THE SACRAMENTO BEE sacbee.com

Sierra Nevada climate changes feed monster, forest-devouring fires

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Published Sunday, Nov. 30, 2008

Driving home from Lake Tahoe, Leah Wills watched the column of ash-gray smoke from the Moonlight fire grow and grow – until finally she was under it.

Overhead, the sky that September afternoon in 2007 turned eerie pink. Orange-red flecks of burning bark streaked like missiles through the air. And the smoke – eye-watering and acrid – was inescapable.

"It was like a nuclear cloud," said Wills, 59, a policy analyst for the Plumas County Flood Control District who lives near the tiny hamlet of Genesee. "I've been to Denali and Kilimanjaro. I grew up with tornadoes. I've seen some big things. I never saw anything that big in my life."

Wildfire has marched across the West for centuries. But no longer are major conflagrations fueled simply by heavy brush and timber. Now climate change is stoking the flames higher and hotter, too.

That view, common among firefighters, is reflected in new studies that tie changing patterns of heat and moisture in the western United States to an unprecedented rash of costly and destructive wildfires.

Among other things, researchers have found the frequency of wildfire increased fourfold – and the terrain burned expanded sixfold – as summers grew longer and hotter over the past two decades.

The fire season now stretches out 78 days longer than it did during the 1970s and '80s. And, on average, large fires burn for more than a month, compared with just a week a generation ago.

Scientists also have discovered that in many places, nothing signals a bad fire year like a short winter and an early snowmelt. Overall, 72 percent of the land scorched across the West from 1987 to 2003 burned in early snowmelt years.

Across the Sierra, satellite imagery shows that today's wildfires are far more destructive than fires of the past, leaving larger portions of the burned landscape looking like nuclear blast zones. That searing intensity, in turn, is threatening water quality, wildlife habitat, rural and resort communities and firefighter lives.

As the climate warms, the ability of the region's mixed conifer forest ecosystem to recover from these destructive fires is in danger.

"We're getting into a place where we are almost having a perfect storm" for wildfire, said Jay Miller, a U.S. Forest Service researcher and lead author of a recent paper published in the scientific journal Ecosystems linking climate change to the more severe fires in the Sierra.

"We have increased fuels, but this changing climate is adding an additional stress on the whole

situation," Miller said. "When things get bad, things will get much worse."

Longer, more intense fire seasons

That future may already have arrived. This year, the fire season got off to an early June start in the north state and only recently came to a close. Statewide, 1.4 million acres burned in 2008, just shy of last year's 1.5 million acres, the highest total in at least four decades.

"When I started fighting fire, the normal fire season was from the beginning of June to the end of September," said Pete Duncan, a fuels management officer for the Plumas National Forest. "Now we are bringing crews on in the middle of April and they are working into November and December."

"And we're seeing fires now burning in areas that normally we wouldn't consider a high-intensity burn situation."

Just a few weeks ago, Duncan heard about one such incident: the Panther fire on the Klamath National Forest near the Oregon border.

"It made an eight-mile run one afternoon, in late October. It burned through an area of fairly high elevation old-growth timber and at very high severity," Duncan said.

"I was kind of amazed," he added, "that something would have burned to that scale. To make a 40,000-acre run in an afternoon is significant for any time of year – but particularly for that time of year."

The Moonlight fire, which burned across the Plumas National Forest and timber industry land north of Quincy, was one of the most environmentally destructive in recent memory.

Vast stands of trees exploded into flame like matchsticks, including forest set aside to protect spotted owls. Smoke spread across Northern California and drifted as far south as Bakersfield. In all, six of 10 acres were burned so badly that in many places few living trees remain.

The global climate suffered, too. In two weeks, the fire pumped an estimated 5 million tons of carbon dioxide into the air, equivalent to the annual emissions of 970,000 vehicles or one coal-fired power plant.

"The intensity of the fire was pretty spectacular," said Bill Molumby, the incident commander who directed firefighting forces on the Moonlight and has battled many of California's biggest blazes over the past 35 years.

"Looking at everything I've seen, there appears to be an increase in fires, year-round fire, large fires," Molumby said. "It has to definitely be weather-affected, somehow."

