Kalmiopsis

Journal of the Native Plant Society of Oregon

Juniper Canyon, Umatilla County, Oregon.

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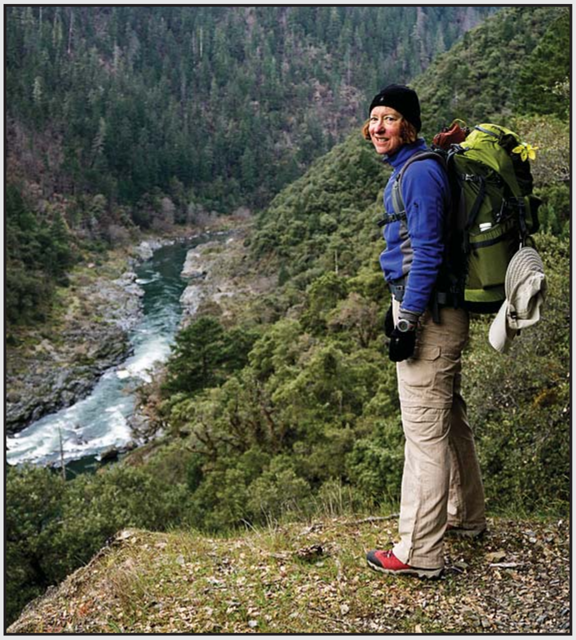
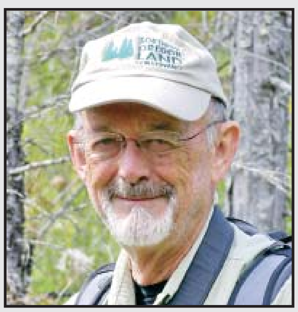
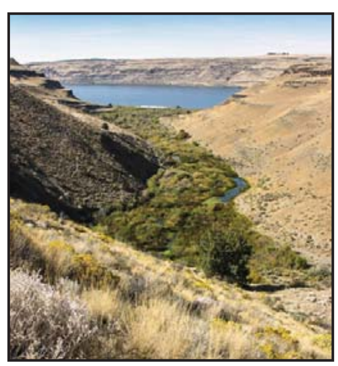




Editorial

Two years have passed since my last editorial in which I resigned from the position of editor and, yet, here I am finishing another issue of *Kalmiopsis*. I'm pleased with this final issue. It has the breadth and depth that I strive for in each issue. Subjects range from Wallula Gap in far northeastern Oregon to the remote Owyhee region of southeastern Oregon; north to south along the salt-sprayed rock bluffs of the Pacific coast and along the crest of the Cascade Range that divides western and eastern Oregon. The Plant of the Year is sea bluff bluegrass and the Oregon Plants, Oregon Places article highlights Juniper Canyon in Umatilla County. Two articles give details of newly described species in Oregon, *Fragaria cascadensis*, *Lomatium bentonitum* and *L. ravenii* var. *paiutense*.

As of yet, no one has volunteered to take over as editor of our Society's journal, but this year I have no unfulfilled promises to authors, so I can retire. In the interim I've made one change to transition *Kalmiopsis* into the future. When it was clear that no one wanted to store old issues anymore, Kareen and I heaved the paper archives into the recycle bin, an experience that was transforming for me. I vowed that future issues would be entirely electronic. Beginning this year, *Kalmiopsis* will not be printed, but is available online for anyone to print an article or file a PDF on a computer or tablet for future reference. Not only is this approach environmentally justified, but it saves NPSO the cost of printing and mailing. At the same time, the journal continues to provide a record of Oregon's rich botanical legacy. Perhaps the next incarnation of *Kalmiopsis* will be a blog or an app. It will please me immensely if someone volunteers who has the skills and passion to carry it forward. —*Cindy Roché, Editor*.



Cover Photo: Juniper Canyon is part of the McNary National Wildlife Refuge in Umatilla County, Oregon. Photo by Robert Carson.

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Members of the Native Plant Society of Oregon and others are invited to submit articles, book reviews, artwork, and photographs for publication in *Kalmiopsis*. All materials submitted should pertain to Oregon's native vegetation and flora. Acceptance will be based on suitability (articles dealing with formal nomenclatural proposals or of a highly technical nature are not acceptable). *Kalmiopsis* publishes two series articles: *Plant of the Year* and *Oregon Plants, Oregon Places*. We also publish articles about botanical history and features related to native plants or plant communities in Oregon.

Please consider that the readers of *Kalmiopsis* are people with varied educational backgrounds and all articles must be comprehensible to a broad, but relatively well educated, audience. The goals of *Kalmiopsis* are to disseminate correct information about and generate interest in native plants; thus each article is reviewed by the editorial board and selected technical reviewers before publication.

Contributions of artwork and photographs without accompanying manuscripts are welcome; color submissions must be suitable for publication in grayscale. Contact the *Kalmiopsis* editor to request a copy of Instructions to Authors or to inquire about the suitability of an idea for an article.

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Juniper Canyon, Wallula Gap: An "Oasis in the Desert"

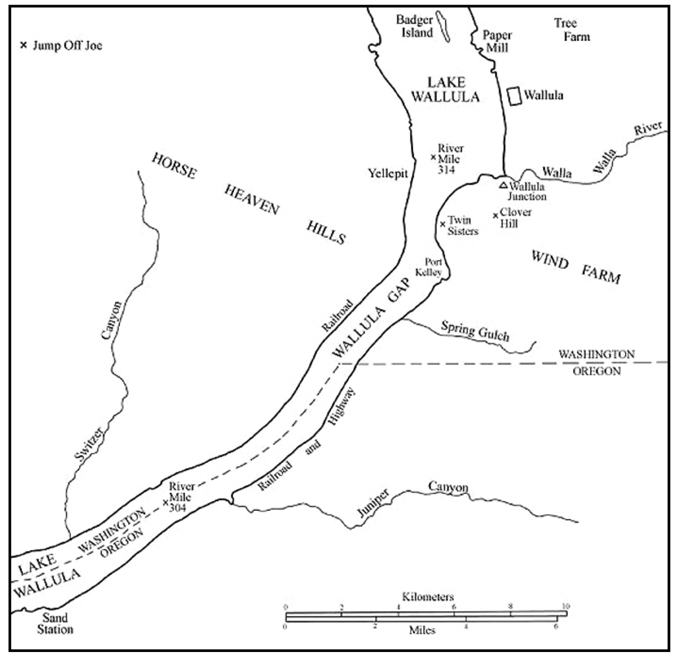
Marin Axtell, Chelsea Cordell, Heidi Dobson, Bob Carson
Whitman College, Walla Walla, Washington

Mike Denny
Walla Walla Community College, Walla Walla, Washington

"Where the Great River bends" is where the mighty Columbia turns west toward the Pacific Ocean to form the boundary between Washington and Oregon. This locality, known as Wallula Gap, is unusually rich in natural and human history. On the southeast side is Juniper Canyon, where a creek enters the Columbia River in Umatilla County, just south of the Washington border. A popular destination for spring wildflower hikes for members of the Washington Native Plant Society, Juniper Canyon is not (yet) well known by Oregon botanists.

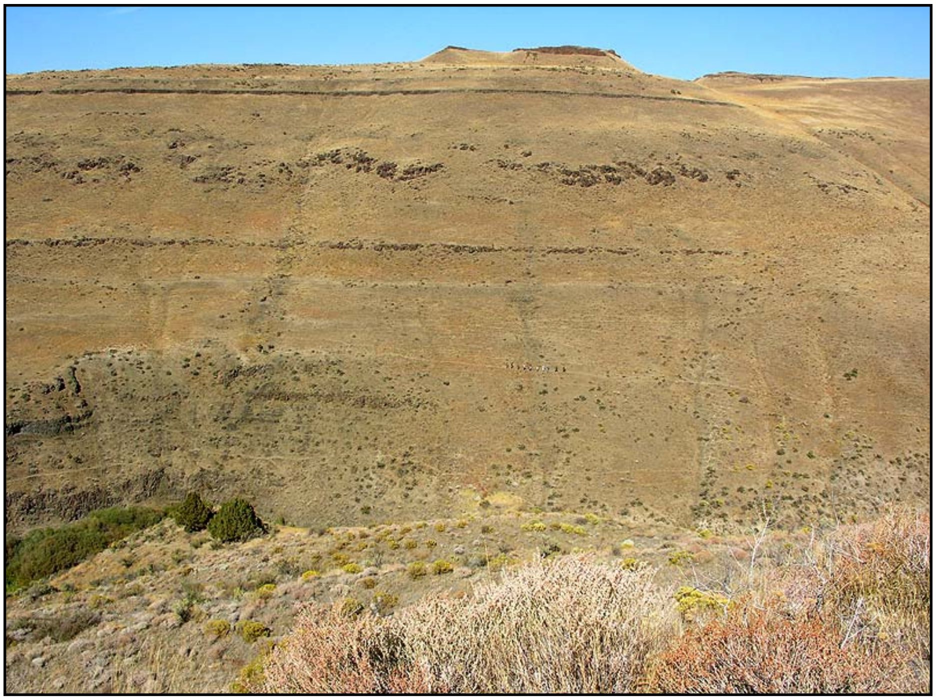
Carson (2008) described Wallula Gap as an "oasis in the desert" because the vegetation adjacent to Juniper Creek differs completely from the upland vegetation: "Wallula Gap is part of a desert, yet there are beavers. Wallula Gap has no mountains, yet there are bighorn sheep. The bedrock is all basalt, yet there are granitic boulders" (Carson 2008). This region of the Columbia Plateau receives an average of only six inches of precipitation a year. Although many people think of it as a desert, much of eastern Oregon and Washington is shrub steppe (dry grassland with a shrub overstory) or bunchgrass steppe. Here, low rainfall combined with high summer temperatures, cold winters, and desiccating winds have selected for plants adapted to survive in an arid environment.

The Columbia River at Wallula Gap has been known as Lake Wallula since it was impounded behind McNary Dam in 1954. When the McNary National Wildlife Refuge was established in 1956 to mitigate lost wildlife habitat, Juniper Canyon was selected as one of three parts of the Refuge. The stream and wetland provide critical habitat for migratory waterfowl, as well as a diverse array of plants, lichens, and other animals. Juniper Canyon is a patchwork of public and private land; the US Fish and Wildlife Service manages the bottom of the canyon for most of the lower six miles of Juniper Creek. The flanks of the canyon are privately owned and used for grazing. The current rancher allows public access across his land for hiking. Upstream, easements for a power line and a pipeline cross the canyon approximately 2.5 and 5 miles east of US Highway 730.



Map of Juniper Canyon area. Prepared by Bob Carson.

Juniper Canyon appears as a green "oasis in the desert" on Google Earth© imagery. Accessed online by Marin Axtell.



View looking north from the south side of Juniper Canyon. In the foreground are snow buckwheat and rabbitbrush, with two junipers growing on sandy soil farther down the north-facing slope. In the background, the relatively barren, hot south-facing slope has thin, silty soil over horizontal lava flows. The Missoula floods created scablands at the top of the highest basalt outcrops by scouring the soil away. Raging waters also left a granitic boulder resting just beneath the saddle between the two scabs. Look carefully to see the line of ten hikers. Photo by Bob Carson.

The plants, animals, and geology make this canyon a fascinating place for hiking and nature study. Carson and Denny have been studying and leading field trips into Juniper Canyon for decades and have written chapters for a book published by Keokee Press with a grant from the National Park Service, *Where the Great River Bends: a natural and human history of the Columbia at Wallula* (Carson 2008). Juniper Canyon has been the subject of three senior theses at Whitman College (Leslie 2008, Axtell 2014, Cordell 2014). The two recent ones are a floristic study under the guidance of Professor Heidi Dobson.

Because the underlying geology of Juniper Canyon is the basis for its ecological diversity, Carson begins this paper with an overview of its geologic history. Then Dobson, Axtell, and Cordell describe the plant communities in the canyon, and Denny's description of the natural history through one revolution around the sun completes the article.

Geology of Juniper Canyon: a landscape built by lava flows, sculpted by water and wind

The headwaters of Juniper Creek begin near Vansycle Canyon, about 15 miles east-southeast of Wallula Gap. The two forks of Juniper Creek originate at an elevation of approximately 2,000 feet,[1] where they carve into wind-deposited soil (loess). The creek works its way westward, gradually cutting down into the basalt flows, then into remnants of an immense gravel bar on both sides of the canyon, and finally into sand dunes that flank the south side of the canyon. In the final mile above its mouth, Juniper Creek forms a partially natural wetland augmented by water impounded by McNary Dam.

Lakes of lava

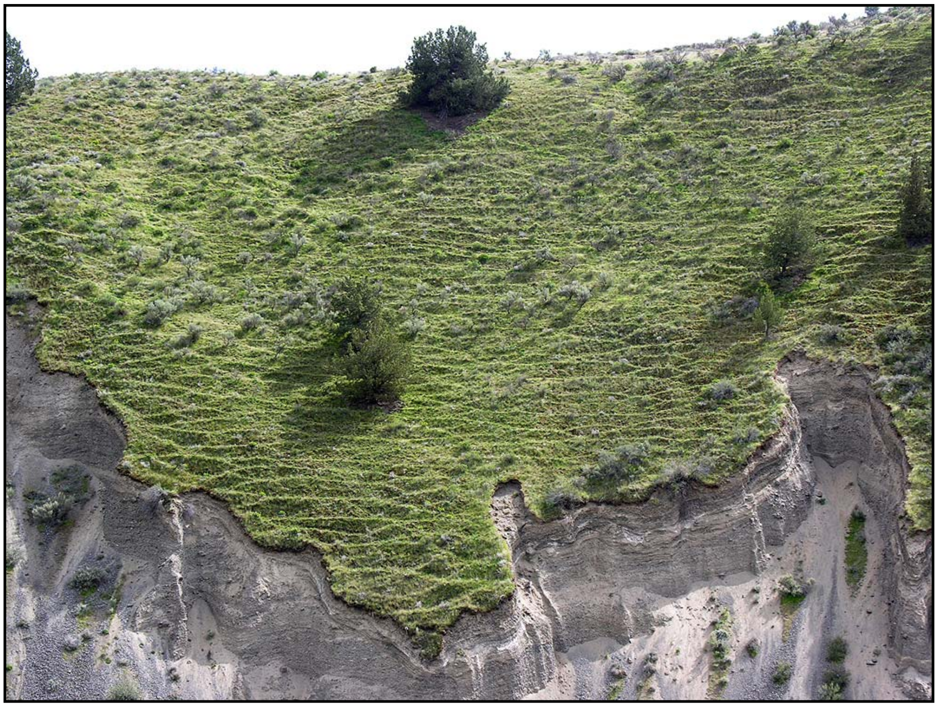
About 16 million years ago, large fissures opened and, until 6 million years ago, massive amounts of lava poured periodically across the landscape. The basalt flowed in a generally westward direction, filling the area between the Rockies and Cascades to make the Columbia Plateau. Movement of the earth's crust wrinkled these basalt flows into anticlines and synclines known as the Yakima Fold Belt.

Although the Columbia River now flows through Wallula Gap, 15 million years ago its course was farther west against the Cascades where lava flows had pushed it. The Clearwater-Salmon River flowed from the east across the basalt flows and crossed at the lowest point of the Horse Heaven Hills, an anticlinal ridge stretching all the way from the Cascades to the Blue Mountains. As this anticline grew upward, the Clearwater-Salmon River cut Wallula Gap. The evidence is at 1140 feet at the top the west rim of the gap where an 8.5 million-year-old lava flow lies over gravels that originated in the Clearwater and Salmon drainage basins. As the anticlines of the Yakima fold belt grew upward and eastward, the Columbia River was forced eastward, eventually being captured by the Clearwater-Salmon River. Much later, perhaps 2.5 million years ago, the Salmon River captured the Snake River, adding its discharge to the Columbia River that now flows through Wallula Gap.

Walls of water

The Pleistocene Ice Age began about 2 million years ago. Colder glaciations alternated with warmer interglaciations, during which the climate was like that of today. Every 100,000 years or so, glaciers from the mountains of British Columbia coalesced to form the Cordilleran Ice Sheet, which advanced south into northern Washington, Idaho, and Montana. Often, a lobe of this ice sheet dammed the Clarks Fork River, creating an enormous lake in western Montana known as Glacial Lake Missoula. Although this lake formed many times in the last million years, we know the most about the consequences of the last occurrence. When Lake Missoula reached a depth of about 2,000 feet, it floated the ice dam. This triggered a sudden release of massive amounts of impounded water, thus an enormous flood. This Missoula flood raced southwest across eastern Washington until it reached the bottleneck of Wallula Gap. About 900 feet of water poured through Wallula Gap at 60 miles per hour. Even so, the gap acted as a hydraulic dam that created a temporary lake with an elevation of 1200 feet in the Pasco Basin. At Wallula giant eddies swirled at the mouths of every tributary canyon, including Juniper Canyon, depositing huge gravel bars. Icebergs from the disintegrating ice dam rushed downstream, carrying rocks that had been plucked by glaciers crossing the landscape. Some of these icebergs were stranded in the tributary canyons, depositing boulders as they

1 Surface elevation of Lake Wallula is 340 ft.



Most of the gravel deposited in Juniper Canyon by the Missoula floods has been eroded or buried in sand. Here, at the outside of a bend of Juniper Creek, the gravels are exposed. Photo by Bob Carson.

melted. Two large granitic erratic boulders rest on the north side of Juniper Canyon, one near the east end of the wetland, the other at an elevation of about 1000 feet between two large outcrops of basalt.

Glacial Lake Missoula drained, but the ice re-advanced to block Clarks Fork again within 50 years. This ice dam created another lake, which then ruptured, sending another flood ravaging across eastern Washington. This cycle repeated 80 to 100 times from about 18,000 to 15,000 years ago. Gravel bars in the tributary canyons grew to 600 feet thick. Despite its small size, Juniper Creek eroded most of the gravel in its valley over the course of 15 thousand years. A good exposure of the remaining gravel exists on the outside of a meander bend of Juniper Creek near the beaver ponds; it is best seen from the north side of the creek.

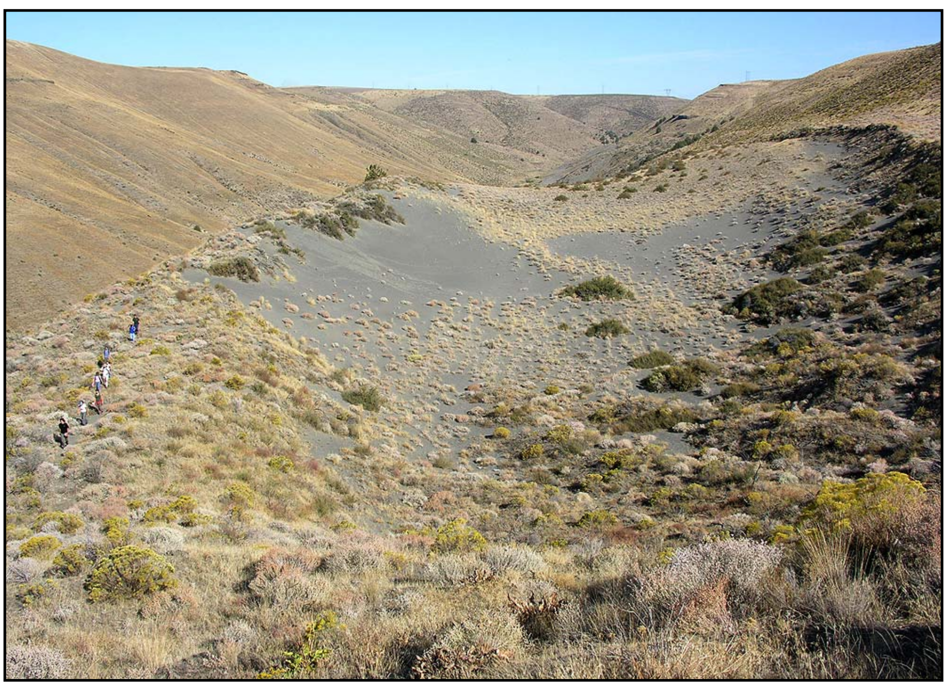
Soil from the sky

As the rocks at the bottom of the Cordilleran Ice Sheet were dragged over bedrock, abrasion made silt-size fragments of rock flour in the glacial meltwater. Much of this silt was deposited in the Pasco and Umatilla Basins, where it was picked up by the prevailing southwesterly winds and deposited as a blanket of loess on the Horse Heaven Hills and the Palouse Hills to the northeast. This is the source of the silt loam soil that caps the uplands north and south of Juniper Canyon.

The Missoula floods also deposited sand in the Pasco and Umatilla Basins. Prevailing southwesterly winds blew sand from the Umatilla Basin and from sandbars along the Columbia River toward the Horse Heaven Hills, leaving a large sand deposit on the south side of Juniper Canyon. Some of sand landforms are transitional between parabolic dunes and blowouts. The features resemble blowouts in that the wind has eroded hollows in the sand; the sandy ridges at the edges of the blowouts are like parabolic dunes. Unlike silt, which may become airborne, wind-blown heavier sand particles remain close to the ground. Even though wind moved the sand northeast, it fell into Juniper Creek before reaching the north side of the canyon.

About 7700 years ago, Mt. Mazama (now Crater Lake) in the southern Oregon Cascades erupted violently, spewing volumes of ash that was blown far to the northeast; some was deposited on the Horse Heaven Hills. Rain washed the ash off the hillsides and down into the channel of Juniper Creek.

As the water in the reservoir behind McNary Dam (downstream on the Columbia River in the Umatilla Basin) rose, it inundated the lowermost part of Juniper Canyon. This small arm of the reservoir became filled with sediment deposited by Juniper Creek and was colonized by plants. As beavers dammed Juniper Creek, the wetland extended upstream.



Naturalists hike along the north rim of a sand dune, a combination of an erosional blowout on the south side and a parabolic dune on the north side. In the distance sits another sand dune on the north-facing side of Juniper Canyon. Photo by Bob Carson.

The puzzle of the giant stairs

The trail along the south side of Juniper Canyon crosses five benches topped with a thick layer of sand (Carson 2014). These terrace-like landforms resemble a short flight of giant stairs. The treads are 120 to 200 feet wide and more than 1000 feet long; they slope upvalley 4 to 5% toward the northeast. The risers slope 24 to 43% to the northwest and are 40 to 60 feet high.

Several explanations of the origins of these giant steps don't survive careful scrutiny. These benches are not likely bedrock buried by sand because, while the basalt flows here are nearly horizontal, the benches are not. If the benches in Juniper Canyon are merely thin sand overlying eroded basalt flows, the benches would also be horizontal.

Nor is the explanation plausible that they are terraces that were deposited or eroded by the Missoula floods, because all known gravel eddy bars slope downvalley, not upvalley as these do. It is unlikely that they are strath or alluvial-fill terraces eroded or deposited by Juniper Creek, because stream terraces also slope downvalley.

Another possibility is that they are slumps (a type of landslide) caused as Juniper Creek cut its valley and reduced lateral support for the hillsides. Geologic materials like the basalts, gravels, and sands in Juniper Canyon are not usually susceptible to mass wasting, and the benches here seem too regular to be slump blocks. In addition, the headscarps of almost all slumps are convex upslope; no such landforms exist here.

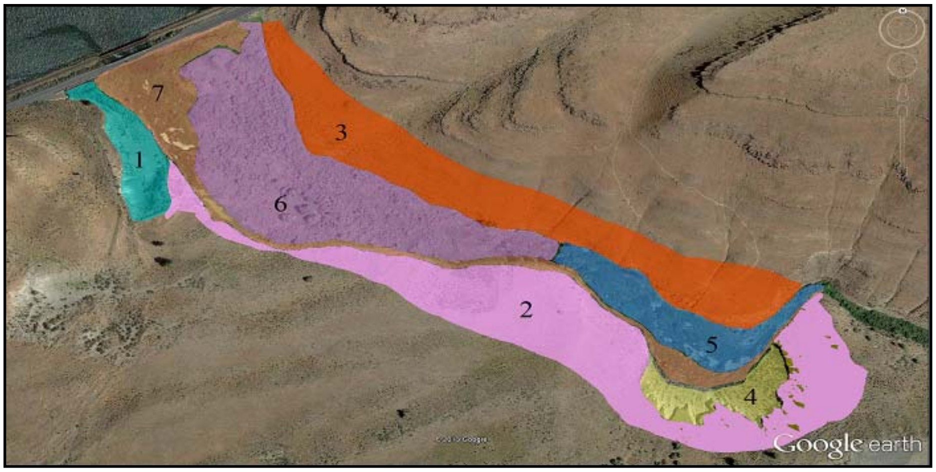
Sand dunes are common northeast of the Umatilla and Pasco basins; some are longitudinal dunes parallel to the prevailing wind. The long axes of the giant steps in Juniper Canyon have almost exactly the same orientation (N60°E) as the longitudinal dunes north and south of Wallula Gap. Longitudinal dunes are most commonly deposited on flat terrain. The longitudinal sand dunes of Juniper Canyon are unusual because they are draped across steep slopes.

