

Forest Understory Plants and Climate Change in the Morrell Nature Sanctuary

Introduction

In a previous paper (Misc. paper No. 5), the potential impact of climate change, particularly in relation to moisture stress, on two dominant tree species in the Morrell Nature Sanctuary, Coastal Douglas-fir and Western Red Cedar, was examined. While Western Red Cedar has been shown to be somewhat prone to low moisture levels, it was concluded that both species are generally fairly resilient and expected to remain as part of the forest ecosystem at the sanctuary for the foreseeable future.¹

According to climate projections for the regional district of Nanaimo (RDN) it is predicted that with continued high global emissions of carbon dioxide, the region can expect: hotter summer temperatures, with more extreme heat days and heatwaves; warmer nights and a longer growing season; warmer winter temperatures and less days with ice or frost; less rain and more dry days in the summer months; more precipitation in fall, winter, and spring; more precipitation falling as rain instead of snow; and more rain delivered in extreme rainfall events.² Most of the RDN has a Mediterranean-like climate that is home to a variety of ecosystems, including Douglas Fir, Garry Oak, wetlands, alpine, and shorelines. Because ecological systems are highly complex, it is difficult to make specific predictions about how they will be impacted by climate change. The speed and scale of the projected changes may exceed the adaptive capacities of many species. Specialist species may be particularly vulnerable, resulting in a decline in regional biodiversity and creating new opportunities for invasive species to thrive. In the summer, hotter and drier conditions will continue to stress trees and other terrestrial and riparian vegetation, especially for species that are sensitive to drought such as Western Red Cedar. Drought conditions can also slow the decomposition of bacteria, fungi, and other soil organisms, and decrease the availability of nutrients, adding further stress to certain species. Stressed plants may become more vulnerable to competition with other species, including damage from insects and diseases. Generally, species are expected to migrate northward and into higher elevations with the changing climate.

Because forests naturally operate on long ecological timelines, mature trees shift their geographic ranges and adapt to changing climates significantly slower than understory vegetation. Since they are already established, their populations can lag behind rapid climate changes by one to two centuries, making migration incredibly slow.³ Ecological systems have inertia, much of it due to “priority of place”. Established plants are not easily displaced by new arrivals, even if the climate has become suboptimal for them. Superior competitors will eventually prevail but they may need to wait for a window of opportunity provided by the mortality of existing plants. This may take decades in forest systems. The paleoecological record shows that all of our species, including those with low apparent dispersal ability, were able to shift ranges across vast distances. In some cases, Canadian species took refuge as far south as the southern US during glacial periods.⁴ It is also apparent that all current species, including habitat specialists and endemic species, have the flexibility to persist under novel conditions. It has been suggested that changes in species composition due to climate change will generally follow the trajectories described by bioclimatic envelope models, but the projected equilibrium conditions will not be reached until well into the next century, or beyond. In the meantime, novel transitional ecosystems will dominate.⁵

Given the disparity between tree migration and that of the understory species, it may be worth examining the distributional range of common understory species at the Morrell Nature Sanctuary. In

this report, the geographical distribution of 11 shrubs and 26 herbs established in the sanctuary are reviewed to determine if these species may be “pre-adapted” to more southern climates and therefore potentially able to persist on Vancouver Island as the climate changes.

Geographical Ranges of Common Shrubs found in the Sanctuary

Arctostaphylos columbiana (hairy manzanita) is distributed along the Pacific Coast of North America, ranging from Sonoma County, California, north through Oregon and Washington to Vancouver Island and the Vancouver area in British Columbia. It prefers dry, rocky slopes and open forests at low elevations, largely west of the Cascade crest. In British Columbia, the species is confined to the southern portion of Vancouver Island and areas just north of Vancouver, typically within the Coastal Douglas-fir (CDF) zone. In Washington, it is common in the Puget Lowlands, the Columbia River Gorge, and the northern/eastern Olympic Mountains. Oregon has extensive populations, particularly in the southwestern part of the state and the western slopes of the Cascades. In California, this shrub extends through the Coast Ranges down to Sonoma County. Hairy manzanita is primarily found below 2,500 feet (762 m) in California, but up to 4,950 feet (1,500 m) in Washington. It prefers sunny, dry, well-drained, acidic sites, often on rocky, gravelly, or sandy soils, and is often found in successional coastal shrub communities and open-canopy coniferous forests.

