

First Comprehensive Botanical Survey of the Columbia Plateau, Washington: The Sandberg and Leiberg Expedition of 1893

Abstract

In 1893 two field agents of the U.S. Department of Agriculture, John H. Sandberg and John B. Leiberg, made the first comprehensive botanical survey of the Columbia Plateau. Leiberg's never-published report of their expedition provides a general account of the distribution of much of the region's flora and its early agriculture. In addition, he identified the comparatively few native species that were becoming more prominent through disturbance (e.g., *Deschampsia danthonioides*, *Descurainia richardsonii*, and *Festuca microstachys*) and members of the enlarging alien flora (e.g., *Amaranthus retroflexus*, *Artemisia vulgaris*, *Bromus mollis*, *Bromus secalinus*, *Erodium cicutarium*, and *Verbascum thapsus*). His narrative provides a heretofore unavailable view of the region's flora just before the massive transformation of the steppe through the introduction of aggressive aliens, including *Bromus tectorum*, *Salsola kali*, and *Sisymbrium altissimum*.

Introduction

The natural grasslands or steppe in the Pacific Northwest have been drastically altered since European settlement: the frequency of fire, the magnitude of erosion, the cycling of minerals, the composition and productivity of the biota have all been changed irrevocably. The steppe in Washington exemplifies these changes (Daubenmire 1970, Rickard *et al.* 1977, Busacca *et al.* 1985, Mack 1986). Although this region was once dismissed as the "Great Columbia Desert," a land rush was sparked by the discovery in the late 1870's that much of these grasslands was eminently suitable for growing winter wheat. By 1890 almost 25,000 km² was in private ownership as farms or pasturage (Meinig 1968). These grasslands display low resiliency to disturbance (Mack and Thompson 1982, Harris *et al.* 1987), and the introduction of wheat agriculture, livestock and alien plants transformed the region by 1920 into arable fields and rangelands dominated by alien species such as *Bromus tectorum*, *Poa pratensis*, and *Salsola kali*¹ (Mack 1986).

This level of destruction is particularly unfortunate because the record of the natural vegetation compiled before 1940 is almost entirely anecdotal. Each plant collector beginning with the Lewis and Clark expedition of 1805-1806 included notes on vegetation along with his herbarium specimens (Thwaites 1905). But these

early explorers seldom mentioned the region's vegetation and physical environments except in reference to their own hardships. For example, in 1841 Brackenridge trekked along the northern rim of the Columbia Plateau (McKelvey 1955). Neither his notes nor those of Geyer (1846) are little beyond a diary of the plants seen each day. Resident plant collectors such as Suksdorf (1892) compiled much of the regional flora but provided little ecological information. No detailed commentary was prepared of unplowed grasslands until Griffiths (1902) and Cotton (1904) examined the Okanogan Valley and northern half of the Columbia Basin, respectively. The first ecological investigation that included quantification was not conducted until 1913 and was restricted to Whitman County (Weaver 1917). Shantz's commentary on the regional vegetation was based on a rapid trip that was largely restricted to railways (Shantz and Zon 1924). Comprehensive study of the steppe vegetation in Washington did not begin until 1937, culminating in Daubenmire (1970).

Given this paucity of information from the 19th century, the recent discovery of a heretofore unknown manuscript based on a botanical survey on the Columbia Plateau in 1893 provides the earliest known account of the original distribution of much of the steppe flora. Unlike other accounts written before 1940, many of the botanical observations in the manuscript can be verified because the field notes and most of the catalogued specimens to which it refers have been preserved. The report was apparently

¹Nomenclature follows Hitchcock *et al.* (1955-69).

written by John B. Leiberg based on the expedition he and J. H. Sandberg undertook as U.S.D.A. field agents in the spring and summer of 1893. The timing of their trip was fortuitous because they would have seen the Columbia Plateau in transition from native steppe to agro-ecosystems. As early as 1893, it was becoming widely recognized that the region's original bunchgrasses (particularly *Agropyron spicatum* and *Festuca idahoensis*) were severely over-grazed and were being rapidly destroyed (e.g., An Illustrated History of Whitman County 1901, Shear 1901). The Union Pacific Railroad had already ended the open range policy on its land in a futile attempt to reduce the damage by itinerant herders (Brodie 1898), and feeble and often misguided attempts were being launched to find substitute forage grasses (Mack 1981).