The flora of Juniper Canyon

Given the geologic history, it isn't surprising that this small canyon harbors a variety of plant communities. The thick sand of the south side of the valley supports juniper trees, shrubs, bunchgrasses, a variety of wildflowers, and a cryptobiotic crust. The floodplain supports willow trees, cattails, tules, bulrushes and a variety of marsh-loving plants. Bunchgrasses dominate the thin, silt loam soil over basalt bedrock on the north side of the valley floor. Our survey of plant species, combined with previous collections and observations by coauthors (Dobson and Denny), totaled 168 species in 49 families (see Table at end of article). Until this survey no one had compiled a comprehensive list for the canyon. Other incomplete species lists for commonly visited sites in the Wallula Gap area (Juniper Canyon, Twin Sisters, and Telephone Hill (http://www.wnps.org/cbasin/hikes_lists.html) have been assembled by members of the Columbia Basin Chapter of the Washington Native Plant Society, but these were based solely on springtime hikes. Scientists at the Pacific Northwest National Laboratory published a complete vascular plant list (725 taxa) for the Hanford Site (Sackschewsky and Downs 2001), but that survey covers a much larger diverse area.

We (Cordell and Axtell) visited Juniper Canyon at three week intervals between February 2013 and April 2014. First, we mapped seven plant communities on a Google Earth image and developed two walking routes, one through the floodplain, and one through the uplands, along which we collected each plant species at its

Large slanted terraces covered by thick sand are present on the south side of lower Juniper Canyon. The most plausible theory for the origin of these terraces is that they are longitudinal dunes, oriented parallel to the dominant wind direction. Photo by Bob Carson.



Plant communities in Juniper Canyon, mapped on a Google Earth image. Codes are 1=Basin wildrye/saltgrass (disturbed grassland), 2=Western juniper/big sagebrush-bitterbrush, 3=Bluebunch wheatgrass/Sandberg bluegrass, 4=exposed gravel bar (Rock), 5=marsh, 6=willow riparian woodland, 7=narrowleaf cattail marsh. Prepared by Marin Axtell and Chelsea Cordell.

reproductive stage. Voucher specimens of all documented taxa have been deposited in the Whitman College Herbarium (WCW).

The seven communities in the canyon included the following: a disturbed grassland (basin wildrye/saltgrass), juniper/big sagebrush/bitterbrush, bluebunch wheatgrass/Sandberg bluegrass, rock, marsh, willow riparian woodland and a narrowleaf cattail marsh. We recorded in which communities each species occurred and its flowering period.

Upland communities

The four upland types of Juniper Canyon include a severely disturbed grassland at the mouth of the canyon (which probably supported Basin wildrye/saltgrass in presettlement time), western juniper/sagebrush/bitterbrush on the canyon flank south of the creek, bluebunch wheatgrass/Sandberg bluegrass on the north side of the creek, and a rocky area in the upper reach of the south side of the creek.

Basin wildrye/saltgrass

This heavily disturbed grassland lies at the entrance of Juniper Canyon, southeast of State Highway 730 (see area 1 on map, above).

Disturbed grassland in an old gravel pit that is currently used illegally as a shooting range. Photo by Marin Axtell.

Based on topographic position and soils, it is likely that this site originally supported a community of Basin wildrye (*Leymus cinereus*) and saltgrass (*Distichlis spicata*). Saltgrass is the only remnant of that association. Our working name for the site was "disturbed grassland," derived from the obvious human disturbance: trash (beer cans, clay pigeons, shotgun shells, animal bones), soil compaction, and dominance by non-native species. Of the current community, the three introduced perennial grasses, bulbous bluegrass (*Poa bulbosa*), intermediate wheatgrass (*Thinopyrum intermedium*) and creeping bentgrass (*Agrostis stolonifera*), as well as the introduced Canada thistle (*Cirsium arvense*), reproduce vegetatively and are highly tolerant of grazing and trampling. The remaining grasses are all weedy annuals that are unpalatable to livestock after inflorescences form: ripgut brome (*Bromus diandrus*), cheatgrass (*Bromus tectorum*), and rattail fescue (*Vulpia myuros*).

Shaggy fleabane (*Erigeron pumilus*) flowers in early May in the severely disturbed grassy area and on the north-facing slope. Photo by Marin Axtell.

The soil in this area is hard packed, rocky, and very disturbed. Scattered shrubs (*Artemisia tridentata, Ericameria nauseosa,* and *Purshia tridentata*) are surviving native plants. Our most noteworthy discovery in this community was salt heliotrope (*Heliotropium curassavicum*), a sensitive species in Oregon (List 2). Its presence has been reported to the Oregon Biodiversity Information Center (ORBIC).

Western juniper/Big sagebrush-Bitterbrush

The north-facing canyon wall supports a thriving shrub steppe community, characterized by a sparse overstory of western juniper with an understory of shrubs (principally bitterbrush, big sagebrush, and rabbitbrush) and native bunchgrasses (area 2 in map, above). Moving south along the ridge, shrubs become less dominant and the soil becomes slightly rockier. Native grasses include bluebunch wheatgrass (*Pseudoroegneria spicata*), Sandberg bluegrass (*Poa secunda*), bottlebrush squirreltail (*Elymus elymoides*), Basin wildrye,

Bastard toadflax (*Comandra umbellata*) flowered in early May on the north-facing slope. Photo by Chelsea Cordell.

and two sand-loving species, Indian ricegrass (*Achnatherum hymenoides*) and needle-and-thread (*Hesperostipa comata*). Evidence of grazing disturbance includes numerous non-native grasses: annual bromes (*Bromus tectorum, B. hordeaceus, B. commutatus*), longspine sandbur (*Cenchrus longispinus*), rabbitsfoot grass (*Polypogon monspeliensis*).

Daubenmire (1970) did not describe a western juniper shrub steppe community for eastern Washington[2], but western juniper communities with big sagebrush and bitterbrush are widespread in eastern Oregon (Franklin and Dyrness 1984). Two bitterbrush/bunchgrass communities are described at the Hanford Site west of Pasco, Washington (Sackschewsky and Downs 2001). Bitterbrush commonly grows on deep, sandy soils, so its occurrence on the south side of Juniper Canyon is characteristic. Here the soil is mapped as Quincy loamy fine sand and Rock outcrop-Xeric Torriorthents complex (Umatilla Area Soil Survey[3]). The Quincy series is eolian sand that has blown over the ridge from the south and migrated downslope. Orthents are soils that lack profile development other than an A horizon; in this case these are deep soils on unstable slopes characterized by fine sandy loam in the upper 10 inches and very cobbly loamy fine sand below that. These deep soils have a high water storage capacity which, combined with a cooler north-facing aspect, support a dense canopy of perennial vegetation and a scattered cryptobiotic crust.

Bluebunch wheatgrass/Sandberg bluegrass

This community is located on the north side of the canyon, facing south, with a gentle slope up from the bottom of the canyon (area 3 on map on previous page). It is characterized by a sparse cover of shrubs (gray rabbitbrush and big sagebrush) and remnants of the native bunchgrasses (bluebunch wheatgrass, Sandberg bluegrass, sand dropseed and red threeawn) growing on hard packed rocky silt loam soil. The soil is mapped as Lickskillet-Rock outcrop complex. The Lickskillet series are shallow, well drained soils that formed in stony colluvium consisting of loess, rock fragments, and residuum weathered from basalt and rhyolite.

Evidence of disturbance in this area is the compacted soil, terracettes (numerous livestock trails following the contour across the slope), and a variety of non-native grasses, ripgut brome, cheatgrass, rattail fescue, and bulbous bluegrass, which increase in abundance under grazing pressure. The fence along the property line was in disrepair, allowing grazing livestock to range freely through the area.

Goatheads or puncturevine (*Tribulus terrestris*), an invasive exotic weed with stout sharp spikes on its fruits, dominates the lower slope near the bottom of the canyon. The sprawling stems of this warm-season annual are well adapted to the hot, harsh conditions of summer and occur on the south-facing exposure.

Among the plants on the steep north-facing slope of Juniper Canyon are gray rabbitbrush (yellow flowers), big sagebrush (light green leaves), and juniper trees. One beaver pond is visible in the wetland on the valley floor. Sparse vegetation grows on thin, silty soil over lava flows on the north side of the canyon. In the distance are the Columbia River and the west side of Wallula Gap. Photo by Bob Carson.

Cliff, scree, and rock[4]

An area of sparse vegetation over a loose rock substrate is located on the south canyon wall on the outside of a meander of Juniper Creek (area 4 on map on previous page). It is the most barren of the communities, due to disturbance caused by the deterioration of an old gravel bar in the wall of the canyon. The steep, north-facing slope is a substrate of loose sand, pebbles and cobbles, mostly of basaltic composition, that shift down toward the canyon floor when disturbed. Cover in this community is sparse, consisting of a Russian olive (*Elaeagnus angustifolia*), a few big sagebrush, rabbitbrush, and cheatgrass.

Among the weedy species, bull thistle (*Cirsium vulgare*) and Russian thistle (*Salsola tragus*) are characteristic of the farmland above the canyon, while moth mullein (*Verbascum blattaria*) is characteristic of the canyon walls along the Snake and Columbia rivers. This is the only community in which we found silverleaf phacelia (*Phacelia hastata*).

2 The northernmost population of western juniper in North America lies only about 30 air miles north of Juniper Canyon; that population is protected by the Juniper Dunes Wilderness Area east of Pasco, Washington (http://www.blm.gov/or/resources/recreation/files/brochures/brochure-juniper.pdf).

3 http://websoilsurvey.nrcs.usda.gov/app/

4 nhttp://www1.usgs.gov/csas/nvcs/nvcsGetUnitDetails?elementGlobalId=849126

East of the beaver ponds, Juniper Creek has eroded the base of gravels deposited by the Missoula floods. Photo by Bob Carson.

A grassy marsh covers the upper half of the canyon floor (east of the willow riparian woodland), sandwiched between the north and south canyon walls. Here the stream is impounded by beaver dams, creating a lush environment. Photo by Bob Carson.

Marsh

Covering the upper half of the canyon floor that slopes gently westward (area 5 on map on page 5), the marsh formed where the stream was impounded by beaver dams, creating lush vegetation. It is sandwiched between the north and south canyon slopes east of the *Salix* Riparian Woodland, which is dominated by two willow species, peachleaf (*Salix amygdaloides*) and narrowleaf willow (*Salix exigua*), the latter appearing to be a favorite food of the beavers.

This community has a dense cover of grasses and rushes, both in the slow moving water and in the surrounding mud flats, attracting cattle grazing year-round. The wetter areas are dominated by narrowleaf cattail (*Typha angustifolia*), common reed (*Phragmites australis*), hardstem bulrush (*Schoenoplectus acutus*), and three-square bulrush (*S. americanus*).

Here we also found American licorice (*Glycyrrhiza lepidota*), a traditional medicine plant for Native Americans, and common cocklebur (*Xanthium strumarium*), a native species of floodplains that is often mistaken for an introduced noxious weed (*Xanthium spinosum*) because the spiny fruits of both species cling tenaciously to boots, pants, and backpacks.

Salix amygdaloides/Salix exigua Riparian woodland[5]

This community covers the relatively flat eastern portion of the canyon floor (area 6 on map on page 5), downstream from the marsh and bounded by the narrowleaf cattail community on the east and south. Because the channel of Juniper Creek is narrower and the water flows faster here, the silt loam soil is drier, and also more compacted than the marsh area.

As reflected by our name for this area, vegetation is dominated by narrowleaf willow. Two abundant species in this type are an introduced perennial, whitetop (*Lepidium draba*), which flowers from May to September, followed by a native annual, horned seablight (*Suaeda calceoliformis*), flowering from late August through early November.

Floodplain communities

We mapped three types of vegetation in the floodplain of Juniper Creek: marsh, riparian woodland, and cattail marsh. The silt loam soil of these communities is classed as a xerofluvent, meaning a floodplain soil that developed in a semi-arid Mediterranean climate (moist cold winter, dry warm summer).

Narrowleaf cattail marsh[6]

This community borders both sides of Juniper Creek extending upstream from the mouth at the Columbia River, on the south side of the marsh and *Salix* riparian woodland (area 7 on map on page 5). Due to a high water table, the soil in this community is wet

5 http://www1.usgs.gov/csas/nvcs/nvcsGetUnitDetails?elementGlobalId=689863
6 http://www1.usgs.gov/csas/nvcs/nvcsGetUnitDetails?elementGlobalId=684716

The willow riparian woodland covers the relatively flat eastern portion of the canyon floor, downstream from the marsh and bounded by the narrowleaf cattail community on the east and south. Photo by Marin Axtell.

Seasons in the sun: Juniper Canyon through a naturalist's eyes

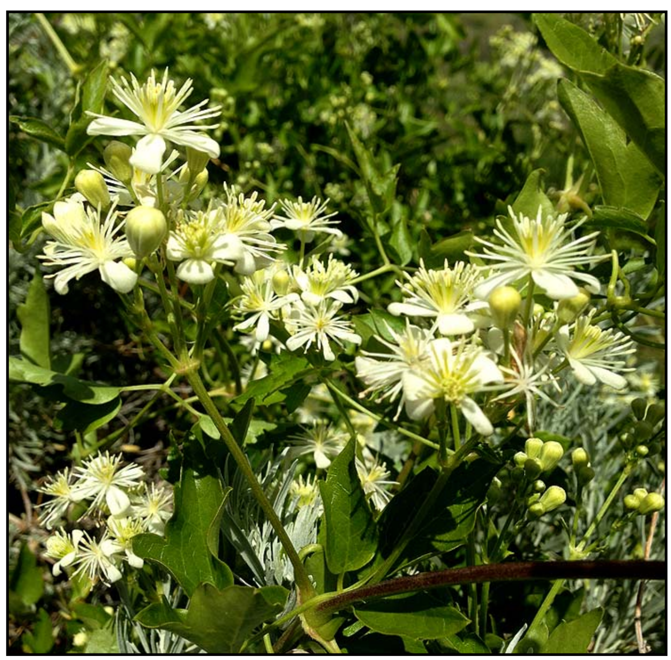
Spring

Early spring starts in February, and in some years as early as mid-January, with the blooming of salt-and-pepper desert-parsley (*Lomatium gormanii*). As soon as the soils warm and the last few cool nights fade in early March, sagebrush buttercup (*Ranunculus glaberrimus*) appears, along with the delicate prairie starflower (*Lithophragma parviflora*), the spectacular yellow bell (*Fritillaria pudica*), and desert shooting star (*Dodecatheon conjugens*). The first native grasses to emerge from dormancy for the new growing season are Sandberg bluegrass, Indian ricegrass, and bluebunch wheatgrass. On the dunes, veiny dock (*Rumex venosus*) pushes its way up through the sandy soil; its thick leathery leaves attract the first shiny metallic blue leaf beetles that use the plant for breeding and feeding. Soon, low carpets of gold star (*Crocidium multicaule*) brighten the sage and bitterbrush stands. In April, the pale yellow flowers of bitterbrush bring the first mass bloom for pollinators in this canyon. Bitterbrush provides important seasonal thermal cover (shade) to animals that live in this hot environment, as well as being the favored forage of many native browsers. Patches of cryptobiotic soil crust, composed of lichens, mosses, and other microorganisms (cyanobacteria and algae), are evidence of recovery from decades of heavy grazing and trampling by cattle. Where they coat the surface of sandy soils that have stabilized enough to support sagebrush, rabbitbrush, bunchgrasses, and forbs, these soil crusts help conserve soil moisture by limiting evaporation

Peachleaf willow (*Salix amygdaloides*) is one of two willows that grow in the floodplain. Photo by Marin Axtell.

nearly year-round. During the colder part of the winter, ice forms over the water, particularly near the edges. Emergent vegetation, including tules, bulrushes, sedges, and cattails, creates a haven for frogs, herons, ducks, and numerous song birds. We found two aquatic species, common duckweed (*Lemna turionifera*) and Pacific mosquitofern (*Azolla filiculoides*).

Other native plants include narrowleaf willow, stinging nettle (*Urtica dioica*), Hall's willowherb (*Epilobium hallianum*), pale smartweed (*Persicaria lapathifolia*), and northern bugleweed (*Lycopus uniflorus*). A number of non-native species have invaded this wetland, including poison hemlock (*Conium maculatum*), yellow flag iris (*Iris pseudacorus*), false indigobush (*Amorpha fruticosa*), purple loosestrife (*Lythrum salicaria*) and, on the better drained edges of the community, whitetop, diffuse knapweed (*Centaurea diffusa*) and bull thistle (all Class B species on the Oregon Noxious Weed list).



Western white clematis (*Clematis ligusticifolia*) flowered in late May in the floodplain. Photo by Chelsea Cordell.

and hinder invasive species by preventing seed contact with the soil. Early spring ends with the emergence of needle-and-thread, poisonous woolypod milkvetch (*Astragalus purshii*), and rough wallflower (*Erysimum capitatum*) from the sandy soils. The first native wasps, bees, butterflies, ants and flies also emerge under the warm sun, ready to pollinate the peak season flowers.

Desert shooting star (*Dodecatheon conjugens*). Photo by Mike Denny.

Yellow bells (*Fritillaria pudica*). Photo by Mike Denny.

Summer

In late May temperatures rise dramatically, drying the soil surface. Many early flowering plants have already produced seed. On the dunes, veiny dock is loaded with bright pink winged fruits that many mistake for large clumps of flowers. Desert paintbrush (*Castilleja chromosa*)**,** a hemiparsitic plant with a limited distribution in Juniper Canyon, flashes forth in fiery colors to light up the shrub-steppe communities. Gairdner's beardtongue (*Penstemon gairdneri*) attracts ants and native bees to its spectacular pale pink tubular flowers. Out of the dry soil also appears the low, thick-growing Munro's globemallow (*Sphaeralcea munroana*) with its vivid orange-red flowers emerging from gray-green buds; these plants create patches of brilliant orange in an otherwise drab gray/green sandy area. Northern wyethia (*Wyethia amplexicaulis*), now in full bloom, is a spectacular large composite flower named in honor of Nathaniel Wyeth, who passed by the mouth of Juniper Canyon on 19 October 1832 on his way to Fort Vancouver. Known to many as mule's ears, this resplendent native flower marks the start of the hot season in Juniper Canyon. The emergence of whitestem evening

Flat-topped broomrape (*Orobanche corymbosa* ssp. *corymbosa*) is a small native annual that is parasitic on roots of *Artemisia tridentata*. Photos by Mike Denny.

primrose (*Oenothera pallida*) creates opportunities for crepuscular pollinators such as moths, crickets, and rodents. Locoweed, biscuit root, buckwheat, and the cool season grasses are already fruiting. Along the riparian zone of Juniper Creek the growth is rank with black cottonwood, coyote and peachleaf willows, and a few American hackberry (*Celtis occidentalis*). There are many patches of common cattail, hardstem bulrush, and several sedge species (*Carex*). Invasive reed canarygrass (*Phalaris arundinacea*) grows in dense mats all along the creek. The hydrology of the valley floor is naturally managed by a beaver population whose dams create pools that extend the growing season through the hot summers typical of the canyon.

Autumn

From late August into early September, snow buckwheat (*Eriogonum niveum*) graces the sandy soils with its showy silver-green leaves and papery white flowers lightly tinged with pink. The foliage and flowers are naturally dry, so persist until battered by fall rainstorms and wind. When most plants have finished flowering and set seed, rabbitbrush comes into its full glory, giving a golden glow to the canyon. It is complemented by purple flowers of hoary tansyaster (*Dieteria canescens,* formerly *Machaeranthera*). Late-flowering Asteraceae set out the last great offering of pollen and nectar for the numerous insect pollinators that are getting ready to meet the arrival of winter. These shrubs and herbs provide food for a wide array of rodents, birds, and mammals also preparing for the cold winter months.

Winter

Winter can be short in this canyon, sometimes becoming intermittent by mid-January. But when Arctic air flow brings ice and snow, small birds and other animals seek food and cover in the dense evergreen foliage of the juniper trees. The round silvery-blue juniper "berries" provide winter forage for American Robins, Western Bluebirds, Townsend's Solitaire, and mule deer, and are also eaten by Cedar Waxwings, coyotes, and wood rats. The trunks of old mature junipers are host to numerous wintering spiders, insects, hibernating tree frogs, and many species of bats, along

Ice along Juniper Creek during the coldest part of the winter. Photo by Chelsea Cordell.

with seasonal nesting Ferruginous, Swainson's, and Red-tailed Hawks. Long-eared and Great Horned Owls depend on the nests of Black-billed Magpies in these trees.

Most native plants are dormant in the winter, but some of the native bunchgrasses (*e.g.*, bluebunch wheatgrass and Sandberg bluegrass) develop green leaves with fall rains and grow intermittently when temperatures rise above freezing. Introduced Mediterranean annuals, *e.g.*, cheatgrass and yellow starthistle (*Centaurea solstitialis*), germinate with the first rains of late fall and grow at temperatures just above freezing, extending their roots deep into the soil. This gives these invaders a competitive advantage over seedlings of native plants, especially when the weeds are less palatable to livestock. Some species pass the winter as seeds in the plant litter over the soil surface, providing a food source for small rodents and birds.

Acknowledgements

Travel to Juniper Canyon was funded in part by Suzanne and Philip Moss (through Heidi Dobson at Whitman College) and by the Whitman College Department of Biology. Peter Zika (University of Washington Herbarium) and Cindy Roché identified the graminoid species, Fred Hrusa (Herbarium, California Department of Food and Agriculture, Sacramento, California) identified *Kochia scoparia* var. *subvillosa*. Jannelle Downs (ecologist with Pacific Northwest National Laboratory, Richland) reviewed the manuscript and offered valuable edits.

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Hiking in Juniper Canyon

Driving directions to Juniper Canyon: From Interstate 84 east of Boardman, turn north on US Highway 730 at Boardman Junction toward Irrigon and Umatilla. Continue northeast on 730 past Umatilla for 15 miles. Alternatively, take Exit 182 on Interstate 84 onto Highway 207 north (toward Hermiston), follow 207 for about 12 miles and turn right onto Highway 730. Follow Highway 730 east for about 7.5 miles to Juniper Canyon. Pull off at a turnout and park in the small parking area on the southeast side of Highway 730 between mileposts 198 and 199.

The bedrock here is all Columbia River basalt; outcrops by the creek are Wanapum Basalt, whereas the "scabs" at the top of the canyon are younger Saddle Mountains basalt. Two crude trails lead eastward along the sides of Juniper Canyon; both become faint in about a mile. However, numerous game and cattle trails provide easy access to the open country. The trail on the south side of Juniper Canyon starts at the gate and climbs up and over several sandy benches. A remnant of this Mazama ash deposit is exposed just to the left of and below the trail a short distance east of the parking lot. Within a few minutes of walking are two large juniper trees to the north and a patch of bare sand high to the south. At an elevation of 760 feet, small juniper trees grow on sand that overlies a giant gravel bar deposited by the Missoula floods. Below this hill Juniper Creek has undercut the eddy bar to expose the thick, steeply dipping gravels. Along the creek are beaver ponds and wetland vegetation. Farther east are dune complexes with patches of bare sand. The prevailing westerly winds have blown the sand here from the Umatilla Basin. Juniper Canyon is a sand trap as the creek prevents further transport northeast.

To access the trail on the north side of Juniper Canyon, one can also cross the bridge to the north side of Juniper Creek; a path goes east along the fence on the north side of the wetland. The creek is easily crossed by foot on a basalt outcrop at the east end of the wetland. The trail along the north side of Juniper Canyon stays close to the wetland and passes by the beaver dams. The scabland topography high above is due to erosion by the Missoula floods; on the south side of the 975-foot hill, and farther east up to an elevation of 1,030 feet, are granitic boulders up to 6 feet in diameter. These erratic boulders were deposited here during the melting of icebergs stranded at the shorelines of the Missoula floods. To the northeast, above the level of the Missoula floods, loess covers the basalt.

Continued public access across private land depends on responsible use. Visitors should reclose gates when entering and leaving (or leave the gates as they were found). Remember that both the floodplain and the privately owned slopes should be treated respectfully.

Russian olive (*Elaeagnus angustifolia*) is a non-native invader of wetlands and floodplains. Photo by Chelsea Cordell.

Marin P. Axtell

Marin Axtell is a native Idahoan and a recent graduate of Whitman College in Walla Walla, Washington, with a BA in Spanish and biology. She currently works with the Idaho Immunization Program and hopes to begin a Masters program in the near future.

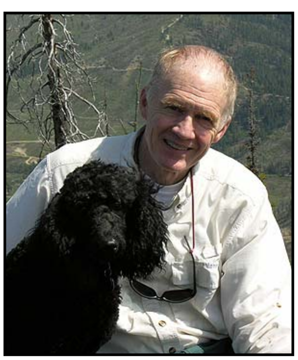
Chelsea C. Cordell

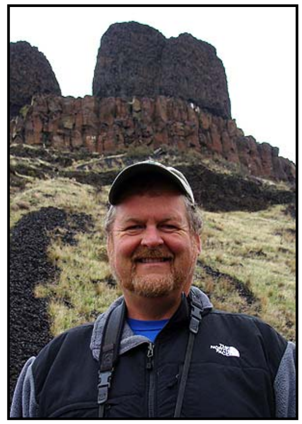
Chelsea grew up in the rainy forests of Olympia, Washington, and graduated from Whitman College in Walla Walla, Washington, with a BA in biology and anthropology. After a summer as a sea kayak tour guide in Ketchikan, Alaska, she is currently residing in San Francisco, California, spending her time hiking, backpacking, and getting to know the flora of the Bay Area and the Sierra Nevada.

