Alaska forests hit with more wildfires, infestations as climate changes

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BONANZA CREEK — It was just getting cool when Glenn Juday went out to see his trees. The leaves were still on the birch and aspen, and the summer growing season was lingering. But it was already October, and gathering data would be much harder once it snowed. So Juday had to hurry.

“I’ll work till dark,” he had declared that morning in his office at the University of Alaska Fairbanks, where he teaches forest ecology. “We’re seriously behind.”

Now Juday was about 20 miles from the university — down the George Parks Highway, across a rutted dirt road and down a worn footpath crossed by the fallen trunks of old white spruce.

He’s been here every year since 1988.

Judy has come to know trees almost like children. He knows, for instance, exactly how old each tree is, how tall and thick it is, how much it has grown over the last year and whether it’s getting pestered by bugs.

This time he came with a graduate student from Germany and a lab technician he had hired.

The lab tech carried a small metal case with papers showing the research plots and the individual white spruce trees in them.

There were 2,200 trees in all.

Judy started in section 2.05 with tree No. 36.

He measured its height — it was tiny — and its circumference at the base, then looked around for signs of a bud-eating insect that’s been showing up more and more in white spruce trees in Interior Alaska.

“This one is budworm free,” he said, not quite believing it.

Judy checked again.

“No, sorry, very light.”

The lab tech wrote down the new figures, and Juday moved on to the next tree.

Judy started his research 20 years ago to unlock the secrets of the boreal forest, as he says. He chose a site in the Bonanza Creek Experimental Forest that had recently burned so that he could track new trees from seedling to maturity. He learned a lot, published papers on his research, and could have stopped at any time.

He didn’t stop, and over the years climate change worked its way into his research and another finding emerged — things are not looking good for white spruce in the Interior.

“We’re in the biggest period of change that has happened in this part of the world for several centuries at least,” Juday said. “No matter what you do, or what interest you have in this part of the world, it’s very likely to be affected.”

Alaska’s forests have looked relatively the same for thousands of years. Tree species shifted in range and elevation as the climate warmed and cooled, but the same species stuck around.

Now the climate is changing again — at least in part because of human-induced climate change — and the forests are responding.

Changes in temperature and precipitation are favoring some species over others, and weather-related threats like wildfires and insect infestations are becoming more common.

According to Juday, the warming is already stressing many Interior trees and could bring them to the limits of their survival within decades.

“It’s not just one species, it’s all species,” he said. “And it’s not just some places, it’s most places.”
Climate change is affecting Alaska’s forests in a number of ways, many of them complex and indirect. But warming temperatures themselves are also affecting forests and are likely to cause the most dramatic impacts in the future.

As the climate warms, Alaska’s trees are expected to gradually shift their ranges to cooler areas but also give way to species more suited to the new climate.

If white spruce start to die in upland areas, deciduous trees could start to take over in Interior forests, says Terry Chapin, a professor of ecology at the University of Alaska Fairbanks.

Some south-facing slopes with lots of sun already resemble the aspen woodlands more common to Saskatchewan and Alberta, and if the warming continues, the forests could eventually become grasslands, according to Chapin.

“The climate is getting closer and closer to what you might expect for grassland,” he said last fall.

According to Juday, the birch and white and black spruce that dominate the boreal forest could all be eliminated from the Interior as the climate warms.

Consider white spruce, the trees Juday monitors at Bonanza Creek. By studying temperature records and tree ring data, as well as his own trees, Juday has figured out how white spruce respond to climatic conditions.

In general, they like it cold and wet. In fact, the colder and wetter, the better. A graph plotting growth against temperature should look something like a bell, with an ideal temperature in the middle and less and less growth if it’s too warm or too cold. But in the 20 years Juday has been keeping track, he’s only seen one side of the bell.

That is, it’s already warmer and drier than ideal.

None of Juday’s trees have died from the heat — most of the trees that have died were killed when standing, fire-killed trees collapsed on them — but in 2004 and 2005, when it was hot and dry for months at a time, some trees came close. Tree growth during those two summers was less than half the long-term average, and, judging by tree ring width, some trees grew about a fifth as much as they would normally.

Black spruce also tend to struggle in the heat, and some birch already seem to be stressed and dying from warm, dry conditions, according to Juday.

If temperatures rise as climate models predict, Juday figures all three boreal forest species could be eliminated from vast portions of the Interior by the end of the century.

“Essentially the trees come to a point where they just won’t grow anymore,” said Val Barber, who studied with Juday and now teaches at the University of Alaska Fairbanks. “We’re actually predicting that our trees aren’t going to be able to make it here in Alaska.”