The Moonlight fire even incinerated the soil, leaving stair-steep mountain slopes barren and prone to erosion. With no natural seed source across wide swaths of terrain, the future of the mixed conifer forest is in doubt; many fear it could morph into brush, stands of deciduous oak, even desert.

"I don't envision sand dunes like the Sahara," said Mike Yost, a retired forestry professor from Taylorsville. "But I can envision places where there aren't going to be forests again in many human lifetimes and in some places, maybe never."

Today, in fact, the region is the focus of the largest federal reforestation effort in Sierra Nevada history. Over the next two years, 3.4 million seedlings will be planted across 37 square miles – but climate change is sowing uncertainty about that, too.

"You will always be left wondering: Is the tree I am planting today going to be able to survive the climate of the future?" said Mike Landram, reforestation manager for the Forest Service in California. "That will be a lingering question."

Fire roars through 'a sick forest'

One thing Landram doesn't want is a forest like the one that burned, an incendiary thicket of pine,

fir, cedar and oak that had grown unnaturally dense during a century of fire suppression.

Such overcrowded stands are common in the Sierra, and walking through them can be a challenge. Where John Muir once strolled through parklike groves of 50 to 60 large, stately conifers per acre, hikers today find shadowy tangles of sun-starved trees, some no wider than a fence post, at densities of more than 350 trees per acre. The forest floor – littered with dead limbs, logs and spiky branches – resembles a giant game of pick-up sticks.

This month, John Shower – a retiree whose home was nearly destroyed by the Moonlight fire – visited the burned area. "This is where I used to run, mountain bike and bird watch," Shower said. From the back seat of a passenger car, he stared out at an enormous snarl of dead trees the color of charcoal. "Look! These trees are barely two to five feet apart. Look how spindly they are," Shower said. "This right here is a sick forest."

Mike Kossow, a friend riding in the front seat, corrected him. "It was a sick forest," he said.

While such conditions are a major reason why fires burn so hot, they are not the only variable. Strong winds, steep terrain and low humidity all push flames into a frenzy as well. Now there is another brick in the oven: the changing climate.

One of the first to make the link was Anthony Westerling, an assistant professor at UC Merced whose 2006 paper in Science magazine found fires grow more unruly in years when the mountain snowpack melts early.

"An early spring means you're going to have a longer fire season (and) drier vegetation," Westerling said at a conference in Sacramento earlier this year. "On the other hand, when it's a late spring, you never get a big fire year."

Last year's Moonlight fire fits the pattern. The snow melted early in 2007. Precipitation was well below average, and the fuel moisture content of the forest was at or near historic lows by the end of August.

"When we moved here in 1980, the snow stayed around through August," said Shirley Kossow, who lives along Indian Creek near Genesee with her husband, Mike. "In the 1990s, it was gone by the Fourth of July. Now, it doesn't make it to the end of May."

The fire, which began in early September on private land, spread quickly to the Plumas National Forest. Fanned by gusty winds, it burned with uncommon fury, roaring down canyons, leaping over ridges and startling all who saw it.

Most impressive were the embers of flaming debris – clinkers, as firefighters call them – that streaked through the ash-filled sky, kindling new "spot fires" miles from the main fire front.

Even after dark, when fires normally calm down, the Moonlight continued to rage.

"There was this eerie red glow, all night long," said Yost, the retired forestry professor who manned a fire station near the inferno one evening. "You could hear trees crashing down. It was a spooky night."

In many areas, little was spared. Even cool, north-facing slopes were toasted. So were majestic stands of old-growth that had survived centuries of less intense fire.

"I've never seen such large patches taken out," said Duncan, the Plumas fuels manager. "In some areas, it burned so hot and so long it killed trees from the sheer heat on the cambium. It basically cooked the trees.

"Even though the trees looked like they survived because they had needles on them, within a year, they were dead."

Natural regeneration difficult

After the fire, satellite imagery showed the fire had burned 102 square miles, making it the largest blow-up in Plumas County history. But they also revealed something more troubling: 62 percent of

the overall fire burned at high severity, a term scientists use to describe a stand-destroying fire.

"I can't go up there without crying," said Wills. "That used to be my backyard. Everybody is depressed. It's just nuked."

Historically, fires in Sierra mixed conifer forests skipped lightly across the landscape. They singed some areas, scorched others, but most of the forest remained healthy. Only five to 10 percent burned at high severity, said Hugh Safford, regional ecologist with the U.S. Forest Service who works in Davis.

