Testimony of Deborah L. Williams
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House Subcommittee on Energy and Mineral Resources
"Towards a Clean Energy Future: Energy Policy and Climate Change on Public Lands"
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It is an honor to testify before the Subcommittee on Energy and Mineral Resources about the significant, pervasive, and costly impacts that climate change is having on public lands in Alaska, and Alaska's potential renewable energy contributions to the nation. As described more fully below, global warming represents the single greatest threat to Alaska's public lands, and to the people who rely on those public lands. Fortunately, renewable energy from Alaska and elsewhere will benefit our environment, our economy, and our national security. Accordingly, I urge this Subcommittee to expand renewable energy opportunities and to support other actions to reduce greenhouse gas emissions and to protect our public lands in response to global warming.

I. Alaska's Public Lands and Global Warming: We are the Paul Revere of Climate Change

More than anywhere else in the United States, Alaska has experienced widespread, adverse impacts from global warming, which are negatively affecting our public lands and our public resources. These impacts are well documented and representative of many of the substantial human and economic costs associated with climate change. Alaska serves as an early warning system for the rest of the nation and world. We demonstrate clearly the need to recognize the assault of BTUs associated with global warming – and the imperative to take action now.

A. Alaska's Public Lands: Their scope and contributions. Alaska is very significant with respect to global warming on public lands for two reasons. First, Alaska contains a substantial percentage of our nation's public lands:

National Park acreage:	approximately 68% in Alaska
Bureau of Land Management Public Lands:	approximately 33% in Alaska
National Forest Service Lands:	approximately 11% in Alaska
National Wildlife Refuge:	approximately 83% in Alaska

There are also many other public land superlatives that apply to Alaska. Alaska hosts the largest National Forest (the Tongass), the largest National Wildlife Refuge (the Arctic National Wildlife Refuge), and the largest National Park (Wrangell-St. Elias National Park). Approximately half of the nation's congressionally designated wilderness resides in Alaska. Our vast public lands nourish species that migrate to states throughout the nation. Of particular importance, Alaska's public lands nourish vibrant Alaska Native cultures through fish and wildlife subsistence opportunities, a unique and priceless relationship. Others in Alaska and throughout the nation benefit from Alaska's public lands, and the fish and wildlife that these lands sustain, through tourism; ecosystem services; recreational opportunities; existence values; the support of beloved and irreplaceable ecosystems (such as the temperate rainforest) and species (such as the polar bear); and other services. Alaska's national public lands are a priceless national asset.

B. Alaska Has Warmed Four Times More than the Global Average. Alaska is also significant because we have warmed much more than the rest of the nation, and we are able to document scientifically and with traditional knowledge dramatic impacts throughout the state. While the earth as a whole has warmed approximately 1^{o} F in the last 50 years, according to the National Assessment Synthesis Team, Alaska has warmed approximately 4^{o} F during this same time period. The impacts in the Last Frontier are pervasive and include, with respect to public lands, damage to: Alaska's water bodies and wetlands; vegetation; ice, glaciers, and permafrost; animals; and subsistence opportunities. Because of global warming, Alaska has also experienced damage to our infrastructure, health, economy, and quality of life.

In this testimony, after a brief background section, I will describe the major scientific evidence regarding the impacts of global warming on public lands and related resources, and I will make recommendations to the Subcommittee associated with certain section as appropriate. Attached to this testimony is a comprehensive bibliography of the sources that support the factual information presented.

II. Background

I currently serve as President of Alaska Conservation Solutions, located in Anchorage, Alaska. Founded in 2005, Alaska Conservation Solution (AkCS) exclusively addresses the impacts of and solutions to global warming, with a focus on Alaska. As President of AkCS, I have extensively toured the state of Alaska. In this capacity, I have not only observed the clear, dramatic impacts of global warming on our public lands, but I have also talked with federal land managers, scientists, Alaska Natives, and others about the impacts that they are measuring, documenting and observing. Furthermore, I have had the opportunity to work with many groups, companies and individuals regarding Alaska's renewable energy potential and contributions.

In the past, I have had the privilege of working for the Department of Interior, and have been extensively engaged in public land issues. Upon graduating from Harvard Law School in 1978, I participated in the Department of Interior's Solicitor's Honors Program in Washington DC. After the completion of the program, I transferred to Alaska to represent the National Park Service and the Fish and Wildlife Service in the Department of Interior's Regional Solicitor's Office in Anchorage.