Robert J. Carson

Bob Carson is Phillips Professor of Geology and Environmental Studies at Whitman College in Walla Walla, Washington. After he earned an AB in geology from Cornell University, he worked for Texaco, Inc. His other geology degrees are an MS from Tulane University and a PhD from the University of Washington. Summer employment included Washington's Department of Ecology and Division of Geology and Earth Resources.

His interests are in the earth and environmental sciences; his courses deal with resources and pollution, human interaction with the biosphere, glaciers, volcanoes, water, global climate change, landforms, and natural hazards. As a whitewater guide and member of the American Alpine Club, he has led field trips in Africa, Eurasia, South America, and throughout North America. His books include *Hiking Guide to Washington Geology*, *Where the Great River Bends*, *East of Yellowstone,* and *Many Waters.*





Michael E. Denny

Mike Denny was born in Oregon. He began studying natural history at age eight while growing up in southeast Africa, where he was in awe of all things living. After he returned to the US, he studied biology and art in college. He and his wife MerryLynn now live in Walla Walla. Mike illustrated the *Birders Guide to Idaho* (1998), and co-authored several books: *The Birds of the Inland Northwest and Northern Rockies* (2008), *Where the Great River Bends* (2008), *The Birds of Interior BC and the Rockies* (2009) and *Many Waters* (2015). Mike greatly enjoys hiking, birding, Lepidoptera and botanizing. He also taught adult education classes at Walla Walla Community College for fifteen years and guest lectured at Whitman College and Walla Walla University. He works for Walla Walla Community College, Water and Environmental Center as a grant writer.

Heidi E. M. Dobson

Heidi Dobson is Professor of Biology and Director of the Whitman College Herbarium, in Walla Walla, Washington. She earned her AB in botany and BS in agricultural science from the University of California Berkeley, her MS in entomology from the University of California, Davis, and her PhD in botany from the University of California Berkeley. As an undergraduate, she worked during the summers in Yosemite National Park conducting research on the ecological carrying capacity of the subalpine backcountry. Her expertise and passion lie at the intersection of botany and entomology, encompassing the biology of solitary bees and the factors underlying their associations with flowers and particularly with pollen. Her research has taken her from the California chaparral, to eastern Washington, the Mediterranean, and Sweden.

List of the plant species collected and observed in Juniper Canyon

Codes are 1=Basin wildrye/saltgrass (disturbed grassland), 2=Western juniper/big sagebrush-bitterbrush, 3=Bluebunch wheatgrass/ Sandberg bluegrass, 4=exposed gravel bar (Rock), 5=marsh, 6=willow riparian woodland, 7=narrowleaf cattail marsh. MD in the column under ** indicates taxa observed by Mike Denny. For all other taxa, voucher specimens have been deposited in the Whitman College Herbarium (WCW). Weed status indicates taxa on the Class B list of Oregon Noxious Weeds.

Family: Genus and Species	Family: Common Name	**	Community	Weed status	Origin	Lifespan	Dates seen in Flower
FLOWERING PLANTS: MONOCOTS							
ARACEAE							
Lemna turionifera	COMMON DUCKWEED		5, 7		NATIVE	PER	
ASPARAGACEAE							
Triteleia grandiflora	LARGEFLOWER TRITELEIA		2		NATIVE	PER	14-Apr
CYPERACEAE							
Carex sp.	SEDGES	MD	7		NATIVE	PER	
Eleocharis palustris	COMMON SPIKERUSH		5, 7		NATIVE	PER	5-Jul
Schoenoplectus acutus	COMMON TULE		5, 6, 7		NATIVE	PER	26-Jun
Schoenoplectus americanus	CHAIRMAKER'S BULRUSH		5, 6, 7		NATIVE	PER	5-Jul
IRIDACEAE							
Iris pseudacorus	YELLOW FLAG IRIS		7	B	INTROD	PER	30-May
JUNCACEAE							
Juncus saximontanus A. Nels.	ROCKY MOUNTAIN RUSH		5, 6, 7		NATIVE	PER	
Juncus torreyi	TORREY'S RUSH		5, 7		NATIVE	PER	
LILIACEAE							
Fritillaria pudica	YELLOW BELLS	MD	2		NATIVE	PER	30-May
POACEAE							
Achnatherum hymenoides	INDIAN RICEGRASS	MD	2		NATIVE	PER	
Agrostis stolonifera	CREEPING BENTGRASS		1, 2, 5		INTROD	PER	5 July - 21 July
Aristida purpurea var. *longiseta*	RED THREEAWN		2		NATIVE	PER	26-Jun (fruiting)
Bromus commutatus	HAIRY CHESS		1, 5		INTROD	ANN	
Bromus diandrus	RIPGUT GRASS		1, 3		INTROD	ANN	6-May
Bromus hordeaceus	SOFT BROME		2		INTROD	ANN	30-May
Bromus tectorum	CHEATGRASS		1, 2, 3,4		INTROD	ANN	14-Apr
Cenchrus longispinus	MAT SANDBUR		2		INTROD	ANN	21-Jul
Cynodon dactylon	BERMUDAGRASS		7		INTROD	PER	16 June - 21 July
Distichlis spicata	SALTGRASS		1, 5		NATIVE	PER	
Elymus elymoides	SQUIRRELTAIL		2		NATIVE	PER	30-May
Hesperostipa comata	NEEDLE-AND-THREAD	MD	2		NATIVE	PER	
Hordeum jubatum	FOXTAIL BARLEY		6		NATIVE	PER	16-Jun
Hordeum murinum	WALL BARLEY		6		INTROD	ANN	21-Jul
Leymus cinereus	BASIN WILDRYE		6		NATIVE	PER	16-Jun
Muhlenbergia asperifolia	ALKALI MUHLY		6		NATIVE	PER	21-Jul
Phalaris arundinacea	REED CANARYGRASS		5		INTROD	PER	16-Jun
Phragmites australis	COMMON REED		5, 6		INTROD/N	PER	10-Aug
Poa bulbosa	BULBOUS BLUEGRASS		1, 3		INTROD	PER	6-May
Poa secunda	SANDBERG BLUEGRASS		2		NATIVE	PER	29-Mar
Polypogon monspeliensis	ANNUAL RABBITSFOOT GRASS		5, 6		INTROD	ANN	16-Jun
Pseudoroegneria spicata	BLUEBUNCH WHEATGRASS		2, 3		NATIVE	PER	26-Jun
Schedonorus arundinaceus	TALL FESCUE		5, 6		INTROD	PER	6-May
Sporobolus cryptandrus	SAND DROPSEED		2		NATIVE	PER	16-Jun
Thinopyrum intermedium	INTERMEDIATE WHEATGRASS		1, 3		INTROD	PER	5-Jul
Thinopyrum ponticum	TALL WHEATGRASS		5, 6		INTROD	PER	5 July - 21 July
Vulpia myuros	RATTAIL FESCUE		1, 3, 6		INTROD	ANN	6-May
FLOWERING PLANTS: DICOTS							
ADOXACEAE							
Sambucus nigra	BLUE ELDERBERRY		5		NATIVE	PER	30-May
AMARANTHACEAE							
Atriplex canescens	FOURWING SALTBRUSH		3		NATIVE	PER	10-Aug
Amaranthus albus	PROSTRATE PIGWEED		3		INTROD	ANN	21-Jul
Chenopodium rubrum	RED GOOSEFOOT		6,7		NATIVE	ANN	10-Aug
Kochia scoparia var. *subvillosa*	KOCHIA		2	B	INTROD	ANN	15-Oct
Salsola tragus	RUSSIAN THISTLE		1,2,3,4,5,6,7		INTROD	ANN	10 Aug - 22 Sept
Suaeda calceoliformis	HORNED SEABLIGHT		5		NATIVE	ANN/PER	22-Sep

Family: Genus and Species	Family: Common Name	**	Community	Weed status	Origin	Lifespan	Dates seen in Flower
APIACEAE							
Anthriscus caucalis	BUR CHERVIL		2		INTROD	ANN	6 May - 30 May
Conium maculatum	POISON HEMLOCK		1,2,7	B	INTROD	BIEN	30-May
Cymopterus terebinthinus	TERPENTINE CYMOPTERUS		2		NATIVE	PER	26-Jun (fruiting)
Daucus carota	WILD CARROT		1		INTROD	BIEN	21-Jul
Lomatium gormanii	SALTANDPEPPER	MD	3		NATIVE	PER	
Lomatium grayi	GRAY'S BISCUITROOT		2,4,7		NATIVE	PER	14-Apr
APOCYNACEAE							
Asclepias speciosa	SHOWY MILKWEED		2, 4, 8		NATIVE	PER	16 June - 5 July
Asclepias fascicularis	NARROWLEAF MILKWEED	MD	5		NATIVE	PER	
ASTERACEAE							
Achillea millefolium	COMMON YARROW		1,2,3,7		NATIVE	PER	14-Apr
Acroptilon repens	RUSSIAN KNAPWEED		2,4	B	INTROD	PER	5-Jul
Agoseris grandiflora	LARGE FLOWERED AGOSERIS		2,3		NATIVE	PER	20-Jun
Ambrosia acanthicarpa	BUR RAGWEED		2		NATIVE	ANN	3-Sep
Arnica longifolia	SPEAR-LEAF ARNICA		7		NATIVE	PER	21 July - 10 August
Artemisia absinthium	ABSINTHE WORMWOOD	MD	3		INTROD	PER	
Artemisia rigida	SCABLAND SAGE	MD	3		NATIVE	PER	
Artemisia tridentata	BIG SAGEBRUSH		1,2,3,4		NATIVE	PER	21 July - 15 Oct
Balsamorhiza careyana var. *intermedia*	CAREY'S BALSAMROOT		2		NATIVE	PER	20-Jun
Balsamorhiza sagittata	ARROWLEAF BALSAMROOT		2		NATIVE	PER	14-Apr
Bidens cernua	NODDING BEGGARTICKS		2		NATIVE	ANN	3-Sep
Centaurea diffusa	DIFFUSE KNAPWEED		1	B	INTROD	BIEN	10-Aug
Centaurea solstitialis	YELLOW STARTHISTLE		1,3	B	INTROD	ANN	16-Jun
Chaenactis douglasii	DUSTY MAIDENS		2		NATIVE	BIEN/PER	30-May
Chondrilla juncea	RUSH SKELETONWEED		1,3		INTROD	PER	
Chrysothamnus viscidiflorus	YELLOW RABBITBRUSH		2,7		NATIVE	PER	10-Aug
Cirsium arvense	CANADA THISTLE		1	B	INTROD	PER	5-Jul
Cirsium undulatum	WAVY-LEAF THISTLE		2, 7		NATIVE	BIEN/PER	16-Jun
Cirsium vulgare	BULL THISTLE		4, 7	B	INTROD	BIEN	21-Jul
Conyza canadensis	MARESTAIL		2,3		NATIVE	ANN	
Crepis acuminata	TAPERTIP HAWKSBEARD		2		NATIVE	PER	30 May - 16 June
Crepis capillaris	SMOOTH HAWKSBEARD		7		INTROD	ANN/BIEN	21-Jul
Crocidium multicaule	GOLD STAR		2		NATIVE	ANN	29-Mar
Dieteria canescens	HOARY TANSYASTER		2,3		NATIVE	ANN/PER	15 Oct - 3 Nov
Ericameria nauseosa	RUBBER RABBITBRUSH		1,2,3,4		NATIVE	PER	10 Aug - 22 Sept
Erigeron pumilus	SHAGGY FLEABANE		1,2		NATIVE	PER	6-May
Euthamia occidentalis	WESTERN GOLDENTOP		2, 7		NATIVE	PER	3 Sept - 22 Sept
Helianthus annuus	ANNUAL SUNFLOWER	MD	1		NATIVE	ANN	late Aug-Sept
Heterotheca villosa	HAIRY FALSE GOLDENASTER		7		NATIVE	PER	5 July - 21 July
Lactuca serriola	PRICKY LETTUCE		2,3		INTROD	ANN/BIEN	5 July - 21 July
Solidago lepida	WESTERN CANADA GOLDENROD		8		NATIVE	PER	21-Jul
Sonchus arvensis	FIELD SOWTHISTLE		2		INTROD	PER	15-Oct
Stephanomeria paniculata	TUFTED WIRELETTUCE		3		NATIVE	ANN/PER	10-Aug
Symphyotrichum ascendens	WESTERN ASTER		1,2,3		NATIVE	PER	3-Sep
Tragopogon dubius	YELLOW SALSIFY		1		INTROD	ANN/BIEN	16-Jun
Wyethia amplexicaulis	NORTHERN MULESEARS	MD	2		NATIVE	PER	
Xanthium strumarium	COMMON COCKLEBUR		5, 7		NATIVE	ANN	3-Sep
BORAGINACEAE							
Amsinckia lycopsoides	TARWEED FIDDLENECK		2		NATIVE	ANN	26-Jun
Amsinckia menziesii var. *menziesii*	MENZIES FIDDLENECK		2		NATIVE	ANN	29-Mar
Cryptantha flaccida	WEAKSTEM CRYPTANTHA		3		NATIVE	ANN	14-Apr
Heliotropium curassavicum	SALT HELIOTROPE		1		NATIVE	ANN/PER	30-May
Phacelia hastata	SILVERLEAF PHACELIA		4		NATIVE	PER	6 May - 16 June
Phacelia linearis	THREADLEAF PHACELIA		2		NATIVE	ANN	14-Apr
BRASSICACEAE							
Descurainia pinnata	WESTERN TANSYMUSTARD		2,7		NATIVE	ANN/PER	29-Mar
Draba verna	SPRING DRABA		1		INTROD	ANN	24 Feb - 19 March
Erysimum capitatum	WALLFLOWER	MD	2		NATIVE	BIEN/PER	
Lepidium chalepense	ASIAN WHITETOP		2	B	INTROD	PER	6 May - 30 May
Lepidium draba	WHITETOP		1,6,7	B	INTROD	PER	30-May
Nasturtium officinale	WATERCRESS		5,6		INTROD	PER	30-May
Sisymbrium altissimum	TALL TUMBLE MUSTARD		1,2,3		INTROD	ANN/BIEN	14-Apr
CANNABACEAE							
Celtis reticulata	NETLEAF HACKBERRY		6		NATIVE	PER	14-Apr

Family: Genus and Species	Family: Common Name	**	Community	Weed status	Origin	Lifespan	Dates seen in Flower
CARYOPHYLLACEAE							
Arenaria serpyllifolia	THYMELEAF SANDWORT		1		INTROD	ANN	29-Mar
Stellaria media	COMMON CHICKWEED		7		INTROD	ANN	29-Mar
COMANDRACEAE							
Comandra umbellata	BASTARD TOADFLAX		1,2		NATIVE	PER	6-May
CRASSULACEAE							
Sedum lanceolatum var. *lanceolatum*	LANCELEAF STONECROP	MD	2		NATIVE	PER	
DIPSACACEAE							
Dipsacus fullonum	FULLER'S TEASEL		6,7		INTROD	BIEN	5-Jul
ELAEGNACEAE							
Elaeagnus angustifolia	RUSSIAN OLIVE		4		INTROD	PER	
EUPHORBIACEAE							
Chamaesyce serpyllifolia	THYME LEAVED SPURGE		5		NATIVE	ANN	5-Jul
FABACEAE							
Amorpha fruticosa	FALSE INDIGOBUSH		7	B	INTROD	PER	5-Jul
Astragalus purshii	WOOLLYPOD MILKVETCH		2, 3		NATIVE	PER	29-Mar
Astragalus whitneyi	BALLOONPOD MILKVETCH		2		NATIVE	PER	16-Jun
Glycyrrhiza lepidota	AMERICAN LICORICE		2		NATIVE	PER	5-Jul
Laedeania lanceolata	SCURFPEA		2		NATIVE	PER	30-May
Melilotus officinalis	YELLOW SWEETCLOVER		1		INTROD	ANN/PER	16 June - 5 July
GERANIACEAE							
Erodium cicutarium	REDSTEM STORK'S BILL		1		INTROD	ANN/BIEN	14-Apr
GROSSULARIACEAE							
Ribes aureum	GOLDEN CURRENT		6		NATIVE	PER	29 Mar - 30 May
LAMIACEAE							
Lycopus uniflorus	NORTHERN BUGLEWEED		5,6,7		NATIVE	PER	3-Sep
Mentha spicata	SPEARMINT		6,7		INTROD	PER	21 July - 10 Aug
Nepeta cataria	CATNIP		7		INTROD	PER	5-Jul
Salvia dorrii	PURPLE SAGE		2,3		NATIVE	PER	6 May - 30 May
LYTHRACEAE							
Lythrum salicaria	PURPLE LOOSESTRIFE		7	B	INTROD	PER	5-Jul
MALVACEAE							
Sphaeralcea munroana	GLOBEMALLOW	MD			NATIVE	PER	
MONTIACEAE							
Claytonia perfoliata	MINERS LETTUCE		1,2		NATIVE	ANN/PER	29-Mar
ONAGRACEAE							
Clarkia pulchella	PINKFAIRIES		2		NATIVE	ANN	30-May
Epilobium hallianum	HALL'S WILLOWHERB		7		NATIVE	PER	3-Sep
Oenothera pallida	PALE EVENING-PRIMROSE		2		NATIVE	BIEN/PER	16-Jun
OROBANCHACEAE							
Castilleja chromosa	DESERT PAINTBRUSH	MD	2		NATIVE	PER	
Orobanche corymbosa ssp. *corymbosa*	FLAT TOPPED BROOMRAPE	MD	2		NATIVE	ANN	
PLANTAGINACEAE							
Collinsia parviflora	MAIDEN BLUE EYED MARY		2		NATIVE	ANN	29 March - 14 April
Penstemon gairdneri	GAIRDNER'S BEARDTONGUE	MD	2		NATIVE	PER	
Plantago patagonica	WOOLLY PLANTAIN		1,3		NATIVE	ANN	6 May - 30 May
Veronica anagallis-aquatica	WATER SPEEDWELL		7		NATIVE	BIEN/PER	30 May - 5 July
POLEMONIACEAE							
Navarretia capillaris	SMOOTH LEAVED GILIA		1		NATIVE	ANN	3-Sep
Phlox diffusa	SPREADING PHLOX	MD	2		NATIVE	PER	9-Apr
Phlox longifolia	LONGLEAF PHLOX		2		NATIVE	PER	19-May
POLYGONACEAE							
Eriogonum strictum	BLUE MOUNTAIN BUCKWHEAT		1,2		NATIVE	PER	3-Sep
Persicaria lapathifolia	PALE SMARTWEED		7		NATIVE	ANN	21 July - 10 Aug
Polygonum douglasii	DOUGLAS' KNOTWEED		7		NATIVE	ANN	30-May
Polygonum majus	LARGE KNOTWEED		2		NATIVE	ANN	22-Sep
Rumex crispus	CURLY DOCK		5		INTROD	PER	20-Jun
Rumex occidentalis	WESTERN DOCK		2, 7		NATIVE	PER	6-May
Rumex venosus	VEINY DOCK		1, 2, 4		NATIVE	PER	14-Apr
PRIMULACEAE							
Dodecatheon conjugens	DESERT SHOOTINGSTAR	MD	7		NATIVE	PER	
RANUNCULACEAE							
Clematis ligusticifolia	WESTERN WHITE CLEMATIS		1, 6, 7		NATIVE	PER	30-May
Delphinium nuttallianum	TWO-LOBE LARKSPUR		2		NATIVE	PER	14-Apr
Ranunculus glaberrimus	SAGEBRUSH BUTTERCUP	MD	2		NATIVE	PER	

Family: Genus and Species	Family: Common Name	**	Community	Weed status	Origin	Lifespan	Dates seen in Flower
ROSACEAE							
Prunus americana	AMERICAN PLUM		5		NATIVE	PER	14-Apr
Prunus virginiana	CHOKECHERRY		2		NATIVE	PER	6 May - 30 May
Purshia tridentata	ANTELOPE BITTERBRUSH		1, 2		NATIVE	PER	14 April - 30 May
RUBIACEAE							
Galium parisiense	WALL BEDSTRAW		1, 2		INTROD	ANN	14-Apr
SALICACEAE							
Populus trichocarpa	BLACK COTTONWOOD		7		NATIVE	PER	
Salix amygdaloides	PEACH-LEAF WILLOW		5		NATIVE	PER	6-May
Salix exigua	NARROW-LEAF WILLOW		5, 6, 7		NATIVE	PER	29 March - 14 April
SAXIFRAGACEAE							
Lithophragma glabrum	BULBOUS WOODLAND-STAR		2		NATIVE	PER	24 Feb - 29 March
Heuchera cylindrica	DESERT ALUMROOT	MD	2		NATIVE	PER	
SCROPHULARIACEAE							
Verbascum blattaria	MOTH MULLEIN		7		INTROD	BIEN	16-Jun
Verbascum thapsus	COMMON MULLEIN		4, 7		INTROD	BIEN	5-Jul
SOLANACEAE							
Solanum dulcamara	CLIMBING NIGHTSHADE		7		INTROD	PER	30-May
Solanum triflorum	CUT-LEAF NIGHTSHADE		2		NATIVE	ANN	22-Sep
TYPHACEAE							
Typha angustifolia	NARROW-LEAF CATTAIL		5, 7		NATIVE	PER	30-May
URTICACEAE							
Urtica dioica	STINGING NETTLE		6, 7		NATIVE	PER	5 July - 21 July
VALERIANACEAE							
Plectritis macrocera	LONGHORN PLECTRITIS		1, 7		NATIVE	ANN	29 March - 14 April
ZYGOPHYLLACEAE							
Tribulus terrestris	PUNCTURE-VINE		4	B	INTROD	ANN	10-Aug
GYMNOSPERMS							
CUPRESSACEAE							
Juniperus occidentalis	WESTERN JUNIPER		1, 2		NATIVE	PER	
SEEDLESS VASCULAR							
EQUISETACEAE							
Equisetum arvense	FIELD HORSETAIL		7		NATIVE	PER	
Equisetum variegatum	VARIEGATED SCOURINGRUSH		2, 7		NATIVE	PER	
SALVINIACEAE							
Azolla filiculoides ?	PACIFIC MOSQUITOFERN ?		5, 6, 7		NATIVE	ANN	
WOODSIACEAE							
Woodsia scopulina	WOODSIA	MD			NATIVE	PER	

The Discovery of Two New Tufted Desertparsleys from Southeastern Oregon: *Lomatium ravenii* var. *paiutense* and *Lomatium bentonitum*

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Anyone who has ever tried to identify a biscuitroot or desertparsley (*Lomatium*) or springparsley (*Cymopterus*) can appreciate how variable these plants can be. As a consequence of my floristic study of southeastern Oregon, most recently the Owyhee region, I often encounter unusual forms of plants. Sometimes these forms are just minor variations within the range of what might be expected for a given species, and other times the variations seem different enough to warrant a closer look. Further investigation may include more field observations, locating additional populations with the unusual characters, careful measurements and comparisons of these characters between closely related species, greenhouse or experimental manipulations, or even phylogenetic analysis of DNA sequence data. At the small liberal arts college where I teach, some of these aberrant populations that "don't read the books" make for fun research projects for keen undergraduate students. That was the case in the mid-2000s when I suggested to my student, Kim Carlson, that she make some measurements on specimens of three species of *Lomatium* from southeastern Oregon and southwestern Idaho.

Figure 1. *Lomatium foeniculaceum* var. *macdougalii* is a wide-ranging, yellow-flowered, tufted biscuitroot entering southeastern Oregon from the southeast. Photo courtesy of Gerald Carr.

Flowers in these "apioids" (Apiaceae, the carrot and parsley family) are small and rather nondescript white, yellow, or sometimes purplish, reddish, or brownish-green. Easily recognized by the characteristic umbel, members of the genera *Lomatium* and *Cymopterus* harbor a wild and confusing variation in the fruits, leaves, stems and roots. Many new species are still being described, for two reasons: differences among species are subtle and many of these plants are restricted to very narrow geographic ranges (narrowly endemic). For example, within the past five years, scientists described eight new taxa within *Lomatium* in the Pacific Northwest: *L. bentonitum* from the Succor Creek area in southeastern Oregon, *L. brunsfeldianum* from northern Idaho, *L. tarantuloides* from the Greenhorn Mountains of northeastern Oregon, *L. swingerae* from west-central Idaho, *L. knokei* from central Washington, *L. ochocense,* from the Ochoco Mountains of central Oregon, *L. pastorale*[1] from northeastern Oregon [see *Kalmiopsis* 20:1-5], and *L. ravenii* var. *paiutense* from northern Nevada, southeastern Oregon and southwestern Idaho. Several more narrowly endemic species are in the process of being described.

1 Originally published as *L. pastoralis*.

This is the story of the research that led to the discovery of two of these new taxa: bentonite desertparsley (*L. bentonitum*), and Paiute desertparsley (*L. ravenii* var. *paiutense*). This research also revealed to me that our current understanding of the evolution of this group of plants is still in its infancy.

