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WASHINGTON NATIVE PLANT SOCIETY

To promote the appreciation and conservation of Washington's native plants and their habitats through study, education, and advocacy.



NORTH CASCADES NATIONAL PARK — 50 YEARS

About This Issue

by David Giblin

Sometime last year WNPS Fellow Fred Weinmann suggested that the summer 2018 *Douglasia* issue be dedicated to the flora of Washington's national parks. The editorial board thought this was a great idea, so here it is. Thanks to Fred for the inspiring idea and to all of the authors for sharing their knowledge about the plants, people, and resources affiliated with these parks.

WNPS President Don Schaechtel provides a delightful reminiscence of his more than 30 years of hiking, climbing, and botanizing throughout Washington's three national parks. Two articles in this issue remind us of the significant contributions that amateur botanists have made at two of these parks. Sarah Gage provides a wonderful and thorough timeline of the lives of the late WNPS Fellows Joe and Margaret Miller, who were involved in the establishment, restoration, and botanical exploration of North Cascades National Park. As a result of their dedication, and that of many other devoted individuals, the park is celebrating its fiftieth anniversary. We thought it worthy to honor the fruits of the Millers' effort on the cover of this issue. Susan McDougall recounts the summers that she and husband David Biek spent exploring Mount Rainier National Park in an effort to photograph all of the plant species there. Eric DeChaine and Sam Wershow share the results of their research on potential climate change impacts on the endemic flora of Olympic National Park. Spoiler alert: it may not end well.

We expanded the scope of this issue to include Julie Combs's article on what she has learned about the diversity of pollinators at San Juan Island National Monument. Kathy Murray reminds us that each of Washington's national parks has a herbarium documenting its respective flora and how to access a portion of these specimens online. And there's more, including an article on seed cleaning and storage (Bridget McNassar), a hike to Freezout Ridge (Jim Duemmel), and a book review of Tim McNulty's recently released fourth edition of *Olympic National Park: A Natural History* (Fred Weinmann). Collectively these articles remind us of how rewarding an interest in native plants can be and how many ways there are to pursue this interest in Washington.



On the cover:

Scarlet paintbrush (*Castilleja miniata*) in the subalpine meadow at Easy Pass in North Cascades National Park, looking toward Fisher Peak and the Fisher Creek basin.

PHOTO: MARK TURNER

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* WNPS Fellow is the highest honor given to a member by our society. This title is given to those who have made outstanding contributions to the understanding and/or preservation of Washington's flora, or to the success of WNPS.

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President's Message: The View from Here

Alpine Botanizing in Our National Parks

by Don Schaechtel

Dear Fellow WNPS Members,

In my youth I had the good fortune of visiting many of the national parks in the western United States on family vacations. I have many good memories of these adventures and am grateful that my parents took my brother and me along. I am certain that these trips helped shape my interest in natural history. Many of you probably have had similar experiences, either as a child or as a parent.

Despite our rambling (some of which was done in a 1963 Rambler station wagon), we never made it to Washington to see the three national parks featured in this issue of *Douglasia*. So when my wife and I moved to Seattle in 1986, during our first summer we visited Mount Rainier and Olympic National Parks. One of our first purchases was Stephen Whitney's *Field Guide to the Cascades and Olympics*. Purchases of books in the 100 Hikes series soon followed. Then we joined The Mountaineers and learned to climb, which took us to amazing places in Washington's national parks.

Our trips involved alpine ascents, and I always enjoyed watching how the tree species changed as we gained elevation. We often traversed meadows filled with wildflowers, which I learned to name. Was it John Muir who said that when you learn the names of the flowers you can greet them each year as old friends? He was right.

With its many accessible peaks, Mount Rainier National Park was a popular destination for us. Mowich Lake, in the northwest corner of the park, was the gateway to many fine trips. It's also a terrific place to see subalpine flowers. Hiking through Spray Park was also always a treat. On one early August trip to Observation Peak, through the mist we marveled at the displays of magenta paintbrush (*Castilleja parviflora* var. *oreopola*), subalpine lupine (*Lupinus latifolius* var. *subalpinus*), and pink mountain heather (*Phyllodoce empetriflora*) that filled Spray Park.

We were so impressed that for the next five years we brought students from The Mountaineers Introduction to the Natural World course to Spray Park to learn about subalpine habitats. About this time, two things happened that accelerated my studies. At one of the visitor centers I found a copy of David Biek's excellent *Flora of Mount Rainier National Park*. And I

rejoined WNPS. Our species list for Spray Park grew as a result. We discovered that the pinpricks of yellow flowers that we saw were not a *Lomatium* but were Strickland's *Tauschia* (*Tauschia sticklandii*). We found four species of louseworts (*Pedicularis*) and diminutive alpine laurel (*Kalmia microphylla*). Upon reaching the alpine areas above Spray Park our students were always thrilled to see alpine lupine (*Lupinus lepidus* var. *lobbii*) and alpine saxifrage (*Micranthes tolmiei*).

I also have great botanical memories of trips to Olympic National Park. One of my favorites involves observing lichens below Mount Worthington on the park's east side. I had recently completed a workshop presented by lichenologist Katherine Glew, who told us about her studies on nearby Buckhorn Mountain. I was eager to see the lichens she described. Watching where we stepped, we marveled at the beauty of tundra lichens. Snow lichen (*Flavocetraria cucullata*), Iceland lichen (*Cetraria* sp.), and whiteworm lichen (*Thamnolia vermicularis*) provided many great photo opportunities. And I would be remiss if I didn't mention the Pacific rhododendron (*Rhododendron macrophyllum*) near the trailhead or the endemic Flett's violet (*Viola flettii*) near the summit. It was a great trip from start to finish. The botanizing was better than the climbing.

North Cascades National Park is a rugged place and not nearly as accessible as the other two national parks in Washington. For climbers it is unmatched for its challenges, and I have been fortunate to have explored many parts of it. There is something special about coming eye-to-eye with a plant that is new to you when you are focused on not falling. It is even better when you can stand up and take a good look at it. This happened below the summit pyramid of Mount Shuksan when I found pygmy saxifrage (*Saxifraga hyperborea*). I knew what it was right away, but I did not realize that years later it would be listed in Pam Camp's and John Gamon's *Field Guide to the Rare Plants of Washington*. What a beautiful setting for this rare plant, tucked away in a crevice of wet rock for a growing season that couldn't last more than three months.

I'll bet you have your own tales of botanical highlights in our national parks. I would love to hear them! And if you have yet to visit these parks, why not do so this year and enjoy their botanical wonders.



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The Remarkable Lives of Joe and Margaret Miller

by Sarah Gage, Central Puget Sound Chapter

Joe Miller (1915–2007) and Margaret McAlpine Miller (1922–2015) lived long and full lives, leaving an extraordinary legacy with their work and their persevering spirits. In January 2018, the Washington Native Plant Society received a generous bequest from their estate. The following timeline and the quotes it contains give just a taste of their work and their character.



The Millers in 2005. PHOTO: NORTH CASCADES CONSERVATION COUNCIL

Year	Event	
1915	Joe Miller is born in Kansas City, Missouri, where he grows up.	
1922	Margaret McAlpine is born in Little Rock, Arkansas. She too grows up in Kansas City.	
1936	In the depths of the Great Depression, Joe graduates with an English major from the University of Kansas. He takes a job with the US Railroad Retirement Board. He later described working for the federal government as “like peeing in your pants while wearing a dark suit. It gives you a warm feeling, but no one notices.” (Ehlert 2005–2006)	1946 Joe and Margaret marry. They honeymoon in the Rocky Mountains. Joe resumes work with the Railroad Retirement Board. Margaret teaches math at the University of Kansas City.
1941	Joe is drafted into the United States Army.	1947–1953 Joe is transferred to Denver. Margaret teaches general science at a junior high school. “Within two years, the young former flatlanders had climbed 20 peaks higher than 14,000 feet.” (Porterfield 2002)
1943	Joe serves as an officer in the 20th Engineer Combat Battalion. On one of their first assignments they provide site security for a meeting between Franklin D. Roosevelt and Winston Churchill in Casablanca.	1953–1955 Joe is transferred to Reno. Margaret collects desert fauna (lizards, snakes, pupfish) for the museum at the University of Nevada.
	Margaret completes an undergraduate degree at the University of Missouri, with a double major in math and biology. She teaches math in Missouri for a year.	1955–1956 Joe is transferred to Salt Lake City. Margaret teaches high school biology and finds that the evolution chapter has been razor-bladed out of the textbooks.
1944	After building roads, rebuilding bridges, clearing mines, and disarming bombs in North Africa and Italy, Joe wades ashore on Omaha Beach on D-Day under “savage artillery, mortar, rifle, grenade, machine gun, and small arms fire” (Ehlert 2005–2006). His men later recall him shouting, “Come on you bastards! We’re all going to die if we stay here!” (Ehlert 2007).	1956 Joe is transferred to Seattle. Margaret takes several courses at the University of Washington.
	Margaret works on a zoology project, observing tracks and collecting scat along the Missouri River.	1956–1960 Joe and Margaret join the newly formed Northwest Chapter of the Sierra Club. Joe “soon became chairman of the Northwest chapter, just 200 people scattered across four states and two provinces.” (Porterfield 2002)
1945	Joe sees action across Europe, enduring the Battle of the Bulge, crossing into Germany and Czechoslovakia. He earns eight battle stars and ends the war with the rank of Captain.	1958 Joe and Margaret move to Bellevue, Washington, where they live for the rest of their lives.
	Margaret earns a Master’s Degree in math and receives an award for teaching math and science.	1960 Joe and Margaret join the North Cascades Conservation Council (NCCC), then three years old, to help advocate that the beauty and wildness of the North Cascades should be preserved as a national park. They both serve on the NCCC board for the next 34 years. Margaret starts teaching general science and biology in Bellevue junior and senior high schools.
		1962 Joe becomes the treasurer for NCCC; he will stay in that role for 32 years.
		Joe prepares a North Cascades slide show and outdoor films such as <i>Family Camping in the North Cascades</i> . “It was quite a struggle,” Joe says.

“We started lobbying for a national park. It took 10 years, but we finally got it in 1968. . . . It was really something to be happy about.” (Porterfield 2002)

1968 The federal government establishes the North Cascades National Park Complex.



Margaret Miller with large western red-cedar (*Thuja plicata*) in Big Beaver Valley, North Cascades, 1969. PHOTO: JOE MILLER

1969 Seattle City Light releases a plan to raise the level of Ross Lake, which would flood low-lying areas of Big Beaver Valley. Joe Miller writes, “If any conservationist felt he was honorably discharged from the wars upon passage of the 1968 North Cascades Act, he lacked knowledge of the history of the American National Park system. He may have said to himself, ‘Whew! I’m glad that’s over. Now I can forge my pens into pitons—trade my typewriter for a tent and start enjoying this country I’ve been fighting for.’ To any such cat we say, ‘Man, that was only an armistice, not a peace! We just put you in the active reserve, and we need you NOW!’” (Miller 1969)

Joe and Margaret start their work in Big Beaver Valley: “In July and August of 1969 (we) spent 15 days in the valley. In June, July, and August of 1970, 20 more days were spent in the valley, and the entire drainage, from Beaver Pass to Ross Lake, was examined.” (Miller and Miller 1971)

1970 Joe and Margaret retire. “They decided to retire in 1970 so that they could work as volunteers for the National Park Service. Joe and Margaret made the decision as partners, recognizing a shared obligation, retiring together, embarking on a new career together.” (Ehlert 2005–2006)

They submit a 50-page report, “Phytosociological Reconnaissance of Western Red-cedar Stands in

Four Valleys of the North Cascades National Park Complex” to the National Park Service.

The superintendent of the newly formed North Cascades National Park recruits the Millers to work on Cascade Pass, which was “a real mess . . . people had pooped, trenched around tents, burned up the meadow.” (Porterfield 2002)

“The upshot . . . was that increased ranger patrols and signing would try to halt the illegal camping, and the Millers, invincible in our ignorance of high altitude growing conditions, would try to revegetate it . . . with only native plants . . .” (Miller 1991)



Joe Miller in the North Cascades. PHOTO: IRA SPRING

1971 Joe is one of the founders and initial directors of the tax-exempt North Cascades Foundation, formed to help raise funds for the High Ross Dam fight. He serves as a member of the board and treasurer for 32 years.

They campaign tirelessly to stop the raising of the dam. “We got questioned by a lot of high-powered lawyers,” Joe says. “Margaret would come home from those hearings and cry.” Joe shows his slide show more than a hundred times. (Big Beaver vs. High Ross; Porterfield 2002)

Joe and Margaret distribute their typewritten report, “A Preliminary Ecological Survey of Big Beaver Valley, North Cascades National Park Complex.”

1973 The Millers determine that using rooted cuttings is more successful than direct seeding or transplanting plugs. They backpack plant starts to Cascade Pass and plant them in the highly impacted areas.