Subsequently, in 1995, I received a Presidential Appointment as the Special Assistant to the Secretary of Interior for Alaska. In this position, I managed the Secretary's office in Alaska, the only such office outside of Washington, DC, and assisted the Secretary in overseeing the Department's extensive legislative mandates in the 49^{th} state. I held this position for five years. Among my many responsibilities, I was actively engaged in public lands issues, subsistence matters, and climate change.

III. The Adverse Impacts of Climate Change on Alaska's Public Water Bodies and Wetlands

Because of global warming, water bodies throughout Alaska's public lands are shrinking substantially in size and numbers. In an exhaustive study of 10,000 closed ponds, scientists with

the University of Alaska have documented a significant loss in the number of ponds, and in the surface area of those ponds, in key public land areas in the last half of the 20th century. For example, Innoko Flats National Wildlife Refuge lost 30% of its ponds during the last fifty years and experienced a total pond surface area loss of 31%. Similarly, the Copper River Basin, Wrangell St. Elias National Park, lost 28% of its pond surface water area in the last half century. Tetlin National Wildlife Refuge lost 20% of its ponds. According to the scientists, these dramatic changes present

> "profound consequences for provisioning services and the management of natural resources on National Wildlife Refuges in Alaska…These refuges provide breeding habitat for millions of waterfowl and shorebirds that winter in more southerly regions of North America. Wetland areas have also been traditionally important in the subsistence lifestyles of native peoples in interior Alaska, and changes in the structure and function of wetlands has the potential to affect the sustainability of subsistence lifestyles" (Riordan 2006).

Similarly, wetlands in studied areas in the Kenai National Wildlife Refuge have decreased by 88% and pond area has declined by over 70% from 1950 to 1996. According to evidence from peat core samples, bushes are now in areas in the Kenai where there were no trees or shrubs during the last 8,000 to 12,000 years. These and other scientific studies confirm reports of disappearing and shrinking ponds from Alaska Native elders, with many ramifications including adverse impacts on migratory birds, water dependent species, subsistence opportunities, and fire.

There are other documented impacts from global warming on Alaska's public waterways, the "life blood line" of Alaska's public lands. Rivers, like the Yukon River, have warmed substantially. According to temperature graphs produced by Dr. Richard Kocan from the University of Washington, the summer temperature of the Yukon River has increased over 10^{o}F in the last 25 years. (The impact of this increase on salmon is discussed below.) Also, massive collapses of river-side permafrost are increasing sedimentation in the waterways. Unfortunately, however, we have very little information about the warming. ***Recommendation 1****: There is inadequate stream and river monitoring data regarding temperatures and resulting impacts; Congress should fund additional monitoring, analysis and management response in this critical area.*

IV. The Adverse Impacts of Climate Change on Vegetation on Alaska's Public Land

A. Trees. Trees throughout Alaska's public lands have been adversely affected by global warming, including white and black spruce, yellow cedar, birch and larch. According to a study that analyzed thousands of satellite images taken over two decades, there are vast reaches of boreal forest on our public lands where photosynthesis has clearly decreased over the last 22 years. In central Alaska where it is dry, white spruce and black spruce have shown documented declines in growth. Projecting forward, a 4^{o}C increase in July temperatures would result in no growth of these species in much of interior Alaska (Please see Figures 1 and 2).

Trees throughout Alaska are also subject to substantially increased diseases because of warmer temperatures. Southcentral Alaska experienced the world's largest outbreak of spruce bark

beetle, killing mature trees on over 4 million acres of land, including vast forests in the Kenai National Wildlife Refuge, the Chugach National Forest, Lake Clark National Park, and other areas. Three global warming factors contributed to this. With longer warmer summers the spruce bark beetle can complete its life cycle in one instead of two years. Winter temperatures have not been cold enough for two consecutive years to depress survival rates. Lastly, the trees have not been able to defend themselves with sufficient pitch because of the stress of heat and drought.

