration is a divisive topic in Kaktovik. In a 2019 poll, slightly more than half of residents surveyed supported development activity in ANWR's coastal plain, while 32 percent were opposed and 16 percent were unsure.[422] While a majority of surveyed residents of Kaktovik supported the idea of mainland energy exploration and development, they largely rejected offshore drilling and seismic activity.[423]

The Gwich'in tribe, a neighboring Athabascan people group, have voiced strong opposition to oil and gas development on the coastal plan. Although they inhabit the southern portion of ANWR, the Gwich'in people have expressed concerns that development could disturb the Porcupine caribou herd which they rely on for food and for cultural practices.[424]

These issues can be further discussed with residents and representatives of Kaktovik. Jerry Sikvayugak is a member of the NSB Assembly and represents Kaktovik. They can be contacted via Sheila Burke, Borough Clerk, at (907) 852-0360.

Water/Air Quality

No readily available information on the water and air quality in Kaktovik, although the NSB found in 2019 that the air and water quality throughout the borough is generally good.[425]

Natural Resources Available

The nearby coastal plain, designated the 1002 Area of the ANWR covers an area of 1.5 million acres and, according to a U.S. Geological Survey (USGS) assessment, contains 10.4 billion barrels of technically recoverable crude oil resources in the area. The USGS suggested there was a 5 percent chance of fewer than 5.7 billion barrels and a 5 percent chance of more than 16 billion barrels.[426]

Effects of Climate Change

Coastal erosion occurs during the summertime around Kaktovik. Declining sea ice cover and an increase in summertime sea surface temperature has lengthened the period in which nearby waters of the Beaufort Sea are free of ice, thus exposing the shoreline to wave action for a longer period of time. Thawing permafrost from higher ambient air temperatures has also made the bluffs more vulnerable to erosion. In 2019, the USGS found that the coastal bluffs near Kaktovik had thawed by mid-July and were exposed to a high rate of erosion from storm tides and wave activity for the remainder of the summertime. However, a 2006 study by the U.S. Army Corps of Engineers concluded that erosion was not a threat to the town in the foreseeable future (more than 100 years) and that there was no need for residents to relocate.[427]

Point Hope

Overview

Location

Point Hope is an Inupiat village at the western tip of the Tigara Peninsula (part of the larger Lisburne Peninsula) on a spit that extends fifteen miles into the Chukchi Sea. The town is located at latitude 68° 20′ 49″ N and longitude 166° 45′ 47″ W. Point Hope is considered one of the longest continuously-inhabited areas along North America. Human presence can be traced back 2,000 years, when it is posited that inhabitants of Siberia crossed the land bridge to take advantage of the abundance of bowhead whales. The town encompasses 6.3 square miles of land and 0.1 square miles of water. Point Hope is 149 miles northwest of Kotzebue and 330 miles southwest of Utqiagvik. The spit on which Point Hope lies is comprised of sediment from the Kukpuk River.[428] The community of Point Hope was officially incorporated in 1966.

Figure 1. Point Hope

Demographics

Point Hope has approximately 749 inhabitants, overwhelmingly of the Inupiat ethnicity (nearly 93 percent). Median household income in Point Hope is $60,208.

Climate/Weather

Point Hope lies 125 miles north of the Arctic Circle. It exists in an arctic climate with an extreme temperature range from -49 degrees Fahrenheit in the winter to 78 degrees in the summer. Winters are long; summers are short but warm. The community receives 10 inches of precipitation annually, including 36 inches of snow.[429] Winds typically range from a light breeze to a strong breeze. Winds rarely exceed 42 miles per hour.

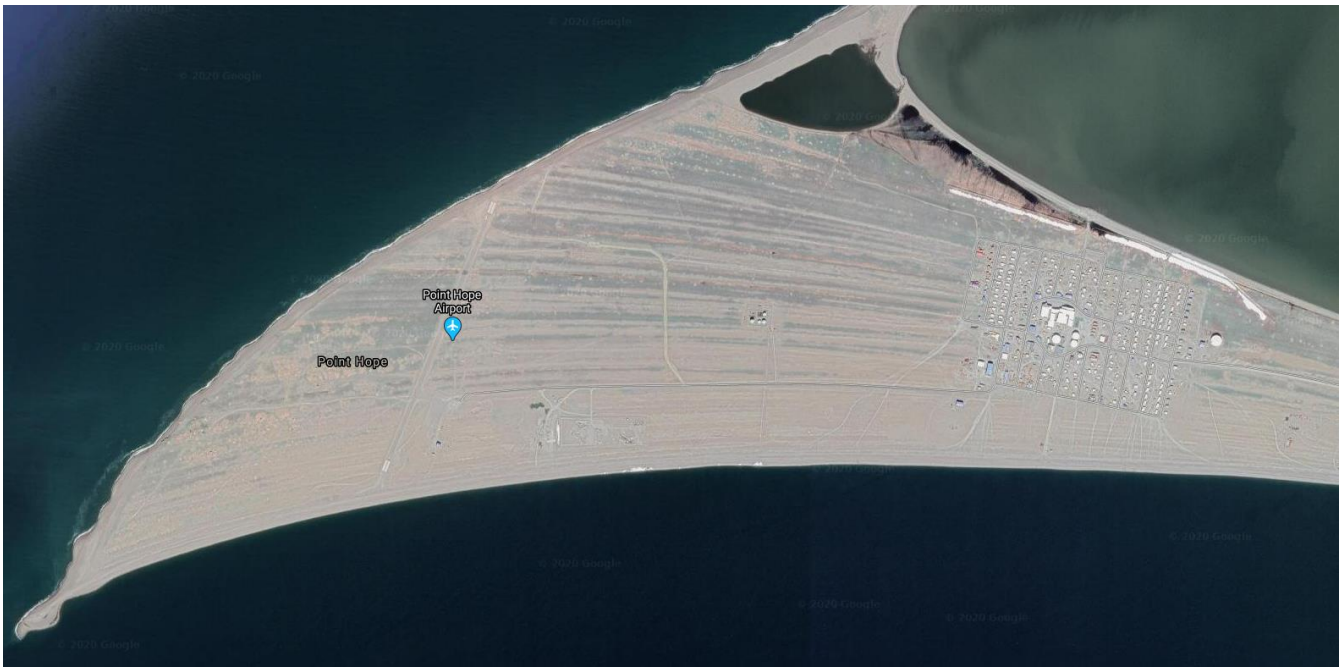


Figure 2. Port of Point Hope

Municipal Utilities & Services

The North Slope Borough (NSB) provides water and wastewater treatment facilities to Point Hope. The town has a vacuum pump waste disposal system. The NSB also owns and runs the facilities that provide power to Point Hope through diesel-powered generators. The Maniilaq Association offers health and social services to the residents of Point Hope.[430] The community has more than 14 miles of mostly gravel roads.[431]

Accessibility

Transportation Links

Point Hope has a 3,992-foot-long paved, unattended airstrip (PHO) that is owned by the State of Alaska. There are twice-weekly non-direct flights to Utqiagvik's Wiley Post-Will Rogers Memorial Airport.[432] These flights typically include a stop at Point Lay. Bering Air and Ravn Air are the main providers of air transportation services for Point Hope. Bering Air offers a flight to Kotzebue. The average price for a roundtrip flight between Point Hope and Utqiagvik is $852. The average price for a roundtrip flight between Point Hope and Kotzebue is $504.[433]

The 7 Mile Road provides an evacuation route in the case of an emergency. Otherwise, transportation methods mainly include boats and snow machines that transport goods from barges landing ashore during warmer months.[434] Trucks and ATVs frequently use these roads to travel inland during warmer months. No roads lead outside of the community.

Community members mainly rely on air and water travel due to the lack of road infrastructure. Vessel traffic has been steadily increasing due to increasingly ice-free conditions for longer durations. Native-made vessels are frequently used by locals to travel in both low-ice and no-ice conditions.[435]

Figure 3. Aerial Perspective of Point Hope

Seasonal Constraints

Point hope is only accessible via barge in the summer months when waters are free of ice.

Port Characteristics

Port Infrastructure

Point Hope receives much of its supplies via barges, which offload onto a beach consisting of sand and gravel that can only withstand barge dockings. Point Hope has a controlling depth of 40 feet, which allows fairly easy barge access. Due to the beach's makeup, offloading of fuel and cargo can prove difficult, but is achieved through the use of platform ramps and hoses to move the fuel into tanks.

Point Hope overall lacks infrastructure, and barge operators frequently adjust their unloading options to suit the weather and water conditions. Most operators believe that a permanent unloading facility would hinder them rather than help them due to the difficulty managing environmental conditions. [436] Beach landings occur during the summer months when the shore is free of ice.

Vessel Count

From 2017 through 2018, there were 438 unique arrivals in Point Hope between 29 different vessels.[437]

Vessel Characteristics

Community members of Point Hope frequently use personal vessels created from skins and other materials harvested from subsistence activities. Otherwise, the most common vessels are cargo barges, which deliver supplies and fuel to the village. The barges frequently ship from Seattle, and have grown in number due to increasingly ice-free conditions, allowing for greater amounts of cargo to be delivered and more frequent shipments.[438]

Barge Operators

Alaska Marine Lines (AML) provides marine support services to Point Hope.[439]
Bowhead Transport Company (BTC), a subsidiary of the Ukpeagvik Inupiat Corporation (UIC), is a

marine common carrier that has served the North Slope since 1982. BTC offers barge and lighterage services to Point Hope.[440]

Main Imports/Exports
Given the seasonality of barge deliveries, residents largely rely on planes to deliver food items.

Point Hope imports a number of commodities by barge, however, including:

- Food;
- Fuel; and
- Household goods and supplies.

Local Economy

Major Employers
Local government employs most of the people in the community (around 57 percent). Others are employed with local for-profit corporations dedicated to maintaining Inupiat heritage. The main village corporation, Tikigaq, operates the local stores, selling essential goods. There are 19 active business licenses in Point Hope, among them are a small number of companies that focus on subsistence activity, lodging, and food and/or groceries. Nevertheless, unemployment is high and job opportunities are scarce. In the North Slope, Point Hope has one of the lowest proportions of household heads with full-time employment (only 38 percent).[441]

Subsistence Activities
The local economy in Point Hope relies heavily on subsistence activities. Point Hope location is advantageous for spotting migrating whales and walruses. The spring whaling season typically begins in early May. The bowhead whale is considered sacred to the people of Point Hope and is a frequent food source, along with other fish and wildlife. Residents harvest caribou, seals, fish, birds, and berries. The foods and resources brought in from subsistence hunts and fishing go towards feeding the residents and providing them with materials with which to engage in traditional crafts. Some of the products that are frequently sold in local stores are parkas, harpoons, spears, masks, baskets, and carved ivory.[442]

Because of the community's reliance on subsistence lifestyles, many members leave the community for months to participate in fishing and whaling. Additionally, families of those employed seasonally (such as those employed by the educational system) may leave the area during their months off.[443]

Planning and Future Growth
Local trails exist for the purpose of subsistence activities. The members of Point Hope have long petitioned for better access and construction, and have received grants that will be put towards making safer roads and trails.[444]

Environment

Environmental Justice
Environmental Justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.[445] Consequently, proposed activities need to be mindful of the impact on Alaska Native communities. These communities are usually comprised of low-income and minority populations and are more at risk to experience the negative consequences of global climate change and economic development.

During the Cold War, plans emerged to detonate a nuclear bomb in Cape Thompson, only miles from Point Hope, in order to create a harbor. The purpose of the project (dubbed "Operation Plowshare") was to showcase the peaceful usage of a nuclear weapon. After the project fell through due to opposition from the community of Point Hope, select U.S. government officials pushed to conduct Project Chariot, which sought to prove the ways in which nuclear weapons could be used as an effective tool and energy source for human and community development. This also failed to come to fruition, but despite the opposition, radioactive materials were leached into the water and soil in order to test the effects prior to the project's supposed initiation. The effects can be felt today in surrounding animal and human populations, with studies showing high concentrations of radioactive isotopes in both. To this day, Point Hope residents are attempting to receive compensation and justice for the longstanding consequences of these experiments.[446]

This issue can be further discussed with residents and representatives of Point Hope. Steve Oomittuk is the community's current representative on the NSB Assembly. They can be contacted via Sheila Burke, Borough Clerk, at (907) 852-0360.

Figure 4. Remains of Project Chariot

Natural Resources Available

There are coal deposits within 36 miles of Point Hope.

Effects of Climate Change

While vessel traffic increases have brought positive change to the community, the consequences of melting ice conditions have led to coastal erosion and increased risk of storm surges. Like other

villages of its kind, it is at risk for coastal erosion and flooding, which led to relocation to higher elevations in the 1970s.[447] Local residents of Point Hope continue to face the threat of coastal erosion, as it occupies a relatively narrow spit of land that extents miles into the Chukchi Sea. Much of the damage is frequently felt by the already fragile infrastructure of the village. Subsistence lifestyles have also been compromised due to the effects the melting ice has on key food sources, such as whales and walruses.

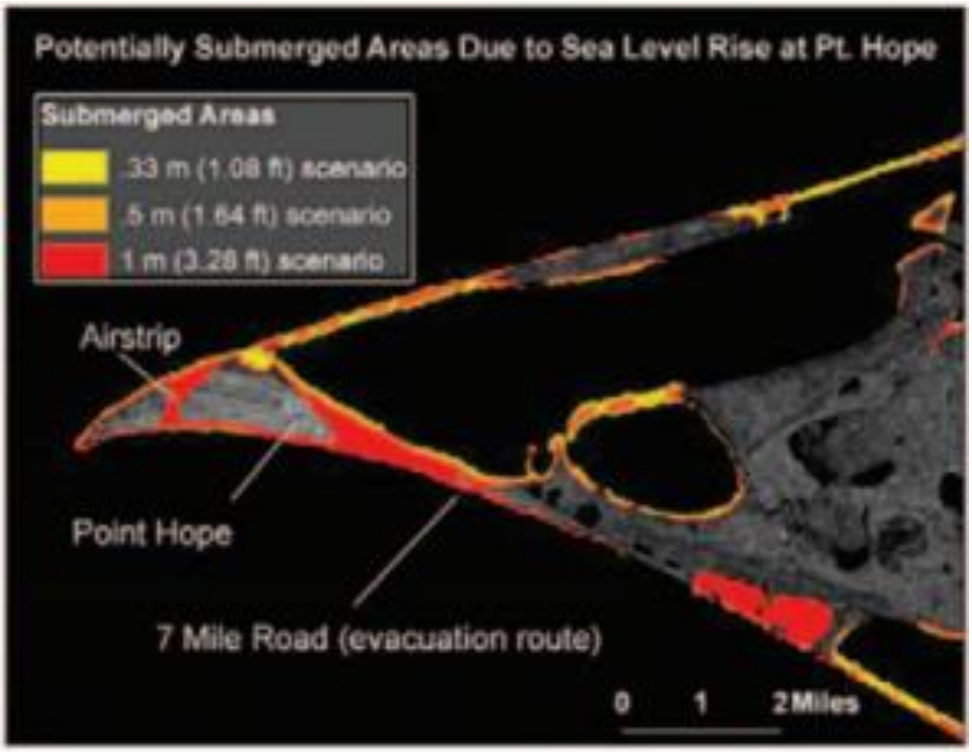


Figure 5. Potentially Submerged Areas Due to Sea Level Rise

Other hazards that have resulted from the changing environmental conditions include threats from invasive species and polar bears, diseases, and algal blooms toxifying the water sources.
The community has relocated due to the conditions, and remains challenged by their frequent exposure to storms and erosion. [448]

Near Point Hope, there is the Ipiutak Site, a village with more than 500 prehistoric ruined houses.[449] Due to the longevity of human habitation in the area, Point Hope contains prehistoric landmarks, with some housing structures dating back to 500 BC. The historical sites are considered a part of the National Register of Historic Places. Severe fall storms and flooding threaten this ruined site.

Point Lay

Overview

Location

Point Lay is an unincorporated municipality located in the northern slope region of Alaska, east to the Chukchi Sea, protected from the ocean by the Kasugaluk Lagoon, and approximately 300 miles southwest of the city of Barrow (Utqiaġvik).[450] The village in itself is geographically protected from the open ocean by a narrow strip of barrier reef islands, followed by Kasegaluk Lagoon which stretches vertically approximately 125 miles.[451] The precise coordinates of the village of Point Lay are latitude 69°44′28″N and longitude 163°0′31″W.

Figure 1. Point Lay

Demographics

As of 2017, the estimated population was 287[452], and 89.7 percent of all residents were considered Iñupiat. Point Lay is considered one of the most remote villages in Alaska, and its economy is primarily based on subsistence hunting, fishing and whaling with seventy-eight percent of the workers employed by the public sector.[453] The median age in Point Lay is approximately 20 years old. The poverty rate is around 20 percent, the median household income is approximately $60,000, and the median property value is around $76,700 with an ownership rate of 38.8 percent.

Climate/Weather

The winter temperatures range from zero degrees Fahrenheit to -20 degrees Fahrenheit on average. The summer temperatures range from 30 degrees to 50 degrees Fahrenheit.[454] Like most of Alaska, the village of Point Lay is also experiencing warmer weather, and with it swift ecological changes. Climate change is considered the greatest challenge for the residents of Point Lay along with their subsistence activities. In fact, the northwest Arctic experienced a 3.2 degrees Fahrenheit increase in average annual temperatures between 1949 and 2006.[455]

Figure 2. Aerial Perspective of Point Lay

Municipal Utilities & Services

Similar to other villages in the Northwest Artic region, the North Slope Borough (NSB) provides public electricity and water/sewer services, which also includes free trash pick-up services.[456] A health clinic, located in 210 Qatalik Avenue, was established in 2009 and employs about 5 people year-round[457]. The NSB School District operates the Kali School, which serves kindergarten through twelfth grade students. Other facilities in Point Lay include the community center, police station, and a fire station equipped with fire engines and an ambulance.[458]

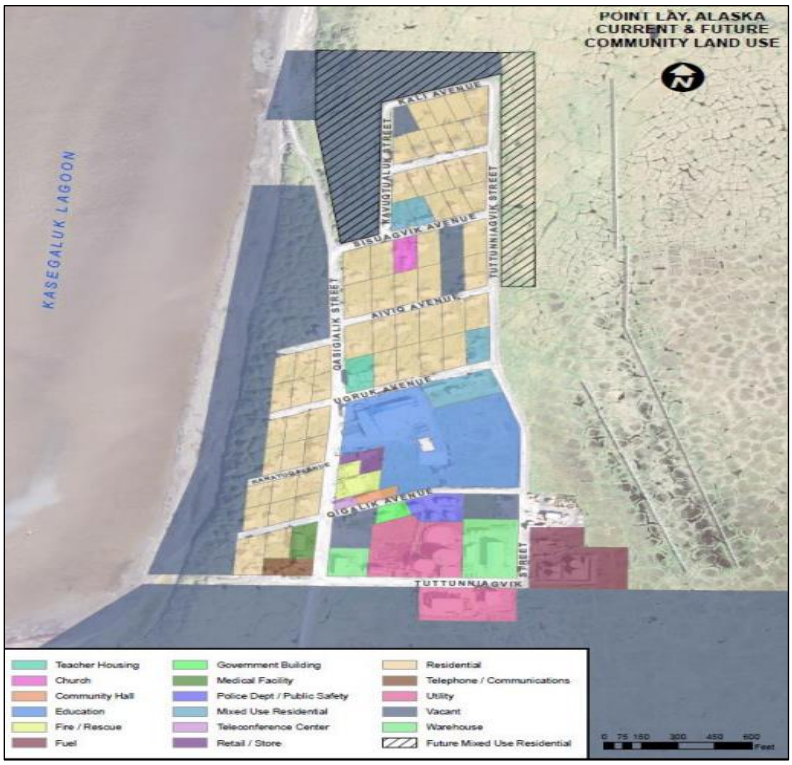


Figure 3. Current and Future Community Land Use

The water system includes 13,000 linear feet of 6-inch and 8-inch diameter pipes built in trenches throughout the community, including 12 fire hydrants.[459] Water is derived from a surface water source, a nearby lake, filtered and stored in a tank. Approximately 60 percent of the residents have piped water and 40 percent have water delivered from a central watering point and stored in

household tanks[460].The sewing system was built in 2000, and approximately 60 percent of the households have flush toilets that are hooked to a sewer line.[461] There are, however, some households that still depend on the water truck for restroom operations.

Figure 4. Point Lay Fire Station

Power is primarily supplied by a combination of diesel fuel and electricity to heat their homes.[462] The North Slope Borough operates the local utility. Electricity transmission is transported by underground lines, and residents receive a power cost equalization subsidy. Communications in the village include phones, mail, public radio and cable TV.