1974 Friends help them pack 340 pounds of greenhouse-propagated plants to the pass.

1975 They find that 85 percent of the greenhouse-propagated plants they had returned to the pass had survived. The National Park Service builds a small cold frame at Marblemount.

1976 Margaret serves on a steering committee prior to the formation of the Washington Native Plant Society and chairs the first nominating committee. She is a charter member and becomes the first chair of the Central Puget Sound Chapter.

Joe signs the Washington Native Plant Society Articles of Incorporation and becomes a member of the first board of directors.

1977 The National Park Service puts in a small, plastic-covered greenhouse at Marblemount. Joe serves on the publicity committee for WNPS.

1980s Joe serves as president of WNPS, 1983–1985, and is a member of the Survey and Inventory Committee. Hearing someone mention “The Holy Land,” Joe comments: “I thought it was all holy.” (Ehlert 2007)

Margaret serves on the Bellevue Park Board for eight years.

1989 Big Beaver Creek Research Natural Area is established, as the Millers had recommended 19 years before.

1990 A celebration of the twentieth anniversary of the Millers’ first revegetation efforts at Cascade Pass includes planting 4,000 plants brought up from Marblemount by helicopter.

1993 The North Cascades National Park dedicates a new, larger greenhouse to the Millers and makes them Honorary Employees of the National Park Service (The Wild Cascades 1993).

1994 Joe steps down from his roles as NCCC Treasurer and Board Member, having shown that “like the flowers and meadows he so loved, he could push his way quietly through concrete.” (Ehlert 2007)

1996 Joe and Margaret Miller are named Fellows of the Washington Native Plant Society, in recognition

of their efforts in conservation, education, research, and advocacy on behalf of Washington’s native flora. This is the highest accolade given by WNPS (Wooten 1996).

Joe and Margaret celebrate their 50th wedding anniversary by planting trees at a national park in Arizona.



Joe and Margaret Miller Greenhouse in Marblemount. PHOTO: STACY MCDONOUGH

1999 Joe and Margaret continue to think ahead, and they set up charitable gift annuities with the Earthjustice Legal Defense Fund. They say “perhaps we can restore this country, the forests, the streams and rivers, and the fish runs, to a semblance of what they were . . .” (Earthjustice Legal Defense Fund 1999)

2002 Age starts taking a toll. At age 86 Joe falls from his roof, fracturing his back, then suffers a broken hip. Margaret, 79, is nearly blind from macular degeneration (Porterfield 2002).

2003 Joe steps down from the North Cascades Foundation Board.

2005 Joe and Margaret attend the opening of the new North Cascades Environmental Learning Center at Diablo Lake in June and ride The Lady of the Lake up Lake Chelan in July.

In a Christmas card poem, Joe writes,

. . . Though aging body keeps me now from the wilderness scene,

I visit these places still on memory’s screen.

*My legacy is that I restored wild lands,
With years of work with mind and hands.*
(Miller 2005)

2007 Joe dies a few weeks before turning 92. “It is sometimes said of World War II vets that they

- 'saved the world'. For Joe Miller, saving the world was a life-long pursuit" (Ehlert 2005–2006).
- 2008 A military funeral is held for Joe at Tahoma National Cemetery.
- 2010 Margaret, though legally blind, hikes to Cascade Pass to scatter Joe's ashes, where "... event staff and onlookers met her with applause and cheers." She hikes "through 33 switchbacks, thousands of biting flies, and crowds of hikers ..." between family friends, the Buchanans, who use a dual-pole system to help her keep her balance and make the trek (Buchanan 2010).
- 2015 The Millers' work on Big Beaver Valley is a focus for an international scholarly paper: "The Millers' ... biodiversity accountings are demonstrated examples of how capturing biodiversity information and combining it with informed argument can mobilize the fight for our critical and delicate ecosystems" (Khan 2015).
- Margaret dies in December.
- 2016 Friends scatter Margaret's ashes at Cascade Pass. "Her legacy persists in those who she knew and educated personally, and in all those who continue to seek the joy and solitude of the wild Cascades" (Buchanan 2016).
- 2018 The Washington Native Plant Society receives a generous bequest from the Millers' estate.

We honor the memory of Joe and Margaret Miller and marvel at all they accomplished. The WNPS Board is thinking hard about how best to use their bequest to further our programs and honor the Millers' passion for conservation and restoration of our native flora.

Many thanks to staff at North Cascades National Park (Regina M. Rochefort, Stacy McDonough, and Samantha Richert) and to Tom Hammond and Phil Fenner of the North Cascades Conservation Council (northcascades.org) for their help with this article.

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Sarah Gage has been active with WNPS since 1988. She never met the Millers, but she wishes she had. She curates the WNPS blog, Botanical Rambles.



Seedlings of western red-cedar (*Thuja plicata*) growing in the Joe and Margaret Miller Greenhouse. PHOTO: STACY MCDONOUGH

Finding What We Looked For, Amazed at What We Found: Photographing Native Plants at Mount Rainier National Park

by Susan McDougall

Chocolate Lily (*Fritillaria affinis*)



The unmistakably patterned chocolate lily (*Fritillaria affinis*), growing in a roadside ditch on the main park road. PHOTO: SUSAN MCDUGALL

As my husband, David Biek, and I drove uphill on narrow State Highway 123 south of Cayuse Pass in Mount Rainier National Park, my attention was not on the expansive view south toward rugged Governor's Ridge nor up the cliff towering above us. Instead, I was leaning out the window as far as my seatbelt would permit, peering into the rock-strewn ditch, searching for a native species rarely seen at Mount Rainier: the strikingly patterned chocolate lily (*Fritillaria affinis*).

David had found a few of these plants along this stretch of road some 20 years earlier, but the fate of the small population was unknown. Nevertheless, there we were in early June, hazard flashers signaling our presence as we slowly climbed toward the pass. We began to doubt the plant's survival. And then, within a few yards doubt turned to exclamations of success as

the unmistakable, characteristic largish brown bells swaying on slender, leafy stems came into view. Distinctive among the roadside grasses, the chocolate lilies were nearly obvious, as if the plants had been waiting for someone to notice. Yet we knew it might have been overlooked by anyone traveling a few miles per hour faster.

In Washington, chocolate lily is most commonly found near Puget Sound, especially in the San Juan Islands, where it grows in meadows and among rocky outcrops. It also occurs east of the Cascades in Chelan and Kittitas Counties. At Mount Rainier, chocolate lily was first collected in the southwest corner in 1896 on Mount Wow (elevation unknown) by the park's first botanist, Oscar Dana Allen. Why it grows at such diverse spots on opposite sides of the mountain is an intriguing question.

Our Project

In June 2014 David and I made the following proposal to the National Park Service for a volunteer project at Mount Rainier:

We propose to systematically photograph the flora of Mount Rainier National Park, as the season progresses, and request permission to carefully and discretely photograph native plants. . . . Each photograph will be matched with GPS data to provide a "voucher" for that plant. For each photograph, a high-resolution file will be given to the park for its use, with credit to the photographer; the photographer will retain copyrights.

By this time in 2014, I had already photographed nearly 200 of what we believed to be a total of 746 native plant species at Mount Rainier. We knew that to locate as many species as possible we would need to survey places normally closed to visitors, such as the employee housing area at Longmire, the service area at Kautz Creek, the slopes around Box Canyon, and the meadow at Longmire. Ultimately we were accepted by the park as accredited, uniformed volunteers, and we were given permission to stay in the volunteer campground at Longmire. Our little Winnebago served as home for 41 nights that summer.

By the end of 2014, I had taken 2,344 photographs of 480 species. David noted details of the photographed plants, recorded GPS data for each, and made many species identifications using both Hitchcock and his *Flora of Mount Rainier National Park* as primary references.

Beginning at the entrances to the park in early spring, we moved to higher elevations over the summer, picking up late-flowering grasses and sedges as the season advanced. That year we volunteered 820 hours over 13 visits, a total that included photo editing, identifications, and other research. We gave digital image files to the National Park Service, and we created a website with a selection of the best photos of each species (rainierinbloom.com), where a mobile app version can also be downloaded.

Although we were not official park volunteers in 2015 or 2016, we continued the work and added 123 additional species, for a total of 603 species photographed. Spring and summer of these years were devoted to finding the less common species not photographed in 2014. We also searched for species historically located in the park but with little documentation, species previously recorded by David but not photographed, as well as several species not included in David's Mount Rainier flora.

Here, then, are a few anecdotes of the more rare and unusual discoveries for us.

Yellowcress (*Rorippa curvisiliqua*) at Ghost Lake



Yellowcress (*Rorippa curvisiliqua*), found at an unusually high elevation. PHOTO: SUSAN MCDOUGALL

Locating yellowcress (*Rorippa curvisiliqua*) proved to be quite a challenge, and it was one of the last species I would photograph for the project. David had visited Ghost Lake 20 years earlier and found the yellowcress, so this was another case of hoping it had persisted. (The species was collected at Longmire in the 1930s but was otherwise undocumented in the park.) It was early September 2016 when we began our search.

Ghost Lake is located close to Cayuse Pass, on the east side of the park. You can see it if you walk along the west side of Highway 410 a little ways downhill from the pass and look over the edge—about 250 feet down a very steep slope. Ghost

Lake is a relatively new topographical feature, having been created by a landslide a few hundred years ago that blocked Klickitat Creek and formed a small basin near its headwaters. The lakebed is shallow, and by autumn large parts are flats of sandy mud. Yet this annual drying feature of the basin is perfect for the yellowcress.

Instead of descending the steep slope we took a longer but gentler route (or so we thought), heading down a ravine that led north toward the lake. Although travel was easy (and encouraging!) at first, the path soon disappeared and the route led us over more fallen logs than we wished to count, through thick growths of young conifers, and along rocky terrain that made us long for a solid, dirt trail. And, of course, the lake was farther than we had estimated.

Once we reached the lake, we found yellowcress growing in abundance across the mud. After photographing this attractive mustard and resting on a log for a snack, we realized we lacked enthusiasm for a return up the ravine. Thus we switchbacked our way upslope to the car, hot and bedraggled, but feeling deeply satisfied with our discovery.

Sierra Marsh Fern (*Thelypteris nevadensis*)



Sierra marsh fern (*Thelypteris nevadensis*), known from just one locality in the park. PHOTO: SUSAN MCDOUGALL

Sierra marsh fern is rare in Washington, known from a few collections in the North Cascades, the mountains of Skamania County, and at Mount Rainier. The most recent park collection was made in 1963 by J. R. Slater of the University of Puget

Sound at “Ohanapecosh, 2.7 mi north on trail to Cowlitz Divide.” In 1935, J. William Thompson from the University of Washington found it “by trail to Indian bar on Mt. Rainier, 4000 feet.” J. B. Flett, a Tacoma high school biology and geology teacher found it in 1919 on the “Ohanapecosh Trail about two miles from Hot Springs” and again in 1929 “3 mi. from Ohanapecosh Hot Springs on Ohan - Paradise trail 3000 feet.”

We weren’t sure what to make of this interesting but confusing information. We had already explored the Ohanapecosh River valley from the campground to the Grove of the Patriarchs, and along the current park road from the Stevens Canyon tollbooth to the Cowlitz Divide. We also knew that this stretch of road, connecting the east and west sides of the park, was not completed until 1957.

Our best guess was that Flett’s Ohanapecosh-Paradise Trail was what is now called the Cowlitz Divide Trail (or the Olallie Creek Trail on some maps), which roughly lines up with Slater’s directions.

On July 1, 2016, we set off up Olallie Creek, not far uphill from the Grove of the Patriarchs on the southeast side of the park. Aside from several blow-down trees across the trail from a recent windstorm, the quest was almost **too** easy. Right at trail-side, at 3,003 feet, according to the GPS, was a sizable stand of the ferns. The shade of the forest floor implied less-than-ideal light conditions, with much competing vegetation, but, in the end, the photos revealed the delicate beauty of this robust fern.

White Brodiaea (*Triteleia hyacinthina*)



White brodiaea (*Triteleia hyacinthina*) growing on a steep, wet cliff.
PHOTO: SUSAN MCDUGALL

This lovely wildflower grows in areas scattered across Washington, but is particularly common in the Puget Trough and San Juan Islands. A collection from the park was made by Marcus Huntley in 1951 on the “Reflection Lake trail” (not very helpful, since many trails could fit that designation). It is held at the University of Puget Sound Herbarium and was misidentified by Huntley as *Brodiaea coronaria*. However, a second collection, held at the UW Herbarium, was made by David in 2000 from a roadside cliff close to milepost 15 where the

park road crosses Backbone Ridge west of the Stevens Canyon tollbooth.