Other serious warming-related diseases that have damaged or killed large numbers of trees on public lands include the larch saw fly, spruce bud worm, birch leaf miner, aspen leaf miner, spruce aphid, and birch leaf rollers. For example, before 1990, spruce budworm was not able to reproduce in central Alaska. After warming in the 1990's, large infestations of budworms have occurred. With increased warming, all white spruce in Alaska will be vulnerable to outbreaks. Furthermore, trees in Southeast Alaska, including in the Tongass National Forest, are now, with warming, harboring aphid infestations.

In Southeast Alaska's Tongass National Forest, scientists have documented a massive die-off of yellow cedar on over 500,000 acres of land. Many consider yellow cedar the Tongass National Forest's most valuable tree both economically and culturally. Because of warmer temperatures, there has been less snow to protect the tree roots and also early dehardening of the foliage. Then, when a subsequent late freeze occurs, the foliage and roots are severely injured, leading to tree death.

B. Fires. Vegetation on Alaska's public lands has also been impacted by record breaking fire seasons. In 2004, over 6.6 million acres burned, the largest Alaska fire season ever documented. In 2005, approximately 4.6 million acres of Alaska burned, the third largest area ever recorded. (Please see Figure 3). Cumulatively, during these two years, over 25% of the forests in the northeast sector of Alaska perished. These burn rates are entirely consistent with global warming models and predictions. Some of the public lands most impacted by massive, global warming enhanced fires are Kanuti and Tetlin National Wildlife Refuges.

C. Invasive Species. Finally, because of warming, Alaska's public lands and waters are now subject to increasing threats from invasive species. Plants that could not previously reproduce in a colder Alaska can now do so with our warmer climate. One example is Purple Loosestrife. This plant is an aggressive invader of wetlands, and a serious threat to habitat and biodiversity. It requires warm temperatures for germination (15-20C), and now, for the first time, can reproduce in Alaska waterways.

V. Dramatic Reductions in Ice, Glaciers and Permafrost, and their Impacts on Public Lands

A. The Arctic Ice Cap. The Arctic Ice Cap is a key ecological component of our nation's northernmost public marine environment and the adjacent public lands: the Arctic National Wildlife Refuge and the National Petroleum Reserve - Alaska. There was a record low amount of Arctic sea ice in September 2005. Between 1979 and 2005, an area twice the size of Texas has melted away, over a 20% decrease in the minimum summer area. It has since failed to fully recover. In November 2006, ice coverage was the lowest ever recorded for that month. Another

way of stating this substantial loss is that, according to the IPCC, "since 1978…(the) annual average Arctic sea ice extent has shrunk by 2.7 (2.1 to 3.3)% per decade, with larger decreases in summer of 7.4 (5.0 to 9.8)% per decade." Throughout the Arctic Ice Cap, the thickness has also decreased on average by 40%. Arctic ice is critical habitat for polar bears, ice seals, walruses, certain species of bird, and other animals. It is also essential for the traditional subsistence activities of Alaska's Inupiat people.

Equal to any other evidence, the projected modeling of the future of the Arctic Ice Cap supports the importance taking meaningful action now to reduce greenhouse gas emissions. The modeling shows that if we continue to increase emissions of greenhouse gases that the Arctic Ice Cap, and the entire critical habitat that it fosters, could be eliminated as early as 2040. However, that same modeling shows that if we substantially reduce emissions, we can save the Arctic Ice Cap and even expect some recovery. In other words, according to Dr. Marika Holland with the National Center for Atmospheric Research, their modeling "indicates that society can still minimize the impacts on Arctic ice." ***Recommendation 2****: Explore further the emission reduction scenarios that will, according to modeling, help sustain the Arctic Ice Cap, and support legislation that achieves those reductions*.

B. Glaciers. The rapid retreat of Alaska's glaciers represents about 50% of the estimated mass loss by glaciers through 2004 worldwide. Between 1961 and 1998, Alaska and a small part of Canada lost over 588 billion cubic yards of glacial mass. In southeast Alaska, glacier surface elevations decreased over 95% of the area analyzed, with some glaciers thinning in a 52 year period by as much as 640 m (approximately 2,100 feet). The loss of Alaska's glaciers alone has contributed over 9% to global sea level rise.

