Buried and Submerged Forests of Washington and Oregon: Time Capsules of Environmental and Geological History

BY PATRICK PRINGLE

Tree rings of subfossil forests are unlocking secrets about the past history of earthquakes, volcanoes, and landslides in the Pacific Northwest and elsewhere. The tree victims are found in more than 50 different locations in Oregon and Washington. Dead trees are labeled “subfossil” when they have been preserved with little or no permineralization. Some subfossil trees are found submerged in intertidal zones along coastal British Columbia, Washington, Oregon, and the Salish Sea. The subsided trees indicate these locations likely dropped dramatically during great earthquakes; the trees show the scale of the movement (as much as 3 m) and the tree rings record the timing of those events. In valleys of rivers that head on volcanoes, it is a common occurrence to find forests buried by far-flowing volcanic debris flows (lahars) and lahăr-derived sediment-rich floods (see Fig. 1). Closer to the volcano, trees might be charred and/or buried by pyroclastic flows (hot avalanches of ash and rock).

Landslides can bury forests or block streams to create landslide-dammed lakes that drown forests (see Fig. 2). Many of these landslides, most in Washington State, were likely triggered by ancient earthquakes, and thus dating the trees via radiocarbon and possibly by tree rings could estimate the timing of the earthquakes. At least two faults, the Saddle Mountain fault and Tacoma fault in Washington, and two lava flows impounded water to drown ancient forests (at Merrill Lake in Washington and Clear Lake in Oregon).

Glacial deposits buried trees, and local standing (unburied or partially buried) “ghost” forests, such as the one on the south flank of Mount Hood, are preserved near timberline—the ones at Mount Hood might have been killed by a pyroclastic flow. Still other subfossil trees are preserved in dunes.

Lewis and Clark were among the first to document subfossil trees in the Pacific Northwest. On October 30, 1805, near the mouth of the White Salmon River along the Columbia, Clark writes: a remarkable circumstance in this part of the river is, the Stumps of pine trees are in many places are at Some distance in the river, and gives every appearance of the rivers being damed up below from Some cause which I am not at this time acquainted with...

And also on October 30, from the present location of Cascade Locks, Ore., Clark notes that rocks there had fallen into and obstructed the river and... “must be the Cause of the rivers daming up to Such a distance above” (to drown trees along its banks).

Botanist Donald Lawrence, a native of Portland, Ore., was a pioneer in

Figure 1. Photo of an in situ subfossil Douglas-fir (about 10 feet in diameter) at Orting, Wash., that was buried by the Electron Mudflow from Mount Rainier about A.D. 1502-03.

Figure 2. This 1992 photo shows a subfossil forest in Spider Lake in the southeast Olympic Mountains. The trees were killed about 1,100 years ago when a rock avalanche blocked a tributary in the headwaters of the middle fork of the Satsop River.

All Lewis and Clark quotes use the original journal spelling, capitalization, and punctuation.
studies of the subfossil trees in the Pacific Northwest. Having read Lewis and Clark’s interpretations, Donald and his wife Elizabeth spent decades investigating the geologic and botanical history of the Columbia Gorge. They counted more than 3,000 of the submerged forest trees along the banks of the Columbia River upstream of the great landslide. The trees are now drowned again by the Bonneville Dam impoundment. Lawrence sampled the snags beginning in the mid-1930s, and in 1958 he and Elizabeth published the first radiocarbon dates on what is now called the Bonneville landslide, which at one time had damned the entire Columbia to form the “Bridge of the Gods.” Some of the stumps sampled by Lawrence are visible in a 1909 George Weister photo taken at Wyeth, Ore. (see Fig. 3).

Lawrence began sampling the submerged forest trees in 1934 and continued his work for nearly 60 years, publishing papers on the subject in 1936, 1937, and 1958.

During field work in 1987 Lawrence noted with disappointment that all his samples of the submerged forest had disappeared—disks he had stored at his mother’s house had vanished, and he had assumed the ones located at the Forestry Building in Portland were lost when the building burned in 1964. But in 2001, research colleague Nathan Reynolds inquired about the slabs at the World Forestry Center (WFC), and staff there said they had some slabs stored in a large crate that might be of interest. Inside the crate were two disks of the submerged forest trees that had been sampled by Lawrence as well as two disks from living trees that he had hoped to use for ring matching!