David’s recollection of the specific cliff on which the white brodiaea grew was a bit vague, and the narrow road does not have safe parking. This was another case where he drove slowly, and I leaned out the window. The plant grows in crevices high on a rock face, and when not in bloom the slender, long basal leaves are nearly impossible to discern. After visits over a number of weeks, on a rainy day in late July we saw several flowers high on the damp cliff. The flowers nearly sparkled, and, once seen, the brilliant white display was unmistakable!

Western Pearlflower (*Heterocodon rariflorum*)



Western pearlflower (*Heterocodon rariflorum*), hiding in plain sight and not yet in bloom. PHOTO: SUSAN MCDUGALL

Early in summer 2016, we were once again in Stevens Canyon, searching along the base of the rock wall that towers above the park road for the tiny, annual Brewer’s monkeyflower (*Erythranthe breweri*). Just two very old collections of this species have been made in the park, but we had recent information from Crow Vecchio, a park service volunteer, that it could be found in Stevens Canyon.

We located the plant with some difficulty, for most were past bloom. It was growing on a rock face in patches of very thin, damp soil. A few small flowers offset by deeply toothed leaves composed an interesting photograph, but it wasn’t until we enlarged the images on my computer that we noticed that the lone Brewer’s monkeyflower was growing with another tiny plant.

Although its flowers were not yet open, we determined that the deeply toothed leaves belonged to western pearlflower (*Heterocodon rariflorum*), a native annual of the bellflower family (the Campanulaceae) known from central and eastern Washington, but never before seen at Mount Rainier.

Species Bagging on Crystal Mountain



Michaux's mugwort (*Artemisia michauxiana*), growing high on Crystal Mountain. The leaves have a lemon scent. PHOTO: SUSAN MCDUGALL

A portion of the eastern boundary of the park runs along the Crystal Mountain ridgeline. At a subalpine elevation between 6,000 and 6,800 feet, the ridge is dry and quite open. We had hiked from the north end in the past, but the central section, previously accessible by chairlift and now by gondola, provided access for David in 2000, the year following the publication of his book. His notes, written in his copy of the book, indicated a surprising number of species, until then not known to occur in the park.

In early August 2014 we took the gondola to the Summit House and set out north along the ridge, taking care to keep our observations to the west side of the trail, that is, inside the park. We had a "shopping list" from his earlier trip, including Michaux's mugwort (*Artemisia michauxiana*), Thompson's paintbrush (*Castilleja thompsonii*), sulphur buckwheat (*Eriogonum umbellatum* var. *hausknechtii*), Oregon sunshine (*Eriophyllum integrifolium* var. *integrifolium*), ball-head waterleaf (*Hydrophyllum capitatum*), silky lupine (*Lupinus sericeus*), Utah honey-suckle (*Lonicera utahensis*), and clustered broomrape (*Aphyllon fasciculatum*).

We found and photographed each of these species, except for the *Aphyllon*, but added slender arnica (*Arnica gracilis*) to the list. **All of these species are new to the park flora** and were not expected within the park due to their ranges being exclusively east of the Cascades crest.

Other Highlights

Between 2014 and 2016 we found other species new to the park flora, including coastal wormwood (*Artemisia suksdorfii*), Scouler's popcorn flower (*Plagiobothrys scouleri* var. *scouleri*), Douglas's knotweed (*Polygonum douglasii*), wiry knotweed (*Polygonum majus*), and annual burnet (*Poteridium occidentale*).

And the 150 or so plants I wasn't able to photograph? Some plants are, quite literally, out of my reach, such as letterman's

bluegrass (*Poa lettermanii*), which grows on rocks above Camp Muir. Some are plants that grow in highly unstable environments, including floating pondweed (*Potamogeton natans*). Its presence in the park flora is based on a collection made in 1932 in a small pond on Tahoma Creek, a pond almost certainly no longer in existence.

But a few of those that have escaped the lens are just plain frustrating to a photographer who knows her way around the park. Consider cascara (*Frangula purshiana*). In his 1938 park flora, George N. Jones wrote that it is common on moist ground in the Transition Zone. There is one very old collection, made by Allen in "the upper valley of the Nisqually." We have looked and looked to no avail, and any information about its current locations in the park would be welcome.

Another missing tree is quaking aspen (*Populus tremuloides*), supposedly located (and photographed) in Steven's Canyon near Nickle Creek. We followed a sketchy trail in search of the reported grove, reaching the indicated position, bush-whacking to the river and throughout the area, and eventually giving up. Perhaps it has not persisted, but that seems unlikely.



Brewer's monkeyflower (*Erythranthe breweri*), a tiny, lavender-colored blossom, not easily seen. PHOTO: SUSAN MCDUGALL

The sense of adventure, finding something new (or equally as interesting), and having the opportunity to photograph a species recorded long ago, provided both David and me over the course of three seasons with what we consider a unique and fulfilling opportunity at Mount Rainier. Many of the species have been mapped with Google Earth, while all those photographed have been made available on a website. But the quest is not finished, and for anyone with an interest, the lure of the many unusual and often elusive species at the mountain awaits.

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A lover of trees, gardens, and photography, Susan McDougall has written Trees Live Here: the Arboretums of America, The Trees of Mount Rainier, Wildflowers of Mount Adams, Washington, and, with her husband, The Flora of Mount Adams, Washington.



San Juan Islands National Monument Provides Refuge for Island Pollinators

by Julie Combs, PhD

Insects, birds, bats, and even small, ground-dwelling mammals provide pollination services. Pollinators ensure food security for humans, maintain plant biodiversity, and form important connections across food webs. Over the last two decades, an increasing number of studies show a decline in pollinators worldwide, especially bumblebees, European honey bees, and our lesser known native solitary bees. In response, many land managers are working to preserve pollinators on public lands through conservation and restoration efforts.

In 2013 President Obama signed a proclamation to designate the San Juan Islands National Monument (SJINM). The proclamation states, “The protection of these lands in the San Juan Islands will maintain their historical and cultural significance and enhance their unique and varied natural and scientific resources, for the benefit of all Americans.” The SJINM is managed by the Bureau of Land Management and protects over 1,000 acres (76 sites) across the San Juan Island archipelago nestled soundly in the Salish Sea.

One conservation target for the SJINM is to document pollinator diversity and floral associations to inform conservation planning. In spring 2017 I met with Marcia deChadenes, the SJINM manager, to walk the perimeter of the Cattle Point monument site (approximately 27 acres) and discuss my research and monitoring plan. This site has a unique combination of xeric meadows, coastal bluffs, and a narrow stretch of beach. Here, I share observational highlights from the many plant-pollinator interactions I documented over the course of the season.

One of the early-blooming wildflowers at this site is checker lily (*Fritillaria affinis*). Checker lily is both a culturally and ecologically significant perennial herb that serves as an impor-

tant source of pollen and nectar to early-season (that is, from April through May) pollinators. Checker lily grows along a narrow footpath leading out to the Cattle Point Lighthouse. The pendant, brown-yellow mottled tepals can be difficult to see tucked in the meadow grasses. Flies and wasps, the most common pollinators in early spring, are attracted to the flowers’ fetid odor and dark coloration that resemble food and/or brood sites. I think the most intriguing pollinator of checker lily is the bumblebee-mimicking syrphid fly (*Volucella bombylans*). This large fly has a round body, yellow-black stripes, and an orange rump—morphological patterns closely resembling the fuzzy-horned bumblebee (*Bombus mixtus*), a common bumblebee found at Cattle Point.



The two-form bumblebee (*Bombus bifarius*) collecting pollen from shore lupine (*Lupinus littoralis*) at Cattle Point. PHOTO: JULIE COMBS

Other early-blooming plants at this site include coast black gooseberry (*Ribes divaricatum*), tall Oregongrape (*Mahonia aquifolium*), field chickweed (*Cerastium arvense*), shore lupine (*Lupinus littoralis*), the nonnative common vetch (*Vicia sativa*), and beach pea (*Lathyrus japonicus*). Throughout the season, I conducted repeated 15-minute patch surveys on every flowering species. Once I was settled with my field notebook in hand, I heard the familiar low rumble-buzz of a bumblebee approaching a patch of shore lupine. I looked up to watch a female use her forelegs to “trip” the keel petals of the flower and quickly gather nectar and pollen into “baskets” located on her hind legs. The mix of pollen and nectar was tightly packed and eventually offloaded to provision her nest.

Bumblebees are eusocial (there is a division of labor and cooperative rearing of young), typically nesting in ground cavities made by small mammals, but are also known to nest above-ground in thick moss, grasses, and decaying logs. At this site, I located a nest entrance of the yellow-head bumblebee (*Bombus flavifrons*) buried deep within a thorny coast black gooseberry shrub. I watched them fly in and out like planes arriving and departing from a busy airport runway.

On this small parcel of conservation land, I encountered six species of bumblebees in 2017. The two-form bumblebee (*Bombus bifarius*) is one of the more visually stunning—with



Bumblebee-mimicking syrphid fly (*Volucella bombylans*) is an early season pollinator of checker lily (*Fritillaria affinis*) found in the meadow at Cattle Point, San Juan Island. PHOTO: JULIE COMBS



Field assistant Josephine Lambert conducting a pollinator survey on beach morning-glory (*Convolvulus soldanella*). PHOTO: JULIE COMBS

two bright-orange bands, yellow and black on her abdomen, and a characteristic black notching pattern embedded in the fluffy yellow pile on the thorax. One could mistake this species for the black tail bumblebee (*Bombus melanopygus*), which also parades two brilliant orange stripes mid-abdomen but lacks the black notching pattern.

Pollinator activity ramps up as the season progresses with warming temperatures and increasing floral resources. Some of the mid- to late-blooming plants that occupy the meadow, bluffs, and shoreline are harvest brodiaea (*Brodiaea coronaria*), common snowberry (*Symphoricarpos albus*), beach morning-glory (*Convolvulus soldanella*), Puget Sound gumweed (*Grindelia integrifolia*), and several nonnative plants, such as American sea-rocket (*Cakile maritima*), hairy cat's-ear (*Hypochaeris radicata*), Himalayan blackberry (*Rubus bifrons*), and Canada thistle (*Cirsium arvense*).

At this time in the season, I observed the tiny, but ubiquitous, metallic green-black carpenter bees (*Ceratina* spp.). It is easier to spot them in open flowers, such as Puget Sound gumweed or Himalayan blackberry, but they are difficult to find when concealed deep in the blue-purple harvest brodiaea tepals. If you peer directly into the flower you can see the bees collecting pollen from the three fertile stamens, their dark bodies contrasting starkly against the three white staminodia (sterile stamens). *Ceratina nanula* and *C. acantha* both occur here and use broken twigs and dead wood as nest sites. They

are mainly solitary (they do not tend to the young or live in colonies) but are known to guard their nest until the young complete development.

Later in the season I observed male long-horned bees (*Eucera* spp.) zig and zag up and down the sandy pathways patrolling for females and defending their territory. I found females buried deep in the broadly funnel-shaped corolla of the beach morning-glory. *Melissodes* spp. are in the same taxonomic group as *Eucera* spp. (males with extraordinarily long antennae) but are more of a specialist pollinator, visiting plants only in the sunflower family, such as the Puget Sound gum plant. Like other solitary bees, females carry pollen on tibial scopa (a dense mass of branched hairs where pollen is carried) and look like they are wearing cowboy chaps when fully pollen-packed.

Peering over the edge of a south-facing slope that looks out toward the Olympic Peninsula, I discovered a large aggregation of turret-shaped entrance holes dug out by female digger bees (*Anthophora bombooides*). These bees, as their names suggests, are powerful diggers, making their nests deep in the sandy soil along the cliff edge. Females fly speedily in and out rushing to provide food for their developing young. I noticed the variation in pollen color packed on their scopa, evidence of their generalist nature. It made me consider the hundreds, if not thousands, of flowers in the meadow pollinated by digger bees and the many other species I observed over the course of the season.



Female *Melissodes* spp. captured while pollinating Puget Sound gumweed (*Grindelia integrifolia*) on the bluff edge at Cattle Point. Pollen of gumweed is transported on specialized broom-like structures called scopae on the hind legs. PHOTO: JULIE COMBS

My work documents key plant-pollinator relationships, identifies critical nesting habitat, and illustrates the important role protected lands, such as the SJINM, play in the long-term conservation of plants and their pollinators. As I write this, I wonder about the pollinator-plant associations at the other 75 SJINM sites scattered throughout the remarkably beautiful San Juan Island archipelago.

Dr. Julie Combs lives in Seattle and is an independent ecological consultant and affiliate faculty at the University of Washington. Her work focuses on rare and invasive species ecology/management, pollination ecology, citizen science, and sustainable resource management. Contact her at jcombs@uw.edu.



A Love of the Olympics' Endemic Alpine Flowers in the Time of Climate Change

by Eric G. DeChaine and Samuel T. Wershow

Olympic National Park protects an enchanting island of mountains that have been continually isolated from neighboring ranges in the Pacific Northwest by glaciers, outwash plains, oceans, and lowland forests. The lofty peaks rise precipitously above the moss-laden valleys of old growth temperate rainforests in the west, creating an incredibly steep precipitation gradient in which the summits sequester the moisture blowing off the Pacific and leave little for the drier forests on their eastern

isolated to disperse off the peninsula, and are already occupying the highest elevation habitats therein.