Given the extreme temperatures experienced in Point Lay, some of the critical utility infrastructure faces severe challenges, such as frozen pipes that end up leaking or exploding altogether. This in turn can cause water supply and/or land contamination.[463]

Accessibility

Transportation Links

In Point Lay, air transportation is serviced by the Point Lay (PIZ) airport with daily service to Barrow[464], AK. This airport is owned by the U.S. Air Force and it is used for both civilian and military purposes.[465] The airline company Ravn Alaska provides most commercial transportation in and out of the village[466] with two daily scheduled flights to Barrow. The composition of the runway is gravel with about 4,500 feet of runway.[467]

Figure 5. Point Lay Regional Airport (PIZ) Gravel Strip

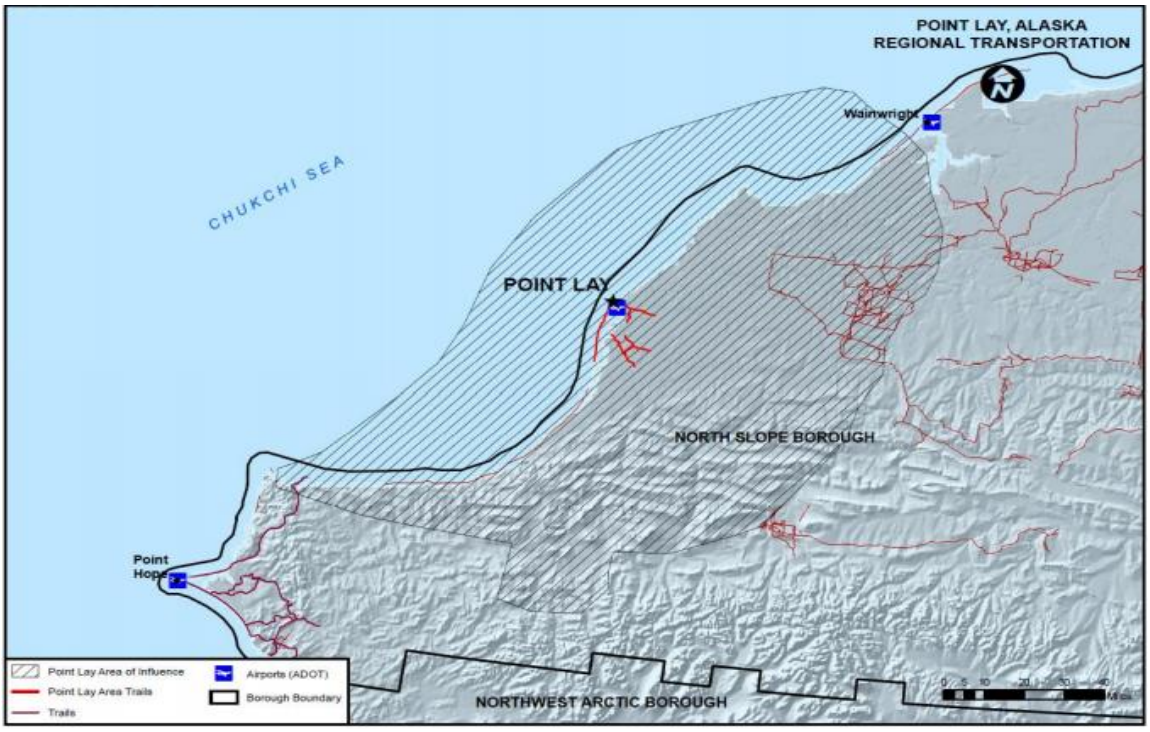


Figure 6. Point Lay Regional Transportation

The lack of a developed infrastructure of roads and streets implies that 73.9 percent walk or bicycle to their destination, and 14.1 percent) drive.[468] The average commute time is 4.71 minutes.[469] However, it is estimated that the village has 7.98 miles of gravel roads.[470]

Figure 7. A Gravel Road in Point Lay During Celebration

Seasonal Constraints

Similar to the rest of the villages in the Northwest Artic region, the waters surrounding Point Lay are largely frozen during the non-summer months, making it only accessible through the local airport, and ATV machines. Transportation of fuel and other goods are usually delivered during the summer, ice-free months, starting in July 1st of each year. Barges leave from Seattle on and carry about 3,000 to 5,000

tons, estimated to be 75 percent business usage and 25 percent individual goods.[471]

Port Characteristics

Port Infrastructure

According to the North Slope Borough's village profile publication, there are no ports in the village of Point Lay, and barges usually have to offload onto the beach.[472] It is in fact a community priority to build a port capable of managing the goods normally imported to the village. Offloading goods on the beach is a dangerous task which can lead to the hazards such as oil or fuel spill given that the condition of the ocean changes on a daily basis.[473]

Vessel Count

No reliable data could be found concerning the amount of vessels arriving or departing from the village of Point Lay.

Vessel Characteristics

No reliable data could be found concerning the characteristics of vessels arriving or departing from the village of Point Lay.

Barge Operators

Point Lay is primarily served by the Alaska Marine Lines transportation company, which transport mostly freight consisting of building and construction materials, heavy equipment and vehicles, grocery items, and fishing supplies.[474]

Fuel is delivered to the community by Crowley Marine with the use of a fuel-transfer line. Point Lay has fuel storage capacity for 30,000 gallons of gasoline and 750,000 gallons of diesel in the bulk tank farm located in the southeast corner of the community. There are two 250,000-gallon diesel tanks and two 125,000-gallon diesels tanks in the village.[475]

Main Imports/Exports

On a seasonal basis, cargo barges deliver supplies to many western villages including Point Lay. These barges typically leave Seattle starting July 1 of each year and carry about 75 percent business goods and 25 percent of individual goods. Freight goods consist of building and construction materials, heavy equipment and vehicles, grocery items, and fishing supplies.[476]

Local Economy

Major Employers

Point Lay's economy is closely related to local subsistence hunting and other subsistence activities. The economy employs 76 people which are distributed among three major sectors: administration (17 people), educational services (14) and utilities (13).[477]

There are no restaurants or hotels for people who would like to visit the village. Point Lay's official position is for tourists to not visit the village because walruses are easily scared by the sound of boats, polar bears, or low-flying airplanes, which will sometimes create a stampede which leads to the deaths or severe injuries of the younger or older members of the pack.[478] The carcasses of more than 130 mostly young walruses were counted after a stampede in September 2009 at Alaska's Icy Cape.[479] Locals are also concerned about the safety of tourists who need to hitch a hazardous ride across a cove in order to see the walrus spectacle from a barrier island.[480]

Subsistence Activities

Point Lay has a high level of subsistence activity year-round. Approximately 77 percent of the households in Point Lay participate in the local subsistence economy. Mammals such as caribous and seals are available year-round. Polar bears are typically hunted in the winter months, while whaling, duck hunting, walrus hunting, occur in the summer months. Some hunters from Point Lay travel to Barrow, Wainwright, or Point Hope to participate in spring hunting of bowhead whales.[481]

Table 4.7-6
Point Lay Subsistence Harvest Summary, ADF&G 1987

Resources	Estimated number	Estimated pounds	Average Pounds	Per Capita Pounds
All Resources		107,321.00	2495.83	890.11
Fish	2,807	2,983.00	69.38	24.74
Salmon	147	425.00	9.88	3.52
Non-Salmon Fish	2,660	2,559.00	59.50	21.22
Land Mammals	458	21,426.00	498.27	177.71
Large Land Mammals	167	21,309.00	495.56	176.74
Small Land Mammals	292	117.00	2.72	0.97
Marine Mammals		76,853.00	1787.27	637.41
Birds and Eggs	3,531	5,836.00	135.73	48.40
Vegetation		223.00	5.19	1.85

Source: (Alaska Department of Fish and Game 2004b)

Table 1. Point Lay Harvests, By Resource

Port Planning and Future Growth

Goods are transported through barges and unloaded in a beach area, or through airplanes into the village. Because there is no formal port in Point Lay, unloading is complicated and difficult because of the offshore barrier islands that separate the Chukchi Sea and the Kasegaluk Lagoon. Unloading and transporting fuel is entirely weather dependent but barges also have access to a four-inch floating line which makes the fuel shuttle barge to operate more efficiently. The Kasegaluk Lagoon is too shallow for the larger barges so the unloading is done on the Chukchi Sea side of the barrier Islands with the use of a small tug and barge operation.[482]

Environment

Environmental Justice

Like the rest of Alaska, one of the most pressing issue for Point Lay is the continuous receding of ice and the ecological changes comes with it. A 2006 aerial survey, conducted by the U.S. Fish and Wildlife Service (USFWS), estimated the walrus population at 129,000, but due to the difficulties in counting them the confidence of that estimate is low and the possible range in population size is somewhere between 55,000 and 507,000.[483]

After reviewing available scientific and commercial information, the USFWS found that listing the Pacific walrus as threatened was warranted because of the decrease in sea ice caused by climate warming.[484]

Unlike other towns such as Kotzebue or Red Dog, Point Lay is not located in close proximity to mines or oil fields which are Alaska's major pollutants. However, Point Lay lies within close proximity of the Northern Alaska Coal Province, which is believed to contain one-ninth of the world's known coal reserves, and one-third of U.S. reserves.[485]

Water/Air Quality

Until 2016, water for Point Lay was largely extracted from a tundra pond called Fresh Lake Water, located approximately 1.5 miles east of the village. However, in August 2016, the reservoir suddenly drained into the Kokolik River. Ice wedges in the permafrost separating the lake from the river disintegrated.[486]

When originally commissioned, the water system at Point Lay served 61 homes, and the typical demand is 34 to 44 gallons of water per household on a daily basis, but there are records of water consumption as high as 77 gallons per day. A total of 4,000,000 gallons of water is consumed in Point Lay on an annual basis.[487]

There has been some problems associated to the quality of water in Point Lay, such as the continuous erosion of the permafrost near the Kokolik River, and damage caused by fuel and glycol spill near the water tanks, the treatment plant has the capacity to treat the necessary amounts of water, especially if the water quality from the new water source has a low and acceptable conductivity level.[488]

Since, residents of Point Lay have relied on temporarily extracting water from the Kokolik River. Other efforts to create a permanent solution include the installation of reverse osmosis (RO) system to replace the water treatment plant's non-filtration system, drill of groundwater wells, and the installation and operation of a desalination unit to consume ocean water.[489]

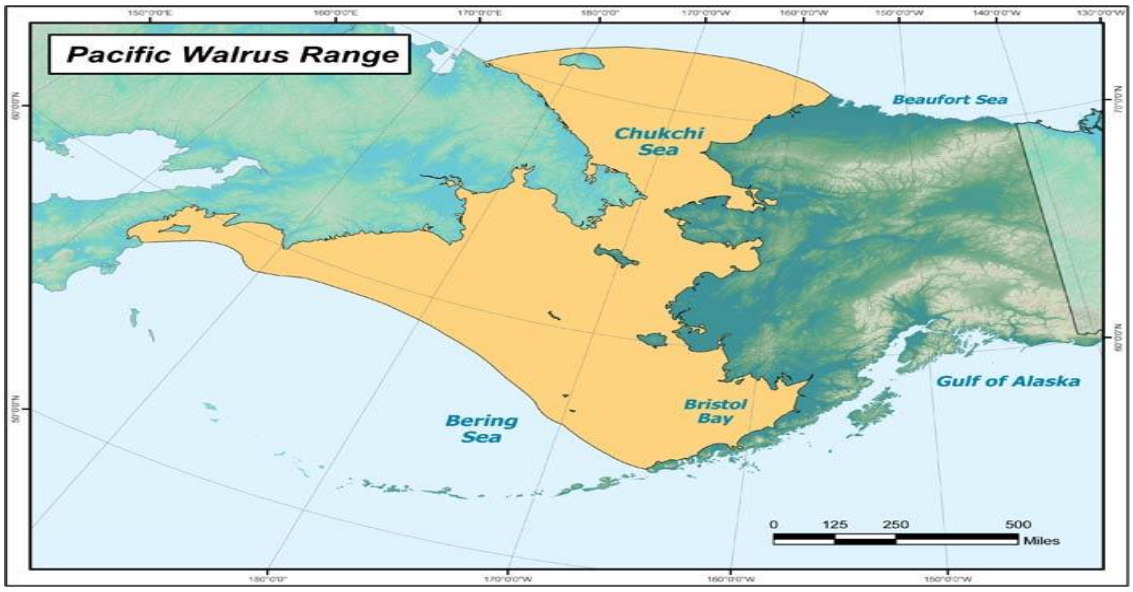


Figure 8. Area Encompassing the Pacific Walrus

Natural Resources Available

Point Lay is an ecologically important village given the various herds (mostly land and sea mammals) that the region hosts on a seasonal basis, such as caribou, moose, waterfowl, and various species of fish[490]. Economic indexes such as the median income and property value decreased in 2017 relative to 2016, while the healthcare costs increased relative to the prior year of study. This economic downtrend is also reflected in the larger tendency experienced by the greater Alaskan territory in the recent years.[491]

Between years 2010 and 2011, a herd of walrus (mostly females and young walrus) beached in near Akunik Pass, a few miles north of the city of Point Lay. Large haul-outs are atypical and its size is associated with ice receding beyond the continental shelf into the deeper waters of the Arctic Basin. Unlike seals, walruses require areas to rest out of the water, either on ice or land, with access to relatively shallow feeding areas. Although large haul-outs have been historically observed in Point Lay, the haul-out of 2010 and 2011 were judged to be "exceptional events."[492] More recently, in 2015, as many as 35,000 walruses were spotted about 5 miles north of Point Lay.[493]

Figure 9. Walrus Haul-Out

Each summer and fall, caribous migrate from the mountains into coastal areas where they are hunted by residents of Point Lay. Caribous are a major source of food and protein to residents of Point Lay. However, their route and timing cannot always be determined accurately; for instance, noise and human activity in coastal areas (i.e. boats, helicopters) can disrupt their movements during their migration route. In fact, from 2006-2009, the movement of caribou was disrupted by coal exploration about 40 miles south of Point Lay. Caribous were observed to return to areas south of the community the year after the exploratory operation ended in 2009. In more recent years, caribou have migrated farther from the community in smaller, more dispersed groups.

The caribou disruption experienced between 2006 and 2009 was the result of the exploration and testing of coal prospects by the Australian company BHP Billiton. In September 2009 the company announced that it would not continue exploration activities and would instead focus on reclamation and rehabilitation the sites already explored. As a potential transport route for the coal obtained from the potential coal deposit involved a north-to-south railroad to the Red Dog mine port facility. This railroad route would cut across a major east-to-west migration route of the Western Arctic Caribou herd. [494]

Each spring, white beluga whales pass Point Lay while migrating north along the Chukchi Sea coast. Similar to the caribou, belugas also represent a major source of food for residents of Point Lay; hunters bring belugas through inlets into the shallows of Kasegaluk Lagoon where animals are harpooned and shot, then pulled ashore for processing and distribution among participants. The hunt of white belugas starts in late June and lasts through mid-July, subject to ice conditions, weather, and beluga migrations.[495]

Effects of Climate Change

The continuous loss of sea ice is one of the several threats that residents of Point Lay are confronting in the 21st century. For instance, the lack of ice in late summer are driving walruses closer to shore which makes some members of the pack susceptible to stampedes, such as the younger and older walruses[496]. In an interview granted to the Associated Press, Julie Speegle, a spokeswoman from the National Oceanic and Atmospheric Administration (NOAA) explained the challenges that walruses confronts as the ice surface recedes: "Pacific walrus spend winters in the Bering Sea. Females give birth on sea ice and use ice as a diving platform to reach snails, clams and worms on the shallow continental shelf… As temperatures warm in summer, the edge of the sea ice recedes north. Females and their young ride the edge of the sea ice into the Chukchi Sea... In recent years, sea ice has receded north beyond shallow continental shelf waters and into Arctic Ocean water, where depths exceed 2 miles and walrus cannot dive to the bottom."[497]

The summer of 2014 ranked the sixth smallest sea ice area since satellite monitoring began in 1979. Also, in August 2017, one of the largest and earliest walrus pack arrival was spotted near Point Lay, according to the U.S. Fish and Wildlife Service (USFWS)[498]. The early arrival season of walruses is largely attributed to climate change and its pattern of continuous diminishing ice sheet.

Prudhoe Bay

Overview

Location

Prudhoe Bay holds the largest oil field in North America. It is located 250 miles north of the Arctic Circle and covers 213,543 acres at latitude 70° 19′ 32″ N and longitude 148° 42′ 41″ W. It is located between the cost of the Beaufort Sea and the Brooks Range Mountains. It is 1,200 miles south of the North Pole. It was first developed in the 1970s for oil drilling, and an 800 mile oil pipeline now transports crude oil from Prudhoe Bay to Valdez. From there, it is shipped in marine tankers to terminals across the United States.

Figure 1. Prudhoe Bay

Demographics

Prudhoe Bay has a population of around 2,094 people, most of whom work on the oilfield. The demographics of the area are 81.9 percent White, 7.98 percent American Indian & Alaska Native, and 3.2 percent two or more races.[499] Most people accounted for in population statistics in the area do not actually reside in Prudhoe Bay or the surrounding region, and instead are seasonal workers.[500]

Figure 2. Prudhoe Bay Oil Fields

Accessibility

Transportation Links

Prudhoe Bay is connected to Dalton Highway, which is the main route by which truckers transport supplies to the oilfield.[501] The Dalton Highway has experienced increased activity and slightly improving weather conditions in recent years.

The Arctic Ocean Shuttle offers transportation to the Arctic Ocean, and operates in the Deadhorse and Prudhoe Bay areas. The shuttle is operated with high security, and moves through the oil fields and eventually reaches the Arctic Ocean coast. Prudhoe Bay's fields are not the main attraction site, but are a stop along the way.[502]

Deadhorse airport, located in Deadhorse, AK, close to Prudhoe Bay, is a public airport that is accessed through the Dalton Highway.[503] Seasonal workers typically arrive in Deadhorse before being transported via Dalton Highway to the oil fields.

Port Characteristics

Port Infrastructure

Prudhoe Bay is a primary site for the transportation of drilling and production equipment for the North Slope Borough. A causeway and a dock system, located respectively on the east and west sides of the port, service line-haul barges that aid in this transportation.

Prudhoe Bay is home to the Trans-Alaska Pipeline, which was built to transport oil from the field's Pump Station No. 1 to a port terminal in Valdez, AK. The pipeline has 12 pump stations and can transport two million barrels of crude oil per day at maximum. It was designed specifically because the Arctic Ocean at Prudhoe Bay is only operational for six weeks a year due to icy conditions, whereas the port terminal at Valdez is generally ice-free. The Trans-Alaska pipeline is four feet in

diameter, and is built above ground for wildlife safety purposes. The pipeline is robustly designed and formed into a zigzag pattern to withstand Alaska's numerous earthquakes.

Pump stations across the pipeline contain refineries that produce jet fuel that powers the movement of oil through the pipeline. Once at Valdez, the oil is transported to refineries on the West Coast via oil tankers.[504]

Vessel Characteristics

The actual port at Prudhoe Bay is extremely small and does not function as a traditional port. In fact, according to experts on a project to create a port authority in the North Slope Borough, no port exists in this region. While docking facilities can be found, ports in the North Slope tend to rely on crude means for unloading. Instead, most typical port activities take place in neighboring Deadhorse.

Most deliveries of supplies and fuel to Prudhoe Bay via water occur in Deadhorse, where barges dock. This is because the area is experiencing improving icy conditions, but the primary method of delivering supplies to the area is still by truck and via highway routes. While barges have been used due to safer offloading measures involved with shipping over water, icy conditions still prevent widespread use of barges.

Main Imports/Exports

Prudhoe Bay's oil fields are among the top 10 oil-producing fields in the North Slope, and contain four of the largest oil-producing fields in North America.[505]

Economic Impact

Statehood brought Alaska enormous oil wealth because the Prudhoe Bay oil field is on state-owned land. Between 1980 and 2016, oil supported Alaska's government services through oil and gas related property tax revenues. The industry contributes 1,845 jobs to the region and $105 million annually, accounting for direct, indirect, and induced effects. Seventy-five percent of jobs in the North Slope Borough are in Prudhoe Bay, and the oil industry produced approximately a third of Alaskan jobs.[506]

Prudhoe Bay has produced 17.5 billion barrels of oil that have been transported to Valdez. BP, ConocoPhillips, and ExxonMobil all hold ownership stakes in the Prudhoe Bay oil field.[507]

North Slope oil production was at its lowest in 2014, but is predicted to stay a significant source of revenue for the region and the state due to changes in Alaskan tax laws that made oil cheaper to pursue. Global demand for oil has reached a significant high, with worldwide consumption reaching 100 million barrels a day. New oil projects are expected to develop in the Prudhoe Bay region in the coming decades as investors take advantage of new laws and policies.[508]

Environment

Environmental Justice

Environmental Justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.[509] Consequently, proposed activities need to be mindful of the impact on Alaska Native communities. These communities are usually comprised of low-income and minority populations and are more at risk to experience the negative consequences of global climate change and economic development.

