

Final Report

HISTORICAL FIRE REGIMES OF THE WILLAMETTE VALLEY, OREGON: PROVIDING A LONG-TERM, REGIONAL CONTEXT FOR FIRE AND FUELS MANAGEMENT

(Project No. 04-2-1-115)

Principal investigators: Cathy Whitlock¹, Emily Heyerdahl², Jane Kertis³, Megan Walsh⁴, Andrew Marcus⁴

Affiliations:

¹ Department of Earth Sciences, Montana State University, Bozeman MT 97403; office: 406-994-6910, fax: 406-994-6923, whitlock@montana.edu

² USDA Forest Service Rocky Mountain Research Station, Fire Sciences Laboratory, P.O. Box 8089, Missoula MT 59807; eheyerdahl@fs.fed.us

³ USDA Forest Service Suislaw National Forest, PO Box 1148, Corvallis OR 97339; jkertis@fs.fed.us

⁴ Department of Geography, University of Oregon, Eugene OR 97403; office: 541-346-2698, fax: 541-346-2067; mwalsh2@uoregon.edu, marcus@uoregon.edu

Introduction:

Local fire history and fire regime information are necessary in fire management plan development and implementation. Understanding the relationship of fire, climate and vegetation is useful in resolving restoration, wildfire risk reduction, and wildfire for resource benefit issues. In the Willamette Valley and adjacent fringe of western Oregon, population growth and land-use change are expected to double in the next few decades. Oak woodlands, savannas and prairies, and dry Douglas-fir and grand fir forests occur within the largely wildland-urban interface within the valley and fringe. A fire history study based on lake-sediment records of the last 2000 years and tree-ring records from the Willamette Valley and surrounding lowlands was undertaken with three objectives: (1) reconstruct the variation in historical fire regimes from the foothills of the Coast Range across the Willamette Valley to the foothills of western margin of the Cascade Range; (2) examine the historical vegetation changes, including major shifts in vegetation composition and fire regimes prior to Euro-American settlement and in recent centuries; (3) communicate our findings to land managers and researchers through oral presentations, written reports and peer-reviewed publications.

Key findings:

Prior to Euro-American settlement of the Willamette Valley, vegetation and fire regimes were influenced by a combination of natural and anthropogenic factors, but marginal valley sites show a stronger influence from climate. Seasonally inundated valley sites that provided important food resources were more impacted by human activity.

- Between AD 800 and 1450, Battle Ground Lake, Lake Oswego, and Beaver Lake recorded relatively high fire activity, as did Warner Lake from ca. AD 1075–1450 (see Fig 1 for site locations; Fig. 2 for site results). At Battle Ground Lake, generally small, low- to moderate-severity fires prior to ca. AD 1300 had little impact on the surrounding forest, but two large fires at ca. AD 1350 and 1390 opened the landscape for the next approximately 100 years. At Lake Oswego, large fires between ca. AD 1350 and 1550 led to a shift from a relatively closed forest to a more open landscape dominated by herbaceous taxa. Similarly at Beaver Lake, frequent, low- to moderate-severity fires before ca. AD 1450 increased the openness of the vegetation. At Warner Lake, relatively

frequent low- to moderate-severity fires maintained an open forest between ca. AD 1075 and 1250 as compared to later in the record.

- The climate conditions associated with the Medieval Climate Anomaly (AD 850-1250; Mann, 2002) may explain the relatively high fire activity at Battle Ground Lake, Lake Oswego, Beaver Lake, and Warner Lake prior to ca. AD 1250. Following this period, large fires at all three sites occurred between ca. AD 1300 and 1450. Fire activity was reduced between ca. AD 1650 and 1800 from Battle Ground Lake, Lake Oswego, Beaver Lake, and Porter Lake and may be the result of regionally cooler temperatures and greater precipitation associated with the Little Ice Age (AD 1450-1850). Climate change, however, cannot explain the record from Warner Lake, which indicates that fires increased in size/severity until ca. AD 1800.
- Human activity, including Native American use of fire as a land management tool, superimposed on regional climatic shifts helps explain the fire and vegetation history of the Willamette Valley. Archaeological evidence suggests relatively large populations in the valley prior to European contact. Sites in the lower Willamette Valley reveal a greater burning than those along the valley margin, suggesting deliberate anthropogenic burning in the prairie regions.