Gaultheria shallon (salal) is a native, evergreen shrub dominant in the coastal understory of western North America, ranging from Alaska down to California. It primarily thrives west of the Cascade Mountains, from sea level to mid-elevations, but is also naturalized in parts of Europe, including the UK and Ireland. The northern limit of salal is southeastern Alaska (including Baranof Island) and the Alaska Panhandle. It's core range includes coastal areas of British Columbia, Washington, Oregon, and California (extending as far south as Santa Barbara County). The plant's inland range extends mainly west of the Cascade Crest in Washington and Oregon, extending into the Coast Ranges. Salal is common in coniferous forests, coastal woods, rocky knolls, and bluffs.

Holodiscus discolor (oceanspray) is native to western North America, ranging from southern British Columbia south to California and Mexico, and east to Montana, Colorado, and Texas. It is widely distributed in mountainous and coastal regions, flourishing in sunny, open forests, disturbed areas, and rocky slopes. In Canada, it is common in southern British Columbia, including the coast and Vancouver Island. In the United States, oceanspray is found in Washington, Oregon, California, Idaho, Montana, Nevada, Utah, Wyoming, Colorado, and Arizona. The shrub is very common in the Pacific Northwest, particularly on both sides of the Cascade crest. It occurs from sea level on coastal bluffs up to 10,500 ft (3,500 m) in interior mountain ranges. It thrives in Douglas-fir forests, oak woodlands, chaparral, and edge habitats. The plant is often found in disturbed sites, such as logged or burned areas, and along roadsides, and prefers well-drained, rocky to gravelly soil.

Mahonia nervosa (dull Oregon grape) is native to western North America, ranging from British Columbia south through Washington and Oregon to central California, and east into Idaho and Montana. It is predominantly found west of the Cascade and Sierra Nevada Mountains, typically in coniferous forests and open wooded areas. The shrub prospers in dry to moist, shady coniferous forests and open woodlands, and is frequently found in Douglas-fir forests. It grows from low to middle elevations 6000 ft (0–1800 m). It is abundant throughout its range, and is particularly common along the coast. *Mahonia nervosa* acts as an understory dominant in various forests and is often found in second-growth forests.

Oemleria cerasiformis (Indian plum or osoberry) is native to western North America, distributed along the Pacific Coast from southwestern British Columbia through Washington and Oregon to California, primarily west of the Cascade and Sierra Nevada Mountains. It is found as far south as Santa Barbara County, California. This shrub is primarily found at low elevations (below 250 m), though it can occur up to 1,700 m in the southern part of its range. It is commonly found in moist to moderately dry open woods, stream banks, ravines, and along roadsides. It is highly common on the west side of the Cascades and along the coast. Osoberry is often found in Douglas-fir forests and Oregon white oak woodlands. It is known for being the first deciduous shrub to bloom in the Pacific Northwest, typically blooming in early spring (February–April).

Rubus parviflorus (thimbleberry) is a widespread native shrub found throughout western North America, ranging from Alaska down to California and Mexico, and east to the Rocky Mountains, with distinct, disjunct populations in the Great Lakes region. It proliferates in diverse habitats including coniferous forests, riparian areas, and disturbed sites, often forming dense thickets at low to subalpine elevations. The primary range spans from Alaska (coastal southeast), through British Columbia, Alberta, Washington, Oregon, Idaho, Montana, and down to California (as far south as San Diego County), Nevada, Utah, Arizona, and New Mexico. It is also found east of the Rockies, including populations in the Black Hills of South Dakota and scattered locations around the Great Lakes (Ontario, Michigan, Minnesota). Thimbleberry is frequently found in shady, moist areas on the edge of woodlands, forests, and stream banks, but can also grow in disturbed areas like roadside clearings and logging areas. It occupies a wide elevation range, from sea level in the north to subalpine areas, up to 3,000 meters in the southern part of its range.

Rubus spectabilis (salmonberry) is native to the Pacific Northwest, with a distribution stretching from west-central Alaska, through British Columbia, and down to the California coast, extending inland to Idaho. It thrives in moist, shaded environments, including riparian areas, forests, and wetlands, often forming dense thickets at low to subalpine elevations. The shrub is primarily found on the western slope of the Cascades and is predominant in the Georgia Depression and the Coast and Mountains ecoprovinces of B.C. Salmonberry flourishes in dappled shade, moist woods, swamps, and along streambanks. It typically grows in areas below 1,400 m. This plant is often dominant in early-seral communities and acts as an indicator of wet, nitrogen-rich soils.