Glaciers are an important component of many of Alaska's public lands, ecologically, aesthetically, recreationally, and for tourism. Repeatedly, Alaska tourists list glaciers as one of the top three reasons they visit the state. Unfortunately, many of our most visited glaciers are retreating quickly and significantly. An entire US Forest Service Visitor Center was built on a site to view the Portage Glacier in the Chugach National Park. That glacier is no longer visible from the visitor center. The most observed glacier in Alaska, the Mendenhall Glacier in the Tongass National Forest, has retreated hundreds of feet a year, and is projected to recede from its frequently photographed lake terminus.

Rapidly retreating glaciers disrupt both fish and birds associated with our public lands. Sockeye salmon fry in Skilak Lake, part of Kenai National Wildlife Refuge, showed substantial declines in size in two recent years of large glacial melting. Fry in 2004 were about 50% smaller than average for the prior decade; fry in 2005 were 60% smaller. Similarly, the Kittlitz's murrelet, which feeds at the edge of glaciers, declined 60% between 1991 and 1999 in Glacier Bay National Park and declined 83% since 1976 in Kenai Fjords National Park (Please see Kittlitz murrelets photo, Photo 1).

C. Permafrost. With respect to permafrost, all of the observatories in Alaska, on both public and private lands, have shown a substantial warming during the last 20 years, often resulting in damage to infrastructure, rivers, shorelines, lakes, and forests. (Please see Photo 2 demonstrating damage to National Wildlife Refuge forests from melting permafrost). In

locations such as Franklin Bluff on the North Slope, the top layer of permafrost has warmed 3^{o}C between 1987 and 2003. Notably, the warming of permafrost has penetrated great depths, with observations of 2^{o}C warming 60 feet under the ground. One should note that melting and warming permafrost also makes the construction of oil and gas infrastructure more difficult and costly.

VI. The Impact of Global Warming on Animals Associated with Alaska's Public Lands
Whether on ice, land, or water, animals throughout Alaska, have experienced declines due to global warming within our public areas.

A. Polar Bears and Other Ice Dependent Species. Polar bears rely on sea ice for their survival, including feeding, mating, and resting. Because of global warming, Alaskan polar bears have experienced less ice, drownings, dislocation from sea ice, cannibalism, starvation, smaller skull size, and higher cub mortality. Similar ice conditions and trends in the Western Hudson Bay population in Canada have resulted in a 22% population decline in 17 years. In the last fifteen years, the population of Southern Beaufort Sea polar bears has been estimated to be as high as 2,500 bears, and then 1,800 bears. Recently, using the most rigorous surveying methodology to date, the population is believed to be only 1,526 bears.

The decrease in sea ice jeopardizes this iconic national species. The impacts include a statistically significant decline in the survival rate for first year polar bear cubs in the southern Beaufort Sea from 61 cubs per 100 adult females between 1967-89 to 25 cubs per 100 adult females between 1990-2006. Furthermore, skull measurements of both first year cubs and adult males were also statistically significantly smaller. Previously, between 1979 and 1991when there was more ice, 87% of Alaska polar bears surveyed were found on sea ice. This percentage fell to 33% from 1992 to 2004. This, and increased storm intensity, have contributed to documented drownings.

Finally, the Arctic National Wildlife Refuge coastal plain and other coastal areas are becoming more important to the survival of this species. Between 1985 and 1994, 62% of Alaska polar bears denned on ice. That has shifted dramatically. Between 1998 and 2004, only 37% denned on ice, the rest denned on land. The Arctic Refuge supports the highest concentration of polar bear denning sites for our nation.

As a result of the all the evidence the World Conservation Union (IUCN) in 2006 classified polar bears as vulnerable, concluding that five populations, including Alaska's southern Beaufort Sea population. ***Recommendation 3****: The House Natural Resources Committee should support listing polar bears as threatened under the Endangered Species Act.* ***Recommendation 4****: As sea ice thins and retreats due to global warming, protecting the coastal plain of the Arctic National Wildlife Refuge is more important than ever to safeguard polar bear denning sites on public lands.*

Other Alaska ice dependent species are also showing signs of global warming stress. As ice pulls away from the continental shelf there are observations of walrus mothers having abandoned their calves. Further out on the ice, the snow cavities for some ring seals and other ice seals are collapsing with warming temperatures, exposing their young to predation or freezing.