Despite the potential scientific value of an account of the 1893 expedition, it was not published. Much of the manuscript had been completed by early 1896 because Leiberg then informed C.V. Piper, a botanist at what is now Washington State University that, "I think the report of the Washington collection of '93 will appear next spring, possibly also that of the Oregon trip of '94 and the one in Idaho of '95, but am not sure." (papers of C. V. Piper, in Manuscripts, Archives, Special Collections, Washington State University). In the annual Report of the Botanist (U.S.D.A.) for 1897, Leiberg's report is noted as forthcoming, "...but its publication has been postponed in order to permit the incorporation of the data by now being secured by local botanists in remote portions of the area." Further delay probably resulted from Leiberg's transfer to the U. S. Geological Survey. Leiberg continued his botanical work in the Pacific Northwest (Leiberg 1900), but neither the report for the 1893 trip in Washington nor for his 1894 trip to eastern Oregon was completed before his death in 1911. The appearance of Piper's more comprehensive *Flora of Washington* in 1906 probably signalled the end of any need for further U.S.D.A. botanical surveys. Fortunately, the 122 page typed manuscript of the 1893 trip was preserved in the archives of the now defunct Division of Botany in the National Archives and Records Service.

My paper is based on this unpublished manuscript (Sandberg and Leiberg n.d.), the

"Catalogue of plants collected by J. H. Sandberg and J. B. Leiberg in Washington during 1893" (Anonymous n.d.), Leiberg's list of plants collected on this trip (unpublished notes in the Archives of the University of Oregon), and the examination of 613 of their 837 vascular plant specimens that are deposited at Washington State University (WS) and the National Museum of Natural History (US). (They also made 44 collections of bryophytes and hepatics that I have not examined.) I will refer throughout this paper to Leiberg's report, thereby acknowledging his authorship of the manuscript.

Leiberg's Report of the 1893 Trip

"Acting under orders from the Hon. Secretary of Agriculture, J. Sterling Morton and the chief of the Botanical Division, Frederick V. Coville to make a collection of the flora of the Plains of the Columbia, to determine its east and west limits and to make observations on the climate, pasture, and agricultural areas of the region, and later in the season to ascend the eastern slopes of the Cascades to the summit of some of the higher elevations, we proceeded to Spokane, Washington, this city having been designated as the outfitting and starting point."

Upon leaving Spokane, Sandberg and Leiberg's first camp was established on May 15 on Hangman Creek south of the city; while based at this site they collected in northern Whitman County and southern Lincoln County. The rest of the trek proceeded in a generally westward direction: at Coal Creek (Camp 4), along Crab Creek (Camp 5, 6, & 7), to Wilson Creek (Camp 8), and arriving at Egbert Spring (near Ephrata) on June 30. They camped on the Columbia River near Rock Island, and then followed the Columbia to its confluence with the Wenatchee River. The rest of the survey was conducted along the Wenatchee River or its tributaries until they camped at the summit of Stevens Pass on 9 August. They stayed up to two weeks at each campsite and made daily collecting trips (Figure 1). At the end of August Leiberg recrossed the Columbia Plateau to Spokane along a more northerly route so as to ensure that no taxa were overlooked. By Leiberg's account they travelled 413 km from Spokane to the summit of Stevens Pass in the Cascade Range in about four months. Including the side trips and daily forays, he estimated that the expedition travelled a total of 2000 km.

