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Natural Resource Stewardship and Science

# Climate Change Implications for Grizzly Bears (*Ursus arctos*) in the North Cascades Ecosystem

Natural Resource Report NPS/NOCA/NRR—2018/1814

**ON THE COVER**

July snow pack and alpine vegetation looking southeast from Cascade Pass, a transition area from the maritime west slopes of the Cascades to the continental east slopes, 2017. Photo by Jason I. Ransom/NPS

Inset: Grizzly bear tracks near Mt. Baker in the Mount Baker-Snoqualmie National Forest, 1989. Photo by Roger Christophersen/NPS

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## Abstract

The North Cascades Ecosystem of north-central Washington State and southern British Columbia, Canada, is one of six designated recovery zones for grizzly bears (*Ursus arctos*) in the conterminous United States. The National Park Service and US Fish and Wildlife Service evaluated a range of alternatives for restoring grizzly bears in the Cascades, and carrying capacity models estimated the ecosystem could support approximately 250–300 bears under current habitat conditions. As climate change shapes the North Cascade Ecosystem, there is considerable uncertainty as to how grizzly bear habitat may change through time. Projected increases in growing season length, winter and spring water surplus, summer water deficit, wildfire, and decreases in snow pack will likely to lead to substantial vegetation changes by the end of the century. These changes are in turn likely to affect grizzly bear foraging and denning behaviors, and thus could influence their population dynamics through time. The North Cascades Ecosystem supports many of the primary food sources used by grizzly bears in other populations, including graminoids, starchy tubers like *Hedysarum* spp., montane forbs like glacier lilies, forest plants like horsetails and cow parsnip, clovers, and a wide variety of berry-producing plants (*Vaccinium* spp. and others), as well as ants, ungulates, and carrion. Because grizzly bears are habitat generalists, they are projected to be relatively insensitive to climate change effects. More grizzly bear food resources in the North Cascades are expected to increase in abundance over time than those projected to become more scarce. For example, some important bear food sources, like *Vaccinium* spp., are projected to significantly increase in abundance as meadows become shrubbier and fire opens forests over the coming decades. Many grizzly bear food sources are projected to migrate up in elevation, potentially creating higher quality habitat farther from low elevation roads and human settlements where human-bear conflict is more likely. Disease and pest outbreaks such as blister rust disease in whitebark pine, beetle infestations of conifer forests, and salmon poisoning disease introduce a suite of uncertainties for the future of specific potential grizzly bear foods. Changes in winter snowpack may delay denning, exposing grizzly bears to negative human interactions for a longer period of time each year, underscoring the importance of human sanitation practices and education. The complex relationship between changes in climate, natural processes, and natural and anthropogenic features will expose grizzly bears to a range of changing resource conditions, but the species low sensitivity to changing climate and high adaptive capacity portends positive long term outcomes if a successful founding population can be re-established. This report aims to synthesize the scientific literature and develop the conceptual basis for understanding potential climate impacts on grizzly bear habitat quality in the North Cascades Ecosystem. It is expected that the outcome of this effort will be used to inform modeling efforts for estimating grizzly bear carrying capacity under future climate change scenarios.

## Acknowledgments

Funding for this report was provided by the National Park Service and the Skagit Environmental Endowment Commission. MC2 vegetation models were run by Katherine Hegewisch (University of Idaho), and climate figures were created by Robert Norheim (University of Washington Climate Impacts Group). Thanks to Kristin Rine (National Park Service) for assistance in assimilating and managing grizzly bear food species data from many sources. Thanks also to the Interagency Grizzly Bear Committee (IGBC) North Cascades Ecosystem Subcommittee Technical Team members, the North Cascades Grizzly Bear Restoration Environmental Impact Statement Science Team, Harriet Morgan (University of Washington Climate Impacts Group), Mignonne Bivin (National Park Service), and Jon Riedel (National Park Service) for their reviews and thoughtful comments on this report. We are also grateful for the assistance of Mark Huff and Lise Grace for peer review management and document formatting, respectively.