B. Salmon. Salmon populations in Alaska depend on public lands and these ecologically, economically and culturally significant species are adversely affected by increased temperatures. One of the state's most important rivers with respect to public lands, the mighty Yukon, flows through or is adjacent to multiple parks and refuges, including the Yukon Delta National Wildlife Refuge (our nation's second largest refuge), Innoko National Wildlife Refuge and Yukon Flats National Wildlife Refuge. In the last 25 years, the Yukon has warmed more than 10^{o}F in summer months. As a result, up to 45% of Yukon salmon are now infected with the parasite *Icthyophonus,* never found before 1985. This disease weakens fish because it attacks heart and skeletal muscle tissue. It also prevents the drying of fish, making infected fish inedible as fish-rack dried subsistence foods, a critical component of many Alaska Native diets.

Global warming has also adversely affected other public land dependent salmon. After the warm summer of 2004, the pink salmon harvest in Southeast Alaska, which mostly relies on the Tongass National Forest, was dramatically lower than predicted in 2006. The Alaska Department of Fish and Game (ADF&G) had forecast a purse seine catch of 52 million. According to ADF&G, the actual harvest was only 11.4 million, 40 million less than predicted. Officials with ADF&G targeted warmer temperatures as the cause. Fewer salmon are bad for fisherman, the fishing economy, and the entire ecosystem, which relies on abundant salmon runs for nutrition and nutrients.

ADF&G has established standards for water temperatures, concluding that temperatures above 55^{o}F are unhealthy for spawning areas. In four streams monitored in Alaska's salmon-rich Kenai Peninsula in 2005, there were more than 80 days that exceeded this temperature threshold. (Please see Figure 4).

C. Ungulates. Other species on our public lands are also experiencing declines because of global warming. The Porcupine Caribou herd, which relies on the Arctic National Wildlife Refuge as well as public lands in Canada, has experienced a population decline since 1989 of 3.5% per year to a low of 123,000 animals in 2001." (ACIA 2004) Scientists believe this is attributable to global warming caused by freezing rain (which coats their lichen making it very hard to access in the winter), changing river conditions, and less tundra.

For species that rely on high elevation ecosystems on public lands, they are also experiencing the impacts of global warming. For example, Dall sheep live exclusively in alpine tundra. Due to warmer temperatures, the treeline in the Kenai Mountains of the Kenai National Wildlife Refuge has risen at a rate of about 1 meter/year over the past 50 years. According to Dr. John Morton, chief scientist with the Refuge, "…we're going to have declining Dall sheep. We're losing their habitat."

D. Bering Sea Species. Fish and other species in the Bering Sea, our nation's fish basket, are also showing signs of impact. Because certain National Wildlife Refuge islands are surrounded by the Bering Sea and because many other Refuges and Parks are adjacent to the Bering Sea, the health of the Bering Sea has a major impact on them. The Northern Bering Sea is changing from arctic to subarctic conditions caused by warmer air and water temperatures, and less sea ice. Even bottom water temperatures are demonstrably increasing. As a result, the prey base of benthic (bottom) feeding walrus, endangered sea ducks like spectacled eiders, and gray

whales is declining; snow crab catches have declined 85% in six years along with other crab decreases; and crab populations have shifted northward. Yellowfin sole and Greenland turbot catches have been dropping, in addition to declines in fur seals and seabirds. Some pollock are moving into cooler Russian waters because of global warming. Recent surveys have measured the first decrease in US pollock stocks in Alaskan waters in six years, resulting in a reduction of the catch allotment. In short, warming waters are creating a northward migration of marine life on an unprecedented scale. ***Recommendation 5****: Because the Bering Sea is so important to the nation for fishery production (including salmon, pollock, crab and halibut), for sustaining marine mammals, and for nourishing Alaska Natives and others; and because the Bering Sea is already being stressed by global warming, Congress should re-instate the Moratorium on off-shore oil and gas production. Instead, renewable energy options, such as wind, wave and geothermal should be fully explored and implemented.*

