By Karen L. Monsen | Photo Credit: Karen L. Monsen

Shakespeare's line in The Tempest, "What is past is prologue," implies that history sets the stage for the future as a prologue does to a play. As climate scientists use historical data for predictive weather modeling, fire ecologists and researchers in Arizona, Nevada, and Utah are tapping tree-ring data to monitor forest health, anticipate climate changes, and understand relationships between climate and forest fires.

The first tree-ring lab was established in 1937 at The University of Arizona in Tucson (Lab for Tree Ring Research [LTRR] http://ltrr.arizona.edu/). The LTRR includes hundreds of thousands of samples—some from a bristlecone tree named Methuselah, the oldest confirmed living tree, and a cross-cut of the bristlecone called Prometheus, which was felled in 1964 and subsequently identified as the oldest known tree at over 4,900 years.

Following the invention of the increment borer in the 1880s, tree ring data has been accessible without cutting down trees. The increment borer, a hollow steel pipe with a sharp edge and screw thread that digs into the tree trunk as the operator pushes and turns, removes a wood cylinder from which researchers can study the rings. The most common bore diameter is only 1/5-inch, and therefore removing that small amount of material does not harm the tree.

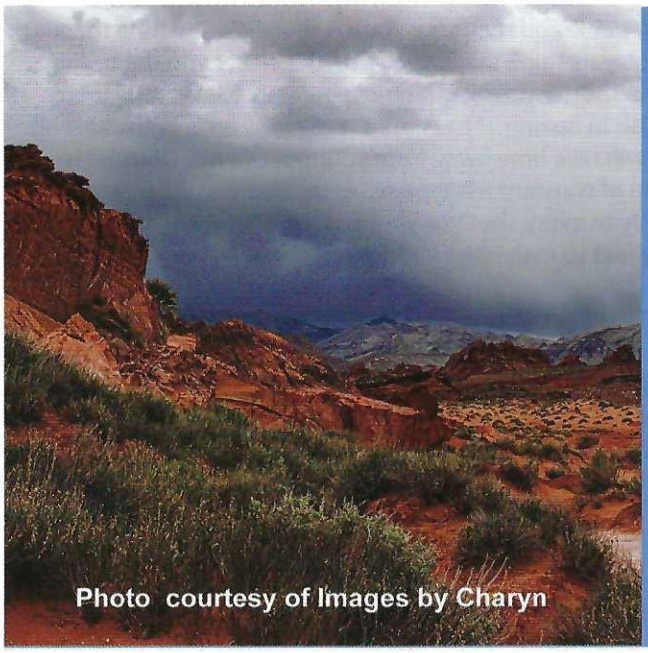


Photo courtesy of Images by Charyn

Great Basin

Great Basin National Park in Nevada, with varied microclimates, alpine lakes, rock glaciers, and long-lived bristlecone pines, stands out in tree-ring research. Every summer since 2007, faculty, staff, and students from Ohio State University have visited Great Basin to conduct research on paleoclimate, climate change, alpine glacial and hydrologic processes, and climate of montane environments.

In 2019, senior researcher James DeGrand from Ohio State University and Dr. David Porinchu of the University of Georgia were in Great Basin extracting limber pine core samples as an outgrowth of paleoclimate work on fire frequency and intensity. DeGrand teaches courses on weather, climate, biogeography, and microclimate instrumentation; he is an assistant state climatologist for Ohio; and is involved in climate monitoring, awareness, and literacy.

De Grand explains that trees like conifers, pines, spruces, and firs are preferred for dendrochronology studies in the U.S. Southwest because they produce annual growth rings—distinctive lines at the end of one growth season (latewood) and the beginning of the next growth (earlywood). Tropical species, growing year-round without dormant periods, do not form distinctive rings. Hardwoods, including deciduous trees like maples, oaks, and beeches with complex wood anatomy, are also used in dendro-studies, especially in Europe.

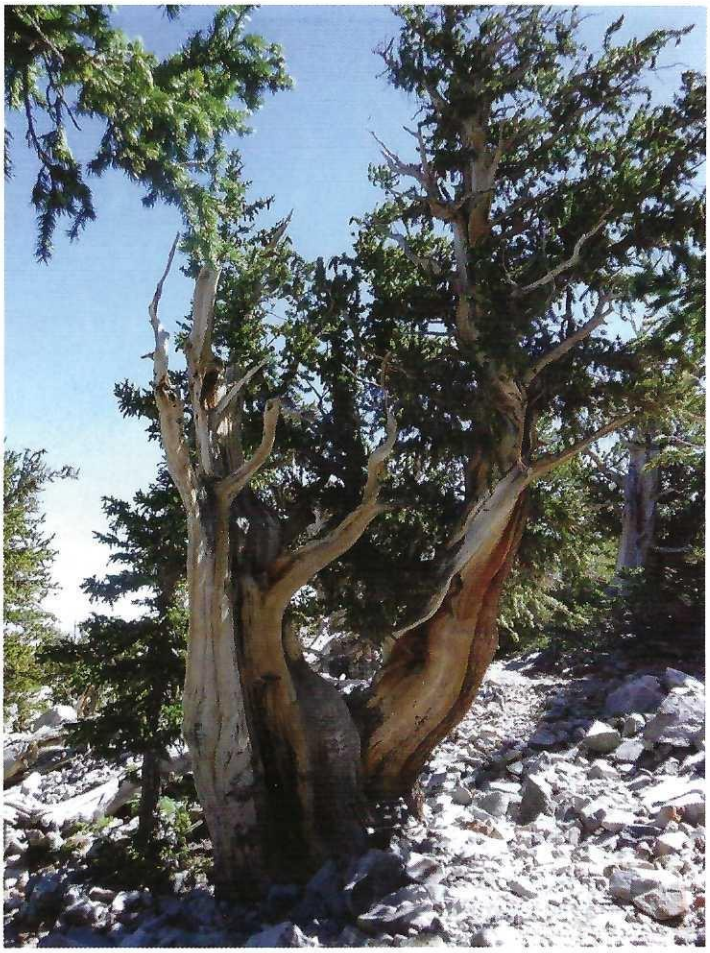
Bristlecone longevity, along with its resistance to insect attacks and the fire-resistant qualities of ponderosa and sugar pines, make them Lords of the Rings in the southwest U.S. and ideal for tree-ring research. Rings record the tree's life history: wider rings represent rapid growth, narrow rings indicate slow growth, and scars mark the frequency and seasonality of forest fires. Generally, ring width is the sum of precipitation, growing season length, genetics, micro-site, and other variations.