Now, that number is climbing, up from 17 percent two decades ago to 28 percent for the period from 1997 to 2006. In 2007, it soared to 60 percent. "Last year was the most severe fire year we've seen since the beginning of Landsat (satellite) imagery" in 1984, Safford said. "It was astounding. Things burned really, really hot."

Safford is one of the authors of the paper in Ecosystems that ties more high-severity fire to climatic changes, including less snowy springs and rising summer nighttime temperatures. Earlier this month, he tromped around the blackened aftermath of the 2007 Angora fire at Lake Tahoe, which burned at 52 percent high severity and destroyed 254 homes.

"There were large areas where every needle got burned right off those trees," he said. "There isn't anything to cover the soil when the rainy season hits."

Two days before his visit, rain fell. "The streams were running brown," Safford said.

Increasingly, people are at risk, too. "Look at the subdivisions in the Angora drainage," Safford said. "Fire wasn't on anybody's minds when they built those homes. It wasn't even a consideration because we put everything out.

"And now, with climate getting warmer and the forest becoming denser, I think we're at a position where it's really becoming a critical problem."

For many, though, it's the future of the mixed conifer landscape that is most worrisome – in part because of its remarkable ability to soak up large quantities of carbon dioxide, the atmospheric gas most responsible for global warming.

As Westerling wrote in Science in 2006:

"An increased frequency of large fires will lead to changes in forest composition and reduced tree densities, thus affecting carbon (storage).

"Current estimates indicate that western forests are responsible for 20 to 40 percent of total U.S. carbon sequestration. If wildfire trends continue … the forests may become a source of increased atmospheric carbon dioxide rather than a (reservoir)."

With fires burning hotter and temperatures rising, though, there is no guarantee conifer forests will remain evergreen.

Makeup of forests changing

Already, parts of the northern Sierra that once grew pine now sprout more grass and deciduous black oak – a possible early warning sign of climate change. In places, whitethorn, manzanita and other native brush species – which bounce back rapidly after a fire and shade out sun-loving pines – are expanding over large swaths of terrain.

In the Moonlight's wake, brush is now starting to spread across the blackened slopes. Indeed, on large swaths of private land inside the fire zone, adjacent to national forest land, a private timber company is spraying herbicides by helicopter this fall to kill it.

"Maybe in the drying climate, it doesn't come back as forest," Wills said. "Maybe the Great Basin desert, which is mainly grassland and sage, is moving west."

Malcolm North, a research scientist with the Forest Service's Sierra Nevada Research Center, said

the Moonlight's intensity created "seed source" problems.

"When you have the nearest live trees a mile, two, even three miles from the center of the burn area, it's unlikely that you are going to get seed back in there," North said.

Solving that problem will take human assistance, said Landram, the Forest Service reforestation manager – and a herculean effort.

Next spring, crews hired by the Forest Service will fan out across the rugged terrain, planting 1.7 million trees across 12,000 acres. In 2010, they will do it again, all by hand. Every speck of brush near each seedling will be scraped away, again by hand, because herbicides are not allowed in the forest.

In a break from tradition, the work will be funded not by logging burned trees, which creates conflict and slows planting, but with federal funds and donations from groups such as the Arbor Day Foundation and American Forests.

"There is a fairly narrow window of opportunity after the fire where we can take action," Landram said. "We are not going to wait."

Landram is confident it will work. But he acknowledged the Forest Service has not adjusted the mix of conifer species it will plant to accommodate a warming Sierra.

"We are at the beginning of understanding what the right thing to do will be," he said. "We are trying to understand the research. And we are at the very beginning of that."

Playing catch-up with climate change could prove risky. "If you end up with a couple of dry years – which is probably going to happen more commonly with climate change – you could lose 80 to 90 percent of your stock," North said.

Successful or not, he feels the region will remain wooded, probably with a different mix of conifers – in particular more white fir, incense cedar and other species that can more readily grow up beneath the heavy shade of brush fields.

Climate, however, will make the final call.

"There are so many different factors at play," North said. "It's very difficult to predict what plant and forest communities are going to look like in the future.

"To quote 'Star Trek,' we are going where no man has gone before – where no plant community has gone before."

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