E. Migratory Birds. Unfortunately, in addition to the impacts described above, there are many more species of animals that reside on public lands, which are being adversely affected by global warming. Because of space constraints, I will discuss just one more: a representative migratory bird that touches many states in the union, the scaup. Population of these diving ducks appears "to be in peril" (Consensus Report 2006). They have declined from over 7 million in 1970s to a record low in 2006 -- 3.2 million (Ducks Unlimited 2007). Why? We see the fingerprints of global warming, once again, with respect to Alaska public lands. Approximately 70% of these birds breed within western boreal forests, where there is the fastest rate of decline (94,000 birds per year [1978 to 2005]). These declines reflect breeding season events. There has been a19% wetland loss in Yukon Flats (1985-89 v. 2001-03). Recently, scientist have determined that where ponds lose 20% or more of their surface, there is a decline in scaup food sources such as amphipods, gastropods and chironomid larvae (Corcoran et. al 2007). Therefore, where there is more warming, less water, and less food, there are population declines.

VII. Greater Storms, Sea Level Rise and Ocean Acidification from Global Warming and Their Impacts on Public Lands

Global warming causes more intense ocean-based storms, not only in the Atlantic Ocean, but also in the Bering Sea and the Arctic Ocean. While in 2005 the nation focused on hurricanes in the Gulf of Mexico, Western Alaska experienced a brutal storm, adversely affecting 34 communities and our public lands. The storm surge in Nome was 9 feet above normal high tides with waves of 12 to 15 feet. Newtok saw 5 to 10 feet of beach disappear along with equipment like a 1,000 gallon fuel tank. Unalakleet lost 10 to 20 feet of beach.

Much less noticed, this global warming fueled storm also had a serious impact on public lands, including the Yukon Delta National Wildlife Refuge, one of the nation's most important geese breeding areas. Because so much of the Refuge is low in elevation, it was heavily influenced by storm surges of at least 9 feet that inundated considerable areas of fresh water lakes and wetlands. As a result, animals such as lemmings were killed, and as a precaution, the Refuge instituted a large fox trapping program to reduce predator populations to protect geese eggs. Major storms have also damaged Fish and Wildlife property.

More generally, because global warming in Alaska is resulting in accelerated shoreline erosion, melting permafrost and greater flooding, global warming is redefining our public land maps in Alaska. Some shorelines have retreated more than 1500 feet over past few decades, and in one area in Western Alaska, Newtok lost 2-3 miles of shore in 40 years. The critical habitat area north of Teshekpuk Lake in the northeast corner of the NPR-A, is already losing low elevation lakes, as the ocean breaches their boundaries and erases previous land masses. This inundation not only affects habitat, in some places on Alaska's North Slope, it is also affecting past and current oil and gas infrastructure. Older drilling sites in the National Petroleum Reserve – Alaska are now under water. ***Recommendation 6****: Study the likely threats to oil and gas infrastructure and past drilling sites on public lands in Alaska, especially on or adjacent to the National Petroleum Reserve, from inundation caused by global warming.*

Notably, according to a General Accounting Office estimate, approximately 184 communities in Alaska are at risk from flooding and erosion. In response to a Congressional request, the Army Corps of Engineers issued a report detailing relocation needs for seven Alaska coastal communities. The report estimates that Shishmaref, Kivalina and Newtok have only 10 to 15 years left at their present storm-battered locations, and predicts that it will cost as much as $355 million to move them. This cost estimate does not include the social upheaval associated with relocating, as in the case of Shishmaref, from a special location that has been occupied for over 4,000 years by a culturally recognized tribe. Because most of these communities are surrounded by public lands, their moves will have consequences to these lands, in many cases requiring land exchanges (as was necessary with Newtok), road access, and other responses. ***Recommendation 7****: Our nation has a moral responsibility to assist in and finance these moves in a culturally and environmentally sound manner, while at the same time insuring that the impacts on our public lands are minimized. In this appropriations cycle, Congress should insure adequate funding for planning and initial relocation efforts for the communities of Shishmaref, Kivalina, and Newtok, while determining future funding sources for these relocation needs.*