Other impacts are less direct.

Warming temperatures are degrading permafrost, altering the hydrology over wide areas, and causing some places to get wetter and others to dry out. In the Tanana Flats southwest of Fairbanks, the changes have already killed stands of birch, according to Chapin.

“Those forests have drowned, basically, and are turning into wetlands,” he said.

In the rainforests of Southeast Alaska, scientists are blaming the widespread decline of yellow cedar on a changing climate. During the last century, trees that started growing hundreds of years ago in a cooler climate have been dying across roughly 500,000 acres of coastal rainforest — from north of Sitka to Ketchikan.

In an ironic twist, researchers from UAF and the U.S. Forest Service believe the trees are essentially freezing to death. February and March temperatures have warmed over the last 100 years, but there are just as many late-winter frosts. (Snowfall at low elevations has also decreased in the last 50 years.)

It’s more common now for the air to warm up, melt the snow insulating the ground, and then drop below freezing again. Scientists figure
the thaw-freeze combination is killing the trees by freezing their roots after warm weather has jump-started tree growth.

"It's kind of one of those things you would not have expected," said Paul Hennon, a forest pathologist with the Forest Service.

Wildfires on the way

A week after Jaday went to measure his trees, snow started to fall in the Interior.

On a chilly October morning, Marc Lee drove south from Fairbanks to check on a wildfire mitigation project he was overseeing for the state's Division of Forestry.

He took a detour down a dirt road and studied the landscape. A few houses sat at the top of a valley filled with highly flammable black spruce.

"Those homes are toast, basically," he said.

Lee turned off the road and drove down a hill through patches of white spruce and birch. He parked in a stand of black spruce and walked along an icy trail to a giant clearing in the woods — a fuel break covering 320 acres.

Piles of cut trees crackled with flames, and a tower of gray smoke rose thousands of feet in the air. Two men lit more piles on fire with a giant torch spitting gelled diesel fuel.

Wildfires are a natural part of the ecosystem, and they're common enough in the Interior that they burn just about everything every few hundred years.

But as temperatures have warmed in recent decades, fires have increased in number and intensity, threatening communities and altering ecosystems. Fire seasons are starting earlier in the year, and big fire years are more common.

"Things are changing, there's no doubt about that," said Lee, who's worked for the Division of Forestry for 27 years. "We're seeing it in the fires."

In 2004, fires consumed more than 6 million acres of forests across Interior Alaska, more than in any year since records began in 1950. In 2005, roughly 4 million acres of forests burned, making that year the third worst on record.

Increased fires are already adding to the costs of fighting fires, threatening homes and other infrastructure, and posing health risks for people with respiratory problems.

"It was pretty awful for people with problems," James Conner, the Fairbanks North Star Borough's air quality specialist, said of the thick smoke in 2004 and 2005.

It's hard to pin any specific event on climate change, but warmer temperatures tend to result in more fires. When scientists at UAF studied the factors contributing to big fire years, they found a strong correlation between the area burned in any given year and how and dry the summer was. The number of fires started by people doesn't seem to be a large factor.

The summers of 2004 and 2005 were unusually warm and dry and, according to Lee, never got the rains that normally come in July and August.

As the climate warms, researchers at UAF expect fires to increase in the Interior. Climate models project that Alaska will generally get more precipitation in the future, but warmer temperatures could dry out forests and even tundra by increasing evaporation. Last fall, a rare tundra fire spread across more than 220,000 acres north of the Brooks Range, sending smoke as far north as Barrow.

In part because of the increased fire risk, Lee said, the state is working with the Fairbanks borough on an ambitious wildfire protection plan that involves clearing wide swaths of flammable trees in key locations around the city. The goal is to cut of fires completely or at least allow firefighters a place to get in and fight.

The break Lee checked on was meant to stop fires rolling up the Goldstream Valley toward Fairbanks.

In addition to their direct impacts, wildfires also have the potential to reshape the forests themselves in connection with a warming climate.
In the past, Interior forests have generally grown back in predictable ways after fires.

Willow, alder, and poplar dominate at first, then birch and aspen, and finally, in upland areas, white spruce. In cold and wet areas, the forest might go straight from willow to black spruce.

But now that process is changing. Fires are burning hotter, destroying organic matter in the soils and thawing permafrost deep into the ground. According to Chapin, a burn area might come back as birch or aspen and transition very slowly — or not at all — to white or black spruce.

"The plant succession is different from what we might have expected 10 or 20 years ago," he said.

A race against bugs

Juday grabbed the branch of a small white spruce near his research plot and studied the tip. It was brown, and bits of debris were nestled in the needles — budworm.