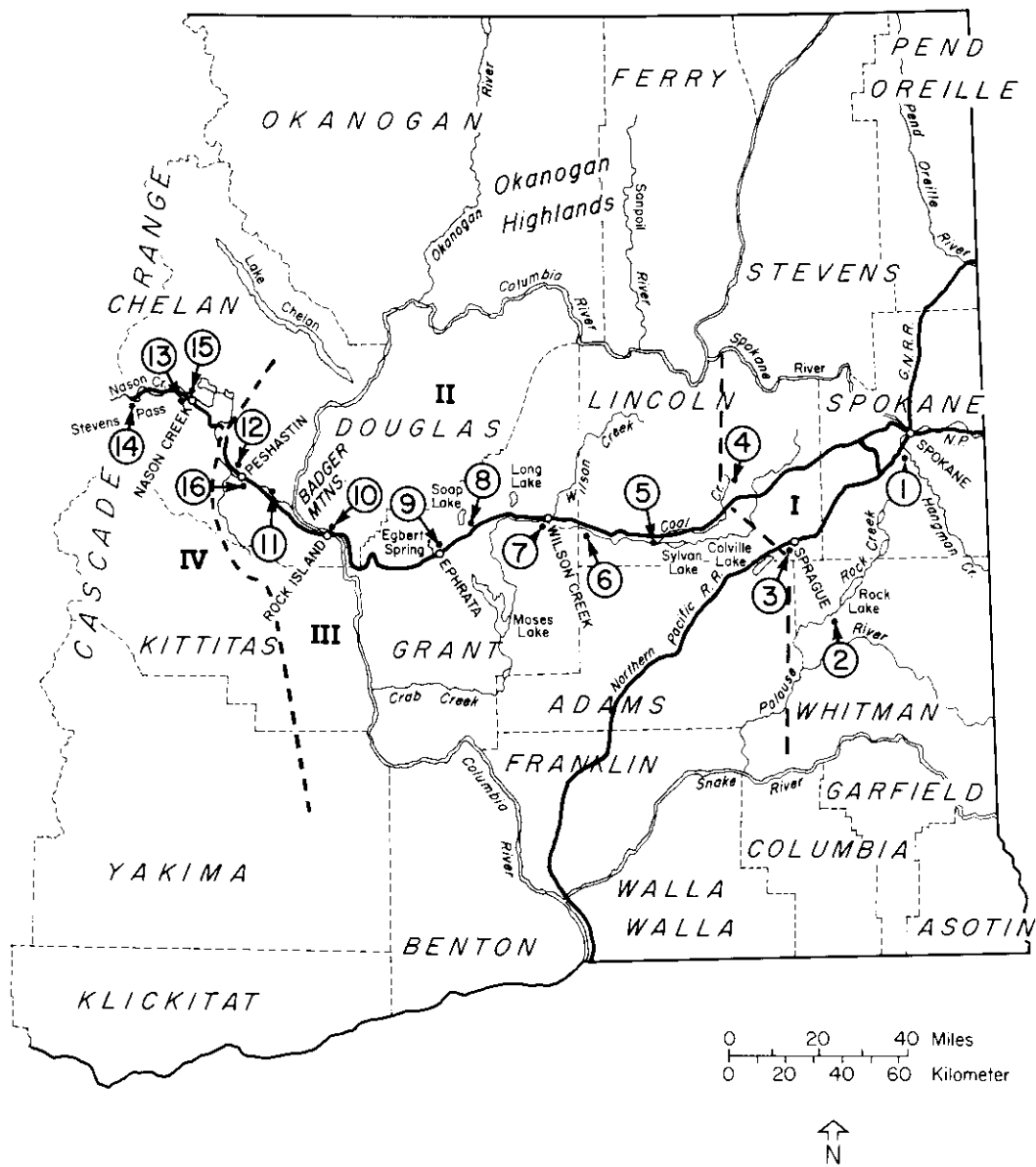


Figure 1. The westward trek of Sandberg and Leiberg's expedition across the Columbia Plateau in 1893 generally followed the roadway of the Great Northern Railroad. The circled numbers indicate Sandberg and Leiberg's designation of their campsites as well as the campsites' locations and the chronology in which the camps were established. Roman numerals refer to their four major botanical districts; the Columbia River is the boundary between Districts II and III.

Compared to earlier collectors Sandberg and Leiberg were more mobile because their wagons could follow the newly-completed roadway of the Great Northern Railway in eastern Washington. Nevertheless, the trek was not easy. In a letter

to C. V. Piper, Leiberg described plant collecting in the region as a slow and arduous process because of the rough terrain and the necessity of carrying supplies to deal with any emergency (papers of C. V. Piper, in Manuscripts, Archives,

Special Collections, Washington State University). Having Sandberg in nominal charge of the venture probably did not help. In 1893 Sandberg was described by a colleague at the University of Minnesota as, "... actually the most disputable botanist I ever had any thing to do with" (E. P. Sheldon letter to C. V. Piper, 1893, in Manuscripts, Archives, Special Collections, Washington State University). Sandberg also seems to have been careless in his note taking. Leiberg reported to Piper that Sandberg's report of 1892 (Holzinger 1895) erred by as much as 240 km in the location of specimens (papers of C. V. Piper, in Manuscripts, Archives, Special Collections, Washington State University).

Despite these difficulties the expedition accomplished its first goal of collecting the flora of the Plains of the Columbia. Even though other botanists had collected in the region, these collections from 1893 yielded at least 20 holotypes or isotypes. Leiberg described several of these new forms, including *Crepis barbiger* Leiberg ex Coville and *Delphinium viridescens* Leiberg. Several taxa were eventually named after Leiberg (e.g., *Erigeron leibergii* Piper, *Astragalus leibergii* Jones). Other taxa for which Sandberg and Leiberg's collections provided type specimens include *Antennaria tomentella* E. Nels. [*A. alpina* (L.) Gaertn.¹], *Arenaria congesta* var. *prolifera* Maquire, *Carex nebrascensis* var. *ultriformis* Bailey [*Carex nebrascensis* Dewey¹], *Carex neurophora* Mackenzie, *Crepis rostrata* Coville [*C. modocensis* ssp. *rostrata* (Coville) Bab. & Stebb.¹], *Distichlis dentata* Rydberg [*D. stricta* var. *dentata* (Rydb.) C. L. Hitchc.¹], *Erigeron poliospermus* var. *cereus* Cronq., *Hymenopappus columbianus* Rydberg [*Hymenopappus filifolius* Hook. var. *filifolius*¹], *Lomatium suksdorfii* var. *thompsonii* Math. [*L. thompsonii* (Mathias) Cronq.¹], *Mertensia brachycalyx* Piper [*M. paniculata* (Ait.) G. Don¹], *Oreocarya spiculifera* Piper [*Cryptantha interrupta* (Greene) Parp.¹], *Poa brachyglossa* Piper [*P. juncifolia* Scribn.¹], *Saxifraga plantaginea* Small [*S. integrifolia* vars. *columbiana* and *leptopetala* (Piper) C. L. Hitchc.¹] and *Viola verbascula* Greene [*V. adunca* Sm. in Rees¹].