Rubus ursinus (trailing blackberry) is native to western North America, ranging from British Columbia south to California and Baja California, and east to Montana and Idaho. It is most common in the Pacific region west of the Cascades, favoring disturbed areas, forest edges, and coastal sites. The key distribution range includes British Columbia (Canada), Washington, Oregon, Idaho, Montana, California, Arizona, and Baja California (Mexico). It is primarily found in the Pacific Northwest and California, spanning from the coast to middle elevations in the mountains. Trailing blackberry proliferates in open to dense forests, woodland margins, shrublands, canyon bottoms, and riparian zones. It is often found in disturbed sites, logged areas, and on areas that have burned. It generally occurs at low to middle elevations, often below 3,000 ft, though it can grow higher. *Rubus ursinus* is notable for being the only native blackberry in many parts of its range, including coastal British Columbia.

Spiraea douglasii (Douglas spirea or hardhack) is native to western North America, ranging from Alaska south to California and east to Montana. It is widely distributed along the Pacific coast and in the Pacific Northwest, frequently found in moist habitats like wetlands, streambanks, and bogs, often forming

dense thickets. Its range includes British Columbia, Alaska, Washington, Oregon, California, Idaho, Montana, with some occurrence in Colorado. Hardhack thrives in wet areas including marshes, swamps, bogs, and stream banks, and prefers sunny to partially shaded, wet to seasonally damp locations. It is an erect, deciduous shrub reaching up to 2 meters (6-8 feet) in height, spreading via rhizomes to form large colonies. Two main subspecies exist in British Columbia: *Spirea douglasii* subsp. *douglasii* (coastal, gray-woolly leaves) and *S. d.* subsp. *menziesii* (interior, less woolly).

Symphoricarpos mollis (creeping snowberry) is a native, low-trailing shrub widely distributed across western North America, ranging from southern British Columbia, Canada, south through Washington, Oregon, and California to New Mexico. It is most common in coastal chaparral, mountain slopes, and woodlands, often in dry, shady areas. It is also found in Nevada and Idaho. Trailing snowberry is typically found in California on the coast, in the Sierra Nevada, and within chaparral ecosystems. It is also prevalent on southeast Vancouver Island, the Gulf Islands, and the lower Fraser Valley in British Columbia. The shrub grows from sea level up to roughly 9,000–9,840 ft. in woodlands, along stream banks, and on north-facing slopes. It is frequently found along forest edges and in shaded or partially shaded areas.

Vaccinium parvifolium (red huckleberry) is native to the Pacific Coast of North America, ranging from southeastern Alaska through British Columbia, Washington, and Oregon to central California. It is primarily found in coastal regions west of the Cascades and Sierra Nevada mountains in low-to-mid elevation moist coniferous forests. It is predominant in western BC, coastal Washington, and Oregon, extending to the California Coast and Sierra Nevada. Red huckleberry flourishes in moist, shaded conifer forests, particularly in openings and on edges, often found at low to middle elevations. A notable feature is its preference for growing on nurse logs, decaying wood, and old tree stumps.

Geographical Ranges of Common Herbs found in the Sanctuary

Achlys triphylla (vanilla-leaf) is native to the Pacific Northwest of North America, ranging from southern British Columbia, Canada, south through Washington and Oregon to northwestern California. It is found in moist-to-mesic, shady, coniferous forests and along streambanks at low to middle elevations (up to 1,500m). It is found primarily west of the Cascade Mountains, frequent in southwest British Columbia (including Vancouver Island), Washington, Oregon, and Northern California. Vanilla-leaf prefers deep shade to partial shade, often in forests with high organic matter, usually associated with sword ferns, trailing blackberry, and red huckleberry. It is typically found from sea level up to 1,500 meters (4,900 ft). It is very common and widespread in the coastal Pacific Northwest, forming extensive carpets in understories.

Claytonia perfoliata (miner's lettuce) is native to western North America, ranging from Alaska and British Columbia south to Guatemala and east to the Rocky Mountains (including AZ, CO, MT, SD, UT, WY). It is most common in California's Sacramento and northern San Joaquin Valleys, preferring shady, moist, and disturbed areas. Key distribution areas are western North America, predominantly coastal and mountain regions from Alaska through British Columbia down to Baja California. Eastern limits extend to South Dakota, Colorado, and Arizona. Miner's lettuce prefers cool, damp, shaded sites, such as woodlands, forest openings, and canyons, often in sandy or disturbed soil. It is typically found at low to middle elevations (e.g., below 6,500 feet in California).

Claytonia sibirica (Siberian miner's lettuce or candy flower) is native to Siberia, eastern Asia, and western North America, ranging from Alaska to California and east to Montana. It is highly common in the Pacific Northwest, particularly in moist, shady, and low-elevation habitats, and has been naturalized in parts of Europe, such as Britain. In North America this introduced species is found along the coast and inland, including Alaska, British Columbia, Washington, Oregon, California, Idaho, and Montana. Siberian miner's-lettuce inhabits shady, damp woods, streambanks, marshes, alder thickets, and in the understory of coniferous forests. The plant thrives in moist, often sandy or acidic soil, forming patches in shaded, riparian environments. It may be found primarily in the lowland and montane zones, up to 2000 meters.