Lomatiums from Malheur County that "don't read the books"

In southeastern Oregon we commonly encounter several tufted lomatiums, three of which I'll discuss here. One of these, Macdougal's biscuitroot (*L. foeniculaceum* var. *macdougalii*), is yellow-flowered (Figure 1). It grows in shallow soils high in clay content and ranges to the east and southeast (Idaho and eastern Nevada). A very similar

Figure 2. Anomalous white-flowered desertparsley (*Lomatium ravenii* var. *paiutense*) from southeastern Oregon, northern Nevada, and southwestern Idaho. Cronquist included this as *L. nevadense* in the *Intermountain Flora*. Photo by the author.

plant growing in comparable habitats, but with white flowers and with other minor, subtle differences, enters southeastern Oregon from the southwest (western Nevada and northeastern California). This plant (Figure 2) has been called different names by different botanists, and became the focus of our research in 2005. The name Lassen parsley (*L. ravenii*) is given for this plant in the USDA Plants Database (http://plants.usda.gov). But in his treatment of *Lomatium* for the *Intermountain Flora*, Art Cronquist (1997) placed these white-flowered desertparsleys (Figure 2) under the name *L. nevadense*. This white-flowered species, commonly called Nevada biscuitroot (Figure 3), is a widespread southwestern species that reaches into Oregon from California and Nevada and grows in loamy soils often at higher elevations. In his discussion of *L. nevadense*, Cronquist noted that "a few plants with the leaves…dissected into very numerous small segments, nearly as in *L. foeniculaceum*, but with the bractlets…scarcely hirtellous, as in *L. nevadense* occur in a swath from Lassen County, California across northern Nevada…. At least some of these plants have white flowers with purple anthers, as in *L. nevadense*: these have been described as *L. ravenii*." Thus, Cronquist acknowledged that our unusual white-flowered tufted *Lomatium* specimens in southeastern Oregon (Figure 2) were similar to three species: *L. foeniculaceum*, *L. ravenii,* and *L. nevadense*. Cronquist chose to call the unusual Oregon specimens *L. nevadense*

Figure 3. White-flowered *Lomatium nevadense* var. *nevadense* is a wide-ranging and highly variable southwestern US species that extends into southeastern Oregon. Photo courtesy of Gerald Carr.

and, in the process, lumped all the other white-flowered specimens called *L. ravenii* into *L. nevadense* as well. The justification for lumping was that the morphology of the type specimen of *L. ravenii* fell within the range of the highly variable *L. nevadense*. But we were not satisfied with Cronquist's reluctance to accept *L. ravenii* as a distinct taxon, when other authors did. Thus, the taxonomy of *L. ravenii* became the focus of our research in 2005. The distributions of these three species are shown in Figure 4.

First, Kim examined the morphological variation among specimens of these three species from our herbarium at The College of Idaho, which included a large number of specimens from Malheur County and surroundings. In the following year, she examined a few more species and varieties and from a wider geographic range. She measured 29 different morphological characters (such as length-to-width ratios of bracts below the flower clusters, flower color, and density of hairs on various structures) in plants from more than 50

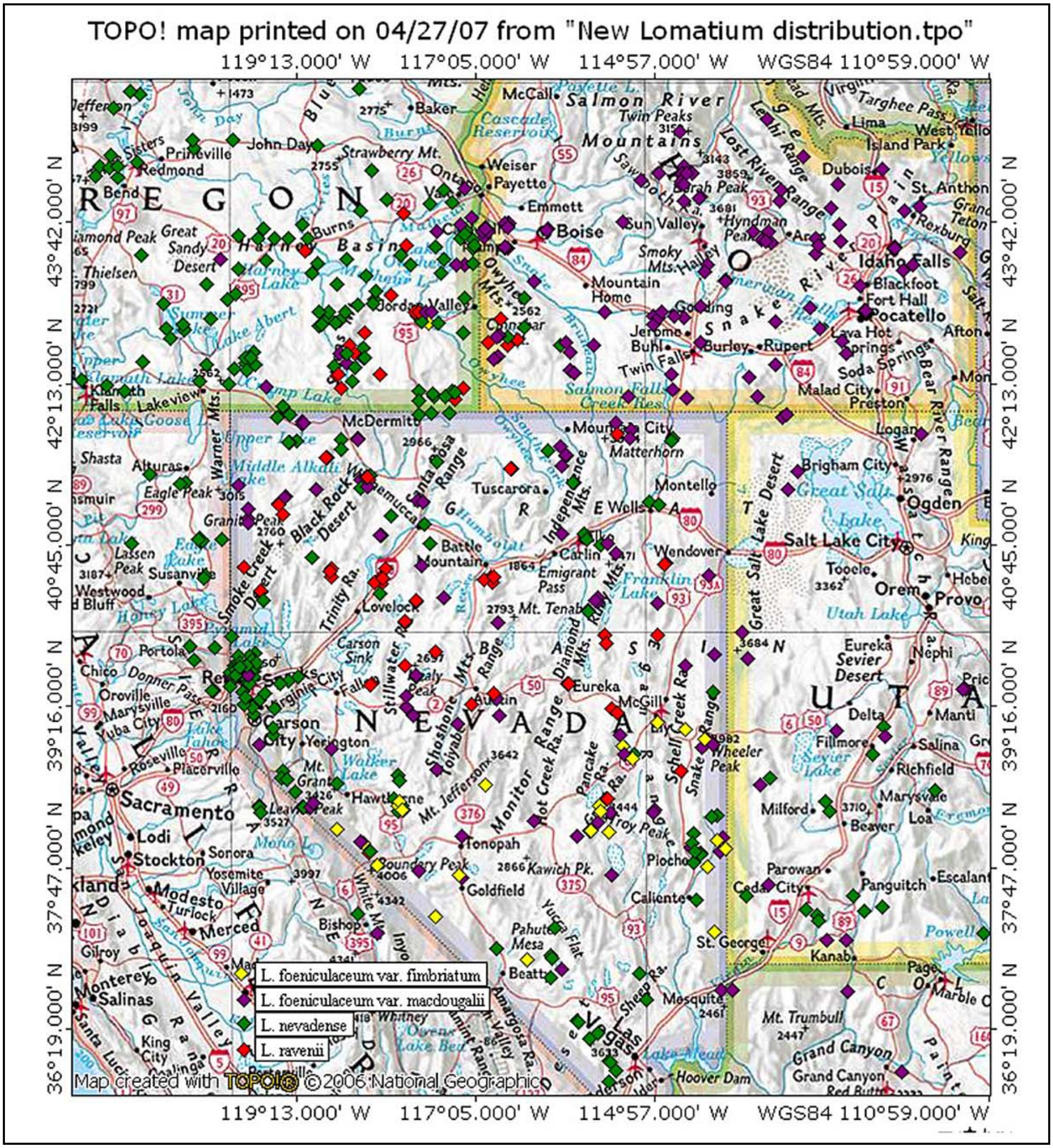

Figure 4. The distributions of *Lomatium foeniculaceum*, *L. nevadense*, and *L. ravenii* in our region (not showing the entire range of *L.foeniculaceum* and *L. nevadense*). Map by author.

populations of these three taxa and other related *Lomatium* species.

One way to visualize the results of her study is to reduce the variation among those 29 characters into a two-dimensional graph with two axes that describe much, but not all, of that variation (Carlson *et al.* 2011). Through this procedure, non-metric multidimensional scaling (NMDS), we were able to see (Figure 5) that the specimens from throughout the full geographic range of *L. ravenii* (Nevada, Idaho, California and southeastern Oregon) were distinct from both *L. foeniculaceum* and the highly variable *L. nevadense.* Data points for plants recognizable as *L. ravenii* (enclosed by a polygon in Figure 5), *L. nevadense* and *L. foeniculaceum* formed clusters distinct from one another, rather than being scattered throughout the variation typical of each species. These clusters supported distinguishing three distinct species. Among the white-flowered desertparsley specimens with tightly clustered leaves, we recognize *L. ravenii* as a species rather than including some of the specimens in *L. nevadense* and others in *L. foeniculaceum*.

However, there were two unresolved questions remaining from this analysis that we pursued in the following year or so. First, it was clear that Cronquist did not accept *L. ravenii* as a good species, so we needed to find out where it fit in an analysis of the DNA of all of the *Lomatium* taxa throughout northeastern California, northern Nevada, and Malheur County in southeastern Oregon. Second, in our analysis there was one rather odd specimen from Succor Creek (marked with the blue star on Figure 5) that we had initially thought was *L. ravenii*, but differed from other *L. ravenii* specimens, both on the herbarium sheet and on the NMDS graph.

To pursue both of these questions we joined forces with Dr. James F. Smith at Boise State University, whose phylogenetic work using DNA sequences of both nuclear and chloroplast genes enabled him to distinguish among closely related species in the largely tropical family *Gesneriaceae*. So in 2007 and 2008 we returned to the field to locate both more populations of the anomalous Succor Creek specimen and to find true *L. ravenii* from the type locality. Kim and I, with help from Jim, Dr. Ron Hartman (University of Wyoming), and some of my other students collected fresh leaf samples of many populations of *L ravenii*, *L. nevadense*, *L. foeniculaceum,* the unusual Succor Creek specimen, and several other species of *Lomatium*, from which Kim began extracting DNA for analysis.

Two varieties of *Lomatium ravenii*

First, we examined plants from the population where Mildred Mathias and Lincoln Constance collected the type specimen of *L. ravenii*, which is the plant on which they based their initial description of the species and named it. We reasoned that, perhaps *L. ravenii* specimens from the type locality were different than the *L. ravenii* we had been studying. With the help of Dr. Barbara Ertter (University of California, Berkeley, and The College of Idaho) and Matt Guilliams (a UC student at the time), we were able to get leaf samples and voucher specimens of three *L. ravenii* from both the type locality and nearby locations.

After refining techniques for sequencing the same genes from all samples, we were able to decipher some presumed evolutionary relationships using techniques of phylogenetic analysis. The results of these analyses (Figure 6) demonstrate that *L. ravenii* is indeed closely related to *L. foeniculaceum.* It is within the same terminal branch, or clade, in this phylogenetic tree. *Lomatium nevadense*, the species in which Cronquist thought *L. ravenii* should be included, is in a part of this tree widely separated from *L. foeniculaceum* and *L. ravenii* by several other *Lomatium* species (Figure 6). This phylogenetic tree also revealed that *L. ravenii* specimens consist of two different, related groups, one that includes plants resembling the *L. ravenii* type specimen and another that includes other *L. ravenii* from Malheur County and northern Nevada. We named this second group of *L. ravenii* as a new variety (Carlson *et al.* 2011b): *L. ravenii* var. *paiutense* or Paiute desertparsley, in recognition of the Northern Paiute tribe, which shares a similar range throughout northern Nevada, southeastern Oregon, southwestern Idaho and whose members may have used the plant as a food source. The new variety, *L. ravenii* var. *paiutense* is more densely hairy on the leaves and bracts beneath the umbels and has broader, shorter leaf segments than the typical variety (*L. ravenii* var. *ravenii*) that is restricted to California (not overlapping the range of the Paiute

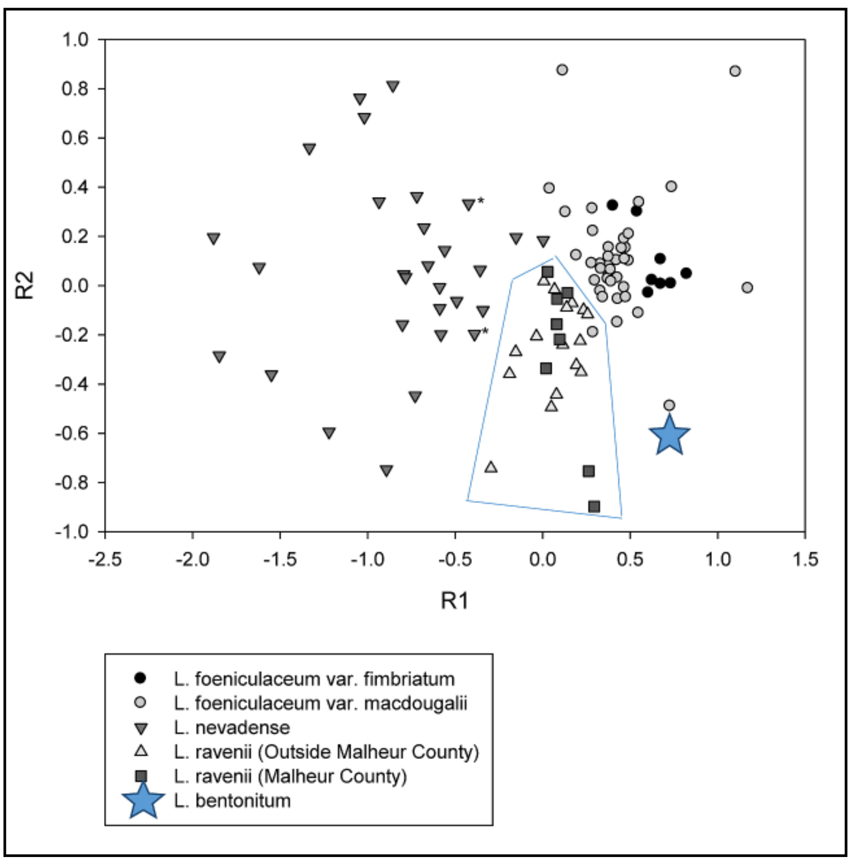

Figure 5. An NMDS graph illustrating variation among plants in the three species of *Lomatium* that the author and his student Kim Carlson investigated in 2007, showing also the unusual specimen that led to the discovery of *Lomatium bentonitum*. The two axes represent a composite of the greatest amount of variation possible in two dimensions from among the 29 variables measured among the 50 plants observed. Each point on the graph represents one plant from a unique population. (adapted from Carlson *et al.* 2011a)

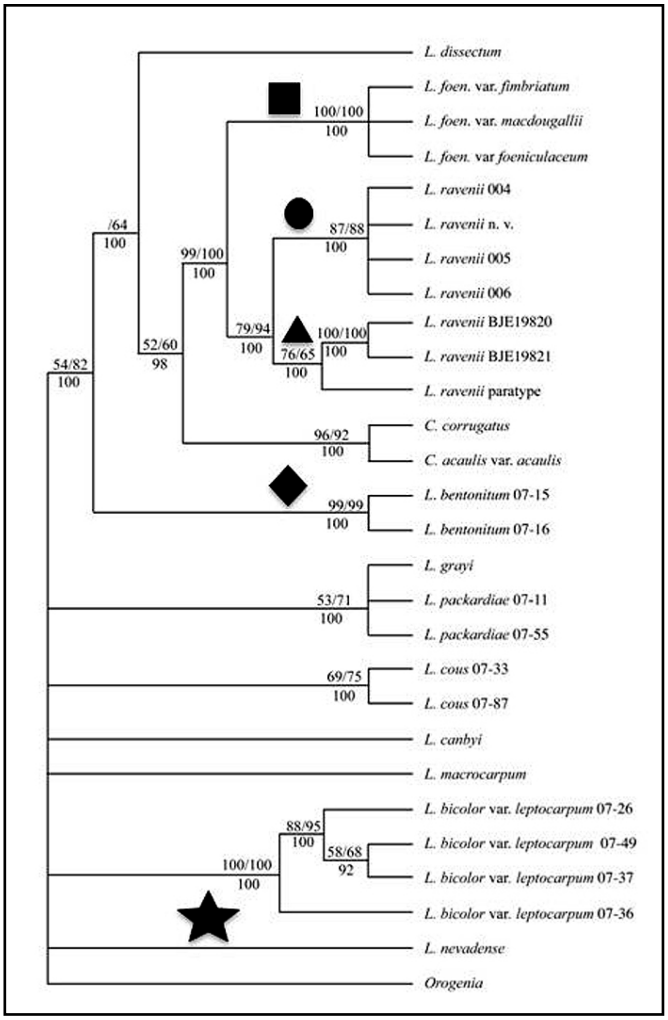

Figure 6. A phylogenetic tree (cladogram) of *Lomatium ravenii*, its closest relative, *L. foeniculaceum*, and other less closely related species of biscuitroots and desertparsleys. The groups (clades) discussed in this article are marked on the figure: *L. foeniculaceum* (square), L. *ravenii* var. *paiutense* (circle), *L. ravenii* var. *ravenii* (triangle), *L. bentonitum* (diamond), and *L. nevadense* (star). The numbers are degrees of support (likelihood of true phylogenetic relationship) for each branch based on different methods of analysis. (adapted from Carlson *et al.* 2011b)

desertparsley—see Figure 7). Also, *L. ravenii* var. *ravenii* has other characteristics more closely resembling *L. nevadense* than does *L. ravenii* var. *paiutense.* Cronquist may well have recognized the difference between what we are calling two varieties of *L. ravenii*, but preferred to lump all plants resembling *L. ravenii* in the widespread and variable *L. nevadense*. His note suggesting that what we now call *L. ravenii* var. *paiutense* might have merely been another form (possibly a variety?) of *L. foeniculaceum* was indeed insightful, as the results of the DNA cladogram illustrate (Figure 6).

Bentonite desertparsley (*Lomatium bentonitum*) is a new species

Having settled the *L. ravenii* enigma to our satisfaction, the phylogenetic tree revealed that the unusual Succor Creek specimens (shown by the blue star in Figure 5) not only represented a different branch on the tree (labeled as *L. bentonitum* on Figure 6), but the specimens were so different that they were separated from specimens of the two *Lomatium* species, *L. ravenii* and *L. foeniculaceum* by specimens from a different genus (*Cymopterus*)! Indeed the DNA analysis strongly indicated that we had turned up another species.

We decided to examine the morphology of specimens in more detail, such as the root form and additional features related to form, density and location of surface hairs. Fortunately, we had some additional specimens in our herbarium that had been collected a few years earlier. A subsequent NMDS analysis of these specimens distinguished this new species from the other species similar to it, including *L. nevadense*, *L. ravenii*, *L. foeniculaceum*, and *L. canbyi* (Figure 8). We named it *Lomatium bentonitum* because the only place where we found it (or have found it since we described it) is a bentonite clay mine in Succor Creek basin (Figure 9).

Lomatium bentonitum, or bentonite desertparsley (Figure 10), is found only in azonal soils on outcrops of Miocene ash of the Sucker Creek Formation in Succor Creek drainage where light colored ash has weathered to bentonite clay, a shrink-swell clay with tremendous capacity to absorb water. The similar species, *L. ravenii* var. *paiutensis*, Paiute desertparsley, lives nearby but not on the bentonite-rich outcrops. Though similar in appearance to Paiute desertparsley, bentonite desertparsley has more planar leaves, which are less hairy, making the plant appear more green than gray. The root is perhaps its most distinctive feature. Figure 11 shows how the top of the root is abruptly narrowed in *L. bentonitum* but tapered in *L. ravenii* var. *paiutense*. However, now that we have been able to recognize *L. bentonitum* as a distinct species, and know how rare it is, I recommend against digging

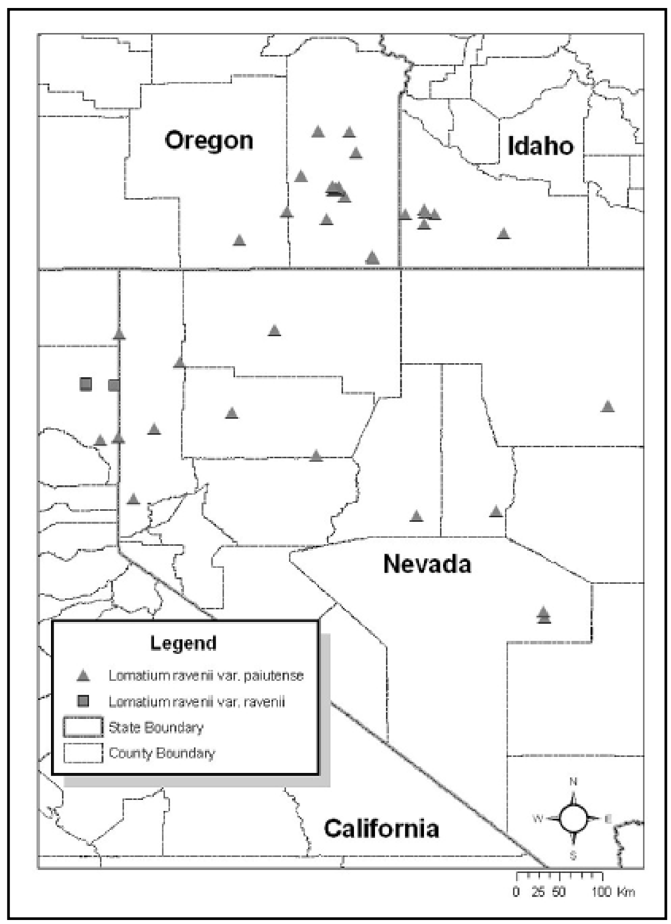

Figure 7. The distributions of the two varieites of *L. ravenii*. Map by author.

it up to examine its root. We know of just one population of this species, though we have not searched exhaustively in this region. Other clay rich substrates in the area should be investigated for this extremely rare endemic. Originally we had thought that an additional population existed deep in the desert plateaus in southern Owyhee County, Idaho because we had one specimen that resembled *L. bentonitum* in our herbarium (still cited in PLANTS USDA (http://plants.usa.gov). But in 2012 we revisited populations from that area and realized that, although some plants in the *L. ravenii* var. *paiutense* populations have a distinctive abrupt narrowing to the bulbous root, most root tops are tapered. Furthermore, those plants were not in bentonite clay outcrops, but rather are growing in rocky soil having a clay substructure, which is the typical habitat of *L. ravenii* var. *paiutense*. Furthermore, the surfaces of leaves were much more typical of *L. ravenii* var. *paiutense*.

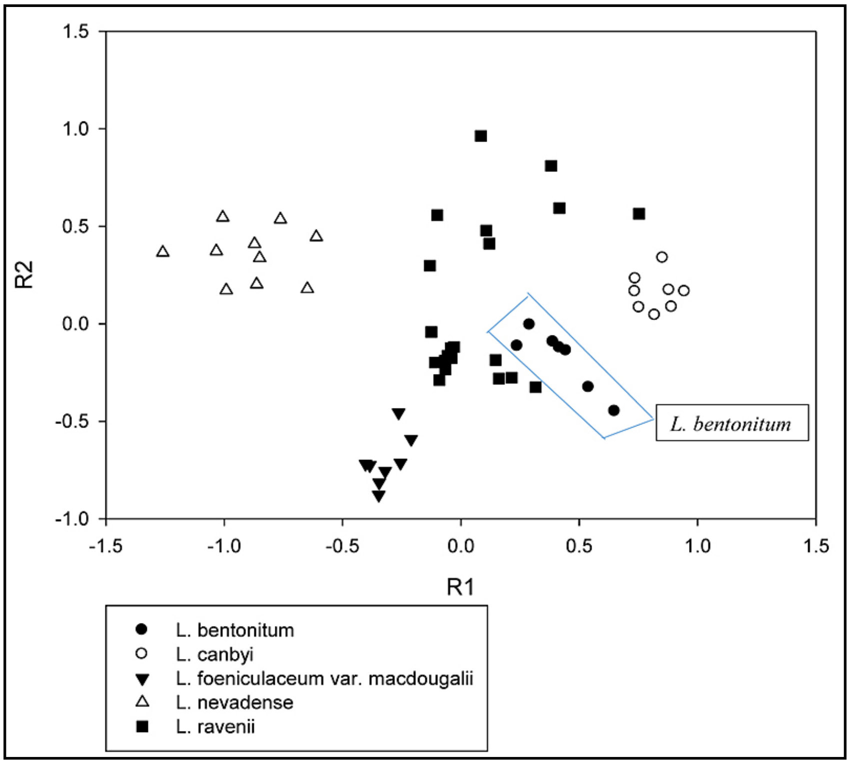

Figure 8. An NMDS graph illustrating variation among samples of *Lomatium bentonitum* and nearby species resembling it. (adapted from Carlson *et al.* 2011a)

The Succor Creek location of the new bentonite desertparsley is in the vicinity of several other unusual soil outcrops from weathered ash deposits high in clay content where other rare plants are found, including *Lomatium packardiae*, *Cymopterus glomeratus* var. *greeleyorus* (*C. acaulis* var. *greeleyorum*), *Mentzelia mollis*, and others. This area is unusually rich in rare plants restricted to specific substrates. *Lomatium bentonitum* is one more to add to the growing list of narrow endemic *Lomatium* species found in southeastern Oregon's deserts.

Evolutionary relationships in *Lomatium*

The observation (in Figure 6) that two species of the genus *Cymopterus* are situated between very similar and closely related species of *Lomatium* is curious and rather unsettling. After all, shouldn't all species within a genus be more closely related to each other than to species in a different genus? On the surface, this does not seem to be true in

Figure 9. The bentonite clay mine in Succor Creek drainage in Malheur Co., Oregon—the only known locality of *Lomatium bentonitum*. Photo by the author.