We investigated the potential responses for endemic alpine plants of the Olympic Mountains to predicted climate change scenarios of this century (Wershow and DeChaine 2018). Specifically, we set out to estimate how the area and distribution of suitable habitat for the alpine endemics would change by the year 2080 as determined by both climate and micro-topographic features. Within that framework, we endeavored to identify the locations and characteristics of potential thermal refugia (cold microhabitats that could serve as sanctuaries for alpine taxa) in the Olympic Mountains. By doing so, we hoped to provide a platform for understanding the plight of endemic alpine taxa and an informed basis for conservation priorities.



Piper's harebell (*Campanula piperi*). PHOTO: MARK TURNER



Flett's violet (*Viola flettii*). PHOTO: MARK TURNER



Flett's fleabane (*Erigeron flettii*). PHOTO: MARK TURNER



Olympic Mountain groundsel (*Senecio neowebsteri*). PHOTO: MARK TURNER

flanks. The topographic and environmental variations therein have promoted a diversity of habitats, with deeply carved river valleys and sharply exposed ridgelines throughout the peninsula. This combination of island-like isolation, a ruggedly variable landscape, and a remarkable diversity of micro-environments has generated a flora and fauna uniquely Olympic (Buckingham 1995; Peterson et al. 1997; Gavin 2015). And yet, much of what makes the Olympics exceptional, its irreplaceable endemic taxa, may be lost as the climate warms.

What will happen to the endemic alpine plants as the climate changes? The Pacific Northwest may experience a 3°C increase in mean annual temperature over the next century, with wetter winters and drier summers (Mote and Salathé Jr. 2010). The potential responses of endemic alpine plant species to these changes are largely unknown, though endemics likely face the greatest risk (Malcolm et al. 2006). Alpine endemics are adapted to a narrow set of local conditions in their micro-environments and probably cannot adjust well to environmental changes (Bruchmann and Hobohm 2014). Indeed, few options are available for them to weather the changes, because they are adapted to a narrow range of environmental conditions, are too

The Olympic alpine is rich in endemic flowers, with eight taxa (a collective term for species, subspecies, and varieties) restricted to the Olympic Peninsula and another five shared between the Olympics and Vancouver Island.

We focused our study on five of the endemic alpine taxa found only in the Olympics. Piper's harebell (*Campanula piperi*) is a prostrate, spreading herb, often forming dense cushions along cracks in rock. Likewise, Flett's violet (*Viola flettii*) is a small, perennial herb that inhabits crevices in rock outcrops, though it can occasionally be found on nearby talus or scree. Flett's fleabane (*Erigeron flettii*) is uncommon on rock outcrops. Olympic Mountain groundsel (*Senecio neowebsteri*) is a perennial herb that inhabits steep, loose, rocky substrates. Finally, Olympic Mountain synthyris (*Synthyris pinnatifida* var. *lanuginosa*) is a prostrate, cushion-forming herb that inhabits exposed ridgetop fellfields (references for the previous five plant descriptions: Hitchcock et al. 1969; Pojar and MacKinnon 2013).

We adopted an iterative sampling approach to obtain enough accurate population location data to generate predictive models of habitat distributions for our five focal taxa. The first problem that we had to overcome was one of sample size: her-

baria specimens for our focal taxa were very limited, and some were unreliable due to poor location data, especially among older specimens. From the limited accurate data, we generated a first round of current species distribution models (SDMs) for each taxon.

An SDM uses population locations to estimate the climatic conditions that are suitable for a species. The output is a map of where a species is likely to occur, given the climate. Because accurate location data are critical to generating reliable SDMs, we improved our models through repeated rounds of sampling and model building: (1) estimating the species distributions, (2) going into the Olympic Mountains and looking for populations where the SDM predicted occurrences, and then (3) using the new location data to refine our models.



Olympic Mountain cut-leaf
Synthyris (Synthyris pinnatifida var.
lanuginosa). PHOTO: MARK TURNER

We also estimated the current and future climatic conditions of the Olympic alpine in general, defined as the terrain above 1,400 meters (4,593 feet).

The outlook for Olympic alpine plants is fairly bleak in general, especially so for the endemic taxa. Overall, future conditions in the Olympic alpine will become hotter and drier, which will lead to considerable restructuring of the alpine community (see Figure 1). Our five focal endemics occupy narrow climate envelopes at the cold, snowy edge of the current alpine climate space, and that will all but disappear in the future, leaving them nowhere to go as the climate warms. Indeed, they will

Our field sampling dramatically improved our knowledge of the distributions of the five endemic taxa. We then refined the species distributions by incorporating topographic constraints (for example, slope and aspect), which necessarily reduced the area of suitable habitat further. In the end, we generated current and future (2080) SDMs for each taxon (singular of taxa).

lose 86 to 99 percent of their suitable habitat by 2080, marooning their remaining populations on ever-shrinking islands in the sky. Moreover, suitable habitat will be completely lost in the northeastern Olympics. Within the remaining habitat, species distributions will be governed by micro-topographic features. In the end, the broadly distributed and more abundant taxa (for example, *C. piperi*) will retain more suitable habitat, while others (for example, *E. flettii*) will experience nearly complete loss (see Figure 2, next page).

Yet, hope remains. Suitable habitat for all taxa will persist in thermal refugia on the highest peaks of the eastern Olympics. For instance, an optimal combination of elevation, projected temperatures, and precipitation exists around Mount Constance indicating the continuation of favorable habitats for all five focal taxa. How long a species survives into the future will likely depend on their populations' proximity to the thermal refugia and the distribution of suitable topography within it, their innate adaptability, and the pace and magnitude of climate change.

What is one to do? At this stage, one of the best approaches is for each of us to take the time and energy to get out into the alpine and observe these endemic taxa. At least two rewards may be earned through careful and thoughtful explorations of the alpine tundra. First, one may discover previously undocumented populations of the alpine endemics—data that are critical for continuing our iterative approach for improving predictive models and monitoring any changes in species distributions.

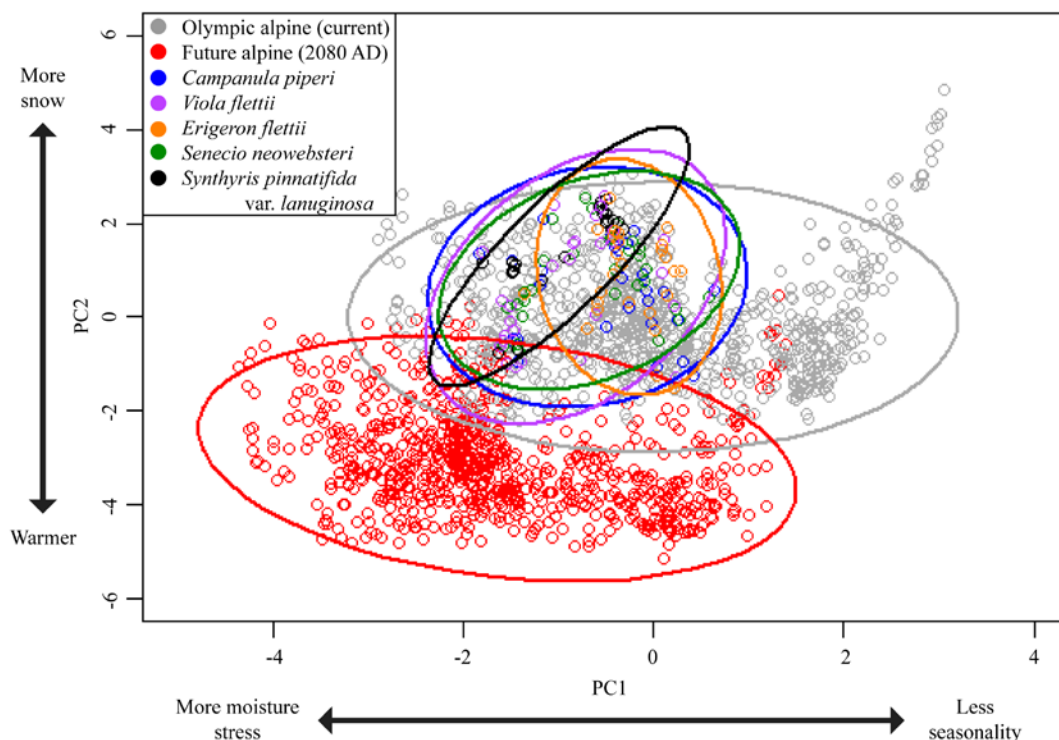


Figure 1. Climate space for the alpine zone and its endemic alpine taxa relative to current and future conditions. Scatterplots of the first two principal components of climate conditions at presence sites for the study taxa, and the current and future conditions at randomly sampled sites representing the Olympic alpine (terrain over 1,400 meters in elevation) are shown. Ellipses represent the 5th to 95th percentile range of each group's climate envelope (Wershow and DeChaine 2018).

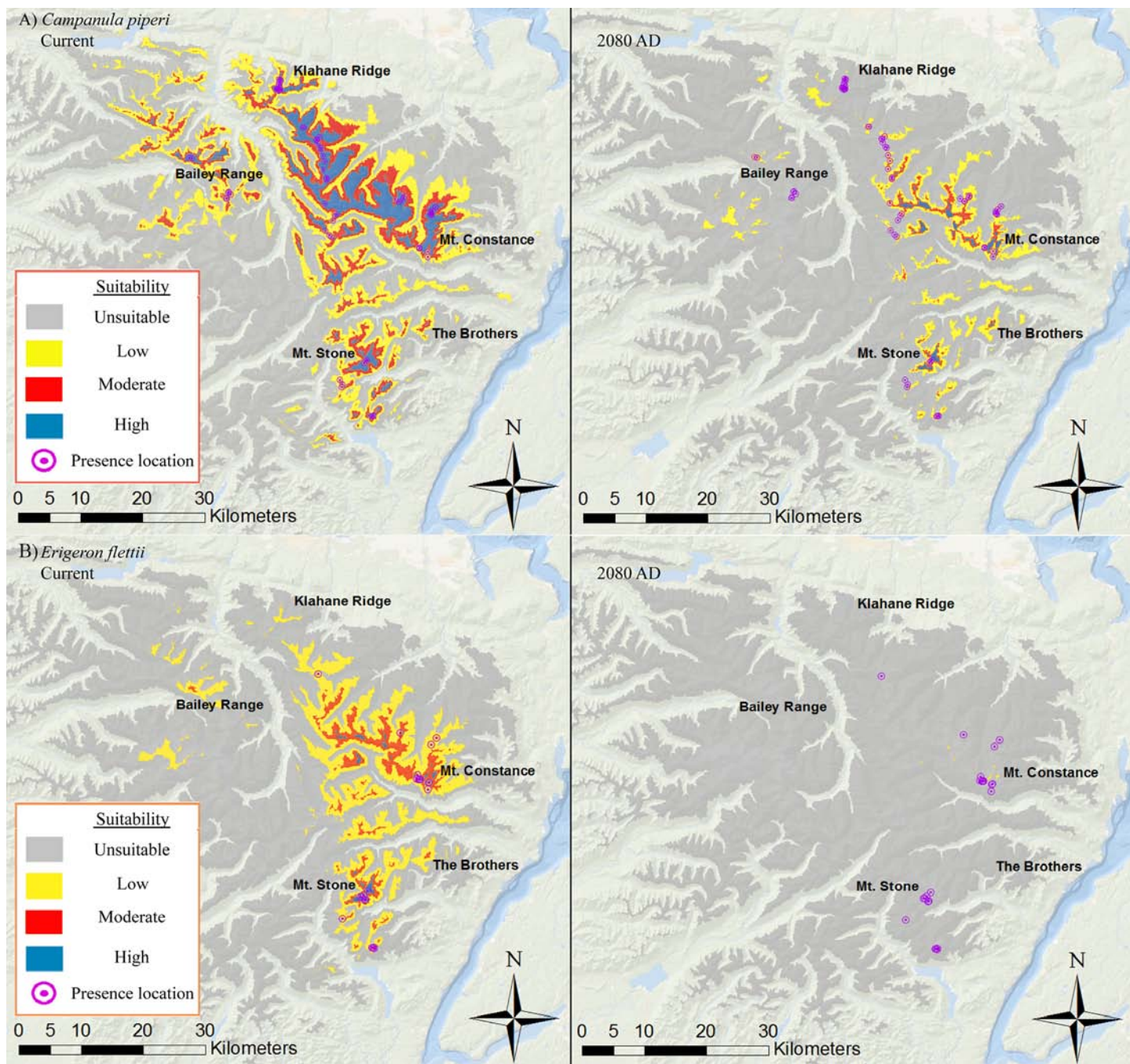


Figure 2. Current (normal period) and future (2080 AD) species distribution models (SDMs) for alpine endemics. Model extent is defined as the Olympic Peninsula over 800 meters (about 2,625 feet) in elevation. Habitat suitability was classified based on Maxent suitability scores as Unsuitable (<0.01), Low (0.01–0.1), Moderate (0.1–0.34), or High (>0.34). SDMs for A) Piper's harebell (*Campanula piperi*) and B) Flett's fleabane (*Erigeron flettii*) (Wershow and DeChaine 2018).