Impacts of Euro-American settlement (ca. AD 1830 - present) in the Willamette Valley were relatively synchronous and heterogeneous. The most dramatic shifts in vegetation over the last 2000 years occurred in association with land clearance for agriculture and logging. The charcoal records indicate few fires in the Willamette Valley since ca. AD 1930, and fires today are predominantly grass fires.

- Battle Ground and Warner lakes record concurrent logging and burning activities in the local watersheds (ca. AD 1890-1900). Charcoal data from Beaver and Porter lakes indicate major post-settlement fires (ca. AD 1880-1890) at the time of major land clearance and agriculture. The pollen and charcoal records from Lake Oswego show little land-use impact.
- The records from Battle Ground, Beaver, Porter, and Warner lakes indicate a period of widespread fire from ca. AD 1800–1925. Fire elimination in the Willamette Valley since ca. AD 1930 is recorded by most of the charcoal records.

Reconstructing historical fire regimes from tree rings was challenging in the forest fringe of the Willamette Valley and yielded a relatively short record of frequent, small fires that had a range of severities but little synchrony.

- Most tree-ring evidence of historical fire regimes in this area comes from stumps (catfaces generally don't form in this region) which decay rapidly, destroying evidence of past fires.
- Using non-JFSP funding, we removed and crossdated partial cross sections from 867 stumps (primarily Douglas-fir) at 35 plots (0.2 ha each) distributed on land managed by the BLM around the forest fringe of the Willamette Valley.
- The historical record we obtained from this region is relatively short, with half our 35 plots extending back into the 1800s and only 25% with records in the 1700s. Some plots (20%) had records only for the 1900s.
- We reconstructed 116 fire dates from fire scars and the establishment dates of post-fire cohorts.

- Plot-fire intervals averaged 23 years, with half the intervals falling between 9 and 30 years. However, based on our sample, there was no statistical difference in fire frequency among our plots.
- Fire dates were not highly synchronous among plots with most fire dates occurring at only 1 to 6 plots, suggesting that climate may not have been a primary driver.
- The severity of the fire regime at a plot through time varied across the study area. Most plots had only low-severity fires (58% of plots with only fire scars). The rest were mostly mixed- (33% of plots with both fire scars and post-fire cohorts of trees) or high-severity (only cohorts).

Management Implications:

The current vegetation cover of the Willamette Valley, Oregon, is vastly different from that seen by early 19th-century Euro-American explorers and settlers. Survey notes from the General Land Office (GLO) document a complex mosaic of pre-settlement vegetation (ca. AD 1850) that included Quercus (oak) savanna and woodland, prairie, coniferous upland forest, and extensive riparian forests. Today, only small patches of these ecosystems remain, precariously perched between rapidly expanding urban and agricultural areas (Hulse et al., 2002). Studies have shown that over the past ca. 150 years, shrubs and trees have established in former wet prairie and upland grassland, and conifers have come to dominate former oak savanna and woodland. Removal of fire, both naturally- and human-ignited, from these ecosystems has partially, if not entirely, been responsible for this vegetation conversion.

- This fire-history study demonstrates the need for better assessment of fire regime condition class.
- Historical approaches that incorporate information from both lake-sediment and tree-ring studies can be used to identify and develop restoration opportunities for a range of community types.
- Baseline data on past fire regimes and the impacts of anthropogenic and climate-induced burning should be considered in developing fire and resource management plans.

Cross-walk between proposed and delivered FFS outreach activity as indicated in our communication plan, submitted December 31, 2004

Proposed	Delivered	Status
Final report to Forest Service RMRS, BLM, and JFSP	Sent July 15, 2008 to RMRS and JFSP	Done BLM report will be sent in Fall 2008 when tree-ring study is complete
One peer-reviewed publication	Walsh, M.K., C. Whitlock, and P.J. Bartlein. 2008. <i>Quaternary Research</i> , in press (citation below)	Additional publications are forthcoming
Oral presentations to Salem and Eugene districts of BLM	Walsh, M.K., C. Whitlock, E. Heyerdahl, J. Kertis, P.J. Bartlein, and C. Pearl. "Natural and anthropogenic influences on the Holocene fire and vegetation regimes of the Willamette Valley, OR: study overview." Poster presented at Eugene BLM meeting, April 2005. Kertis, J and E. Heyerdahl. "Fire history and regimes of the Willamette Valley foothills" Presented at annual Salem BLM Silviculture Group meeting, February, 2005.	Additional presentations are planned for Fall 2008
Public archiving of fire-history data	Battle Ground data submitted to NOAA-NCDC International Multi-proxy paleofire database (IMPD) http://www.ncdc.noaa.gov/paleo/impd/paleofire.html	Additional data will be submitted in 2008-2009 as results are published
Permanent archiving of the sediment cores	Sediment cores reside at the University of Oregon Department of Geography under refrigeration	Tree-ring cores are available at the Suislaw National Forest
Oral presentations to scientific meetings	See list below	Additional presentations are planned
PhD Dissertation of Megan Walsh		Final defense in Fall 2008