Spruce budworm caterpillars spin silken nests in tree needles in the summer and come out the next spring, Juday explained. If the spring is cool, the tree buds have a good chance to grow before the caterpillars emerge. If it’s warm, the caterpillars will hatch early and eat the buds, stunting the tree’s growth.

"It’s a race," Juday said. "And that race is controlled by temperature — when it’s warm, the insect wins."

Spruce budworm is just one of the insects affecting Alaska’s forests. Spruce bark beetles and engraver beetles also attack spruce trees; leaf miners feed on aspen and birch.

Each insect has its own life cycle and preferred host tree, but scientists say many of the bugs are already doing more damage as temperatures rise and will likely have a bigger and bigger impact in the future.

Warmer temperatures allow the insects to thrive while also stressing trees, making them more susceptible to damage.

The most devastating of the insects so far has been the spruce bark beetle.

Between 1989 and 2002, bark beetles killed white, Sitka, and Lutz (a cross between white and Sitka) spruce trees across more than 3 million acres in Southcentral Alaska, including roughly half of the forested land on the Kenai Peninsula.

It was the biggest single insect infestation recorded in North America until scientists this year documented an even larger outbreak of pine beetle in British Columbia.

Ed Berg, who has worked as the Kenai National Wildlife Refuge’s ecologist for the last 15 years, studied the outbreak on the Kenai. By looking at past outbreaks, he found that beetles thrived when the average summer temperature stayed above 51 degrees Fahrenheit for two or more years in a row. (The warmer temperatures can shorten the beetles’ life cycle from two years to one.)

Before the outbreak in the late 1980s, warm summers were typically offset by cool summers, keeping the outbreaks in check, he said recently. But starting in 1987, summer temperatures went into “overdrive” and stayed warm for 11 years in a row.

"Basically the beetles just kept building until they ate themselves out of house and home," Berg said. "We’ve had warm summers since then, but there’s not much for the beetles to eat."

In recent years, beetles have infested trees on the Kenai Peninsula that were too young and small during the main outbreak but have since matured. In 2006, beetles attacked tens of thousands of acres in Katmai National Park & Preserve in Southwest Alaska.

Other insects are affecting forests in the Interior.

Infestations of aspen leaf miner were hardly noticeable before 1999 but have ballooned in recent years. In 2005, insects affected aspen trees across more than 650,000 acres of Interior forests, according to the state’s Division of Forestry. In some cases, the bugs contributed to the death of trees already stressed by warm and dry conditions.

An outbreak of spruce budworm in the early 1990s defoliated trees across roughly 280,000 acres of forest along the Tanana and Yukon rivers.
The outbreak died down, but the insects returned.

In 2006, the bugs were “horrendous,” Juday said. Aerial surveys showed damage along ridges near Fairbanks — the Nenana, Parks, and Chena Ridges — and in the northern foothills of the Alaska Range. The outbreaks were so bad they spilled over from white spruce to black spruce.

Last year, budworm showed up in the spruce around Juday’s house.

A changing ecosystem

The extent to which climate change affects Alaska’s forests will depend on how fast things change and how various impacts play out together.

While disturbances like fires and bugs are a natural part of the ecosystem, a dramatic increase in the extent of those disturbances could overwhelm existing species, according to Juday. Black spruce forests could turn to white spruce, or lodgepole pine could extend into Alaska.

More severe fires could also change which trees grow in a given area, and severe droughts could make trees more susceptible to insect damage. Invasive plants and insects could pose additional threats to the species here now.

Judy is still trying to figure out exactly what climate change will mean for his 2,200 white spruce trees.

The tallest spruce in the plots is about 25 feet, and countless birch already rise well above that height.

Fifty years ago, the white spruce almost certainly would have won out on this south-facing hillside above the Tanana River.

But things are different now, and Juday figures the birch could possibly win out this time.

In 2007, Juday’s trees did OK. Tree growth wasn’t back to normal, but the trees were recovering from the warm summers of 2004 and 2005, thanks in part to cool weather in 2006. Most trees had some sign of budworm, but the insect damage was less than the year before.

Judy crawled under the bows of one of his bushier trees. He wrapped a special tape measure around its trunk — converting from circumference to diameter — and called out numbers to his lab tech.

The trees’ fate wouldn’t be clear for years or decades, and Juday had work to do now.

He climbed over thick logs of white spruce felled by the fire 30 years ago and measured another tree. There were still well more than 1,000 to go, and winter was coming.

Tomorrow: Permafrost changes and impacts on infrastructure and the natural environment.