

# Effects of Climate Change on Subsistence Communities in Alaska

Don Callaway, National Park Service, Anchorage, Alaska

## *Contributing authors:*

Joan Eamer, Environment Canada, Whitehorse, Yukon, Canada; Etok Edwardsen, Fairbanks, Alaska; Carl Jack, Rural Alaska Community Action Program (RurAl CAP), Anchorage, Alaska; Suzanne Marcy, U.S. Environmental Protection Agency, Anchorage, Alaska; Angie Orlun, Aleutian/Pribilof Islands Association, Anchorage, Alaska; Michael Patkotak, Barrow, Alaska; Delbert Rexford, Barrow, Alaska; Alex Whiting, Kotzebue IRA, Kotzebue, Alaska

## **Preface: A Consensus Position**

Although attaching dollar costs to potential impacts had been a major intent of the workshop, workshop group participants (see Appendix) stressed that the two most important aspects of subsistence, spiritual values and community well being, are not easily monetized.

It is widely recognized that subsistence resources provide basic nutrition and sustenance for isolated rural communities. However, what is not widely understood is that subsistence resources *and the activities associated with the harvest of these resources* provide more than food.

Connected to the physical challenges in harvesting wildlife resources are the sense of accomplishment and the feelings of self-worth associated with the harvest and sharing of wildlife resources within the extended family and with families throughout the community.

Participation in family and community subsistence activities, whether it be clamming, processing fish at a fish camp or seal hunting with a father or brother, provide the most basic memories and values in an individual's life. These activities define and establish the sense of family and community. These activities also teach how a resource can be identified, methods of harvest, efficient and non-wasteful processing of the resource and preparation of the resource as a variety of food items.

The distribution of these resources establishes and promotes the most basic ethical and spiritual values in Native and rural culture—generosity, respect for the knowledge and guidance of elders, self-esteem for the hunter who successfully harvests a resource and family and public appreciation in the distribution of the harvest. No other set of activities provides a similar moral foundation for continuity between generations.

## **Health**

Potential climatic threats to the harvest of wildlife resources elicit fundamental concerns for the health of rural residents. Many Native rural residents believe subsistence foods are healthier for them than are store bought foods. Many subsistence users also believe that wild foods provide a better protection against the cold (Kruse 1983). In addition, the harvesting of wildlife resources takes considerable physical exertion, which contributes to the physical and mental well being of individuals.

Epidemiologists have also linked diet changes with increased morbidity (e.g., diabetes and heart disease). Increased illness is also linked with increased medical care costs.

Alex Whiting, a working group participant, also noted that a warm fall, heavy rains and a lack of shore fast ice impede access to tundra and offshore resources. Many elderly who can no longer participate in more rigorous hunting activities count on being able to pick berries or ice fish. Being stuck in camp and failing to accomplish these activities dramatically affects their quality of life and their personal sense of contributing to the community. In addition, common to all age groups is the spiritual need to feel that one is a productive and contributing individual.

There was also great concern that interruption of subsistence activities may have serious impacts on young men. Already dealing with the considerable problems of adolescence, more free time and diminished community approval (due to their inability to harvest and share resources) could be linked to decreased self-esteem. Both these factors may exacerbate drinking and drug use.

The central theme and basic consensus of working group members was that subsistence activities provide the most basic spiritual and moral activities in their lives. Harvesting resources on the land determines their feelings about themselves, structures the organization of their social relations, contributes to community well being and provides a framework for relating to their environment.

### ***The Political Economy of Subsistence Activities***

The ability to carry out subsistence activities and the quality of life in rural Alaskan communities are intrinsically linked to the state's economic and political environment. Etok Edwardsen forcibly argued that cash is an absolute prerequisite for households to engage in subsistence activities. The technologies of subsistence activities (boats, motors, snow machines, guns, ammunition, fuel) are very expensive in these distant communities. A significant proportion of a household's disposable income is often used to pay for these expenses. Some of the events in the state and regional economy that affect cash flows to subsistence include:

- Decreases in state revenues from oil royalties.
- Fewer state programs and decreased funding to existing services.
- Welfare reform.
- Demographic changes in rural areas.

Michael Patkotak and other working group participants emphasized how recent climatic changes have increased the cost and risk of subsistence pursuits. For example, in the last two years the ice pack has retreated a significantly greater distance from land for North Slope hunters. The greater expanse of open water and the increased time and distance needed to access marine mammal resources all add to the risk of these activities. Costs increase from two sources—the greater distances traveled increase fuel and maintenance costs and decrease the use expectancy of the technology. In addition, for safety reasons larger boats with larger engines need to be purchased. Linked to this is the fact that larger parties and more boats are now required and harvests, in terms of manpower and cost, are less efficient.

A detailed analysis of the relationship between income and subsistence activities is provided in later sections. However, as Michael Patkotak notes, the census figures for median income can be very misleading because of the high cost of living (due to shipping costs and low volume), lack of jobs and the high proportion of families below the poverty level. Subsistence foods provide a key mechanism for coping with inconsistent levels of cash income.