Presentations and publications from this project:

Robbins, D. Temporal and Spatial Variability in Fire Frequency in the Southern Willamette Valley Foothills of Oregon. 2005. Oregon State University Master's Thesis 106 pp.

Walsh, M.K., C. Whitlock, and P.J. Bartlein. (In press). A 14,300-year-long record of fire-vegetation-climate linkages at Battle Ground Lake, southwestern Washington. *Quaternary Research*.

Walsh, M. K., C. Whitlock, P. J. Bartlein, and C. Pearl. "From Native-American Habitation to European-American Settlement: Reconstructing the Last 1200 years of Landscape Change in the

Willamette Valley, Oregon and Washington. Talk given at the Association of American Geographers Annual Meeting, Boston, MA, April 2008

Walsh, M.K., C. Whitlock, P.J. Bartlein, and C. Pearl. "Reconstructing the Holocene Fire and Vegetation History of the Willamette Valley, Oregon and Washington, Using High-Resolution Macroscopic Charcoal and Pollen Analysis." Talk given at the Association of American Geographers Annual Meeting, San Francisco, CA, April 2007.

Walsh, M.K., C. Whitlock, P.J. Bartlein, and C. Pearl. "Using Macroscopic Charcoal to Reconstruct the Holocene Fire Activity of the Willamette Valley, Oregon and Washington." Poster presented at the American Geophysical Union Fall 2006 Meeting, San Francisco, CA, December 2006.

Walsh, M.K., C. Whitlock, and P.J. Bartlein. "Climate Variability vs. Anthropogenic Activity: Reconstructing the Holocene Fire History of the Willamette Valley Using Macroscopic Charcoal Analysis." Talk given at Portland State University, Portland, OR, for Oregon Archaeology Month, October 2006.

Walsh, M.K., C. Whitlock, P.J. Bartlein, and C. Pearl. "The Holocene Landscapes of the Willamette Valley, Oregon: Reconstructing Prehistoric Fire Activity through Macroscopic Charcoal Analysis," Poster presented at the Association of Pacific Coast Geographers 69th Annual Meeting, Eugene, OR, September 2006.

Walsh, M.K., C. Whitlock, P.J. Bartlein, and C. Pearl. "The Holocene Fire and Vegetation History of the Willamette Valley: Results from Battle Ground Lake, Washington, Beaver Lake, Oregon, and Warner Lake, Oregon," Poster presented at the American Quaternary Association (AMQUA) 19th Biennial Meeting, Bozeman, Montana, August 2006.

Walsh, M.K., C. Whitlock, and P.J. Bartlein. "An 11,000-Year-Long Record of Fire and Vegetation History from Battle Ground Lake, Washington," Talk given at the 22nd Biennial Pacific Climate Workshop (PACLIM), Monterrey, California, March 2006.

Walsh, M.K., C. Whitlock, and P.J. Bartlein. "Reconstructing the Holocene Fire Regimes of the Willamette Valley through the Use of Macroscopic Charcoal and Pollen Analysis," Talk given at the Oregon Academy of Science Annual Meeting, Eugene, Oregon, February 2006.

Walsh, M.K., C. Whitlock, and P.J. Bartlein. "Holocene Climate, Vegetation, and Fire History at Battle Ground Lake, Washington," Talk given at the Geological Society of America Annual Meeting, Salt Lake City, Utah, October 2005.

Walsh, M.K., C. Whitlock, E. Heyerdahl, J. Kertis, P.J. Bartlein, and C. Pearl. "Natural and anthropogenic influences on the Holocene fire and vegetation regimes of the Willamette Valley, OR: study overview." Poster presented at Eugene BLM meeting, April 2005.

Walsh, M.K. (2005). Vegetation history of the southern Willamette Valley. *In*: "Mount Pisgah Arboretum Guidebook: A Natural History of the Southern Willamette Valley, Oregon, 11th Edition," (Rhoda M. Love, ed.), pp. 140-146.