Collinsia parviflora (small-flowered blue-eyed Mary) is broadly distributed across western and northern North America, ranging from Alaska and the Yukon south to California and Arizona, and east to Ontario, Michigan, and Colorado. It is a common annual herb often found in moist to dry, rocky or grassy, open habitats. In Canada, this herb is widespread in British Columbia, and present in Alberta, Saskatchewan, Manitoba, Ontario, and Yukon. It occurs throughout the western U.S. and Mountain West, including Alaska, Washington, Oregon, California, Idaho, Montana, Wyoming, Colorado, Utah, Arizona, New Mexico, Nevada, South Dakota, Nebraska, and as far east as Michigan, Pennsylvania, and Vermont. Blue-eyed Mary may be found from lowlands to subalpine altitudes (up to 3,500 m), often in rocky, sandy, or disturbed soil. It is particularly known for blooming on vernal moist slopes and understory areas in early spring (March–July). It is often found in large, dense groups and is considered one of the most wide-ranging species in the *Collinsia* genus.

Collomia heterophylla (vari-leafed collomia) is native to western North America, ranging from British Columbia south to California and east to Idaho. It is most common west of the Cascade Mountains in Washington and Oregon, typically situated in moist, shaded to open wooded areas, rocky slopes, and along stream banks. In Canada, the species is prevalent in southern British Columbia, particularly on Vancouver Island, adjacent coast, and lower Fraser Valley, and in the United States it is present in California, Idaho, Oregon, and Washington. Vari-leafed collomia does well in forest openings, disturbed sites, and gravelly areas at low to moderate elevations.

Dicentra formosa (Pacific bleeding heart) is native to western North America, with a distribution ranging from southern British Columbia, Canada, south through Washington and Oregon to central California. It is primarily found west of the Cascades crest and in coastal mountains, thriving in moist forests and streambanks. It is common in southwestern British Columbia, Washington, Oregon, and California. This plant is a rhizomatous perennial that forms dense, fern-like colonies, preferring cool, moist, shaded areas, including coniferous forests, streambanks, and woodlands from low to mid-elevations. Subspecies *Dicentra formosa* subsp. *formosa* is found throughout the entire range, from British Columbia to California, while *Dicentra formosa* subsp. *oregana* is restricted to specific serpentine soils in the Siskiyou Mountains of southern Oregon and northern California.

Erythronium oregonum (white fawn lily) is native to western North America, distributed from southwestern British Columbia (including Vancouver Island and Gulf Islands) south through Washington and Oregon to northern California. It primarily grows west of the Cascade Range in coastal mountains, lowlands, prairies, and open, rocky woodlands. This herb thrives in dry to moist meadows, rocky knolls, and open woodlands (often under Garry Oak) at elevations from 0–1800 meters. While it can grow at higher elevations, white fawn lily is most prevalent in low-elevation forested areas. It is frequently found

in open-canopy forests with well-drained soils and is particularly known for its dense colonies in the Pacific Northwest.

Geum macrophyllum (large-leaved avens) is a native perennial with a broad distribution across North America, ranging from Alaska through all provinces in Canada to the northeastern US, and south to California and New Mexico. It prefers moist to wet habitats, including meadows, forests, and stream banks, at low to subalpine elevations, often appearing in areas with fluctuating groundwater. Large-leaved avens is a shade-intolerant plant frequently found in disturbed soils or open-canopy forest, abundant on nitrogen-rich soils. Subspecies *Geum macrophyllum* subsp. *macrophyllum* (round-lobed) is typically found west of the Coast-Cascade Mountains, while *Geum macrophyllum* subsp. *perincisum* (coarsely toothed) is generally found east of the Coast-Cascade Mountains. This plant is frequently considered a weed in disturbed sites.

Lysichiton americanus (skunk cabbage) is native to wet, swampy habitats along the Pacific coast of North America, ranging from Alaska (Cook Inlet) south through British Columbia, Washington, Oregon, and California (Santa Cruz County), with inland populations in Idaho, Montana, and Wyoming. It is very common west of the Cascade Mountains. It prevails in low-to-mid elevation forests, bogs, and marshes, and is often found along streams, in swampy areas, and wet forests. Skunk cabbage prefers very wet to submerged soils and can tolerate both sun and shade.