While Prudhoe Bay does not have local communities in the area, the community of Nuiqsut is located close to Prudhoe Bay and is heavily impacted by oil industry development. While a beneficiary of the infrastructure and fuel transported by the pipeline, the community is dedicated to maintaining its cultural heritage and identifies the preservation of subsistence traditions as its most important priority. [510] The community is rich in natural resources and development has expanded ever closer to the village since Prudhoe Bay's discovery. Currently, they are in a legal struggle with the ConocoPhillips Company to prevent the expansion of Prudhoe Bay's oil fields into the North Slope Borough, where a proposed oil project along with two other existent development projects threaten to negatively impact the community's fish and caribou food sources. Combined, at least two of the projects will produce 250,000 barrels of oil a day, which is over half the amount of oil that is transported through the Trans-Alaska pipeline daily.

Planning commissions and officials in Alaska have encouraged the development of oil and mining projects across the state due to the massive economic benefits, but have run into pushback from native communities, Nuiqsut being one. While the community readily acknowledges the economic benefits of oil development, they wish to approach it cautiously and have received support from commissions with regards to their concerns.[511] A group called the Nuiqsut Environmental Information Website was started by ConocoPhillips, the Bureau of Land Management, and the North Slope Science Initiative to evaluate and analyze the environmental concerns of the community and the surrounding area, and to generate reports and maps that help provide transparency when working with the community. [512]

Figure 3. Nuiqsut

<u>Water/Air Quality</u>

In Barrow, AK, air emissions from Prudhoe Bay have been detected. In 2006, 267,000 gallons of oil leaked in what is currently the largest spill experienced at the site. Because of the freezing temperatures, spills in the Arctic are more difficult to clean up and recover from, and thus can pose a threat to wildlife in the area. [513]

Natural Resources Available

Prudhoe Bay is home to a variety of marine and terrestrial wildlife, including many species of waterfowl, bowhead whales, polar bears, and ringed seals. [514] The oil fields have a substantial environmental impact on the North Slope, with an estimated 500 spills occurring each year.

Utqiagvik

Overview

Location

Utqiagvik (formerly Barrow) is a city on Alaska's Arctic coast that borders the Chukchi and Beaufort seas. Situated 329 miles north of the Arctic Circle, Utqiagvik is the northernmost community in the United States and is located at latitude 71° 17′ 26″ N and longitude 156° 47′ 19″ W. The city encompasses roughly 18.4 square miles of land and 2.9 square miles of water.

Demographics

It is the largest city in the North Slope, with approximately 5,256 residents.[515] It is also the chief administrative, economic, and transportation hub for the North Slope. The median household income is $78,804 and the median property value is around $181,200.[516][517] Roughly 10.4 percent of the city's population was below the poverty line, according to 2017 U.S. Census Bureau data.[518] Sixty-three percent of the population is Alaska Native.

Figure 1. Utqiagvik

Climate/Weather

Utqiagvik is in an arctic environment with temperatures averaging between -19 and 47 degrees Fahrenheit. Utqiagvik typically receives less than five inches of precipitation each year. The city experiences easterly winds that average 12 miles per hour (with maximum recorded wind speeds of 48 miles per hour). The nearby coast is typically free of ice by early- or mid-July, and returns in late fall. In the winter of 2017-2018, however, shore ice had not returned until January.[519]

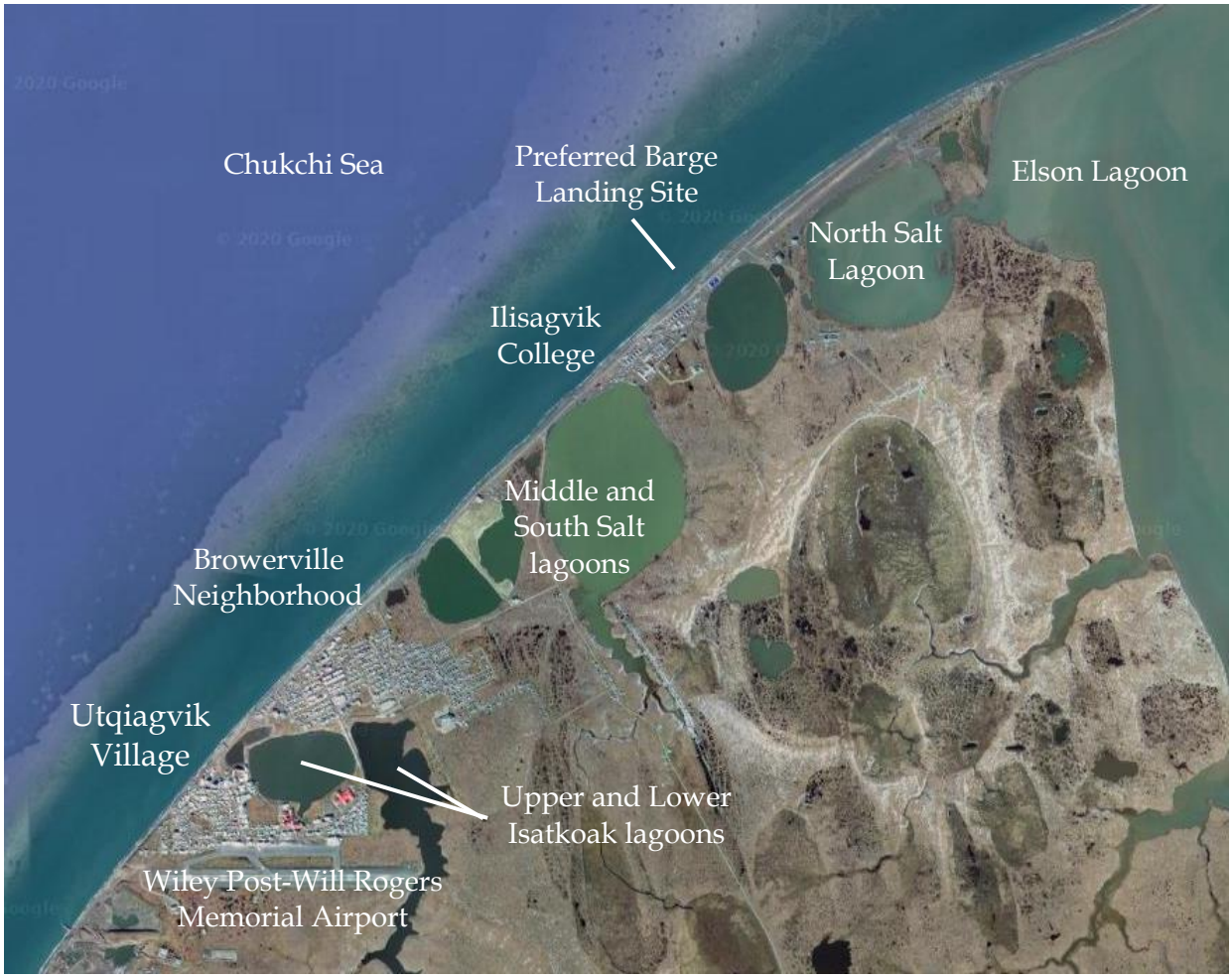


Figure 2. The Port of Utqiagvik

Municipal Utilities & Services

The community has a police station, two fire stations, a hospital, a post office, an elementary school, a middle school, a high school, and an accredited college. As the regional seat of the North Slope Borough (NSB), many health and community services are based in Utqiagvik. The city also has the Samuel Simmonds Memorial Hospital, a senior center, a women's shelter, a children's center, a public library, and an art museum called the Inupiat Heritage Center. The city is also home to the Barrow Arctic Research Center (BARC), a state-of-the-art facility that environmental researchers and scientists use to study the climate.

Residents have access to mail, a public radio station, telephone, cable television, and Internet. In 2017, Quintillion brought high-speed fiber optic cable Internet access to the city.[520]

A local member-owned cooperative called the Barrow Utilities and Electric Cooperative, Inc. (BUECI) supplies electricity, natural gas, and water and sewer services. The power plant runs on natural gas from the gas fields south of the city but can be powered by diesel during emergencies. Natural gas is piped into most homes to provide heating. Most homes also have modern water and sewer connections. A subsurface utilidor system houses these utilities and runs through a large portion of the Village of Utqiagvik and the Browerville neighborhood.[521,522]

The NSB is responsible for fire and police services. It is also in charge of trash pickup and maintaining more than 60 miles of the city's roads which are mostly gravel.[523] The city's water facility is able to treat water throughout the year. Trucks deliver water to homes not directly connected to the water system. The proportion of homes lacking piped water is unclear.

Accessibility

Transportation Links

Utqiagvik is accessible year-round via the Wiley Post-Will Rogers Memorial Airport (BRW), a 7,100 foot-long state-owned asphalt runway that serves as the regional transportation center for the North Slope. Air carriers make cargo deliveries year-round. The largest aircraft to perform routine flights to Utqiagvik is the Boeing 737-800. There is a 620,000 square foot apron that connects to the runway by three 75-foot-wide taxiways. The runway is 150 feet wide and has turnarounds at the ends to allow larger aircraft to maneuver prior to take-off. The airport is also capable of providing minor aircraft repair services. The NSB uses the airport to support its search-and-rescue operations for the entire North Slope region.[524]

Utqiagvik has flight connections to three transportation centers: Anchorage, Deadhorse, and Fairbanks. Some of the cargo the city receives is then transported by aircraft to the nearby villages of Atqasuk, Nuiqsut, Point Lay, and Wainwright. In 2017 alone, the airport at Utqiagvik enplaned nearly 46,000 passengers, enplaned roughly 4.58 million pounds of freight and mail, and deplaned nearly 1.95 million pounds of cargo.[525]

The airport is an important resource for regional oil and gas exploration and development. Shell uses the airport to transfer crews from Anchorage to Utqiagvik aboard a chartered Boeing 737-400. The airport also acts as a staging area for crew transfer and for its search-and-rescue operations.[526] Utqiagvik has no permanent road connections to other communities.

Seasonal Constraints

Recently, the NSB has attempted to improve access to and from Utqiagvik during the winter. In the winter of 2018, the NSB, with the help of the State of Alaska, the Bureau of Land Management (BLM), and the private sector, created the Community Winter Access Trails (CWAT). The CWAT system consists of 300 miles of temporary snow roads connecting Utqiagvik and Atqasuk to the Dalton Highway through Deadhorse.[527] These roads are only seasonal and usually thaw in the spring. NSB staff serve as escorts for caravans traveling along the snow road; solo travel is prohibited. The NSB is expected to continue the CWAT pilot program through the winter of 2022-23.[528]

The project is designed to help lower the cost of transporting passengers, goods, and supplies by providing an alternative to air and seasonal barge transportation. Historically, if a resident wanted to bring in a new automobile they had to do so by barge. In recent years, however, they have started using the CWAT snow roads from Deadhorse to Utqiagvik to bring in new vehicles.[529] This alternative has saved the population money and allowed them to bring in new vehicles outside of the summer months.

Port Characteristics

Port Infrastructure

Like other Arctic coast communities, Utqiagvik has no formal port facilities. From mid-June through October, barge landings often occur on the beach north of town between Ilisagvik College and Dewline Road. This stretch along the coast consists of good gradual beach that is favorable to unloading;

however, landings are heavily dependent on weather conditions. Strong easterly winds and rough seas, combined with a lack of infrastructure, can make unloading inefficient and dangerous. Barge operators have indicated that they can use the Elson Lagoon to wait out bad weather. A temporary sand berm helps protect the community from flooding and heavy wave action. A variety of coastal protection measures shield certain areas along the beach; these measures include: Gabion walls, HESCO concertainers, Longard tubes, super sack revetment, angled tar barrels, and beach nourishment.[530]

Figure 3. Barge Landing North of Ilisagvik College

Portions of the beach support subsistence activity. Residents can launch small boats on the beach in front of the community with a portable mat or from boat trailers. Residents also launch boats from multiple points along the shore of the Elson and North Salt lagoons. There is no preference as to where whaling crews bring harvested whales ashore.[531] In 2014, the City constructed a new dock, boat launch, and breakwater at the northern end of North Salt Lagoon.

Vessel Count

From January 2017 through September 2018, there were 243 unique arrivals in Utqiagvik among 42 unique vessels.[532]

Vessel Characteristics

Shallow draft vessels with roll-on/roll-off capability land in front of the town. Barges push onto the beach to offload, and then cargo is hauled onto Stevenson Street, which runs parallel to the beach from the bluff near the airport to Point Barrow. Line haul barges are capable of servicing Utqiagvik, where the barge lands stern first and is secured with lines fastened to heavy pieces of machinery. Cargo is moved from the barge to a landing craft by crane. Once loaded the landing craft can proceed to the landing site and drop a ramp directly onto the beach, where it is then unloaded with rubber tire loaders. This process requires favorable wind and sea conditions, however, and if a line haul barge cannot directly land on the beach, then crews perform a lightering operation half a mile offshore.[533]

Barge Operators

- Alaska Marine Lines (AML) provides marine support services to Utqiagvik.[534]
- Bowhead Transport Company (BTC), a subsidiary of the Ukpeagvik Inupiat Corporation (UIC), is a marine common carrier that has served the North Slope since 1982.[535] In 2019, BTC and AML announced a partnership to continue providing barge and lightering service to North Slope communities, including Utqiagvik.
- Crowley Maritime carries out routine line barge fuel deliveries to Utqiagvik with its Alaska tug and barge fleet.[536]
- Cook Inlet Tug & Barge, which is owned by Saltchuk, also provides marine services to Utqiagvik.[537]
- Clipper Oil barges supply Utqiagvik with marine gas, bunker fuel, and lubricants from companies like Shell and ExxonMobil.[538]

Cruise Ship Operators

There are several cruise lines that include Utqiagvik as a stop as part of their Northwest Passage tours to and from Nome or Anchorage. Crews use small inflatable rubber boats to bring passengers ashore.

- Polar Cruises has a 25-day Northwest Passage tour from Kangerlussuaq, Greenland, to Nome between August and September that carries 240 passengers and 208 crew.[539]
- Hapag-Lloyd has a similar trip from Nome to Greenland that accommodates 155 passengers. This tour includes a stop in Utqiagvik when weather conditions allow.[540]
- Silversea offers two 24-day trips beginning in late August that run from Kangerlussuaq to Nome and accommodate roughly 254 passengers. These tours include stopovers in Utqiagvik from morning through afternoon. [541]

Main Imports

Air carriers fly mail in from Anchorage or Fairbanks. Given the seasonality of barge deliveries, residents also rely on planes to deliver food items.

Utqiagvik imports a number of commodities by barge, however, including:

- Construction materials and equipment;
- Furniture and household appliances;
- Snow machines and all-terrain vehicles (ATVs) are popular among residents;
- Automobiles; and
- Fuels such as diesel, aviation fuel, marine gas, bunker fuel, and unleaded and premium gas. The city is not dependent on large quantities of imported heating fuels because of nearby sources of natural gas.

Local Economy

Major Employers

Within Utqiagvik there are several restaurants, hotels, grocery stores, and auto parts stores. There is also a supermarket, a dry cleaner, a bank, a hardware store, and a gas station. As with other remote arctic communities, food prices in Utqiagvik are exceptionally high since groceries have to be brought in via plane. For instance, a bottle of cranberry juice costs nearly $10 and two boxes of cereal cost $14. It is not uncommon for a household to spend $500 a week on groceries.[542]

As of 2012, there were 234 registered businesses in Utqiagvik.[543] The unemployment rate is 6.9 percent.[544]

Popular tourist attractions include polar bear viewing, bird watching, the Inupiat Heritage Center, the whale bone arch, shopping for native clothing, arts, and crafts, the spring festival and blanket toss, and the prehistoric mounds at the Birnirk archeological site. Alaska Tours runs a 2-day trip from Anchorage to Utqiagvik, and includes guided sightseeing around the community.[545]
The local economy is heavily reliant on public sector jobs and contracting. Roughly 58.7 percent of the working population in Utqiagvik are government workers, with the largest employers being the regional government (the NSB) and the North Slope Borough School District (NSBSD).[546] The NSB alone employs roughly half of Utqiagvik workers. The local government and Federal governments each employ about four percent of the workforce, while the state government employs roughly 1 percent. Private sector employment accounts for roughly 40.3 percent of jobs. Relatively few residents were employees of the Prudhoe Bay oil companies. The major private sector employers are the Arctic Slope Regional Corporation (ASRC) and the UIC and their subsidiaries.

The Arctic Slope Regional Corporation (ASRC), headquartered in Utqiagvik, is a private, for-profit Alaska Native corporation that provides services in six business areas, including government services, energy services, industrial services, petroleum refining and marketing, and construction and resource development. The company employs roughly 15,000 worldwide and has about 13,000 Inupiat shareholders. The ASRC earned $2.5 billion in revenue in 2015.[547]

The Utpeagvik Inupiat Corporation (UIC), incorporated in 1973, is one of Alaska's largest companies. Also headquartered in Utqiagvik, UIC operates in a variety of sectors, including design and construction, environmental consulting, oil and gas support services, marine services, government contract services, and businesses to support local economic development.[548] A UIC company called UIC Science manages the Barrow Arctic Research Center (BARC), a leading Arctic research laboratory located a few miles north of town, and the Barrow Environmental Observatory (BEO). BEO is a 7,466 acre area of privately-owned land specifically designated for environmental field research.[549]

Subsistence Activities
The population relies heavily on subsistence harvests to meet dietary needs. Nearly 95 percent of all of Native Alaskan households in Utqiagvik rely on at least some subsistence foods. Among 60 percent of Native Alaskan households, subsistence foods make up at least half of household diets.[550] Subsistence harvests are a communal affairs, since many of those who are not directly involved in whaling, fishing, or hunting nevertheless support these activities in some way. This may include such activities as creating or fixing clothing, butchering harvested animals, or buying fuel for the vehicles used for hunting. It is also common practice for residents to share food within the community. In figure 4 below, Utqiagvik's area of influence is outlined in orange, which depicts the areas in which residents hunt for key subsistence resources and engage in traditional land use.

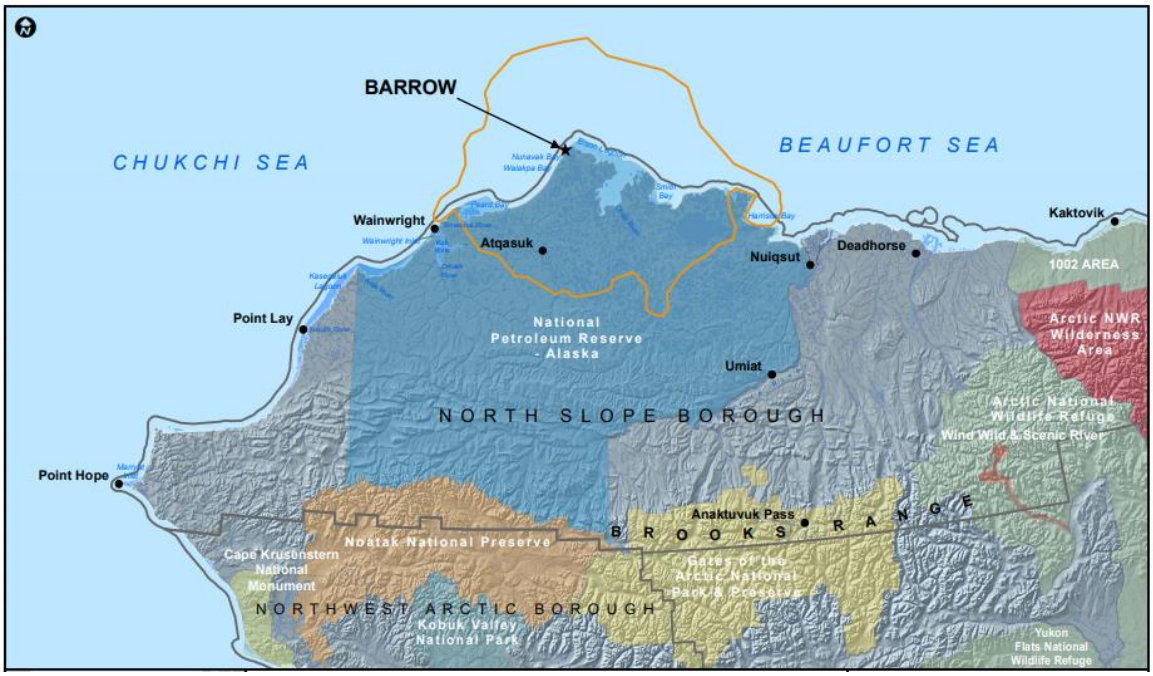


Figure 4. Utqiagvik (Barrow) Area of Influence

The most essential subsistence animal for the people of Utqiagvik is the bowhead whale. Bowheads are an important source of nutrition and have immense cultural value to the Inupiat people. The city's unique location allows whaling crews to hunt bowheads during the spring and fall as they migrate between the Bering and Beaufort seas. In the spring, bowheads migrate northeast along the western and northern Alaskan coast, moving further away from shore upon reaching the Beaufort Sea. In the fall, bowheads migrate westward along Alaska's northern coast, but once they reach Point Barrow they continue west towards the Russian coast before turning south to the Bering Sea.

Figure 5. Bowhead Seasonal Migration Pattern

Crews are usually formed among kin. In the spring, crews typically hunt closer to shore and west of Point Barrow, while fall hunts occur further out from shore and to the east of the Point. They use traditional seal skin boats, called umiaqs, during spring harvests, but favor conventional aluminum power boats in the fall. Crews may travel as far out as 70 miles from shore to hunt bowheads.[551] Once a whale is killed, it is pulled ashore, portioned, and then distributed within the community.