The Natural Vegetation of the Steppe

Sandberg and Leiberg were taxonomists, and their geographic divisions of the Columbia Basin were based on floristic, rather than vegetational,

changes they saw as they travelled. Nevertheless, their delineation of four floristic "districts" adjacent to or within the Columbia Basin reveals the general distribution and composition of the natural communities they traversed. Proceeding westward from Spokane, their District I (Figure 1) was a 16-35 km wide belt of open forest, corresponding to the *Pinus ponderosa*/*Festuca idahoensis* zone (Daubenmire and Daubenmire 1968).

They included in District II much of the treeless plain in a 135 to 170 km swath across the northern half of the Columbia Plateau to the Columbia River. This large area encompassed three vegetation zones dominated by shrubby species of *Artemisia*: the *Artemisia tripartita*/*Festuca idahoensis*, the *Artemisia tridentata*/*F. idahoensis*, and the much larger *Artemisia tridentata*/*Agropyron spicatum* zone (Daubenmire 1970). District III delineated the vegetation from the Columbia River on the Douglas-Chelan County border to continuous forest about 30 km further west; a combination of the *A. tridentata*/*A. spicatum* zone and stands dominated by *Pinus ponderosa* (Daubenmire and Daubenmire 1968) (Figure 2). A fourth district included the mesophytic forests on the east side of the Cascade Range to its summit at Stevens Pass.

District I

The forest-steppe boundary in eastern Washington still retains the major features that Sandberg and Leiberg saw: open stands of *Pinus ponderosa* with understory dominants of either xerophytic grasses on zonal soils or mesic shrubs along the stream courses. They found that *Abies grandis* and *Pseudotsuga menziesii* were common associates along with *Betula occidentalis*, *Populus trichocarpa*, *Populus tremuloides* and *Salix lasiandra* var. *caudata*. Shrubs in these communities, especially near the stream edge, included *Ribes aureum*, *Salix* spp., *Sambucus cerulea*, and *Symphoricarpos albus*. *Crataegus douglasii* was also present, but Leiberg did not mention the extensive *Crataegus* thickets that Daubenmire (1968) reports occupying the stream courses further south in Whitman County. Perhaps wild fires set by the settlers had already eliminated these stands by 1893. Leiberg viewed the understory in these stands as a mixture of montane species at their western limits (*Arnica cordifolia*, *Ranunculus uncinatus*, *Smilacina stellata*) and steppe species more prevalent to the west

(e.g., *Eriogonum compositum*, *Eriogonum niveum*, *Polemonium pectinatum*). Sandberg and Leiberg found alkaline ponds invariably fringed by *Hesperochiron pumilus*; it was sometimes so abundant that in flower it appeared "... to whiten the ground as with a fall of snow." In contrast, Hitchcock *et al.* (1959) state that *H. pumilus* seldom if ever occurs on alkaline soil.

District II

This floristic unit included the bulk of the Columbia Plateau and contained communities on zonal soils dominated by *Purshia tridentata* and *Artemisia tridentata* with xerophytic grasses in the understory. Leiberg found these two shrubs "immensely abundant, especially in the middle and western portions of this section." Other arid shrubs included *Artemisia cana*, *Artemisia frigida* and *Artemisia rigida*. *Chrysothamnus viscidiflorus* was confined to the middle and western portions of the district, while *Sarcobatus vermiculatus* occurred around the margin of alkaline ponds. Grasses were clearly the co-dominants in all these communities. Aside from stating that *Agropyron spicatum* was the most prominent grass in this district, Leiberg gave no indication of the role of other grasses. Grasses he simply listed as occurring within District II include *Aristida longiseta*, *Bromus secalinus*, *Deschampsia danthonioides*, *Festuca microstachys*, *Festuca ovina*, *Koeleria cristata*, *Oryzopsis hymenoides*, *Poa sandbergii*, *Sitanion hystrix* and *Stipa comata*.