Lysimachia latifolia (broad-leaved or Pacific starflower; aka *Trientalis latifolia*) is a native Pacific Northwest understory plant. Its distribution spans the western coast and mountainous regions of North America, stretching from southern Alaska and Yukon down to California, and extending eastward to Idaho and Montana. It is predominant in southwestern British Columbia (including Vancouver Island). The species is also found in localized parts of the British Columbia interior, Alberta, and a disjunct population in the Yukon. In the United States, starflower is native and widespread across Washington, Oregon, Idaho, and California. It extends into Nevada and has scattered occurrences further inland. The plant does best in the lowlands and montane zones as part of the understory in moist to mesic coniferous forests, mixed woodlands, and riparian margins. It flourishes in deep, shaded soils rich in organic matter and leaf mould. This herb is usually found within Douglas-fir forests, often appearing in open, shady, or disturbed sites.

Mimulus alsinoides (chickweed monkeyflower) is native to western North America, distributed from British Columbia through Washington and Oregon to northern California. It occurs in the Cascades, the Columbia River Gorge, southern Vancouver Island, the Gulf Islands, lower Fraser River, and the Klamath Mountains, thriving in vernal moist, mossy, and shady rock ledges, cliffs, and seeps at low to lower montane elevations.

Montia parvifolia (small-leaved montia) is native to western North America, with a distribution ranging from Alaska south through British Columbia and southwestern Alberta, extending through Washington, Oregon, Idaho, and Montana to California. It prefers moist to wet areas, including streambanks, wet mossy rocks, cliffs, talus slopes, and forest floors, and is found from sea level up to 2,800 meters. Small-leaved montia often forms mats, utilizing stolons and easily detached bulblets to spread.

Osmorhiza berteroi (mountain sweet-cicely) has a broad, amphitropical distribution, native to forested regions of western North America, eastern Canada, the Great Lakes, and temperate South America. It ranges from Alaska south to California and New Mexico, and east to New England, thriving in thickets, moist coniferous and hardwood forests, and shaded mountain slopes, often at elevations from near sea level to 2,800 meters.

Polystichum munitum (sword fern) is native to western North America and very abundant in coastal forests, stretching from southeastern Alaska down through British Columbia, Washington, Oregon, and California, extending into Mexico. Inland populations reach Idaho, Montana, and South Dakota. In the Pacific Northwest it is a foundational understory plant. It dominates the floors of moist coniferous and redwood forests, growing everywhere from sea level up to mid-elevations in the mountains.

Prunella vulgaris (self-heal) is a widely distributed perennial herb native to temperate and tropical regions of Europe, Asia, North Africa, and much of North America. Due to its adaptability, it is found globally in moist disturbed areas, gardens, and roadsides, often acting as an introduced species in Australia, New Zealand, and Hawaii. In North America, self-heal is present throughout most of the continent, including all 50 US states and most Canadian provinces. It prevails in habitats ranging from forest edges to disturbed meadows. It prefers moist, open areas, including lawns, road banks, forest edges, and pastures, and is known to grow in both basic and neutral soils, often spreading via stolons to form dense mats.

Tellima grandiflora (fringecup) is native to western North America, ranging from Alaska through British Columbia, Washington, Oregon, and Idaho to California. It is abundant in moist, shaded environments like forests, streambanks, and coastal habitats. The species is very common west of the Cascades crest in Washington and British Columbia, where it colonizes moist coniferous forests, riparian zones, and shady sites, typically below 5,000 ft (1,500 m). It has been introduced and naturalized in parts of Europe, including Great Britain and Ireland. While secure in the west, fringecup is listed as critically imperiled in Alberta. It is a resilient, clump-forming perennial known for its preference for cool, shaded, and damp areas.

Tiarella trifoliata (foamflower) is a native perennial herb widely distributed in western North America, ranging from Alaska south to California and east to Alberta, Montana, and Idaho. Foamflower is common throughout British Columbia (south of 58°N) and in western Alberta, while in the US it is found in Alaska (including the Aleutian Islands), Washington, Oregon, Idaho, Montana, and California (coast ranges). It is predominant in moist, shaded woods, stream banks, and coniferous forests, often present at low to middle elevations. The herb typically grows in moist coniferous forests (Sitka spruce, western redcedar). There are three varieties of foamflower: *Tiarella trifoliata* var. *trifoliata* occurs mostly west of the Cascades and is abundant in BC and Alaska; *Tiarella trifoliata* var. *unifoliata* is found on both sides of the Cascades up to subalpine zones, extending to Montana; and *Tiarella trifoliata* var. *laciniata* has a smaller range, found in select areas of Washington, Oregon, and BC. The species is known for its shade tolerance and affinity for wet-to-moist nutrient-rich soils.