Figure 10. The habit of *Lomatium bentonitum* in its native habitat. Photo by the author.

this group of desertparsleys. In the past few years we, and others, are continuing to examine the genetic and morphologic relationships among other members of this group. Within the group of plants that includes *Cymopterus* and *Lomatium,* at least 10 cases have been identified where species of one of the genera appear to be more closely related to species of the other genus than to members of their own genus (George *et al.* 2014, Sun and Downie 2010). This situation termed "polyphyly[2]" indicates that our understanding of the evolutionary relationships among species in the two genera is not yet clear. Some characters that we thought defined a genus are more than likely ones that appear repeatedly in multiple evolutionary lineages, and do not indicate that the groups share a common ancestor. For example, one character used to separate *Cymopterus* from *Lomatium* is the multiple elaborated wings on the fruits of *Cymopterus*, which are normally absent on fruits of *Lomatium* — but there are exceptions (*L. packardiae* var. *tamanitchii, L. thompsonii, L. suksdorfii, C. glomeratus* var. *concinnus*). As we continue to study this group of interesting plants, we expect that the coming years will reveal dramatic reinterpretations of their evolutionary relationships and plenty of new names for botanists to learn.

Acknowledgements

I wish to acknowledge many people who have contributed to this project. I could not have become so engaged with *Lomatium* without my collaboration with Dr. James F. Smith at Boise State University. Kim Carlson's interest, keen eye, and careful attention to detail got this all off the ground. Emma George moved the project forward by tireless work that demonstrated the incredible polyphyly in the group. Many of my students have worked to the project, including Lauren Polito, McKayla Stevens, Kelsey Nelson; many more in field botany classes have contributed to important field collections. Several others including Richard Heliwell, Mark Darrach, Rick McNeil, Cody Hinchliff, and Jim Duncan have contributed invaluable samples and vouchers. I continue to appreciate collaborations with Barbara Ertter, Ron Hartman, Cody Hinchliff, and Stephen Downie. Mark Darrach read and contributed to the final manuscript. Finally, I wish to thank Cindy Roché and Kareen Sturgeon for their many helpful editing suggestions.

2 Polyphyly refers to branches of a phylogenetic tree that do not include their common ancestor.

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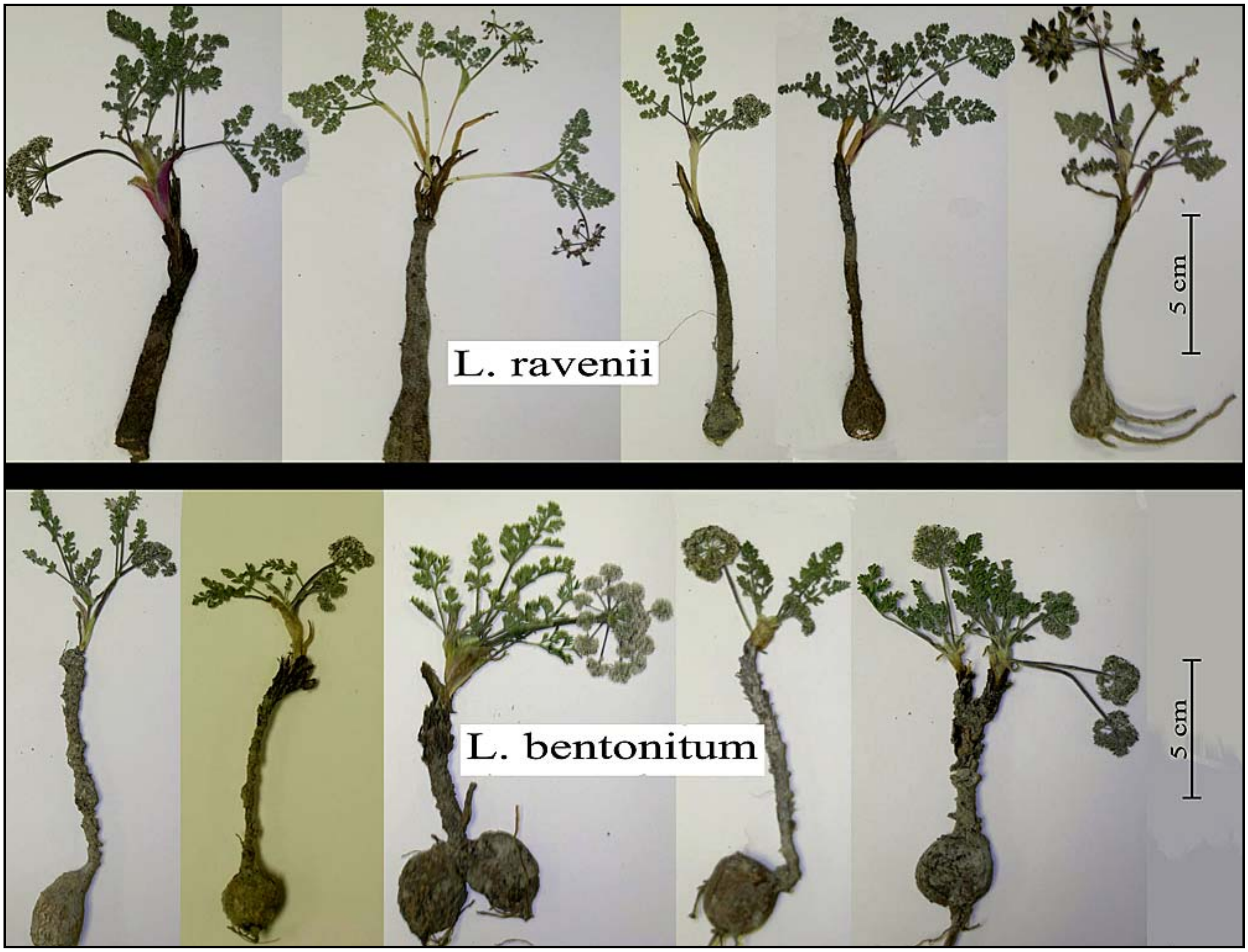
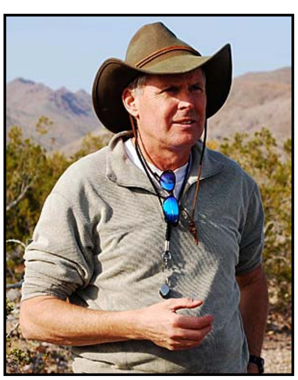


Figure 11. The two new desertparsleys of southeastern Oregon: *Lomatium ravenii* var. *paiutense* and *Lomatium bentonitum*. They are distinguished by their tapering and bulbous roots, respectively, and by their grayer, more hairy and greener, less hairy foliage, respectively. (from Carlson *et al.* 2011a)

George E, Mansfield DH, Smith JF, Hartman R, Downie S, Hinchliff C. 2014. Phylogenetic analysis reveals multiple cases of morphological parallelism and taxonomic polyphyly in *Lomatium* (Apiaceae). Systematic Botany 39 (2):662-675.

Sun FJ, Downie SR. 2010. Phylogenetic relationships among the perennial, endemic Apiaceae subfamily Apioideae of western North America: additional data from the cpDNA trnF-trnL-trnT region continue to support a highly polyphyletic *Cymopterus*. Plant Diversity and Evolution 128:151–172.



Don was born in Salem, Oregon, and grew up all over the US. He took his first biology class from Dr. Martha Springer at Willamette University and transferred to Colorado College where he completed a BA in biology in 1973, discovering field botany in his senior year studying under Dr. Jack L. Carter. After completing his MSc in botany at University of British Columbia, working with Dr. Iain E.P. Taylor on a biochemical problem, but also studying with Dr. Wilf Schofield and others, Don decided that he loved both teaching and botanical research. He earned his Doctor of Arts degree in biology at Idaho State University (1979) working with Dr. Jay Anderson. There he began studying the botany of Steens Mountain in eastern Oregon, often studying with Dr. Karl Holte. After brief post-doctoral employment at University of California, Davis, where he worked on post-harvest physiology while spending weekends studying vernal ponds of northern California, he taught botany and physiology at Colorado College (1981-1984). While Assistant Professor of Biology at Rollins College in Florida (1984-1989), Don returned each summer to Steens Mountain and Colorado to pursue his growing love of floristics. In 1989 he took a faculty position at The College of Idaho in Caldwell, where he teaches field botany and a variety of biology courses and serves as Curator of the Harold M. Tucker Herbarium. His floristic research resulted in the Flora of Steens Mountain (2000), and he continues to study the floristics of SE Oregon, SW Idaho, and N Nevada. His work has turned up many interesting problems, such as the ones described in this article, which he continues to pursue with his wonderful and talented undergraduate students.

Key to the low-growing (generally < 1.5 dm), tufted desertparsleys, springparsleys, and related biscuitroots (*Lomatium* and *Cymopterus*) of SE Oregon and SW Idaho

(These are species with highly dissected leaves with very short ultimate leaf segments.)

1a. Foliage lacking hairs or with sparse, short stubbly hairs

2a. Mature fruits lacking papery ribs between the two lateral wings; roots swollen and spherical (smelling of turpentine), sometimes only at the base of an elongate upper portion; widespread in clay soils in SE Oregon and SW Idaho .... Chucklusa (*Lomatium canbyi*)

2b. Mature fruits with papery ribs between the two lateral wings; roots elongate, cylindrical and never spherical .... *Cymopterus*

3a. Leaves dissected 1-2 times with one to a few pairs of distinct leaflets; bracts beneath the terminal umbels of flowers narrow and finger-like, not fused to one another at their bases; flowers white; plants of sandy soils in southern Malheur and Harney Counties .... Corrugated springparsley (*C. corrugatus*)

3b. Leaves dissected 2-3 times into small segments; bracts beneath the terminal umbels of flowers broad and generally fused to one another at the base; flowers white or yellow; plants generally of clay soils, in Malheur County .... Plains Cymnopoterus (*C. glomeratus* (=*C. acaulis*))

4a. Flowers yellow; plants restricted to brown to tan Sucker Creek Formation ash outcrops that have weathered to clay.. Greeley springparsley (var. *greeleyorus*)

4b. Flowers white; plants in clay soils other than those of the brown to tan ash outcrops in Succor Creek .... Plains springparsley (var. *glomeratus*)

1b. Foliage distinctly hairy, though sometimes sparsely so

5a. Flowers yellow; anthers yellow.. *L. foeniculaceum*

6a. Petals with a fringe of hairs on their margins; plants known only from barrens a few miles west of Rome, OR (not known in ID) .... Fringe-petal biscuitroot (var. *fimbriatum*)

6b. Petals entire, lacking a fringe of hairs on their margins; plants scattered throughout SE Oregon and SW ID .... Macdougal's biscuitroot (var. *macdougalii*)

5b. Flowers white; anthers generally purple

7a. Plants with spherical thickening in the roots (see Figure 11) abruptly narrowing at the top; foliage similar to *L. nevadense* (see lead 8a); plants restricted to azonal soils of white ash outcrops in the Sucker Creek Formation that have weathered to bentonite clay .... Bentonite desertparsley (*L. bentonitum*)

7b. Plants with either elongate roots or, if roots are thickened then tapering gradually at the top of the thickened base (see Figure 11); plants widely distributed in SE Oregon and SW Idaho generally on zonal, loamy or rocky (with clay subsurface) soils

8a. Leaves divided about 2.5 times; leaflets somewhat open, with ultimate leaf segments neither narrowly linear (pencil-shaped) nor narrowed at the base; foliage sparsely hairy; bracts beneath the umbels with few hairs; plants generally of well-developed loamy soils.. Nevada biscuitroot (*L. nevadense*)

8b. Leaves divided 3 or more times; leaflets tightly clustered, with tiny ultimate segments that are either much longer than wide or narrowed at the base; foliage densely to sparsely hairy; bracts beneath the umbels densely to sparsely hairy; plants of rocky soils with clay substructure .... (*L. ravenii*)

9a. Ultimate leaf segments wider in the middle or near the tip than at the base, generally < 3.0 times longer than wide; bracts at base of umbels densely hairy; stems generally 1-2 per plant; leaf bases rarely persistent; plants widespread in N NV, SE OR, and SW ID................ Paiute parsley (var. *paiutense*)

9b. Ultimate leaf segments generally uniformly narrow, generally > 3.5 times longer than wide; bracts at base of umbels hairless or nearly so; stems generally 2-4 per plant; leaf bases generally persistent; plants from vicinity of Ravendale, CA (see Figure 7) .... Lassen parsley (var. *ravenii*)

The Discovery and Naming of the Cascade Strawberry

(*Fragaria cascadensis* Hummer)

Kim E. Hummer, USDA ARS NCGR
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I have a great job. I am the Research Leader and Curator of a US Department of Agriculture *ex situ* (off site) genebank and research laboratory called the National Clonal Germplasm Repository (USDA ARS NCGR). At this facility in Corvallis, Oregon, my staff and I preserve about 12,000 living plants representing collections of important specialty crops, including berries, pears, hazelnuts, mint, hops, and their wild relatives.

Our assignment is to collect, maintain, distribute, and evaluate the global genetic diversity of these crops. We're part of the US National Plant Germplasm System. The federal government does good work in germplasm[1] conservation through our program!

Type specimen of *F. cascadensis*. If you look closely, white hairs are visible on the upper leaf surface of the four-foliate leaf. Note that the distal tooth of the distal leaflet is smaller than that of adjacent teeth. Photo by author

Our facility maintains plants in the field in orchards, in containers in greenhouses and screenhouses, as tissue-cultured plantlets, and as seed. We preserve heritage cultivars and species of crop wild relatives. Each year we host the public at open house events, in which visitors sample fruit of the 350 blueberry genotypes in mid-July, and about 2,000 types of pears in late August. At other times, the public can visit our laboratory by appointment.

As curator of the strawberry collection, I have had the good fortune to have participated in more than 18 major international plant-collecting expeditions throughout the world to obtain samples of regional cultivars and diverse wild species for our genebank. Our strawberry collection includes 42 taxa (including species and subspecies) and 1,842 accessions from 42 countries.

Native strawberries in Oregon

Until recently, only four native taxa of *Fragaria* were known in Oregon: Virginia strawberry (*Fragaria virginiana* ssp. *platypetala*), alpine or woodland strawberry (*F. vesca* ssp. *bracteata*), beach strawberry (*F. chiloensis*) and a natural hybrid between beach and Virginia strawberries (*F.* × *ananassa* nothosubsp. *cuneifolia*). Like many plant species, ploidy levels[2] vary among *Fragaria* species. The base number of chromosomes in a haploid strawberry gamete is $x = 7$ (Darrow 1966). Alpine strawberry, Oregon's only diploid strawberry, is widespread, occurring in the Coast Range, the Willamette Valley, the Cascade Mountains, and throughout eastern Oregon in moist montane habitats. The octoploid beach strawberry, with two subspecies recognized by some authorities, is found along the coast. The octoploid Virginia strawberry, which was named for the Virginia colony in the 1700s, is widespread throughout the United States; in Oregon, it is found from the western Cascade foothills and eastward in moist montane habitats. The natural strawberry hybrid, which occurs in the Coast Range and the Willamette Valley, is also octoploid, like its parents.

As everyone knows who has ever grown strawberries in their garden or a container, these plants reproduce vegetatively by runners as well as by seed. The seeds are found in the achenes on the surface of the tasty fruits. Wild populations of strawberries consist of clonal colonies of plants with either imperfect (male or female) or perfect (hermaphrodite) flowers arising from the runners. Hermaphrodite plants are very rare in the species *F. chiloensis*, and this species is considered dioecious. In populations of *F. vesca* subsp. *bracteata* only females and hermaphrodites are found, a situation called gynodioecious (Staudt 1999, Tennessen *et al.* 2013).

1 The term germplasm refers to living tissues that contain the genetic makeup or propagules of plant species.

2 Polyploid organisms have two or more sets of homologous chromosomes, designated as 4x, 6x, etc.

A puzzle in strawberry polyploidy

During a routine survey of wild strawberry germplasm using molecular markers, our geneticist, Dr. Nahla Bassil, and her graduate student, now Dr. Wambui Njuguna Young, found some anomalies in some samples of what we thought were the octoploid Virginia strawberry. They observed several samples with unusually high numbers of alleles per locus, many more than they expected. This discovery prompted us to count the chromosomes of those samples using a microscope. Visiting scientists Dr. Tomohiro Yanagi from Japan, Dr. Preeda Nathewet from Thailand, and I found that the atypical samples did, in fact, have more chromosomes; they were decaploid (10*x*), not octoploid (8*x*). Now this was really intriguing, because the only previously known naturally occurring decaploid strawberry grows on the Kurile Islands between Japan and Russia (Hummer *et al.* 2009). Other known decaploids are cultivated types that were produced in a laboratory, not found in the wild.

Inflorescences of the Cascade strawberry showing young and mature fruits. Photo by author.

Tracking decaploid strawberries in the mountains of Oregon

One of the plant samples in question was collected in 1982 by the germplasm repository's former curator, Dr. Otto Jahn along the Pacific Crest Trail near Big Lake, south of Santiam Pass in eastern Linn County, Oregon (ca. 1400 m. elev.). I became curious whether this decaploid cytotype[3] was just an anomaly or whether other strawberry plants nearby had similar chromosome numbers. Also I wondered if decaploid plants were widely distributed or whether there was just one small colony. No one had described a native wild decaploid strawberry from North America before, although many strawberry breeders had synthesized them in the laboratory using chemicals and specific crosses.

So I set out to obtain samples of wild strawberries from many locations around Oregon. I first went to the original location along the Pacific Crest Trail and obtained samples from east and west of Big Lake (near Hoodoo Butte). The strawberries were growing alongside a forest road and in the alpine meadows.

One location where *F. cascadensis* grows in the high peaks of the Oregon Cascades near the Pacific Crest Trail. Photo by author.

We started analyzing the number of chromosomes of the strawberries using a technique called flow cytometry, which is faster than counting chromosomes using a microscope. The first results were exciting: many clones near the original locality were decaploid. Soon I found that many sites from elevations above 1,000 m. in the Cascades, starting near Mt. Hood in the north and extending to Crater Lake in the south, supported decaploid strawberries. Like other *Fragaria* taxa in Oregon, plants from these populations are sub-dioecious.

3 An organism with a chromosome number that differs from others.

Identification key for wild *Fragaria* in Oregon

1a. Leaves thick (or moderately so), lower surface often strongly reticulate-veined, upper surface dark green or bluish green; achenes large to medium; plants coastal to inland.

2a. Leaves thick, strongly reticulate-veined beneath, upper leaf surface dark green; achenes 1.8 (1.4-2) mm long; plants coastal, octoploid ($2n=8x=56$); beach strawberry. .... *F. chiloensis*

3a. Petioles, peduncles, pedicels and runners with appressed-ascending hairs, occasionally macroscopically almost glabrate .... subsp. *lucida*

3b. Petioles, peduncles, pedicels and runners with spreading, dense hairs .... subsp. *pacifica*

2b. Leaves somewhat thick, not strongly reticulate-veined beneath, sometimes bluish green to slightly glaucous; achenes 1.4 (1.3-1.75) mm long; plants coastal to inland, octoploid ($2n=8x=56$); hybrid strawberry........ *F.* ×*ananassa* nothosubsp. *cuneifolia*

1b. Leaves thin, not reticulate-veined beneath, upper surface bluish green; achenes 1.4-1.6 mm long; plants inland.

4a. Leaves bright green; leaflets ovate or obovate to slightly rhomboidal; distal tooth of terminal leaflet usually longer than adjacent teeth; teeth ca. 38 or more per leaf; flowers ~ 20 mm in diameter; inflorescence usually above foliage; flowers usually perfect, sometimes female; calyx mostly reflexed from ripe fruit; achenes 1.4-1.6 mm long, frequently with persistent style; Coast Range, Willamette Valley, Cascade Mountains, moist montane habitats in eastern Oregon; plant diploid ($2n=2x=14$); alpine or woodland strawberry .... *F. vesca* subsp. *bracteata*

4b. Leaves green to bluish green; distal tooth of terminal leaflet usually shorter than adjacent teeth; inflorescence usually lower than foliage or variable length; flowers male, female, or perfect; calyx mostly clasping ripe fruit; achenes 1.5 (1.3–1.8) mm, style not persistent.

5a. Upper leaf surface glabrous; achenes generally tear-drop shaped, about 1.5 mm long; Oregon Coast Range, Willamette Valley eastward in moist montane habitats throughout Oregon, generally < 1,000 m elev.; plants octoploid ($2n=8x=56$); Virginia strawberry .... *F. virginiana* subsp. *platypetala*

5b. Upper leaf surface with scattered white hairs (~ 1mm); many achenes comma-shaped with concave edge, sometimes tear-drop shaped; crest of Cascade Range from ca. Mt. Hood to Crater Lake, extending down west side to about 1,000 m elev.; plants decaploid ($2n=10x=70$); Cascade strawberry .... *F. cascadensis*

Achenes of *F. vesca* subsp. *bracteata*, *F. cascadensis*, and *F. virginiana* ssp. *platypetala*. (Images by Dr. Sugae Wada).

($2N = 10x = 70$) chromosomes of the Cascade strawberry, *F. cascadensis*. The bar = 5 µm. Image by Dr. Preeda Nathewet.

Should the decaploid plants be considered a new species?

After establishing that the decaploids were widespread along the crest of the Cascades, I began collecting samples from many river drainages and trails in the Willamette Valley to see how far west the distribution of the decaploids extended. Samples from the Valley and the Coast Range proved to be octoploids. It occurred to me that perhaps the decaploids were restricted to higher elevations, so I sampled strawberries on Marys Peak (ca. 1240 m.). Not so! Samples from Marys Peak were octoploid, as were populations in eastern Oregon. Samples from high elevations in the Blue and Wallowa Mountains, the Washington Cascades, and in California from Mount Shasta and Mount Lassen were also octoploid. Thus, the decaploid strawberry was limited, as far as we know, to a band high in Oregon's Cascade Range.

The restricted distribution and the higher chromosome number, which served as a barrier to crossing with the octoploid Virginia strawberry, signified that these populations might represent a new species. I asked my colleague, Dr. Aaron Liston (Professor and Director of the Oregon State University Herbarium), what it took to name a new species. He said I would first need to determine how the morphology of the decaploids differed from other Oregon strawberries. Then I would need to write and publish a detailed description based on a type specimen[4], along with a taxonomic key to separate it from other Oregon species of *Fragaria*.

4 A type specimen is the plant, deposited in a herbarium, on which the description and name of a new taxon is based.

Naming the new species

I went to one of my favorite populations of the decaploid strawberries, at the entrance road to Waldo Lake (1700 m.) in Lane County in the western Cascades. I began systematically measuring and counting flower parts (anthers and petals), leaves, and runners, making notes of any unusual characters. At first, I did not detect differences in morphology between the decaploid and the octoploid plants at other locations.

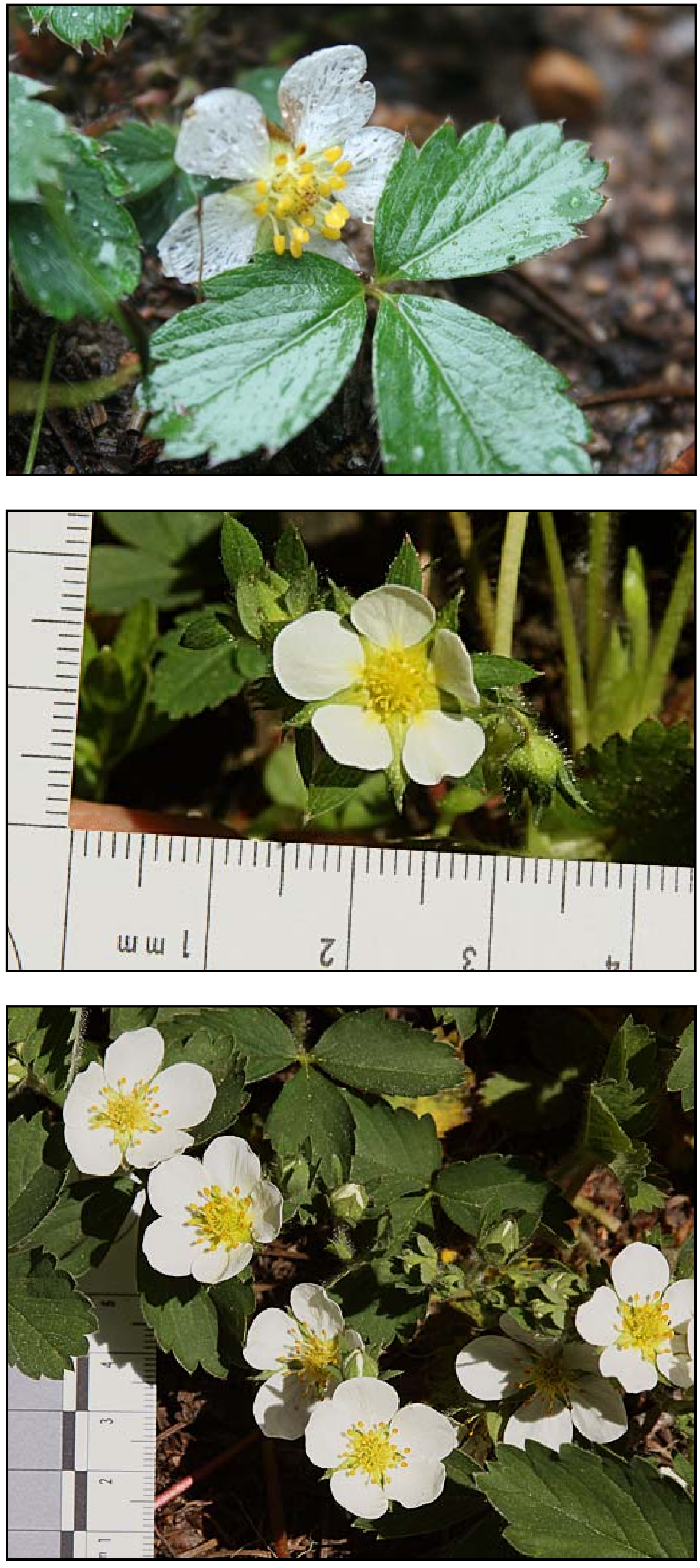
Then, one day, I re-read a description of *F. virginiana* subsp. *platypetala* written by Dr. Guenter Staudt, a German taxonomist, in his monograph on strawberries of North America (Staudt 1999). He described the upper leaf surface of Virginia strawberry as being "smooth and usually glaucous." I looked at the leaf of a decaploid under a microscope and observed that it had a number of 1 mm. long white hairs on the adaxial (upper) surface; it was not "smooth." Those hairs became my first diagnostic character. As I looked at more samples, I confirmed the distinction: those with hairs on the upper side of the leaf occurred consistently on decaploid samples; the ones that were bald on top were octoploid.