Leiberg also listed a diverse herbaceous understory in the upland communities on the northern Columbia Plateau. Prominent or frequently encountered species were *Antennaria dimorpha*, *Antennaria stenophylla*, *Astragalus collinus*, *Crepis atrabarba* var. *atrabarba*, *Crepis occidentalis*, *Erigeron filifolius*, *Eriogonum thymoides*, *Eriophyllum lanatum*, *Lagophylla ramosissima* and *Leptodactylon pungens*. *Balsamorhiza sagittata* is replaced by *B. careyana*. Many other species are listed but without any information on their abundance or distribution in the district.

Rhus glabra was common on the rocky slopes of the Columbia River in Douglas County as well as along the Spokane River. These records suggest that stands with *R. glabra* were once more extensive than reported by Daubenmire (1970). *Abies grandis*, *Pinus ponderosa* and *Pseudotsuga menziesii* were rare and confined to the bottom

of coulees, talus slopes, and pond margins. *Juniperus occidentalis* was confined to the shoreline on the east bank of the Columbia River. These stream communities also contained many shrubs, including *Ribes aureum*, *Rosa woodsii*, and *Salix scouleriana*. *Alnus incana*, *Crataegus douglasii* and *Cornus stolonifera* were present only in the eastern portion of the district.

Sites with high salt content in valley bottoms supported a unique flora that could tolerate these alkaline and often water-logged soils. *Heliotropium curassavicum*, a borage, was widely distributed among these sites. Other species found were *Atriplex argentea*, *Distichlis stricta*, *Eurotia lanata*, *Iva axillaris*, *Myosurus minimus*, *Scirpus americanus*, *Scirpus nevadensis*, and *Spergularia marina*. Although Daubenmire (1970) recognized several associations on alkaline soils (e.g., *Elymus cinereus/Distichlis stricta*; *Sarcobatus vermiculatus/Distichlis stricta*), Leiberg made no distinction between the communities the expedition saw on these azonal soils.

Sandberg and Leiberg encountered sand dunes at three locations. One dune set at the southern end of Moses Lake was approximately 50 km south of the expedition's main route. For this site and the other dune sets they visited Leiberg merely listed the flora without commenting on relative abundance or distribution. The flora at the Moses Lake dunes included *Agropyron dasystachyum*, *Arenaria franklinii*, *Oenothera pallida*, *Orobanche fasciculata*, *Oryzopsis hymenoides*, *Phacelia glandulifera*, *Psoralea lanceolata*, *Rumex venosus* and *Coldenia nuttallii*. The species lists Sandberg and Leiberg compiled largely agree with the results of a reconnaissance Daubenmire (1970) made on a similar dune set in southern Franklin County.

Despite detailed floristic lists, Leiberg apparently did not detect the sharp E-W boundaries among communities that Daubenmire (1970) recognized. For example, in moving from their second to third campsite he apparently failed to notice a major change in the vegetation from the mesic sites supporting the *Symphoricarpos albus/Festuca idahoensis* association to the more arid sites dominated by the *Artemisia tripartita/F. idahoensis* association. He also took no apparent notice of crossing from the communities in Lincoln County dominated by *A. tripartita* into the much larger zone to the west dominated by *Artemisia tridentata* (Figure 2).