Trillium ovatum (western trillium) is the most widespread trillium in western North America, ranging from British Columbia and southwestern Alberta south to central California, and east to Montana, Wyoming, and Colorado. It is common along the Pacific coast from BC through Washington, Oregon, and down to Monterey County in California. Small, isolated populations exist in Wyoming and Colorado. It thrives in moist, coniferous, and mixed forest understories at low to mid-elevations, frequently

appearing on stream banks. Western trillium prefers shady, moist woods, riparian areas, and coniferous forests, often under redwoods or in Douglas-fir and hemlock forests.

Viola glabella (stream violet) is a perennial herb native to western North America, with a distribution extending from Alaska south through British Columbia, Washington, Oregon, and Idaho to California, and east to Montana. It is common in British Columbia (south of 56°N), Washington (both sides of the Cascades), and the Sierra Nevada mountains in California. It favours moist, shaded environments, particularly along streams, in marshes, and in wet coniferous forests. The preferred habitat is cool, moist, nitrogen-rich soils. Stream violet is often found at low to middle elevations, but can also be found in submontane to subalpine zones.

Geographical Ranges of Non-photosynthetic plants found in the Sanctuary

Allotropa virgata (candystick) is a non-photosynthetic wildflower found in the western United States and Canada, with a primary range from British Columbia, Canada, south through the Cascade Range and Sierra Nevada of Washington, Oregon, and California. It is also found in Idaho, Nevada, and Montana, often at elevations from 75 to 3000 meters. It is concentrated primarily west of the Cascades crest in Washington and Oregon, and the coastal ranges of California. Separate populations exist in Idaho and Montana. In British Columbia, the plant is present in extreme southwestern parts and is generally rare. Candystick thrives in deep, moist humus of coniferous or mixed forests. Its distribution is directly tied to the presence of matsutake mycelium (often associated with *Abies* or *Pinus* species) upon which it depends. It is found in both low-elevation forests and subalpine areas. The plant appears in early to mid-summer, featuring distinct red-and-white striped stalks.

Boschniakia hookeri (Vancouver groundcone) is a parasitic plant native to the Pacific coast of North America, ranging from British Columbia to northern California. It occurs on southern Vancouver Island, the Gulf Islands, and rarely on the Queen Charlotte Islands (Haida Gwaii) in British Columbia. The plant is present west of the Cascades crest in Washington, along the Puget Sound, and outer coasts, while in Oregon and California it extends south through coastal regions. It primarily inhabits moist, low-elevation coastal coniferous forests, specifically parasitizing *Gaultheria shallon* (salal). Vancouver groundcone prefers shady, moist to mesic forests, often found along forest edges, in wooded areas, and in meadow openings. It is a holoparasite, relying entirely on the roots of salal for nutrients. It is locally common in specific, suitable coastal habitats from low to moderate elevations.

Calypso bulbosa (fairy slipper) has a circumboreal distribution across the northern hemisphere, found in North America, Europe, and Asia. It thrives in cool, moist coniferous or mixed forests with deep humus, often in shady environments, ranging from Alaska across Canada to Newfoundland, and south to California, Arizona, New Mexico, and the Great Lakes region. There are two varieties: *Calypso bulbosa* var. *occidentalis* occurs in western North America from Alaska to Northern California, particularly west of the Cascade Mountains, and *Calypso bulbosa* var. *americana* is found across North America, typically east of the Cascades, stretching toward the Great Lakes and New England. This species prefers cold, damp coniferous woods, often in sphagnum moss or thick humus.

Corallorhiza maculata* var. *maculata (spotted coralroot) is widely distributed across North America, ranging from Alaska and Newfoundland in Canada, south throughout the United States, including the Appalachian Mountains, and down the west coast of North America to California, Arizona, New Mexico, and parts of Mexico and Guatemala. In the west it is commonly found on both sides of the Cascade crest, ranging from British Columbia down to southern California. It thrives in coniferous, deciduous, and mixed forests. Spotted coralroot is a mycoheterotrophic plant (non-photosynthetic) found in moist to dry forests, preferring areas with low herbaceous cover. This orchid is generally considered globally secure, although it can be rare in some areas.

Corallorhiza maculata* var. *ozettensis (Ozette coralroot) is a rare, unspotted variety of spotted coralroot with a narrow distribution centered on the Pacific Northwest coast. It is found on the Olympic Peninsula of Washington (first discovered near Lake Ozette), Whidbey Island, and coastal British Columbia, including Vancouver Island. It is primarily restricted to the northwest corner of the Olympic Peninsula in Washington state, with occurrences extending to coastal British Columbia and Vancouver Island. It inhabits moist to dry, low-elevation sites, and often coniferous forests. Unlike the typical *Corallorhiza maculata* which has red-spotted lips, the Ozette variety is typically completely white or yellowish and lacks purple spots. It is generally the last of the *Corallorhiza maculata* varieties to bloom, often appearing when others are finishing. It is red-listed and considered rare in British Columbia.