Then I began to recognize differences in achenes: edges of decaploid achenes curved, while edges of octoploid achenes were straight. The achenes of the diploid alpine strawberry are smaller than the others and have persistent styles. While this species also has hairs on the upper leaf surfaces, it could be separated from the decaploids by its prominent veins and characteristics of the teeth on leaflet margins.

Having pinpointed key morphological differences, it was time to review the strawberry collection at the Oregon State University Herbarium. As I anticipated, I found a number of specimens labeled Virginia strawberry (some annotated by Staudt!) with 1 mm. hairs on the upper surface of the leaves, all from the high peak region of the Oregon Cascades (except for one 1915 collection with only the vague description "Hood River").

Now I had a distribution map, morphological differences, and differences in the chromosome number. I chose a population near Waldo Lake east of Oakridge in Lane County for the type locality[5] and published an article describing the new species, naming it for the Cascade Range of Oregon, *F. cascadensis* (Hummer 2012).

Populations of this new species have been found from near Mount Hood on the Burt Lake Trail, Echo Mountain Trail, near Hoodoo Butte, Hayrick Butte, around Big Lake, near Waldo Lake, near Diamond Lake, and to southwest of Crater Lake. Populations are found only above about 1,000 m. elevation on the west side of the crest in the Oregon Cascade Range. Significantly, all of the strawberries in this band of the High Cascades in Oregon were Cascade strawberry; no Virginia strawberries grow at this elevation.



Male (top), female (middle), and hermaphroditic flowers (bottom) of the Cascade strawberry. Photos by author.

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5 The type locality is the place where a type specimen was collected.

NCGR screenhouses in Corvallis. Photo by author.

Strawberry collection at NCGR. Photo by author.

How might the decaploid Cascade strawberry have formed?

During the past century, scientists have created decaploid strawberries in the laboratory using colchicine, a chemical mutagen, but the first discovery of a native wild decaploid (10*x*) species was of *F. iturupensis* Staudt from the Kurile Islands (Hummer *et al.* 2009). The exact process that produced this decaploid isn't known, but mutations causing the spontaneous doubling of chromosomes in gametes may occur naturally following hybridization. Such mutations occur fairly frequently in strawberry pollen, in which the genetic material for two pollen grains gets packaged into a single large one. For example, colonies of plants with mixed ploidy levels (5x, 6x, 9x) have been identified in California as a result of crossing of diploid (*F. vesca* ssp. *californica*) and octoploid (*F. chiloensis*) strawberries (Bringhurst 1990).

This same process could have occurred in Oregon for Cascade strawberry. To fully understand how the decaploid plants evolved, plants with intermediate ploidy levels between 2*x* and 10*x* would need to be identified within or near the decaploid populations. It might be that the intermediate-ploids necessary to form the decaploid may have had a transient existence in Oregon. Many intermediate ploidy levels have very low fecundity because their homologous chromosomes do not pair properly during meiosis. However, vegetative reproduction of strawberries by runners may have allowed unstable intermediate forms to persist long enough to produce a stable decaploid.

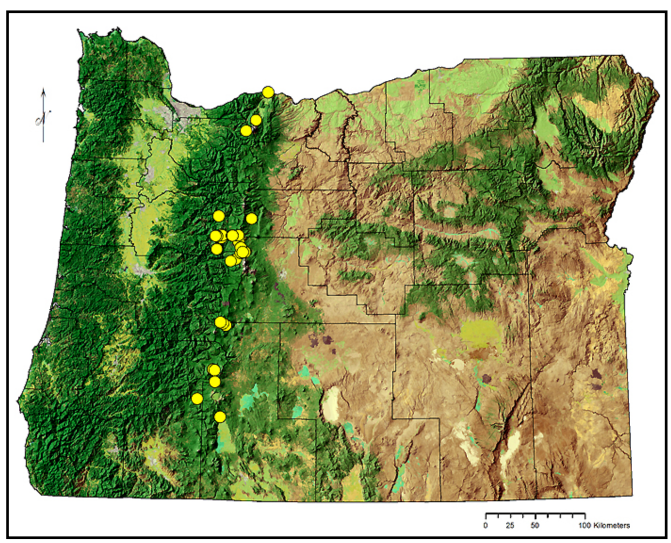
An explanation for the distribution of Cascade strawberry?

Scientists examining the chloroplast genome of the octoploid Virginia strawberry determined that it evolved between 400,000-2 million years ago (Njuguna *et al.* 2012). Thus, if the decaploid Cascade strawberry originated from a combination of the genomes of Oregon's octoploid Virginia and diploid alpine strawberries, it must have evolved more recently. This led us to consider events in Oregon that might have fostered a narrow band of strawberries in the Oregon High Cascade Range. About 10,000 years ago, Pleistocene glaciers retreated northward, leaving only a remnant ice cap over the highest part of the Oregon Cascades (Porter *et al.* 1983). A subsequent hypsithermal (rapid warming) event melting this ice cap would have opened up prime territory for expansion of a newly formed decaploid strawberry species with a pioneering nature.

Potential of the decaploid Cascade strawberry for commercial use

If trends over the past decades are an indication, consumers are interested in ever bigger strawberries. Fruit of the cultivated hybrid octoploid strawberry is much bigger than that of the diploid alpine strawberry. Thus, one might predict that the decaploid Cascade strawberry fruit would be even larger. Unfortunately, its fruit diameter is small, about the size of a thumbnail. Fruits of the common commercial strawberry (cultivars of octoploid *F.* × *ananassa*) weigh ten times that of the Cascade strawberry. Moreover, the flavor of the decaploid fruit is mostly bland and not as complex as that of the alpine strawberry.

Despite this, breeders may want to use it in developing a new class of cultivated strawberries at the decaploid level. Several artificial decaploid strawberries (Dermen and Darrow 1938) already exist: in Germany, *F.* ×*vescana* hybrids from polyploid



Distribution map of the Cascade Strawberry from the Oregon Flora Project, (accessed 3 December 2014) published with permission.

Insect (hover-fly, possibly *Sphaerophoria sulphuripes*) visiting a male flower of Cascade strawberry. Photo by author.

F. vesca and cultivated *F.* × *ananassa*; in Japan, hybrid polyploid aromatic F. *nilgerrensis* with cultivated *F.* × *ananassa.* Perhaps new flavors or resistant genes could be available to agriculturalists by intercrossing native and artificial decaploid strawberries. Scientists from around the world are now examining the genetics of the decaploid strawberries.

Oregon's fifth native strawberry in the wild

So, now Oregon has five native strawberry species, not four. My team at the strawberry genebank and I will continue to collect samples to see if any strawberries with intermediate ploidy can be found in Oregon. That will help us determine how the Oregon decaploids strawberries came to be.

While hiking in the Cascades, I found that I wasn't the only one interested in the decaploid flowers. Several different types of insects, including flies and ants, visited the flowers as well. Maybe the fly pollinators played a role in the evolution of this strawberry species. Research on the entomology of the pollinators of the High Cascades is underway by Dr. Andrew Moldenke in the Department of Botany and Plant Pathology at Oregon State University.

The next time you are hiking near the Pacific Crest Trail in the Oregon Cascades, look down and see if the strawberry plants at your feet have green-blue leaves. Feel for hairs on the top side of the leaf surface or look closely at the leaves with your hand lens. If you find hairy leaves, you have likely found Oregon's newest strawberry species, the Cascade strawberry.

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Kim E. Hummer was born in Washington, DC in 1952, received her BS in Biology from St. Lawrence University in 1974, her MS in plant and soil science from the University of Vermont in 1978, and her doctorate in horticulture from Oregon State University in 1981. Her scientific expertise includes the conservation of fruit, nut, and specialty crop genetic resources. Her present research passion involves the study of ploidy in berry species. She also actively studies genetics and chemical constituents of strawberries, blueberries, blackberries, raspberries, currants, gooseberries, and unusual berry crops such as blue honeysuckle.

During her career she has participated in more than 18 plant collecting expeditions to locations including Canada, China, India, Italy, Japan, Portugal, Russia, and throughout the United States including Alaska and Hawaii. She was selected as Specialty Crop Curator for the US Department of Agriculture, Agricultural Research Service, National Clonal Germplasm Repository in Corvallis, Oregon in 1987 and became Research Leader of that gene bank in 1989. Dr. Hummer is an active member of the American Society of Horticultural Science, and was selected as a Fellow in 2006. She was the first woman president of the American Pomological Society (2004-2006) and, in 2006, chaired the committee that developed the Global Conservation Strategy for Strawberry, sponsored by the Global Crop Diversity Trust. From 2002-2010, she was Chair of the International Society for Horticultural Science, Commission on Plant Genetic Resources, and was the first woman Vice President of that Society from 2010-2014.

Sea Bluff Bluegrass (*Poa unilateralis*)

Kathleen Sayce and Cindy Roché
Nahcotta, Washington, and Medford, Oregon

It is as if someone had urged, "Go west, young bluegrass, go west!" and it did. Sea bluff bluegrass teeters on the western edge of the North American continent, clinging to ledges of cliffs and headlands, misted by saltspray. Some populations have left the continent altogether and grow on rocky islands along the coast, inhabited mainly by seabirds.

Also known as ocean bluff bluegrass, the most northern populations grow on a series of bluffs along a 3-mile stretch of the southern Washington coast in Pacific County (Camp and Gamon 2011). This rare grass is now reported from five counties on the Oregon coast: Clatsop, Tillamook and Lincoln in the north and Coos and Curry in the south, separated by a gap in the central coast characterized by long stretches of sand (lacking suitable habitat). In California, where it is known as San Francisco bluegrass, populations extend south along the coast from Humboldt County as far as San Luis Obispo County (http://www.calflora.org/cgi-bin/species_query.cgi?where-calrecnum=6699).

Roché first became interested in *Poa unilateralis* (ssp. *unilateralis* and ssp. *pachypholis*) when working on photographs for a field guide to grasses in Oregon and Washington. Floras gave the habitat as "fairly common on dunes and along ocean-facing cliffs," "sea cliffs and bluffs, weathered sandstones to heavy clays, in open ground and meadows in saltspray zone," or "growing on grassy bluffs and cliffs near the Pacific Coast of North America" (Hitchcock *et al.* 1977, Soreng 1991, Soreng 2007). After the second year of looking unsuccessfully for this bluegrass, Roché realized that she needed to consult someone who knew this coastal grass. As it happened, Kathleen Sayce had written an article for *Kalmiopsis* about the flora of the north coast of Oregon (Sayce 2010), and she had already surveyed for sea bluff bluegrass in Pacific County for Washington State Parks (Sayce and Eid 2004). Possessing an overabundance of botanical curiosity, Sayce continued surveying into northern Oregon. The closest Roché has come to finding sea bluff bluegrass occurred when Sayce showed it to her with a spotting scope on an NPSO hike to the Neahkanie sea cliffs in June 2014.

While looking at Oregon Flora Project Atlas maps, Roché came upon the names of Dave and Diane Bilderback, botanists in Bandon who have surveyed this species on the south coast for the US Fish and Wildlife Service (Bilderback and Bilderback 2010, 2014). Like Sayce, they had become proficient at surveying with a spotting scope or high powered binoculars, but they also had access

Sea bluff bluegrass (*Poa unilateralis*) clings to small ledges in basalt cliffs along the coast of Oregon and southern Washington. Photo by Kathleen Sayce.

to a boat from the USFWS to visit the islands. *Poa unilateralis* had to be one of the least accessible grasses Roché had (not) encountered in Oregon. Clearly, among the threats to its existence, over-collecting by botanists did not rank very highly. Both Sayce and Roché found this rare grass intriguing, so they agreed to pool their efforts to see what they could discover about it.

A peek up into the bluegrass family tree

The genus *Poa* is so large that its taxa have been grouped into subgenera, sections, and subsections. Within this hierarchy, *Poa unilateralis* is in the subgenus *Poa*, section *Secundae*, subsection *Halophytae*, for which the type is *Poa unilateralis* (Soreng 1991). It is closely related to two taxa in its halophytic (salt-loving) subsection, *P. stenantha* and *P. napensis,* and is relatively closely related to the widespread Oregon species *Poa secunda*. Defining characters for subsection Halophytae include the following: halophytic plants; intravaginal branching, long-cells of firm leaves producing a single oblique papilla per cell, the papillae tending to overarch the stomata (as in *Puccinellia*); spikelets more or less compressed; lemmas keeled; rachilla internodes 1 mm or less in length (Soreng 1991). Members of this group also share characteristics with the genus *Puccinellia*: open sheaths, cespitose habit and papillae on the leaves. Stebbins (1950) first suggested a hybrid origin with *Puccinellia* for section *Secundae* (including the *Halophytae*). Soreng (1991) explained that these taxa couple ancestral non-*Poa*-like characters with the advanced *Poa* chloroplast type. For example, *P. unilateralis* (and *pachypholis*) have papillae on epidermal long cells similar to those in *Puccinellia*.

Evidently, somebody's mother up the line had sex with a saltgrass! Thus, most likely, sea bluff bluegrass didn't migrate west. One of its widespread *Poa secunda* ancestors mated with a *Puccinellia* and acquired a "taste for saltspray," or more accurately, a *tolerance* of salt spray, which is not generally conducive to plant growth. Perhaps one of those descendants found refuge on the rock bluffs along the ocean where competition for resources was less intense than in the surrounding coastal shrublands and tall grass/forb meadows.

Type specimens and taxonomy

M.E. Jones first collected this *Poa* at San Francisco in May 1882 and Scribner (1893) used it as the type specimen for a new species he called *Poa unilateralis*, in reference to its inflorescence with branches directed toward one side. C.V. Piper collected a similar grass from ocean cliffs at Ilwaco, Pacific County, Washington, on June 22, 1904, and named it *Poa pachypholis* (Piper 1905). (*Pachy* = thick, *pholis* = scale).

The two species were differentiated primarily on the basis of pubescence on the lemmas, with glabrous lemmas in *P. unilateralis* and pubescent ones in *P. pachypholis*. The leaves of *P. pachypholis* were described as narrow and firm, with frequent cork-cell/silica-body pairs. In contrast, leaves of *P. unilateralis* lacked the cork-cell/silica-body pairs and were described as narrow to broad, lax or firm (but not narrow and firm; if narrow, then lax). Panicles in *P. pachypholis* were typically less congested than *P. unilateralis* (Soreng 1991).

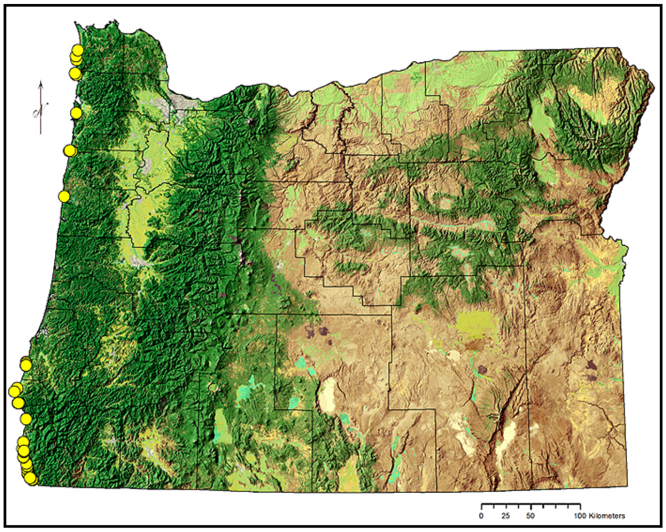
Upon further review of specimens, Soreng found that the lemma pubescence character was not so clearcut. He discovered that nearly all plants of *P. unilateralis* have at least some pubescence on the lower lemmas of any given spikelet, sometimes even on the upper lemmas. Based on the other characteristics (leaves and panicles), some Oregon *pachypholis* specimens were indistinguishable from *P. unilateralis*. Both species have "puccinellioid" papillae on the leaf-blade epidermis and are hexaploid with chromosome numbers of $2n=6x=42$[1] (Soreng 1991). Thus, Soreng reclassified the pubescent

Inflorescence of *Poa unilateralis* ssp. *unilateralis* from Bandon. Specimen collected by Dave and Diane Bilderback, photographed by Cindy Roché and Robert Korfhage.

Floret of *Poa unilateralis* ssp. *unilateralis* from Bandon. Note the villous pubescence along the lemma and marginal veins in the lower third of the lemma. Photo by Cindy Roché and Robert Korfhage.

Spikelet of *Poa unilateralis* ssp. *unilateralis* from Bandon. Photo by Cindy Roché and Robert Korfhage.

1 The exception to this chromosome number is one population in California, which is duodecaploid, $2n=12x=84$.



Distribution of sea bluff bluegrass in Oregon. Map courtesy of the Oregon Flora Project Atlas, with survey data from Kathleen Sayce and Dave and Diane Bilderback.

lemma form (*pachypholis*) as a subspecies of *P. unilateralis*. The key characters are pubescence on the lemmas and the relative widths of cauline and innovation leaf blades. In ssp. *pachypholis*, keels and marginal veins are villous for more than 1/3 of the lemma and cauline leaf blades are similar to the innovation blades; in ssp. *unilateralis*, lemmas are glabrous or pubescent for less than 1/3 the length and cauline blades are wider and thicker than the innovation blades (Soreng 2007). Of the two subspecies, *pachypholis* is the rarer, limited to one county in Washington and some populations along the northern coast of Oregon. Specimens of sea bluff bluegrass from northern Oregon tend to be more variable than those from other locations, bearing characteristics of both subspecies, or even tending toward *Poa stenantha* (Soreng, pers. comm.).

Physical appearance

In Washington and the north coast populations, sea bluff bluegrass has a mop-headed appearance, in which the inflorescences are not upright, but project stiffly out at angles from 20 to 70 degrees. When actively growing, its color is a distinctive light bluish-grayish-green. The slightly flat and wide leaves distinctly contrast with *Festuca rubra*, which often grows in association with it and has narrower leaves, is more upright in growth habit, and tends to a more yellowish-green or bright green leaf color.

Among the southern Oregon populations (ssp. *unilateralis*), leaves are also light bluish-gray-green, and the culm nodes, the basal sheaths of the culms and inflorescence are reddish purple prior to anthesis. The position of the inflorescences is distinctive: they stand at about a 60 degree angle; they are not upright, not horizontal. The stiff appearance of the reproductive culms is one of the characteristics that the Bilderbacks use for field recognition of the plant.

Habitat

Over its range, sea bluff bluegrass is reported as growing on sea cliffs and bluffs, on weathered sandstones to heavy clays, in open ground and meadows in the saltspray zone (Soreng 1991). Reports of inland populations in California (http://www.calflora.org/cgi-bin/species_query.cgi?where-taxon=Poa+unilateralis) are undoubtedly other species (Soreng, pers. comm.). Until the recent surveys by Sayce and the Bilderbacks, populations in Oregon were not well documented.

In Washington, this coastal plant is known only from rock crevices and small ledges on steep basalt sea cliffs, at elevations ranging from 10 to 100 feet above sea level. Associated species include Oregon stonecrop (*Sedum oreganum*) and red fescue (*Festuca rubra*). The northern-most populations begin on the Cape Disappointment headlands, where this bluegrass persists on sea cliffs from the lighthouse north to O'Donnell Rock, a seastack that is now surrounded by sand in Beard's Hollow. Nancy Eid helped Sayce survey for sea bluff bluegrass in 2004, and they found hundreds of plants in more than ten populations, from the Cape Disappointment Lighthouse cliffs on the Columbia River north to O'Donnell Rock. These populations are always below the cliff tops, which are often densely covered with Sitka spruce forest and its associated shrubs or with meadows dominated by Pacific reedgrass (*Calamagrostis nutkaensis*), a large bunchgrass that grows in very dense stands, often with salal (*Gaultheria shallon*). Fescue-sedum meadows form a narrow band immediately below either spruce forest or reedgrass meadows; below that band sea bluff bluegrass grows on the rock ledges.

In 2004, Sayce and Eid found two populations that are now more than 2,000 feet from the ocean due to sand accretion on the north side of the mouth of the Columbia River. These were found on McKenzie Head and Middle Head, between North Head and

Habit of *Poa unilateralis* ssp. *pachypholis*. Note the sprawling habit with horizontal inflorescences and distinctive light bluish-grayish-green foliage. Photo by Kathleen Sayce.

Cape Disappointment lighthouses, and well east of the current beach. They have been separated from direct salt spray since the 1950s. Likewise, O'Donnell Rock's population is also more than 500 feet from the beach and has been out of reach of salt spray since the 1960s.

South of the Columbia River, if a rock is high enough above the ocean to have a meadow on top of it, sea bluff bluegrass probably grows on it: on both ends of Tillamook Head, Haystack Rock in Cannon Beach, and south to Neahkahnie Mountain. On sea cliffs, it is found only below the *Festuca-Sedum* meadows. Lichens, mosses and the occasional mist maiden (*Romanzoffia traceyi*) or monkey flower (*Mimulus guttatus*) are its main companions. On the north coast of Oregon and south coast of Washington, populations are consistently located on north to northeast-facing cliffs, or on west-facing cliffs that are well shaded by nearby outcrops. The base rock is basalt, either Miocene or Eocene, or very hard sedimentary rocks (sandstone). This grass has not been seen on other rock types or on soft sedimentary formations.

Along the rocky south coast of Oregon, plants more closely fit the description of *P. unilateralis* ssp. *unilateralis*. Rittenhouse (1996) included *Poa unilateralis* in a list of species found in coastal headlands, bluffs and prairies of the south coast of Oregon, but he did not specify whether it grew only on the sea bluff habitats or was also found on the coastal headlands and prairies. Curiously, his list did not include the common associate of sea bluff bluegrass, *Festuca rubra*.

Bilderback and Bilderback (2010, 2014) completed two distribution surveys along the Oregon coast from Florence to the California line. They found 64 populations of sea bluff bluegrass in Coos and Curry counties, none of which were north of Bandon. Most plants were restricted to north- and east-facing ledges and pockets of soil on the rocky, vertical faces of headlands, spires, rocks and islands. No populations were found growing in grassy headlands or coastal prairies, on south-facing rocky slopes, or farther than 300 feet from the ocean. In the 2010 survey of seven islands of the Oregon Islands National Wildlife Refuge, they recorded sea bluff bluegrass on the east side of four islands, usually growing in a stonecrop/herb association. Common associates included *Dudleya farinosa, Armeria maritima, Spergularia rubra, Sedum spathulifolium, Fragaria chiloensis,* and *Erigeron glauca* (Bilderback and Bilderback 2010). The survey completed in 2012 brought the total number of populations to 30 on islands and rocks within the Oregon Islands National Wildlife Refuge. An additional 34 populations grew on rocks within Oregon State Parks, on rocks surrounded by public beaches or on rocks adjacent to the beach.

Isotype of *Poa pachypholis* collected by CV Piper June 22, 1904, from Ilwaco, Pacific County, Washington. Courtesy of the C.V. Starr Virtual Herbarium of the New York Botanical Garden. (http://sciweb.nybg.org/science2/vii2.asp)

Phenology and reproductive biology

Historic comments in floras indicated that sea bluff bluegrass flowers in late spring or early summer, although photoperiod and seasonal temperatures may influence its phenology. Seasonal temperatures are strongly influenced by El Niño-Southern Oscillation events, which typically bring warm weather that promotes early flowering, and by La Niña events, which bring colder than normal weather that delays flowering.

At Cape Disappointment, sea bluff bluegrass greens up in fall and goes dormant in winter, then greens up again in spring. Flowering occurs from April to June, depending on the warmth of the winter to spring season. Seeds are shed as the plants go dormant for summer.

When Sayce and Eid first surveyed for it at Cape Disappointment in 2004, State Park staff told them that it flowered in June-July, but that year they found it flowering in early May.