Second, and at least as important as the first, one will experience firsthand and likely fall in love (perhaps again) with the alpine world of Olympic National Park. Hopefully, this will be carried through as motivation to reach out and educate others about this wonderful place and its unique, but potentially fleeting, alpine flowers. As our study shows, the Olympic Peninsula is an exceptional model for learning about climate driven habitat loss in endemic alpine taxa, with lessons that should be applied globally.

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Eric DeChaine is professor of biology at Western Washington University, where he researches the biogeographic history and evolution of tundra ecosystems. Eric is also curator of the Pacific Northwest Herbarium. He is a member of the Koma Kulshan Chapter.



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Herbaria of Mount Rainier and Olympic National Parks

by Kathy Murray, *Salal Chapter*

All three of Washington's national parks have herbaria where dried and mounted specimens of plants are preserved to record park flora. Mount Rainier's herbarium collection, with the identifier MORA, has more than 10,000 specimens, and the Olympic National Park herbarium (OLYM) has more than 26,000. The North Cascades facility (NOCA), profiled in the Fall/Winter 2017 issue of *Douglasia*, has about 9,000. Duplicates of some of these specimens are held at the University of Washington herbarium at the Burke Museum (WTU): MORA, 2300; OLYM, 700; and NOCA, 1800.

Currently there is no direct online access to the specimens held at MORA and OLYM (NOCA was added to the Consortium of Pacific Northwest Herbaria online database in spring 2018 [www.pnwherbaria.org/data/search.php]). The duplicate specimens at WTU and other specimens collected from MORA and OLYM are currently accessible through the Consortium database. To search for specimens only held at NOCA, scroll down below the header **Select Herbaria to Search**, and then click the box next to NOCA.

To access MORA and OLYM specimens held at various herbaria, use the **Create Polygon** function above the map on the search page to draw a boundary around either park. Be

sure to use the drop-down list in the **Tax. Group** field to select **Vascular Plants** so that your search does not also return fungal, lichen, and moss specimens, and then click the **Search** button. Note that there is a 10,000 specimen limit on a search.

All three parks have diverse climatic zones that are related to location and elevation. The 789-square-mile North Cascades National Park spans the Cascades crest. Elevations range from 605 feet at Goodell Creek on the west side of the park to 9,206 feet at the summit of Goode Mountain, a peak that is difficult to access and cannot be seen from any highway. Mount Rainier is the smallest park: 369 square miles (about one-third the size of the state of Rhode Island). Its low point is 1,600 feet; Mount Rainier's summit, far above the tree line, is 14,410 feet. Olympic National Park is by far the largest of the parks, some 1,442 square miles and larger than Rhode Island. Its elevations range from sea level to 7,980 feet at the summit of Mount Olympus.

Mount Rainier National Park is the fifth oldest of the nation's national parks, and its herbarium collection dates to its founding in 1899. Park Curator Brooke Childrey says the herbarium collection contains both vascular and nonvascular plants dating to 1893. The early specimens are from the Oscar Dana Allen vascular plant collection; however, according to Childrey, "The vast majority of the specimens are vascular plants collected between 1920 and 1945."

Olympic National Park was founded in 1938, and its herbarium was started four years later when Charles Webster, an early resident of Port Angeles and a naturalist, donated his

Search Label Data:
Enter any combination of search terms. Partial terms are accepted in most fields. See below for a list of search operator.

Search by Location:
Zoom in, click "Create Polygon", then click your mouse to draw a polygon around the area you want to search.

Select Herbaria to Search:

Search Operators:

Screenshot showing polygon search of vascular plants at Olympic National Park. Red boxes indicate location of Tax. Group field and Create Polygon tool. Note that the polygon drawn on the map is an estimation of the park's boundary but does not include the area along the coast.

collections to the park. Webster also owned a Port Angeles newspaper, the Port Angeles Evening News. Matthew Dubeau, the OLYM curator, said other collections came from Nelsa Buckingham and Edward Tisch. Ms. Buckingham, a prolific collector of plants, did much Olympic Peninsula plant research in the 1970s and 1980s and wrote or co-authored several significant flora publications. Edward Tisch was a local botanist and professor at Peninsula College, who was also an active collector from the 1970s through the 1990s. His collections were donated to the park herbarium after his death.

Dubeau said three major publications are based on the OLYM collections:

Hutten, Martin, Karen Hutten, and Andrea Woodward. 2001. *101 Common Mosses, Liverworts, and Lichens of the Olympic Peninsula*.

Buckingham, Nelsa, Edward Schreiner, Thomas Kaye, Janis Burger, and Edward Tisch. 1995. *Flora of the Olympic Peninsula*. Northwest Interpretive Association and the Washington Native Plant Society, Seattle, WA. 199 p.

Buckingham, Nelsa, and Edward Tisch. 1979. *Vascular Plants of the Olympic Peninsula, Washington*. Northwest Interpretive Association and the Washington Native Plant Society, Seattle, WA. 199 p.

Olympic National Park and the Olympic Peninsula have a number of endemic plants that are found only on the peninsula.



White avalanche lily (*Erythronium montanum*) herbarium sample from the Mount Rainier (MORA) collection. PHOTO: COURTESY MOUNT RAINIER HERBARIUM

Information and photos are on a web page of the WNPS Olympic Peninsula Chapter: <http://www.wnps.org/olympic/nativePlants/endemicPlants.html>. According to the Northwestern Chapter of the North American Rock Garden Society, Mount Rainier has two endemic species, obscure Indian paintbrush (*Castilleja cryptantha*), described as a “drab little paintbrush,” and a yellow lousewort, *Pedicularis rainierensis*. Photos can be viewed at <https://www.nargsnw.org/mount-rainier>.

The national park herbaria are open by appointment (see accompanying box for contact information).

References

<https://www.national-park.com/welcome-to-olympic-national-park/>

<https://www.nationalparked.com/north-cascades>

<https://www.nps.gov/parkhistory/onlinebooks/mora/notes/vol16-1-2a.htm>

<https://www.nps.gov/state/wa/index.htm>

Richert, S. 2017. North Cascades National Park Service Complex herbarium. *Douglasia* 41(3):3–4.

Kathy Murray is a retired technical editor. She joined WNPS in 2004 and chaired the WNPS Editorial Board from 2007 to 2016. She is active in the Salal Chapter and writes occasionally for Douglasia.



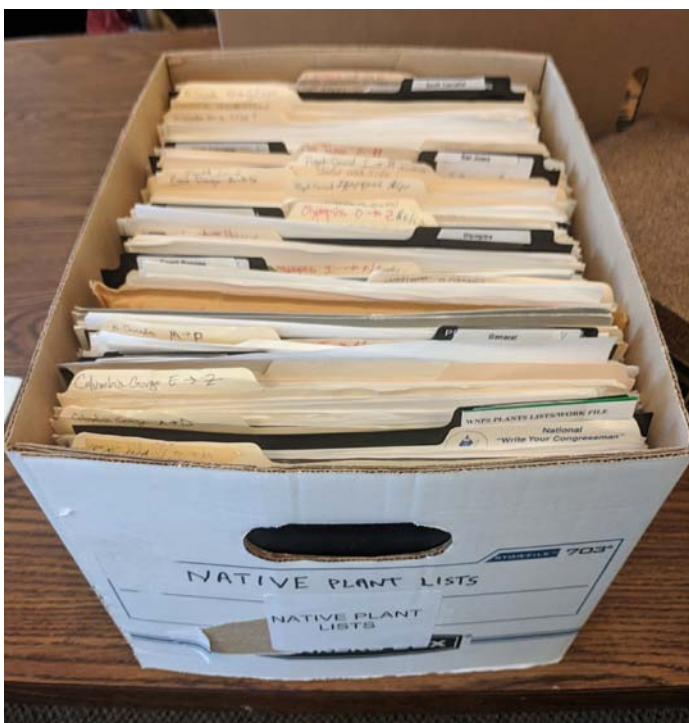
Herbaria of Mount Rainier and Olympic National Parks

	Mount Rainier National Park Herbarium	Olympic National Park Herbarium
Identifier	MORA	OLYM
Number of specimens	About 10,000	26,000 (including 9,747 bryophytes and 4,373 lichens)
Collection focus	Vascular and nonvascular plants of the park	Olympic Peninsula with emphasis on plants from within the park boundaries
Date established	1899	1942
Location	55210 238th Ave. E., Ashford, WA	Park Headquarters, Cultural Resources, 600 E. Park Ave., Port Angeles, WA
How to see and contact information	By appointment with Park Curator Brooke Childrey (360-569-6784; brooke_childrey@nps.gov)	By appointment with Museum Curator Matthew Dubeau (360-565-3054; Matthew_Dubeau@nps.gov)
Online access to herbarium sheets or park flora	None to herbarium sheets; https://www.nps.gov/mora/learn/nature/wildflowers.htm	None to herbarium sheets (scanning is proceeding slowly due to lack of dedicated funding) https://www.nps.gov/olym/learn/nature/plants.htm
Volunteers needed?	To repair specimens, catalog inventory, and correct data entries	Not at this time

WNPS Plant Lists: Exciting New Developments

by Ben Legler, University of Washington Herbarium, Burke Museum; Central Puget Sound Chapter

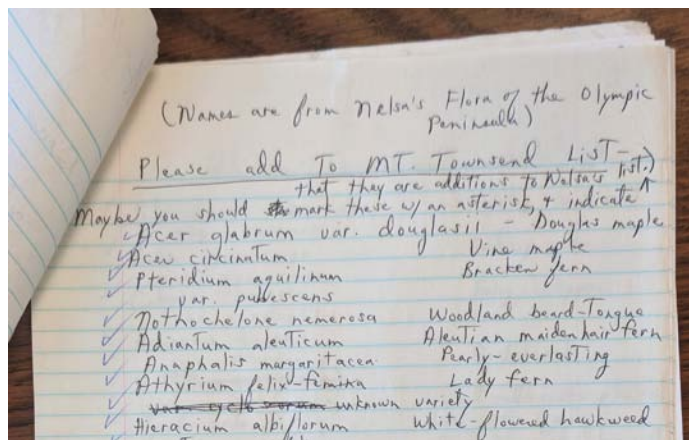
The WNPS plant lists represent the work of over 280 individuals spanning many years. Most started as handwritten or typed lists, which in 2003 became digital documents available through the WNPS website thanks to the hard work and dedication of former WNPS member Don Knoke (for more background on the lists and Don's involvement, see Ellen Kuhlmann's article in *Douglasia*, 40(2):19 Summer 2016). Here we share the exciting news of the plant lists' next chapter: their migration into a new framework that makes them easier to manage and enhances their value.



Box packed with old typed and handwritten plant lists organized by regions within Washington, archived at the WNPS office. These were converted to digital documents for access on the WNPS website.

PHOTO: BEN LEGLER

The idea of migrating the plant lists to a database was first discussed five years ago by Catherine Hovanic and David Gibling, who approached WNPS member Martin Cheney to further explore the idea. Then in 2016 the plant lists were included as part of a larger herbarium grant proposal to the National Science Foundation. Although this proposal was not funded, Don Schaechtel and David reformulated some of the ideas therein for a grant proposal to the Garneau-Nicon Family Foundation of Seattle, which provided \$5,000 toward the project. WNPS chapters responded with an additional \$7,500 from their own chapter fundraising efforts. As Don Schaechtel noted, "Member enthusiasm for the project confirmed that this was an investment worth making."



A handwritten list of additions to the Mount Townsend plant list, compiled in 1998 by Autumn Scott. PHOTO: BEN LEGLER

Early this year we began work on the first phase of modernizing the plant lists, which has now been completed and is available online at <https://www.wnps2.org/plant-lists> (this will become <https://www.wnps.org/plant-lists> once the new WNPS website is finished).

The new plant list web pages provide a number of enhancements and features, opening up exciting new possibilities for access and use. They also provide a framework for easily updating existing lists or adding new lists, enabling WNPS members to not only use the lists but also become more active contributors to what we hope will soon become a premier source of information on where and when to see Washington's native wildflowers as we pursue the next phases of development.

Alongside the previous organization of plant lists by county are two new ways of accessing the lists. The first is an interactive map of Washington showing the locations of all lists. This feature might help you discover new wildflower destinations or find lists relevant to your next planned trip. Just zoom in on the map, and then click one of the red icons to access the list for that site.