### ***Subsistence Integrates Climate Change Issues***

As suggested by Joan Eamer, subsistence is a prime example of an integrative issue. All the issues discussed at this workshop, and nearly all those discussed at previous workshops, have direct or

substantial indirect impacts on how subsistence users respond to climate change. For example, all the issues at this workshop were identified as having substantial and direct impact on subsistence activities.

- Fishing: decreases in anadromous fish stocks directly affect the economic and dietary well being of subsistence users.
- Wildlife: changes in the distribution and density of wildlife resources will have a direct effect on subsistence harvests.
- Forestry: disturbance of existing habitat and wildlife as the boreal forest intrudes further north will affect subsistence users.
- Transportation: as a higher proportion of limited state budgets go to support urban transportation infrastructure, fewer resources are available to mitigate the dramatic changes impacting small rural subsistence communities.

Also discussed in this paper are the links in the abiotic environment that have direct and secondary effects on subsistence activities:

- Increases in the frequency and ferocity of storm surges in the Bering Sea.
- Accelerated thawing of the discontinuous permafrost.
- Changes in the distribution of sea ice.

As Alex Whiting noted, there also seems to be substantial cultural differences in how climate is evaluated. Kotzebue receives the weather forecast from TV stations in Anchorage. Often times the weather person seems to be rooting for warmer weather and becomes ecstatic when Kotzebue reaches 40 degrees Fahrenheit. People in Kotzebue who depend on early freeze-up to access marine mammals on the ice, to ice fish, or to use snow cover to access terrestrial mammals by snow machine are yelling “No! No!” to 40 degrees. In western culture weather appears to be an inconvenience, whereas expectations about its effects are absolutely integral to subsistence communities.

### ***Multilateral Coordination***

As Carl Jack noted, “any initiatives taken by the U.S. cannot succeed in the long run unless the other side [of the Bering Sea] is included in making decisions about monitoring, allocation and pollution.” After presentations made by representatives of the Commander Islands at the workshop, it was the strong consensus of the working group that bilateral connections need to be initiated and maintained with the Russian Far East, but especially with the Commander Islands and the communities on the Chukotka Peninsula.

Further discussion and analysis also need to be initiated on issues of “equity.” Given finite financial resources, how can one develop a fair and equitable process to address and mitigate the consequences of climate change on human institutions, especially in the critical arena of subsistence?

### ***Comparison with the Mackenzie Basin Impact Study (MBIS)***

During the workshop, Stewart Cohen (1997) provided a copy of his article entitled “What If and So What in Northwest Canada: Could Climate Change Make a Difference to the Future of the Mackenzie Basin.” This article, which appears in the journal *Arctic*, describes a series of issues raised in the Mackenzie Basin Impact Study with some suggestions on how to mitigate the impacts of climate change. What is interesting is that many of the issues and suggestions elicited from stakeholders in Canada closely overlap similar issues and mitigation measures suggested by members in the subsistence working group.

**Pollution.** Both groups were concerned that pollution and environmental contaminants would affect the ability of natural resource populations to respond to climate change (e.g., by reducing their resistance to infection). In addition, as Delbert Rexford noted, new circulatory patterns in water and air may bring contaminants, especially from environments in the Russian Far East degraded by decades of industrial and military pollution. Heavy metals such as mercury and cadmium can become concentrated in the food chain and subsistence consumers of marine mammals may be at risk for birth defects and other morbidities.

**Construction.** While Canadians proposed “a more compatible style of construction, based on local rather than imported materials...Sustainable construction...” (1997:301), Alaskan stakeholders were concerned that human construction and industrial practices, e.g., removing gravel from barrier islands for construction purposes, had the potential to exacerbate climate-induced threats, e.g., storm surges. Such practices need to be identified, modified or eliminated.

Etok Ewardsen detailed an example from the North Slope Borough. Beach gravel removed for an airport runway caused waves to become stronger as the water was now deeper offshore. This in turn led to increased erosion as wave action and currents carried existing beach gravel and sediments 25 miles to the east.

**Research.** Canadian participants identified the assessment of climate change impacts on wildlife populations and plant communities as a major problem:

Researchers were hampered in making firm conclusions by lack of long term data, complexity of life cycles, and incomplete information on wildlife responses to previous environmental changes... (1997:297)

Long-term inventory and monitoring issues were also alluded to in the Alaskan workshop, although issues of Traditional Ecological Knowledge (TEK) figured prominently.

**Recommendations.** For subsistence users, there is a strong concurrence on what kind of institutional response is needed to mitigate fluctuations in natural resources that may be due to climate change stresses. Both groups emphasized the need for improved communication in plain language. Money is needed to keep local communities and regional entities informed about research and possible policy decisions. Significant monetary resources are needed because of the logistical expenses and labor-intensive nature involved in communicating complex issues on a consistent basis to the local level. At the same time, working group participants thought that local input in the form of traditional knowledge and local values must also be accommodated in establishing research priorities and in making resource management and policy decisions.

