Alaska Climate Change Adaptation Series

Wildfires are a natural part of the boreal forest ecosystem. Fires are necessary for maintaining vegetation diversity and provide a diverse habitat for wildlife, but fires can also present a threat to human values. Alaska has seen a recent increase in the frequency of large fire years, with three of the top ten largest years (since 1940) occurring in the last decade. Over the past 50 years, Alaska has warmed at more than twice the rate of the rest of the United States. Warmer temperatures have lead to longer snow-free seasons, changes in vegetation, and loss of ice and permafrost, all of which can contribute to longer and more active fire seasons. It is likely that the Alaskan boreal forest will experience some dramatic changes over the next century. Learning about these changes and their potential impacts can help guide us in planning for the future.

A Changing Climate Fuels Wildfires

If it seems likes things are changing, it's because they are. In fact, everything is *always* changing and climate is no exception. However, now the Earth's climate is changing more rapidly than previously seen in the modern human era. Though the impacts of these changes are not fully understood, it is likely that the environment we live in will start to experience some significant changes.

Many scientific experts agree that the effects of climate warming will be more pronounced and happen earliest at high latitudes[1]. Since 1949, the average summer temperature in Alaska has increased 2.1°F while the average annual temperature has risen 3.0°F, twice the global average increase of 1.4°F[2].

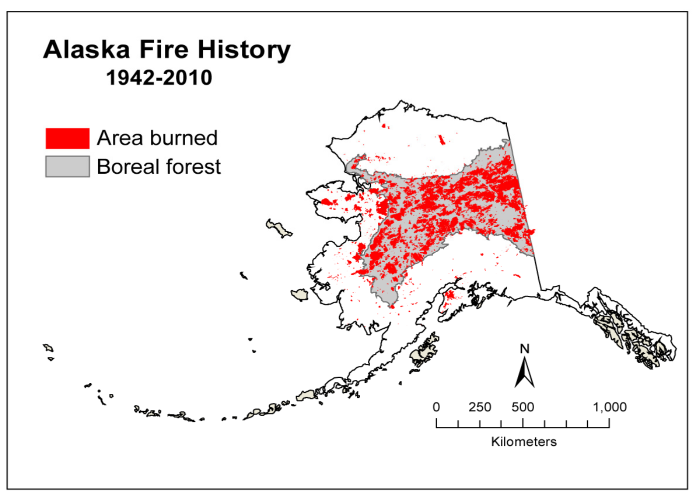
Fire in Alaska is closely linked to climate.

The acres burned per year in Alaska can be highly variable, ranging from a few hundred thousand to several million. However, the area burned in Alaska was twice as high in the last decade (2000-2009) than in any decade in the previous 40 years (1960-1999), and two of the three largest fire seasons on record occurred in 2004 and 2005, burning 6.6 million and 4.6 million acres. In fact, the average area burned per decade in Alaska is projected to double by the middle of this century[3].

How could these changes impact us and the ecosystems we live in? First it is important to understand how and why they are happening.

Wildfires in Alaska

Fire is an important natural component of the boreal forest and tundra ecosystems, and benefits forests, wildlife and people. Most fires in Alaska occur in the interior boreal forest, the area bound by the Brooks Range to the north and the Alaska Range to the south. This area is dominated by black and white spruce trees along with substantial components of deciduous trees (aspen, poplar and birch), and alder and willow shrubs.



Tundra ecosystems are primarily composed of grasses, low shrubs, mosses, and lichens. Although tundra fires are fairly common in western Alaska, fires are less so in the arctic tundra north of the Brooks Range. Tundra fires are generally smaller and fewer in quantity than fires in the interior boreal forest. However, a recent and unprecedented large and long-lasting fire occurred on the North Slope of the Brooks Range in 2007.

Over the last two decades, nearly twice as many fires in Alaska have been started by human activities compared to lightning ignitions. Although human-caused fires occur more frequently, they are usually smaller than fires started by lightning. They are also generally located in close proximity to communities, roads, or other infrastructure and are quickly suppressed. During the 1990s and 2000s, human-caused fires accounted for only 5% of the total area burned in Alaska[4].