The second is a way to search the plant lists. Let's say you want to figure out where to go to see a particular wildflower species. Instead of guessing which lists and locations might have that species, you can now do a quick search to find all the lists containing it and see where they occur on a map. Here's another idea: Help us update old lists by searching for those that have not been visited in recent years, and then revisit these sites and see what you can add.

Not to be underestimated was the challenge of keeping the previous plant lists up-to-date with current family and scientific names. With the lists now in a database, the task of updating names becomes automatic through direct connections to the UW Herbarium's Washington Flora Checklist and the soon-to-be published second edition of the *Flora of the Pacific Northwest*. Those of us who know the old Hitchcock names can now use the plant lists to help with the daunting task of learning current names. But the choice is yours: there are options to display each plant list using the old family and scientific names, if you prefer.

SAVE

CANCEL

Record History:

Created on: 1/9/2018

Last edited: 1/29/2018

Edit another name in this list:

EDIT

(The name you are currently editing will be saved.)

Edit Name:

Scientific Name:

Polystichum munitum

Qualifier:

Identification Reference:

Optionally, specify the field guide, flora, or literature source you used to identify the species.

Family:

Polypodiaceae

Enter the scientific name of the family to which this species belongs (e.g., Asteraceae). This field will normally be populated automatically once a scientific name is entered above.

Common Name:

Sword fern

Enter the common name you would like to use for this species. This field will normally be populated automatically once a scientific name is entered above.

Nomenclatural Information:

Name Status: Accepted

Current Family: Dryopteridaceae

Accepted Name: *Polystichum munitum*

Subspecies/varieties in Washington: [none]

Treated in 1973 Flora of PNW as: *Polystichum munitum* var. *munitum*

Treated in Revised Flora of PNW as: *Polystichum munitum*

Ambiguous Name?

The scientific name entered above, as used in the past, has been split into two or more accepted species in Washington:

Polystichum imbricans, *Polystichum munitum*

If possible, please determine the correct identification of the plants at this location. If the scientific name entered above is the correct identification, you can prevent the name from being listed as ambiguous in this plant list by checking the option here:

Attributes:

☒ **Introduced?** Select this option if the species is introduced to Washington or to the location represented by this plant list.

☐ **Planted?** Select this option if the species has been planted at the location represented by this plant list (e.g., for restoration work or as an ornamental or crop plant).

The new interface for adding or editing a single species name in a plant list, showing controls for validating the scientific name and the information associated with the name (not visible is a comments field). PHOTO: BEN LEGLER

We have also developed a set of easy-to-use interfaces for managing the plant lists. WNPS members can request a user account to access these interfaces through their web browser. Once signed in, they can create new plant lists or edit lists they previously helped create, even lists from many years ago. The tools for adding species names eliminate the need to know the current family and scientific names—the interfaces handle the nomenclature for you. They will also alert you to potential misspellings, tell you if the species is potentially out of range for the location and thus possibly misidentified, mark it as native or introduced, and handle all the work of formatting the names into a nice-looking document for you to download. A tool for entering multiple names at once makes list creation or expansion even easier, especially if you have been maintaining a personal list from which you can copy and paste. The account-based system also allows you to invite other contributors to collaborate on a list. An online Contributor's Guide provides many more details on using the new database.

Looking forward, we hope to further enhance the plant lists in new and exciting ways. For example, imagine if you could consult the plant lists to also determine the best time to visit

a location or when a certain wildflower species might be in bloom there or where exactly to find it. How can we make that possible? With your help! You'll be able to take a plant list with you on your next hike and record which species you saw where and whether they were in flower or fruit, and then return to the plant lists website after your trip to add your phenology observations. You'll also be able to write a trip report and upload photos to inspire others.

Credit for the plant lists extends to many individuals, especially those who compiled lists over many years. The new plant lists database is managed as a joint project between WNPS and the UW Herbarium, with the herbarium providing server space, code development, and nomenclatural man-

agement, and WNPS members creating and curating the lists. Don Schachtel and David Giblin worked to develop ideas, garner support, and raise funds. Ben Legler developed the database and new web pages, and converted the plant list documents into a database format with help from Julia Bent and Jim Duemmel. John Bassett georeferenced the plant list localities for placement on the map. Ron Bockelman has generously agreed to serve as the new plant lists manager.

Even though the current tally of nearly 700 lists may seem like an impressive number, many more wildflower destinations still lack a list. Would you like to help out? Become a contributor by contacting Ron Bockelman at plantlists@wnps.org to obtain an account, and then go outside and start making lists!

Ben Legler works at the University of Washington Herbarium at the Burke Museum, where he works on the Flora of the Pacific Northwest revision project and manages the herbarium's databases and online resources. Contact Ben at blegler@uw.edu.



Growing Natives from Seed: Simple Seed Propagation Methods for Native Plants

Part 2: Simple Methods for Seed Cleaning and Storage

by Bridget McNassar

Once you've successfully made your native seed collections (see Part 1 of this article series in the spring 2018 issue of *Douglasia*: Vol. 42(1):3–4), you'll need to clean your seed in preparation for either sowing or storage. Cleaning seed involves separating it from the fruit and other structures that enclose it or are attached to it. Besides being a satisfying endeavor for the detail-oriented, this task is an important step in improving germination, because fruits surrounding the seed may harbor damaging microbes or contain germination inhibitors. In the end, you'll also have a much better idea of the quantity of seed you have collected.

Large seed operations use some pretty amazing Rube Goldberg-type contraptions to clean seed, but there are simple methods that clean and store small amounts of viable seed just as effectively.

Cleaning Fleshy Seeds

Removing seed from fleshy fruits should be done within a few days of collection. To start, soften the fruit by soaking it in water for one to three days in a cool place, changing the water twice a day. When fully soaked, the fruit should be easy to squish and should slide off the seed. I've found that some species, such as Pacific crabapple (*Malus fusca*), have a tougher fruit, which makes it difficult to get the fruit soaked, so in

those cases I first give the fruit a few soft smashes with a potato masher to break the outer fruit wall.

The next step is to separate the softened fruit from the seed. You can simply squish the fruit repeatedly with your hands in water, but I find this gets old (and a bit painful if you've got bad joints), so we use other methods at Oxbow. Either a potato masher or applesauce strainer (the metal cone with wooden paddle) can gently crush fruits in a small bucket of water. We primarily use a food processor with blades that we've coated in plastic and pulse small batches of the soft fruit and water. With all these methods, always begin gently and check your seed to make sure you are not crushing or damaging it before applying more pressure.

Conveniently, seed generally sinks and pulp floats. By filling a small pitcher or bucket with the pulp/seed mixture, you can gently pour off the pulp while the seed stays at the bottom of your container. You'll likely need to do this a few times, adding more water each time, before you get all the pulp out, being careful not to pour out your seed. Immature or unfilled seed will float too, allowing you to conveniently discard this with the pulp. The remaining seed can be strained, dried, and stored.

Cleaning Dry Seeds

With seed that is enclosed in dehiscent (splitting open) fruits, such as the capsules of nodding onion (*Allium cernuum*) or fringecup (*Tellima grandiflora*), I simply cut the entire inflorescence, and then place it upside down in a plastic container or hanging cloth bag tall enough to contain it. Much of the seed simply falls down into the container, and you don't need to do much else.

With seed in indehiscent (non-splitting open) fruits, such as blanketflower (*Gaillardia aristata*), or Roemer's fescue (*Festuca roemeri*), crushing and sorting with screens is in order. Start by gently crushing the inflorescence. You may need to rub the crushed inflorescences with a gloved hand over a rough surface, like a screen, to free the seed. Again, some species are delicate, so start gently and inspect your seed (a hand lens is handy here) to be sure that you are not damaging it. You'll now have a mix of seed and everything else (called chaff), and you can work to get rid of the chaff. There are sets of sieves or screens just for this purpose, but I started out with three kitchen strainers, each with a different-sized mesh. As you work with the seed, you can get it pretty clean if you can find a mesh size that allows your seed to fall through while larger chaff gets trapped on top and a second screen that keeps your seed on top and lets smaller chaff through.

Winnowing is a finishing method that works to remove the last bits of chaff, which are typically lighter than most seed. I put the remaining seed and chaff in a shallow dish with a



Separating fleshy fruits from seeds: here the red seeds of blackcap raspberry (*Rubus leucodermis*) sink, while the purple pulp floats in water, making them easy to separate.

PHOTO: BRIDGET MCNASSAR

lip, and then shake it a little and lightly blow over the surface. Once you get the right amount and angle of blowing, you can easily get rid of the lighter chaff, leaving just the seed in the dish. Additionally, you can spread it out on a lipped baking pan, and then shake the seed around in such a way that the particles separate by weight and you can simply brush the chaff away.

Drying and Storing Seeds

You'll want to dry your cleaned seed before storage. Warmer moving air is best for removing moisture, so your seed needs to be in a warm, dry area with good air circulation on all sides, either laid out in a single layer in a tray or on a screen, or hanging in a cloth bag. This should be done out of direct sunlight and protected from animals. We use a simple dryer that blows air over a stack of mesh bottom trays that hold seed (see Resources below).

After about a week or two in a warm, dry place, or a day or two in the dryer, the seed is ready to be stored. In storage, you want to keep the metabolism of the seed low and prevent pathogen damage, accomplished by keeping both humidity and temperature low. Cooler air holds more humidity, so store seed in containers that don't allow moisture in. At Oxbow, we use thicker plastic bags (4–6 mil or higher); airtight vials or jars work as well. We also include in the bag small color-indicating silica gel packets to absorb additional moisture. Seed is stored in a refrigerator set to 34° F. Using these simple precautions, seed can store up to 5 years or so.

Of course, there are always exceptions. Some seed loses viability or enters into a much deeper state of dormancy if dried, so these types of seed should be sown without allowing them to dry out. Examples include maples (*Acer* sp.) and seeds with a fatty appendage called an elaiosome, such as Pacific bleeding heart (*Dicentra formosa*) and Pacific trillium (*Trillium ovatum*).

As always, I encourage you to keep good records. For example, it helps to know how much seed you get out of half a pound of salmonberries (*Rubus spectabilis*). Maybe you'll need to collect much more or less next time based on your sowing needs. Write down all the tricks you find for cleaning different species, because this will make it so much easier next time.

In Part 3, we'll address seed dormancy and how to overcome it.



Simple tools such as baking pans, screens, and kitchen strainers can be used to clean seed at home. PHOTO: BRIDGET MCNASSAR

Resources

How to build a seed dryer, from the USFS National Seed Laboratory. Click the Seed Drying - Seed Moisture Mgmt & Building Pressurized Dryers link found on this page: https://www.fs.usda.gov/nsi/nsi_fsstc.html

Dumroese, K. (ed.), 2004. Low Tech Devices for Collecting, Processing and Planting Seeds (a series of seven short articles on the topic). *Native Plants Journal* 5(1):46–55.

Luna, T. and K.M. Wilkinson, 2009. 7: Collecting, processing, and storing seeds. Pages 113–131 in Dumroese, R.K., T. Luna, and T.D. Landis (eds.), *Nursery manual for native plants: A guide for tribal nurseries, Volume 1: Nursery management. Agriculture Handbook 730*. Washington, D.C.: U.S. Department of Agriculture, Forest Service.

Bridget McNassar is the manager of the native plant nursery at Oxbow Farm & Conservation Center (www.oxbow.org) in Carnation, WA. You can contact her at bridget@oxbow.org.



Pacific trillium (*Trillium ovatum*) and Pacific bleeding heart (*Dicentra formosa*) both have seeds that should be sown fresh, rather than drying them.

PHOTO: MARK TURNER

Freezeout Ridge Trail

by Jim Duemmel

The Freezeout Ridge trail has been described in David Giblin's *Douglasia* article, "Late Summer in the North Cascades" (18(3):1, Fall 2014), and in at least one book, *Best Wildflower Hikes, Washington* by Kruckeberg, Sykes, and Romano (The Mountaineers Books, spring 2014). In this article, I supplement those previous reports with some details of the current status of the trail.

The Trail and the Plants



The burned area at the start of the trail, with dead snags and vigorous regrowth of fireweed (*Chamaenerion angustifolium*), willow (*Salix scouleriana*), and lodgepole pine (*Pinus contorta*). PHOTO: JIM DUEMME

The trail is just 2.2 miles long and rises 1,680 feet to the summit of Tiffany Mountain. The first half-mile climbs through an area that burned in 2006. Young lodgepole pines (*Pinus contorta*) and Scouler's willows (*Salix scouleriana*), all about 10 feet tall, numerous tall charred snags, and abundant fireweed (*Chamaenerion angustifolium*) dominate the vegetation. Next the trail winds through a largely unburned area with tall lodgepole and whitebark pines, and only pockets of burned trees and fireweed.