Both groups (e.g., Cohen 1997:300) heavily emphasized the need to:

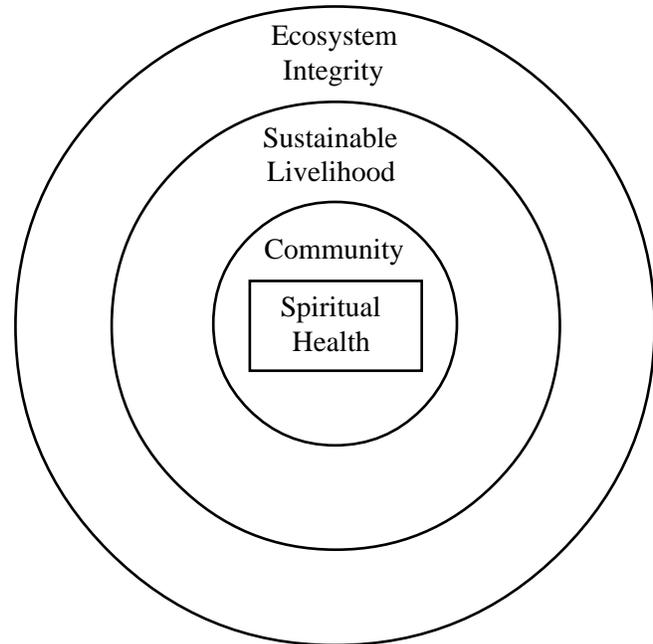
- Establish community-based monitoring projects that incorporated both western science and traditional ecological knowledge (TEK).
- TEK must be at the table when resource management decisions are made, e.g., continued (if not increased) reliance on Regional Advisory Councils in Alaska.
- Carl Jack stressed the need for cooperation among managers and stakeholders and suggested expanding the use of co-management bodies which would include federal, state, local and regional rural representation.
- Institutions and agencies that are responsible for resource management need to adopt strategies that allow for flexibility and rapid response in the setting of seasons and bag limits for subsistence resources.

Space does not permit a detailed consideration of these issues, but see Spaeder, Callaway, Johnson (forthcoming) for an extended discussion (200 pages) of the relationship between co-management, TEK, resource management and the spiritual values associated with subsistence activities.

It should be emphasized that while this paper focuses on the nutritional and economic aspects of wildlife harvests, in fact, it is the spiritual and social relations linked to the harvesting, processing, and sharing of subsistence resources that are of paramount concern to rural Alaska Natives.

### ***Subsistence Working Group Overview***

Suzanne Marcy, one of the subsistence working group participants, provided a distilled overview of the two-day session. She noted that during discussions at the workshop, four interdependent relationships emerged. At the core was spiritual health of the individual (see diagram), which has a direct effect on that individual's physical and mental health. This individual's health both influences the community's well being and is supported by the larger community's cultural traditions and values. Individuals and households, interacting, harvesting subsistence resources, sharing, and establishing mutual dependencies provide the means by which a community sustains itself. Finally, all these interactions—spiritual, social, economic and cultural, depend on the health and viability of the natural ecosystems in which they are embedded.



### **Introduction**

Complex climatological processes related to El Niño's impact on the Aleutian Low have the potential for disastrous consequences to the subsistence activities for the 56 communities that border the Eastern Bering Sea. In addition, a possible climate regime shift and its impact on fisheries and habitat will be felt throughout Alaska but especially in the Bering Sea, Yukon/Kuskokwim and Bristol Bay regions. Although our discussion will focus on these regions, other areas within Alaska, notably the interior and southeast sectors, will also be impacted. However, the consequences for these latter regions may be quite different. For example, recent red salmon runs in the Copper River area of the southeast have actually increased, while Kodiak fisheries have experienced a tremendous return of pink salmon.

A different set of repercussions, mediated through a vastly different political economic system, will also occur for a number of communities on the Chukotka Peninsula in the western Bering Sea.

As the Aleutian Low shifts eastward, major changes occur in the circulatory patterns of water and air currents. These changes influence:

- Anadromous fish stocks.
- The distribution of sea ice.

- Existing habitats as the boreal forest intrudes further north.
- Increases in the frequency and ferocity of storm surges in the Bering Sea.
- Accelerated thawing of the discontinuous permafrost.

Each of these changes, which have important implications for subsistence activities, will be discussed in greater detail below. In addition, there are a number of current social, economic and political issues that are linked to the impacts of climate change on subsistence practices. Some of these issues include:

- Decreases in state revenues from oil royalties.
- Fewer state programs and decreased funding to existing services.
- Welfare reform.
- Demographic pressures in rural areas.
- “Dual” management of wildlife resources within the state.

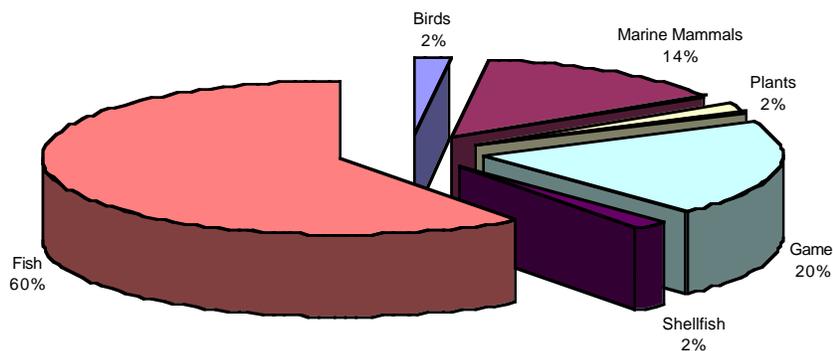
It is beyond our capacity to model the enormously complex interrelationships and feedback loops that exist among the abiotic, biotic and social spheres. In fact, strong skepticism exists about our ability to model even the Bering Sea ecosystem. Therefore, this paper will discuss some of the proximate influences on subsistence from climate change in the context of the existing social and political environment and describe some possible outcomes in Alaska’s institutional response to these changes.