Them's Fire Words

Fuel: potentially combustible material

Fuel load: amount of flammable material around a fire

Fire intensity: the amount of energy released by a fire, usually described as the maximum temperature or maximum height of the flames

Fire severity: the degree to which a site is altered by fire, which depends on fire intensity and duration

Fire regime: long-term pattern of fires in a given area, and its effect on the ecosystem

Fire weather: weather variables that influence fire potential, behavior and suppression

Wildfires & Forest Succession

Most of the North American boreal forest (including Alaska and Canada) has a relatively short fire return interval (or fire-free interval) of 50-150 years[5], which means that if left untouched by humans, the time between successive fire events for a given area will be 50-150 years.

Black Spruce: "Born to Burn"

Fires typically burn unevenly, resulting in a mosaic pattern, or patchwork, of vegetation across the landscape. Differences in fuel types (vegetation), fuel moisture, terrain, and weather all contribute to how a fire burns and how much biomass is consumed.

Typical succession in a spruce stand starts with grasses and herbs, shifts to shrubs, then to deciduous trees, and finally returns to a coniferous dominated stand. Recent studies have shown that the process of succession can be more complicated and can skip stages. Interactions between soils, hydrology, and seed source, as well as the extent and severity of the disturbance (fire), can strongly influence the successional pathway.

Fire Management

In the past, there was an attempt to suppress all fires in Alaska. This was neither possible, cost effective, nor good for the landscape. The Alaska Interagency Wildland Fire Management Plan (AIWFMP) tries to balance ecosystem health with the need to protect values and resources.

The intent of this state wide plan is to maximize the use of fire fighting personnel and resources in the most critical areas, while allowing fire to play its natural role in others. To accomplish these goals, four different fire suppression options were created and implemented across the state of Alaska. This management plan allows fires to be monitored where no resources are threatened and fire benefits the ecosystem, but also allows aggressive suppression where human life, property and other critical resources are at risk. Land managers are responsible for designating fire suppression areas in Alaska.

Burn areas are now slower to return to black spruce stands.

Fires are a necessary and healthy part of a forest ecosystem. So, what's the big deal?

Warmer conditions may lead to fires that are larger, more frequent and consume more biomass.

Fire Regime Change – Boreal Forests

Black spruce has been the dominant tree species in Alaska's boreal forest for the past 5500 years[6]. While black spruce stands are well adapted to fire, they are also vulnerable to changes in the fire regime[7]. The response of the Alaskan boreal forest to predicted climate changes may impact how the forest burns. For example, warmer temperatures and less rain can result in drying of fuels and vegetation making forests more flammable. Changes in the length of the seasons, for example earlier springs or drier falls, could increase the length of fire season. Late-season burning may allow fire to burn more deeply, thus increasing burn severity.

In Alaska, the increased area burned during the 2000s resulted in a 25% decrease in fire intervals. Instead of fires recurring at an average of 196 years, they now reoccur at an average of every 144 years[8]. Changes in the fire return interval and the amount of surface fuel layers consumed have the greatest impact on black spruce forests. A shorter fire return period could prevent spruce trees from reaching maturity and reproducing before the next fire comes through.

Wildfires can turn Alaskan boreal forests from carbon sinks to carbon sources.

Research shows that the depth of the burn can have a significant impact on post-fire tree regeneration because of the disturbance in soil/surface temperature and moisture. In areas where fires burn longer and hotter, the surface layer is burned more deeply, which favors deciduous tree establishment. Shifts from black spruce stands to hardwood stands have been observed in several areas in interior Alaska.

Fire Regime Change – Tundra

Recent studies have found that tundra fires in western Alaska have occurred fairly regularly over the past 2000 years. Though widely variable, lake coring sediments in the Noatak River watershed revealed fire return intervals ranging from 113 to 240 years[9]. In contrast, there is relatively little evidence of fire occurrence over the past 5000 years in arctic tundra regions of the North Slope. One exception was the 2007 Anaktuvuk River Fire that more doubled the known area burned in that area.

Alaskan paleorecords indicate that shrub dominated tundra systems of the past had higher fire frequencies then seen today[10]. Predicted future shrub expansion coupled with climate warming and lower fuels moistures could lead to a more flammable landscape, suggesting that fire activity will increase in the shrub dominated tundra ecosystems over the next century[11].