In a great twist of luck, the disks had been on loan to Thornton Munger, director of the Pacific Northwest Forest and Range Experiment Station, at the time of the forestry building fire and had ultimately been returned to the WFC!

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With assistance from staff at the WFC, we were able to sample the wood. Radiocarbon analysis of the drowned forest disks facilitated by another research colleague, Jim O’Connor of the US Geological Survey, showed they died in the mid-1400s, and tree ring analysis indicates that the ring pattern of the two drowned forest samples correlates with that of a tree that had been buried by the Bonneville landslide and was recovered during excavations for the second powerhouse in 1978. We are continuing our tree-ring studies of Lawrence’s samples in hopes of dating the Bonneville landslide more precisely.

My own investigations of buried trees began in 1983 with US Geological Survey colleague Ken Cameron and were initially focused on Mount Hood and the buried forests there described by Lawrence and USGS geologist “Rocky” Crandell. A turning point for Ken and me came when we realized that Lewis and Clark’s observations of the “Quicksand” River—now renamed the Sandy River—probably were not long after an eruption and lahar from Mount Hood.

On November 3, 1805, Clark had written: [we] “halted at the mouth of a large river on the Lard Side, This river throws out emence quantity of quick Sand and is very Shallow, the narrowest part 200 yards wide bold Current, much resembling the river Plat, Several Islands about 1 mile up and has a Sandbar of 3 miles in extend imedately in its mouth, discharging it waters by 2 mouthes, and Crowding its Corse Sands So as to throw the Columbia waters on its Nothern banks, & confdg it to 1/2 ms. in width…” (confined it to 1/2 mile width).

Given that the buried trees we were seeing along the Sandy and Zigzag rivers might have died only a couple centuries earlier and that there were much older trees growing in localities of the Mount Hood National Forest, it seemed imperative to try using tree rings to solve the case. We teamed up with USGS geologist Thomas Pierson, who was also using tree rings to better understand the effects of the Mount Hood eruptions on the Sandy River. Cross dating revealed the trees had died after the end of the growing season in 1781 and before the growing season of 1782, and the sedimentation in the Sandy River continued for decades after the eruption, thus explaining Lewis and Clark’s curiosity about the “quick sand” river.

Dendrochronologist David Yamaguchi has dated several past explosive eruptions of Mount St. Helens to within a year or two by studying subfossil trees buried in pumice and ash from ancient Mount St. Helens eruptions, as well as the ring patterns of living trees that survived the ashy bombardment but recorded trauma in their tree rings. He later teamed up with USGS geologist Brian Atwater to date the death of trees in the coastal ghost forest of western Washington to about 1700. Japanese historical records of an “orphan tsunami” showed that a great earthquake (~ M9) had occurred on the Cascadia Fault on the evening of January 26, 1700! In a separate study, dendrochronologist Gordon Jacoby also dated the Cascadia earthquake to about 1700.

While this article describes selected subfossil forests of the Pacific Northwest, it is not by any means an exhaustive listing. For example, the ages of more than 30 landslides have been estimated by radiocarbon dating of associated subfossil wood or by dating of volcanic ash. However, fewer than 25 percent of these allow constraint of the actual timing of tree mortality, and more sampling will be required to determine outer wood. Additional tree-bearing lakes have been discovered but not sampled, and more than two dozen candidate sites lack reconnaissance. Many likely record paleo-earthquakes, but funding for radiocarbon dating is an ongoing challenge.

Aside from providing clues to the timing of the geologic events or disturbances that killed subfossil forests, the samples of these trees are of great value as repositories of climate and environmental information and should be archived for future studies. We have established a small tree-ring lab at Centralia College via a Department of Education grant so we can use tree-ring research as a tool for teaching science and training future researchers. We are also collaborating via a National Science Foundation grant to develop undergraduate science curriculum that uses tree-ring data. Selected students are studying the subfossil wood and helping to unlock the secrets in the rings.

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