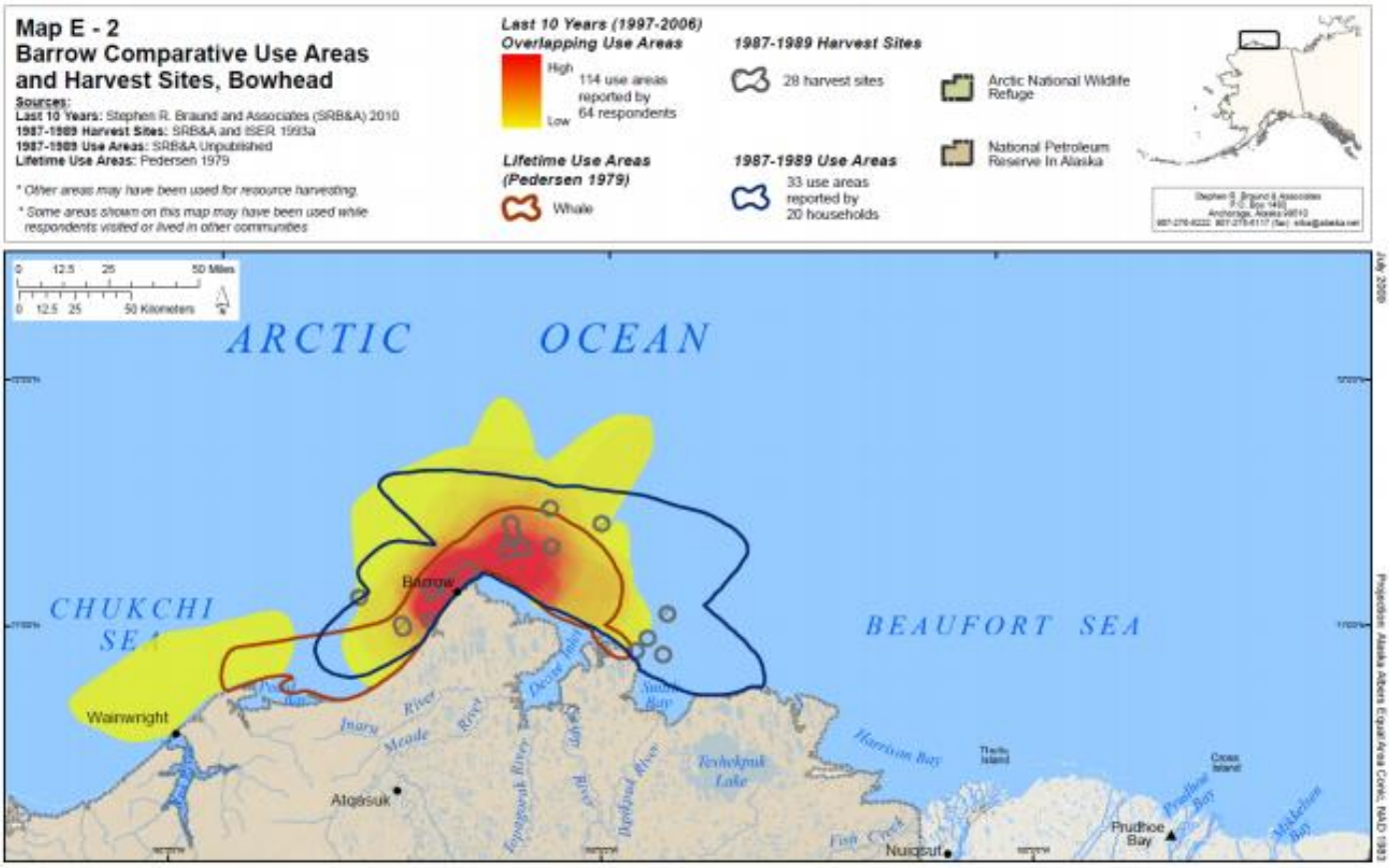


Figure 6. Concentration and Extent of Bowhead Harvesting Near Utqiagvik

During the fall 2019 whaling season, crews had not successfully hunted a bowhead until November 17th, nearly two months after the season opened on September 21st.[552] The previous year, whaling crews had landed 19 bowheads between the 7th and 23rd of October. Scientific researchers speculate that bowheads may be traveling further from shore in search of food and colder waters.[553]

Locals also hunt a number of marine mammals for tools, clothing, and to supplement diets, including beluga whales, polar bears, bearded, ringed, and spotted seals, and walruses. Beluga whales are typically harvested from mid-July through late-August. These whaling crews tend to be smaller and less organized than those that hunt for bowheads. Polar bear hunting is largely incidental and typically occurs in late winter or early spring. Residents will hunt seals and walruses for skins used to make umiaqs. Bearded seals follow the sea ice north past Utqiagvik each year, making hunts dependent on sea ice conditions. They are typically hunted from June through August. Residents will hunt both walruses and ringed seals alongside bearded seals.[554]

Residents in Utqiagvik supplement their diet with a variety of fish. Commonly harvested fish include several species of whitefish, sockeye salmon, cisco, grayling, char, cod, and burbot. Common fishing locations include the Elson Lagoon and the Meade, Inaru, and Chipp rivers. Freshwater fishing takes place from ice breakup in June to November. The most favorable times to harvest whitefish is from June through October; cisco in October; and graylings from August through October.[555]

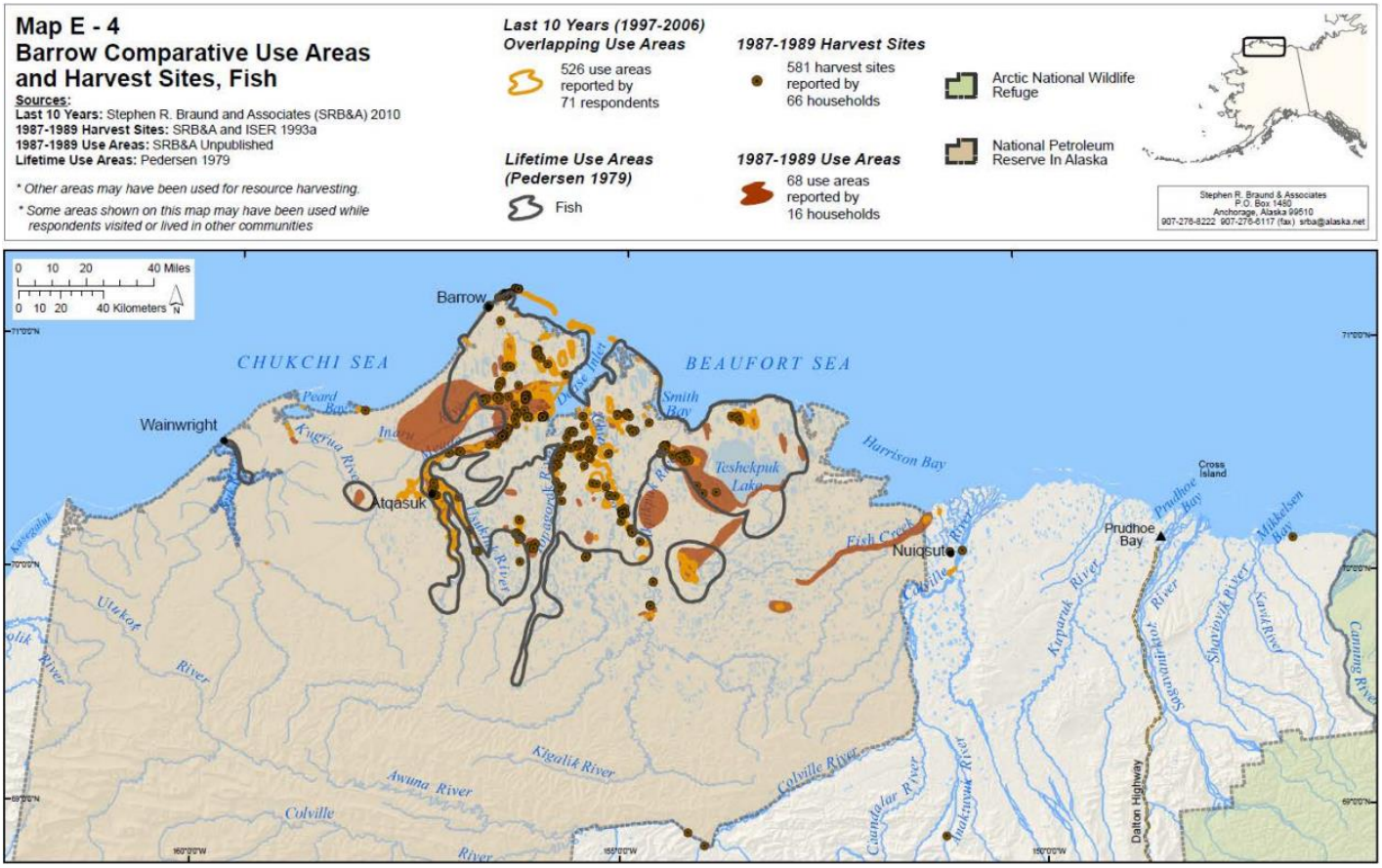


Figure 7. Utqiagvik Local Use Areas and Fish Harvest Sites

The population also hunts King and common eider ducks offshore near the spit of land south of Point Barrow or in the western parts of Elson Lagoon in the spring and fall. They also hunt several species of geese along the coast from Utqiagvik to Peard Bay to the southwest and inland along several local rivers and creeks south of the city. The goose hunting season is May through June.

Among land animals, caribou is an especially important food source for the population, and are second only to bowhead whales in terms of the most amount of meat harvested. They can be hunted inland year-round and are regularly harvested with the use of boats, snowmobiles, and ATVs.

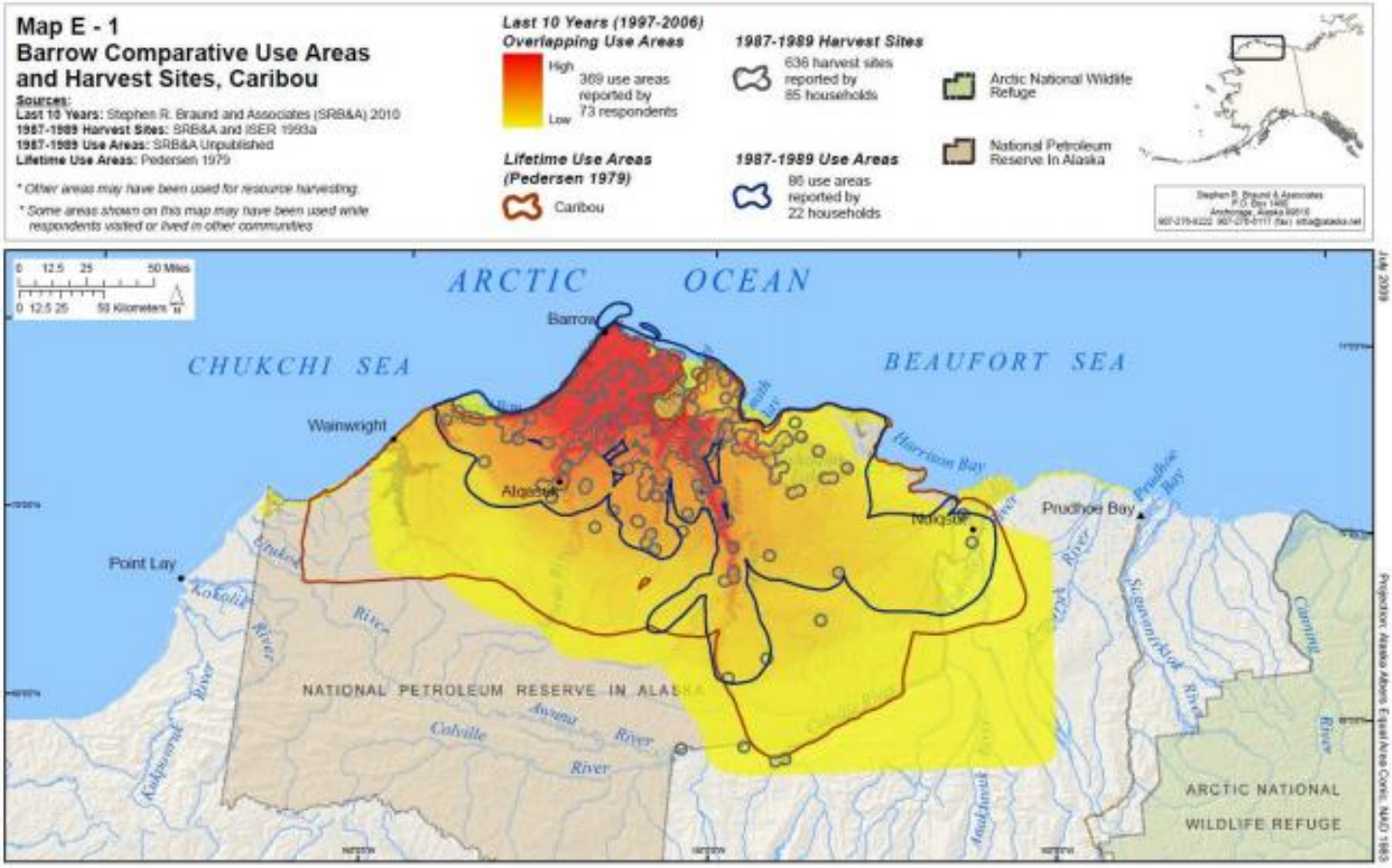


Figure 8. Concentration and Extent of Caribou Harvesting Near Utqiagvik

Other hunted land animals include the moose, arctic fox, Dall sheep, wolverine, red fox, and brown bear. Many of these animals, however, are hunted opportunistically and for commercial use, and therefore do not constitute a large portion of the local diet.[556]

Port Planning and Future Growth

In 2014, the NSB authorized the creation of the NSB Port Authority to design and construct port infrastructure to promote efficient unloading of vessels, reduce the costs of delivering cargo, encourage economic development, and develop means to respond to emergencies and oil spills.[557] In the 2015 comprehensive city plan, the NSB considered two port proposals, one located in Elson Lagoon, the other in Middle Salt Lagoon. The NSB commissioned a port study in 2017 that is evidently still underway. These potential ports can accommodate a variety of activities, including tourism, industrial, scientific research, oil and gas exploration, and development. They can also support development by allowing for safe harbor access and efficient shipping.

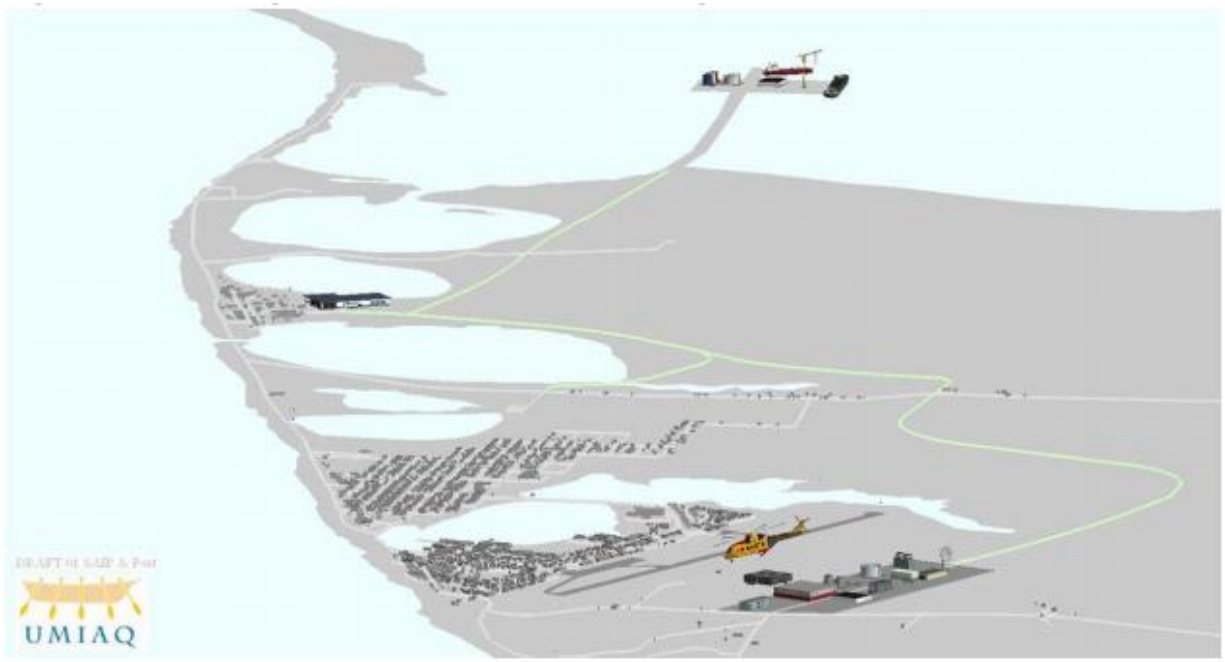


Figure 9. Potential Port at Elson Lagoon

Figure 10. Potential Port at Middle Salt Lagoon

The population of Utqiagvik is expected to increase to anywhere between 5,785 and 6,985 by 2035.[558] In a 2015 NSB report, inhabitants expressed concerns with the costs of maintaining current infrastructure and planning new infrastructure improvements. Another potential challenge to further growth is the need for both market rate and affordable housing and concerns regarding overcrowding and lack of housing construction. Approximately 13 percent of Utqiagvik households are overcrowded (more than one person per room); 4 percent are severely overcrowded (more than 1.5 people per room). This is significantly higher than the national average of 3.2 percent (a combined average of overcrowded and severely overcrowded). The city will need an additional 783 housing units by 2035.[559]

Environment

Environmental Justice

Environmental Justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.[560] Consequently, proposed activities need to be mindful of the impact on Alaska Native communities. These communities are usually comprised of low-income and minority populations and are more at risk to experience the negative consequences of global climate change and economic development.

One potential concern outlined in the city's comprehensive report was the increased possibility of the introduction of invasive species into the Arctic by opening up the Northwest Passage to a greater degree and allowing for more vessel traffic and shipping routes.[561]

Another concern and source of uncertainty for the community is the possible changing of the migration pattern of bowhead whales. The fall 2019 bowhead hunting season in Utqiagvik was nearly non-existent compared to the previous year. If the community continues to experience poor bowhead harvest seasons, it would place a severe strain on residents.

These issues can be further discussed with residents and representatives of Utqiagvik. Vernon Edwardsen, Doreen Lampe, Roy Nageak, Crawford Patkotak, Herman Ahsoak, and Josiah Patkotak are members of the NSB Assembly and represent Utqiagvik. They can be contacted via Sheila Burke, Borough Clerk, at (907) 852-0360. Andreas Tziolas is the director of the Native Village of Barrow's environmental department and can be contacted at atziolas@nvbarrow.net or (907) 301-2160.

Water/Air Quality

There is little readily available information on the water and air quality in Utqiagvik, though the NSB argued in 2019 that the air and water quality throughout the borough was generally good. In September 2019, however, a report by Anchorage-based non-profit Alaska Community Action on Toxics (ACAT) found that drinking water in Utqiagvik had been contaminated with PFAS (a hazardous chemical found in firefighting foam). The report argued that the contamination originated from the airport. The main source of the community's drinking water, the Isatkoak Reservoir, borders the airport.[562]

Natural Resources Available

There are three natural gas fields near Utqiagvik known as South Barrow, East Barrow, and Walakpa. As of 2018, cumulative production at these fields were 24, 9.4, and 32 billion cubic feet of natural gas, respectively.[563] These fields also serve roughly 93 percent of Utqiagvik households. Given the abundance of natural gas, heating costs in Utqiagvik are lower than almost anywhere else in Alaska.[564]

Effects of Climate Change

Utqiagvik is subjected to frequent coastal storms and flooding that threaten life, private property, and key infrastructure. As an Arctic community with temperatures below freezing roughly 300 days out of the year, frigid flood waters are exceedingly dangerous and difficult to combat. Frequent flooding can also cut off important subsistence areas, like Point Barrow. Due to the amount of coastal erosion taking place, it is common for road conditions along Stevenson Street (one of the most heavily trafficked roads in the city) to become dangerous during storms. Stevenson Street is also one of the few barriers between the waters of the Chukchi Sea and the rest of the town. The threat and severity of flooding has diminished the quality of life among residents.[565]

In the fall of 2017, a storm with sustained winds above 35 miles per hour and waves 8-feet high or higher hit Utqiagvik and caused roughly $10 million worth of damage. The temporary berm was eroded in multiple places, causing spillover of seawater into the community that damaged or destroyed several roads. The flooding also damaged or seriously threatened other critical infrastructure, including one of the city's freshwater lagoons which came within inches of contamination.[566]

In 2018, the U.S. Army Corps of Engineers (USACE) proposed a plan to reinforce the beach to help mitigate flood risks. USACE identified concerns regarding greater exposure to wave action from increases in temperature and declines in summertime sea ice extent. It also identified the thawing of permafrost along the bluff south of the village as another risk to the community. In response, USACE's proposal called for a bluff revetment, a revetted berm along the beach, and the raising and revetting of Stevenson Street. The proposal had an estimated total cost of $193 million, which the federal government and the NSB would fund together. The NSB supported the USACE's plan but it is unclear where the project is in its stage of development.