Walsh, M.K., C. Whitlock, and P.J. Bartlein. "Natural and anthropogenic influences on the Holocene fire regimes of the Willamette Valley: Preliminary results from Battle Ground Lake, WA." Poster presented at Fire/Climate Conference in Flagstaff, AZ, May 2005.

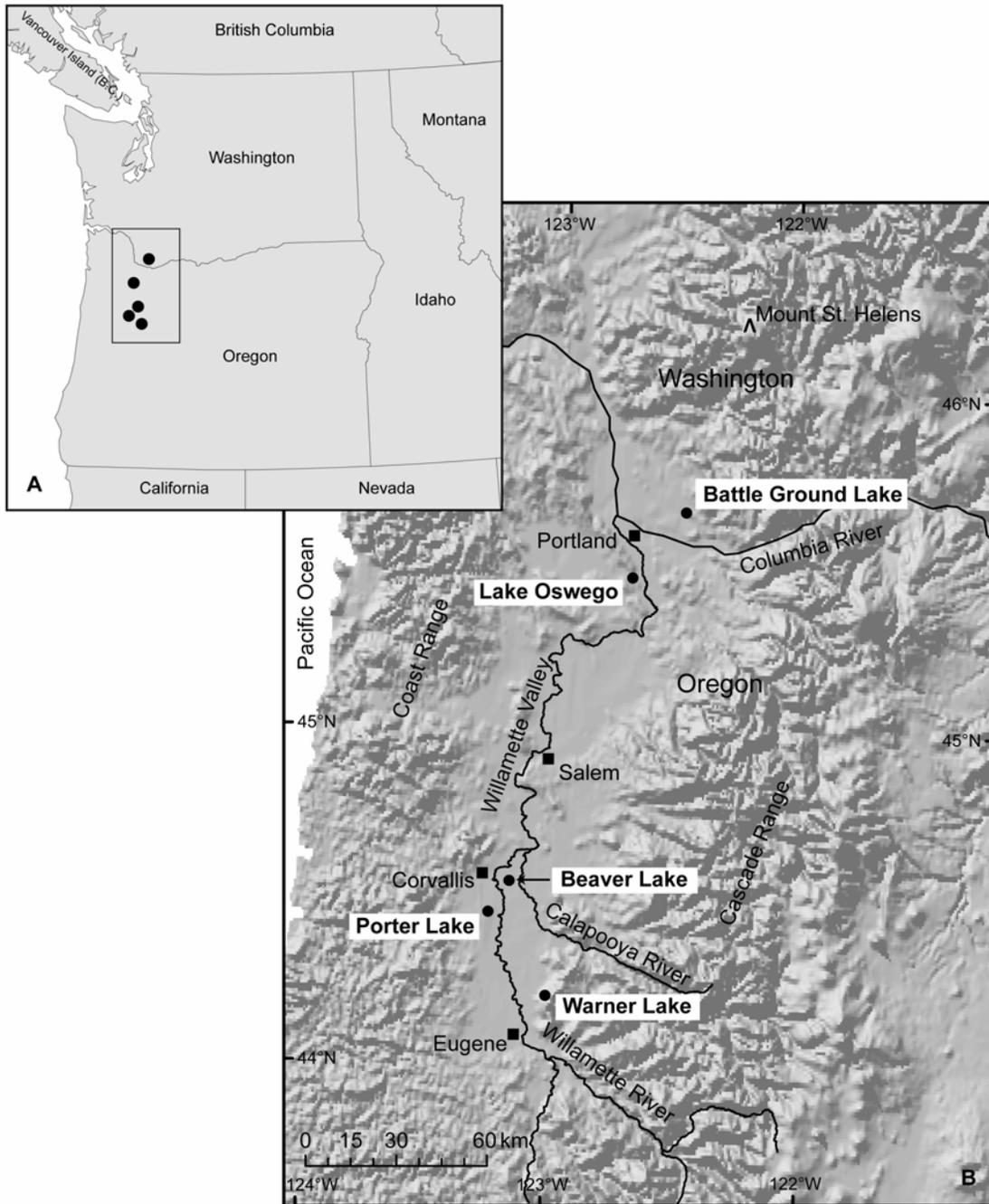


Figure 1. (A) Map of the Pacific Northwest showing the location of the study area (gray box) and (B) map of the Willamette Valley showing the location of the five study sites.

