BIOGRAPHICAL MEMOIRS

Estella Bergere Leopold

January 8, 1927–February 25, 2024 Elected to the NAS, 1974

A Biographical Memoir by Cathy Whitlock, Peter Dunwiddie, Caroline A. E. Strömberg, and Susan Flader

IN A CAREER spanning over six decades, Estella Leopold was widely acclaimed both for her research in paleoecology and paleobotany and as an ardent spokesperson for conservation. Her lifelong commitment to science, her delight in the natural world, and her dedication to the environment sprang from deep roots in her remarkable family.

Estella was born January 8, 1927, in Madison, Wisconsin, the youngest of five children of noted conservationist Aldo Leopold and his wife Estella Bergere. At the time of her birth, Aldo was already a highly respected forester and pioneer in the nascent field of wildlife management, and he was also emerging as a national spokesperson for wilderness preservation. Estella was only eight when her father bought a derelict farm along the Wisconsin River with its chicken coop shack. It was this place that Aldo Leopold would later immortalize in his book A Sand County Almanac (1949).¹ As a youngster, Estella went virtually every weekend with her family to "the shack," and together they began restoring degraded upland and wetland habitat to a modicum of health. Thus, from a very early age, Estella developed a keen naturalist's eye and love of nature, and she was immersed in many of the ideas that she would enthusiastically embrace throughout her life.

When her father asked her one day what she wanted to be when she grew up, she thought a while before replying, "a bug-ologist." Asked why, she said, "Because everything else is taken." From her perspective as the youngest Leopold, her four older siblings had an early jump on pursuing careers in the natural sciences. Starker would become an influential



Figure 1 Estella Bergere Leopold (2010). Photo credit: Mary Levin, University of Washington.

zoologist, wildlife biologist, and noted conservationist. Luna, a geologist and hydrologist, co-authored a leading textbook in fluvial geomorphology.² Nina studied geography and oversaw the Leopold property in her later years, and Carl was a distinguished professor in plant physiology.

Rather than encouraging Estella's pursuit of entomology, her father gave her a copy of Norman Fassett's *Spring Flora of Wisconsin* and a vasculum, and in short order she discovered the joys of identifying and studying plants, eventually finding her niche in palynology. She earned an undergraduate degree in botany at the University of Wisconsin in 1948, a master of science degree at the University of California, Berkeley in



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Figure 2 Estella planting pines at the shack with Poco, her pet squirrel (1942). *Photo credit: Carl Leopold, Aldo Leopold Foundation.*

1950, and a Ph.D. at Yale University in 1955 under the supervision of leading ecologists of the day: Paul Sears, Edward Deevey Jr., and G. Evelyn Hutchinson. At Yale, Leopold was introduced to the field of palynology (the study of fossil pollen and spores) as a tool to reconstruct past vegetation, and her dissertation focused on the late-glacial forest history of New England based on pollen records from bogs. She later expanded the temporal reach of her research to study the long-term evolution of vegetation through the Cenozoic Era (the last 66 million years), a direction that would require her to extract pollen from sedimentary rocks.

In 1955, Estella was hired as a paleobotanist at the United States Geological Survey (USGS) in Colorado, where she examined fossil pollen and spores in a variety of settings to reconstruct the vegetation history of different geological periods. She discovered the presence of tropical rainforests during the Miocene (23 to 5 million years ago) on what are now low-lying coral atolls in the Marshall Islands.³ She reasoned that the vegetation there must have grown in upland habitats that no longer exist, providing tangible evidence for Darwin's hypothesis that atolls formed atop subsiding volcanoes. She and USGS paleobotanist Jack Wolfe characterized Miocene and Pliocene floras in Alaska to trace the vegetation changes associated with late-Cenozoic climatic cooling along the Pacific slope.⁴ Her work on Cenozoic floras in the Rocky Mountains and Pacific Northwest documented the development of grassland and dry forest as a result of cooling, increased seasonality, and mountain uplift.⁵ To better understand how far various pollen grains were transported by wind, she and Alan Solomon (then at the University of Arizona)

set a network of pollen traps near Searles and Mono Lakes in the Mojave Desert to match the pollen rain with different plant communities. These data were used to develop a pollenvegetation calibration that still informs paleoecological studies in the region and beyond.

Early in her career at the USGS, Estella was struck by the exceptionally well-preserved plant and insect fossils found in Eocene lake sediments in the Florissant Valley, southwest of Denver. Her analysis of the fossilized pollen and spores revealed a diverse flora of angiosperms and conifers that she hypothesized grew in a warm temperate climate with a distinct dry season. She began leading field trips in the 1960s with ecologist Bettie Willard of Boulder to show people the Florissant area, and, in 1965, she co-founded the Colorado Open Space Coordinating Council (COSCC), an umbrella organization of conservation groups. She did so to build public support for a national monument at Florissant while protecting it from housing development. Leopold and COSCC tackled many environmental issues of the day, including Colorado Front Range development, proposed Grand Canyon dams, and oil-shale mining, but protecting Florissant was their greatest success.

