How restoring old-growth forest in Washington state could help fight climate change

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Standing between nearly uniform rows of hemlock trees, scientist Tiara Moore clutched a tiny vial of evidence.

Filled with dirt and no bigger than her pinkie finger, the vial contained traces of hundreds, perhaps even thousands of creatures that had oozed by, crawled past or fluttered into this tiny corner of the Ellsworth Creek Preserve.

The microscopic flecks of DNA—from insects, amoebas and mushrooms—could help tell the story of a forest trying to regrow to its former might.

These forest forensics, part of a fast-growing field called environmental DNA, will tell researchers what's living here, which, in turn, tells forest managers if what they're doing is working here.

The soil where Moore dug for DNA was once rooted with old-growth trees common across the coastal Northwest, before decades of clear-cutting stripped them from the land.

Restoring landscapes like these helps take up and store more carbon, part of the solution to reduce the impacts of climate change.

The Nature Conservancy, a nonprofit which owns about 8,000 acres at Ellsworth, hopes Moore's work can help in pursuit of a longtime Northwest quest: to restore its old-growth forests—rich with biodiversity—and fast.

"These are some of the most carbon-rich systems on Earth," said David Rolph, director of land conservation for the organization in Washington. "Could we rebuild?"

The project began in 1999, when The Nature Conservancy sealed a $1.2 million deal for Teal Slough, a 338-acre property with some of Southwest Washington's last coastal old-growth.

Over two decades, the nonprofit began to shape an ambition: to protect in its entirety, the nearby watershed, which had been "hosed over pretty well," said Michael Case, a forest ecologist with the nonprofit.

The nonprofit spent about $20 million on a smattering of parcels from logging companies. The conservancy now owns nearly every piece of land draining into Ellsworth Creek.

Steelhead trout, coho salmon and chum salmon swim the forest's streams, according to a 2009 survey. The threatened and hard-to-find marbled murrelet, a seabird that relies on coastal old-growth to make nests, likely inhabits mature pockets of forest. On an early September day, elk wandered the gravel roads. Bear and coyote scat fertilized the understory.

In 2004, The Nature Conservancy convened scientists to scheme up restoration strategies. Only a few patches of old-growth remained at Ellsworth, leaving uneven swaths of young forest, often seeded with rows of a single species. Abandoned logging roads threatened to give way to landslides.

The scientists decided to experiment with three forest management regimes.

In areas of active management, they decided to improve roads and commercially thin forests by about 30%, leaving "skips and gaps," Rolph said. Loggers were directed to prioritize species diversity, leaving less common cedars and spruces, for firs or hemlock.

Passive management areas would see roads removed, but no thinning. Control areas would be treated similarly, but roads would remain.

The conservancy's theory—backed by years of Northwest forest science—was that thinning and mimicking nature would create a more complex, vibrant forest with a diversity of species, more light for trees and less competition among them for nutrients.

"Any modeling you do will show you get bigger trees faster with thinning," Rolph said. "You can manipulate and accelerate that complexity."

The larger the tree, the more carbon can be absorbed and stored, making old-growth forests a boon to mitigating climate change.

"It's a fairly simple relationship. About half of the mass of the tree is carbon," said Malcolm North, a U.S. Forest Service research scientist who runs a lab at the University of California at Davis. "As trees get older, they actually grow as fast and faster than they used to. Because of their size, they pack carbon on at a much faster rate than a young forest."

About that word—fast.

A walk through Ellsworth's remaining old-growth, where cedars the width of Smart cars tower above, yields perspective.

No doubt: Size matters, for carbon uptake.

And in a rapidly warming climate, speed matters.

But what makes old-growth trees so special, and valuable in mitigating climate change, is their ability to persist.

The titans of perseverance at Ellsworth have weathered perhaps 800 years of traumas—droughts, pests and windstorms.

Their candelabra tops, like gnarled hands reaching to the heavens, show where leading branches have died only to see another upstart lead the skyward charge. Salal and huckleberry plants are rooted on branches several dozen feet off the ground.

The forest growing today must be prepared for hardship later.

"It has to be a resilient landscape. Not what it looked like 150 years ago. It has to be resilient to climate change," Case said.

Younger trees are more prone to drought and fire, North said.

"If you're trying to think of carbon as a financial investment, your junk bonds are kind of the small trees. You really want to focus your investment on gold, the Muni bonds, the big, old trees," he said.

For carbon, old-growth is a safer vault.

It's a daunting task for the young trees at Ellsworth. Their predecessors took centuries to grow. Now, humans want to spur them along—bigger, faster and more resilient—in a warmer world. Their performance is tested.

At the University of Washington's environmental genomics lab, Tiara Moore, the postdoctoral research associate at the University of Washington and The Nature Conservancy, held a pipette to her 259th Ellsworth soil sample and gingerly dropped in a solution.

Moore would spend her morning breaking cells down and whittling soil away from DNA by adding a series of chemicals, repeatedly spinning the samples in a centrifuge at 10,000 times the force of gravity and occasionally incubating them in a fridge.

Each sample, which corresponds to a specific tree on plots being studied by researchers, began as a rich espresso color, then faded to a latte shade before turning transparent.

"Now, it's just a bunch of fragments of DNA," Moore said.

Later, the DNA will be copied and amplified in a process called Polymerase chain reaction. Then, it's sent to a genomic sequencer.

That analysis will identify hundreds, if not thousands, of creatures who left pieces of themselves behind in the soil in roughly a week's time.

Environmental DNA, a monitoring technique developed about a decade ago, is growing "exponentially" in use, said Katherine Strickler, a research scientist and instructor at Washington State University.

It allows scientists to catalog entire communities, or "the richness of life in a given spot," said Case, the forest ecologist.

Moore hopes the data can explain which forest management style best promotes biodiversity. In samples of deeper earth, she's looking for signs of soil health, like the presence of symbiotic fungi, bacteria or microbial DNA.

"With the clear-cuts, there's so much disturbance to the soil community. That can take a while to establish," she said.

Meanwhile, Case is measuring tree width, density and canopy thickness on the test plots, along with other data. The plots were first measured more than a decade ago, so the data will show growth over time. Also, research planes in 2007 and 2017 flew over the property with Lidar technology, which beams laser light at the earth surface to create three-dimensional models.

Combining Case's forestry measurements with the Lidar models will determine how much carbon the forest is storing and could indicate which forest management method produces more biomass.

The researchers expect to finish collecting, processing and analyzing this winter.

No matter how urgent our warming world makes forest restoration projects like this seem, the trees at Ellsworth won't reach their former bulk for several human lifetimes.

But, with today's science, "we can tap in to see if what we're doing is working," Moore said.

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