Answers From the Ice Edge

The consequences of climate change on life in the Bering and Chukchi seas

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June 1998

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ACKNOWLEDGMENTS

Our heartfelt appreciation to the people of Savoonga, Gambell, Wales, Kotzebue, Deering, Point Hope, Point Lay and Wainwright for their participation

&

to Art Ivanoff of Maniilaq and Mike Holloway of Alaska Friends of the Earth for joining us in the village visits.

For helping chart our initial course, the authors thank Patricia Cochran of the Alaska Native Science Commission, and Bill Keller. Within Greenpeace, Steve Sawyer and Kalee Krieder provided very alert assistance throughout. We are grateful to the crew of the Arctic Sunrise and her captain, Arne Sorensen; as well as Angie Olrun, Cath Stewart, Pamela K Miller and Jeanne Patton for helping us with village visits.

In addition we are appreciative of help received collecting materials or reviewing this document from:

Vera Alexander
the ARLIS staff
Dorothy Childers
Joel Clement
Mark Floegel
Carl Hild
Mike Holloway
Kathy Frost
Charlie Johnson
Paul Johnston
Flore Lekanof
Michael Pederson
John N Schullinger
Alan Springer
Julia Triplehorn and her staff
US Fish and Wildlife Service
Gunter Weller

Printed by Color Art Printing on recyled paper with no chlorine bleaching used in the recycling process.

PREFACE

Is there evidence of climate change taking place in the Arctic? Scientists predict this is where the first and greatest impacts will occur. What do arctic people see? Is sea ice thinner? Is spring arriving earlier? How are people's lives affected? These are some of the many questions we sought to answer when the Greenpeace ship Arctic Sunrise visited eight remote communities in the northern Bering and Chukchi seas.

We began at Savoonga on Saint Lawrence Island, and then visited Gambell. From Saint Lawrence Island we headed north to Wales, Deering, Kotzebue, Point Hope, Point Lay and Wainwright. Members of Greenpeace and the Alaska-based conservation group Arctic Network held public meetings in each village. We also recorded individual interviews with Yup'ik and Inupiat elders, gatherers and hunters.[1]

The Arctic Sunrise

During the course of our voyage we listened to many people — from elders, sometimes speaking in their Native language, to young adults. We listened to men who hunt marine mammals, birds and caribou. We listened to women who harvest greens and berries from the tundra and prepare meat provided by the hunt. They spoke of many changes they have seen in the sea and land around them. We recorded observations of people who continue to live off the land in the traditions of their ancestors, using knowledge passed down for hundreds of generations.

This report is about changes Alaska Native peoples of the northern Bering and Chukchi seas observe in their surroundings. Climate change is a grave threat to northern ecosystems and thus to the subsistence way of life that is the heart of Yup'ik and Inupiat cultures.

Painted skin boat at Savoonga Margie Ann Gibson

Introduction

Each winter Arctic pack ice advances across the Chukchi Sea and into one of the most productive marine ecosystems on earth — the Bering Sea. With the pack ice come animals that depend on it for life - bowhead and beluga whales, walruses, seals and polar bears. At this interface of ice and open water life flourishes and diversity of species is greatest. The richness of this marine life in turn attracts animals and people from the land. For thousands of years indigenous people of Alaska have relied on marine resources for food, clothing and cultural traditions.

The lands bordering the Bering and Chukchi seas have an abundance of their own. Birds migrate here from six continents to nest on coastal tundra. Millions of seabirds raise their young in colonies along the water's edge. Streams and coastal spawning grounds contribute to the rich fisheries of this region. Caribou wander the tundra, also home to wolves, foxes and a variety of small mammals. These living resources are likewise vital to the survival of coastal people.

Climate change upsets the dynamics of marine and coastal ecosystems and Native cultures that depend on them. The consequences of global warming are affecting the subsistence way of life of Alaska's Native peoples now.

"There were no libraries or computers in the past. The important things that needed to be passed down were in the stories and songs which everyone heard. Everything was in the mind and each person was responsible to learn the lessons of the previous generations. The traditional style of learning was watching, listening, feeling. Young people learned from adults as well as from the animals, and the environment."[2]

Dr. Walter Soboleff

Ancient arctic house sites Keith Trexler/National Park Service

Cultural Traditions

People have lived on the northwestern Alaska coast for at least 4,000 years.[3] Artifacts at the oldest coastal archaeological sites show seasonal use, probably during late spring or summer. A few hundred years before the birth of Christ, fully maritime cultures evolved.[4] The use of kayaks and skin-covered boats called *umiaks* aided in harvesting the richness of the sea. In winter, people traveled by hand-drawn sled. The abundance of walrus in particular allowed time away from subsistence activities so that technical and artistic skills developed.[5] In another five to seven hundred years a new subsistence pattern emerged on Saint Lawrence Island and the adjacent Russian coast — the Punuk culture of large sea mammal hunting. They established several Bering Sea settlements along major marine mammal migration routes.[6]

New sea mammal hunting technology spread north. Sites at Cape Prince of Wales, Cape Krusenstern, Point Hope and Point Barrow show a dramatic change in subsistence.[7] These sites on the Alaska mainland were the focus of year round rather than seasonal harvesting of coastal resources. The Birnirk culture developed as people became progressively more skilled marine mammal hunters.

Thule culture was the culmination of the Punuk and Birnirk traditions. The Thule were highly skilled hunters of the sea, especially as whalers.[8,9] Increasingly specialized tools mark their development.[10] Large umiaks enhanced hunting efficiency.[11] Hunting, towing and cutting up of bowhead whales depended on cooperation. Communities and social structures grew resulting in major whaling communities at Point Barrow, Wainwright and Point Hope.[12]

Thule culture was distinctive for adaptability in both social groupings and technology.[13] Beginning about 1000 AD this culture spread from Alaska, east across the Canadian High Arctic to Greenland,[14] expanding across thousand of miles in just a few hundred years. From the Thule, historic Eskimo cultures evolved.

Russian, European and American contact brought new cultural adaptations. Cultures

What is Subsistence?

In US federal law, subsistence is the customary and traditional use of naturally occurring wild resources for food, clothing, art, crafts, sharing and customary trade. To Alaska Native peoples the definition is much broader. Subsistence is a way of life, spirituality and connectedness. It brings a sense of pride and well being, family strength, community interdependence and stewardship of the earth.[15] Subsistence is a basic human right.

John Kulowiyi, Savoonga

© Daniel Beltra/Greenpeace

"I was taught by the elders here and now I'm trying to teach it to my grandkids and my younger son here. I'm trying to tell them to pass it on to their grandkids, before I pass away."

John Kulowiyi Savoonga

whose survival depended on flexibility in a harsh arctic environment were quick to use newer technologies useful for harvesting wild resources. Contact also had many negative impacts.

In 1848 an American whaler discovered bowhead whales in the Chukchi Sea.[16] The rush for profits in whale oil and baleen sent East Coast fleets sailing to the Arctic. When heavy commercial harvests decimated the whales the fleets turned to walrus hunting. Loss of these subsistence resources and diseases such as smallpox took their toll on Native communities.

Beginning in the late 1890s the work of Alaska missionaries and demands of schooling brought people together into permanent villages.[17] People used traditional camps for seasonal harvesting and then returned to the village.

Today Alaska Native peoples live in established communities with schools, snow machines, computers and other benefits of Western society and technology. Native languages, as well as English, are spoken. Cultural traditions of harvesting and sharing natural wild resources are still central to people's lives. There are also people of non-Native descent living in rural communities who value these traditions.

Populations of arctic fish and wildlife naturally cycle up and down, or are only seasonally available. No one hunter or family is always successful. This creates interdependence between people and strong expectations about sharing.

Hunting and gathering activities also provide continuity between generations. The subsistence way of life is not taught from a book. Children learn from observation and practice, by going hunting with an uncle or picking berries with a grandmother. The knowledge and experience of one generation passes to the next.

The value of subsistence is much greater than the food provided. Hunting and gathering, sharing of food, and spiritual beliefs surrounding these activities tie families, generations and communities together. These practices are not the same as a trip to the grocery store. Subsistence activities connect people to their environment and each other. Alaska's Yup'ik and Inupiat cultures depend on the health of the natural world.

The experience and accumulated knowledge of the natural environment are parts of a worldview called *traditional knowledge.* Its foundation includes thousands of years of observing, testing and practice. Traditional knowledge is holistic and spiritual, including relationships between people and between people and their environment.[18] This way of knowing depends on the use of Native languages and encompasses many values and subtleties that are hard to define in a Western context. Traditional knowledge offers different values and perceptions that could help us better understand and heal our ailing planet.