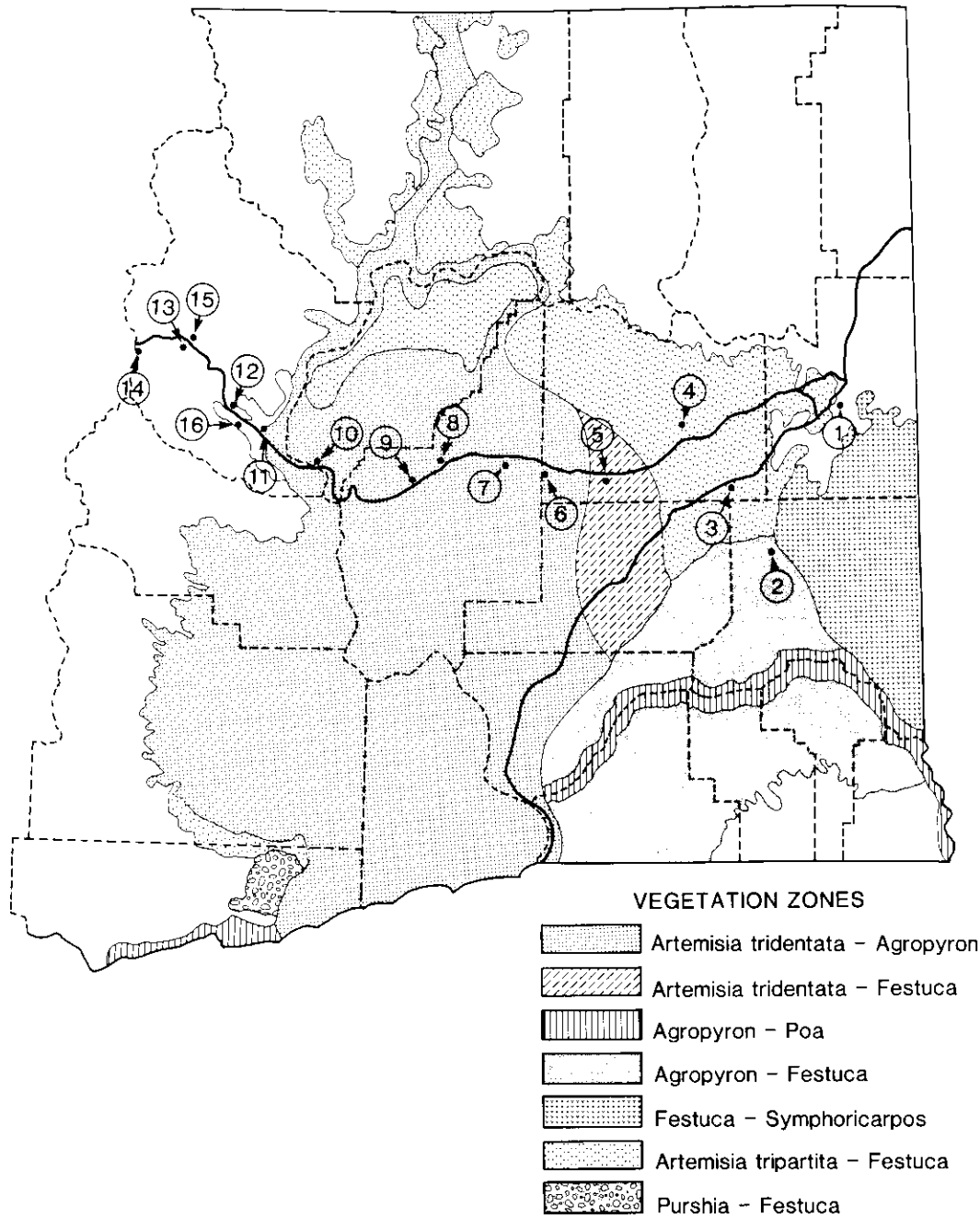


Figure 2. The westward trek of Sandberg and Leiberg's expedition across the Columbia Plateau in relation to the steppe zones according to Daubenmire (1970).

District III

Entering the Columbia River Valley at the Douglas-Chelan County boundary the expedition encountered outliers of the forests that cover the Cascade Range. The flora in their District III reflects the transition between steppe and coniferous forest: open forests of *Abies grandis*, *Pinus ponderosa* and *Pseudotsuga menziesii* occupied the north and west facing slopes, while steppe communities dominated by *Artemisia tridentata* and *Purshia tridentata* occupied the south and east slopes in a 11-13 km wide swath. Shrubs (e.g., *Acer glabrum* var. *douglasii*, *Ceanothus velutinus*, *Ceanothus sanguineus*, *Spiraea douglasii*) extended from the stream courses into these open forests. Although this district included extensive overlap in the distribution of species more typical of the steppe or forest, Sandberg and Leiberg recognized some characteristic herbaceous species. These included *Aster conspicuus*, *Erigeron divergens*, *Lomatium nudicaule*, *Madia sativa*, *Phacelia pro-cera*, *Solidago missouriensis* and *Stachys mexicana*.

District IV

This district encompassed most of the forests in the Cascade Range, a diverse array of forest communities that Sandberg and Leiberg did not differentiate in detail. Their general description of the elevational distribution of major conifers agrees however with the modern distribution of the forest communities and requires no elaboration: *Pinus ponderosa* and *Pseudotsuga menziesii* dominating communities at the lower elevations; *Abies lasiocarpa* and *Pinus albicaulis* at higher elevations. *Tsuga mertensiana* and *Thuja plicata* occurred along stream courses.

Leiberg was much impressed with the extent to which the forests on the eastern slope of the Cascade Range were being destroyed by fire. He remarked that these forests, "... are in a much more rapid and thorough process of extermination than in any other portion of the Pacific Northwest." So extensive were the fires set by prospectors that one could, "Climb any peak in a supposed or proved mineral district during the summer, and you will see the clouds of smoke from the burning forests roll up from many a valley or mountain side." Fires were also started accidentally by trains and settlers. Burned sites

often displayed poor tree regeneration for years after a fire and were instead dominated by grasses or shrubs. If the prominence of fire along Sandberg and Leiberg's route was representative of the extent of 19th century burning on the eastern slope of the Cascade Range, this area would have supported few mature forest stands even before wholesale logging in the 20th century.