In 1969, as congressional action stalled and bulldozers threatened to roll into the valley, Estella and several of her COSCC and scientific colleagues formed Defenders of Florissant Inc. to take legal action against the developers. With the services of charismatic New York attorney Victor Yannacone and future Colorado governor Richard Lamm, they sought a restraining order in federal court to protect the fossil deposits. Denver Audubon president and activist Vim Crane Wright, who had been following the issue in the press, called



Figure 3 The Leopold siblings (I-r: Nina, Starker, Estella, Carl, Luna) at the shack in 1982 to establish the Leopold Foundation. *Photo credit: Trish Stevenson, Aldo Leopold Foundation.*

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Estella and offered to gather some of her female friends to sit down in front of the bulldozers if necessary, and so they did. These efforts bought time and ultimately paved the way for the establishment of the national monument. In his closing argument to the court, Yannacone declared:

The Florissant fossils are to geology, paleontology, paleobotany, palynology, and evolution what the Rosetta Stone was to Egyptology. To sacrifice this 34 million-year-old record, a record you might say written by the mighty hand of God, for 30-year mortgages and the basements of the A-frame ghettoes of the seventies is like wrapping fish with the Dead Sea Scrolls.

Days later, Congress acted, and the bill to establish Florissant Fossil Beds National Monument was signed by Pres. Richard Nixon on August 20, 1969. For both her scientific achievements and these conservation activities, Estella was elected in 1974 at age forty-seven to the National Academy of Sciences, joining her brothers Starker and Luna. It remains the only time in the history of the academy that three siblings have achieved this signal honor.

In 1976, Estella left Colorado to become director of the Quaternary Research Center (QRC) at the University of Washington (UW) in Seattle. Her partner, activist Vim Wright, moved with her to take a position as assistant director of UW's Institute for Environmental Studies, and they shared a home and each other's conservation causes until



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Figure 4 Estella Leopold discusses a palm leaf fossil found at Florissant with attorneys Dick Lamm (center) and Victor Yanaconne (right) (1969). This unique fossil was shown to the justices in federal court to secure a restraining order to protect the fossil beds until Congress could act. *Photo credit: Mel Schieltz, Rocky Mountain News, July 11, 1969. (Permission from Photosales, Denver Public Library).*



Figure 5 Estella (center) with students Rudy Nickmann and CW sampling lake-sediment cores from western Washington at the Quaternary Research Center (1981). *Photo credit: University of Washington*.

Vim's death in 2003. In Estella's new role at the QRC and UW, her research interests shifted to the last 2.6 million years (the Quaternary Period) and to the Cenozoic history of the Pacific Northwest and China. At the QRC, she led a large and vigorous group of researchers. When Mount St. Helens violently erupted in 1980, scattering volcanic ash across the Pacific Northwest, Estella engaged her QRC and other conservation colleagues in developing a plan for a volcanic national monument and mobilizing Congress and the public; Congress established the 110,000-acre Mount St. Helens National Volcanic Monument in 1982 as a natural laboratory for scientists and the public to examine the recovery process from different angles. The numerous publications that resulted from this effort have informed our understanding of biotic succession following volcanic eruptions, with implications for the fields of ecology and paleoecology.

Two of us (CW and PD) couldn't pass up the opportunity to be part of the dynamic QRC 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 visiting scientists. We positively beamed when Estella favored us with (what we called) her 1000-volt look, an expression that indicated that we were heading in an exciting, possibly original intellectual direction. 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

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and students, eminent scholars from around the world, conservation leaders, and even politicians. Estella continued to host such gatherings well into her eighties, engaging and connecting new generations of faculty, students, and visitors.

Estella stepped down as QRC director in 1982 but continued as a professor in both the Department of Botany and College of Forest Resources. She devoted much of her time to exploring new research areas, including the development of intermountain grasslands with the uplift of the Rockies and the Cascade Range,⁶ western floras during the Miocene warm period,7 and investigations into the ecological consequences of Quaternary seismic, volcanic, and climatic events in the Pacific Northwest.8 She also engaged in a decades-long collaboration with Chinese paleobotanist Gengwu Liu (University of Nanjing) and other Chinese colleagues to explore affinities in the Miocene and Pliocene vegetation history of China, Alaska, and western North America.⁹ This research revealed the striking floristic similarities of the two continents in the early Miocene and their subsequent divergence with late Cenozoic cooling.

Leopold used her academic credentials to advocate for important environmental matters in the Pacific Northwest. She helped document what is now known as the Seattle fault zone running through the city, raising awareness among city planners. She also argued for the return of indigenous burning practices to Puget Sound prairies to prevent encroachment by surrounding conifers. As a member of the Washington governor's Advisory Council on High-Level Nuclear Waste Management from 1982 to 1987, she engaged colleagues to present evidence regarding flow patterns in the highly pervious basalts beneath the Hanford Reservation, resulting in an agreement not to bury nuclear wastes there. In her later career, she served on the boards of the National Audubon Society, the Nature Conservancy, the Environmental Defense Fund, the Institute of Ecology, and the Friends of the Earth Foundation, as well as on numerous editorial boards and award committees.