SUBSISTENCE

"The spiritual aspects of our culture are very important in terms of how we do things and why we do things, and are based on knowledge passed on for thousands of years....

Most non-Natives don't understand the spiritual nature of Native peoples hunting. We do things a certain way. When you do things a certain way, you provide respect to that animal, then that animal will give himself to you at a later time. Also on the same token, we are always told to give our first catch to elders, to always give food to elders. When we hunt, we think of providing these foods for other people. All the time. And there's no question on that."

Roswell Lincoln Schaeffer, Sr.
Kotzebue

"I've been hunting all my life, since the time I was able to handle a firearm, close to 40 years now. Of course, that's the way we live up here. You can't just walk down to the local Safeway because we don't have one."

Gilbert Barr
Deering

"I grew up with a big family and my mom taught me how to pick greens. As I grew up I noticed it was my interest. Picking greens, and helping my mom for the winter. My mom used to fill up four barrels; later in September or early October she put them in a kind of large size seal poke for the winter. So I've been picking, ever since. But when I first had small children I quit picking for a while and let them grow up some.

...My mom taught me how to pick them and how to pack them and how to

save them for winter. How we find good greens is to look for the big, healthy-looking, fat greens. Especially when they first grow up they are real smooth... We pick three or four different kinds... They are real sour. They keep in barrels for months."

Rose Martin
Savoonga

"I was born in Nome and I was raised here in Deering. I am 25. I started hunting 12 years ago with my dad and my brothers... I like to spring hunt for birds and hunt sea mammals. During wintertime I go out and hunt caribou that migrate from north on down here. The past couple years, the caribou have been coming down pretty close. I love fishing and I love going out camping and enjoying the land we've got here."

Alvin Iyatunguk
Deering

"I'm always out there in the hills, on the ocean, in wintertime anyway, getting food. If I stay home I'll have nothing to eat."

Gibson Moto
Deering

"Arctic owl is a good bird, it's good eating too. I think they're next best food to a porcupine. Porcupine is a good food."

Charlie Tuckfield, Sr.
Point Lay

Ecosystems of the Bering and Chukchi Seas

Where Ice and Ocean Meet

© Kathy Frost/Alaska Department of Fish and Game

Ribbon seal on sea ice

The interplay of Arctic pack ice with the waters of the Bering and Chukchi seas sets the stage for a rich and dynamic marine environment. Pack ice is home to a fascinating assemblage of arctic life, from ice algae to polar bears. Life concentrates at the ice edge, and its productivity each spring attracts an unmatched array of birds and mammals. Marine mammals from temperate climates venture north to feed on the seasonal abundance of arctic waters. For them, ice is not habitat but a physical barrier. The meeting of ice and open ocean habitats creates an unmatched richness in biodiversity of marine mammals.

For a variety of unique arctic wildlife, ice provides transportation, as well as a floating platform for resting, feeding, and producing their young. The maximum areal extent of pack ice is in April in the Bering Sea; in spring ice retreats up to 1,700 kilometers, reaching its minimum extent in the Arctic Ocean in September. At its maximum Arctic pack ice covers twice the area as it does at its minimum. Its advance and retreat takes ice-associated animals to new feeding areas.

Several types of ice provide different types of habitat. As ocean waters freeze each fall, winds and currents drive ice toward the coastline. Some of it anchors to shore as *landfast* (or *shorefast)* ice. New or *slush* ice becomes part of the pack ice. As ice ages the salt begins to leach out. In the Arctic Ocean, pack ice lasting more than a year becomes *multi-year* ice. Second and third-year ice is progressively fresher, harder and thicker. In the Chukchi and farther north, moving pack ice meets landfast ice in the *shear zone*. Within pack ice are pond-like open water refuges called *polynyas* and long, linear cracks called *leads*.

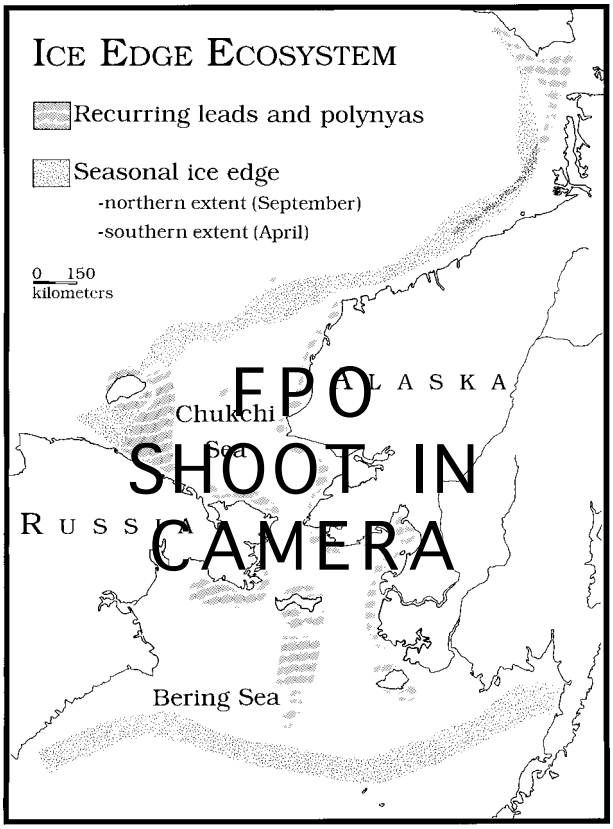
Walrus and ice-dwelling seals — ringed, ribbon, bearded and spotted — use ice as a platform to rest, mate, and molt. Gregarious walrus use areas of broken pack ice in winter and need floes thick enough to support their weight — up to 1,200 kilograms for an adult male. Walrus and the mainly solitary bearded seal, called *ugruk,* are bottom feeders. Both give birth to single offspring on ice floes, as do fish-eating ribbon and spotted seals.

Ringed seals are the most northern seal, living not just in floes along the pack ice edge, but in the thick ice of the far north. They eat a variety of creatures from the sea floor up, but their main prey is arctic cod. Ringed seals are in turn the principal prey of polar bears. Arctic fox search the ice to clean up the polar bear's leftovers. Ringed seals are the only seal to oc-

cupy landfast ice in winter, where their accessibility makes them an important resource for coastal peoples.

Sea ice is more than a traveling platform for wildlife; ice also supports an unusual community beneath it. During winter, tiny marine plants concentrate on the bottom of the ice. This *ice algae* is thickest where openings or thinner ice allow more light to penetrate. By spring it forms a thin, dense layer. These tiny plants are food for a whole *epontic,* or under-ice, community. Crustaceans and other small creatures feed on the algae and are in turn food for fish. A key member of this unique assemblage is the arctic cod. With a mouth that opens forward and upward, it is well suited to its upside down world.[19] The arctic cod is food for other fish, birds, seals and beluga whales.

The open water of polynyas allows for higher productivity. Marine mammals and birds take advantage of this increased life. In spring polynyas are oases and leads the migratory corridors for a great abundance of species. Countless birds and thousands of whales use these openings as they move north. Polar bears — and coastal peoples — hunt leads and polynyas for unwary prey.



EPO SHOOT IN CAMERA

Nikita Ovsyanikov courtesy US Fish and Wildlife Service

Polar bear cub with mother investigating walrus skull

Ice algae flourish at the edge of the pack ice. The "ice edge" is not a solid line of unbroken ice, but a zone of ice floes meeting open ocean. As pack ice retreats north each spring, the luxuriant growth of ice algae under the floes helps seed a bloom of *phytoplankton* (tiny free floating plants) in the water column. Fresh water from the melting ice floats on top of denser seawater forming a layer that keeps plankton in the light. This bloom is most intense just as the ice is breaking up.[20]

As the ice edge retreats over the continental shelf, much of the plankton sinks down to fuel important bottom-dwelling, or *benthic*, communities. Benthic animals include clams, worms, *amphipods* (small crustaceans with an insect-like shell) and mollusks. Their abundance is so high — particularly in the nutrient rich waters of the northern Bering and southern Chukchi seas — that gray whales migrate from Baja California to obtain a year's worth of calories, stored as fat. The benthic community also supports large resident populations of marine mammals including bearded seals and walrus.

Beyond the maximum extent of the pack ice, a bloom of phytoplankton occurs several weeks later in open water. *Zooplankton,* minute floating grazers, feed on the plankton. The rich waters of the northern Bering and southern Chukchi seas provide dense summer concentrations of zooplankton. Plankton-eating whales such as the bowhead, the only baleen whale with a range restricted to icebound seas, thrive on these zooplankton.