Wainwright

Overview

Location

Wainwright is a small city along Alaska's Arctic coast bordering the Chukchi Sea. It is located three miles northeast of the Kuk River estuary at latitude 70° 38′ 50″ N and longitude 160° 0′ 58″ W. The town was built atop a 20 foot-high wave eroded coastal bluff on a narrow strip of land between the Chukchi Sea and the Wainwright Inlet.

Demographics

There are approximately 555 inhabitants, making it the third largest community in the North Slope.[567] The median household income is $51,563.[568] The median property value is around $100,800.[569] The population is 94.6 percent Alaska Native and 5.4 percent Caucasian.

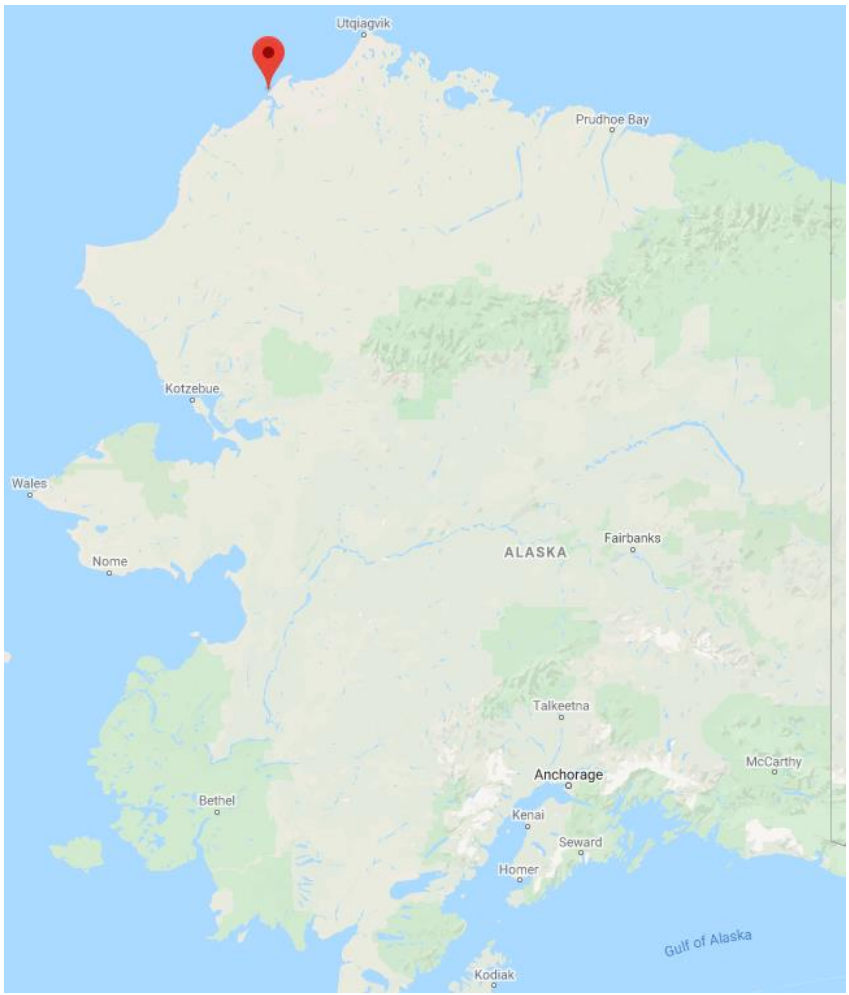


Figure 1. Wainwright

Climate/Weather

Wainwright is an arctic community that experiences temperatures from -56 to 80 degrees Fahrenheit, and easterly winds average 12 miles per hour, with gusts up to 60 miles per hour. Wainwright receives 5 inches of rainfall and 12 inches of snow each year on average.[570] The sea around the town is usually free of ice from mid-July through September.

Municipal Utilities & Services

The community has a search and rescue facility, fire station, police station, post office, health clinic, general store, fuel station, vehicle maintenance facility, hotel, and a restaurant. The local native Olgoonik Corporation (OC) sells groceries, clothing, first-aid, household goods, and supplies. The native corporation is also a major land owner. Residents have access to mail, public radio, VHF radio, cable television, and high-speed fiber optic Internet. Recreational activities include boating, riding snow machines, and springtime smelt fishing.[571]

There is also sewage and water treatment facilities and a relatively new landfill north of town. The North Slope Borough (NSB) supplies electricity, water, sewer, and trash services to residents, and the town's power generators run on diesel. The town has 9.2 miles of gravel roads.[572]

Figure 2. The Port of Wainwright

Accessibility

Transportation Links

RavnAir is the only air carrier that services Wainwright. There are one to three flights every day to and from Utqiagvik, which serves as a transportation hub, for $336 roundtrip.[573]

Like other communities on the North Slope, Wainwright is only accessible year-round by plane. The NSB owns and maintains a gravel airstrip that is roughly 4,500 feet long and 110 feet wide immediately east of the community. In 2017, Wainwright Airport (AWI) enplaned and deplaned 3,756 and 3,806 passengers, respectively. During the same year, the airport enplaned and deplaned 47,087 and 6.28 million pounds of freight and mail, respectively.[574]

Seasonal Constraints

Wainwright only has seasonal land transportation access. In 2016, Barrow Search & Rescue, with funding from the Arctic Slope Community Foundation, undertook a trail-marking project by driving stakes into the permafrost along the trails between Utqiagvik, Atqasuk, and Wainwright.[575]

The five-year snow road pilot project, called the Community Winter Access Trails (CWAT), now in its second year, connects North Slope communities during the winter months. Wainwright is included in this pilot project, but it is not clear that the town is currently connected to the network of snow trails.

Port Characteristics

Port Infrastructure

Wainwright has no port, so residents only have seasonal access to marine services. Fuel and cargo deliveries occur in the summer but are dependent on the weather. Barge operators unload fuel offshore by running a hose to a fuel header. Freight deliveries occur in the Wainwright Inlet, where cargo is offloaded onto the beach, hauled to the other side of the spit near a small lagoon, transferred to a shallow draft barge, where the barge will travel north, offloaded into trucks, and taken to the community. This process is time-consuming and very costly.[576]

There is a seawall 500 feet long that was built in 2013 to protects some of the town's critical infrastructure.[577] There is a boat launch south of town on Wainwright Inlet, but launches can still be dangerous during stormy conditions. The shallowness of the water at nearby launch areas limit the kind of boating activity that can take place, and at times the nearby river is too shallow to navigate.

Figure 3. Wainwright Port Infrastructure

Vessel Count
From 2017 through 2018, there were 58 unique arrivals in Wainwright between 13 different vessels.[578]

Vessel Characteristics
Shallow draft tugs, double-hull fuel, and freight cargo barges service Wainwright.

Barge Operators
- Alaska Marine Lines (AML) provides marine support services to Wainwright.[579]
- Bowhead Transport Company (BTC), a subsidiary of the Ukpeagvik Inupiat Corporation (UIC), is a marine carrier for Wainwright.[580]
- Crowley delivers fuel to the town.[581]

Figure 4. Crowley Fuel Barge Landing at Wainwright

Main Imports/Exports
Wainwright imports a number of commodities by barge, including:
- Fuels such as marine gas, diesel, propane, and unleaded and premium gas;
- Building and construction materials;
- Heavy machinery and vehicles;
- First aid and household goods; and
- Fishing supplies.

Local Economy
Major Employers
The median individual income in Wainwright is $45,000.[582] The unemployment rate is approximately 14.7 percent.[583] Roughly 13.3 percent of the city's population was below the poverty level.[584] The largest share of employment takes place in the following industries: educational services, health care, and social assistance (23.9 percent); public administration (19.4 percent); professional, scientific, and management, and administrative and waste management services (17.2 percent); retail trade (12.8 percent); and construction (11.7 percent).[585]

Like other North Slope communities, a large number of employment positions are government jobs, either with the NSB or the North Slope Borough School District (NSBSD). Residents supplement their income with arts and crafts, such as ivory figurines and jewelry, baleen boats, whale bone carvings, clocks, and knitted hats and gloves.[586] Wainwright has close economic ties to Utqiagvik, which is only 72 air miles away.

The local Olgoonik Corporation manages the Native store that sells groceries (e.g., meat, milk, vegetables, and canned goods), clothing, and household goods. The OC also runs a hotel and restaurant, a fuel station, and a vehicle and equipment rental company. The Olgoonik Oilfield Services, a subsidiary of the OC, provides operational and support services for oilfield exploration and production and uses Wainwright as a base of operations.[587]

Subsistence Activities

Like other North Slope communities, the two major sources of subsistence food are bowhead whales and caribou. Other key subsistence resources are beluga whales, bearded seals, smelt, geese, and ducks. In figure 4 below, Wainwright's area of influence is outlined in orange, which depicts the areas in which residents hunt for key subsistence resources and engage in traditional land use.[588] Wainwright also lies just 25 miles southwest of Peard Bay, which is a protected zone because of its importance to marine mammals as a haul out area and as a staging area for migratory birds.

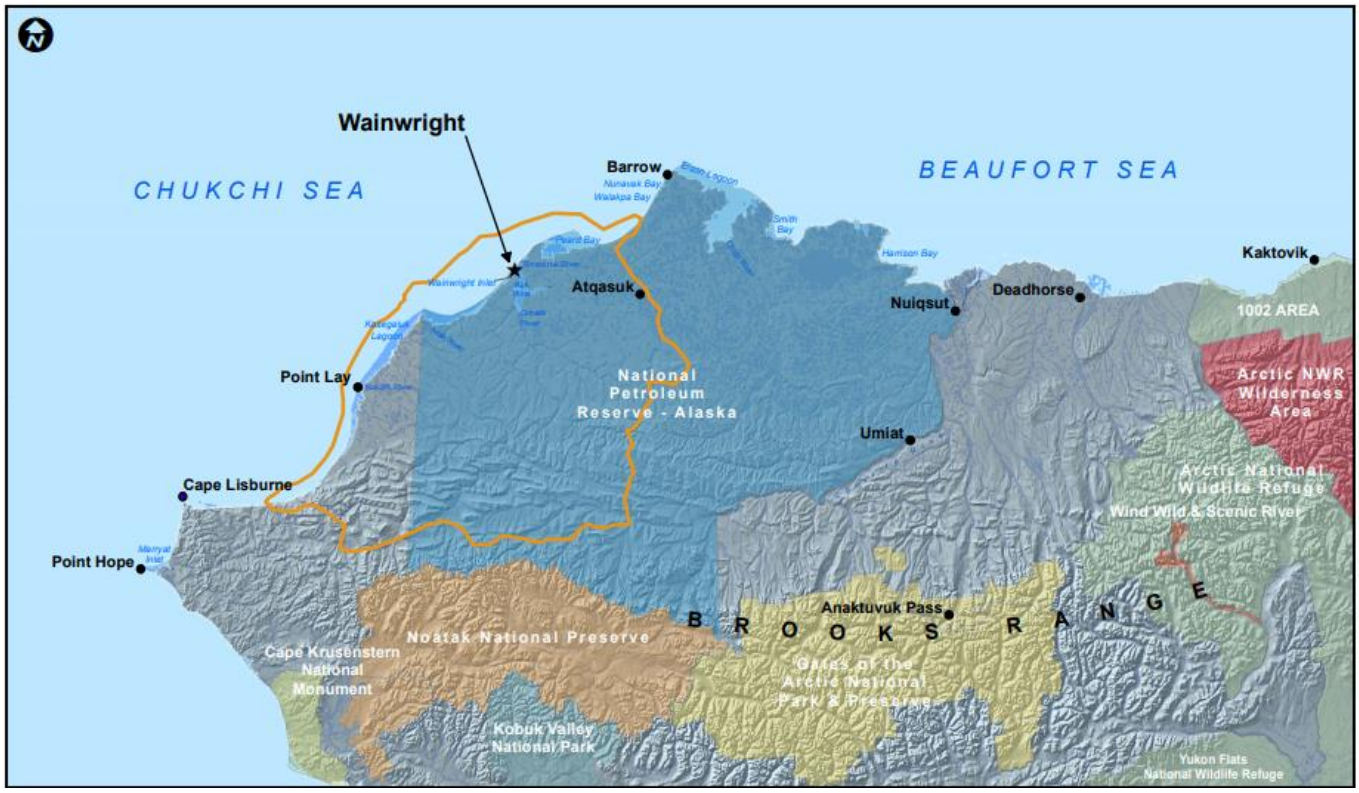


Figure 5. Wainwright Area of Influence

Along with Utqiagvik, Wainwright's location is unique in that it allows for residents to hunt for bowheads in both the spring and the fall. Local whaling crews typically begin hunting bowheads in early May as bowheads begin migrating along the coast and again in the fall as they return south. Subsistence hunters may go as far out as 50 miles offshore to hunt bowheads and other marine mammals.

Caribou herds arrive in the summer months when they migrate towards the coast to graze, calve, and escape insects.

Most of the population engage in some form of subsistence living. Some 76 percent of households hunted seals, caribou, or waterfowl, or fished, while twenty-one percent of households took part in whaling, and 1.3 percent of households were totally detached from subsistence foods. Harvesting subsistence resources is a communal affair, most of which (75 percent) obtained with social cooperation outside of the household, either through cooperative hunting or sharing.[589]
Residents of Wainwright receive a significant portion of subsistence foods from harvested fish. The main harvest areas include the Kuk River and Peard Bay. Common harvest fish include chum and pink salmon, Bering cisco, and rainbow smelt.[590]

Figure 6. Fish Harvest Area

Port Planning and Future Growth
According to a 2014 report, the OC expressed a desire to construct a bulkhead dock at the entrance of the Wainwright Inlet, another bulkhead dock north of town, and a boat ramp near the old DEW radar site. While the community favored a dock at the entrance of the Inlet with an access road,[591] it is unclear whether the town, the OC, or the NSB have undertaken any of these plans.

Environment

Environmental Justice

Environmental Justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.[592] Consequently, proposed activities need to be mindful of the impact on Alaska Native communities. These communities are usually comprised of low-income and minority populations and are more at risk to experience the negative consequences of global climate change and economic development.

The NSB estimates that Wainwright's population will increase to anywhere between 608 and 671 by 2035, depending on oil and gas exploration and production.[593] Under conditions of oil exploration and construction, an influx of 50 to 100 people would strain the community's public resources and infrastructure. Past efforts to house workers lacked plans in place to guide construction and development within the community in an orderly manner. In the 2014 comprehensive report, locals had already identified a shortage of residential housing as a problem for the community. They also expressed concerns that an arrival of new visitors and workers could disrupt the community's traditional culture.

A small share of Wainwrights population are employed in the energy sector (only 0.5 percent in 2010). Oil and gas exploration and development offshore in the Chukchi Sea has the potential for significant short-term and long-term employment opportunities. However, the NSB has suggested that development may not produce desired employment benefits for the population, stating that "the more valuable long term employment in production has been elusive, as shown by the NSB 2010 Economic Profiles and Census."[594] The NSB argued that training and employment of locals could help mitigate potential Environmental Justice concerns.

These issues can be further discussed with residents and representatives of Wainwright. Current NSB Assembly President John Hopson Jr. represents Wainwright. They can be contacted via Sheila Burke, Borough Clerk, at (907) 852-0360.

Water/Air Quality

Wainwright has access to fresh water lakes, however, the town is plagued with water main and sewer line leaks and breaks. Recurring breakages in certain sections is common. As a result, the drinking water within the community is expensive and limited.[595]

Natural Resources Available

There are currently no oil or gas leases in the Chukchi Sea. Oil companies such as Shell, Conoco-Phillips, and Statoil have previously acquired leases as close as 80 miles offshore from the town. In late-2016, President Barack Obama instated a ban on drilling in the Chukchi and large parts of the Beaufort Sea. In 2017, President Donald Trump issued an executive order to rescind the ban, but this reversal was struck down by a judge from the U.S. District Court for the District of Alaska in March 2019.[596] In the event of future leases for energy exploration and production, Wainwright would be in close proximity to those activities.

Effects of Climate Change

Coastal erosion poses a significant challenge to the community. There is anecdotal evidence from residents that the thawing accelerates erosion, which has led to the collapsing of some of the ice cellars in the community. Ice cellars are an important component to subsistence lifestyles, offering an

affordable and convenient form of refrigeration. Furthermore, without them locals cannot store harvested subsistence food year-round. In 2014, residents generally agreed that roughly half of the town's ice cellars had been lost in the previous 30 years.[597] Thawing permafrost also increases erosion and sedimentation in inland rivers, which impedes navigation and limits boat access to upland areas. As a result, this thawing trend could disrupt subsistence activities.

Thawing permafrost and above ground meltwater has eroded the earth around the town's underground pipeline corridor, causing the pipes themselves to sag and buckle. This causes flooding that rushes down grade triggers a cascading effect of subsequent erosion and pipe breakages.[598] The thawing has also resulted in sinking foundations and damage to one of the town's main water storage tanks and to the airport.[599]

Wainwright has nine historic or prehistoric indigenous sites that are included in the National Register of Historic Places.[600] Coastal erosion presents a threat to some of these sites.

Endnotes

[1] Hoegh-Guldberg, O., & Bruno, J. F. (2010). The Impact of Climate Change on the Worlds Marine Ecosystems. Science, 328(5985), 1523–1528. doi: 10.1126/science.1189930.
[2] https://www.cmts.gov/downloads/NSAR_1.1.2_10-Year_MTS_Investment_Framework_Final_5_4_16.pdf.
[3] Image created with Google Earth Pro.
[4] https://www.epa.gov/eco-research/ecoregions.
[5] Gallant, A.L., Binnian, E.F. Omernik, J.M. and Shasby, M.B., 1995, Ecoregions of Alaska: U.S. Geological Survey Professional Paper 1567.
[6] http://www.adfg.alaska.gov/static/species/wildlife_action_plan/section3b.pdf.
[7] http://www.adfg.alaska.gov/index.cfm?adfg=ecosystems.ecoregions.
[8] Norwacki, G., Spencer, P., Fleming, M., Brock, T., & Jorgenson, T. (2001). Ecoregions of Alaska: 2001. USGS Open-File Report 02-297 (map).
[9] Modified from Norwacki, G., Spencer, P., Fleming, M., Brock, T., & Jorgenson, T. (2001). Ecoregions of Alaska: 2001. USGS Open-File Report 02-297.
[10] *Ibid*
[11] Gallant, A.L., Binnian, E.F. Omernik, J.M. and Shasby, M.B., 1995, Ecoregions of Alaska: U.S. Geological Survey Professional Paper 1567.
[12] Modified from Norwacki, G., Spencer, P., Fleming, M., Brock, T., & Jorgenson, T. (2001). Ecoregions of Alaska: 2001. USGS Open-File Report 02-297.
[13] *Ibid.*
[14] Gallant, A.L., Binnian, E.F. Omernik, J.M. and Shasby, M.B., 1995, Ecoregions of Alaska: U.S. Geological Survey Professional Paper 1567.
[15] Modified from Norwacki, G., Spencer, P., Fleming, M., Brock, T., & Jorgenson, T. (2001). Ecoregions of Alaska: 2001. USGS Open-File Report 02-297.
[16] *Ibid.*
[17] Gallant, A.L., Binnian, E.F. Omernik, J.M. and Shasby, M.B., 1995, Ecoregions of Alaska: U.S. Geological Survey Professional Paper 1567.
[18] *Ibid.*
[19] Modified from Norwacki, G., Spencer, P., Fleming, M., Brock, T., & Jorgenson, T. (2001). Ecoregions of Alaska: 2001. USGS Open-File Report 02-297.
[2020] *Ibid.*
[21] Gallant, A.L., Binnian, E.F. Omernik, J.M. and Shasby, M.B., 1995, Ecoregions of Alaska: U.S. Geological Survey Professional Paper 1567.
[22] *Ibid.*
[23] Modified from Norwacki, G., Spencer, P., Fleming, M., Brock, T., & Jorgenson, T. (2001). Ecoregions of Alaska: 2001. USGS Open-File Report 02-297.
[24] *Ibid.*
[25] Gallant, A.L., Binnian, E.F. Omernik, J.M. and Shasby, M.B., 1995, Ecoregions of Alaska: U.S. Geological Survey Professional Paper 1567.
[26] *Ibid.*
[27] Arctic Biodiversity Assessment: Status and trends in Arctic biodiversity
http://arcticlcc.org/assets/resources/ABA2013Science.pdf.
[28] U.S. Fish & Wildlife Service at https://www.fws.gov/endangered/species/us-species.html.
[29] Audubon at https://www.audubon.org/magazine/winter-2018/a-journey-heart-alaskas-pristine-and-imperiled.
[30] Alaska Department of Fish and Game at http://www.adfg.alaska.gov/static/species/wildlife_action_plan/section3b.pdf.
[31] Gallant, A.L., Binnian, E.F. Omernik, J.M. and Shasby, M.B., 1995, Ecoregions of Alaska: U.S. Geological Survey Professional Paper 1567.
[32] *Ibid.*
[33] Norwacki, G., Spencer, P., Fleming, M., Brock, T., & Jorgenson, T. (2001). Ecoregions of Alaska: 2001. USGS Open-File Report 02-297.
[34] ADFG at https://www.adfg.alaska.gov/index.cfm?adfg=viewing.marinemammals.
[35] Alaska Ocean Observing System at https://aoos.org/aoos-data-resources/.
[36] https://response.restoration.noaa.gov/oil-and-chemical-spills/oil-spills/how-oil-harms-animals-and-plants-marine-environments.html.
[37] Darnis, G. *et al*. (2012) Secondary production, pelagic-benthic coupling, and biodiversity. *Climate Change*.