# Introduction

Grizzly bears (*Ursus arctos*) were once present across much of western North America, but direct killing and extensive habitat loss over the last century extirpated them from 98% of their historic range (USFWS 1993, 1997; Servheen 1999; Rine et al. 2018). The species was provided protection under the Endangered Species Act by the US Fish and Wildlife Service in 1975, and a Grizzly Bear Recovery Plan was established in 1982 and revised in 1993 (USFWS 1993). The North Cascades Grizzly Bear Recovery Zone was established as one of six recovery zones where grizzly bears were either extant or were known to have recently occurred in the lower 48 states (USFWS 1993, 1997).

The North Cascades Ecosystem (NCE) is one of the largest and most intact wilderness areas in the contiguous United States. It spans the US-Canada border between central Washington State and southern British Columbia, and is bisected north to south by the rugged Cascade Mountain range. Archeological evidence, traditional knowledge from tribes and First Nations, and historic trapping records indicate that grizzly bears once occurred across this ecosystem (Rine et al. 2018). The very few grizzly bear observations confirmed in recent decades have led managers to conclude that the species may persist at extremely low numbers but is functionally extirpated (USNPS/USFWS 2017). In 2017, the National Park Service and US Fish and Wildlife Service evaluated a range of alternatives for restoring grizzly bears in the Cascades and aim to reach a final Record of Decision in 2018 (USNPS/USFWS 2017).

The potential carrying capacity for grizzly bears in the North Cascades has been estimated as approximately 250–300 bears, based on current habitat quality, impacts of road presence, and an average individual female home range size of 280 km2 (Lyons et al. 2018). The Resource Selection Function model underlying this spatially-explicit simulation of carrying capacity considered habitat quality as a function of alpine vegetation, riparian vegetation, overall vegetation greenness, and presence of anthropogenic features (e.g., roads). Even the most conservative estimate of carrying capacity from that study indicates the ecosystem can support a grizzly bear population much larger than the relict numbers currently assumed to remain today. Those estimates, however, do not account for potential changes in habitat that may occur across the North Cascades due to changing climate conditions through time.

While the biota of the North Cascades is believed to have changed very little over the last several millenia (Mierendorf 1986), global changes in climate are now rapidly influencing biota across a variety of ecosystems (Bellard et al. 2012, Groffman et al. 2014). Some species are expected to dramatically shift their range or abundance while others may be impacted by changing phenology and complex trophic interactions (Gilman et al. 2010, Thackeray et al. 2016, Pacifici et al. 2017). Climate change impacts on wildlife species may include changes to food availability as well as altered interspecific relationships, predator-prey dynamics and competition, disease and parasite prevalence and distribution, and invasive species colonization (Kareiva et al. 1993, Schneider et al. 2002, Lawler et al. 2014). Despite the uncertainties around future wildlife community interactions, all wildlife species are directly subject to changes in the plant communities on which they rely, and plant communities are directly affected by climate (Stephenson 1990, Churkina and Running 1998, Nemani et al. 2003). How vulnerable a wildlife or plant species is to climate change is a product of its exposure (i.e., how much the climate will change where it lives), sensitivity (i.e., how much change it can endure before responding), and adaptive capacity (i.e., the ability of a species to change to reduce its exposure or sensitivity) (Lawler et al. 2014).

Plant communities change through time as a function of climate, disturbance, and ecosystem processes (Churkina and Running 1998, Nemani et al. 2003, Raymond et al. 2014). Most climate change projections for the North Cascades Ecosystem over the next century suggest it is likely to experience warming temperatures, drier summer months and wetter winter and spring months, decreased snow pack, and increased number of disturbance events (Raymond et al. 2014). Disappearing glaciers may also reduce fresh water influx into watersheds, ultimately influencing associated riparian plant communities, while warming stream temperatures may negatively impact freshwater fish species (Hoffman et al. 2015). Any of these changes could impact availability of specific food sources for grizzly bears either directly or through trophic interactions, and thus could influence their population dynamics through time. It is unknown what specific foods in the North Cascades Ecosystem are most critical for grizzly bears because no empirical data exist specific to the NCE; however, the species is widely regarded as a generalist consumer and is expected to primarily persist on plant-based foods in the North Cascades, as it does across much of its North American interior range (Almack et al. 1993, Gaines et al. 1994, Roberts et al. 2014). There are at least 2,668 plant and fungi species and 448 animal and insect species present in the NCE that have either been documented as grizzly bear diet components in other ecosystems or are possible food resources based on biological similarities to those confirmed foods (Appendix A).