## Climate Change Effects

### *Climate Change Effects on Subsistence/Commercial Fishing*

*Currents responsible for the rich nutrient upwelling over the continental shelf move westward to deeper water with a drastic decline in anadromous fish stocks in the Bering Sea and Bristol Bay regions.*

a) As Figure 1 shows, approximately 60% of the 43 million pounds of wildlife resources that rural residents harvest in Alaska comes from fish. This means about 26 million pounds of fish were harvested per year for subsistence purposes during the mid-1990’s.



**Figure 1. Composition of wildlife harvests by rural Alaskan households, 1990s.**

Climate change, whether it is attributed to the short-term effects of El Niño or a longer-term regime shift, has important implications for subsistence harvests and its intimate links to commercial fishing.

Commercial fishing is intrinsically linked to subsistence fishing in that subsistence fish are often taken during commercial fishing activities and the profits from commercial fishing often help to pay for the technology (boats, outboard motors, guns, snow machines, ATV's) necessary to perform subsistence activities.

A variety of limitations (lack of available data, time and space constraints) preclude a thorough consideration of the relationship between commercial fishing and subsistence activities. However, three sources (Jorgensen 1990; Wolfe 1984; and a recent Alaska Department of Fish and Game data set associated with communities affected by the *Exxon Valdez* oil spill) provide some insight into this relationship. For example, Jorgensen (1990:198) notes that:

The benefits for subsistence uses of equipment purchased for commercial fishing are very important, and the availability of loans, the extension of payback dates, and the support of the village and regional corporations make commercial fishing possible. Subsistence pursuits are benefited by the availability of loans for commercial fishing, even if a fisherman spends more than he makes.

For Unalakleet in 1982, where naturally occurring resources comprise about 75 percent of the local diet, the primary source of income for about 115 Natives was commercial fishing. While the average household income was \$20,100 per year, the average household equipment and trip expenses for subsistence purposes might run \$10,000, or nearly half the total household income.

Wolfe (1984:176), using a sample of 88 households from six communities in the lower Yukon region, provides detailed information on the proportion of the commercial catch retained for subsistence purposes. He states that:

On average the sampled households sold 91 percent by weight of the salmon harvest (10,477 lbs.) and retained 9 percent for subsistence use... However, the Stebbins sample sold 66 percent by weight of their herring catch and retained 34 percent for home use.

Both authors underscore the importance of sharing, not only as a cultural ethic but also as an adaptation to fluctuations in resource populations. Jorgensen (1990:127) notes that:

When, in 1982, late breakup and very high water destroyed the salmon fishing for Yukon River villages, Unalakleet families connected to families along the Yukon River through marriage packed and shipped huge quantities of fish, caribou, and moose to their affines.

In considering the impacts that climate change may bring to these small rural communities, one must also be cognizant of traditional strategies that have evolved to mitigate uncertainty. How much flexibility exists when region-wide fluctuations occur is difficult to assess.

b) Fish provide the most substantial contribution to subsistence diets throughout rural Alaska. However, this "averaged" data masks a lot of inter-regional variation. Rural communities in the northern part of the state are more dependent on marine mammals than they are on fish and many interior communities are more dependent on game (primarily large land mammals), whereas communities in western Alaska are heavily fish dependent.

Recent changes attributed, at least in part, to climate shifts, have differential effects on existing fish stocks. For example, the total number of commercial salmon harvested was about 131 million in the summer of 1998, close to the 20-year average but about 10% less than forecast. However, as the Anchorage Daily News points out (09/06/98), the "catch is far less valuable than the \$400 million average of the previous five years. It's also less than half the value of the 1992 harvest, in which fishermen caught a comparable number of fish." The difference in revenue is attributable to the composition of the harvest. Red salmon, the real money maker (\$1.00-\$1.20/lb in 1998), had a predicted catch of 20 million in the Bristol Bay region. However, for the second year in a row the actual harvest had a shortfall of 10 million fish. In contrast, Kodiak had a huge run (4x the forecast) of pink salmon. In addition to abundance, individual fish (@ 12-15 cents/lb) were larger than average.

The Yukon and Kuskokwim Rivers sustained drastically low runs and the state designated communities in those areas as economic disasters. In contrast, the Copper River in southeast Alaska had a strong red salmon run of 1.7 million fish. This strong run may be linked to the fact that these stocks are independent from Bristol Bay and Bering Sea stocks.