In 1982, Estella joined her siblings to establish the Aldo Leopold Foundation and was closely involved with the foundation for the remainder of her life. She served variously as president and board chair, heading a science advisory committee to help guide stewardship of the site and ensuring the Foundation's advocacy of Aldo Leopold's land ethic. With her brother Luna, Estella established the Estella B. Leopold Professor & Curator of Paleobotany endowed faculty position at the University of Washington's Burke Museum in 2005 to encourage interdisciplinary studies in the biological and geological sciences. (Memoir co-author CAES is the first and current holder of this distinguished position.) Leopold served as an officer or board member on numerous scientific and professional committees over the years, including at least



Figure 6 Estella in 2004 teaching a field course called Reading the Landscape at the Cedar Rock Preserve on Lopez Island. *Photo credit: Don Burgess, Western Washington University.*

eight committees of the National Academy of Sciences dealing with environmental quality, climate, and global change. She served as president of the American Quaternary Association, chair of the U.S. Committee of the International Union for Quaternary Research, and in various capacities with the Ecological Society of America, the Geological Society of America (GSA), the Botanical Society of America, and the National Science Foundation Scientific Steering Committee for Earth System History.

In addition to her election to the NAS, Leopold was a fellow of the GSA (1984), the American Association for the Advancement of Science (1980, 1986), the American Academy of Arts and Sciences (1992), and the American Philosophical Society (2000). In 2010, she received the International Cosmos Prize—considered by many the equivalent of a Nobel Prize in natural and cultural ecology—for her contributions to conservation and honoring her lifelong work illuminating the harmonious coexistence of nature and mankind.¹⁰ She also was honored with the Wilbur Cross Medal from Yale University (1993), the Association of Stratigraphic Palynologists Medal for Scientific Excellence (2013), the Paleontological Society Medal (2014), and the Distinguished Career Award from the American Quaternary Association (2022), among other awards and honors.

In her eighties and after a career of erudite professional scientific research and writing, Estella became more introspective about her scientific legacy and began writing for a more general audience—although she still contributed to many scientific publications with mentees and colleagues. She had long intended to write a textbook in her own field of paleobotany and produced some drafts over the years, but she gradually let go of that in favor of a case study describing the epic struggle to save what would become Florissant Fossil Beds National Monument. In addition to a gripping dayby-day account, *Saved in Time* (2012) includes chapters by National Park Service paleontologist Herbert Meyer on the long-range significance of the Florissant fossils and Estella's own reflections on the historical and cultural significance of the struggle for the conservation movement and environmental law.¹¹

After her sister Nina died in 2011, Estella embraced a new role as the last direct link to her illustrious father and equally remarkable mother and as a mentor and core of her extended family, with a responsibility to pass the family legacy and sense of place to the younger generations. In addition to taking over Nina's role holding the generations together as individuals and as a group, she began working on a second book based on her family's experiences at the shack, including working shoulder to shoulder to restore the land. Profusely illustrated with photographs mostly by her brother Carl, Stories from the Leopold Shack (2016) provides touching and illuminating backstories for some of the essays in her father's Sand County Almanac, vignettes about the family dogs and wild pets, and Estella's own reflections on the history of the place.¹² She explained that much of the narrative was undertaken on long plane flights between Madison and Seattle when she found time to pen a series of tales for the nieces, nephews, cousins, and grand- and great grandchildren. In the end, she produced a thoroughly charming and invaluable companion piece to the almanac for the general reader.

Upon completion of that project, she began work on a book focused on the Hispanic heritage of her mother, Estella Bergere, so that the younger generations could come to a greater appreciation of the central role her mother played in the family. She worked happily on her new project with the help of her research assistant, Stephanie Zaborac-Reed, but advancing age and the forced isolation of the COVID years slowed her efforts. When health episodes slowed her further, a group of friends (including memoir co-author SF) worked to put the memoir in shape for a small private printing. *Aldo's Wife Estella Bergere: My Remarkable Mother*, was presented to Estella and relatives and friends gathered for her ninety-sixth birthday. Estella passed away in Seattle, Washington, on February 25, 2024, at the age of ninety-seven.

In closing, we want to express how fortunate we feel for the many good times that we shared with Estella over the decades. She was an inspiring big-picture intellectual, but she loved a good joke, strumming her guitar, and time with family and friends. She believed in the power of collaboration and the need for interdisciplinary approaches to advance science and solve environmental problems, and she was keenly aware of the power of her voice as a scientist to fight for environmental justice. In her view, paleoecological studies provided the long-term perspective that supported her scientific and conservation efforts. She reached the highest levels in academia at a time when there were very few women in science, and she did it with grace, grit, and humor. Her tenacity, abiding optimism, and generosity were an inspiration for younger scientists, including authors of this memoir. Estella's legacy to us is to carry on her mission to understand Earth's past and care for its present and future.

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