Grizzly bears typically digest plant material poorly due to their relatively short digestive tract, but also have extraordinary energy requirements to meet during their short season of feeding (Bunnell and Hamilton 1983, Pritchard and Robbins 1990). Most grizzly bears supplement their plant-based diet with meat and insects, with considerable variability in diet by sex and ecosystem (see Munro et al. 2006, for example). Thanks to their extreme dietary plasticity and high mobility, when localized food sources diminish in quantity or quality, grizzly bears are proficient at moving around the landscape to exploit the most nutritious resources as they become available across seasons and years (Hamilton and Bunnell 1987, Stirling and Derocher 1990). The ability of grizzly bears to utilize a wide variety of food resources resulted in occupancy of a broad variety of habitats, with a historic range extending across much of North America (Storer and Tevis 1955, Rausch 1963, Peterson 1965, Guilday 1968, Leonard et al. 2000, Mattson and Merrill 2002).

As climate change shapes the North Cascade Ecosystem, there is considerable uncertainty as to how specific grizzly bear food resources may change through time. There is also uncertainty as to how the human footprint will change through time as populations grow, resource extraction plans change, and recreation increases. At the continental scale, grizzly bears are projected to be relatively insensitive to climate change effects, with more food resources expected to increase in abundance than those projected to become more scarce (Roberts et al. 2014). The complex relationship between changes in climate, natural processes, and natural and anthropogenic features will ultimately determine the future quality of grizzly bear habitat across the ecosystem. This report aims to synthesize the scientific literature and develop the conceptual basis for understanding potential climate impacts on grizzly bear habitat quality in the North Cascades Ecosystem. It is expected that the outcome of this effort will be used to inform modeling efforts for estimating grizzly bear carrying capacity under future climate change scenarios.

## North Cascades Ecosystem

The North Cascades Ecosystem Grizzly Bear Recovery Zone (US) and the North Cascades Grizzly Bear Population Unit (Canada) span north-central Washington State and south-central British Columbia, respectively, to form the North Cascades Ecosystem (Figure 1). The US portion of the ecosystem is approximately 24,600 $km^2$ and includes areas of Whatcom, Skagit, Snohomish, Chelan, Okanogan, Kittitas, and King Counties (USFWS 1997). Within this area, 10,500 $km^2$ form a mosaic of contiguous wilderness areas and public lands that together comprise the US recovery zone. The North Cascades National Park Service Complex (park complex) comprises roughly 11% of the recovery zone and includes North Cascades National Park, Ross Lake National Recreation Area, and Lake Chelan National Recreation Area. Approximately 8,000 $km^2$ (74%) of the recovery zone is composed of the Mount Baker-Snoqualmie and Okanogan-Wenatchee National Forests, with the remaining lands classified as state (5%) and private (10%) (USFWS 1997). The adjacent North Cascades Grizzly Bear Population Unit (GBPU) in British Columbia spans over 9,700 $km^2$ and includes 1,600 $km^2$ of protected lands (Gyug 1998). The GBPU is bounded on the west by the more densely human-populated Puget lowlands and to the northwest by the Fraser River, which along with two national railroads and the TransCanada Highway, may represent barriers to natural movements of grizzly bears (North Cascades Grizzly Bear Recovery Team 2004).

