Summary of Main Implications of Global Change in the Region

From the onset of the industrial revolution, human activities have increased production of "greenhouse" gases, principally CO_2, methane, chlorofluorocarbons (CFCs), nitrous oxide, and water vapor. These gases occur naturally in the atmosphere, trapping heat which would otherwise escape from the Earth. In the elevated concentrations due to human activities, however, they exacerbate warming. We refer to this as the "greenhouse effect."

Computer models have predicted a global warming of about 2-3°C (5°F) when the carbon dioxide content of the atmosphere doubles (expected within 80-100 years at the present rate). In the high northern latitudes, including Alaska, the warming is projected to be twice as much, i.e., about 4-6°C (10°F).

This has led to concern about the possible environmental and socioeconomic impacts due to this climate change. Sixteen-thousand scientists around the world, including the majority of living Nobel Prize winners in the sciences, have joined together to sound the alarm about this projected global warming. This unprecedented response provides testimony to the growing level of concern within the international scientific community.

Private sector industries with long-term financial horizons or climate dependent activities such as banking, insurance, and agriculture firms and the several island states are also expressing increasing concern about both the market and non-market impacts. The seriousness of the potential long-term impacts is reflected in recent statements of interest in their mitigation from energy firm top executives.

Assessments of the likely impacts of global change are most relevant at a regional level where the stakeholders, the individuals and groups who are directly affected, can address issues, uncertainties, market and non-market impacts, and other problems of particular concern to them and can participate in decisions on mitigation and adaptation to the occurring and expected changes. The present assessment deals with the implications of climate change in Alaska and the Bering Sea region.

One of the first questions usually asked is: How real are these changes and how sure can one ever be that they will have the expected impacts? Here are some facts to explain what is known.

FACT: The carbon dioxide content of the atmosphere has increased by about 20 percent since the beginning of the industrial revolution, following the same upward trend as the world population (i.e., more people = more pollution).

FACT: This increase is a man-made effect and is primarily due to the burning of fossil fuels such as oil, gas, coal, and wood, and the large-scale deforestation in the Amazon and elsewhere.

FACT: Carbon dioxide and other so-called greenhouse gases (e.g. methane, nitrous oxide, CFCs) produce climate warming through the greenhouse effect. This result follows from basic physics.

FACT: Observations from meteorological stations in Alaska, NW Canada, and Siberia indicate that the annual mean temperature in these areas has become warmer by up to 1°C per decade over the last 30 years or so. *This exceeds the rate of change predicted for the greenhouse effect,* but is not necessarily due to the greenhouse effect alone.

FACT: Other indicators support this dramatic change. Permafrost is thawing throughout Alaska and Siberia, sea ice extent in the Bering Sea has shrunk by about 5 percent over the last 30 years, and glaciers are melting.

IMPACTS: Among the numerous implications of climate change in the Alaska and Bering Sea region are the following, indicating whether they have positive (+) or negative (-) impacts on human activities .

I. Socioeconomic impacts that have occurred over the last decade:

- Major increases in catches of Alaskan salmon have occurred in recent years, due to the increase of El Niño conditions since the mid-1970s (+)
- The same conditions have unfavorably affected Pacific Northwest and Canadian salmon stocks due to increased smolt predation and adverse streamflow (-)
- Accelerated permafrost thawing has led to costly increases in road damage and road maintenance, up to $3 million to replace 1 mile of road system (-)
- Permafrost thawing has also caused major landscape changes from forest to bogs, grasslands, and wetland ecosystems, affecting land use (-)
- Increased slope instability, landslides, and erosion have occurred in thawing permafrost terrain, threatening roads and bridges and causing local floods (-)
- The disappearance of permafrost reduces construction problems; in some areas permafrost boundaries have moved north by 80 miles in the last century (+)
- The warmer and drier climate has caused forest problems such as increased fire frequency and insect outbreaks which have reduced economic forest yields (-)
- A warmer climate has lengthened the growing season and growing degree days by 20% for agriculture and forestry, with the potential of producing higher yields (+)
- Boreal forests are expanding north at the rate of 60 miles for each 2°F temperature increase, thus increasing potential yields (+)
- With less sea ice in the Bering Sea, increased storm surge frequency and severity have caused increased coastal erosion and inundation and threats to structures (-)
- Subsistence lifestyles have been adversely affected, for example through changes in sea ice conditions making hunting on the ice more dangerous (-)
- The availability of marine mammals for subsistence is lower, due to changes in oceanographic and sea ice conditions (-)
- A warmer climate has also thawed traditional ice cellars in several northern villages, making them useless (-)
- Human health problems have increased due to new diseases moving north (-)
- The extended length of the summer season has been accompanied by an expansion of summer tourism (+)

II. Possible additional future consequences of climate change:

Fisheries

- ♦ Change in catches by location, volume, and species, and in markets (- and +)
- ♦ Seafood and fish industry (harvesters and processors) financial stresses caused by the need for relocation (-)
- ♦ Local loss of fishing industry jobs due to relocation of support services (-)
- ♦ Eventual worldwide financial losses as global fisheries decline (-), perhaps benefiting Alaskan fisheries (+)

Oil and Gas

- ♦ Cost of maintaining structures (pipelines etc.) in thawing permafrost terrain (-)
- ♦ Improved construction after the melting of permafrost (+)
- ♦ Economic benefits resulting from extended surface mining (+)
- ♦ Improved offshore exploration and production with less sea ice (+)
- ♦ Increased threats from higher sea levels and erosion to coastal installations (-)

Agriculture, Forestry, and Wildlife

- ♦ Higher yields in agriculture and forestry due to longer growing season (+)
- ♦ Increased incidence of forest fires and losses to timber industry (-)
- ♦ Increased insect outbreaks and infestations, leading to economic losses (-)
- ♦ Losses/changes in wildlife and reindeer herding as ecosystems change (+ and -)
- ♦ Losses/changes in fish and marine mammals with decline in sea ice extent (-)
- ♦ Effects on tourism: longer season (+), but melting glaciers, smoke from forest fires (-)
- ♦ Flooding of coastal wetlands, affecting waterfowl and shorebird breeding (-)

Government

- ♦ Reduction in local income/need for higher subsidies in villages to keep standards of living, as subsistence resources decline (-)
- ♦ Greater investments needed to combat rising sea level, thawing of permafrost (-)
- ♦ Possible need for greater investment in health services (new diseases) (-)
- ♦ Reconstruction costs of government infrastructure (-)
- ♦ Increased costs of forest fire control (-)

Subsistence and Local Economy

- Increased village economy problems due to fewer subsistence resources (-)
- Possible greater availability of other subsistence resources (e.g. salmon) in some areas (+)
- Possible relocation of populations closer to new subsistence harvest sources (-)
- Change in energy pattern use due to climate change (+)
- Change in local transportation methods (+ and -)

Construction and Transportation

- Higher cost of maintaining roads, bridges, etc. in thawing permafrost terrain (-)
- Easier construction of buildings, roads, airports, etc. in permafrost-free terrain (+)
- Greater availability of freshwater resources, potable water (+)
- Improved shipping to villages and oil facilities due to less sea ice (+)

Global Economy

- Impacts on the insurance industry and the costs to the insured (-)
- Changes in world markets and resource prices (-)
- New, quicker, and therefore cheaper trans-Arctic shipping routes (+)
- Relocation/protection of port and coastal facilities due to sea level rise (-)

Non-Market Concerns

- Changes in quality and duration of human life (+ and -)
- Loss of cultural and historic assets, particularly in coastal areas (-)
- Surprises and new risks due to non-linear changes (+ and -)