Life on the Edge of the Sea: Coastal Ecosystems

Red throated loon on nest US Fish and Wildlife Service

At the edge of the sea, rivers, bays and estuaries provide food, shelter and access to the rich ocean environment. Flat barrier islands protect long stretches of coastline. Rivers cross rolling foothills and coastal tundra dotted with ponds, lakes, marshes and meadows. These habitats are excellent nesting sites. Millions of birds fly from around the world to raise their young here.

In spring, leads in the pack ice along the Chukchi coast are a migratory corridor for king eiders and thousands of other waterfowl.[21] As sea ice recedes beluga whales and spotted seals move along the coast. As ice breaks up in rivers, young salmon, arctic char and rainbow smelt migrate to the sea. Herring spawn as ice melts along the coast. Millions of seabirds arrive on bluffs and headlands bordering the Bering and Chukchi seas to raise their young on marine life.

After spring migration, most shorebirds and waterfowl scatter to coastal nesting sites. Broods of shorebirds and waterfowl hatch in coastal wetlands. Moist tundra and thick willow shrubs along rivers are nesting sites for songbirds. Birds nest on the first snow-free ground and hatching of young corresponds to peak insect and plant abundance.

The meeting of river and ocean waters in lagoons and river deltas form rich estuaries. Waterfowl feed in lagoon and delta waters while shorebirds search the mudflats. Beluga whales use Kasegaluk Lagoon, which stretches for 200 kilometers along the Chukchi Sea coast, for molting. The warmer water and rubbing on submerged gravel bars help these white whales remove old skin.[22] Spotted seals rest on lagoon sandbars and spits.

As days grow shorter, large numbers of molting eiders, oldsquaw, and black brant use lagoons and barrier islands. These areas, along with bays and river mouths, are feeding and resting sites for concentrations of waterfowl and shorebirds prior to and during fall migration. The migration south in late August and September is more concentrated along the coast than spring migration.[23]

Nearshore waters, estuaries, river mouths and bays are habitat for a variety of fish. Capelin, a type of smelt that is food for many marine birds and mammals, spawn along barrier islands.[24] Bays and river mouths are important spawning habitat for saffron cod and starry flounder.[25] Chum and pink salmon, rainbow smelt and arctic char return to rivers to spawn. Schools of feeding or spawning fish attract fish-eating beluga whales, spotted seals and birds.

Coastal Tundra

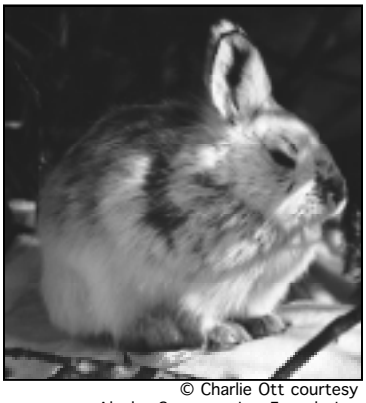
On the tundra, extremes of arctic climate present immense challenges to survival. Arctic plants and wildlife adapted to a short growing season and cold temperatures — to the sudden shift from winter's frozen darkness to the summer explosion of activity and light. Coastal tundra is a harsh environment, yet supports an intriguing variety of species year round. Plants and resident animals take advantage of the energy produced in summer and store it for the long, cold months ahead.

The bumpy terrain supports mosses, lichens, grasses, flowers and dwarf shrubs. Tundra is dominated by the presence of *permafrost,* large areas of ground that remain frozen for two or more years. In Alaska, perma-

© Larry Aumiller/Alaska Department of Fish and Game

A grizzly bear with more than the usual number of cubs

frost up to 600 meters in depth is the result of thousands of years of subzero temperatures.[26] Permafrost restricts drainage, resulting in small pools of surface water. In some areas marshes develop while in others, poor decomposition of plants leads to peat deposits. Permafrost also limits the depth of plant roots.



© Charlie Ott courtesy Alaska Conservation Foundation

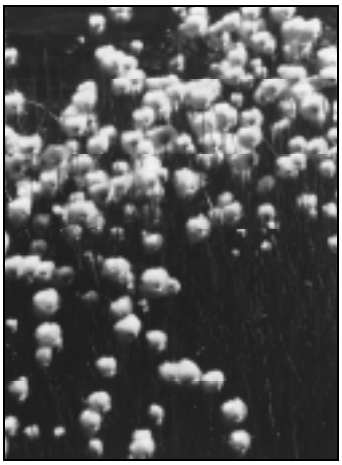
Snowshoe hare

Only a thin layer of soil remains active, thawing in summer and refreezing in winter. The depth of this active layer, from 0.5 to 5 meters, depends on soil moisture and the penetration of summer's warmth. The water content of the active layer affects nutrients needed for plant growth. A variety of small rodents burrow in the active layer of soil. Their burrowing affects drainage and the ability of the soil to retain heat. Foraging habits of lemmings and voles also control the exchange of nutrients between the soil and vegetation.[27]

Snow cover plays an important and varied role in the tundra ecosystem. It insulates burrowing mammals during winter and protects plants. In spring, it is an important source of moisture. Hollows where snowmelt collects support lush meadows, providing food for many insects, small mammals, and birds. Melting snow gives rise to a network of lakes and rivers, home to fish such as arctic char, trout, salmon, grayling, and cisco.

Tundra plants support small mammals, such as ground squirrels and arctic hares, and rodents, like lemmings and voles. These are in turn food for tundra predators such as weasels, arctic fox and wolverine. The magnificent grizzly bear digs up the tundra in search of squirrels, but also forages on plants. The breeding success of birds, like the snowy owl and pomarine jaeger, depends on availability of tundra rodents. When populations are low, these birds may not breed at all.[28]

Coastal ecosystems of the Chukchi Sea are part of the range of Alaska's largest caribou herd, the Western Arctic caribou herd. Caribou feed on lichens and mosses in the winter, and eat leafy plants in spring and summer. Exposed coastal habitats such as sand spits and river deltas offer escape from biting insects. Like the small grazers of the tundra, population changes in caribou affect their predators, the wolf and grizzly bear, and scavengers like the raven.



Gerry Atwell/US Fish and Wildlife Service

Cotton grass is a common plant of wet tundra

Evidence of Climate Change

The world's leading climate scientists, including the Intergovernmental Panel on Climate Change (IPCC), believe escalating climate extremes are early warning signs of global warming. The majority of living Nobel Prize winners in the sciences are part of a group of 1,600 scientists from around the world sounding the alarm about projected global warming. Computer models used by the IPCC predict that the first and most severe climate change impacts will occur in polar regions, particularly the Arctic. Alaska's coastal indigenous people already are observing these changes. University and government research reinforces their knowledge and understanding of arctic ecosystems.

Alaska coastal peoples observation: *Winters are warmer than they used to be.*

Western scientific support: Alaska meteorological records indicate winters averaged 2°C warmer after 1977. According to meteorological data from Siberia, Alaska and Northwest Canada, the annual mean temperature has gone up 1°C per decade in about thirty years.[29] This rate is consistent with climate model predictions.[30]

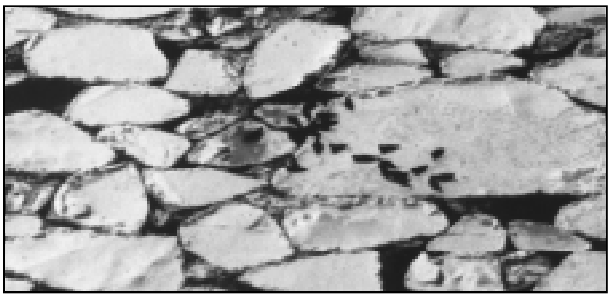
Alaska coastal peoples observation: *Hunters notice that there is more open water and thinner sea ice.*

Western scientific support: Climate models used by the IPCC predict that global warming will cause a large change in the extent and thickness of sea ice. Detailed records of global sea ice extent are available from satellite data beginning in November 1978.

While the pattern of sea ice extent varies every year, satellite data shows sea ice extent in the Bering Sea decreased 5 percent in the winter of 1976 to 77; this reduced extent persists.[31] Satellite data also documents that the most extreme reductions in Arctic sea ice extent happened since 1990. Record lows occurred in 1990, 1993, and 1995.[32]

The area covered by Arctic sea ice declined 2.8 percent each decade since the late 1970s. This decline accelerated to a rate of 4.5 percent per decade beginning in 1987.[33] While Arctic pack ice is showing an overall reduction in area and extent, the behavior of pack ice is highly complex — some areas actually have more ice.