About a mile from the trailhead the path turns south and swings around a prominent rocky knob that is topped by large dead whitebark pine. Now the trail enters a much more open area. Sulphur buckwheat (*Eriogonum umbellatum*) is common here. Downhill to the right is a colony of the high-elevation form of big sagebrush (*Artemisia tridentata*). The trail skirts a barren-looking sandy area to the left. The first glance is deceiving; walking over to it reveals an abundance of the buckwheat look-alike, pussypaws (*Calyptidium umbellatum*).

For the next half-mile the trail traverses an open subalpine area with scattered moderate-sized conifers. This area is ideal for

sharpening your skill at identifying Washington's high-elevation trees: alpine larch (*Larix lyallii*), whitebark pine, Engelmann's spruce (*Picea engelmannii*), and subalpine fir (*Abies lasiocarpa*) are all here. Many of the trees are clustered close around large bedrock outcrops. Why? Is there more moisture around these outcrops? Or better protection from the wind?

Whitebark pine is abundant here, and its caretaker, Clark's Nutcracker, is frequently seen, announcing its presence with raucous calls and flashing white wing and tail patches. The pines appear healthy; I detected no evidence of blister pine rust. *Ribes* species (currant, gooseberry) are the usual alternate hosts for the rust, and one species, sticky currant (*Ribes viscosissimum*), is present but only near the trailhead. If you search under the pines you'll find piles of scales from the pine cones, evidence of the nutcrackers' work, but nary an intact cone.

About one-and-a-half miles from the trailhead and just before you reach a junction with the trail to Whistler Pass, the character of the land changes radically again. The trees, mostly whitebark pine, are dwarfed and widely scattered. The huge bedrock outcrops are replaced by large, moderately spaced boulders of the same type of rock (diorite?). The trail steepens for the final climb to the summit of Tiffany Mountain.

The summit once held a fire lookout, whose only obvious remnant is a vertical pipe. (The end of that pipe is covered by a large old-time orange juice can, rusty and much in need of replacement. If you like to leave your name on the summit of peaks, remove the can and look inside the pipe.) The contrast between the slope you just climbed and the slope you now encounter is stark.



Conifers clustered around, and hiding, a bedrock outcrop. Many flowers shelter in the shade of these trees. PHOTO: JIM DUEMME

The northeast slope of Tiffany Mountain is a cliff: you look down to trees and small lakes 1,000 feet below. Exploring right and left along the ridge will lead to a few breaks in the cliff where, with care, you can descend a few feet. Here, clinging to the cliff face or hiding in cracks in the boulders, you can find plants such as purple saxifrage (*Saxifraga oppositifolia*), spotted saxifrage (*S. bronchialis*), mountain sorrel (*Oxyria digyna*), and



The open, upper part of the trail, looking toward the summit of Tiffany Mountain, with many large boulders and scattered small trees. The two common species are easily distinguished: whitebark pines (*Pinus albicaulis*) have rounded tops; Engelmann's spruces (*Picea engelmannii*) have pointed tops. PHOTO: JIM DUEMMEL

trapper's tea (*Rhododendron columbianum*) that you did not encounter along the trail. Because of its distinctive leaf structure, purple saxifrage is easily noticed even when it isn't in bloom. However, if you want to see it in bloom, plan to visit the area before mid-July. On this trail in June you may find snowshoes useful.

The Freezeout Ridge trail is one on which you'll really want to spend a lot of time off the trail. This is easy to do in the open upper part of the trail, especially as you are descending. You can roam widely, investigating behind boulders and in slight depressions in the ground, spots that harbor slightly more moisture. I've never noticed yellow columbine (*Aquilegia flavescens*) from the trail, but you can find it sheltering beside boulders off the trail. Colonies of white dryas (*Dryas octopetala*) dot the upper slope off the trail. Several species, hard to see from the trail, favor the dappled shade under the clumps of tall conifers lower down. However, in the burned area on the lowest part of the trail, stay on the trail. The numerous charred logs and the dense regenerating vegetation discourage off trail walking.

In its upper reaches, the trail is, as are so many other mountain trails, deeply incised into the turf and sometimes doubled. Roaming off the path here may actually benefit the environment. The trail is popular; on weekends expect to share the trail with hikers and runners, though I have not seen trail bikes on the trail. For solitude, visit on a weekday.

A Contrasting Area

Thirty-five miles to the west of Freezeout Ridge lies the better-known Harts Pass. Comparing the two areas is interesting. Getting to either is roughly comparable in difficulty, except that the road to Freezeout Ridge lacks anything like the quarter-mile, hold-your-breath trip around Deadhorse Point on

the Harts Pass road. The elevations are similar, but Harts Pass is the center of a much larger area with roads and developed campgrounds. On Freezeout Ridge the trail is the only development.

Harts Pass is renowned for the diversity of its flora; the plant list for Freezeout is much shorter. Although the smaller size of the area partially accounts for this, water may be the key to the differences. At Harts Pass, the tributary of Slate Creek that you cross when you travel the road to Slate Peak is a reliable water source even in late summer. The streamlet that runs through the Meadow Campground is smaller and less reliable, but it is there. There are no streams on the Freezeout Ridge Trail and no permanent snowfields. Once the winter's snow cover melts, the water you see is the water you brought with you. National Water and Climate Center (www.wcc.nrcs.usda.gov/) records suggest the Salmon Meadows and Muckamuck, two areas close to Freezeout Ridge but lower in elevation, receive just 45 to 52 percent of the yearly precipitation recorded at Harts Pass. Water does make a difference for plants, and Freezeout Ridge receives much less annual precipitation than Harts Pass.

With or without water, Freezeout Ridge is still a first-class hike for those who want to see mountain plants.

Getting There

The Freezeout Ridge trail is in the Okanogan highlands, northeast of Winthrop. From Winthrop, take the East Chewuck Road north for 6.7 miles, and then turn onto Forest Road (FR) 37. The first 7.4 miles are paved (which is not the same as "smooth"). There is an undeveloped campground on the left (a snowpark in the winter) near the start of FR 37 and several inviting hunters' campsites beside Boulder Creek near the end of the pavement. After the pavement ends, the road becomes washboardy but is easily traveled. Watch out for cattle. After 13 miles on FR 37 turn north onto FR 39, and then proceed 3.4 miles to the trailhead at Freezeout Pass. Along this last stretch of road there is another informal campsite at Rogers Lake.

From the east, to reach the trailhead from Conconully, follow county road 2017 to FR 37, and then to the intersection with FR 39 described above. The trailhead can also be reached from the north by way of a more roundabout route. Along FR 39 four miles north of Freezeout Pass, there is a forest service campground at Tiffany Springs.

You can find a plant list for this trail on the WNPS website.

Jim Duemmel has been a member of WNPS since 1988. He has compiled several plant lists, including one for the Freezeout Ridge Trail.



Scarlet Gilia (*Ipomopsis aggregata*): A Salmon-Like Wildflower

by David Giblin, University of Washington Herbarium, Burke Museum

Ipomopsis aggregata, also known as scarlet gilia, is one of Washington's most spectacular and well-known native plants. The bright red, tubular flowers scattered along flowering stems to nearly a meter tall are a welcomed and common sight in meadows, forest openings, and along mountain roadsides from the Cascades crest eastward. A member of the Polemoniaceae (Jacob's-ladder Family), scarlet gilia has the characteristic combination of five fused petals, five anthers attached to the corolla tube, and a three-parted stigma found in many members of this family.

Scarlet gilia gets its common name from the genus to which it was originally assigned: *Gilia*. For decades taxonomists had placed a rather large number of species in this broadly defined genus on the basis of superficially similar morphological characters. The application of molecular analyses (that is, DNA) to the genus over the last few decades revealed that many of the species assigned to *Gilia* were not closely related. Specifically, the species comprising the genus were found to descend from multiple ancestors (that is, the genus was polyphyletic). In an ideal taxonomic world, all members of a genus descend from a single common ancestor (that is, they are monophyletic). When the dust settled from the molecular analyses, *Gilia aggregata* was placed in the genus *Ipomopsis* and accordingly renamed



Close-up of a flower showing five yellow anthers attached to the top of the corolla tube and the white, three-parted stigma. Note the streaks in the petal lobes. PHOTO: G. D. CARR

Ipomopsis aggregata. The common name remained unchanged because common names have no taxonomic value.

Though scarlet gilia can be found blooming as early as May in some low-elevation sites, for me it is more of a harbinger of summer in the mountains. I typically see it in meadows at middle to subalpine elevations from July until early September. The flowers are really spectacular, and as you probably guessed they are pollinated most frequently by hummingbirds, though

hawkmoths can be important visitors as well. The anthers are located toward the top of the corolla tube (near the base of the petal lobes), so that when hummingbirds and hawkmoths visit they get a dusting of pollen on their beak, base of the proboscis, or forehead. When they burrow into the next flower in search of nectar, some of the pollen gets deposited on that flower's stigma.

What does scarlet gilia have in common with salmon? Like salmon, scarlet gilia plants spend several years acquiring nutrients to support their one and only reproductive event. Dissimi-



Scarlet gilia growing in a dry, open meadow. PHOTO: MARK TURNER

Root Anatomy and Function

by Ellen Kuhlmann, Koma Kulshan Chapter

In elementary school everyone in my class was given a lima bean, which we put in a Mason jar with a moist paper towel. Within a few days, the seed germinated, with white strands of the root growing downward, while a green shoot grew toward the light. This project was my first foray into the world of plant anatomy, a discipline that explores the various types of cells, tissues, and organs of plants. Anatomy differs from morphology, commonly used in plant identification, in that anatomy looks at the mechanics of structure, while morphology focuses on differences in appearance.

Having a basic knowledge of plant anatomy deepens our understanding of how plants function and interact with the environment. Our native species have adapted to a variety of environments, and plant parts like the roots have evolved to help plants thrive under different conditions. Most roots grow in soil and interact with soil organisms as well as the soil particles. Relationships between roots and fungi, called mycorrhizal associations, and nitrogen-fixing bacteria in root nodules are examples of how root structures form cooperative relationships to enhance plant vitality.

By looking at how plant structures are organized, we can glimpse how plants work—how they meet the everyday challenges of living. Roots are a plant's anchor, holding it in place, and through the roots water and minerals are absorbed. Other crucial functions of the root include storage and transport of materials. Roots are considered a plant organ, as are stems, leaves, and flowers. Plant organs have tissues, which are groups of cells that act as a unit. All tissues develop from three basic tissue systems: vascular, ground, and dermal.

Vascular tissue consists of one system to transport mainly water and minerals (xylem), and another for movement of carbohydrates, proteins, and metabolites (phloem). Xylem and phloem are located near each other. In roots the vascular tissue forms a central vascular cylinder. Water, minerals, and chemicals such as plant hormones are moved upward in xylem from the root to the stem, leaves, and flowers. Sugars, produced mainly in the leaves through photosynthesis, are transported through the phloem to the roots.

Xylem is composed of conducting cells called tracheary elements as well as fiber and accessory cells that help the tissue function. There are two types of tracheary elements: tracheids and vessel elements. Both are hollow and dead at maturity. Tracheids are long, narrow cells with tapered ends. Water and minerals pass between tracheids through openings in the cell walls. Vessel elements are short, wide cells, stacked end to end forming a tube. The cell ends of vessel elements are perforated or lacking, forming a more open pipelike system than that of tracheids.

Interesting Fact: The presence of tracheary elements is a defining characteristic that differentiates vascular from nonvascular plants.

lar to salmon in that they don't migrate, they do share a common post-reproduction fate: death. This life history cycle in plants is referred to as monocarpic—the literal Latin translation is “fruiting once.” Monocarpic plants are distinct from annuals (flower, set seed, and die in one year) and biennials (flower, set seed, and die in second year) because they typically live for several years before reproducing and dying. Scarlet gilia plants can live up to 10 years before flowering, though three to five years is likely more common. Other monocarpic plants that you might be familiar with are monument plant (*Frasera speciosa*, Gentian Family) and many species of agave.

Because of its large flowers and monocarpic nature, scarlet gilia has become a commonly studied species (that is, a model organism) by evolutionary and pollination biologists. The large flowers make it easy to measure flower characters and nectar production to correlate with pollinator visitation. That the plants die after flowering allows evolutionary biologists to study how floral traits evolve to maximize pollinator visitation, how plants allocate resources to male (pollen) and female (ovules) function, and the underlying genetic basis for these various traits. Ultimately these scientists are interested in how these factors interact to determine the number of seeds produced by a plant for the next generation (a component of fitness).



Scarlet gilia blossoms. PHOTO: MARK TURNER

On a personal note, scarlet gilia is one of my favorite plants, because it is striking in appearance, common, and widely distributed (British Columbia to California, east to the Rocky Mountains and southern Great Plains). An overlooked aspect of the flowers is the whitish-gold streaking on the petal lobes as they age—be sure to check this out. Crush the glandular foliage and you'll get a skunky smell that can be found in several members of the Polemoniaceae. Collect seeds and grow it in your garden. My wife, Julie, had it growing for several years in our Seattle garden—it would just reseed. Interestingly, due to the relatively nutrient-rich garden soils, many plants flowered the second year.