The Agricultural Setting

Much of the Columbia Plateau is in the rain shadow of the Cascade Range. As a result, annual precipitation is lowest at the eastern base of these mountains but rises eastward. In an era in which irrigation was confined to small systems of ditches in river valleys, the Basin's agriculture was dictated almost completely by this orographic influence. Within the area they trekked, Sandberg and Leiberg found the most extensive agricultural areas in northern Douglas County and northern and eastern Lincoln County. West of southern Lincoln County wheat fields were confined to the valleys, and they saw only one small irrigated field west of Camp 7. Throughout the region, wheat was the main cereal grown, followed by oats, barley and corn. Rye was locally prominent in eastern Washington.

The flanks of the Columbia and Wenatchee Rivers were primarily devoted to orchards and gardens. In 1893 most of the Plateau had been farmed less than 20 years, and Sandberg and Leiberg's list of the crops they saw reflects the newly-arrived farmers' wholesale experimentation. Orchard crops included apples, pears, plums, cherries, peaches, grapes, raspberries, gooseberries, currants, blackberries, strawberries, and mulberries. The list of row crops was even more extensive: peas, beans, carrots, turnips, parsnips, onions, beets, cabbage, celery, asparagus, lettuce, potatoes, parsley, squash, melons, pumpkins, cucumbers, cauliflowers, tomatoes, radish, and mustard. Hops were also being grown, but as Leiberg assiduously pointed out their role was "as [an] ornamental plant only."

Attempts were also being made to raise trees in "tree claims," i.e., small trials of ornamental trees, on the largely treeless Columbia Plateau. *Acer negundo*, followed by *Robinia pseudoacacia*,

and cultivated *Populus* spp. were the most commonly planted species. Almost all the Box elders Sandberg and Leiberg examined in these trials were dead or dying, while the locust and the poplars appeared much more successful.

Alteration of the Steppe

Even by 1893, the combined effects of livestock, cereal agriculture and the importation of alien plants were causing extensive alteration of the steppe (Mack 1981). Sandberg and Leiberg were in the unique position to assess the effect of these alien species as well as the response of the native flora to recurring disturbance. Much of the grazing area in eastern Washington was already fenced and overgrazed. The pattern of overgrazing was more localized in the central and western parts of the Columbia Basin because livestock could not venture far from the few water holes. As a result, large tracts still remained largely ungrazed.

In Leiberg's opinion, few native species even tolerated grazing; fewer still persisted on a site after it was plowed even once. Lacking thorns or other protective structures, many plants were destroyed through grazing and trampling. Still others, such as *Lomatium* spp. and *Camassia quamash* were rooted up and eaten by hogs. Exceptions were *Geranium viscosissimum*, because of the viscous trichomes that cover the plant, and *Balsamorhiza sagittata* with its coarse leaves. Other species he considered able to resist grazing were *Chrysothamnus nauseosus* and *Chrysothamnus viscidiflorus*; both are still prominent members of frequently grazed rangelands (Daubenmire 1970).

In contrast, a few native species were becoming more prominent as a result of increased disturbance. Among these species were a "few Astragali, a *Gilia* or two, and above all *Sisymbrium incisum* [*Descurainia richardsonii*], which becomes the most ubiquitous and pestiferous of all in run down pastures and impoverished soil generally." *Amsinckia intermedia* and *Lappula redowskii* were both weedy plants and were "excessively common along roadsides and around houses, though not at all conspicuous in the unbroken soil of the plains." *Deschampsia danthonioides* and *Festuca microstachys* were "invariably the species that replace" more palatable species; the fescue already occupied much of the

Columbia River Valley because of grazing. In addition, *Descurainia californica* and *Gnaphalium palustre* had also become prominent with livestock grazing and trampling. The roles Leiberg attributed to *A. intermedia* and *D. californica* are surprising because Hitchcock *et al.* (1959, 1964) consider both species rare in the Pacific Northwest. *Lupinus sericeus* became weedy and robust in abandoned or uncultivated fields. *Matricaria matricarioides*, one of the few natives of the Pacific Northwest that has become naturalized elsewhere (Baker 1972), was also part of this native weed flora.

