A Firefighter's Guide to Protecting Yedoma Permafrost on the Yukon Flats National Wildlife Refuge

What is Yedoma permafrost?

Permafrost is ground that remains completely frozen for at least two consecutive years. It usually lies below an "active layer" of soil that freezes and thaws every year. Permafrost consists of rock, sediment, and soil with varying quantities of ice that binds the different materials together. In Alaska, about 80 percent of the ground is underlain by permafrost.

Yedoma is a specific type of ice-rich Pleistocene-age permafrost found in unglaciated areas of the circumpolar arctic. It is characterized by high silt and organic matter content, and it has larger ice wedges than other types of permafrost, sometimes over 150 feet thick. Yedoma is an important reservoir for fossils of late Pleistocene megafauna. Its high ice content makes it susceptible to climate change, disturbance, and abrupt thaw with potential thaw settlement of 30−100 feet. Consequently, deep thaw lakes are prevalent in Yedoma areas. Roughly 3.5 million acres of Yedoma permafrost has been mapped on Yukon Flats National Wildlife Refuge (YFNWR) lands.

Post-fire Yedoma thaw (Photo: Torre Jorgenson)

Why are we protecting permafrost from wildfires?

Permafrost is structurally important to the soils of Alaska, and thawing can cause landslides, ground subsidence, and erosion as well as changes in hydrology such as lake draining, new lake development, and saltwater encroachment into aquifers and surface waters. Wildfire removes the deep insulating organic mat of live and decaying vegetation over the permafrost, making it more susceptible to heat fluxes and thawing. The high organic content of Yedoma means that its ancient carbon can be released into the atmosphere as greenhouse gasses when it thaws, contributing to climate change long after a fire is out. Yedoma is estimated to contain 130 billion metric tons of organic carbon worldwide, equivalent to more than a decade of global human greenhouse gas emissions. While thawing permafrost can release carbon regardless of type, Yedoma holds more than a quarter of the organic carbon stored in all permafrost. Yedoma on YFNWR is more resilient than that found in other areas of Alaska because: 1. The annual average temperature is below freezing; 2. Topographical relief limits pooling of surface water which can lead to permafrost thaw; and 3. Thick silt layers are poor conductors of heat and help insulate the permafrost.

National, departmental, and agency policies provide guidance for addressing the climate crisis. The National Strategy for the Arctic Region directs us to "reduce emissions from the Arctic as part of broader global mitigation efforts, to improve scientific understanding, and to conserve Arctic ecosystems." Increased initial attack in Yedoma areas can keep fires small, reducing emissions during and after the fire and improving air quality for local residents. Increased suppression will only occur in areas that have not burned since 1990, so this strategy will help maintain mid- to late successional forests on the landscape.

Can we really slow climate change by putting out fires in permafrost areas?

The short answer is we don't know, but we hope to improve our knowledge by studying the results of this effort, considering emissions, economics, and other factors. What we do know is this:

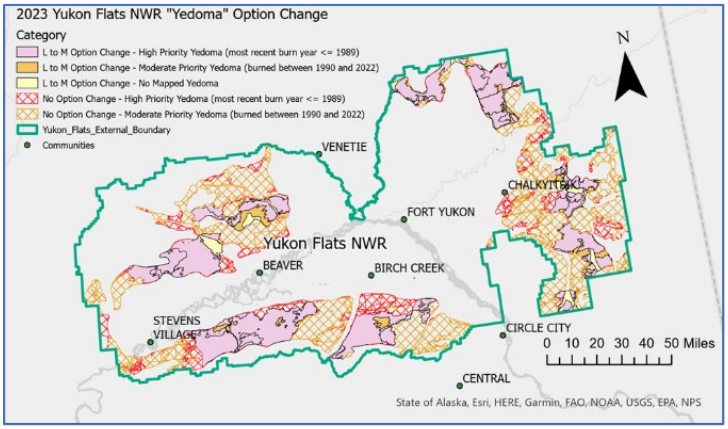
1. Emissions from Alaska fires are significant. For example, in 2019, about 210,00 acres burned on YFNWR emitting an estimated 3.9 million metric tons of carbon. This is equivalent to over 33.1 million barrels of oil consumed, not including subsequent emissions from thawing permafrost.
2. Even if future fires eventually burn an area, delaying carbon release buys time to curb global greenhouse gas emissions and reduce thawing of permafrost.

3. Researchers have investigated the cost of suppression and determined that, while not cheap, increased suppression in the North American boreal forest has costs and benefits on par with other efforts to decrease greenhouse gas emissions.

What about wildfire as a natural process?

For years we have extolled wildfire disturbance as a net benefit to Alaska ecosystems in areas where other values are not threatened. Burned areas can increase habitat diversity, benefit many species, and provide natural barriers to future wildfire growth. But fire seasons have lengthened, acres burned have increased, and predictions are for increased fire occurrence into the future. Between 2000 – 2020, acreage burned was 2.5 times more than the previous 20 years, and studies project increases in burned area up to 169% by 2050. Managers need to account for the consequences of landscape change with increased fire such as a reduction in mature habitats, its effects on human health, and carbon emissions. Concerns about fuel buildup with increased fire suppression are largely based on fire regimes in western North American forests (historically high frequency, low severity surface fires) as opposed to boreal forest fire regimes (low frequency, high intensity crown fires). Limiting boreal fires to historical levels is therefore not likely to result in situations similar to what has occurred in the contiguous US.

What are we asking you to do?



Yukon Flats NWR Yedoma Option Change

The Management Option for 1.6 million acres has been changed from Limited to Modified to provide protection for some Yedoma permafrost within the Refuge. This boosts the default initial response to early and mid-season ignitions from Monitor to Full Suppression if the following conditions are met:

1. Suppression operations do not pose undue risk to firefighters.

2. There are no higher priority threats to life and property that take precedence.

3. There is a high confidence that the fire can be fully contained within 72 hours. Decisions to engage beyond this window will be made on an incident-by- incident basis in consultation with the USFWS.

Are the risks worth the rewards?

It is easy to understand the importance of protecting a community or a home. The value of protecting permafrost is understandably less clear. Our hope is that this pilot effort provides important data to help answer questions about whether we can use fire suppression as a tool to slow climate change. Ultimately, delayed warming may provide long term benefits to communities that far outweigh the protection of a single home. In the meantime, FMOs, Incident Commanders, and every firefighter must consider both the values they are being asked to protect and the risks to themselves and their co-workers in every fire management decision they make.

For more information about fire in Alaska and environmental changes on Yukon Flats National Wildlife Refuge, visit: https://www.frames.gov/sites/default/files/AFSC/AlaskasChangingWildfireEnvironment.pdf

and https://uaf-iarc.org/wp-content/uploads/2021/06/Yukon-Flats-Changing-Environment.pdf.

Interested in learning more about permafrost? Visit https://pdg.open.uaf.edu/virtual-tours/ for a tour of the permafrost tunnel in Fox, Alaska.