### ***Climate Change Effects on Sea Ice***

*Changes in air currents and temperature gradients impact the distribution of sea ice.*

There is a wealth of testimony in *Answers from the Ice Edge* (1998) on the impacts of the changes in sea ice conditions on subsistence. Traditional observers have noted that during the last three years, the sea ice was much thinner, breakup occurred much earlier, formation of shore fast ice came later, and the extent of the ice pack decreased. These phenomena have a variety of outcomes, which when taken in balance, indicate a dramatic reduction in access to sea mammals.

Gibson Moto (Deering) notes:

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. (p. 19)

Benjamin Neakok (Point Lay) observes:

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. (p. 19)

There is also some concern about marine mammal productivity. Benjamin Pungowiyi (Savoonga) notes that "A lot of senior captains were saying the ice conditions weren't really good for the little baby walrus and seals." (p. 18)

Changing ice conditions can also bring increased risk for hunters, as York Mendenhall (Kotzebue) cautions:

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... (p. 17)

To some extent hunters adjust to changing conditions. Pete Schaeffer (Kotzebue) notes:

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. (p. 16)

In addition, linked to changes in sea ice are noticeable changes in snow cover. Many traditional hunters mentioned difficulty in gaining access to land mammals (e.g., caribou) because lack of sufficient snow prevented reasonable use of snow machines. Perceptively, Gilbert Barr (Deering) notes:

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.

Naturally there are also economic limits to some of the logistical fixes (bigger boats, travel further) for marine mammal hunting and these adjustments will be of little help if there are widespread decreases in resource populations. Recent surveys seem to indicate dramatic decreases in recruitment for walrus populations as the proportion of juveniles and pups has dropped precipitously.

Decreasing the area of the pack ice margin has important implications for productivity. The ice-edge bloom depended upon by many organisms, including marine mammals, has been decreasing as increased solar heat stratifies the water column, impeding vertical mixing and decreasing nutrient availability.

Walrus and bearded seals require a special mix of sea ice conditions. For example, walrus require sea ice strong enough to support their weight but over water shallow enough that they can reach the bottom to feed. As *Answers from the Ice Edge* (1998:18) notes, "A retreat of pack ice to deep waters would be disastrous for both these marine mammals."

### ***Climate Change Effects on Existing Habitats***

*Another consequence of this changing weather pattern is a northward migration of the boreal forest and other habitat changes throughout the state. Linked to these shifts in habitat are changes in the distribution and density of a number of wildlife species.*

Careful consideration of the manifold implications of these habitat changes is beyond the scope of this paper. However, a useful overview can be found in chapter 5, "Wildlife and Reindeer," from *Implications of Global Change in Alaska and the Bering Sea Region* by Babcock, Juday and Douglas (Weller and Anderson, eds., 1998)

### ***Climate Change Effects on Storm Surges, Rainfall and Snow***

*Within the last couple of years enormous storm surges have occurred on the western coast of Alaska altering the protection of barrier islands, changing habitat and battering the infrastructure of some coastal communities, e.g., Shishmaref.*

In October of 1997, 55 mph winds and 30 ft waves pounded the barrier island on which Shishmaref, a small Native community of some 500 people, is located. Shishmaref, some 125 miles north of Nome, is about 95% Inupiat and heavily dependent on wildlife resources, especially marine mammals. Storms are common every year for Shishmaref, but not since the early 1980's had storm surges eroded so much of the limited land base. Twenty years ago a housing project was situated 60 feet away from the ocean bluffs; today these same homes are in jeopardy of falling into the sea.

In this storm surge a number of families lost their winter supply of food. Walrus meat, fish, seal and seal oil, which had been stored under sand but on top of permafrost, was lost to the sea (Daily News, 10/05/97). Village spokesman Chuck Newberg said that "Millions of dollars have been spent on erosion control, which has not been effective in battling the elements." In addition to food caches, two homes had their foundations cut to the point where they were hanging over the bluff, one house had been moved, and eleven families had to be evacuated because their homes were at risk of tumbling into the ocean. Only 4 of those 11 houses could be saved by relocation. Other threatened buildings included school housing, the tannery, a warehouse for the local store, a tank farm and the National Guard Armory.

This year's storms eroded 30 feet of bluff and exposed underlying permafrost to the sea. Concerns about erosion are not new. In 1974, after a large storm caused widespread damage all along the Chukchi Sea coast, the village of Shishmaref voted to relocate to a site on the mainland called Five Mile Bluff. About five miles from the current community location, this site would have provided continuing access to subsistence resources. But as a Daily News article noted (10/12/97):

When scientists came in to study the Five Mile Bluff area, they found shallow dirt covering thick layers of ice and a lack of gravel for use as fill. Nayokpuk recalled one of the engineers saying “it would be cheaper for Shishmaref to move to Juneau.”

Given these cost estimates, the relocation effort was shelved.

In 1996, a study by the Alaska Department of Natural Resources recommended that the best solution to the erosion problem was to move the village. Unfortunately, current cost estimates of moving the village to another location exceed \$50 million dollars, exceeding the estimates for relocating another village in similar circumstances—Kivalina. Engineers and scientists have suggested several other locations on nearby islands or on the mainland. However, all have problems relating to access, geology or proximity to subsistence resources.