DeGrand and Porinchu were taking limber pine samples to corroborate lake sediment findings that suggested the likelihood of a large stand-replacing fire approximately 700 years ago. Recognizing that limber pines can live 1,000 years, core samples near the lake revealing only trees younger than 700 years would support the probability of such a fire.

Fire Ecology

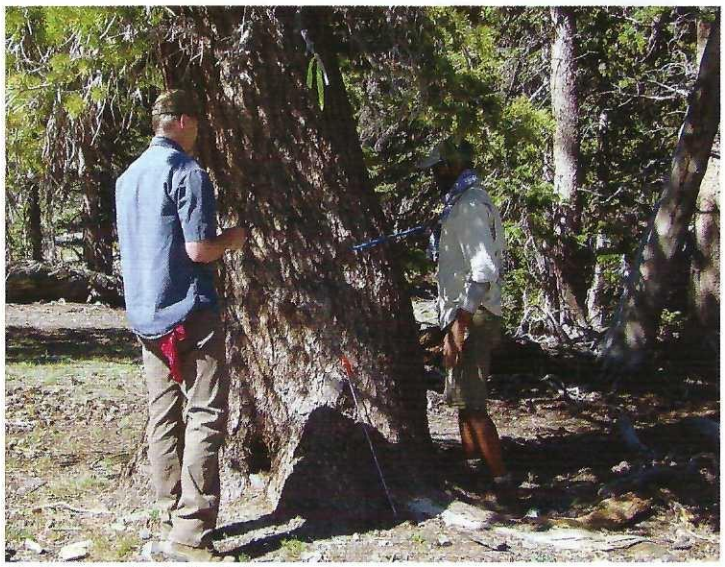
With many subfields, dendrochronology is essentially about finding patterns. Fire Ecologist Brian Van Winkle describes the most important part of his work as "determining the historic range of variability with respect to the fire environment." Van Winkle began working for the Forest Service in 2003 and has worked with Dixie and Fishlake National Forests in Utah since 2014. He is responsible for collecting and analyzing fire data and working with interdisciplinary teams on returning fire to the ecosystem, modeling fire behavior, determining approximate historic fire effects, and liaising with researchers.

Using reconstructions, researchers have determined that the ponderosa ecosystem in Southern Utah experienced fire every 5-10 years, whereas spruce-fir forests went hundreds of years between intense stand-replacing fires.



Bristlecone Pine

Tree Cross Section Yosemite National Park



DeGrand and Porinchu Taking Core Samples

Limber Pine Core Sample

Forest Service Work

Annually, the Forest Service hosts numerous internal dendrochronological studies and collaborates with researchers on dozens of others. Nationwide collaborations have even included working with archaeologists to date pre-Anglo settlements.

Van Winkle will be working with Forest staff in 2020 to develop visitor center interpretative displays and giving local school presentations. Anticipated projects include determining pinyon jay habitat suitability, drought-snow pack relationships, fire-insect-drought synergism, stream-flow reconstructions, as well as cutting-edge spectral analyses on latewood density correlating it to temperatures during the tree's growth. This research will be one of the first direct temperature reconstructions done in the western U.S. and among the first in the world.

Stella Lake, Great Basin National Park

Future Focus

DeGrand hopes his research findings will be useful in managing public lands and understanding dynamic relationships between climate and fire. He emphasizes, "Our current level of understanding in ecology and climatology is incomplete. Anything that gives us insight into climates of the past or past interactions between important species in an ecosystem will help us understand the complexity of the natural world, how our actions affect the environment, and things we might do to lessen the negative impacts we might have on the environment."

Fire ecologist Van Winkle maintains a pragmatic view, "Whereas dendrochronology is not a panacea, it has been extremely useful in informing our management/stewardship of the National Forests."

Through decoding tree rings, researchers and land managers increase our understanding of the relationships between climate, ecosystem health, and disturbances such as fire. Tree-rings capture historical data that can be helpful for predictive modeling; thereby, giving credence to Shakespeare's words that "What is past is prologue."