Recent measurements taken in the central Arctic north of Alaska document that the upper ocean is warmer than in previous years. While traveling on an icebreaking ship to the site where temperatures were recorded, scientists observed the ice was thinner. Multi-year ice was rarely more than 1.5 meters thick; it is normally 2 or 3 meters thick. As sea ice ages salt in it leaches out. The scientists discovered upper ocean water to be less salty, and believe this is due to melting of multi-year ice.[34]



Alaska Department of Fish and Game

Seals rest on sea ice

Alaska coastal peoples observation: *Winter freeze up of ice is occurring later. Spring break up of ice is earlier and faster.*

Western scientific support: Climate models used by the IPCC predict later freeze up and earlier breakup, with less ice on rivers and lakes. Warmer water temperatures delay freeze up and thinner ice allows for an earlier and faster break up.

Alaska Department of Fish and Game

Lead system in sea ice

Alaska coastal peoples observation: *There is less snow than in the past and the snow disappears earlier in the spring.*

Western scientific support: A recent study of snow cover in the Northern Hemisphere for the 18 year period 1972 to 1989 shows that there was generally less snow cover in years following 1981 than in earlier years. Snow cover was at its lowest extent during 1988 to 1989. Data taken in Barrow and Barter Island, from 1935 to 1985 suggest earlier snowmelt trends in northern Alaska. Later data show that trend continuing through the late 1980s.[35] In 1990 snow cover was at a record low in the Northern Hemisphere.[36]

Alaska coastal peoples observation: *The tundra is drier.*

Western scientific support: Soil moisture is predicted to decrease over middle and high latitudes in summer. This is because warmer temperatures and earlier snowmelt increase evaporation.[37] Climate models used by the IPCC predict an increase in precipitation at high latitudes (which may fall as snow in winter). In coastal and interior Alaska, precipitation is controlled by storm interactions with mountain ranges. This interaction may result in large shadows where precipitation is locally decreased. Trends indicate warmer and drier summers in Alaska's interior.[38]

Overall Weather Changes

"We'll get snow and we'll get rain. It's been doing that for the last three or four years now. It turns into glare ice, and then it snows again, and then it'll melt again... The whole area by the village was flooded with water in the middle of January and February. The only things missing were the ducks."

Warren Roy Olanna
Wales

"There used to be heavy snowfall in the spring time; there used to be three feet of slush where we walked and now I don't see it anymore. Instead of dog mushing we had dog slushing."

Jimmie Toolie
Savoonga's eldest elder
translated by Jamie Seppilu

"It seems to me that winters are not as cold as they used to be. Maybe that's due to the lack of precipitation. I've been involved with the City Council off and on for the last twenty or so years, and I guess a good indication would be our financial report for the public road maintenance that we do. Normally that program was always running into the red because of snow removal. For the last couple of years – and I don't know if this is good or bad – we've been operating in the black. It's good for the finances of the city, but not for hunting. Last year there were more caribou than I've ever seen or

heard of in my life here, but the guys couldn't go out hunting due to lack of snow. I guess it probably could be done, if you wanted to really hurt your snow machine. But you'd have to weigh whether the cost of parts for your snow machine would be worth the effort of getting the caribou while they're this close to us."

Gilbert Barr
Deering

"It's freezing up later and breaking up a lot sooner. We didn't have much snow this year. When we go to our camp we have to cross these mountains. People had to pack up right away and come home because the trail conditions were really deteriorating — lack of snow, more bare rocks.

As far as freezing up, we hardly got any snow until November. Usually we have our first snowfall around the end of September. During the summer months we have clouds and rain and drizzle. Now there's hardly any clouds or rain or drizzle, there's more sunshine. It's a lot warmer than before."

Benjamin Pungowiyi
Savoonga

"It seems like it's getting warmer. It's usually cooler here than it is anywhere else. It seems like it's not as cool as it used to be...

There's not as much snow. We first moved up here in the summer of '81 and that winter there would be drifts as high as some of the houses. It hasn't been like that for a while."

Brenda E. Hall
Deering

"The past two, three years, we haven't had any snow. Back about four or five years ago, we'd have snow banks so big on the road here that we'd have to go up and down, like going through swells on the ocean. Sometimes we couldn't even get by with a four-wheeler. But now, people just use their Honda during the wintertime. There's no snow. On the hillside you could see the tundra and the willows. We haven't had any snow the past two years."

Alvin Iyatunguk
Deering

"The fall is later, and what I hear from the elders is that it's not as cold as it used to be. Whereas before in their life time they had to have *mukluks,*[39] I can go around in tennis shoes all winter and the kids can too. And they can wear shorts to school in the middle of winter and it doesn't bother them."

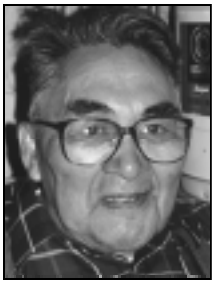
Hannah Mendenhall
Kotzebue

"The changes that we've seen these last few years are that it's been very warm in the winter time. We do have exceptions. Say, three or four years ago, we had our fall start in September, and winter occurred September 15th. We had a real early freeze... Generally I think our temperatures have really warmed up."

Roswell Lincoln Schaeffer, Sr.
Kotzebue

"It's been pretty mild the last few years. We even had rain in January. Last year we hardly had snow on the ground. Spring was a month early. This year almost the same thing but we had a little more snow than last year.

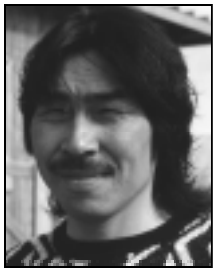
Benjamin Neakok
Point Lay



"There's lots of changes in our weather. Take last fall, we were slow getting snow. When people went up the road they had to go through rivers where there's little ice. Our ocean couldn't form slush for a long time. We used to have solid ice years ago. You could go way out and hunt. Last year, we just wipe out and come back. The ice was not very solid. We didn't have really solid ice all through the winter. There was a lot of open water last winter, pretty close too."

Charlie Tuckfield, Sr.
Point Lay

Changes in Sea Ice, Freeze Up and Break Up



"The most change I've seen is how thin the ice is getting. Year by year. This year is even more. When I was flying to Nome I saw the ice, how thin it was, with more open leads between here and the mainland."

Benjamin Pungowiyi
Savoonga

"When I was younger, we used to go out on the ice. It was real solid. But as the years go by the ice started getting thinner and thinner... Before we had snow machines we used to go about twenty miles out with dog teams ... but after we got snow machines the ice started changing a lot. It started getting thinner and the ice started getting loose. We have shore ice here about a mile and a half to two miles out. That's solid ice, but out beyond two miles is loose ice now. It's always loose, all the way to Nome. It used to be frozen all the way to Siberia. Solid, big, ice. Good, thick ice.

We used to get a lot of ice that came from up North,... but now, we hardly see any big icebergs out there. I'm talking about the real clear icebergs that aren't dirtied up with sand or dust. That was old ice."

John Kulowiyi, Sr.
Savoonga

"The ice used to be five-six feet thick. The last couple of years it's been four, four and a half feet. That's a foot, a foot and a half, and that's a pretty substantial difference...

One year we were hunting in our boats in January. We've never done that before. It was the first time I could remember in my life seeing us boating in January when the water is usually frozen.

Break up seems to come quicker. Sometimes a couple of weeks, sometimes as much as a month sooner... Freeze up was as much as a month late."

Stanley Oxereok
Wales

"There is more open water during winter where there should be solid ice, and when there is solid ice, it's awfully rough, impassable...

It seems like break up is a whole month sooner in the last five years. When it breaks up, we get this south wind that blows the ice out and it doesn't

come back. Normally it stays around all spring until, say mid-June, sometimes early July. It hasn't done that for a while, not for a long time. It just takes off and keeps on going...

In December sometimes, January, there's a lot of open water. We got a lot of branch ice, a lot of young ice that just comes and goes. That's about it until it gets really cold."

Warren Roy Olanna
Wales

"What I've seen over the years is that there is earlier break up of the ocean, and the ice is getting much more difficult to hunt on than it used to be.