For example, most of the land near the current village is low-lying marshy ground. Some of the relocation scenarios involve moving north to an area that the village currently uses as a catch basin for its water supply. Community members fear a relocation to this area would threaten their water supply.

In contrast to these relocation efforts, it would cost \$4–6 million dollars to build a sea wall from shield rock that might last 10–15 years. However, there are no funds currently available to accomplish this construction and the community is working with Senator Ted Stevens to obtain grants, possibly from the Economic Development Agency.

Everyone acknowledges that the sea wall is only an interim solution. Communities like Shishmaref and Kivalina are built on barrier islands, sparsely vegetated peninsulas that extend parallel to the coastline and enclose sheltered lagoons. However, the geological processes that create these “islands” are constantly in action. “Gradually, the barrier islands all over the world have a tendency to migrate shoreward” (Orson Smith, Anchorage Daily News 11/02/97).

### ***Climate Change Effects on Thawing of the Discontinuous Permafrost***

*Documented widespread thawing of the discontinuous permafrost has occurred. This thawing has implications for habitat change (e.g., thermokarsts) but more importantly for the physical infrastructure of communities as buildings sink and roads disappear.*

Shishmaref, Kivalina, and Little Diomedé form only a small fraction of the class of communities that are currently affected by recent climate shifts. Other communities facing erosion problems may become increasingly vulnerable to climatic shifts that induce increased storm surges, changes in snowfall or greater rainfall. Inhabitants of riverine communities such as Bethel rely on sea walls to protect them from the shifting boundaries of the Kuskokwim River as it cuts into their community. For example, the cost of moving the community of Allakaket after the 1994 floods was nearly \$50 million dollars.

Thawing of the discontinuous permafrost has similar impacts on community infrastructure as buildings sink, tank farms are threatened or food caches destroyed. Particularly costly is damage to highways in metropolitan areas or in the stretches of roads between road-connected communities.

All of these climate-induced challenges to the infrastructures of small communities or the larger metropolitan areas such as Fairbanks must be mediated through our state and federal political institutions. The considerable costs to mitigate these problems must be considered in the current social, political and economic context of the entire region. It is impossible to detail the conflicting accusations regarding urban/rural appropriations within the Alaska legislature. A Daily News article (5/03/98) discusses this urban/rural tension and notes:

One explanation offered by Republicans in Juneau for this year's battles is that Alaska is starting a long and difficult debate over the future of the Bush. To some urban lawmakers, that means raising tough questions about the costs of "subsidizing" schools, airports and water systems in villages with no more than a few hundred residents. "I really don't think it's the government's role to prop up a part of Alaska, especially with tax dollars," said Kohring of Wasilla. Rep. Con Bunde, a Republican from South Anchorage, said rural Alaskans must learn to accept the disadvantages of rural life along with the advantages and not expect the same educational opportunities or other services. Communities that can't support themselves may ultimately be forced to consolidate or move, he said.

## Social, Economic and Political Factors

- There are continuing decreases in state revenues from oil royalties in Prudhoe Bay. Income from oil depletion and royalties currently account for about 85% of the revenues in the state budget. As revenues decrease, allocation of scarce dollars tends to go to urban areas.
- Fewer state programs (including decreases in funding for education) lead to fewer services and less employment in rural communities.
- Welfare reform, initiated at the federal level, provides less public assistance to rural communities that suffer from substantial proportions of discouraged workers and high unemployment (near 50%).
- Compounding these potential difficulties are demographic shifts in rural communities resulting from families returning to their natal, rural communities from urban areas during periods of economic downturn. In addition, high birth rates within communities increase demand for services (e.g., education), employment and consumption of wildlife resources. It is unclear what role emigration from rural communities to urban areas plays in these processes.
- Divided management of wildlife resources between federal and state agencies, different mandates among the federal land managing agencies, and the policies and objectives of a variety of environmental groups all make the goal of "ecosystem management" difficult to attain.

## The Importance of Subsistence Resources in Rural Alaska

Figure 2 shows the high dependency on wildlife resources for regions within Alaska.