Despite apparent increases in the abundance or distribution of a few species, the overall prominence of the native flora already seemed to be diminishing: "The native plains flora is rapidly disappearing around the cultivated areas, very much more rapidly and thoroughly than seems to be the case east of the Rockies. It does not as a whole appear to possess much resisting power and when brought into competition with eastern invaders generally succumbs." Among the naturalized species were *Amaranthus albus*, *Amaranthus retroflexus*, *Anthemis cotula*, *Artemisia vulgaris*, *Bromus secalinus*, *Bromus mollis*, *Vaccaria segetalis*, *Verbascum thapsus*, and *Erodium cicutarium*, which had arrived on the Columbia Plateau at least 50 years earlier (Mack 1986). The common sunflower (*Helianthus annuus*), a common escape from cultivation, had already become established on river banks in the Columbia Valley and occurred locally on upland sites. Other alien species they collected on the Columbia Plateau include *Alopecurus pratensis*, *Barbarea vulgaris*, *Capsella bursa-pastoris*, *Lactuca serriola*, *Rumex crispus*, *Stellaria graminea*, and *Xanthium strumarium*. Sandberg and Leiberg encountered less than half the alien species Suksdorf (1892) listed for southcentral Washington. This difference probably reflects the comparatively recent settlement of the area through which they passed compared to the lower Columbia River Valley where Suksdorf resided.

Somewhat paradoxically Leiberg did not foresee a rise in the prominence of alien plants despite the weak ability of the native species to tolerate disturbance: "In general the native flora when exterminated is not abundantly replaced by weeds from elsewhere, and such immigrants as are present do not show any troublesome feature or appear in sufficient quantities to be

of economic importance in any locality along our route." The situation was soon to change drastically. By 1929 there were about 200 alien species on the Columbia Plateau, and vast areas had already become dominated by alien plants (Mack 1986).

Among Sandberg and Leiberg's collections was the alien species most characteristic of this regional transformation in the vegetation, *Bromus tectorum* (cheatgrass). Their collection (No. 191) of cheatgrass near Ritzville is the earliest record of this grass in the Pacific Northwest south of British Columbia. Cheatgrass probably arrived by several means, but it may have first entered the region as a seed contaminant in wheat because Ritzville was the center of an early wheat-growing district. This grass was repeatedly introduced in the region, and by 1930 it had become a dominant in the steppe of the Intermountain West (Mack 1981).

Leiberg's Observations on the Regional Geology

A plant taxonomist's study of the regional geology was not within Sandberg and Leiberg's instructions. Not surprisingly Leiberg often gave a contemporary explanation or his own interpretation for the origin of much of the regional geology. He incorrectly believed that much of the underlying granitic rock in the Columbia Basin had been metamorphosed. In addition, he erroneously assumed (along with most of his contemporaries) that the region's loessal soils were derived from the underlying basalt.

Leiberg did however correctly interpret the eastern Washington landscape as having been extensively, although indirectly, altered by glaciation. "Coulees"—dry waterfalls, obviously carved into basalt by tremendous fluvial action—are conspicuous in eastern Washington. Leiberg speculated that the coulees were widened and accentuated along previously-formed cracks in the basalt, through which water passed in the "glacial epochs." He hypothesized that the Columbia River had been dammed temporarily south of its juncture with the Methow River and that the river then overflowed its banks, discharging water over the plains with enormous erosional force. Leiberg correctly interpreted the large amounts of "boulder drift" (till) and granitic gravels as representing considerable water

transport from above the Columbia River. Flooding on the scale Leiberg envisioned did occur in the Pleistocene, but the damming was not confined to the Columbia River. Ice lobes of Cordilleran ice dammed several rivers in the region, most notably the Clark Fork to the east. The numerous basalt boulders in northwestern Douglas County that he believed had been moved by a stream with extremely high carrying capacity are instead erratics left from the terminal moraine on the Okanogan lobe in the late Pleistocene (Richmond *et al.* 1965). Despite the shortcomings in some of his geological interpretations, it is nonetheless remarkable that Leiberg envisioned the major events associated with scabland flooding more than 25 years before the appearance of the first of Bretz's classic reports (1923, 1959).

Conclusion

Any further erection of dams along the Columbia River, construction of highways and gaslines, and the ambitious plans to expand the acreage under irrigation in the Columbia Basin will inevitably increase the value of Sandberg and Leiberg's collections and Leiberg's account. The biological loss caused by this activity can be dimly perceived by realizing how inaccurate our understanding of plant distribution and community organization would be if botanical inquiry on the Columbia Plateau had begun in the 1980's instead of almost one hundred years earlier. The geographical limits to the distribution of *Artemisia tridentata*, the diversity and composition of many of the lithosolic and riverine communities, and the role of native species in succession would be virtually impossible to decipher if based on the modern remnants of the vegetation (Daubenmire 1970, Mack 1981). How many misconceptions about the ecology of any region have been unwittingly introduced in the literature through our failure to realize that the landscapes we study have often been extensively altered before serious investigation began? To ignore the historical record, however fragmentary, is to increase unnecessarily these misconceptions.

Acknowledgments

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