On the south coast, inflorescences appear in April followed by anthesis during May. Seeds mature in June, although the leaves are still green. By July the inflorescences are dry and only a few leaves remain green. By August plants are in summer dormancy. They begin to grow again after autumn rains, often becoming noticeably green by November and growing over the winter.

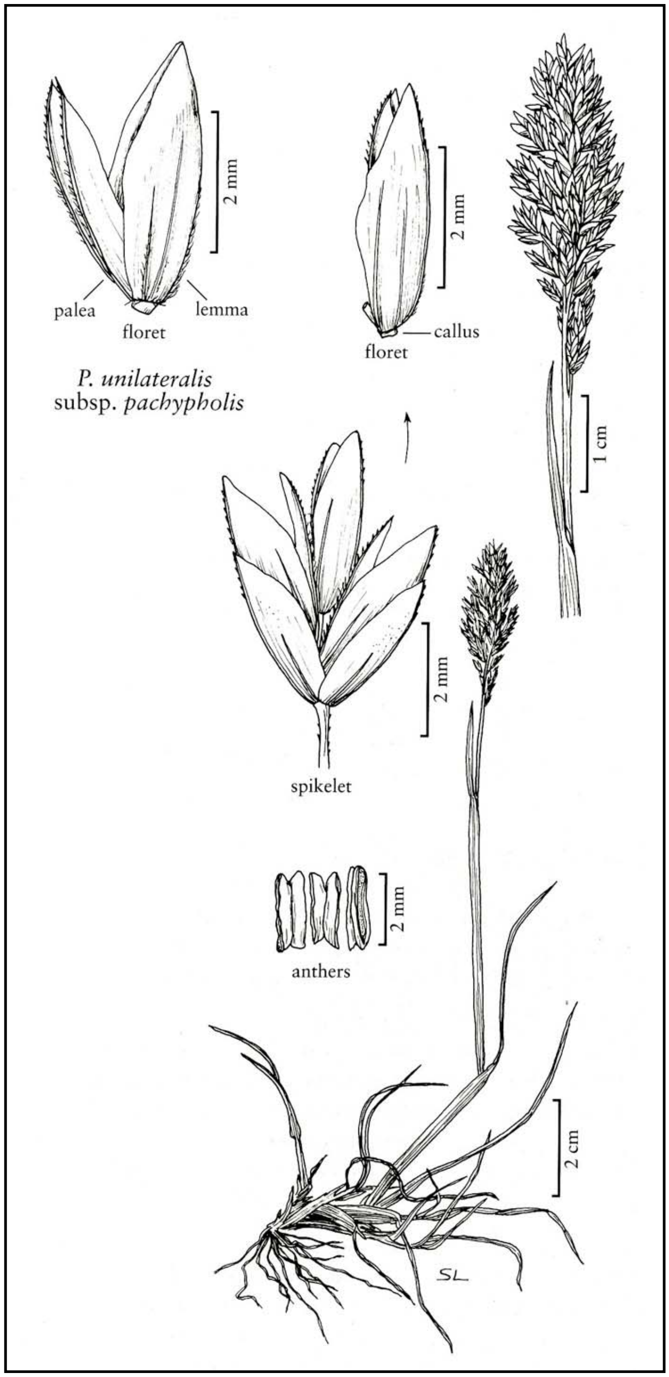
Rare status

In Washington, *Poa unilateralis* ssp. *pachypholis* has a status of Threatened. In Oregon, the Oregon Biodiversity Information Center (ORBIC 2015) assigns *Poa unilateralis* ssp. *pachypholis* a Heritage Rank of G4T2[2] S1[3] and places it on ORBIC List 1[4]. *Poa unilateralis* ssp. unilateralis has a Heritage Rank of G4T4 S4[5] and is on ORBIC List 4[6].

The Bilderbacks' distribution surveys did not evaluate the total number of *Poa unilateralis* plants, only the number of sites[7]. However, they were able to share some anecdotal information about population size. They considered all the plants growing scattered on various ledges of a particular rock as a population. At Fish Rock, there were about 36 plants, which they classed as a medium-sized population. Two groups on Cathedral Rock comprised at least 50 plants each. In their estimation, the 200 plants ranging over an area 700 feet across at Cape Blanco was a large population. On Pirate Rock, there were fewer than 15 estimated plants, scattered over an area about 100 feet in diameter. Some rock faces with only a few suitable ledges may support as few as two or three plants. On the north coast of Oregon and south coast of Washington, populations comprise ten to two hundred individuals or more.

Throughout its range in Washington and Oregon, populations of sea bluff bluegrass are geographically isolated from each other. The two closest populations in southern Oregon are on Cathedral Rock, about 80 feet apart. All other populations are 100 feet or more from their nearest neighboring population. On the north coast of Oregon, suitable rocky outcrops with the right orientation are also separated by large distances: the north end of Tillamook Head is 22 miles from Cape Disappointment Lighthouse; from Tillamook Head south to the sea cliffs below Neahkahnie Mountain is 16 miles, and there are several populations in this section, where outcrops and orientation are suitable. The largest is probably at Cape Falcon.

Nothing is known about the life span of individual plants, effective dispersal distance for pollen, pollen viability, the mating system of the species, and the population fecundity. However, a preliminary assessment of some of the accessible populations reveals a skewed population age structure, dominated by larger, older reproductive plants, with no apparent seedlings and young plants anywhere in Oregon.



Line drawing of *Poa unilateralis* and both subspecies by Sandy Long, as it appeared in Flora of North America Vol. 24, p. 597. Illustration copyrighted by Utah State University.

2 The letters G and T refer to Global and Trinomial (subspecies) rank. The ranking is a 1-5 scale with 1 being critically imperiled and 5 being secure. When determining species rank many factors are taken into account, including the number of known occurrences, threats, inherent sensitivity, area occupied, and other biological and anthropogenic factors.

3 State List 1 = critically imperiled because of extreme rarity or because it is somehow especially vulnerable to extinction or extirpation, typically with 5 or fewer occurrences.

4 ORBIC List 1 contains taxa that are threatened with extinction or presumed to be extinct throughout their entire range. These are the taxa most at risk and should be the highest priority for conservation action.

5 State List 4 = not rare and apparently secure, but with cause for long-term concern, usually with more than 100 occurrences.

6 ORBIC List 4 contains taxa that are of conservation concern but currently do not meet the criteria for begin considered threatened or endangered. This includes taxa which are very rare but are currently secure, as well as taxa which are declining in numbers or habitat but are still too abundant to be proposed as threatened or endangered. While these taxa currently may not need the same active management attention as threatened or endangered taxa, they do require continued monitoring.

7 Total numbers of plants and population sizes are critical information for evaluating the status of a rare taxon and for preparing a management or recovery plan.

Threats

Even though nearly all of the current distribution of sea bluff bluegrass in Washington and Oregon occurs on rocks, islands and cliffs within the Lewis and Clark National Historical Park (National Park Service), Oregon Islands National Wildlife Refuge (US Fish and Wildlife Service), Oregon State Parks or other state lands, its future cannot be considered secure.

In fact, ssp. *pachypholis* is considered imperiled by the Washington Natural Heritage Program. Identified threats in Washington include competition with other plants (particularly non-native invaders), and in some locations, recreational rock climbing (Camp and Gamon 2011) and also fishing at Cape Disappointment State Park. Fishermen climb down over the rocks, especially near North Head Lighthouse. The greatest threat over the entire range of this species is loss of habitat. Since the species is limited to such a narrow range of conditions along the coastline – shallow soil on bluffs or crevices in rock ledges on protected aspects (north and east) in the salt spray zone – it would be particularly vulnerable to changes in sea level and rainfall patterns associated with climate change.

Most of the populations are inaccessible to humans, except for rock climbers. However, all but the hardiest vegetation on the tops of sea bluffs that are easily reached by walkers has been eliminated by trampling on many sites. Thus, we suspect that the grass was formerly more common on grassy headlands and meadows (as indicated in early habitat descriptions). We doubt that M.E. Jones in 1882 or C.V. Piper in 1905 rappelled off a sheer basalt cliff to collect their specimens.

In addition to trampling of fragile sites, humans and other vectors continue to disperse seeds of invasive plant species. Non-native species are now found in virtually every coastal habitat, including the offshore islands and seastacks, where weeds may be introduced by waterfowl. Invaders include ice plant (*Carpobrotus chilensis*), velvetgrass (*Holcus lanatus*), wall barley (*Hordeum murinum*), ripgut brome (*Bromus diandrus*), hedgehog dogtailgrass (*Cynosurus echinatus*), and various bentgrasses (*Agrostis* spp.). Trailplant (*Soliva sessilis*), a recent Patagonian arrival at Cape Disappointment (Wise and Kagan 2012), has made its way north and south along the coasts of Oregon and Washington. Normally found on hard-packed trails, it has been carried out onto sea cliffs by birds, fishermen and other visitors and seems at home there as well. Probably the most severe threat is from introduced clonal grasses, which displace *Poa unilateralis* from ledges of sea cliffs.

Habit of *Poa unilateralis* ssp. *unilateralis* at Crook Point Headland, Curry County, Oregon. Note the upright leaves and compact panicle. Photo by Diane Bilderback on 15 May 2009.

Sea bluff bluegrass grows on the face of Cape Falcon and other stunningly inaccessible habitats along the Pacific Coast. Photo by Kathleen Sayce.

Acknowledgements

The authors thank Dave and Diane Bilderback, local field authorities for sea bluff bluegrass along the southern Oregon coast, for sharing their survey information and knowledge of the species. Also, Robert Soreng, *Poa* expert at the National Museum of Natural History, Smithsonian Institution, helped us tremendously with the taxonomy and origin of this rare bluegrass. Nancy Eid helped Sayce survey populations at Cape Disappointment, Tillamook Head, Ecola State Park, and Cape Falcon. Christina Stanley assisted with the survey at Haystack Rock in Cannon Beach. Thanks also to Dick Brainerd of the Carex Working Group for reviewing the manuscript, Kareen Sturgeon for calling our attention to an accessible population at the beach south of Cascade Head and Stephen Meyers for an updated Atlas Project map.

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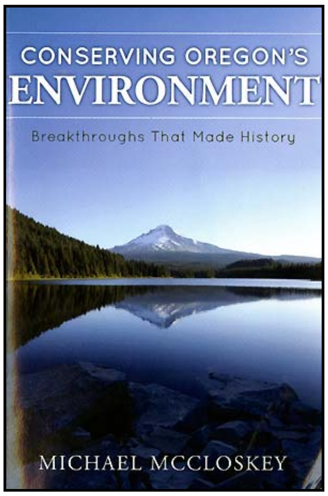
Kathleen Sayce was born in Ilwaco, Washington (same as the type specimen of *Poa pachypholis*). She earned her BS in botany from Fairhaven College at Western Washington University, where she was also interested in marine ecology, scientific illustration and geology. She completed her MS in 1978 at Washington State University, and also worked with lichens and bryophytes at WSU and University of Idaho. Previous experiences with grasses include studying the ecology of smooth cordgrass in Willapa Bay and coastal dune prairies. She was Science Officer for ShoreBank Pacific in Ilwaco 1998-2011. She lives on Willapa Bay north of Nahcotta, Washington, and in her spare time, hikes, botanizes new locations and grows native plants (geophytes and Pacifica iris are favorites). An example of her determined curiosity in mapping this sea bluff bluegrass in Oregon is when surveying Haystack Rock at Cannon Beach, she took her $1,000-spotting scope into the surf at low tide to get a good angle for viewing the north face of the seastack!

Cindy Roché also attended Washington State University (BS 1978, MS 1987) and University of Idaho (PhD 1996). She began working with grasses as a Range Conservationist with the US Forest Service, and then illustrated them for a Range Plants laboratory manual. She came to Oregon in 1998 and joined the Native Plant Society of Oregon. She volunteered to help edit *Kalmiopsis* in 2000 and met Linda Ann Vorobik who promptly enlisted her to ink grass illustrations for the *Flora of North America*. Currently, Cindy and her husband Bob Korfhage are collaborating with the Carex Working Group (Barbara Wilson, Nick Otting and Dick Brainerd) to produce a *Field Guide to Grasses of Oregon and Washington*. Photographing grasses in the field have taken them far and wide in Oregon, to many unforgettably beautiful places.

Conserving Oregon's Environment: Breakthroughs That Made History

Michael McCloskey. 2013. ISBN 13-987-1-59299-937-8.
248 pp. Inkwater Press, Portland, Oregon. $15.95 paper.

In *Conserving Oregon's Environment* Michael McCloskey tells the stories of the most significant milestones of conservation in Oregon. The author, who worked for the Sierra Club for 40 years and became their CEO, is eminently qualified to tell this story[1]; he now lives in Portland, Oregon. A visit to Redwood National Park inspired McCloskey to write this book. At the visitor center he was curious about how the Park Service was going to tell its story; but, "To my amazement, I found almost nothing said about how the national park came to be. … [A]s I looked around in the visitor centers for other national parks, I learned that this silence was the rule. Those who had worked their hearts out to bring about these achievements were rarely even acknowledged, let alone thanked." This book corrects this oversight by recounting the stories of those who led the way and acknowledges their contributions. As the author states, "Someone, or some entity, always seems to step forward and lead when the times call for it. … Once engaged, they just do not give up. They find ways to arouse or rally the public."



The eleven chapters focus on themes: Federal reserves, state parks, rivers, wilderness, Oregon's environmental laws, environmental turning points, new reserves, wildlife, and federal initiatives affecting Oregon. Each chapter is organized chronologically. McCloskey provides a basic overview of each topic, emphasizing the efforts made by individuals and groups to preserve the places. At the end of each chapter is a list of references that provide more in-depth information about each topic. The three appendices are entitled Timeline of Conservation Accomplishments, Map of Places Mentioned in the Text, and List of Organizations That Made Conservation History in Oregon. The pivotal role of politicians in getting the legislation passed for establishment of wilderness areas, wild and scenic rivers, wildlife refuges, etc. is described throughout the book.

Many of the stories exemplify Oregon's leadership as a "wellspring of innovation in broader public policy …[in] the field of conservation and the environment." For example, Oregon was one of the earliest states to protect waterfowl in refuges, to shape laws to guarantee public access to beaches, and to protect forest scenery along highways. Chapter 5 discusses many of these innovations, including the Oregon Beach Bill, Bottle Bill, state land-use legislation, and the aerosol spray ban.

1 http://www.oregonencyclopedia.org/entry/view/mccloskey_michael_1934_/

Efforts to preserve rare plant habitats are mentioned several times, primarily in Chapter 7. Steens Mountain, recognized as "an area of exceptional botanical diversity" by a collaboration among ranchers, conservationists and staff from Oregon's congressional delegation, was protected in 2000 as the Steens Mountain Cooperative Management and Protective Area. The Cascade-Siskiyou National Monument was established in 2000 as an "ecological wonder" containing endemic plants such as Greene's Mariposa lily (*Calochortus greenei*) and Gentner's fritillary (*Fritillaria gentneri*). The Zumwalt Prairie Preserve in Wallowa County, one of the largest unplowed bunchgrass prairies on the continent, was established by the Nature Conservancy in 2000. Protection of the West Eugene Wetlands (Chapter 6) involved lengthy collaboration, from the 1970s until 1992, when the city of Eugene adopted the West Eugene Wetlands Plan.

NPSO is mentioned twice in the book: in Chapter 5, in the discussion of state efforts to protect endangered species ("At the behest of the Native Plant Society of Oregon, the legislature in 1987 enacted the Oregon Endangered Species Act"); and in Appendix C in the list of Organizations That Made Conservation History. NPSO member Dr. Stuart Garrett is recognized in Chapter 7 as one of the primary leaders in the establishment of Newberry National Volcanic Monument through development of a consensus process in which "compromises were sought that would still allow everyone to support the final plan." Dr. Garrett was recognized for his effort by both Senator Mark Hatfield and Representative Robert Smith.

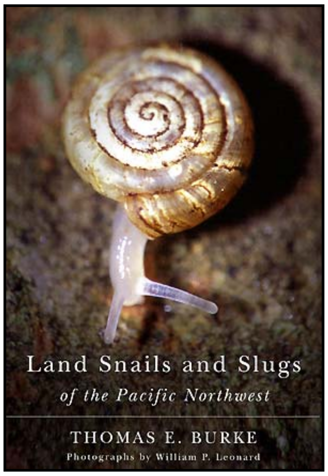
I've lived and worked as a BLM employee in Oregon since the late 1970s, so many of the topics were familiar to me. But I was also surprised by some of the stories. For example, I was not familiar with how Forest Reserves, the predecessors of National Forests, were established in the late 1800s. I also remember wigwam burners from my travels on family vacations in my youth; learning how and when they were all closed (Chapter 5) answered one of my long-standing questions.

There is much more to these and other stories that will enrich your appreciation of our predecessors' hard work. If you are at all interested in conservation efforts in Oregon and why things are way they are, then McCloskey's *Conserving Oregon's Environment* is well worth the price. As the author suggests, readers can either read the book straight through or use it as a reference. —*Lisa Blackburn, Cheahmill Chapter.*

Land Snails and Slugs of the Pacific Northwest

Thomas E. Burke with William P. Leonard, photographer.
2013. ISBN 978-0-87071-685-0. 344 pages. Oregon State University Press, Corvallis. $35.00.

This is the only comprehensive guide to the 245 described taxa of land mollusks in the greater Pacific Northwest. Burke became interested in terrestrial slugs and snails while an undergraduate at Washington State University. He honed his skills as a malacologist while working as a wildlife biologist for the U.S. Forest Service. Leonard is an experienced photographer and author of two field



guides to Pacific Northwest reptiles and amphibians.

The guide's contents include acknowledgements that indicate the broad array of malacologists and others the author consulted in the guide's development. An introduction that follows covers slug and snail ecology, natural history and taxonomy. Topics include mollusk diversity, conservation, reproduction, dispersal, habitat preferences, environmental hazards, collection, preparation, and preservation for scientific purposes, how to use the book, and the nomenclature of shell characteristics used in identification illustrated with Leonard's fine color photographs.

Following the introduction is a taxonomic list of scientific and common names arranged in the usual taxonomic hierarchy (family, genus, species) including authors and a notation indicating whether the taxon is native or not.

Next are *Keys to the Families and Genera*, but the keys are not in a form familiar to users of dichotomous botanical keys, *i.e.*, instead of two options, sometimes there appear to be three or four choices. Fortunately, there are instructions for the use of the keys, so be sure to read them before launching into them. This discussion also includes hints and comments on where difficulties in identification might be encountered; for example, maturity affects shell size and development of some characters, like number of whorls. Characters used in the key are based on mature specimens. Upon arriving at identification of the specimen, the page number refers the reader to a *Species Accounts* section where each taxon has a written description, a discussion of similar species, and a section on distribution, which often provides more geographic detail than the maps; ecological habitat information, such as whether the species is found under logs, in vegetation, the open, in forested or riparian areas; and indicates if the mollusk is native or not.

Leonard's excellent photographs illustrate most species' shells from the front showing details of the opening (aperture) and both sides of the shell sides. Slug habit photos include color variants when appropriate.

Maps of the known ranges of most species show no indication of geographic features other than state lines. These maps quickly reveal the taxon's known distribution across the landscape; some have wide distributions and some are narrow endemics. Other taxa are scattered, known from only a few individual gardens; these are usually alien species, but sometimes this distribution pattern is found for a native species.

The glossary, which is particularly critical for botanists who need to learn an entirely new vocabulary for mollusk identification, seems complete enough, but lacks illustrations. The glossary would be greatly improved by referencing each term to one of the fine photographs that could illustrate the term.

There is an extensive references and literature cited section that will lead one to most but not all of the published material on our slugs and snails. One notable missing citation is The Western Society of Malacologists' *Field Guide to the Slug*, by David George Gordon, a booklet published in 1994 by Sasquatch Press, Seattle.

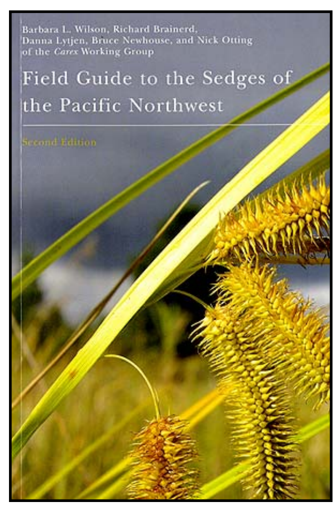
Is *Land Snails and Slugs of the Pacific Northwest*, as the publishers claim, "an essential reference for biologists, horticulturists, …, and anyone wishing to identify species in the field?" Yes, from the standpoint that its keys are based on characters visible using a hand lens (or alternatively, a headband magnifier or reading glasses, which give a wider view than a hand lens). Attributes of the book itself, including size (7x10") and weight (ca. 2.4 lbs), its binding, cover and glossy paper, limit its usefulness in the field, being slightly cumbersome and highly vulnerable to damage under wet conditions.

Why should an NPSO member like you buy and use Burke's book? What do these mollusks usually eat? "Native plants in the field or plants in your garden" is the answer. You should know if your draconian control measures aimed at the creatures that raise havoc in your vegetable or domestic flower garden include rare, narrow endemic natives, common widespread natives or introduced alien pests.

As with all objects of creation, knowing the organism's name is the key to accessing what we know about it. This richly illustrated volume with its identification keys will accomplish that for you. If you interested in the biota of the region, then this is the book for you. —*Frank Lang, Siskiyou Chapter.*

Field Guide to the Sedges of the Pacific Northwest, Second Edition

By Barbara L. Wilson, Richard Brainerd, Danna Lytjen, Bruce Newhouse and Nick Otting. 2014. 432 pages, photographs, line illustrations, distributions map, glossary, index. Oregon State University Press, Corvallis. ISBN 978-0-87071-728-4, $35.00, paper.



Taxonomically, sedges (comprising *Carex* and *Kobresia*) are not only one of the most diverse plant groups, but also (and perhaps because of that vast diversity) a group that is often avoided by even ardent plant enthusiasts. Here in Oregon and Washington, however, we have been given a resource, in the form of *Field Guide to the Sedges of the Pacific Northwest,* that I believe will help alleviate "sedge anxiety."

First published in 2008 by members of the Carex Working Group (Barbara L. Wilson, Richard Brainerd, Danna Lytjen, Bruce Newhouse and Nick Otting), an updated version of this book was released in early 2014. The updated guide contains newly discovered and newly described sedge taxa to our area, increasing the number of species included from 153 to 162 (including subspecies and varieties, 163 to 169 respectively).

Field Guide to Sedges begins with short introductory chapters describing sedge ecology and morphology. These are not merely filler chapters one might read while stuck in the car during a rainstorm on a botanical outing. I particularly encourage readers to study the morphology chapter before using the guide; it makes subsequent keying a much easier task.

Next are 32 pages of keys to the individual taxa of sedges. This key has been updated, adding new taxa and incorporating comments to improve it from users of the first edition. And while the key may seem daunting at first, I have found that, with some practice, the key is highly functional and reliable.

Once readers have successfully keyed a specimen, they are presented with two full page descriptions of each sedge taxon. The first page gives common names, synonyms, a full description with key features, habitat, distribution and a range map (the latter based mainly on herbarium collections, but thoroughly checked by the CWG). In addition, included with every taxon's description is a comments section. This material includes a variety of topics including ecology, genetics, ethnobotany, conservation, and information on rarity and known hybridization. I found this lends a pleasant, conversational flavor to the guide.

The second description page contains color photographs of each taxon, usually with close-ups of key features, general habitat and the inflorescence. Usually there are additional photos of the entire plant and/or line drawings that aid in identification. As with the keys, many of these descriptions and photographs have been updated from the first edition, improving both the esthetics and usability of the guide.

Thoreau wrote in Walden, "We need the tonic of wildness…to smell the whispering sedge where only some wilder and more solitary fowl builds her nest…." I highly encourage those who have avoided sedges in the past to arm themselves with this excellent guide and explore this underappreciated, fascinating group of plants.

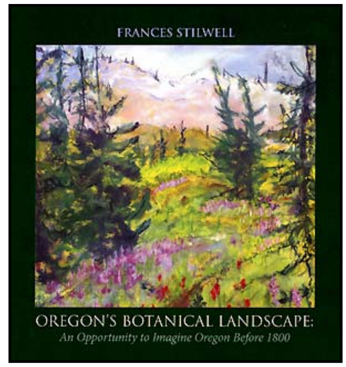
This guide is appropriately dedicated to one of the authors, Danna Lytjen, who died before the publication of the first edition. *—Stephen Meyers, Oregon Flora Project.*

Oregon's Botanical Landscape: An Opportunity to Imagine Oregon Before 1800

Frances Stilwell. 2014. 208 pages. 100 color plates of the author's original pastels. ISBN 978-1-4951-0024-6. Running Cat Press, Corvallis, Oregon. $39.99 at Amazon.

Oregon's Botanical Landscape: An Opportunity to Imagine Oregon Before 1800 is Frances Stilwell's compilation of her wildflower paintings in native settings. She came to Oregon from Ohio in 1961 and eventually began to use painting as a way of learning about her new home. She painted *en plein air* using chiefly pastels or pastels with watercolor, sometimes oils and rarely acrylics. Painting required stopping and looking closely, to see the distinguishing features of the geography and the plants. It was a way of educating herself and served "to communicate a sense of the neighborhood." The comments (she calls them "grace notes") that accompany each painting provide reflections and context, something noteworthy about the plants or their location.