Generally speaking, there is a certain sequence of events that happened during break up. At Kotzebue what we used to pretty much anticipate was that during break up we could generally see shore fast ice melt first, and then a little later the Noatak River would come out. Soon after that was the start of the Kobuk Lake ice coming out. For the past few years, something pretty much unprecedented happened where Kobuk ice just literally rotted in place. So it didn't come out in the force that it used to. What that means for sea mammal hunting here is that hunting patterns have had to accommodate that change. Hunting actually occurs much earlier than before, maybe in part due to advancing technology, and using larger boats. I can recall back years ago, in the mid-70s, it was pretty much a given that we would have ugruk for example, clear up until the fourth of July holiday. But for the past few years, breakup began to occur more rapidly and much sooner. I think in part since the Kobuk ice didn't come out people began to accommodate that weather change. Before, going out there prior to the Kobuk ice coming out was a genuine risk, because it came out in force and power...

Some of the cold weather has changed significantly also in relation to having a fairly rapid freeze come at the end of September. That's not happening anymore. In the area here in the immediate vicinity of the sound, from Kotzebue on up, it's generally late October and sometimes early November. It's sort of dragging out, seems like."

Pete Schaeffer
Kotzebue

"The ice was so thin. We went out there to put out some crab pots, and we found some of the ice to be about 24 inches thick, and — the main part — was about 32 inches, which is fairly thin. It's probably 3 feet to 4 feet thick in a normal winter."

Roswell Lincoln Schaeffer, Sr.
Kotzebue

"Within the last ten years we have been noticing that the ice has been getting thinner and spring is breaking up a lot sooner. It's not breaking up as hard as it used to. In fact, years ago when I was growing up the ice was sometimes 7 and 8 feet thick, and now sometimes it's not even 4 feet...

A lot of times before we would hunt through the 4th of July; there would still be ice out there to hunt on. Now it's gone before the first or third, fourth week in June. You can't go out there and find ice anymore during the 4th of July weekend. A lot of people that work used to wait until that time to do their hunting...

Freeze up is so slow. If it does start to freeze up and you get a layer of snow before it really freezes then you have to be really careful. Because the snow

insulates the ice and it takes a lot longer to freeze...

We used to go to my father-in-law's camp on his birthday, October 15th. That's his and my wife's birthday. We used to go up and go snow machining on the sea ice during that time, but not anymore, because it doesn't freeze up until the end of October or the first of November. Sometimes in the middle of November is when we start traveling and that's like almost a whole month later than we used to go fifteen or twenty years ago."

York Mendenhall
Kotzebue

"Three years ago we noticed the ice started getting thinner, even in the middle of winter it was thin. We travel on snow machines from Deering to Kotzebue. We'd take a break and look at the ice and its always thinner...

The ice broke up two or three weeks earlier than last year. Last year it was a week earlier, but this year it was two or three weeks earlier.

I've got it written down every year when we go out. Normally we go out June 20, and we're out there hunting ugruks, but this year it was June 7 or 8 or 9, fourteen days earlier than ever on account of the ice being too thin and the ice going out."

Gibson Moto
Deering

"There have been considerable changes in the thickness of the ice. I am usually one of the last people to come back on a snow machine. We used to be able to go riding around on the ocean until almost the middle of June. The latest I ever came back was on the 12th of June. But in the last several years, I think because of the thickness of ice, it tends to break up a lot earlier, at least a couple of weeks earlier. This year I had to come back on the 25th of May, and that's almost three weeks earlier than when I used to. The thickness of the ice was roughly 18 inches, and in the past it was usually about 3 feet, especially along the shorefast ice. I've had a crew out test drilling ice in the event that we needed an ice road from here to Kotzebue, and on the shorefast ice it was averaging between 3 and $3^1/_2$ feet thick, but this year it was roughly half of what it used to be."

Gilbert Barr
Deering

"There was no landlocked ice like there used to be, in front of our land claim which is 50 miles from Kotzebue and 40 miles from Kivalina. There was only slush ice, and it was right down to the beach. In previous years we'd have icebergs and ice build up right next to the shore. This year there was hardly any. Slush ice is usually the fall ice, but when it happens in January and February it's strange."

Jack Stalker
Point Lay

"About fifteen years ago, it started getting warmer. The snow melts faster and faster. Even this year I was surprised how fast the ice broke up. The break up season was early. A lot of the senior captains were saying the ice conditions weren't really good for the little baby walrus and seals. Usually the walrus sleep their way through, take a free ride and drift northeast."

Benjamin Pungowiyi Savoonga

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Walrus pushing baby

Climate Change and Marine Life

Potential Effects on Marine Mammals

Less sea ice means less habitat for unique ice-dependent wildlife. The "ice seals" — ringed, bearded, ribbon and spotted — need this ecosystem for pupping, foraging, molting and resting, making them especially vulnerable to its loss.[40] Walrus need ice thin enough to break through so they can breathe, but thick enough to support their weight. This ice must be over water shallow enough that walrus can dive to the bottom to feed. Bearded seals likewise forage the benthic community from the convenient platform provided by shifting sea ice. A retreat of pack ice to deep waters would be disastrous for both these marine mammals.

Ringed seals are the only seal to regularly use landfast ice. They differ from other ice seals by digging lairs in snow on top of ice for resting and pupping. Pups are born in late March and early April in lairs on landfast and stable pack ice. They remain inside for several weeks, protected from bitter arctic weather. An early break up of ice or early rain when pups are in lairs means fewer survive. One April on Baffin Island in the Canadian Arctic an unseasonable heavy rain caused birth lairs to collapse.[41] Polar bears reaped the benefits but in the long term events causing declines in ringed seals are bad for both.

© Llowy Llowry/ADFG

Ringed seal pup and lair

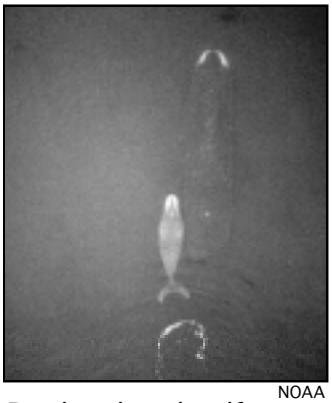
Ringed seals, and in Alaska, bearded seals, are the main prey for polar bears who also eat a variety of other marine animals. Whatever the meal, polar bears need ice as a solid surface to hunt. Polynyas and leads are predictable sources of prey. What will happen to these features in a warmer Arctic is unknown.[42] Polar bears also breed and travel on ice. Earlier spring break up, later fall freeze up, or a smaller areal extent of ice are all losses of habitat.

Many polar bears give birth to their young in dens on land. In fall in the Chukchi and Beaufort seas pack ice is offshore. As open water between pack ice and shore freezes, females head for the coast. If freeze up of coastal water is later and the pack ice is too far offshore, coastal denning sites may be out of reach.[43]

A grave result of warmer winters is the chance that warm weather or late winter rain will cause the collapse of maternity dens. Collapse of a den near the Beaufort coast crushed a female and two newborn cubs to death.[44] Like many arctic animals, polar bears are long-lived and slow to mature. Increased death rates for reproducing adult females have serious effects on the population.

Other Warming Impacts on Marine Mammals

Arctic marine mammals need good insulation to survive their cold environment. Warmer water could be a source of heat stress for some arctic marine mammals, especially the bowhead whale.[45] Warmer air temperatures may overheat seals and walrus resting on shore.[46] Global warming increases the spread of disease. Higher temperatures may help in the growth and spread of marine diseases and parasites in marine mammals.[47]



NOAA

Bowhead and calf

Is It There When You Need It?

The edge of the Arctic pack ice is a source of concentrated food. Multi-year ice supports more complex epontic communities than seasonal ice.[48] Crustaceans at the ice edge feed seabirds and fish such as arctic cod. Arctic cod is a key species in the food web whose life cycle depends on sea ice. This cod is important prey for beluga whales, ringed and bearded seals, marine birds and other fish. Large groups of arctic cod gather at the ice edge and are especially crucial to beluga whales; it is hard to picture the beluga population surviving on scattered arctic cod.[49] A reduction in multi-year ice and the extent of the ice edge is a loss of feeding habitat. The high productivity of the ice edge is also an early source of food for marine mammals and birds. A decline in ice edge extent may shift migratory routes or may simply mean food is not available at a crucial time.

Changes in the location of the ice edge affect coastal environments relying on its productivity. Northern sea birds fish the ice edge to feed young waiting in coastal rookeries. Northern peoples hunt along the ice edge to

continued on next page

Effects on Marine Subsistence

"What I've seen over the years is that there is earlier break up of the ocean, and the ice is getting much more difficult to hunt on than it used to be."

Pete Schaeffer
Kotzebue

"It's harder to hunt for some sea mammals that can't get on the ice. For some odd reason the ugruks that we hunt are further out there. There's lots of clean ice and there's no ugruks or seals on it. Maybe because of the walrus coming around. Hundreds of walrus. They kill the ugruks and the seals."