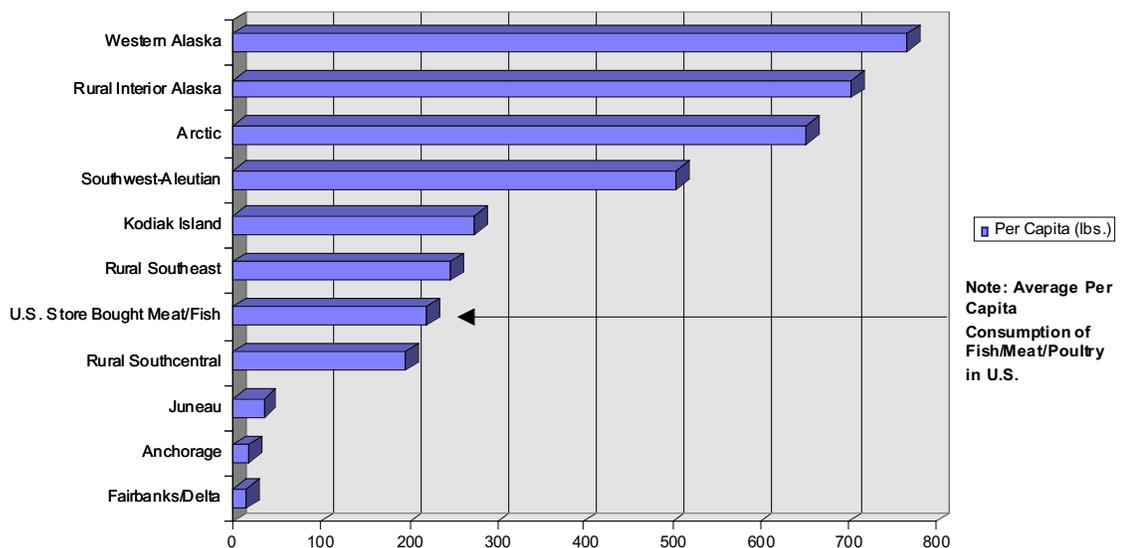


Figure 2. Per capita wild resource harvest (lbs) for selected Alaska regions.

The Arctic Region (of which the Northwest Arctic is a part) averages about 650 pounds per person per year in the consumption of wildlife resources. Although conversion factors for marine mammals may skew the results slightly, it is apparent that the most substantial part of an individual's diet comes from subsistence products. This contrast is more dramatically underscored when we realize the average U.S. per capita consumption of fish, poultry and meat is 222 pounds per person per year.

In addition, rural Northwest Arctic communities are accessible only by air. Bulk items such as food are extremely expensive to transport. For example, in 1995 groceries in Anchorage cost about 25% more than a similar market basket in Portland, Oregon. However, the University of Alaska Cooperative Extension Service (in conjunction with USDA) calculates that while a family of four will spend \$93.22 a week for food in Anchorage, this same amount of food will cost \$217.96 in Stebbins, a community in rural Alaska.

For the Arctic Region (which includes both the Northwest Arctic, North Slope and Calista regions), Wolfe and Bosworth (1994) estimate an annual harvest of 10.5 million pounds of wildlife products per year. They point out that:

Attaching a dollar value to subsistence uses is difficult, as subsistence products generally do not circulate in markets. However, if families did not have subsistence foods, substitutes would have to be imported and purchased. If one assumes a replacement expense of \$3–5 per pound, the simple replacement costs of the wild food harvests....

In the Arctic Region this replacement cost would be \$31.5–\$52 million.

Table 1 and Figure 3 put this into context. With per capita incomes ranging from \$5,000 to \$14,000, the total replacement cost of wildlife resources, in the four communities for which we have detailed harvest data, range from 13% to 77% of the **total income for that community**.

**Table 1. Replacement cost of subsistence products @ \$3 & \$5/lb.**

	Kotzebue	Deering	Noatak	Kivalina
Per Capita Income—1990 Census	\$13,906	\$7,272	\$7,089	\$4,968
Replacement Cost \$3/lb	\$1,779	\$2,016	\$1,383	\$2,283
Replacement Cost \$5/lb	\$2,965	\$3,360	\$2,305	\$3,805

It is clear that subsistence plays an integral and essential role in the economic life of these Northwest Alaska rural communities.

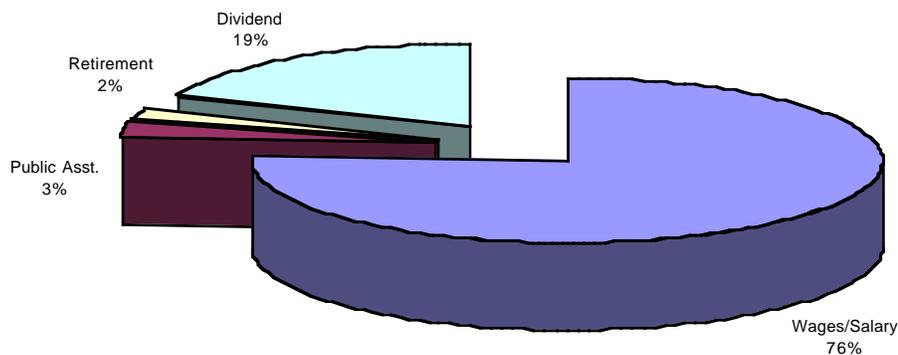
### **Kivalina, a Community Profile**

Kivalina, with a total population of about 300 people (95% Inupiat), provides a representative snapshot of the economic difficulties faced by rural communities in this region (and in Alaska). According to the Department of Community and Regional Affairs (DCRA), Community Information Summary (CIS), Kivalina had an estimated 48 available jobs in 1990. Those 48 jobs must sustain the 168 people

over the age of 16 (and below retirement age) who need wage income to support their families. In actuality, only about 108 out of the 168 were employed or had actively sought employment during the reference year. About 35% (60 individuals) of this group are not in the labor force either because of family reasons or because competition and demand for the limited number of jobs available have discouraged their participation. The CIS indicates an unemployment rate of 56% and notes that 71% of all adults were unemployed. Despite a median household income of \$28,000, nearly a third of the community residents were below the poverty line.