[38] Ocean Conservancy at https://oceanconservancy.org/wp-content/uploads/2017/06/Arctic-Vessel-Traffic-Report-WEB-2.pdf.
[39] Yale at https://e360.yale.edu/features/at-last-the-shipping-industry-begins-cleaning-up-its-dirty-fuels.
[40] National Institutes of Health at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5673872/.
[41] National Oceanic and Atmospheric Administration at https://coast.noaa.gov/states/alaska.html.
[42] Alaska Department of Fish and Game at https://adfg.alaska.gov/index.cfm?adfg=divisions.cfoverview.
[43] https://www.fisheries.noaa.gov/feature-story/us-signs-agreement-prevent-unregulated-commercial-fishing-high-seas-central-arctic.
[44] FWS at https://www.fws.gov/refuge/selawik/.
[45] Audubon at https://ak.audubon.org/teshekpuk-lake-0.
[46] Gallant, A.L., Binnian, E.F. Omernik, J.M. and Shasby, M.B., 1995, Ecoregions of Alaska: U.S. Geological Survey Professional Paper 1567.
[47] National Parks Service https://www.nps.gov/subjects/nationalregister/index.htm.
[48] University of Alaska Fairbankshttps://www.uaf.edu/anlc/languages/inupiaq.php.
[49] UAF at https://www.uaf.edu/anla/collections/map/anlmap.png.
[50] Environmental Protection Agency https://www.epa.gov/environmentaljustice.
[51] Alaska Community Database Online Diomede at https://arcg.is/1uvej.
[52] *Ibid.*
[53] *Ibid.*
[54] Army Corps of Engineers at https://www.poa.usace.army.mil/Portals/34/docs/civilworks/archive/alaskabargelandingsystemdesignstatewidephase1.pdf.
[55] *Ibid.*
[56] Atlas Obscura at https://www.atlasobscura.com/places/little-diomede-island.
[57] ACDO Diomede at https://arcg.is/1uvej.
[58] Kawerak Inc. at https://kawerak.org/congress-improves-air-service-for-diomede/.
[59] Erickson Incorporated at https://ericksoninc.com/.
[60] Pathfinder Aviation at https://www.pathfinderaviation.com/.
[61] ACDO Diomede at https://arcg.is/1uvej.
[62] ACDO Diomede at https://arcg.is/1uvej.
[63] Popular Mechanics at https://books.google.com/books?id=POUDAAAAMBAJ&printsec=frontcover&hl=en#v=onepage&q&f=false.
[64] Atlas Obscura at https://www.atlasobscura.com/places/little-diomede-island.
[65] U.S. Army Corps of Engineers at https://www.poa.usace.army.mil/Portals/34/docs/civilworks/archive/alaskabargelandingsystemdesignstatewidephase1.pdf.
[66] USACE at https://www.poa.usace.army.mil/Portals/34/docs/civilworks/archive/alaskabargelandingsystemdesignstatewidephase1.pdf.
[67] ACDO Diomede at https://arcg.is/1uvej.
[68] State of Alaska Department of Commerce at https://www.commerce.alaska.gov/cbp/businesslicense/search/License.
[69] ACDO Diomede at https://arcg.is/1uvej.
[70] National Geographic at https://www.nationalgeographic.com/environment/2018/11/little-diomede-alaska-faces-rapid-climate-change-threatens-native-inupiat-community/.
[71] Kawerak at https://kawerak.org/congress-improves-air-service-for-diomede/.
[72] National Geographic at https://www.nationalgeographic.com/environment/2018/11/little-diomede-alaska-faces-rapid-climate-change-threatens-native-inupiat-community/.
[73] *Ibid.*
[74] NOAA at https://www.pmel.noaa.gov/arctic-zone/detect/human-shishmaref.shtml
[75] *Ibid.*
[76] Huffington Post at https://www.huffpost.com/entry/shishmaref-alaska-climate-change-relocation_n_6296516.
[77] Alaska Department of Transportation & Public Facilities at http://dot.alaska.gov/nreg/shishmaref/.
[78] Huffington Post at https://www.huffpost.com/entry/shishmaref-alaska-climate-change-relocation_n_6296516
[79] DOT&PF at http://dot.alaska.gov/nreg/shishmaref/.
[80] University of Alaska at https://scholarworks.alaska.edu/bitstream/handle/11122/9151/Marino_E_2012.pdf?sequence=1&isAllowed=y
[81] Climate Adaptation Knowledge Exchant at https://www.cakex.org/case-studies/relocating-native-village-shishmaref-alaska-due-coastal-erosion.

[82] Environmental Justice Atlas at https://ejatlas.org/conflict/climate-change-displacement-of-native-alaskans-usa
[83] Alaska Community Database Online at https://dcced.maps.arcgis.com/apps/MapJournal/index.html?appid=1671c54f43e140339345bf9a4f5c08c7.
[84] *Ibid*.
[85] DataUSA at https://datausa.io/profile/geo/wales-ak.
[86] *Ibid*.
[87] Census Bureau at "ACS Demographic and Housing Estimates" American Community Survey Table DP05 at https://data.census.gov/cedsci/table?q=race&g=1600000US0282860&tid=ACSDP5Y2018.DP05&vintage=2018.
[88] Kawerak at https://kawerak.org/bering-strait-comprehensive-economic-development-strategy-published/, page 56.
[89] USACE at https://www.poa.usace.army.mil/Portals/34/docs/civilworks/archive/alaskabargelandingsystemdesignstatewidephase1.pdf, page 24.
[90] DecisionData at https://decisiondata.org/tv-internet-by-city/wales-ak-internet/.
[91] Kawerak at https://kawerak.org/wp-content/uploads/2018/02/wales.pdf, page 27.
[92] Kawerak at https://kawerak.org/bering-strait-comprehensive-economic-development-strategy-published/, page 57.
[93] Kawerak at https://kawerak.org/bering-strait-comprehensive-economic-development-strategy-published/, page 56, 57.
[94] DOT&PF at http://dot.alaska.gov/nreg/nwatp/files/nwatpAviatationConditions.pdf, page 26.
[95] *Ibid*., page 9.
[96] *Ibid*., page 18.
[97] USACE at https://www.poa.usace.army.mil/Portals/34/docs/civilworks/archive/alaskabargelandingsystemdesignstatewidephase1.pdf, page 25.
[98] DOT&PF at http://dot.alaska.gov/nreg/nwatp/files/nwatpAviatationConditions.pdf, page A-21.
[99] Kawerak at https://kawerak.org/bering-strait-comprehensive-economic-development-strategy-published/, page 57.
[100] DOT&PF at http://dot.alaska.gov/nreg/nwatp/files/nwatpMarineRiverineConditions.pdf, page 44.
[101] USACE at https://www.poa.usace.army.mil/Portals/34/docs/civilworks/archive/alaskabargelandingsystemdesignstatewidephase1.pdf, page 24.
[102] Crowley at http://www.crowley.com/what-we-do/alaska-fuel-sales-and-distribution/overview/.
[103] Alaska Logistics at https://www.alaska-logistics.com/.
[104] Kawerak at https://kawerak.org/wp-content/uploads/2018/02/wales.pdf, page 33.
[105] Lynden at http://info.lynden.com/blog/bid/114774/Lynden-Signs-Purchase-Agreement-to-Buy-Northland-Services.
[106] Kawerak at https://kawerak.org/bering-strait-comprehensive-economic-development-strategy-published/.
[107] SOA at https://www.commerce.alaska.gov/cbp/businesslicense/search/License (search term "Wales").
[108] Denali Commission at https://www.denali.gov/wp-content/uploads/2018/10/2018-Distressed-Communities-Report-Final.pdf, page 13.
[109] Census Bureau "Occupation by Sex and Median Earnings in the Past 12 Months" American Community Survey Table S2411 at https://data.census.gov/cedsci/table?q=S2411%3A%20OCCUPATION%20BY%20SEX%20AND%20MEDIAN%20EARNINGS%20IN%20THE%20PAST%2012%20MONTHS%20%28IN%202018%20INFLATION-ADJUSTED%20DOLLARS%29%20FOR%20THE%20CIVILIAN%20EMPLOYED%20POPULATION%2016%20YEARS%20AND%20OVER&g=1600000US0282860&lastDisplayedRow=9&table=B02001&tid=ACSST5Y2018.S2411&vintage=2018&hidePreview=true.
[110] Census Bureau "Selected Economic Characteristics" American Community Survey Table DP03 at https://data.census.gov/cedsci/table?q=DP03%3A%20SELECTED%20ECONOMIC%20CHARACTERISTICS&g=1600000US0282860&hidePreview=true&table=S1901&tid=ACSDP5Y2018.DP03&lastDisplayedRow=16&vintage=2018.
[111] *Ibid*.
[112] Kawerak at https://kawerak.org/wp-content/uploads/2018/02/wales.pdf, page 50.
[113] *Ibid*.
[114] DOT&PF http://dot.alaska.gov/nreg/nwatp/files/nwatpMarineRiverineConditions.pdf, page 44.
[115] Kawerak at https://kawerak.org/wp-content/uploads/2018/02/wales.pdf, page 42.
[116] USACE at https://www.alaskajournal.com/sites/alaskajournal.com/files/nome_port_draft_12_19.pdf, page 17.
[117] Kawerak at https://kawerak.org/wp-content/uploads/2018/02/wales.pdf, page 76.
[118] *Ibid*., page 64.

[119] Environmental Protection Agency at https://compliancegov.zendesk.com/hc/en-us/articles/212101977-How-Does-EPA-define-Environmental-Justice-.
[120] Kawerak at https://kawerak.org/wp-content/uploads/2018/02/wales.pdf, page 24.
[121] USACE at https://www.alaskajournal.com/sites/alaskajournal.com/files/nome_port_draft_12_19.pdf, page 20.
[122] Alaska Department of Environmental Conservation at https://dec.alaska.gov/Applications/SPAR/PublicMVC/CSP/SiteReport/24272.
[123] Kawerak at https://kawerak.org/wp-content/uploads/2018/02/wales.pdf, page 52.
[124] Northwest Arctic Borough (NAB) at https://www.nwabor.org/village/kobuk/.
[125] Alaska Community Database Online (ACDO)https://dcced.maps.arcgis.com/apps/MapJournal/index.html?appid=5e9414a360c74f06acc9a22da1ff65b0#.
[126] *Ibid.*
[127] *Ibid.*
[128] *Ibid.*
[129] ACDO at https://dcced.maps.arcgis.com/apps/MapJournal/index.html?appid=5e9414a360c74f06acc9a22da1ff65b0.
[130] ACDO at https://dcced.maps.arcgis.com/apps/MapJournal/index.html?appid=e71a281a0f42420fbd2aca12efedd0c2.
[131] ACDO at https://dcced.maps.arcgis.com/apps/MapJournal/index.html?appid=1d4f188c09264925b1f5224a81a5e681.
[132] *Ibid.*
[133]ACDO at https://dcced.maps.arcgis.com/apps/MapJournal/index.html?appid=1d4f188c09264925b1f5224a81a5e681.
[134] *Ibid.*
[135] *Ibid.*
[136] NAB at https://www.nwabor.org/village/shungnak/.
[137] ACDO at https://dcced.maps.arcgis.com/apps/MapJournal/index.html?appid=1d4f188c09264925b1f5224a81a5e681#.
[138]Maniilaq at https://www.maniilaq.org/northwest-alaska.
[139] DOT&PF at http://dot.alaska.gov/nreg/nwatp/files/nwatpAviatationConditions.pdf.
[140] Ravn Air at https://www.flyravn.com/about-us/aircraft-fleet/.
[141] Federal Aviation Administration https://www.faa.gov/airports/airport_safety/airportdata_5010/.
[142] *Ibid.*
[143] ACDO at https://dcced.maps.arcgis.com/apps/MapJournal/index.html?appid=5e9414a360c74f06acc9a22da1ff65b0.
[144] USACE at https://www.poa.usace.army.mil/Portals/34/docs/civilworks/archive/alaskabargelandingsystemdesignstatewidephase1.pdf.
[145] *Ibid.*
[146] *Ibid.*
[147] *Ibid.*
[148] USACE at https://www.poa.usace.army.mil/Portals/34/docs/civilworks/archive/alaskabargelandingsystemdesignstatewidephase1.pdf.
[149] USACE at https://www.poa.usace.army.mil/Portals/34/docs/civilworks/archive/alaskabargelandingsystemdesignstatewidephase1.pdf.
[150] NAB at https://www.nwabor.org/village/kobuk/.
[151] NAB at https://www.nwabor.org/village/shungnak/.
[152] NAB at https://www.nwabor.org/village/ambler.
[153] ADFG at http://swww.adfg.alaska.gov/techpap/TP%20402.pdf.
[154] *Ibid.*
[155] *Ibid.*
[156] *Ibid.*
[157] ACDO at https://dcced.maps.arcgis.com/apps/MapJournal/index.html?appid=5e9414a360c74f06acc9a22da1ff65b0#.
[158] Ambler Access at http://www.ambleraccess.com/#carousel1.
[159] Bureau of Land Management at https://www.blm.gov/programs/planning-and-nepa/plans-in-development/alaska/AmblerRoadEIS.
[160] Duquesne University at https://dsc.duq.edu/cgi/viewcontent.cgi?article=1054&context=duquark.
[161] Alaska Public Media at https://www.alaskapublic.org/2019/12/05/a-northwest-arctic-borough-program-cut-water-bills-by-about-two-thirds-but-one-village-says-it-doesnt-need-the-help/.

[162] Village Economic Development at https://www.ncsl.org/Portals/1/Documents/energy/Tribal_Energy/NTES2019_Adams-Hirsch_present_34163.pdf.
[163] *Ibid.*
[164] *Ibid.*
[165] Alaska Native Tribal Health Consortium Center for Climate and Health https://anthc.org/wp-content/uploads/2016/01/CCH_AR_102011_Climate-Change-in-Kiana.pdf.
[166] *Ibid.*
[167] *Ibid.*
[168] *Ibid.*
[169] *Ibid.*
[170] ACDO at https://dcced.maps.arcgis.com/apps/MapJournal/index.html?appid=13a1685af86d48cfa72ba60f0eb7cfc8#
[171] Ibid.
[172] USACE at https://www.poa.usace.army.mil/Portals/34/docs/civilworks/archive/alaskabargelandingsystemdesignstatewidephase1.pdf.
[173] ACDO at https://dcced.maps.arcgis.com/apps/MapJournal/index.html?appid=13a1685af86d48cfa72ba60f0eb7cfc8
[174] Ibid.
[175] Alaskan Natives at https://www.alaskan-natives.com/228/buckland/.
[176]Airnav at http://airnav.com/airport/PABL.
[177] Bering Air at https://apps6.tflite.com/Public/BER/Booking/Search.
[178] Airnav at http://airnav.com/airport/PABL.
[179] DOT&PF at http://dot.alaska.gov/nreg/nwatp/files/nwatpWinterTrailsTechMemo.pdf.
[180] Alaskan Natives at https://www.alaskan-natives.com/228/buckland/.
[181] USACE at https://www.poa.usace.army.mil/Portals/34/docs/civilworks/archive/alaskabargelandingsystemdesignstatewidephase1.pdf.
[182] *Ibid.*
[183] *Ibid.*
[184] Maniilaq at https://www.maniilaq.org/northwest-alaska/buckland/.
[185] Crowley at http://www.crowley.com/what-we-do/alaska-fuel-sales-and-distribution/western-alaska-marine-delivery/.
[186] *Ibid.*
[187] Maniilaq at https://www.maniilaq.org/northwest-alaska/buckland/.
[188]ACDO at https://dcced.maps.arcgis.com/apps/MapJournal/index.html?appid=13a1685af86d48cfa72ba60f0eb7cfc8#.
[189] Data USA at https://datausa.io/profile/geo/buckland-ak/.
[190] Alaskan Natives at https://www.alaskan-natives.com/228/buckland/.
[191] *Ibid.*
[192] Office of Indian Energy Policy and Programs at https://www.energy.gov/indianenergy/articles/doe-co-funded-pv-project-brings-fuel-cost-savings-three-alaska-native-villages.
[193] *Ibid.*
[194] ADFG at https://library.alaska.gov/asp/edocs/2011/08/ocn748686217.pdf.
[195] *Ibid.*
[196] *Ibid.*
[197] *Ibid.*
[198] *Ibid.*
[199] *Ibid.*
[200] Duquesne University at https://dsc.duq.edu/cgi/viewcontent.cgi?article=1054&context=duquark.
[201] Alaska Public Media at https://www.alaskapublic.org/2019/12/05/a-northwest-arctic-borough-program-cut-water-bills-by-about-two-thirds-but-one-village-says-it-doesnt-need-the-help/.
[202] USACE at https://www.poa.usace.army.mil/Portals/34/docs/civilworks/BEA/Buckland_Final%20Report.pdf
[203] Alaska Public Media at http://www.alaskapublic.org/2014/05/15/working-group-discusses-caribou-decline-ambler-road/.
[204] ACDO at https://dcced.maps.arcgis.com/apps/MapJournal/index.html?appid=52e92b70be5b4d82a061a4a1231d6d98#.
[205] *Ibid.*
[206] DataUSA at https://datausa.io/profile/geo/deering-ak.
[207] *Ibid.*

[208]. NAB at http://www.nwabor.org/wp-content/uploads/NAB-CEDS-Final-Approved-Report-8.27.2019.pdf, page 46.
[209] NWABOR at https://www.nwabor.org/village/deering/.
[210] Maniilaq at https://www.maniilaq.org/northwest-alaska/deering/.
[211] U.S. Department of Energy at https://www.energy.gov/sites/prod/files/2016/12/f34/Adams-NANA.pdf.
[212] The Grand Island Independent at https://www.theindependent.com/news/local/engineer-fulfilled-water-and-sewer-needs-in-alaska/article_29a7b982-6a2a-11e9-850a-a3710e60b4a5.html.
[213] DecisionData at https://decisiondata.org/tv-internet-by-city/deering-ak-internet/.
[214] AirNav at https://www.airnav.com/airport/PADE.
[215] DOT&PF at http://dot.alaska.gov/nreg/nwatp/files/nwatpAviatationConditions.pdf, page 17.
[216] RavnAir at https://www.flyravn.com/flying-with-ravn/route-map/.
[217] Bering Air at https://www.beringair.com/about/our-destinations/deering/.
[218] USACE at https://www.poa.usace.army.mil/Portals/34/docs/civilworks/archive/alaskabargelandingsystemdesignstatewidephase1.pdf, page 104.
[219] USACE at https://www.poa.usace.army.mil/Portals/34/docs/civilworks/BEA/Deering_Final%20Report.pdf, page 1.
[220] DOT&PF at http://dot.alaska.gov/nreg/nwatp/files/nwatpMarineRiverineConditions.pdf, page 31.
[221] *Ibid.,* page 15.
[222] USACE at https://www.poa.usace.army.mil/Portals/34/docs/operations/EFC/2017DeeringStreamBankProtectionOverview.pdf?ver=2018-12-31-111849-033.
[223] Alaska Marine Lines at http://www.lynden.com/aml/PDF/2020-AML_Western_Schedule.pdf.
[224] Crowley at http://www.crowley.com/industries-we-serve/energy/.
[225] Alaska Natives at https://www.alaskan-natives.com/239/native-village-deering/
[226] NWABOR at http://www.nwabor.org/wp-content/uploads/NWAB_profiles_office_use.pdf
[227] Census Bureau "Selected Economic Characteristics" American Community Survey Table DP03 at https://data.census.gov/cedsci/table?q=employment%20rate&tid=ACSDP5Y2018.DP03&t=Employment&vintage=2018&g=1600000US0218510
[228] Census Bureau "Selected Economic Characteristics" American Community Survey Table DP03 at https://data.census.gov/cedsci/table?q=employment%20rate&tid=ACSDP5Y2018.DP03&t=Employment&vintage=2018&g=1600000US0218510.
[229] Census Bureau "Poverty Status in the Past 12 Months" American Community Survey Table S1701 at https://data.census.gov/cedsci/table?q=poverty%20rate&lastDisplayedRow=31&table=-S1701&tid=ACSST5Y2018.S1701&t=Poverty&vintage=2018&mode=&g=1600000US0218510.
[230] Census Bureau "Occupation by Sex and Median Earnings in the Past 12 Months" American Community Survey Table S2411 at https://data.census.gov/cedsci/table?q=S2411%3A%20OCCUPATION%20BY%20SEX%20AND%20MEDIAN%20EARNINGS%20IN%20THE%20PAST%2012%20MONTHS%20%28IN%202018%20INFLATION-ADJUSTED%20DOLLARS%29%20FOR%20THE%20CIVILIAN%20EMPLOYED%20POPULATION%2016%20YEARS%20AND%20OVER&g=1600000US0218510&lastDisplayedRow=9&table=B02001&tid=ACSST5Y2018.S2411&vintage=2018&hidePreview=true.
[231] SOA at http://www.adfg.alaska.gov/download/indexing/Technical%20Papers/TP259.pdf, page 44.
[232] NWABOR at http://www.nwabor.org/wp-content/uploads/NAB-CEDS-Final-Approved-Report-8.27.2019.pdf, page 23.
[233] NWABOR at http://portal.nwabor.org/#map?lg=ebbc9421-4c02-4d54-b245-0c06e15589b6.
[234] Yale at https://environment.yale.edu/climate-communication-OFF/files/Gorokovich_and_Leiserowitz_(2014)_Integrating_coastal_vulnerability_and_subistence_resource_mapping_in_NW_AK.pdf.
[235] NWABOR at http://portal.nwabor.org/#map?lg=ebbc9421-4c02-4d54-b245-0c06e15589b6.
[236] SOA http://www.adfg.alaska.gov/specialpubs/SP2_SP2011-002.pdf, page 7.
[237] National Parks Service at https://www.nps.gov/articles/aps-v12-i2-c15.htm.
[238] NWABOR at https://www.nwabor.org/wp-content/uploads/6-Chapter-4-Coastal-and-Marine-Species-IEAs.pdf, page 9.
[239] USACE at https://www.poa.usace.army.mil/Portals/34/docs/civilworks/archive/alaskabargelandingsystemdesignstatewidephase1.pdf, page 105.
[240] *Ibid.*