Ocean Acidification. The acidification of our oceans is probably the least studied -- but unquestionably represents one of the direst consequences -- associated with human emissions of carbon dioxide. Since the Industrial Revolution, humans have increased the acidity of our oceans by over 30% as we have augmented the amount of CO_2 in our atmosphere from approximately 270 ppm to 380 ppm. Scientists are just beginning to understand the effects of current and projected acidification. Alaska's waters, and associated public lands and resources, will probably be the most negatively effected. For example, acidification dissolves food chain building blocks like the plankton known as pteropods, which are critical food sources for Alaska salmon fry and other species. Acidification also reduces the saturation of carbonate ions, which especially represents a very serious problem for deep water corals found offshore of many of Alaska's public lands, including the Alaska Maritime National Wildlife Refuge. ***Recommendation 8****: Congress should definitely authorize more research on the status of and impacts from ocean acidification on our public resources and economy.*

VIII. Adverse Impacts of Global Warming on Alaska's Oil and Gas Economy and Public Lands-Based Economies

Many sectors of Alaska's economy have been negatively impacted by global warming. The oil industry on Alaska's North Slope has experienced a much shorter winter season in which it can build ice roads and otherwise traverse the tundra for exploratory and drilling activities (Please see Figure 5). Even in the summer, oil production on the North Slope has decreased due to warmer temperatures, since compressor efficiency is reduced. Gas compression is needed to reinject produced gas into the gas cap, and this process represents a major constraint on production rates, particularly with warmer temperatures.

Fires and fishery losses due to global warming also have economic consequences for the nation. Fires are not only costly to health, but also to fight. The record-breaking 2004 season in Alaska cost over $108 million, while in 2005 fire fighting cost $56 million. Representing a loss of tens of millions of dollars, the 6% pollock quota reduction is one of the many fishery economic losses associated with global warming.

IX. Impacts of Global Warming on Indigenous Cultures, Subsistence Activities on Public Lands, and other Matters

Because of their close connection with land, water, vegetation, animals, and weather conditions, Alaska Native cultures are experiencing many severe consequences from global warming. A large number of these impacts are associated with public lands, which surround most Alaska Native villages and have served as their hunting and gathering areas for millennia. According to the Arctic Climate Impact Assessment, "Climate change is occurring faster than people can adapt. [It] is strongly affecting people in many communities, in some cases threatening their cultural survival." The ACIA further notes:"…the Arctic is becoming an environment at risk… sea ice is less stable, unusual and highly variable weather patterns are occurring, vegetation cover is changing, and particular animals are no longer found in traditional hunting areas during specific seasons. Local landscapes, seascapes, and icescapes are becoming unfamiliar, making people feel like strangers in their own land."

The former Chair of the Inuit Circumpolar Conference, Sheila Watt-Cloutier summarizes it well when she states: "For the Inuit, climate change is a matter of livelihood, food, health, and individual and cultural survival. The erosion and potential destruction of our way of life brought about by climate change resulting from emission of greenhouse gases amounts to a violation of the fundamental human rights of Inuit."

Alaskans in rural areas, and especially Alaska Natives, are threatened with increased health problems associated with global warming, including giardia from expanding beaver populations, botulism when storing their food in warming soils, increasing accidents from thinner ice and more intense storms, failing water and sewer systems, greater incidences of paralytic seafood poisoning, and decreased availability of nutritious subsistence foods. Other health problems include respiratory stress due to increased smoke from fires. More generally, larger fires from global warming are also releasing sequestered mercury, especially in Alaska and Canada, at levels up to 15 times greater than previously estimated.

Because of these grave, adverse impacts and threats, Alaska Natives have recently taken the opportunity to speak with a strong voice, stating that they are very detrimentally affected by global warming, that they are deeply concerned about the future of their subsistence way of life and their culture, and that they want Congress to take action to implement mandatory emission reductions. In the last few months, over 130 tribes, Native Corporations and major Alaska Native organizations – representing tens of thousands of Alaska Natives -- have passed strongly worded separate Resolutions seeking meaningful legislative action (please see the representative resolution from the Alaska Federation of Natives that is appended to this testimony.) Congress has a responsibility to heed their compelling observations, meaningful experiences, significant concerns and justified request for action on global warming.

VIII. The Future is in Our Hands

The future course of global warming in Alaska depends on whether the United States and the rest of the world take the actions necessary to significantly reduce greenhouse gas emissions. If we do not, substantial warming is predicted (up to 25^{o}F by the end of the century). The probable consequences of this amount of warming are many, including: the elimination of the Arctic Ice cap, the extinction of American polar bears, the inundation of hundreds of thousands of acres of land and scores of communities, the loss of most of Alaska's boreal forest, substantial increases in diseases, the significant decline and elimination of numerous arctic and subarctic species, the deterioration of our public lands, multiple adverse impacts on Alaska Native cultures, and the loss of billions of dollars of infrastructure. Notably, most scientists believe we still have time to avoid these cataclysmic changes, if we act to reduce emissions quickly and meaningfully.