It is startling to realize that in Kivalina, households average more than five people per household, with median household income at around \$28,000 (in 1990). At current levels of payout from the Alaska Permanent Fund, dividend payments could account for about one-fifth (20%) of a household's total income.

Figure 3 illustrates the relative contribution of income from various sources for the community of Kivalina. Keep in mind two factors related to this chart. First, although income from wages is clearly the predominant source of income for a household, per capita wage income, as we have already demonstrated, is quite low. That is, although the wage income slice in the pie diagram seems large, these are slices from a very small pie. Secondly, because it is a very small pie, even small slices like public assistance play a very crucial role in the household's ability to cope. Also keep in mind, during the discussion of subsistence activities below, the crucial role all income plays in purchasing technology to participate in these activities.



**Figure 3. Kivalina: total household income by source**

With the exception of Kotzebue, rural communities in this region have:

- High unemployment.
- High proportions of discouraged workers.
- Few jobs available in the community.
- More than half their jobs in the government sector.
- High dependence on public assistance and transfer income.
- Modest infrastructures.
- A high reliance on subsistence harvests.

## **Further Assessment of the Impact of Climate Change on Subsistence Practices in Rural Alaskan Communities**

A detailed financial assessment of the effects of climate change on subsistence practices will require careful analysis of a number of topics:

### ***Existing Secondary Data Sources***

- Modeling of state revenues from oil production at Prudhoe Bay (currently 85% of total state revenue).
- Careful analysis of the state budgetary process with special note taken of revenues allocated to transportation and differentials in urban/rural construction and service programs.
- Monitoring and modeling of changes in habitat. A northerly intrusion of the boreal forest and numerous other habitat changes will affect forage and plant species, which will in turn affect the distribution of keystone subsistence species, e.g., land mammals. [See “Climate Change and Alaska’s Forests: People, Problems and Policies,” this volume.]
- Models and assessments of fish productivity, commercial fishing revenues to communities and revenues from community fish quotas (CFQ’s). [See “Human Effects of Climate-Related Changes in Alaska Commercial Fisheries,” this volume.]
- Monitoring of the social, economic and subsistence environment. Some of this can be taken from secondary sources, e.g., regional employment by sector, demographic shifts and state and federal transfers to communities.

### ***New Data Collection Initiatives***

While much information can be gleaned from existing sources, one should note that only five out of the 50 or so communities in the BESIS region have current demographic, income or subsistence harvest data at the community level. There exists a need for a carefully designed sampling initiative that monitors harvest consumption practices and also collects basic household demographic and income data. This social, demographic and cultural data can then be linked to proposed projects that inventory, monitor and model changing resource populations in the area (at both the species and ecosystem level).

## **Summary**

- Sharp decreases in fish stocks, which comprise 60% of subsistence resources, have created a dietary and economic hardship for many rural Alaska communities.
- A decline in commercial fisheries is causing economic hardship and steep declines in income in rural communities. Income from commercial fishing is used to purchase the technology used in subsistence activities. This income is also crucial in purchasing store-bought food during periods of natural resource scarcity.
- Sharp decreases in access to marine mammals, due to variations in the pack ice coverage, have been attributed to climate change. Marine mammals are a stable food source in many coastal communities.

The recent severe declines in fish and access to marine mammals in the Bering Strait, when combined with declining income and increased human populations, all lead to dramatically increased pressures on households to make ends meet. Rural households find themselves in the bind of having access to fewer traditional resources while at the same time declining employment, commercial fishing income, and public assistance prevent purchase of very expensive store-bought goods.

Simultaneous with these declines in household income and the proportion of natural resources in their diet, rural communities are suffering a decline in their quality of life as funding for services such as education, water, sewer and electricity are reduced. Opportunities to replace houses, schools, generators, etc., damaged by storm surges are also becoming more limited.

Thawing of the discontinuous permafrost also affects the physical structure of these communities. Additional difficulties occur when state funds, once distributed to remedy these difficulties, decline. The state legislature, dominated by urban interests, is now more likely to divert scarce revenues to remedy urban infrastructure problems.

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## **Appendix: Subsistence Workshop Participants**

Don Callaway, National Park Service, Anchorage, Alaska

Helen Corbett, AMIQ Institute, Canmore, Alberta, Canada

Joan Eamer, Environment Canada, Whitehorse, Yukon, Canada

Etok Edwardsen, Fairbanks, Alaska

Carl Jack, Rural Alaska Community Action Program (RurAl CAP), Anchorage, Alaska

Suzanne Marcy, U.S. Environmental Protection Agency, Anchorage, Alaska

Angie Olrund, Aleutian/Pribilof Islands Association, Anchorage, Alaska

Michael Patkotak, Barrow, Alaska

Delbert Rexford, Barrow, Alaska

Susanne Swibold, AMIQ Institute, Canmore, Alberta, Canada

Dennis Tol, U.S. Bureau of Land Management, Anchorage, Alaska

Alex Whiting, Kotzebue IRA, Kotzebue, Alaska

Dave Yokel, U.S. Bureau of Land Management, Fairbanks, Alaska