

Most flammable boreal forests in North America become more so

July 22 2013



The magenta-flowered fireweed, which springs up after a burn, dominates a landscape once covered in black spruce in Alaska's Yukon Flats. Credit: Feng Sheng Hu

A 2,000-square-kilometer zone in the Yukon Flats of interior Alaska – one of the most flammable high-latitude regions of the world, according to scientists – has seen a dramatic increase in both the frequency and severity of fires in recent decades. Wildfire activity in this area is higher than at any other time in the past 10,000 years, the researchers report.

The new findings add to the evidence that relatively frequent and powerful fires are converting the conifer-rich boreal forests of Alaska

into deciduous woodlands. Deciduous trees, which shed their leaves in autumn, are more resistant to burning than the black spruce and white spruce that once dominated the Yukon Flats. Whether the shift to deciduous forests will overcome the fire-inducing effects of a warming climate remains to be seen, the researchers said.

A paper describing the study appears in the *Proceedings of the National Academy of Sciences*.

"We reconstructed the fire history by picking charcoal fragments out of sediments preserved over thousands of years," said University of Illinois doctoral student Ryan Kelly, who led the study with Illinois [plant biology](#) professor Feng Sheng Hu. "And from what we can tell, the fire frequency at present is higher than it has been at any time in the past 10,000 years."

The researchers looked at the charcoal and pollen content of mud collected from the bottoms of 14 deep lakes in the Yukon Flats.

"We chose this area because today it is one of the most flammable boreal [ecoregions](#) of North America," Hu said. "So we are focusing in an area that is highly flammable and we are focusing on periods of climate fluctuation during the Holocene. We're trying to figure out what happened in the past to help us to project what may happen in the future."

The Holocene epoch began about 11,700 years ago and continues to the present.

The team paid close attention to a particularly warm period in the Holocene. This period, called the Medieval Climate Anomaly (MCA), occurred about 1,000 to 500 years ago. Global temperatures and tree species in the Yukon Flats were similar during the MCA to conditions

today.

"This period probably wasn't really as warm as today, definitely not as warm as it's bound to get in the future, but may be the most similar to today," Kelly said. "There was lots of burning, almost as much as today, and the fires were particularly severe."

The researchers found that the composition of tree species in the Yukon Flats gradually shifted during the MCA – from forests dominated by coniferous trees to woodlands populated by relatively fire-resistant deciduous trees.

"That feedback from the vegetation prevented fire frequency from increasing much more than it already was," Kelly said. "So there was a limit to fire frequency during the Medieval Climate Anomaly."

The same kind of change in [tree species](#) is occurring today, Kelly said. Much of his study area has burned in the last decade, with young deciduous trees now growing where black spruce once stood.

Current wildfire activity in the study area, however, has already surpassed the limit seen during the MCA, Kelly said. The average fire frequency in this region during the last 3,000 years was nine or 10 fire events per thousand years. But in the last 50 years, the number of wildfire events has doubled, to almost 20 per 1,000 years, he said.

"That's like a fire every 50 years, whereas in the past it was closer to a fire every hundred years," Kelly said.

The findings are notable because boreal forests cover more than 10 percent of Earth's land surface and contain a vast amount of carbon, primarily in the soil, Kelly said.

"There is more carbon in the boreal forests than in the atmosphere," he said. "And one of the main ways that the carbon that's accumulated over thousands of years gets out of the soil is through burning."

The release of this carbon from fires adds to the greenhouse gases in the atmosphere, potentially leading to additional climate warming, he said.

"The Yukon Flats region appears to be undergoing a transition that is unprecedented in the Holocene epoch," Hu said. "And the transition may be indicative of what will happen throughout much of the North American boreal forests in the decades to come."

"Ryan's study area is already covered by deciduous [forest](#) because so much spruce has burned recently – it's already different than the vast majority of boreal forests," Hu said. "The climate today appears to be warmer than in the past 10,000 years in that region, and we know that the climate is continuing to warm up."

As warming continues, Hu said, it's plausible that even deciduous forests will become highly flammable.

"It's wood," he said. "If it's dry, it will burn."

More information: *PNAS*. July 22, 2013. [Doi: 10.1073/pnas.1305069110](#)

Provided by University of Illinois at Urbana-Champaign

Citation: Most flammable boreal forests in North America become more so (2013, July 22) retrieved 24 April 2024 from <https://phys.org/news/2013-07-flammable-boreal-forests-north-america.html>

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