Gibson Moto
Deering

"When it's time to hunt, we usually try to get ready as fast as we can because we know that the last couple years the ice has been melting pretty fast. It doesn't matter if it's cold and windy, or what temperature it is, that ice is still melting. All the elders and old folks have been saying it's been breaking up fast, a lot sooner than we expect."

Alvin Iyatunguk
Deering

"It makes it hard to hunt in fall time when the ice starts forming. It's kind of dangerous to be out. It's not really sturdy. And after it freezes there's always some open spots. Sometimes it doesn't freeze up until January."

Benjamin Neakok
Point Lay

continued on page 21

feed their families. A small loss in the extent of the sea ice can be a tragic loss if it is too far away to provide food.

Changes in Productivity

In the absence of sea ice, heat from the sun layers, or *stratifies* the water column keeping phytoplankton up where light penetrates. An open water phytoplankton bloom takes place about two weeks later than the ice edge bloom. As with the ice edge bloom, nutrients and light determine productivity. Vertical mixing of water layers by winds and currents resupplies nutrients to the photo active zone, increasing nutrient availability. Strong storms accomplish much of this mixing. Climate models predict a decrease in storm intensities and some models anticipate increased cloudiness,[50] which would decrease the amount of light. Either of these factors might result in a decline in productivity. In the subarctic Pacific Ocean, a doubling of summer zooplankton followed winters with intense wind.[51] Many fish benefited from this increased zooplankton, including large numbers of juvenile salmon. Alaska salmon runs hit record levels.[52] A decrease in storm intensities may affect zooplankton productivity with impacts throughout the ecosystem.

In 1997 unusually warm water temperatures in the Bering Sea caused highly stratified water along the coast. Normally this area would have dense concentrations of zooplankton but stratification limited nutrients. Zooplankton, ordinarily food for short-tailed shearwaters, were absent. These birds died of starvation.[53] Warmer water temperatures and longer growing seasons may increase growth of some types of northern plankton over others. Changes in planktonic communities may have effects throughout the ecosystem.

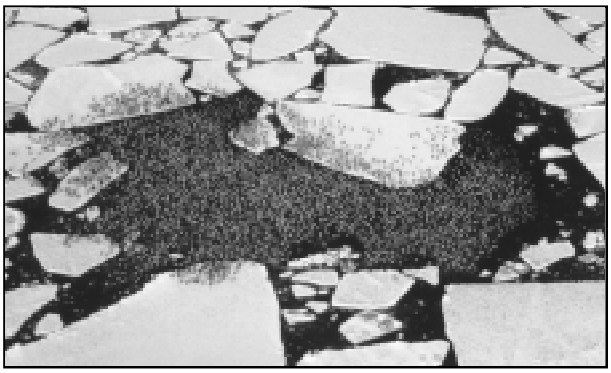
Fish

Warmer ocean water favors survival of some fish over others with possible consequences for fish-eaters. Fish may move north or into deeper water seeking cooler temperatures. In Wainwright it was unusual to catch salmon until about 1976 or 1977[54] when water temperatures shifted to a warmer trend. In 1997, thousands of fish-eating Alaska seabirds died of starvation. It seems that unusually warm surface waters drove the birds' prey into deeper water, out of reach.[55]

Marine Birds

In addition to changes in spring and summer productivity and food availability, climate change may effect overwintering birds. The ice front supports large numbers of overwintering birds.[56] Multi-year ice has more highly developed epontic communities, and leads and polynyas in the pack ice provide access to food for a variety of birds. The effects of a warmer Arctic on under-ice communities is unknown.

Scientists are seeking information about what happens to seabirds and waterfowl in winter. It may be that winter storms kill birds both directly and from reduced food availability.[57] Sea ice is a physical barrier to the interaction of winds and water, preventing the creation of waves. Ice reduces the current. This can protect marine birds — and mammals — from some effects of winter storms.



US Fish and Wildlife Service

Ice protects birds from waves

"The ice went out really fast this year. I went to Kotzebue in May. Usually that's before I hunt ugruks and seal, but I had already gotten two ugruks and two walrus. When I went to Kotzebue, my friends and relatives down there said they didn't get a chance to hunt any ugruks and seals, because the ice left so fast with the wind and current. A lot of them would come down from Noatak, and Noorvik and Selawik, the outlying villages and go to the coast to hunt out of Kotzebue, and they couldn't sled across Kotzebue Sound. They didn't catch the ice this time. So there are a lot of people without oil...[58]

We only got a couple of beluga this year because the ice went so fast we didn't get a chance to herd them into the lagoon..."

Jack Stalker
Point Lay

Changes in Marine Fish and Wildlife

"I was at camp about six years ago, I guess. There is a camp named after my last name, Camp Kulowiyi. One day I went fishing with my fish net and my boys and my grandkids and we caught some kind of strange fish right there. We usually get trout, river trout and here we see chum salmon, king salmon and humpbacks, humpys. That's strange for us. We never used to get those around here. I don't know why they are coming here but it must be the warming climate."

John Kulowiyi, Sr.
Savoonga

"My brother-in-law was fishing commercially a few years ago, and he actually got a dog fish which is a little shark. He was in shock, that was just stuff we see in the movies. That was quite striking to have seen that. The other thing was a couple of sightings of large sharks -- I'm not sure what they were, but they swam differently than porpoises. We have porpoises up here, but people can tell the difference.

We have also seen over the last few years different types of sea gulls show up. The other thing that's happening is that some of them actually stay until November, which in my recollection didn't happen before."

Pete Schaeffer
Kotzebue

"I found a wolf fish, it was the farthest north anyone has identified a wolf fish. I saw one at the University of Alaska-Fairbanks. The farthest north it had ever been recorded was Nome before. I found it washed up on the beach."

Jim Moto
Deering

"They've caught some king salmon in their nets. The only way they can get them is when their teeth get tangled up because the mesh is too small... Usually we just see pink salmon and silvers."

Jack Stalker
Point Lay

Climate Change and Coastal Ecosystems

Global warming predictions include an increase in storm frequency and southerly winds in the Bering Sea.[59] Coastal erosion may increase with more waves generated by storms and a loss of sea ice. Landfast ice also provides coastlines protection from erosion. Coastal transport of sediment by currents creates barrier islands, and climate change might alter these currents. Low lying coastal habitats such as lagoons, barrier islands, and spits may be lost and access to rivers altered, affecting migratory birds, spawning fish and other animals.

As ocean waters warm, they expand, and sea level will rise. This combined with melting of glaciers and sea ice has led the IPCC to predict a global sea level rise between 13 and 94 centimeters by the year 2100. Low lying coastal habitats are at risk of being inundated with sea water. Warmer sea water is more likely to pervade coastal areas, speeding permafrost thawing. As coastlines retreat and sea level rises valuable habitats will be lost.

Many villages are located on river banks, coastal bluffs and barrier islands that provide access to marine resources. These locations are already vulnerable to flooding by storm surges and coastal erosion. On October 4, 1997, a storm with 55 knot winds pummeled the town of Shishmaref, located on a thin barrier island in the southern Chukchi Sea. Surging waves breached a protective sea wall threatening nearly a dozen homes, along with several public buildings including the school, the Shishmaref cannery and two local grocery stores. Eleven families were evacuated to share cramped living quarters with relatives and friends.[60]

Many people notice changes in storm patterns along the coasts of the Bering and Chukchi seas. Storms are more frequent and have a tendency to occur more suddenly. Beyond the ordeal of losing homes to the sea, there are additional costs associated with increased frequency of storms for arctic people. Relocating villages is expensive and means moving away from traditional hunting and gathering grounds, directly diminishing subsistence activities.

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Storms

"Winter storms seem to be much more violent, than what I recall as typical. For example, about four years ago we had a western blizzard that was kind of like a wall of weather that showed up. Between 10:00 and about 10:10 it went from zero to about 65 miles an hour in ten minutes. That was really unusual I guess. I think the severity of the wind has picked up in the last twenty years. I think that sort of poses, along with thinner ice and different snow conditions, another set of circumstances weather-wise, to have to get accustomed to than what we had to deal with in the past."

Pete Schaeffer
Kotzebue

"Shishmaref had a couple of storms this fall. Really bad ones that took out the sea wall and nearly took some houses. Families had to be evacuated and houses had to be moved. I visited Shishmaref in October '97 and saw what happened. It was bad! Some folks lost all of most of their seal oil and meat that would have been used over the winter."[61]

Warren Roy Olanna
Wales

Climate change and tundra

A warming climate is likely to have a dramatic effect on the tundra and consequently on life that relies on it. Changes in timing of nutritional plant growth or peak insect availability, changes in plant communities, or fewer lakes and ponds will affect an array of resident and migratory wildlife.

