

Estella Bergere Leopold: Paleobotanist and conservationist extraordinaire

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Estella Leopold passed away in Seattle, Washington, on February 25th, 2024, at the age of 97. In a career spanning over six decades, she gained renown for her paleobotanical research of past environments during the Cenozoic Era (the last 66 million years) and for her unflinching efforts in environmental conservation. Her lifelong commitment to science, her delight in the natural world, and her dedication to conservation sprang from deep roots in her remarkable family and touched many.

Estella was born January 8, 1927, in Madison, Wisconsin, the youngest daughter of the noted conservationist Aldo Leopold and his wife Estella. At the time of Estella's birth, Aldo was already a highly respected leader in the field of wildlife management and an ardent advocate for wilderness preservation. As a youngster, Estella made many trips with her parents and four older siblings to the family cabin north of Madison to plant trees and restore the highly degraded property. "The Shack" and surrounding lands along the Wisconsin River would eventually become famous in Aldo Leopold's seminal work *A Sand County Almanac* (1). Thus, from a very early age, Estella was surrounded by many of the ideas that she would enthusiastically embrace throughout her life.

Collectively, the Leopold family helped shape the ecological and philosophical ethos that grew into the environmental movement of the 1970s and continues today. Estella's four siblings all pursued careers in the natural sciences. Starker was an influential zoologist, wildlife biologist, and noted conservationist. Luna, a geologist and hydrologist, coauthored a leading textbook in fluvial geomorphology (2). Nina studied geography and maintained the Leopold property, and Carl was a distinguished professor in plant physiology. Estella found her niche in botany, receiving undergraduate and master's degrees at the University of Wisconsin and University of California, Berkeley, respectively, before completing her doctoral studies at Yale in 1955 under Paul Sears, Edward Deevey Jr., and G. Evelyn Hutchinson. At Yale, Estella was introduced to the field of palynology as a tool to reconstruct the late-glacial forest history of New England.

Estella's research in North America and beyond has contributed to our understanding of ancient terrestrial environments as well as the geologic trajectory that has created modern ecosystems. In 1955, she was hired as a paleobotanist at the United States Geological Survey (USGS) in Colorado, where she examined fossil pollen and spores in different geological settings to reconstruct the vegetation history of past ecosystems. For example, she and USGS paleobotanist Jack Wolfe characterized Miocene and Pliocene floras in Alaska to trace the vegetation changes associated with late Cenozoic climatic cooling. Her work on Cenozoic floras in the Rocky Mountains and Pacific Northwest documented the expansion of grassland and dry



Estella B. Leopold (2012). Image credit: Aldo Leopold Foundation.

forest as a result of cooling, increased seasonality, and mountain uplift. She discovered the presence of tropical rainforests on what is now coral atolls in the Marshall Islands during the Miocene (23 to 5 million years ago), providing tangible evidence for Darwin's hypothesis that atolls formed atop subsiding volcanoes.

In 1976, Estella became director of the Quaternary Research Center (QRC) at the University of Washington, Seattle, where she oversaw a large and vigorous group of researchers. Two of us (PD and CW) couldn't pass up the opportunity to be part of this dynamic community and pursue graduate studies with Estella. Under her leadership, the QRC was a hub of cutting-edge research, inspiring classes, and a steady stream of visitors. Ideas flowed freely during brown-bag lunch seminars, in the hallways, and at social events. Weekly wine and cheese parties at Estella's house would be (for us) a mind-bending gathering of local faculty and students, eminent scientists from around the world, conservation leaders, and even politicians. Estella continued to host similar gatherings well into her 80s, engaging and connecting new generations of faculty (including CS), students, and visitors.

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The Leopold siblings (L to R): Nina, Starker, Estella, Carl, Luna (1982). Image credit: Aldo Leopold Foundation.

After stepping down as director in 1982, Estella remained a professor in both the Botany Department and the School of Forest Resources. She continued to expand her paleoecological research, including undertaking studies that explored the ecological consequences of Quaternary seismic, volcanic, and climatic events in the Pacific Northwest, and further studying Cenozoic vegetation history. With Chinese collaborators, she worked on the Miocene and Pliocene vegetation history of localities in China and the western United States, including Alaska, noting the floristic similarities of the regions in the first half of the Miocene. She also taught demanding, hands-on, field-based courses in paleoecology, palynology, and restoration ecology to graduate students, and general biology to lucky undergraduates.

Estella was keenly aware of the power of her voice as a scientist to fight for environmental protection. In her view, paleoecological studies provided the long-term perspective vital for ecosystem preservation and conservation. As she put it:

"How can man keep a perspective on his direction and life's path if he loses track of the routes that life has followed before him?"

While at the USGS, she led a coalition of environmentalists ("The Defenders of Florissant") through a tough and politically charged battle that ultimately resulted in the protection of the Florissant Fossil Beds National Monument in Colorado in 1969. She also spoke out against Front Range development, oil-shale mining in western Colorado, and dams on the Colorado River. At the University of Washington, Estella and colleagues argued in 1981 for the establishment of Mount St. Helens National Monument, so that heavily altered post-eruption ecosystems could be carefully studied. In 1982, she joined her siblings in establishing the Aldo Leopold Foundation, centered on "The Shack" property. She was closely involved with the Foundation for the remainder of her life, variously serving as president and board chair, heading an advisory committee to help guide stewardship of the site, championing the production of the *Green Fire* documentary about her father, and ensuring the Foundation's advocacy of Aldo Leopold's land ethic.

Following her retirement in 2000, Estella continued her writings. In 2012, she coauthored *Saved in Time* with Herbert Meyer, recounting the establishment of Florissant National Monument (3). She also turned out two memoirs, *Stories from the Leopold Shack: Sand County Revisited* (4) and *Aldo's Wife, Estella Bergere: My Remarkable Mother* (5).

Estella was elected to the National Academy of Sciences in 1974 and the American Academy of Arts and Sciences in 1992. Among the awards and honors she received are the International Cosmos Prize for her contributions to conservation in 2010, the Paleontological Society Medal in 2013, and the Distinguished Career Award from the American Quaternary Association in 2022.

Estella's career was extraordinary in every respect, not least in the fact that she reached the top of her field at a time when there were not many women in science. She was a role model for many, someone with a contagious excitement for new discoveries and ideas and an abiding sense that science should be used for the greater good. Beyond her academic accomplishments, Estella's generosity, humility, wit, and optimism touched all who knew her. Her legacy to us is to carry on her mission to understand Earth's past and care for its present.

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