IX. Renewable Energy in Alaska – Our Contribution

Fortunately, Alaska has a positive role to play in the reduction of greenhouse gas emissions. As described fully in the Renewable Energy Atlas of Alaska (accessible online at www.akenergyauthority.org), America's northernmost state has outstanding and inexhaustible geothermal, wind, biomass, wave, tidal, and hydroelectric energy supplies. As the Renewable Energy Atlas states, "With some of the best renewable energy resources in the country, Alaska has an opportunity to be a leader in their development…"

There are some early, exciting developments in Alaska regarding renewable energy, but there needs to be much more Congressional assistance to achieve Alaska's renewable energy potential.

A. Geothermal. Alaska has tremendous geothermal potential, both for direct use (including district heating, greenhouses, hydrogen production, absorption chilling, process heating in the seafood industry) and for electricity production. Currently there is an exciting example of geothermal use at Chena Hot Springs Resort that can serve as a model for many locations in Alaska as well as the nation and the world. Other large scale plants are also being investigated in Alaska. Recently, MIT issued a report declaring that geothermal power has tremendous potential for the United States, and needs more research and investment. ***Recommendation 9****: Congress should quickly and decisively support expanded geothermal research and power production, including supporting Senator Murkowski's REFRESH ACT of 2007.*

B. Wind. Alaska has tremendous wind resources that are highly suitable for the generation of electricity and hydrogen in both urban and rural locations. Alaska's first wind farm, located on the Northwest coast of Alaska, has been displacing a significant portion of the utility's diesel fuel since 1997. To the south, a recently installed wind project in Toksook Bay is providing renewable energy to three communities. Wind power is economic, clean, local, and inexhaustible, and deserves considerable support as a major energy producer of the future. ***Recommendation 10****: Congress should support the work of the Denali Commission and others in the installation of wind generation capacity, and also research the potential for wind to create hydrogen for local use, and ultimately for export.*

C. Ocean Power (Wave and Tidal). With our 34,000 miles of coastline (more than the rest of the nation), Alaska offers exciting opportunities for testing and implementing wave and tidal power. According to the Atlas of Renewable Energy, "Alaska has one of the best wave resources in the world, with parts of its Southcentral and Southeast coastlines averaging 60kW per meter of wave front. The total wave power flux on southern Alaska's coast alone is estimated at 1,250 TWh per year, or almost 300 times the amount of electricity Alaskans use every year!" ***Recommendation 11****: Congress needs to support the research and financial assistance associated developing our renewable wave energy as soon as possible.*

D. Biomass. Two exciting biomass fuels in Alaska are fish byproducts and municipal waste. Recently, with government assistance, a major processor conducted successful tests of raw fish oil/diesel blends, and now uses approximately one million gallons of up to 70% fish oil for power production each year. There is much more potential. According to the Atlas, "currently state, federal and university groups are working together to assess the potential for recovering a portion of the estimated 12 million gallons of fish oil returned to the ocean each year as fish processing waste". ***Recommendation 12****: this research and analysis deserve to be supported, and other biofuel opportunities studied and implemented.* With respect to waste product, Eielson Air Force Base densifies paper separated from the Fairbanks area waste stream and then uses the paper "cubes" at the base's coal-fired power plant. Between 600 to 3,000 tons of this fuel have been produced per year in 1997. This possibility should be explored throughout the nation.

X. Conclusion

The impacts from global warming on Alaska's public lands are real, scientifically measurable, costly, damaging to Alaska Native cultures, harmful to treasured plants and animals, bad for the economy, and detrimental to future generations of Americans.

Because of Alaska's rich ecological and cultural heritage, there is much at stake in the Last Frontier as the planet warms. Alaska's experiences with global warming are also informative to the rest of the nation. Going forward, Alaska represents a compelling reason to implement mandatory reductions on greenhouse gas emissions promptly and significantly, as we move toward a clean and renewable energy path with determination.