Scarlet gilia is a beautiful plant with a fascinating life history that is valued by hummingbirds, studied by scientists, and appreciated by gardeners. Don't miss it this summer!

David Giblin manages the University of Washington Herbarium at the Burke Museum, where he studies the vascular plant flora of the Pacific Northwest. He is a regular contributor to Douglasia.



Most gymnosperms (non-flowering seed plants) lack vessel elements and utilize only tracheids to transport water and minerals. Angiosperms (flowering seed plants) usually have both types of tracheary elements.

Interesting Fact: The only gymnosperms with vessel elements are in the monotypic genus *Gnetum*.

Phloem's conducting cells, called sieve elements, are alive at maturity, and as in xylem the tissue also has fibers and accessory cells. The sieve elements of gymnosperms and ferns are sieve cells, long and narrow with pores in the cell walls through which nutrients pass. Angiosperms have sieve tube elements, which are shorter and wider than sieve cells, stacked end to end. The ends have perforations called sieve plates, allowing nutrients to move easily from cell to cell.

Interesting Fact: Recent research by Liesche et al. (2015) shows that gymnosperms have significantly slower rates of phloem transport than do angiosperms. This difference is attributable to the sieve element anatomy found in each group.

The **vascular cylinder** is surrounded by the cortex that is derived from the ground tissue system. The storage of sugars occurs primarily in the cortex in a type of cell called parenchyma. The roots of species such as many desert-parsleys (*Lomatium* spp.) contain large stores of sugars to grow the next year's aboveground parts. Storing excess sugars in roots is an effective way for a plant to survive periods when sugar production is low or absent, such as during the hot, dry summers of the Columbia Plateau's shrub-steppe habitat.

Interesting Fact: Another common name for *Lomatium* spp. is biscuit root, a reference to the practice of digging up the roots and processing them into a type of flour.

The surface of the root, the **epidermis**, is derived from the third type of tissue, dermal. Root epidermis functions mainly to absorb water and minerals from the soil. Near the root tip, root hairs grow outward from the epidermis. They are very small and usually not visible without magnification. Root hairs have absorptive functions and greatly increase the total surface area available for uptake.

Together the epidermis, cortex, and vascular cylinder make up a basic root. The area where the root system meets the plant stem is called the root crown. In herbaceous perennials and in species that resprout after fire, new stems grow from the root crown. Roots grow from the root tip. The root tip is protected by a structure called the root cap, which also helps the root penetrate through the soil.

Interesting Fact: Some plants go years without growing stems or other aboveground structures. One species known to do this is clustered ladyslipper (*Cypripedium fasciculatum*), a rare orchid.

In dicots and gymnosperms, roots are derived from the embryonic root known as the radicle. The radicle grows into the primary root, which over time develops into a taproot.



The roots of Geyer's desert-parsley (*Lomatium geyeri*), with enlarged cortical tissue used for sugar storage. PHOTO: T. ABE LLOYD

Taproots and their branches are called a taproot system. Some species have deep taproot systems, like ponderosa pine (*Pinus ponderosa*), that allow the tree to withstand strong winds and obtain water far beneath the soil surface. Other species such as western red cedar (*Thuja plicata*) have shallow taproot systems and depend on neighboring trees for protection from wind. It is not uncommon to see an uprooted *T. plicata*, its woody roots fanning out in a circular pattern.

Interesting Fact: Roots often exhibit positive geotropism, a natural inclination to grow in accord with the pull of gravity, downward into the earth.

In monocots like grasses the primary root is short-lived, replaced by roots that grow from stem tissue. This type of root is called a fibrous root system. Fibrous systems form dense networks of thin roots and can absorb water close to the soil surface quickly, which is advantageous in arid environments. Fibrous roots can arise from the basal portion of an erect stem and from specialized horizontal stems such as stolons, which grow above the ground, and rhizomes, which are underground.

There is much more to learn about root anatomy and functions than can be covered in this primer.

Ellen Kuhlmann has worked for the US Forest Service and Rare Care, and joined WNPS in 1995. She studied fire ecology at Western Washington University and is coauthor of Trees and Shrubs of the Pacific Northwest. She is a regular contributor to Douglasia.

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Book Review

Olympic National Park: A Natural History

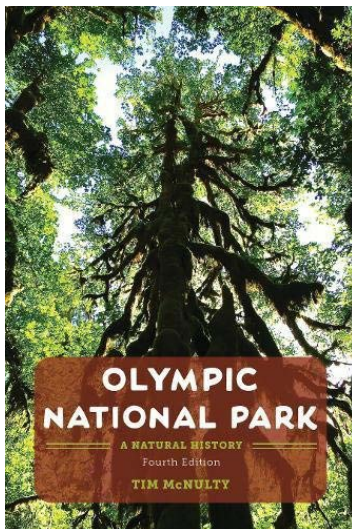
by Tim McNulty

Fourth edition, University of Washington Press, 2018

Paperback, 352 pages

reviewed by Fred Weinmann

I regard Tim McNulty as the poet laureate of the Olympic Peninsula (OP). He is also a superb observer of natural history and a knowledgeable scientist. This combination of traits is showcased in his book *Olympic National Park: A Natural History*, fourth edition. The passage of nine years between editions is important. Some things change and some things not so much. For example, while we may learn more about geological processes, the appearance of geological features remains constant. The same can be said for biological processes. The trees are about the same size, the flowers are just as beautiful, and the food webs remain constant. However, human actions and activities have resulted in major changes along with our knowledge of their impacts and implications. As for the poetry, here is how



McNulty describes the naming of Mount Olympus in 1788: “Remote and hidden behind a retinue of ridges and peaks, the mountain struck the captain as a suitable dwelling place for the Gods of this new land, and he named it Olympus . . .”

The author’s writing and communication skills are reflected early in the book. The first section, “Shuffled Texts of Stone,” reveals the author’s artistry. If you are not a geologist by training, the book is worth purchasing for this section, which provides a coherent description of the origin of the OP, its mountains, and its rivers. Subsequent chapters, equally well expressed, describe the features and processes associated with the rivers, the rain forests, and the old growth forests, illustrating the sometimes dramatic differences between the eastern and western sides of the OP. And also the equally dramatic changes in ecological processes and species present with the change in altitude from sea level to alpine habitats.

At its core, this book is about ecological and geological processes rather than a field guide for identifying plant and animal species. Early in the book McNulty tells us about the 11 endemic plant taxa and how the ancient geology of the OP fostered the conditions for them. Later, he describes the mountain meadow community and concludes that the showy sedge communities are not only the most productive of the subalpine communities, but also “form the heart” of the habitats that the Olympic marmot prefers.

Fourth Edition: New Features

Several dramatic changes have occurred on the OP since publication of the third edition. From a big picture perspective the issue of climate change is front and center. Dramatically receding glaciers are described in some detail. This, of course, sets in motion repopulation by plants and habitation by animals, and eventually could seriously impact OP water supplies.

Perhaps the most biologically important project on the OP has been the removal of the two dams on the Elwha River. While salmon are the main focus of the project, the action also created hundreds of acres of newly exposed terrestrial and riparian habitat. The history and outcome of this huge project is described along with the restoration work including planting of several hundred thousand native plants.

Two other projects have impacted the OP’s biological landscape. Fishers have been reintroduced, and more important botanically, the National Park Service (after 20-plus years of waffling) has apparently committed to removing the mountain goats from the park. This latter action has particular relevance to native plants, because goat foraging and trampling has had significant impacts on native plant communities in some areas. The author has been an effective activist on the mountain goat issue, and this edition provides lucid up-to-date descriptions of these activities.

The book’s concluding section provides a history of human occupation on the OP. The activities and relations of people to the plants and animals of the peninsula are described, from the arrival of first peoples right up to modern times. The section also details the history of the park’s formation, the challenges of maintaining the park’s integrity, and needed additions to protect the park in the future.

The book is highlighted with over 30 color photos by Keith Lazelle, a superb natural history photographer who lives on the OP. The photos have been updated to include a dramatic scene of the Elwha River flowing through a newly demolished section of the Glines Canyon Dam. Also, most of the over 20 black-and-white photos used to illustrate the text are the work of Janis Burger, a long-time active member of the Washington Native Plant Society (and also a long-time excellent photographer).

Obligatory nitpicks: The book is inconsistent with respect to inclusion of scientific names. This is understandable as a litany of scientific names can severely disrupt the flow of the text. Scientific names are included in the species lists following the main text. Also, of all the plant and animals of the park, the shorebirds did not receive much attention even though several species are referred to on page 173.

The book’s popularity is evidenced by the need for a fourth edition in the space of just 20-plus years. If you live here, plan to spend some time in Olympic National Park, or are interested in the natural history of the Pacific Northwest, you will enjoy the book and retain it as a reference source.



Conservation Advocacy: Olympic National Park

by Becky Chaney, WNPS Conservation Committee Chair

The mission of the National Park Service is to preserve “unimpaired the natural and cultural resources and values of the national park system for the enjoyment, education, and inspiration of this and future generations.” For years, WNPS has been arguing that the protection of Olympic National Park’s ecologic integrity and preservation of its irreplaceable alpine and sub-alpine plant communities from its introduced mountain goat (*Oreamnos americanus*) population is integral to upholding this mission. Mountain goats threaten rare and endemic plant species, including Piper’s bellflower (*Campanula piperi*), Olympic Mountain milk-vetch (*Astragalus australis*), Olympic Mountain ragwort (*Senecio neowebsteri*), mosses, and liverworts.

Following a lengthy, well-informed public process, the Olympic National Park management has prepared a Mountain



Mountain goat (*Oreamnos americanus*). PHOTO: MARK TURNER

Goat Management Plan that should eliminate the threat to the park’s native plants that the mountain goats pose. The final plan is intended to result in a zero population level of mountain goats in the park and adjacent Olympic National Forest lands. It recognizes that mountain goats threaten visitor safety and damage the unique vegetation of the Olympic Mountains. Project implementation could start as early as June of this year. Possibly before publication of this article!

WNPS members have written individual and collective letters, attended meetings, and shared knowledge of the science that supported this decision. Member interest and advocacy guided WNPS efforts supporting removal of the mountain goats. This work should now pay off in long-term protection of the unique plants and habitats that exist within Olympic National Park. Congratulations!

Becky can be reached via e-mail at becky@chaney.org. She is always happy to hear your conservation interests and concerns. Please include “WNPS Conservation” in the subject line.



WNPS Implements Mentzelia and Outstanding Partner Awards

by Van Bobbitt, Central Puget Sound Chapter

WNPS has implemented two annual awards, the Mentzelia Award and the Outstanding Partner Award, to recognize people and organizations that have made exceptional contributions to native plant conservation, research, or education. The Mentzelia Award goes to a WNPS member who, through his or her work with WNPS, has made a significant contribution in these areas. The Outstanding Partner Award is presented to an agency, individual, or organization that has made a significant contribution throughout Washington. Van Bobbitt, WNPS vice-president, presented the 2018 awards at the recent WNPS Study Weekend in the Columbia Gorge.

Bill Brookreson, current chairperson for the South Sound Chapter, received the **Mentzelia Award**. His decades-long commitment to WNPS includes overseeing several successful plant sales for the South Sound Chapter, teaming with the Suksdorfia Chapter to sponsor Study Weekend 2018, and serving as chair of the Stewardship Steering Committee, providing oversight of the WNPS Statewide Stewardship Pilot Program. In addition, he continues to work in restoration, as a seasoned Master Native Plant Steward at South Seattle’s Deadhorse Canyon, providing thousands of hours of service.



Bill Brookreson, Mentzelia Award winner, at the 2018 WNPS Study Weekend. PHOTO: MARK TURNER

The **2018 Outstanding Partner Award** was given posthumously to the late Sarah Reichard. The award was accepted by her husband, Brian Reichard. Sarah, who passed away in 2016, earned her bachelor’s, master’s, and PhD degrees at UW. She was a faculty member in the School of Environmental and Forest Resources at UW and, from 2011 until her death, director of the UW Botanic Gardens.

Her work focused on invasive species evaluation and rare plant conservation. She co-authored numerous reports on invasive species and conservation practices, and wrote the popular book *The Conscientious Gardener: Cultivating a Garden Ethic*. Under her guidance, she expanded the role of the UW Botanic Gardens’ role in K–12 education and mentored young women entering the field. She also founded and served as director of the Washington Rare Care and Conservation Program.



The late Sarah Reichard, Outstanding Partner Award winner, holding a copy of her book *The Conscientious Gardener*. PHOTO: BARRY LATTER



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Mount Rainier from Paradise with lupines and paintbrush (*Castilleja parviflora* var. *oreopola*, *Lupinus latifolius* ssp. *subalpinus*). PHOTO: MARK TURNER