Monotropa uniflora (Indian pipe or ghost pipe) is widely distributed across North America, Central and South America, and East Asia, thriving in deep-shaded, moist forests. In North America, it ranges from Alaska to California and east across Canada and the US to Florida, though it is largely absent from the Rocky Mountains and central Plains. In Canada, ghost pipe is widely distributed in all provinces, but is not considered common or in high abundance due to its specific environmental needs. Specifically located in rich, decaying, and moist forested soil, often associated with beech and pine trees and specific mycorrhizal fungi (*Russula* and *Lactarius*).

Pterospora andromedea (pinedrops) is a non-photosynthetic, parasitic plant widespread across North America, ranging from Alaska south to Mexico and across Canada to the northeastern US. It is common in western conifer forests but rare in the east, typically found in coniferous or mixed woods with deep, shaded soil. The species is present in the mountains of British Columbia, Alberta, and throughout the western US states, including California, Idaho, Montana, Oregon, and Washington. In eastern North America disjunct populations exist, primarily near the Great Lakes (Michigan, Wisconsin) and in parts of New England (New Hampshire, Vermont), extending to Quebec and Prince Edward Island. Pinedrops prefers coniferous or mixed forests with deep humus, often associated with Ponderosa pine in the West. *Pterospora andromedea* is listed as rare in parts of its range, particularly in the east and in Texas, due to its specialized habitat needs and reliance on specific fungal and tree partners. It is a rare, non-photosynthetic plant that survives as a mycoheterotroph by stealing nutrients through a specific fungi connection. It relies entirely on *Rhizopogon* species fungi, which connect its roots to coniferous trees for carbon and nitrogen. In the US it is ranked as widespread, but locally threatened in specific regions.

The geographic distributions for all of the understory species listed above are summarized below in the following table:



SHRUBS	AK	BC	WA	OR	CA
<i>Arctostaphylos columbiana</i>		X	X	X	X
<i>Gaultheria shallon</i>	X	X	X	X	X
<i>Holodiscus discolor</i>		X	X	X	X
<i>Mahonia nervosa</i>		X	X	X	X
<i>Oemleria cerasiformis</i>		X	X	X	X
<i>Rubus parviflorus</i>	X	X	X	X	X
<i>Rubus spectabilis</i>	X	X	X	X	X
<i>Rubus ursinus</i>		X	X	X	X
<i>Spirea douglasii</i>	X	X	X	X	X
<i>Symphoricarpus mollis</i>		X	X	X	X
<i>Vaccinium parvifolium</i>	X	X	X	X	X
WILDFLOWERS & FERNS					
<i>Achlys triphylla</i>		X	X	X	X
<i>Claytonia perfoliata</i>	X	X	X	X	X
<i>Claytonia sibirica</i>	X	X	X	X	X
<i>Collinsia parviflora</i>	X	X	X	X	X
<i>Collomia heterophylla</i>		X	X	X	X
<i>Dicentra formosa</i>		X	X	X	X
<i>Erythronium oregonum</i>		X	X	X	X
<i>Geum macrophyllum</i>	X	X	X	X	X
<i>Lysichiton americanum</i>	X	X	X	X	X
<i>Lysimachia latifolia</i>	X	X	X	X	X
<i>Mimulus alsinoides</i>		X	X	X	X
<i>Montia parvifolia</i>	X	X	X	X	X
<i>Osmorhiza berteroi</i>	X	X	X	X	X
<i>Polystichum munitum</i>	X	X	X	X	X
<i>Prunella vulgaris</i>	X	X	X	X	X
<i>Tellima grandiflora</i>	X	X	X	X	X
<i>Tiarella trifoliata</i>	X	X	X	X	X
<i>Trillium ovatum</i>	X	X	X	X	X
<i>Viola glabella</i>	X	X	X	X	X
NON-PHOTOSYNTHETIC PLANTS					
<i>Allotropa virgata</i>		X	X	X	X
<i>Boschniakia hookeri</i>		X	X	X	X
<i>Calypso bulbosa</i>	X	X	X	X	X
<i>Corallorhiza maculata var. maculata</i>	X	X	X	X	X
<i>Corallorhiza maculate var. ozettensis</i>		X	X		
<i>Monotropa uniflora</i>	X	X	X	X	X
<i>Pterospora andromedea</i>	X	X	X	X	X

