

# The Press Democrat

**DNA mapping will include Sonoma County redwoods as hedge to climate change**



**(1 of 4)** David Barnes, visiting from Ohio, takes in the 1400-year-old Colonel Armstrong redwood tree in Armstrong Woods State Natural Reserve, near Guerneville on Thursday, September 28, 2017. (Christopher Chung/ The Press Democrat)

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New technology is coming to the aid of the world's tallest trees, the coast redwoods that blanket Sonoma County hills and date back to the time of dinosaurs.

Climate change has not yet impacted the most iconic of California trees, which live for centuries and in some cases millennia, sheathed in soft, thick reddish bark that shields them from fire and insect damage.

The forest giants are thriving. Despite the rampant logging that for 150 years swept over their historic range having been virtually eliminated, organizations that protect and manage thousands of acres of redwoods in Sonoma County and the North Coast are looking for ways to fortify them against the anticipated stress of rising temperatures.

One answer may be deeply embedded in the trees themselves.

The Save the Redwoods League, a San Francisco-based nonprofit that has helped protect nearly 200,000 acres of forestland in more than 60 parks and preserves, is now betting \$2.6 million on a 5-year project to unravel the remarkably complex DNA of the redwoods, and ultimately gain new tools for their conservation.

“The Redwood Genome Project is our opportunity to apply the world’s most cutting-edge science to save the redwoods for the next century,” said Emily Burns, the league’s director of science. “With genetic insight at our disposal, we will be able to enhance protection for the world’s most beloved trees.”

Already underway, the project has begun teasing out the genetic code of a redwood from Butano State Park in San Mateo County. The code, expressed in the DNA of every living cell, amounts to a “parts list” for the entire organism, said David Neale, a UC Davis professor of plant genetics who is project partner.

Redwoods, like humans, share a basic genetic code, but no two are exactly alike due to naturally occurring DNA mutations that produce traits, such as hair and eye color in humans, and in redwoods resistance to drought or capacity for fast growth.

The project’s ultimate goal is to recognize the genetic diversity within a redwood forest, founded on the premise that greater diversity affords it a better chance of long-term survival, Burns said.

“We are trying to re-create the attributes of old-growth forests,” she said.

## Coast redwoods

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The world’s tallest living things, redwoods reach up to 380 feet, higher than a 30-floor skyscraper, and also are among the oldest with a lifespan that can exceed 2,500 years. Redwood fossils date back more than 200 million years to the Jurassic period, when giant reptiles roamed the earth.

The tallest tree at Armstrong Redwoods State Natural Preserve in Guerneville is 310 feet tall; the oldest more than 14 centuries old.

Prior to the Gold Rush, redwoods grew on 2 million acres or more on the West Coast; today only 5 percent of old-growth redwood forest remains, covering just 120,000 acres in a 450-mile coastal strip from southern Oregon to central California, with about 75 percent of it protected in parks and reserves. Redwood forests of mostly young trees cover 1.6 million acres, about the size of Sonoma and Napa counties combined, and less than one-third of it protected.

For more information on the Redwood Genome Project and the location of redwood parks, click [here](#).

That's necessary because nature, and more recently humans, have been harsh on redwoods, which are descended from cone-bearing trees that flourished more than 200 million years ago when dinosaurs roamed the planet. In a warmer, more humid climate, redwood species grew throughout North America, Europe and Asia.

#### Acreage has dwindled

Successive ice ages narrowed redwoods to small regions, with coast redwoods on a 450-mile stretch of the West Coast from southern Oregon to central California and giant sequoia, the world's most massive tree, on the west slope of the Sierra Nevada. Both are found nowhere else in the world.

There were 2 million acres of redwoods on the coast until the mid-19th century California Gold Rush exploded the demand for timber and subsequent waves of clear-cutting eliminated 95 percent of the old-growth forests. Only 120,000 acres of ancient forest remain, about 75 percent of it protected in parks and preserves.

Armstrong Redwoods State Natural Preserve in Guerneville and the Grove of Old Trees at Occidental are among the places where people can stroll among the old giants.

Save the Redwoods League, founded in 1918, has poured hundreds of millions of dollars into saving the trees through buying protective easements and outright purchases of land.

Since 1991, the nonprofit has contributed to protection of nearly 11,000 acres in Sonoma County, including property that became part of Fort Ross State Historic Park and the 5,630-acre Jenner Headlands Preserve, scheduled to be opened to the public next spring.

They have been a great partner," said Bill Keene, general manager of the Sonoma County Agricultural Preservation and Open Space District, which put \$10 million toward the \$36 million purchase price of the Jenner Headlands, the largest single land conservation deal by dollar amount in county history.

#### Preservation and restoration

The league played a key role, putting down \$8 million to close the deal, and was subsequently repaid with state bond funds, Keene said. The county's tax-funded open space agency looks forward to future deals with the league, he said.

"There's a lot of redwood left to be protected," Keene said.

The Conservation Fund, a Virginia-based nonprofit also concerned about the onset of climate change, is embarking on a massive restoration effort of its 75,000-acre forest holding in Sonoma and Mendocino counties, and has eyes on the genome project, since most of the forestland has been clear-cut twice.

"We're trying to understand how to restore these forest types in a changing environment," said Chris Kelly, the fund's California program director. "Any additional information we can get on the species is going to be valuable."

The fund's holdings also include the former Preservation Ranch, a 20,000-acre tract near Annapolis once targeted for vineyard development.



It took a scientific breakthrough to set the genome project in motion.

The human genome was mapped in 2000, the result of a \$3 billion international research project funded by the U.S. government, opening a vast new approach to medical research and treatment.

But the technology didn't readily apply to redwoods, which have a genome 10 times larger than humans, said Neale, who has worked on forest genetics for 40 years and had already mapped the DNA for simpler species, such as Douglas fir and sugar pine.

Mapping the redwood genome would have cost as much as \$500 million, he said.

Gene map to take 5 years

But in 2010, a new generation of gene-mapping technologies curbed the cost, providing what he called "a game-changer for all of biology." Four years later, Neale proved it would work on redwoods.

The Save the Redwoods League is pursuing donations from individuals and foundations for the genome project, which will not have any government funding.



**(2 of 4)** Jeanne Vonachen, left, and Scott Miller, both visiting from Wisconsin, take a walk through Armstrong Woods State Natural Reserve, near Guerneville on Thursday, September 28, 2017. (Christopher Chung/ The Press Democrat)

The DNA code for the Butano Park tree should be complete next year, and the project team — which also includes a Johns Hopkins University group — plans to tackle 10 more redwoods from various areas in 2018, as well.

The project will also unravel DNA from giant sequoias weighing more than 600 tons. Sequoias can live 3,000 years, protected by thick bark like redwoods but also potentially vulnerable to climate change.

The league's ultimate goal of the 5-year-project is to produce tools that can assess the genetic diversity of redwood forests, informing conservation strategies.

For example, a forest found to have high levels of diversity would become a "top priority for protection" and possible acquisition if it were privately owned, Burns said.

And when DNA maps for an organism are produced, scientists tend to pay attention.

Burns said she's anticipating a "redwood scientific renaissance" with researchers around the world working to "discover the secrets of the redwood genome."

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