[241] DOE https://www.energy.gov/indianenergy/articles/doe-co-funded-pv-project-brings-fuel-cost-savings-three-alaska-native-villages.
[242] National Conference of State Legislatures at https://www.ncsl.org/Portals/1/Documents/energy/Tribal_Energy/NTES2019_Adams-Hirsch_present_34163.pdf.
[243] *Ibid*.
[244] ANTHC at https://anthc.org/wp-content/uploads/2019/06/ETC-Grant-Center-Newsletter-Issue-12-May-2018.pdf.
[245] DOT&PF at http://dot.alaska.gov/nreg/nwatp/files/nwatpMarineRiverineConditions.pdf, page 31.
[246] EPA at https://compliancegov.zendesk.com/hc/en-us/articles/212101977-How-Does-EPA-define-Environmental-Justice-.
[247] ADEC at https://dec.alaska.gov/Applications/spar/PublicMVC/CSP/SiteReport/4141.
[248] NWABOR at https://www.nwabor.org/wp-content/uploads/7-Chapter-5-Afterword-References.pdf, pages 535, 537-38.
[249] Denali Commission at https://www.denali.gov/wp-content/uploads/2019/11/Statewide-Threat-Assessment-Final-Report-November-2019-1-2.pdf, page A-10.
[250] Northwest Arctic Borough at https://www.nwabor.org/village/kivalina.
[251] USACE at https://www.poa.usace.army.mil/Portals/34/docs/civilworks/reports/KivalinaMasterPlanMainReportJune2006.pdf.
[252] Ground Truth Trekking at http://www.groundtruthtrekking.org/Issues/MetalsMining/RedDogMine.html#employment%20and%20revenue%20sharing.
[253] The Annotated ANCSA at http://www.alaskool.org/projects/ancsa/annancsa.htm.
[254] EPA at https://compliancegov.zendesk.com/hc/en-us/articles/212101977-How-Does-EPA-define-Environmental-Justice-.
[255] ADEC at https://dec.alaska.gov/spar/csp/sites/red-dog/.
[256] Alaska Technical Center at https://www.nwarctic.org/domain/524.
[257] Kotzebue Harbor Feasibility Study, Navigations Improvement at Cape Blossom Economic Appendix at https://www.poa.usace.army.mil/Portals/34/docs/civilworks/publicreview/kotzebueharbor/KotzebueAppDEconomics.pdf?ver=2019-01-09-152556-093, page 6.
[258] ACDO at https://dcra-cdo-dcced.opendata.arcgis.com/ (search term "Kotzebue").
[259] NAB at https://www.nwabor.org/village/kotzebue/.
[260] *Ibid*.
[261] *Ibid*.
[262] Town Charts, USA, Alaska, Kotzebue, Alaska Housing Data. https://www.towncharts.com/Alaska/Housing/Kotzebue-city-AK-Housing-data.html
[263] *Ibid*.
[264] *Ibid*.
[265] *Ibid*.
[266] *Ibid*.
[267] Maniilaq Health Center at https://www.maniilaq.org/.
[268] Maniilaq at https://www.maniilaq.org/northwest-alaska/kotzebue/.
[269] *Ibid*.
[270] *Ibid*.
[271] Maniilaq at https://www.maniilaq.org/northwest-alaska/.
[272] *Ibid*.
[273] Alaska Technical Center at https://www.nwarctic.org/domain/524.
[274] Washington Post at https://www.washingtonpost.com/national/health-science/alaskan-arctic-villages-hit-hard-by-climate-change/2012/08/05/e9dbd4a6-d5b0-11e1-a9e3-c5249ea531ca_story.html.
[275] World Port Source at http://www.worldportsource.com/ports/review/USA_AK_Port_of_Kotzebue_3527.php.
[276] *Ibid*.
[277] USACE at https://www.iwr.usace.army.mil/About/Technical-Centers/WCSC-Waterborne-Commerce-Statistics-Center/.
[278]Anchorage Daily News at https://www.alaska.edu/files/uajourney/Kotzebue-Tug-Firm-Merges.pdf.
[279] Lynden at http://www.lynden.com/aml/about/locations/kotzebue.html.
[280] Alaska Logistics. https://www.alaska-logistics.com/index.html
[281] Drake Construction at https://www.drakeconstruction.net/capabilities/marine/.

[282] Alaska Business at https://www.akbizmag.com/monitor/beating-the-ice-crowleys-western-alaska-mariners-skillfully-race-the-seasons-to-deliver-fuel/
[283] AND at https://www.adn.com/alaska-news/article/coastal-communities-reflect-mega-cruise/2015/09/14/.
[284] *Ibid*.
[285] *Ibid*.
[286] *Ibid*.
[287] Town Charts at https://www.towncharts.com/Alaska/Economy/Kotzebue-city-AK-Economy-data.html.
[288] *Ibid*.
[289] *Ibid*.
[290] Magdanz, James S., Braem, Nicole S., Robbins, Brad C., and David S. Koster. 2010. Subsistence Harvests in Northwest Alaska, Kivalina and Noatak, 2007. Technical Paper No. 354, Alaska Department of Fish and Game, Division of Subsistence. http://www.adfg.alaska.gov/techpap/TP354.pdf.
[291] Subsistence Wildlife Harvests in Kotzebue, Alaska, 2013-2014, Mikow, E. and Kostick, M. https://www.arlis.org/docs/vol1/K/934734407.pdf.
[292] *Ibid*.
[293] Gorokhovtch, Y., and A. Leiserowiz. 2012. Historical and future coastal changes. Coastal Research 28(1A):174-186. https://www.researchgate.net/publication/261965975_Historical_and_Future_Coastal_Changes_in_Northwest_Alaska
[294] *Ibid*.
[295] U.S. Climate Resilience Toolkit at https://toolkit.climate.gov/regions/alaska-and-arctic/arctic-weather-and-extreme-events.
[296] USACE at https://www.poa.usace.army.mil/Portals/34/docs/civilworks/publicreview/KotzebueSmallBoatHarborReviewPlan30May17.pdf?ver=2017-06-02-134041-490.
[297] Indian Health Service at https://www.ihs.gov/sites/alaska/themes/responsive2017/display_objects/documents/hf/Kotz.pdf.
[298] Ibid.
[299] EPA at https://enviro.epa.gov/triexplorer/tri_factsheet.factsheet_forstate?pstate=AK&pyear=2018&pParent=TRI&pDataSet=TRIQ1.
[300] NAT GEO at https://www.nationalgeographic.com/news/2018/02/most-toxic-town-us-kotzebue-alaska-red-dog-mine/.
[301] Science Alert at https://www.sciencealert.com/most-toxic-town-in-the-united-states-epa-chemicals-pollution-kotzebue-alaska.
[302] EPA at https://enviro.epa.gov/triexplorer/tri_factsheet.factsheet?pzip=&pstate=AK&pcity=&pcounty=Northwest Arctic Borough&pyear=2018&pParent=TRI&pDataSet=TRIQ1.
[303] City of Kotzebue at https://www.cityofkotzebue.com/vertical/sites/%7BA001CDF5-7F45-4E0C-9DFC-D296959501D1%7D/uploads/CCR_2018_(004).pdf.
[304] U.S. Geological Survey at https://pubs.usgs.gov/fs/2008/3049/fs2008-3049.pdf.
[305] USGS at https://eerscmap.usgs.gov/uswtdb/viewer/#9.58/66.8674/-162.5385.
[306] Federal Reserve Board of San Francisco at https://www.frbsf.org/economic-research/files/wp2020-02.pdf.
[307] National Snow & Ice Data Center at http://nsidc.org/soac/sea-ice.html#seaice.
[308] NAT GEO at https://www.nationalgeographic.com/news/2015/07/150701-alaska-seals-hunt-climate-warming-kotzebue/.
[309] ADFG at http://www.adfg.alaska.gov/static/home/library/pdfs/wildlife/caribou_trails/caribou_trails_2014.pdf.
[310] ACDO Noorvik at https://arcg.is/4mj5e.
[311] ACDO Kiana at https://arcg.is/K1XCX.
[312] ACDO Noorvik at https://arcg.is/4mj5e.
[313] ACDO Kiana at https://arcg.is/K1XCX.
[314] ACDO Noorvik at https://arcg.is/4mj5e.
[315] ACDO Kiana at https://arcg.is/K1XCX.
[316] ACDO Noorvik at https://arcg.is/4mj5e.
[317] ACDO Kiana at https://arcg.is/K1XCX.
[318] ACDO Noorvik at https://arcg.is/4mj5e; ACDO Kiana at https://arcg.is/K1XCX.
[319] NAB at https://www.nwabor.org/village/noorvik/; NAB at https://www.nwabor.org/village/kiana/.

[320] ACDO Noorvik at https://arcg.is/4mj5e; ACDO Kiana at https://arcg.is/K1XCX.
[321] Federal Aviation Administration at https://www.faa.gov/airports/airport_safety/airportdata_5010/.
[322] RavnAir Group at https://www.flyravn.com/flying-with-ravn/route-map/.
[323] Bering Air at https://www.beringair.com/wp-content/uploads/2019/10/WINTER-2019-OTZ.pdf.
[324] FAA at https://www.faa.gov/airports/airport_safety/airportdata_5010/.
[325] RavnAir Group at https://www.flyravn.com/flying-with-ravn/route-map/.
[326] Bering Air at https://www.beringair.com/wp-content/uploads/2019/10/WINTER-2019-OTZ.pdf.
[327] ACDO Noorvik at https://arcg.is/4mj5e; ACDO Kiana at https://arcg.is/K1XCX.
[328] ANTHC at https://anthc.org/wp-content/uploads/2016/01/CCH_AR_102011_Climate-Change-in-Kiana.pdf.
[329] USACE at https://www.poa.usace.army.mil/Portals/34/docs/civilworks/archive/alaskabargelandingsystemde-signstatewidephase1.pdf.
[330] *Ibid.*
[331] DOT&PF at http://dot.alaska.gov/nreg/nwatp/files/nwatpMarineRiverineConditions.pdf.
[332] USACE at https://www.poa.usace.army.mil/Portals/34/docs/civilworks/archive/alaskabargelandingsystemde-signstatewidephase1.pdf.
[333] Crowley Marine Service at http://www.crowley.com/wp-content/uploads/2018/10/Eek.pdf.
[334] *Ibid.*
[335] NAB Noorvik at https://www.nwabor.org/village/noorvik/; NAB Kiana at https://www.nwabor.org/village/kiana/.
[336] *Ibid.*
[337] SOA at https://www.commerce.alaska.gov/cbp/businesslicense/search/License.
[338] ANTHC at https://anthc.org/wp-content/uploads/2016/01/CCH_AR_102011_Climate-Change-in-Kiana.pdf.
[339] *Ibid.*
[340] *Ibid.*
[341] NAB Kiana at https://www.nwabor.org/village/kiana/.
[342] ANTHC at https://anthc.org/wp-content/uploads/2016/01/CCH_AR_102011_Climate-Change-in-Kiana.pdf.
[343] *Ibid.*
[344] *Ibid.*
[345] *Ibid.*
[346] *Ibid.*
[347] *Ibid.*
[348] *Ibid.*
[349] *Ibid.*
[350] *Ibid.*
[351] *Ibid.*
[352] NAB at https://www.nwabor.org/village/selawik/.
[353] Maniilaq at https://www.maniilaq.org/northwest-alaska/selawik/.
[354] World Population Review at https://worldpopulationreview.com/us-cities/selawik-ak-population/.
[355] *Ibid.*
[356] *Ibid.*
[357] Alaska Village Electric Cooperative at https://avec.org/about/communities/.
[358] *Ibid.*
[359] *Ibid.*
[360] Alaska Public at https://www.alaskapublic.org/2020/01/24/about-a-fourth-of-selawik-homes-currently-have-frozen-pipes-and-its-a-chronic-problem/.
[361] Ibid.
[362] AirNav at http://airnav.com/airport/PASK.
[363] Bering Air at https://www.beringair.com/.
[364] Ravn Air at https://www.flyravn.com/.
[365] Alaska Department of Labor and Workforce Development at http://live.laborstats.alaska.gov/cen/acsdetails.cfm#E04.
[366] ANTHC at https://anthc.org/wp-content/uploads/2016/01/CCH_AR_052012_Climate-Change-in-Selawik.pdf.
[367] Ecology and Society at https://www.ecologyandsociety.org/vol17/iss1/art10/.
[368] FWS at https://ecos.fws.gov/ServCat/DownloadFile/18551?Reference=19930.
[369] *Ibid.*
[370] ADEC at https://dec.alaska.gov/Applications/SPAR/PublicMVC/CSP/SiteReport/25656.

[371] Ibid.
[372] DOT&PF at http://dot.alaska.gov/nreg/nwatp/files/nwatpMarineRiverineConditions.pdf.
[373] Lynden at http://www.lynden.com/aml/PDF/2019-AML_Western_Schedule.pdf.
[374] NAB at https://www.nwabor.org/wp-content/uploads/NorthwestArcticStrategicEnergyPlan_2011_5_Update_Draft.pdf.
[375] DOE at https://www.energy.gov/sites/prod/files/2015/11/f27/anthc_final_report_5168.pdf.
[376] *Ibid*.
[377] *Ibid*.
[378] FWS at https://www.fws.gov/refuge/Selawik/visit/plan_your_visit.html.
[379] *Ibid*.
[380] *Ibid*.
[381] *Ibid*.
[382] OMB Reference No: 60536 at https://www.omb.alaska.gov/ombfiles/17_budget/Trans/Enacted/2017proj60536.pdf
[383] UAF at https://snap.uaf.edu/tools/community-charts.
[384] FWS at https://www.fws.gov/refuge/Selawik/wildlife_and_habitat/index.html.
[385] *Ibid*.
[386] *Ibid*.
[387] *Ibid*.
[388] USACE at https://www.poa.usace.army.mil/Portals/34/docs/civilworks/BEA/Selawik_Final%20Report.pdf.
[389] ACDO at https://dcced.maps.arcgis.com/apps/MapJournal/index.html?appid=e42956e357c441c592540bfdb925026c#.
[390] *Ibid*.
[391] DataUSA at https://datausa.io/profile/geo/kaktovik-ak.
[392] Calculated from Census Bureau "Race" American Community Survey Table B02001 at https://data.census.gov/cedsci/table?q=kaktovik%20population%20by%20race&g=16000-00US0236990_1600000US0236990&lastDisplayedRow=9&table=B02001&tid=ACSDT5Y2018.B02001&vintage=2010&mode.
[393] NSB at http://www.north-slope.org/assets/images/uploads/KAK_Comp_Plan_April_2015_Final.pdf, page 12.
[394] Weatherbase at https://www.weatherbase.com/weather/weather.php3?s=68007&cityname=Kaktovik%2C+Alaska%2C+United+States+of+America.
[395] NSB at http://www.north-slope.org/assets/images/uploads/NSB_Comp_Plan_Public_Review.pdf, page 182.
[396] NSB at http://www.north-slope.org/our-communities/kaktovik.
[397] DOT&PF http://dot.alaska.gov/nreg/nwatp/files/nwatpAviatationConditions.pdf, page 18.
[398] NSB at http://www.north-slope.org/assets/images/uploads/KAK_Comp_Plan_April_2015_Final.pdf, page 69-72.
[399] DOT&PF at http://dot.alaska.gov/nreg/nwatp/files/nwatpAviatationConditions.pdf, page 26.
[400] NSB at http://www.north-slope.org/assets/images/uploads/KAK_Comp_Plan_April_2015_Final.pdf, A-5.
[401] ADN at https://www.adn.com/alaska-news/rural-alaska/2018/03/16/new-snow-roads-will-link-alaskas-road-system-to-arctic-communities/.
[402] NSB at http://www.north-slope.org/assets/images/uploads/KAK_Comp_Plan_April_2015_Final.pdf, page 21.
[403] USACE at https://www.commerce.alaska.gov/web/Portals/4/pub/EVCs/alaskabarge-landingsystemdesignstatewidephase1.pdf, pages 13 and 14.
[404] International Maritime Organization "Impact Assessment for a Ban on Heavy Fuel Oil Use and Carriage as Fuel by Ships in the United States Arctic," pages 12 and 14.
[405] Alaska Marine Lines at http://www.lynden.com/aml/about/index.html.
[406] Pacific Maritime Magazine at https://www.pacmar.com/story/2019/04/01/features/untapped-potential-trade-with-alaska-and-hawaii/690.html.
[407] Bowhead Transport LLC at https://uicalaska.com/our-companies/uic-commercial-services/uic-bowhead-transport-llc/.
[408] Crowley Marine at http://www.crowley.com/wp-content/uploads/2018/10/getting-fuel-from-there-to-here.pdf.
[409] Census Bureau "Selected Economic Characteristics" American Community Survey Table DP03 at https://data.census.gov/cedsci/table?q=employment%20rate&g=1600000US0236990&tid=ACSDP5Y2018.DP03&t=Employment&vintage=2018.
[410] Census Bureau "Poverty Status in the Past 12 Months" American Community Survey Table S1701 at https://data.census.gov/cedsci/table?q=poverty%20rate&lastDisplayedRow=31&table=-S1701&tid=ACSST5Y2018.S1701&t=Poverty&g=1600000US0236990&vintage=2018&mode=.
[411] NSB at http://www.north-slope.org/assets/images/uploads/KAK_Comp_Plan_April_2015_Final.pdf.
[412] Alaska Public Media at https://www.alaskapublic.org/2018/09/05/in-kaktovik-sea-ice-loss-means-a-boom-in-polar-bear-tourism/.