2007 Anaktuvuk Fire
Photo: Benjamin Jones/USGS

Wildfires & Carbon Emissions

Carbon is one of the most abundant elements on the planet. Carbon is naturally cycled between the atmosphere, oceans, plants and soils. However, human activities over the past 200 years, such as the burning of fossil fuels and deforestation, have influenced the balance of this cycle and released more carbon gases, along with other greenhouse gases, into the atmosphere. These gases prevent heat from escaping into space and contribute to the rising surface temperatures on Earth[12].

The changing climate may also influence other aspects of the natural carbon cycle. The boreal forests in the Northern Hemisphere contain roughly 40% of the world's reactive soil carbon[13]. When trees and organic surface materials are burned, carbon is released into the atmosphere. Simulations of carbon released from fires in interior Alaskan black spruce stands over the past 60 years suggest that regional carbon losses have accelerated over the past decade[14].

Scientists have attributed this to an increase in the area burned over the last 10 years and more late-season fires, which typically burn deeper into the organic soil layers[15]. Essentially, carbon was released at a rate faster than it could be absorbed.

What does this mean? Under certain conditions, the deep layers of organic materials in Alaskan black spruce stands can function as a carbon source instead of a carbon sink, thus increasing the amount of greenhouse gases and contributing to climate change.

Climate & Wildfires

Climate factors that promote fire include warm temperatures, little or no precipitation, low relative humidity, and high winds. Longer summers and higher temperatures create an environment that is conducive to large fires. Between 1970 and 2000, the length of the snow-free season increased by about 10 days across Alaska, primarily because of earlier snowmelt in the spring. An earlier spring gives fuels (vegetation), soils, and snow-fed rivers more time to dry out. Warm, dry weather also allows fires to burn longer into the summer/fall when organic soils are thawed to their maximum depth. Deeper, late season burns have been found to release more carbon into the atmosphere and may promote a stand type conversion- a long term change from one community type, such as forest, to another, such as grassland. Current trends in Alaska show a slow expansion of boreal forest into tundra in the north, and the retreat of boreal forest at the southern limit[16].

The annual area burned in Alaska is closely correlated with the Pacific Decadal Oscillation (PDO), a pattern of climatic variability that affects Pacific Ocean temperatures and accounts for significant shifts in temperature and precipitation[17]. This is similar to the El Nino/La Nina patterns that people may be more familiar with. Climate and fire model simulations suggest that warmer temperatures in the next century will lead to more frequent large fires[18], an increase in annual area burned[19], and a landscape dominated by more early successional and deciduous vegetation[20]. The effect of the PDO on fire will depend on whether the PDO is in its cool or warm phase; each phase persists for about 20-30 years.

What This Means to You

The changes associated with climate warming and increased fire activity could have significant impacts on the landscape, hydrology, permafrost, wildlife and people of Alaska.

Some potential impacts/changes include:

- Increased risk of damage to valued resources (infrastructure, cultural sites, etc.)
- More exposure to smoke
- Increase of early successional and deciduous species on the landscape —> Deciduous vegetation absorbs and transfers less heat into the atmosphere, having a "cooling effect"
- Changes to wildlife habitat and distribution —> Affects subsistence patterns
- Increase in area burned —> Increase abundance of berries on the landscape
- Loss of forest and surface organic materials —> Permafrost thaw —> Change in vegetation/hydrology dynamics and carbon cycling
- Release of carbon from higher severity (deeper burning) fires —> Emits more greenhouse gases

Scientists continue to study the interactions between climate change, permafrost, fire, and plant successional processes and how they might alter the boreal landscape in Alaska. As we start to understand these interconnected relationships, we can incorporate this information in planning for the future.

For more information or assistance, visit:

Alaska Fire Science Consortium (AFSC)
http://akfireconsortium.uaf.edu

Scenarios Network for Alaska & Arctic Planning (SNAP)
http://www.snap.uaf.edu

Alaska Center for Climate Assessment and Policy (ACCAP)
http://ine.uaf.edu/accap/wild_fires.html

To report a wildland fire in Alaska, call 1-800-237-3633

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