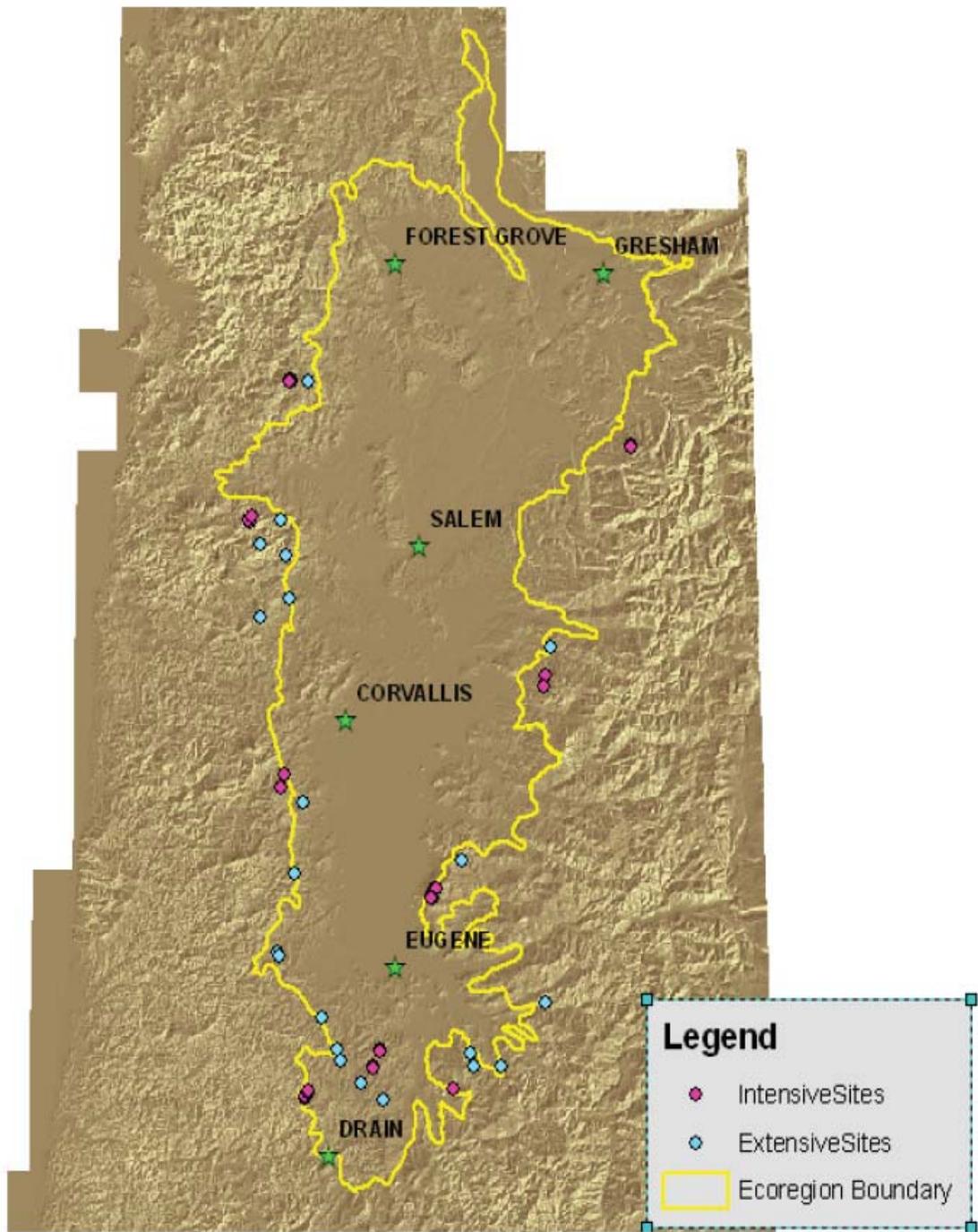


Figure 2: Map of the Willamette Valley showing the location of intensive and extensive tree-ring sites.