Caribou bull US Fish and Wildlife Service

Snow and Rain

Climate models predict an overall increase in arctic precipitation but regional or local weather patterns can result in less precipitation in some areas. Snow insulates tundra, protecting plants from freezing temperatures. Small tundra mammals winter in the space between the ground and snow.[62] Less snowfall provides less protective cover. A lighter snow pack combined with warmer air temperatures leads to earlier snow melt, also affecting soil moisture. A drier tundra changes plant availability. As lakes and ponds dry up waterfowl have less habitat to raise their young and feed during the short summer months. Greens and berries are harder for Native people to find, stunted in growth, or not available at all. Tundra fires may increase, destroying plant communities that are slow to recover.

On the other hand, more precipitation leads to a higher level of water in the soil, altering the availability of nutrients to plants. A deeper snowpack providing more insulation could lead to higher soil temperatures, magnifying permafrost thawing. It also makes it harder for caribou to find winter forage since they must paw through snow to reach the food they need. In winter, caribou depend on lichens, rich in carbohydrates, to provide energy to maintain their body temperature.[63] Additionally, a heavier snowpack could form an impermeable layer on the ground, trapping escaping gases from warming soil and affecting small mammals that burrow there during the winter.[64]

Freezing rain in warmer winters can coat the ground in ice, making it more difficult for caribou to reach lichens. In the fall of 1996 a layer of ice coated forage for an entire winter on the Chukotka Peninsula in Russia and thousands of reindeer died of starvation. Icing events also kill small mammals important in the tundra food chain by trapping carbon dioxide under the ice.[65]

Oldsquaw with ducklings US Fish and Wildlife Service

"There are a lot of lakes and ponds left when the ice melts. Last month all the lakes and ponds were dried up. The majority of the birds that go down and lay their eggs, geese, cranes, and a lot of ducks were seen mostly in the river because that's the only place there was water. The ponds and lakes were drying up."

Alvin Iyatunguk
Deering

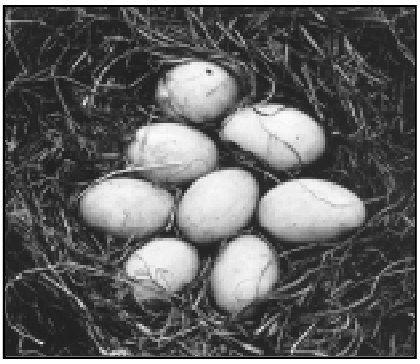
Permafrost

Thawing of permafrost[66] alters the groundwater table and affects the availability of important nutrients for plants. The active soil layer above the permafrost thickens and the ability of the soil to store heat changes. A deeper active layer allows greater drainage, leading to drier tundra.[67]

Arctic plants survive and grow in areas where soil temperatures remain just above freezing, and where even during summer the air temperature can drop at any time. The greatest impact to plants could be from soil warming. This leads to greater depths of soil thawing, deeper active soil layers and increased availability of nutrients favoring some plants over others.[68] Soil warming experiments at Toolik Lake, Alaska over a nine year period resulted in a substantial decrease in cotton grass and a 90 percent increase in the amount of dwarf-birch. At the same time there was a 30 to 50 percent loss in species diversity, mostly in lichens, mosses and grasses. Such changes in tundra vegetation do not benefit the animal community of the Arctic because woody shrubs like dwarf birch are harder to digest, particularly for caribou.[69]

Timing

In the short season of abundance in the Arctic, timing is critical. Movements of most migratory wildlife evolved to take advantage of peak food quality and availability for raising their young. Most migratory birds fly north based on daylength cues.[70] If warmer temperatures and advanced snow melt cause plants to mature earlier, or the abundance of insects to peak before chicks hatch, the breeding success of migratory birds may decline.[71]



US Fish and Wildlife Service

Trumpeter swan eggs

Will Troyer/US Fish and Wildlife Service

Swans on their nest

Caribou also evolved to take advantage of the best food sources by migrating. The nutritious plant growth of early spring is particularly crucial to caribou cows bearing calves.[72] Cotton grass is one of the earliest flowering plants and offers peak nutrients when it is immature, at a time when caribou are just arriving at their calving grounds. In the spring of 1990 most of the cotton grass in the coastal plain of the Arctic National Wildlife Refuge had already matured due to earlier snow melt and the nutritional quality of the flowers had declined by the time caribou cows bearing calves arrived.[73]

Forest Expansion

Most of the Alaskan Arctic is protected from northward migration of boreal forest by a mountain barrier -- the Brooks Range. This is not the case on the Seward Peninsula, where low topographic relief makes it particularly susceptible to invasion by southern plants if the climate warms enough.[74] Less digestible shrubs, and later trees, will replace tundra species, dramatically altering the regions' ability to support resident wildlife. Moose and other forest animals will broaden their range, creating additional stress on tundra animals.

Lack of Summer Rain

"There is less rain now. We used to get a lot of rain between May, June, July, and August."

John Kulowiyi
Savoonga

"We're not getting as much rain as we used to. This is probably like the second or third rain that we've had since break up. Sometimes we get a week's worth of rain or a couple of weeks at a stretch, but now it's just one or two days and it's done for a while and we have to wait for another rain again. It's changed so dramatically even our kids notice it."

York Mendenhall
Kotzebue

"Yesterday was the first rain we had. A lot of people depend on rain for water because we don't have running water. They collect rain water for drinking."

Alvin Iyatunguk
Deering

"It seems like it is getting a lot drier, especially this summer. Yesterday was the only time we've had any significant amount of rain. I was running around all day yesterday collecting as much rain water as I could."

Gilbert S. Barr
Deering

"The tundra is drier due to lack of rain. There are bigger cracks the further out you go from Deering into the hills... Some lakes are cracked and the whole lake just disappears."

Gibson Moto
Deering

Effects on Tundra

"Now I notice where to find good greens is in the kind of low areas. The ones on top in the open areas are already burned from the sun now. I just picked greens yesterday. First I looked around, I looked on the high area; they were no good. And then I went lower, they were good but they were just a little bit red. I went down to the low areas where I thought the snow melted last. It was not good. I thought maybe greens go by their own time, too. The ones that are on the high ground wither, even before they grow up."

Rose Martin
Savoonga

"We've really been hurting for berries the last three years but this is the worst. We knew that was going to happen because the elders know that the rain is connected to the berries, and they know if there is no rain, the berries are going to be poor. There's been less and less rain. It's easy for us to tell too because this is a desert region, the arctic desert and we don't have much rain to begin with."

Gail Moto
Deering

"The berries haven't been good. I know last year there were hardly any salmonberries, just very few... My brother and I went up the road to pick sourdocks on Sunday and the trail is usually wet and it wasn't wet."

Brenda E. Hall
Deering

"The thing that I notice when I walk out the tundra, I notice that the tundra itself is not as spongy as it used to be. Now I can hear it crackle when I walk on it, and it's dry. It's real dry. Whereas before some places I don't go to because they're too wet, now the areas that used to be lakes, all the plants are dried.

There used to be thousands of plants in this one area. I went there to gather greens. Not one sourdock. It's just dry. My girlfriend and I stood there and we were going to cry. No sourdock. There used to be a field. I didn't even bother going there this year. I have to go where there are gorges or gullies, canyons where the water really drains into the bottom, that's where I gather the greens now. I don't do it on top anymore. The higher up you go on the hill, the drier it is.

Last year we had to really search for the salmonberries. They weren't out on the tundra. What I'm hearing from the ladies now is that whatever is out there is dried up, and it's not like before where you had all the plants just ready for the picking. Now you have to search.

We didn't get blueberries this year, last year, and the year before. We're getting fewer and fewer blueberries. I used to be able to find blackberries in abundance, and now I have to really search."

Hannah Mendenhall
Kotzebue

"I notice everything is two weeks early. The seabirds, the geese, the sea gulls, even those little chickadees and snipes. All kinds of birds – everything's early this year."

Stanley Oxereok
Wales

"When I was growing up as a child here, it was very rare to see a moose, but we have a pretty healthy moose population now as far as I know in all of the drainages on the Seward Peninsula."

Gilbert S. Barr
Deering

"A lot of moose come here this summer. That's kind of unusual. The last few years, they've been coming in. I never saw moose in my life time until the last couple of years."