Discussion

It is evident that most of the common understory shrubs and herbs found in the Morrell Nature Sanctuary have very wide latitudinal distributions along the west coast of North America, many ranging from Alaska south to California. The northern range of some species presently does not extend beyond British Columbia (dull Oregon grape, trailing blackberry, vari-leaved collomia, chickweed monkeyflower, western trillium, candystick, Vancouver groundcone) and for others their northern range is restricted to southern BC (hairy manzanita, oceanspray, osoberry, creeping snowberry, vanilla-leaf, Pacific bleeding heart, white fawn lily). It is possible these species will expand their northern presence with climate change, but of particular significance is the expansive southern ranges of all species examined in this review, with the exception of Ozette coralroot which is limited to southernwestern BC and northwestern Washington. This suggests that the common understory shrubs and herbs at the Morrell sanctuary may be predisposed to a warmer climate with the potential to persist indefinitely, at least for several decades, as the climate changes. However, it should be noted that regional climate change is a complex phenomenon and difficult to predict, with the rise in atmospheric greenhouse gases (e.g., industrial carbon emissions) compounded by human-caused landscape disturbances (e.g., deforestation) to jointly affect hydrological cycles and the availability and distribution of moisture.

An unanswered question is whether these species are represented by ecotypes in their southern ranges (that is, genetically distinct populations, races, or varieties within a single species that have adapted to specific environmental conditions in its local habitat) or are exhibiting phenotypic plasticity (the ability of a single genotype to produce multiple physical, physiological, or behavioral traits in response to different environmental conditions). In some cases, we know of the existence of different varieties for some species (e.g., a coastal variety and an interior variety of Douglas spirea; two varieties of Pacific bleeding heart; two varieties of large-leaved avens; three varieties of foamflower; two varieties of fairy slipper, and two varieties of spotted coralroot). It is quite likely that local populations throughout the entire range of a widespread species are genetically distinct ecological races or ecotypes. However, plant ecotypes can share genes with other races or populations of the same species. Because ecotypes belong to the same species, they are genetically compatible and can interbreed to exchange genetic material through pollen and seeds (a process known as gene flow). As southern populations disperse northward with climate change, it is conceivable that gene flow could potentially spread adaptive traits to local populations in British Columbia and improve their chances of survival.

It is probable that certain relatively rare understory herbs found in the sanctuary may disappear with climate change. As noted above, the Ozette variety of spotted coralroot has a very narrow distribution and may be negatively impacted by climate change. Specialist plants like candystick and pinedrops, which rely on specific fungal partners may be threatened as well. Other rare plants observed only on a few occasions in the sanctuary may similarly vanish, such as gnome plant (*Hemitomes congestum*, which is exclusively native to the Pacific Northwest region of North America, distributed along the west coast from British Columbia down to California, mainly inhabiting dense, damp, and shaded coniferous forests) and Scouler's harebell (*Campanula scouleri*, a perennial wildflower native exclusively to the mountainous and coastal regions of western North America, whose distribution stretches from the Alaskan panhandle south through British Columbia, Washington, and Oregon, extending as far as northern California).

It is also likely that wetland plants found in and around the Beaver Pond may be lost as persistent drought causes this small body of water to dry up. Affected species could include mare's tail (*Hippuris*

vulgaris), Pacific water-parsley (*Oenanthe sarmentosa*), water-pepper (*Polygonum hydropiperoides*), water plantain (*Alisma plantago-aquatica*), and nodding beggarticks (*Bidens cernua*).

Finally, the role of invasive species cannot be ignored. Climate change may weaken our native species, leading to increasing encroachment by non-native plants. Warming temperatures, altered rainfall, and extreme weather can stress native species and degrade habitats, creating favorable conditions for invasive species to expand their ranges and outcompete vulnerable native flora and fauna.

The goal of conservation is to maintain biotic systems as close as possible to the natural state; however, as Richard Schneider points out in his book on *Biodiversity Conservation in Canada* (p. 376), "in practice, we do not seek to maintain biodiversity, but to limit the risk to biodiversity from human activities to a socially acceptable level." In the same vein, our conservation goal at the Morrell Nature Sanctuary should be to limit the risk to biodiversity from climate change rather than try to preserve the *status quo*. Our mission statement refers to preserving and promoting the "essential character of Morrell Sanctuary's evolving ecosystem" and this acknowledges that in some respects the system is subject to change beyond our control. Perhaps the most effective conservation measure we can take is to manage the encroachment of invasive species as much as possible to give our native species a chance to adapt to climate change.

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