The paintings are organized by the eight Oregon ecoregions, with each section introduced by a map and brief commentaries on the geography and botany of that region, followed by the paintings, each with a facing page of "grace notes." The focus of the paintings ranges from long views of landscapes such as "Mount Washington: South-Side," in which particular species are hard to discern, and middle views of habitats with a suggestion of species such as *Gaillardia aristata* and *Artemisia tridentata* in "Under the Rimrock," to close views of habits with clearly recognizable taxa such as *Castilleja miniata* at Crater Lake National Park in "Along a Garden Wall." These scenes, both near and far, are familiar ways that we commonly see "botanical landscapes." They are not scientific illustrations.



The subtitle, *An Opportunity to Imagine Oregon Before 1800*, refers to the absence of human-made structures: no cars, barns, houses, or towns, only one fence ruin, and the absence of direct human influence: no cows, dogs, fields, or gardens, but one very distant runner. The paintings could have been done before 1800.

We can learn from this book how to educate ourselves about our natural world, to slow down and stop, to consider colors, shapes, and shadows, to place plants in the landscape, and to add words that reflect our interests and observations. *—Darlene Southworth, Siskiyou Chapter.*

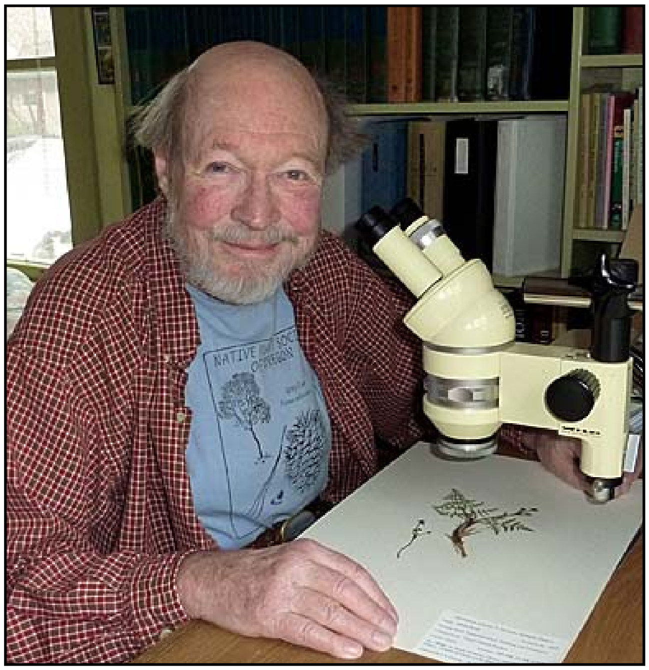
With 82 gorgeous watercolor and pastel paintings, Frances Stillwell reveals in the results of 25 years of hard work the nature of many of Oregon's loveliest and more interesting plants in their native habitats. The dreamlike quality of the paintings truly brings us to appreciate the plants as they are, as they would have appeared to an impressionist painter perhaps, and reminds us that the scenes shown here have existed in the State for thousands of years – and are still there for us to enjoy, study, and conserve. Very few human-made structures are shown, so that the settings and their plants are timeless and, indeed, refreshingly natural. In them, one can almost feel the coolness of the coastal fog, the breezes on mountain meadows, the dryness and heat of the deserts of this incredibly varied state.

Solid technically, the book is divided into eight ecoregions, each introduced with sensitive and instructive notes by Glenn Griffith on what the region is like from a geographic point of view, and then by Victoria Tenbrink on what it is like botanically. They are beautifully written and lead one surely to appreciate the varied regions that make up the rich and varied fabric of the state. Equally instructive and pleasant to read are the artist's notes accompanying each painting, which do indeed give us a sense of being in that place enjoying its unique qualities in many dimensions. This is not a book about how to identify plants, it is a book about how to enjoy them, to take time to look at them and come to know them for what they are and for their place in nature.

This book would make a wonderful gift for an Oregon resident or visitor, a fine place to study and get in touch with the varied beauties of the region. It could be used to teach an appreciation of art and nature, and how they comprise a seamless whole. It is beautifully produced, very well bound, and well worth having and savoring repeatedly. *—Peter H. Raven, President Emeritus, Missouri Botanical Garden, St. Louis, MO.*

Jim Duncan

The Siskiyou Chapter of the Native Plant Society of Oregon (NPSO) nominated Jim Duncan for NPSO Fellow, in recognition of all the service he has given at both the Chapter and State levels during the past 22 years. Jim has selflessly and cheerfully shared countless hours of his time and his expertise, serving as an officer of the Siskiyou Chapter and coordinator of the 4th of July wildflower show, both of which have bolstered chapter stability and continuity. His activities have also improved the visibility of NPSO in the community. In particular, his wildflower brochures and the wildflower show enable us to reach a broader public audience with our message about native plants.



Jim received an AB in zoology from Wabash College (Indiana) in 1954 and a PhD in biology, with a concentration in vertebrate embryonic development, from Stanford in 1960. He taught biology for 31 years in the California university system. His positions included Instructor and Assistant Professor of biology at the University of California, Riverside, from 1960 to 1962, and Assistant Professor, Associate Professor, and Professor at San Francisco State University from 1962 to 1991.

Retirement from San Francisco State University brought him to Ashland in the spring of 1991. He wasted no time in joining the Siskiyou Chapter of the NPSO in the fall of 1991 and has been an active member ever since. The following June (1992) he attended his first statewide Annual Meeting at the Malheur Field Station.

Jim has served in leadership positions at both the state and chapter levels, starting with a three-year term as a member-at-large of the State Board in the late 1990s. He was co-President of Siskiyou Chapter (with his wife, Elaine Plaisance) from 2000 to 2001. In 2001 and 2002 he and Elaine co-chaired the organizing committee for the 2002 Annual Meeting, hosted by the Siskiyou Chapter. The meeting showcased the recently established Cascade-Siskiyou National Monument. Jim assumed the duties of treasurer for the Siskiyou Chapter in the midst of the cash flow for the annual meeting (May 2002) and has held that position ever since (a total of twelve years!).

Jim's first involvement with the Siskiyou Chapter's annual 4th of July wildflower show in Ashland was collecting flowers in 1999. He has collected flowers for the show every year since then. At that time the show was set up on the morning of the 4th in the old wooden gazebo in Lithia Park. After the 2000 show, the chapter realized that if the show venue were moved indoors it could be set it up the night before. Jim negotiated with the Ashland Parks Department to use Pioneer Hall or the Community Center, adjacent buildings which are typically rented for public activities. The show was set up in Pioneer Hall in July 2001 and has been held indoors ever since, mainly in the Community Center. Because the show is a public service in conjunction with the 4th of July celebration in Ashland, the park administration granted use of the building without charge for a 24-hour period. Even though the wildflower show is a major draw to the event, this represents a generous donation from the Ashland Parks Department. Jim took over as organizer of the show in 2001 and has done a superb job for 13 years.

During Jim's years in Ashland he has collected a large number of plant specimens, mainly from Jackson and Josephine counties, but a second assemblage came from southeastern Oregon. He has compiled a personal herbarium of over 3,300 specimens representing almost 1,200 Oregon taxa. This collection has been added to the database of the Oregon Flora Project Atlas. This collection has recently been donated to the herbarium of Southern Oregon University. Two areas where Jim has collected intensively are Grizzly Peak near Ashland and a corner of southwestern Harney County and southeastern Lake County.

Grizzly Peak is a prominent landmark to people living in the Ashland area because it is visible from their homes and streets. It is public land, managed by the Bureau of Land Management (BLM), with an easily accessible five-mile roundtrip trail to the top. Jim first hiked the trail in September 1993 and during the ensuing years he made 38 trips to the top. Seven of those were scheduled Siskiyou Chapter fieldtrips, with the most recent and last trip in June 2011. During the years of those many trips, Jim collected great numbers of plants for his herbarium and gradually compiled a plant list for the area surrounding the trail. In 2008 he wrote a Plants and Places article about Grizzly Peak for *Kalmiopsis*, which included an exhaustive plant list of more than 300 species with notes on phenology and habitat.

In the mid-1990s Jim attended a plant conference at OSU in Corvallis at which Scott Sundberg spoke with considerable passion about the then-new Oregon Flora Project. What particularly caught Jim's attention was the proposed Atlas Project. He was inspired by Scott's message and recognized that he could contribute to the Flora Project by "Adopting a Block." He and Elaine chose Block 170, a square area about 25 miles to the side, which, according to the records at OSU, was the least known botanically (only two records in the herbarium). Block 170 lies in the southwest corner of Harney County and extends a few miles into southeastern Lake County. Jim and Elaine made the first trip to "their" block in June 2000, on their way home from the NPSO Annual Meeting, which that year was again at Malheur Field Station. For nine consecutive years (2000–2008) they made 3- to 4-day trips to the block, dates ranging from mid-May to early August in an attempt to catch the seasonal range of flowering. They always camped out self-contained somewhere in those wilds, and over those many trips they explored a great portion of that area of mostly sagebrush desert. Their final tally for Block 170 was an impressive 262 taxa!

In 2007 a small group of Siskiyou Chapter members decided to produce a wildflower brochure for the Grizzly Peak area in the style of the Jacksonville Woodlands Association brochure. Bob Vos took the photographs with his wife Belinda's help in identification, and Jim worked together with them to choose and organize pictures for the brochure. He wrote the text and arranged for the necessary layout and printing. The Siskiyou Chapter sells these brochures for $1 each to raise money for the chapter. The brochure has become quite popular and in 2009 Jim helped produce a second one, for Mount Ashland and the Siskiyou Crest. Based on the popularity of the first two brochures, Jim is completing a third brochure that will be ready for the 2014 flower season, this one for the Cascade-Siskiyou National Monument.

Jim has also been one of the unfailing volunteers from the Siskiyou Chapter who are maintaining the Southern Oregon University Herbarium (SOC). For three years he spent one afternoon a week working in the herbarium, verifying identifications, and annotating herbarium sheets with updated nomenclature. He's currently taking a hiatus while the university is remodeling the Science Building, but he will undoubtedly be back working there when the dust settles.

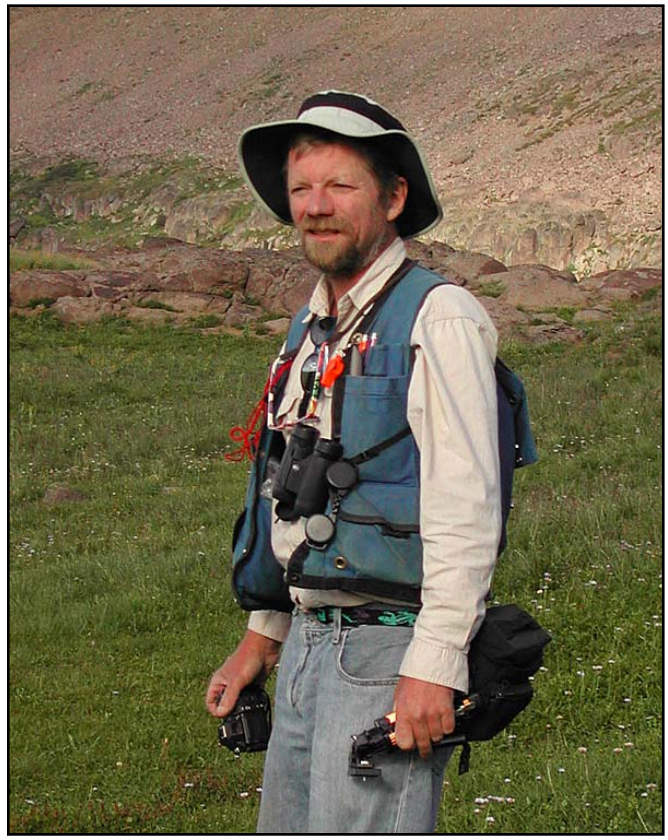
Jim is also an avid gardener, and since about 1980 he has been growing mostly native plants. He grows them from seed collected in the field. He now harvests seeds from his own native plants, which he spreads in his garden, gives to friends, and makes seed packets that are sold at the 4th of July flower show. Although most native plants do not require watering in the dry season, Jim has created a gravity flow water system for those that do and also for his summer vegetable garden. He pumps this water out of a sump in his cellar into storage tanks in his green house, from which it can flow out through plumbing that reaches all parts of his large garden.

Lest you think that Jim's only a plant nut, he does have other interests and activities. He is a fine woodworker, and over the last forty years he has made a large number of items that help furnish his home. He is a home winemaker, and has been making a variety of different wines since 1983 from grapes he purchases. Ten years ago he took up the violin again after not playing it since high school days, which was a long time ago. He is a member of a small string ensemble in Ashland that rehearses weekly and performs once a year for the public. He also plays duets or trios occasionally with some of his musical friends.

For all the years of support Jim has given NPSO and his many contributions to knowledge about the native flora of Oregon, we would like to honor him as a Fellow. —*Marcia Wineteer, Kristi Mergenthaler, Sasha Joachims, Julie Spelletich, Pete Gonzalves, and Frank Callahan, Siskiyou Chapter.*

Bruce Newhouse

Bruce Newhouse has had a lifelong love affair with Oregon's native plants, animals and habitats. As a long-time member of the Native Plant Society of Oregon, Bruce has made major contributions to the conservation of Oregon's flora while also helping to raise awareness of the importance of other native species and ecosystems.



Bruce's early years were spent in the northern Willamette Valley. He grew up in Oregon City, Lake Oswego and Portland. His is a classic demonstration of the role of family in imparting a lifelong passion for the outdoors and nature. During fly fishing trips on the Clackamas River with his dad, his mom would come along to enjoy the plants, and Bruce started learning some native ferns and wildflowers. (He keeps a few wildflowers from a patch of woods near McKay Creek in Hillsboro that were pressed by his mom in her late teenage years.) As a teenager Bruce and his dad skied on Mt. Hood in the winter and during the summer he day hiked and backpacked in the Cascades. He began learning as many Willamette Valley plants and mountain wildflowers as he could using Leslie Haskin's "Wildflowers of the Pacific Coast" and Elizabeth Horn's *Wildflowers 1: the Cascades*. Both books are still on his bookshelf.

At home Bruce's grandmother got him interested in vegetable gardening, and he remembers her crying upon seeing the twinflower (*Linnaea borealis*) transplanted by his mom to a flower garden because it reminded her of her childhood in Sweden. Bruce's mother instilled in him her passion for house plants, knowledge that was to be useful in college when he became the "plant doctor" for others in his dormitory who brought him their ailing plants.

In the early 1970's Bruce majored in Landscape Architecture/ Environmental Science at Oregon State University. He took botany classes from Bill Denison and many classes in forestry and wildlife biology before graduating in 1977. In 1978 he worked as a Resource Specialist for the Multnomah County Outdoor School at Camp Collins on the Sandy River, then landed a job in Grants Pass working for the Josephine County Planning Department. During that time he drove all over southwest Oregon in his 1962 VW Bug, exploring mountain roads. Budget cuts forced a job change to the City of Springfield Planning Department in 1981 where he worked until 1989 when he "retired from government service" and joined with friends on a contract to survey plants on every roadside in Lane County. Bruce became the botanist for the crew; thus began his career as an independent consulting biologist.

After the county road project, Bruce began working full time as a natural resource consultant. In 1992 he co-founded his consulting business (with Dick Brainerd and Peter Zika), Salix Associates, and has done assessments and surveys on hundreds of sites and many thousands of acres of habitats in Oregon, Washington, and northern California. Dick and Peter moved on to other pursuits while Bruce expanded Salix Associates and his areas of expertise beyond plants to fungi, birds, amphibians, butterflies, dragonflies – just about any organism one might encounter in the wild – and applied this knowledge to producing detailed and high quality site analyses.

In the mid-1990s Bruce helped found the Carex Working Group (CWG) with a group of like-minded sedge-lovers (*a.k.a.*, crazy people!) and was a CWG member until 2008, when he elected to focus solely on Salix Associates work. With CWG he helped co-author *"Field Guide to the Sedges of the Pacific Northwest."* Bruce took many of the photographs and did most of the design work for the book.

Among the botanical highlights Bruce has experienced as a consultant were his discovery in 2012 of the only population of suncups (*Taraxia ovata*) known to exist in the Willamette Valley and in 2013 of Oregon's only known population of many-headed sedge (*Carex sychnocephala*) on the Malheur National Wildlife Refuge.

In the early 1990's Bruce became involved with the Emerald Chapter of the NPSO, becoming its chapter president. He served as State President of NPSO from about 1999 to 2004. He also was a member of the NPSO's State Committee for developing policy on native gardening which was adopted by the State Board. Most of Bruce's activity has been on a variety of Emerald Chapter committees: coordinating the Invasive Ornamentals list; working with the Native Gardening Awareness Committee to produce booklets on native trees, shrubs, and wildflowers; coordinating (with Charlene Simpson, a 2001 NPSO Fellow) the Lane County rare plant review preceding each triennial ORBIC update; and co-authoring the book "Vascular Plants of Lane County" with Charlene and others. Bruce served as coordinator for the 2008 NPSO annual meeting in Eugene. He has led numerous NPSO field trips and he has presented shows on native plants and pollinators for several NPSO chapters and many other organizations. Through all these activities he has raised awareness and appreciation for native plants and their role and importance in Oregon's natural habitats.

Bruce has applied his energy and enthusiasm for plants, wildlife and science to a wide range of activities beyond NPSO. He is a member of the Oregon Flora Project Atlas Committee and continues volunteer work for OFP. In recent years he has donated thousands of field photographs of Oregon plants to the Flora Project. He has assisted with setup and expert plant ID at the annual Mount Pisgah Arboretum Wildflower Show for nearly 20 years. A passion for all things fungal prompted him to co-found in 1999 the Cascade Mycological Society with his wife Peg (and one other person). They now serve as CMS's display coordinators for the Mt. Pisgah Mushroom Show each October. Just a sampling of Bruce's other activities includes Chair of the Stewardship Technical Advisory Committee of the Friends of Buford Park; one of the original members of the Eugene-Springfield Chapter of the North American Butterfly Association; an area leader in the annual Eugene Christmas Bird Count since the early 1990's; and certified Master Gardener specializing in native plant gardening.

Bruce credits many people as his botanical mentors, including Ed Alverson, Tanya Harvey, John Koenig, Rhoda Love, Nick Otting, Charlene Simpson, Scott Sundberg, Dave Wagner, Barbara Wilson and Peter Zika.

At home in Eugene, Bruce nurtures a lush garden of locally-native plants and their associated pollinators. He enjoys playing piano, wine-tasting, hiking and sharing life with his wife Peg and their cat Mr. Biggie. —*Richard Brainerd, Corvallis Chapter.*

Cindy Talbott Roché

Through our associations with Cindy as editor of *Kalmiopsis*, the three of us (Kareen Sturgeon, Frank Lang, and Frank Callahan) have come to know her as a valued friend and colleague, and we enthusiastically nominate her to be a Fellow of the Native Plant Society of Oregon. Cindy completed her last issue of *Kalmiopsis* (Volume 20) in June 2013 and turned the reins over to the new editor, Hope Stanton, at the Annual Meeting in Baker City. The time has come to honor Cindy for her contributions to NPSO.

When Cindy asked me (Sturgeon) to write an article for *Kalmiopsis* three years ago and, subsequently, to join the editorial board, I hadn't the faintest notion of what was involved in pulling together an issue of this annual journal. In contrast, Lang had served as the journal's first editor (1991-1993) and, in 2004, Cindy invited him back as a member of the editorial board. When articles were in short supply both Franks pitched in to help: Lang and Roché coauthored a plant of the year article in 2008 and another article with Callahan in 2013. Callahan recently published his fourth article in *Kalmiopsis*. From our combined experiences, we have come to appreciate the brilliance with which she brought to life each beautiful issue of our society's signature journal. For thirteen years, she worked tirelessly to fill the issues by (as she describes it) "trolling for articles" at meetings, on the NPSO listserve, from *Bulletin* programs and NPSO field trips.

In 2000, she joined then-editor Linda Ann Vorobik to produce Volume 7 and Volume 8, which was the Festschrift for Ken Chambers. First as co-editor, then in 2003 as sole editor, she introduced several format changes, including a color cover. Never one to be tied to a desk, she edited fourteen issues of *Kalmiopsis* on a notebook computer, often proofreading the galleys while on bicycle tours and backpacking trips. Of course, rarely, if ever, does an article come to an editor polished and ready for publication.

What we found most amazing about Cindy was her remarkable talent for working with contributors, tactfully cajoling, humoring and encouraging them to clarify their thoughts and find their own voices. Cindy's distinguished and intelligent mark is on every one of the 60 articles, 50 book reviews, and 25 tributes to Fellows she edited during her tenure.

Cindy was born in Lewiston, Idaho and, for the first 10 years of her life, she lived on a 40-acre farm with a big garden, fruit trees and an assortment of animals including chickens, dogs, cats, rabbits, pigs, and a milk cow, which she learned to milk by the time she was five years old. Because her older brother wanted to be a farmer, the family moved to a 400-acre farm in mountainous northeastern Washington, north of Spokane. This move started a chain of events that brought botany into her life.

After graduating from high school she worked on the Colville National Forest as a fire lookout, then fire fighter while attending Washington State University (WSU). In 1978, she completed a BS in Forest Management with additional coursework that qualified her for a position in Range Conservation. As a forester trainee, she observed that Range Conservationists worked with other plants besides trees, which was much more interesting than "getting the cut out." (At that time, the Districts did not employ any botanists, so this was as close as one could get to botany.)

As Range Conservationist, she was responsible for grazing permits, rare plant surveys and noxious weeds. After five years, she returned to WSU and, in 1987, completed an MS in Range Management with emphasis on invasive exotics (*Centaurea* species, a.k.a. knapweeds and starthistles). She married Ben Roché, Jr. in 1988 and continued working at WSU Cooperative Extension writing PNW Extension Bulletins on noxious weeds, illustrating the lab manual for the range plants course, assisting with applied research, and giving talks to user groups. She wrote over 35 PNW Extension Bulletins on Class A and B noxious weeds, illustrating them with her own line drawings and photos. After five years this position lost funding and she started a PhD program at the University of Idaho Weed Science Department on the biology of *Centaurea solstitialis* and *Crupina vulgaris*, completing the degree in December 1996. That same year, Ben retired from WSU and they moved to Asotin, Washington. Ben died the following year. In 1997-98, Cindy was employed as a post-doctoral Research Associate at UI and WSU and, in 1998, she moved to Medford, Oregon. She spent parts of the next two years in Barcelona, Spain, working on a research project on the origins of the invasive Mediterranean winter annual *Crupina vulgaris,* which has populations in Oregon, Idaho, California and Washington.

Cindy joined NPSO in 1998 when she moved to Oregon, attending Siskiyou Chapter meetings and hikes. She served as Siskiyou Chapter president in 2009-10, designed the Siskiyou Chapter T-shirt featuring gray pine, and gave talks about grasses in Oregon and wildflowers in Lapland (from a backpacking trip). She helped organize the 2012 Annual Meeting in Selma, for which she also led a field trip and illustrated wine glasses with *Calochortus howellii*.

Illustration is a thread woven throughout Cindy's life. When Linda Vorobik was principal illustrator for the *Flora of North America* volumes on grasses, she enlisted Cindy as a contributing illustrator. Working with grasses led to a project that Cindy and her husband Bob Korfhage have been working on for the past four years, producing a *Field Guide to Grasses of Oregon and Washington* with the Carex Working Group (Barbara Wilson, Nick Otting and Dick Brainerd). Cindy and Bob are photographing many of the grasses, which she claims is definitely "not an easy task!"

Cindy and Bob, avid outdoors enthusiasts, were married on top of Siskiyou Peak. They ride a tandem bicycle (between 1500 and 2000 miles per year), backpack, and ski (mostly x-country, but some downhill). Bob, who is a retired BLM manager and resource specialist, started his career as a wildlife biologist and is also a member of NPSO. The two of them live in an energy efficient solar home on ¾-acre where Cindy raises a big garden and keeps a dozen or so laying hens, while Bob tends to five varieties of grapes and makes wine. They do some contract work for the Forest Service and BLM, and Cindy also curates the BLM/Forest Service herbarium at the Medford office. In November 2012 she accepted the volunteer position of Regional Coordinator for SW Oregon for the Quilts of Valor Foundation, whose mission is to cover service members and veterans touched by war with comforting and healing quilts. One of us (Callahan), a decorated veteran, was recently honored with one of Cindy's Quilts of Valor in recognition of his service in Vietnam.

The three of us are honored to nominate Cindy Roché as a Fellow of the Native Plant Society of Oregon, an honor she richly deserves. —*Kareen Sturgeon, Cheahmill Chapter and Frank Lang and Frank Callahan, Siskiyou Chapter.*

Kalmiopsis
Native Plant Society of Oregon
Matt Morales, Membership Chair
P.O. Box 80714
Portland, OR 97280

~ Native Plant Society of Oregon ~

Dedicated to the enjoyment, conservation, and study of Oregon's native plants and habitats.

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Table of Contents