[413] Arctic Today at https://www.arctictoday.com/how-the-prospect-of-oil-drilling-in-alaskas-arctic-refuge-is-dividing-north-slope-residents/?wallit_nosession=1.
[414] ADFG at https://www.adfg.alaska.gov/static/education/wns/ringed_seal.pdf.
[415] ADFG at http://www.adfg.alaska.gov/index.cfm?adfg=beardedseal.printerfriendly.
[416] NSB at http://www.north-slope.org/assets/images/uploads/NSB_Economic_Profile_and_Census_Report_2015_FINAL.pdf.
[417] NSB at http://www.north-slope.org/assets/images/uploads/NSB_Comp_Plan_Public_Review.pdf, page 114.
[418] *Ibid*., page 82.
[419] *Ibid*., page 150.
[420] *Ibid*., page 433.
[421] EPA at https://compliancegov.zendesk.com/hc/en-us/sections/202370188.
[422] Alaska Public Media at https://www.alaskapublic.org/wp-content/uploads/2019/07/Kaktovik-Poll_ANWR-1.pdf.
[423] *Ibid*.
[424] ADN at https://www.adn.com/business-economy/energy/2019/07/31/with-anwr-drilling-on-its-doorstep-an-alaska-native-village-is-poised-to-profit/.
[425] NSB at http://www.north-slope.org/assets/images/uploads/NSB_Comp_Plan_Public_Review.pdf, page 100.
[426] Energy Information Administration at https://www.eia.gov/todayinenergy/detail.php?id=36472.
[427] USACE at https://kivalinaarchive.org/system/files/atoms/file/2006_04_USACE_AVETAP_An%20Examination%20of%20Erosion%20Issues%20in%20the%20Communities%20of%20Bethal%2C%20Dillingham%2C%20Kaktovik%2C%20Kivalina%2C%20Newtok%2C%20Shishmaref%2C%20and%20Unalakleet.pdf, pages 17-19.
[428] NSB at http://www.north-slope.org/assets/images/uploads/PHO_plan_08022016_Public_Review_Draft.pdf, page 19.
[429] *Ibid*.
[430] NSB at http://www.north-slope.org/assets/images/uploads/NSB_Comprehensive_Plan_2019-2039_Reduced.pdf, page 28.
[431] NSB at http://www.north-slope.org/assets/images/uploads/NSB_Comprehensive_Plan_2019-2039_Reduced.pdf, page 182.
[432] *Ibid*., page 188.
[433] *Ibid*., page 195.
[434] University of Minnesota at https://www.cidrap.umn.edu/sites/default/files/public/php/26952/Climate%20Change%20HIA%20Report_Point%20Hope_0.pdf
[435] *Ibid*.
[436] NSB at http://www.north-slope.org/assets/images/uploads/9_Transportation_-_NSB_Comprehensive_Plan.pdf
[437] International Maritime Organization "Impact Assessment for a Ban on Heavy Fuel Oil Use and Carriage as Fuel by Ships in the United States Arctic," pages 12 and 14.
[438] Federal Aviation Administration at https://nfdc.faa.gov/nfdcApps/services/ajv5/airportDisplay.jsp?airportId=pho.
[439] Alaska Marine Lines at http://www.lynden.com/aml/about/index.html.
[440] Bowhead Transport LLC at https://uicalaska.com/our-companies/uic-commercial-services/uic-bowhead-transport-llc/.
[441] NSB at www.north-slope.org/our-communities/point-hope
[442] *Ibid*.
[443] *Ibid*.
[444] University of Minnesota at https://www.cidrap.umn.edu/sites/default/files/public/php/26952/Climate%20Change%20HIA%20Report_Point%20Hope_0.pdf.
[445] EPA at https://compliancegov.zendesk.com/hc/en-us/sections/202370188.
[446] Ground Truth Trekking at http://www.groundtruthtrekking.org/Issues/OtherIssues/ProjectChariot.html.
[447] NSB at www.north-slope.org/our-communities/point-hope.
[448] Environmental Justice Atlas at https://ejatlas.org/conflict/inupiat-people-resist-offshore-oil-drilling-and-gas-development-plans-in-point-hope-alaska-usa.
[449] NSB at http://www.north-slope.org/assets/images/uploads/NSB_Comprehensive_Plan_2019-2039_Reduced.pdf, page 15.
[450] NSB at http://www.north-slope.org/our-communities/point-lay.
[451] NSB at http://www.north-slope.org/assets/images/uploads/PIZ_Plan_Adopted.pdf.
[452] ACDO at https://dcra-cdo-dcced.opendata.arcgis.com/.

[453] *Ibid*.
[454] Arctic Slope Native Association at https://arcticslope.org/about/communities/point-lay/.
[455] *Ibid*.
[456] NSB at http://www.north-slope.org/our-communities/point-lay.
[457] Manta at https://www.manta.com/c/mm54j3b/north-slope-county-health-clinic.
[458] NSB at http://www.north-slope.org/assets/images/uploads/PtLayVillageProfile06.pdf.
[459] *Ibid*.
[460] *Ibid*.
[461] *Ibid*.
[462] *Ibid*.
[463] *Ibid*.
[464] Bureau of Transportation Statistics at https://www.transtats.bts.gov/airports.asp?pn=1&Airport=PIZ&Airport_Name=Point%20Lay,%20AK:%20Point%20Lay%20Dew%20Station&carrier=FACTS.
[465] AirNav at https://www.airnav.com/airport/PPIZ.
[466] Ravn Air https://www.flyravn.com/.
[467] Sky Vector https://skyvector.com/airport/PIZ/Point-Lay-LRRS-Airport.
[468] Area Vibes at https://www.areavibes.com/point+lay-ak/transportation/.
[469] Data USA at https://datausa.io/profile/geo/point-lay-ak#about.
[470] NSB at http://www.north-slope.org/assets/images/uploads/9_Transportation_-_NSB_Comprehensive_Plan.pdf.
[471] *Ibid*.
[472] *Ibid*.
[473] *Ibid*.
[474] PR Newswire at https://www.prnewswire.com/news-releases/alaska-marine-lines-expands-western-alaska-service-to-arctic-ports-300753361.html.
[475] *Ibid*.
[476] Lynden at http://www.lynden.com/aml/western.html.
[477] *Ibid*.
[478] Alaskan Village Wages Reverse Tourism Campaign to Keep Visitors Away. https://skift.com/2016/10/12/alaskan-village-wages-reverse-tourism-campaign-to-keep-visitors-away/
[479] Associated Press at https://apnews.com/a3a98d8be2104b668994a0055bd4085c.
[480] News.com.au at https://www.news.com.au/news/this-alaskan-village-is-begging-tourists-to-please-go-away/news-story/be47a15f327242d959ace1423942efb0.
[481] North Slope Borough 2003 Economic Profile and Census Report. Barrow, Alaska, North Slope Borough, Department of Planning and Community Services.
Shepro, C. E., D. C. Maas, et al. (2003). North Slope Borough 2003 Economic Profile and
[482] *Ibid*
[483] Marine Mammal Science, Results and Evaluation of a Survey to Estimate Pacific Walrus Population Size. https://www.fws.gov/r7/fisheries/mmm/walrus/pdf/2006_pw_population_survey_marine_mammal_sci_2011.pdf
[484] Alaska Department of Fish and Game, Pacific Walrus. http://www.adfg.alaska.gov/index.cfm?adfg=walrus.printerfriendly
[485] *Ibid*.
[486] Climate change hits Alaska's rural water and sewer systems. https://www.ktoo.org/2017/04/06/climate-change-hits-alaskas-rural-water-sewer-systems/
[487] *Ibid*.
[488] *Ibid*.
[489] *Ibid*.
[490] *Ibid*.
[491] Department of Numbers at https://www.deptofnumbers.com/gdp/alaska/.
[492] Inupiat Community of the Arctic Slope at https://www.inupiatgov.com/files/North%20Slope%20Sensitive%20Tribal%20Areas%20Final%20Report.pdf.
[493] AP at https://apnews.com/a3a98d8be2104b668994a0055bd4085c.
[494] *Ibid*.
[495] *Ibid*.
[496] AP at https://apnews.com/e5857ed235864b75b187caa438aad83a.

[497] The Guardian at https://www.theguardian.com/world/2014/oct/01/walrus-mass-vast-numbers-alaska-beach-sea-ice-retreats.
[498] *Ibid*.
[499] Data USA at https://datausa.io/profile/geo/prudhoe-bay-ak/.
[500] Alaska Oil and Gas Association at https://www.aoga.org/sites/default/files/final_mcdowell_group_aoga_report_7.5.17.pdf.
[501] Alaska.org at https://www.alaska.org/guide/dalton-highway.
[502] Deadhorse Camp at http://www.deadhorsecamp.com/arctic-ocean-shuttle/.
[503] FAA at https://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/systemops/fs/alaskan/alaska/fai/arpt_photo/brooksnorth/scc/.
[504] UMN at https://www.d.umn.edu/~cstroupe/archive/5230/glocal/prudhoe/www.d.umn.edu/~hoef0049/pbpipeline.html
[505] UMN at https://www.d.umn.edu/~cstroupe/archive/5230/glocal/prudhoe/www.d.umn.edu/~hoef0049/pbpipeline.html
[506] Resource Development Council at https://www.akrdc.org/oil-and-gas.
[507] AOGA at https://www.aoga.org/facts-and-figures.
[508] AND at https://www.adn.com/opinions/2019/09/25/dont-buy-the-decline-rhetoric-oil-and-gas-are-here-to-stay-in-alaska/.
[509] EPA at https://compliancegov.zendesk.com/hc/en-us/articles/212101977-How-Does-EPA-define-Environmental-Justice-.
[510] NSB at http://www.north-slope.org/our-communities/nuiqsut.
[511] Alaska Public at https://www.alaskapublic.org/2019/11/19/a-new-oil-boom-on-alaskas-north-slope-is-encircling-a-village-and-residents-have-raised-a-red-flag/.
[512] North Slope Science at https://northslopescience.org/nuiqsut/.
[513] The Wilderness Society at https://www.wilderness.org/articles/blog/7-ugly-facts-about-prudhoe-bay-alaska.
[514] Ibid.
[515] ACDO at https://dcced.maps.arcgis.com/apps/MapJournal/index.html?appid=2393d4e4452448c4a55af959a3c7c817#.
[516] *Ibid*.
[517] Data USA at https://embed.datausa.io/profile/geo/barrow-ak/.
[518] Census Bureau at "Poverty Status in the Past 12 Months" American Community Survey Table S1701 at https://data.census.gov/cedsci/table?q=poverty%20rate&g=1600000US0281920&tid=ACSST5Y2018.S1701&t=Poverty&vintage=2018.
[519] USACE at https://www.poa.usace.army.mil/Portals/34/docs/civilworks/publicreview/-BarrowDraftFeasibilityReportwithAppendices.pdf?ver=2018-09-06-210148-493, page 13.
[520] Business Wire at https://www.businesswire.com/news/home/20170308005142/en/Alaska-Communications-Contracts-Quintillion-Secure-Fiber-Optic.
[521] NSB at http://www.north-slope.org/our-communities/utqiagvik.
[522] USACE at https://www.poa.usace.army.mil/Portals/34/docs/civilworks/publicreview/BarrowDraftFeasibilityReportwithAppendices.pdf?ver=2018-09-06-210148-493, page 17.
[523] NSB at http://www.north-slope.org/assets/images/uploads/NSB_Comp_Plan_Public_Review.pdf.
[524] NSB at http://www.north-slope.org/assets/images/uploads/Barrow_Comp_Plan_March_2015_FINAL.pdf, page 121.
[525] DOT&PF at http://dot.alaska.gov/nreg/nwatp/files/nwatpAviatationConditions.pdf, page 16.
[526] NSB at http://www.north-slope.org/assets/images/uploads/Barrow_Comp_Plan_March_2015_FINAL.pdf, page 121.
[527] Arctic Sounder at http://www.thearcticsounder.com/article/1812new_snow_roads_will_link_road_system_to.
[528] BLM at https://www.blm.gov/blog/2019-11-22/community-winter-access-trails-reduce-cost-risk-isolated-alaskans.
[529] Alaska Public Media at https://www.alaskapublic.org/2019/02/20/with-winter-snow-trails-north-slope-borough-hopes-to-offer-residents-a-safe-path-over-tundra/.
[530] USACE at https://www.poa.usace.army.mil/Portals/34/docs/civilworks/publicreview/BarrowDraftFeasibilityReportwithAppendices.pdf?ver=2018-09-06-210148-493, page 30.
[531] USACE at https://www.poa.usace.army.mil/Portals/34/docs/civilworks/publicreview/BarrowDraftFeasibility-ReportwithAppendices.pdf?ver=2018-09-06-210148-493, page 17.

[532] International Maritime Organization "Impact Assessment for a Ban on Heavy Fuel Oil Use and Carriage as Fuel by Ships in the United States Arctic," pages 12 and 14.
[533] USACE at https://www.poa.usace.army.mil/Portals/34/docs/civilworks/archive/alaskabargelandingsystemdesignstatewidephase1.pdf, page 13.
[534] Alaska Marine Lines at http://www.lynden.com/aml/about/index.html.
[535] Bowhead Transport LLC at https://uicalaska.com/our-companies/uic-commercial-services/uic-bowhead-transport-llc/.
[536] Crowley Marine at http://www.crowley.com/wp-content/uploads/2018/10/getting-fuel-from-there-to-here.pdf.
[537] Saltchuk at https://www.saltchuk.com/wp-content/uploads/2018/02/Alaska-Brochure-Nov-2016-Print.pdf.
[538] Clipper Oil at https://www.clipperoil.com/port_locations/fuel-in-the-usa/fuel-in-alaska/point-barrow/.
[539] Polar Cruises at https://www.polarcruises.com/arctic/ships/luxury-expedition-ships/silver-cloud-arctic/northwest-passage-%E2%80%94-kangerlussuaq-nome.
[540] Hapag-Lloyd at https://www.hl-cruises.com/cruisefinder/BRE2013#/.
[541] Silversea at https://www.silversea.com/cruise-to/barrow-alaska.html.
[542] Business Insider at https://www.businessinsider.com/barrow-alaska-is-dark-for-65-days-2013-11.
[543] USACE at https://www.poa.usace.army.mil/Portals/34/docs/civilworks/publicreview/BarrowDraftFeasibility-ReportwithAppendices.pdf?ver=2018-09-06-210148-493, page 16.
[544] Census Bureau "Selected Economic Statistics" American Community Survey Table DP03 at https://data.census.gov/cedsci/table?q=Employment%20and%20Labor%20Force%20Status&g=0100000US_1600000US0281920&table=DP03&tid=ACSDP5Y2018.DP03&lastDisplayedRow=98&vintage=2018.
[545] Alaska Tours at https://alaskatours.com/alaska-vacations/barrow-top-world/.
[546] Census Bureau "Selected Economic Statistics" American Community Survey Table DP03 at https://data.census.gov/cedsci/table?q=Employment%20and%20Labor%20Force%20Status&g=0100000US_1600000US0281920&table=DP03&tid=ACSDP5Y2018.DP03&lastDisplayedRow=98&vintage=2018.
[547] Arctic Slope Regional Corporation at https://www.asrc.com/about/history/.
[548] Ukpeagvik Inupiat Corporation at https://uicalaska.com/our-companies/uic-commercial-services/.
[549] UIC Science at https://uicalaska.com/our-companies/uic-commercial-services/uic-science-llc/.
[550] NSB http://www.north-slope.org/assets/images/uploads/Barrow_Comp_Plan_March_2015_FINAL.pdf, page 157.
[551] *Ibid*., page 163.
[552] Alaska Public Media at https://www.alaskapublic.org/2019/11/18/after-two-months-on-the-water-amid-record-warmth-utqiagvik-whalers-have-finally-landed-a-bowhead/.
[553] Alaska Public Media at https://www.alaskapublic.org/wp-content/uploads/2019/10/2018-Village-AK-Bowhead-Harvest-Alaska-FINAL.pdf.
[554] USACE at https://www.poa.usace.army.mil/Portals/34/docs/civilworks/publicreview/BarrowDraftFeasibility-ReportwithAppendices.pdf?ver=2018-09-06-210148-493, page 29.
[555] *Ibid*., pages 29-31.
[556] *Ibid*., page 10.
[557] Alaska Public Media at https://www.alaskapublic.org/2014/07/24/north-slope-moves-to-create-port-authority/.
[558] NSB at http://www.north-slope.org/assets/images/uploads/NSB_Comprehensive_Plan_2019-2039_Reduced.pdf, page 82.
[559] NSB at http://www.north-slope.org/assets/images/uploads/Barrow_Comp_Plan_March_2015_FINAL.pdf, page 68.
[560] EPA at https://compliancegov.zendesk.com/hc/en-us/sections/202370188.
[561] NSB at http://www.north-slope.org/assets/images/uploads/Barrow_Comp_Plan_March_2015_FINAL.pdf, page 33.
[562] Alaska Community Action on Toxics at https://www.akaction.org/wp-content/uploads/Report-Threats-to-Drinking-Water-and-Public-Health-in-Alaska-FINAL-web-version-9-24-19.pdf, pages 5 and 59.
[563] Petroleum News at https://www.petroleumnews.com/pntruncate/595031122.shtml.
[564] NSB at http://www.north-slope.org/assets/images/uploads/Barrow_Comp_Plan_March_2015_FINAL.pdf, page 59.
[565] USACE at https://www.poa.usace.army.mil/Portals/34/docs/civilworks/publicreview/BarrowDraftFeasibility-ReportwithAppendices.pdf?ver=2018-09-06-210148-493, page 16.
[566] ADN at https://www.adn.com/alaska-news/rural-alaska/2017/10/08/autumn-storm-that-battered-utqiagvik-coastline-caused-more-than-10-million-in-damage/.
[567] ACDO at https://dcced.maps.arcgis.com/apps/MapJournal/index.html?appid=bdad9f2bfc7c480497e59ed28707e39d.
[568] *Ibid*.
[569] DataUSA at https://datausa.io/profile/geo/wainwright-ak/.
[570] NSB at http://www.north-slope.org/assets/images/uploads/2014_Wainwright_Comp_Plan_Final.pdf, page 9.
[571] NSB at http://www.north-slope.org/assets/images/uploads/2014_Wainwright_Comp_Plan_Final.pdf, page 10.

[572] NSB at http://www.north-slope.org/assets/images/uploads/NSB_Comp_Plan_Public_Review.pdf, page 182.
[573] NSB at http://www.north-slope.org/assets/images/uploads/NSB_Comp_Plan_Public_Review.pdf, pages 194-95.
[574] DOT&PF at http://dot.alaska.gov/nreg/nwatp/files/nwatpAviatationConditions.pdf, page 17.
[575] NSB at http://www.north-slope.org/assets/images/uploads/NSB_Comp_Plan_Public_Review.pdf, page 201.
[576] USACE at https://www.poa.usace.army.mil/Portals/34/docs/civilworks/archive/alaskabargelandingsystemdesignstatewidephase1.pdf, page 12.
[577] NSB at http://www.north-slope.org/assets/images/uploads/2014_Wainwright_Comp_Plan_Final.pdf, page 51.
[578] IMO "Impact Assessment for a Ban on Heavy Fuel Oil Use and Carriage as Fuel by Ships in the United States Arctic," pages 12 and 14.
[579] Alaska Marine Lines at http://www.lynden.com/aml/about/index.html.
[580] Bowhead Transport at https://uicalaska.com/our-companies/uic-commercial-services/uic-bowhead-transport-llc/.
[581] Crowley at http://www.crowley.com/industries-we-serve/energy/.
[582] Census Bureau "Occupation by Sex and Median Earnings in the Past 12 Months" American Community Survey Table S2411 at https://data.census.gov/cedsci/table?q=S2411%3A%20OCCUPATION%20BY%20SEX%20AND%20MEDIAN%20EARNINGS%20IN%20THE%20PAST%2012%20MONTHS%20%28IN%202018%20INFLATION-ADJUSTED%20DOLLARS%29%20FOR%20THE%20CIVILIAN%20EMPLOYED%20POPULATION%2016%20YEARS%20AND%20OVER&g=1600000US0282750&lastDisplayedRow=9&table=B02001&tid=ACSST5Y2018.S2411&vintage=2018&hidePreview=true.
[583] Census Bureau "Selected Economic Characteristics" American Community Survey Table DP03 at https://data.census.gov/cedsci/table?q=employment%20rate&tid=ACSDP5Y2018.DP03&t=Employment&vintage=2018&g=1600000US0282750.
[584] Census Bureau "Poverty Status in the Past 12 Months" American Community Survey Table S1701 at https://data.census.gov/cedsci/table?q=poverty%20rate&lastDisplayedRow=31&table=-S1701&tid=ACSST5Y2018.S1701&t=Poverty&g=1600000US0236990&vintage=2018&mode=.
[585] Census Bureau "Selected Economic Characteristics" American Community Survey Table DP03 at https://data.census.gov/cedsci/table?q=employment%20rate&tid=ACSDP5Y2018.DP03&t=Employment&vintage=2018&g=1600000US0282750.
[586] NSB at http://www.north-slope.org/our-communities/wainwright.
[587] Olgoonik Oilfield Services at https://olgoonikoilfieldservices.com/.
[588] NSB at http://www.north-slope.org/assets/images/uploads/2014_Wainwright_Comp_Plan_Final.pdf, pages 71 and 72.
[589] NSB at http://www.north-slope.org/assets/images/uploads/2014_Wainwright_Comp_Plan_Final.pdf, page 79.
[590] Ibid., page 19.
[591] *Ibid.*, page 68.
[592] Environmental Protection Agency at https://compliancegov.zendesk.com/hc/en-us/sections/202370188.
[593] NSB at http://www.north-slope.org/assets/images/uploads/NSB_Comp_Plan_Public_Review.pdf, page 82.
[594] NSB at http://www.north-slope.org/assets/images/uploads/2014_Wainwright_Comp_Plan_Final.pdf, pages 69 and 70.
[595] ANTHC Center for Climate and Health https://anthc.org/wp-content/uploads/2016/01/CCH_AR_062014_Climate-Change-in-Wainwright.pdf, page 16.
[596] New York Times at https://www.nytimes.com/2019/03/30/climate/trump-oil-drilling-arctic.html.
[597] NSB at http://www.north-slope.org/assets/images/uploads/2014_Wainwright_Comp_Plan_Final.pdf
[598] ANTHC at https://anthc.org/wp-content/uploads/2016/01/CCH_AR_062014_Climate-Change-in-Wainwright.pdf.
[599] *Ibid*.
[600] NPS at https://www.nps.gov/subjects/nationalregister/database-research.htm.