Charlie Tuckfield, Sr.
Point Lay

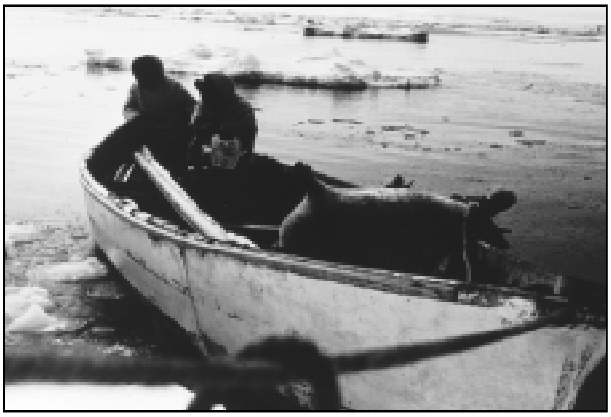
"We've been seeing moose that usually don't frequent this area. I've seen lynx tracks. They usually don't come up this far north, because mainly they're hunting rabbits. I haven't seen any rabbits, but it seems like we'll be seeing some pretty soon."

Jack Stalker
Point Lay

"We're beginning to get insects that are not usually of this climate. We're getting so warm that they're comfortable coming up this way. One year we had caterpillars. I mean I was going to go up a hill, and I noticed that it seemed like the leaves were picked or something. I was wondering what was going on. Right before the hill, there was a gully. And there were *thousands* of caterpillars on the bottom of that gully. We never had that before. Thousands of caterpillars, as far as I could see; I try to get the imprint out of my mind and say, "Okay, this isn't happening." Not here, not up North."

Hannah Mendenhall
Kotzebue

Cultures and Climate Change



Thayer/US Fish and Wildlife Service

Skin boat and seal skin float

The impacts of climate change bring with them new concerns for people who rely so heavily on natural resources of the sea and tundra. Changes in sea ice conditions are affecting coastal communities. Thinner sea ice is more dangerous for hunting. In 1997, more than 100 experienced Inupiat whalers had to be rescued when landfast ice broke away from the shore near Barrow.[75] Earlier break up and later freeze up of ice reduces the amount of time available for hunting and ice-fishing.

Changes in snow and rainfall can affect the vegetation available for birds and animals. Hunters worry that animals they depend on throughout the year may not be available. Alaska coastal people also harvest a variety of plant species from the tundra that provide tastes, textures and nutrients different than animal protein. In some coastal communities up to two dozen kinds of terrestrial plants round out the diet. Stored – sometimes in seal oil – for use over the winter, these plants provide important nutrients year round. A change in quality or quantity of tundra plants may mean an important element of the traditional diet will be lost.

A blanket of snow makes travel possible across frozen tundra. Poor snow cover on this rough terrain is more dangerous for hunters using snow machines increasing the risks of

continued on next page

"The last few years we've had extremely dry summers. This year is no exception ... this is actually the first time it's rained this summer. I think that's led to some concern in Native hunters for changes in migratory patterns. Because if certain weather conditions exist so go the caribou, they follow their food."

Pete Schaeffer
Kotzebue

"This past month[76] our part of the state was unfortunate to have warmer than normal temperatures which kept the caribou further north. This causes great concern among those who hunted locally where the caribou normally were abundant."

Roy Mendenhall
Kotzebue

"The ice seems to stay open a lot longer, most of the winter, before it freezes solid. It goes away between here and Kotzebue in the wintertime and it's not as thick as it used to be. It makes everyone leery about going out, they don't want to fall through. We had to go over 100 miles to Kotzebue by snow machine instead of 58 miles straight across."

Jim Moto
Deering

"You may have noticed as you go from village to village, global warming is going to wipe out these villages. For this reason; you see how high we are off of the bay, and no place to go to. It gets even a couple of feet higher, we're going to be awash."

Gail Moto
Deering

Cemetery at Point Lay

©Daniel Beltra/Greenpeace

serious injuries. There is also the potential expense of costly vehicle repairs after a season's damage.

In addition to access to wild resources, snow and ice are a surface for travel. There are no roads to these coastal communities. People drive over sea ice or snow to visit friends and relatives in other villages. Less sea ice or poor snow cover make communities more isolated, and may even make life less fun. The community of Wainwright used to celebrate Alaska Day[77] on October 15 with snow machine races on sea ice. For the last few years, there hasn't been enough ice to hold the race.

Current changes in marine and coastal ecosystems make wild resources less available. When families cannot get traditional foods they must fall back on expensive and over-processed store-bought goods. These are poorer in nutritional content and lack cultural value.

Conclusion

In an environment where poor judgment can prove fatal, knowledge of the land, sea and ice allows arctic communities to survive. The observations of arctic people today not only match scientists' predictions, but are first hand evidence that impacts of climate change are being felt now. Native knowledge of changes in ecosystems could prove crucial to their continued survival — and our own. We have the opportunity to heed the early warning signs of climate change by adopting strong measures to dramatically reduce the burning of fossil fuels largely responsible for global warming.

Subsistence activities and sharing of wild resources teach generosity, cooperation, and respect for elders. They reinforce community responsibility and provide self-esteem. These activities connect people to their environment and inspire respect for nature. The subsistence way of life is learned by doing, by gathering greens with your grandmother or hunting with your father.

Disrupting subsistence activities means knowledge might not be passed down to the next generation. Climate-caused changes in subsistence ways of life may be the greatest threat to the continued existence of indigenous cultures.

Addendum

The Arctic and Global Climate

The Arctic's significance regarding climate change is twofold. Climate models consistently predict that because of the region's vulnerability to climate change, impacts are expected to be magnified two to three times more in the Arctic than in other parts of the world. These impacts are first detectable here, and can serve as indicators for what may happen in other places. The Arctic also plays a significant and complex role in global atmospheric conditions; changes to arctic systems may in turn magnify or lessen global impacts.

Albedo Effect - Snow cover is an important factor in determining the exchange of heat between the earth and atmosphere. Snow on ice has the highest reflective property *(albedo)* of any naturally occurring substance on earth; it can reflect up to 90 percent of incoming radiation. By comparison, the albedo of soil or vegetation cover reflects only 10 to 15 percent of solar radiation. The remainder is absorbed into the earth's surface.[78]

If snow cover accumulates later in fall and disappears earlier in spring, the total mass of snow cover will be reduced. Exposed surfaces absorb more heat, leading to higher surface temperatures. The sea ice albedo effect is five to eight times greater than that of the land albedo effect; an increase of open water in the Arctic Ocean could lead to a warming by as much as 6 to 8°C at the pack ice edge due to increased solar absorption at the ocean's surface.[79] The resulting temperature rise may then bring about a further loss in ice and snow, reinforcing the original effect.

Ocean Circulation - The Arctic Ocean drives hemispheric circulation by cooling warmer salty waters of the North Atlantic at the Polar Front near Greenland, Iceland and the Labrador Sea. These waters become denser and sink to the lower layers of the ocean. Each winter several million cubic kilometers of water sink and begin moving slowly south along the bottom of the Atlantic towards Antarctica. The cooled water eventually becomes part of what is known as the Ocean Conveyor Belt and returns to the surface in the Indian and Pacific oceans before moving northwards again. This process is called *thermohaline* circulation because it is driven partly by temperature and partly by salt content.

A change in wind patterns could influence temperature and moisture over the ocean, and hence the formation of sea ice and circulation of water in ocean currents. If there is increased melting of ice combined with more precipitation, the Arctic Ocean could become less saline, which would alter the mixing of waters at the Polar Front. Such an effect could, potentially, shut down the Ocean Conveyor Belt, which may reduce the ability of ocean water to absorb carbon.[80]

Transfer of Heat - Sea ice also governs the transfer of heat from earth to the atmosphere by disposing of the heat surplus acquired at lower latitudes. Leads, polynyas and other seasonally open bodies of water in the Arctic Ocean allow for transfer of heat to the atmosphere.[81] A reduction in ice cover in either extent or thickness could result in more heat being transferred to the atmosphere, allowing air to pick up more moisture and become cloudier. The role of clouds in climate change scenarios continues to be one of uncertainty.

Thawing Permafrost - About 20 percent of the world's terrestrial carbon reserves are stored away in dead organic matter that constitutes the active soil layer and seasonally thawed permafrost in the tundra and boreal forest.[82] As permafrost thaws, some upper soils may become drier leading to greater decomposition of organic matter. This will result in release of carbon dioxide and methane, further increasing the concentration of these gases in the atmosphere. Some studies show that the tundra in Alaska has already begun this process and instead of acting as a *sink* by sequestering and storing dead organic material, now serves as a major source of carbon.[83]

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