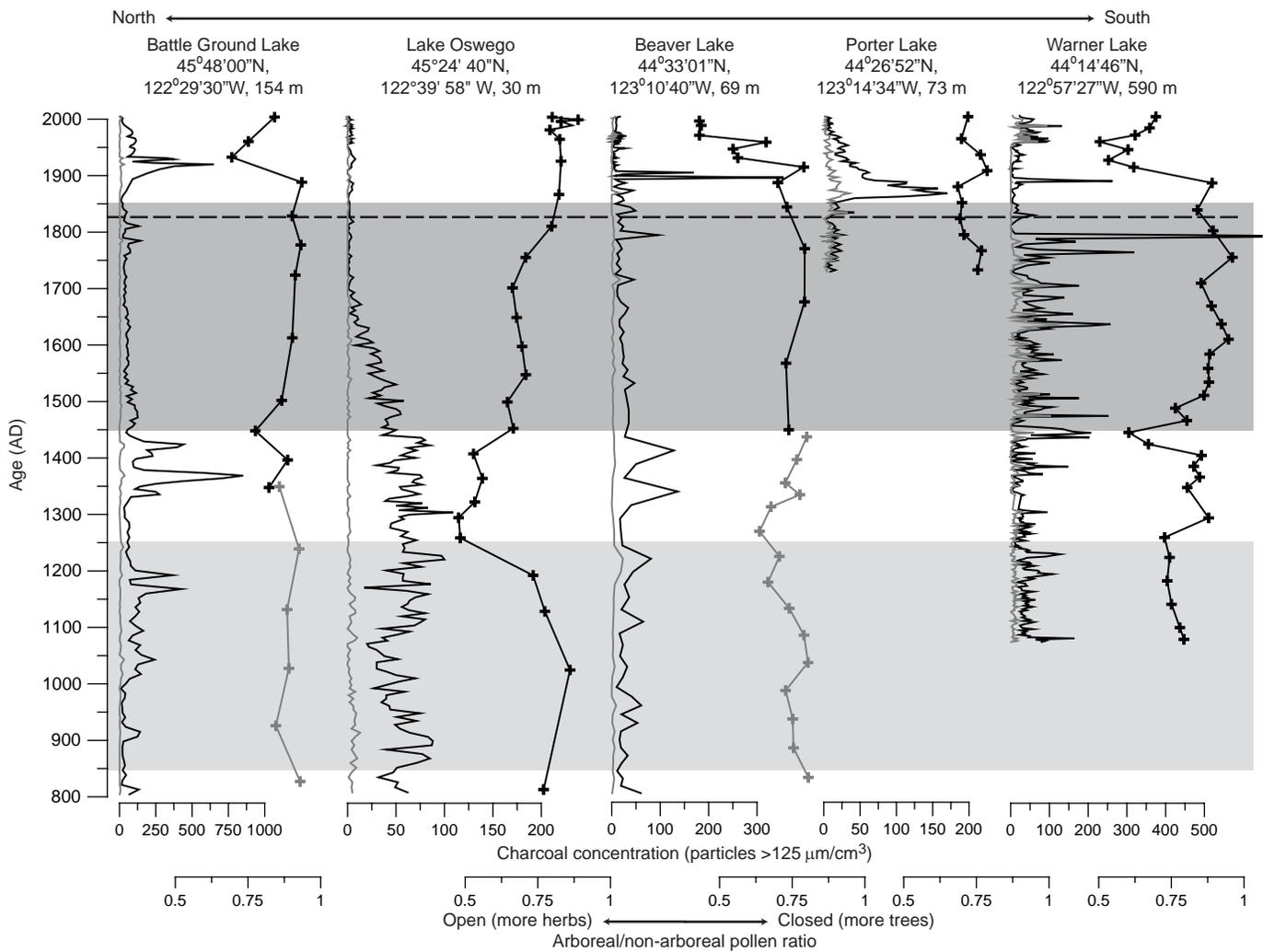


Figure 3. Charcoal concentration (total= black line; herbaceous= gray line) and the ratio of tree to non-tree pollen taxa (Arboreal [AP]/Non-arboreal [NAP]) (black and gray lines with + symbols) for the five study sites (arranged from north to south) plotted against age (AD). The + symbols indicate the pollen samples. The gray portion of the Battle Ground Lake AP/NAP ratio curve was correlated based on age from core BG80B and the gray portion of the Beaver Lake AP/NAP ratio curve was correlated based on age from core BL93A (see chapters 1 and 2 of final report). The lighter gray box represents the approximate years of the Medieval Climate Anomaly (ca. AD 850-1250) and the darker gray box represents the approximate years of the Little Ice Age (ca. AD 1450-1850). The dashed horizontal line marks the approximate start of Euro-American settlement of the Willamette Valley (ca. AD 1830).