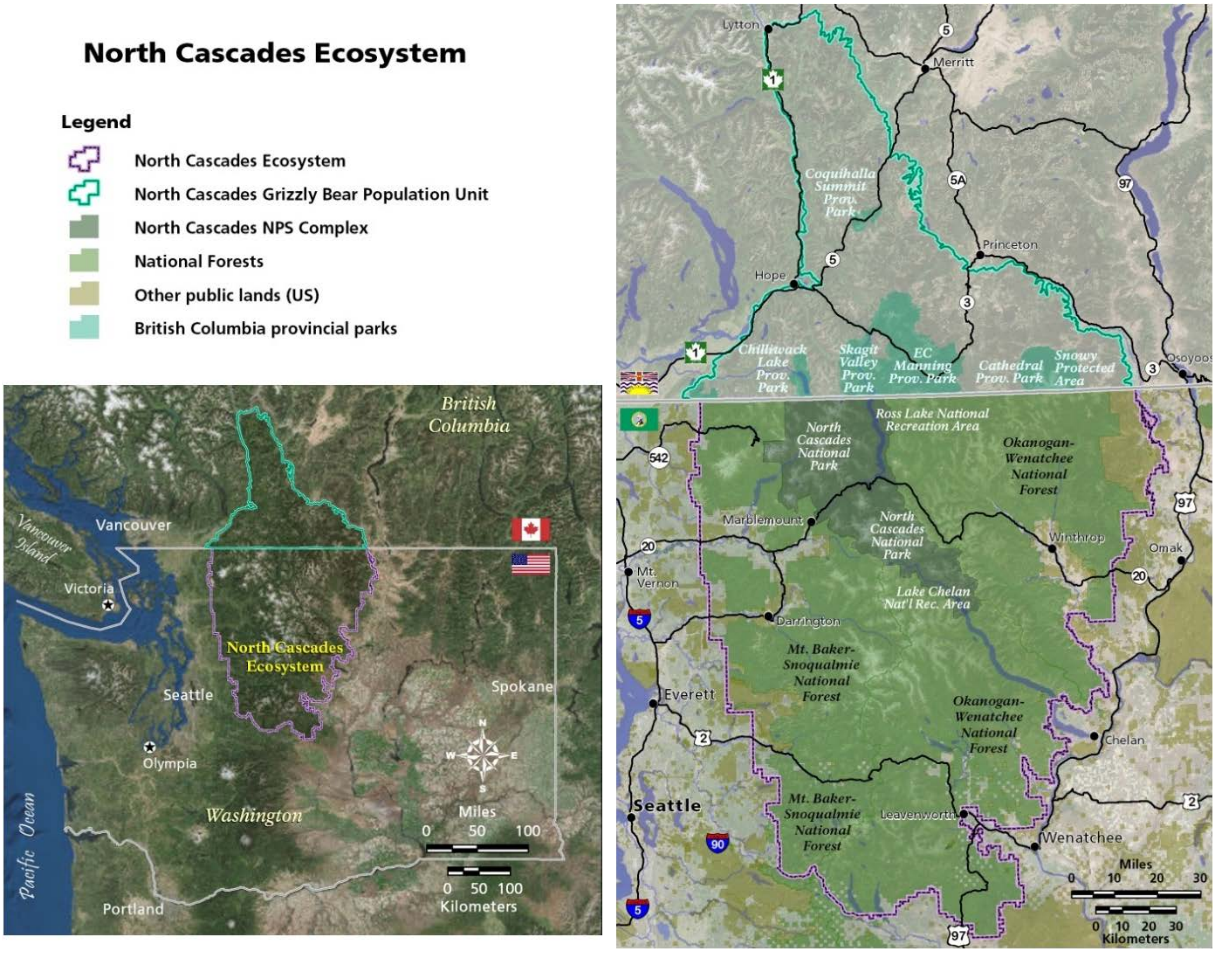


**Figure 1.** The North Cascades Ecosystem, administrated as a Grizzly Bear Recovery Zone in the U.S. and as a Grizzly Bear Population Unit in B.C.

The North Cascades Ecosystem is a wild, rugged landscape with diverse climates and biomes. Elevation ranges from 25 m in the western lowland maritime forest to peaks exceeding 3,200 m at Mt. Baker and Glacier Peak in the Cascade Range. The mountains are home to over 700 glaciers, which to the west feed the Skagit, Nooksack, Snohomish, Stillaguamish, and Skykomish Rivers. This western slope is strongly influenced by the temperate maritime climate, which delivers precipitation averaging roughly 400 cm/yr. This supports extensive mesic lowland and subalpine forests composed predominantly of Douglas-fir (*Pseudotsuga menziesii*), western hemlock (*Tsuga heterophylla*), Pacific silver fir (*Abies amabilis*), and western red cedar (*Thuja plicata*), as well as over 300 species of non-vascular plants such as mosses and lichens. Riparian zones host deciduous forest consisting primarily of alder (*Alnus* spp.), cottonwood (*Populus* spp.), and willow (*Salix* spp.), which support ecosystem architect species like North American beaver (*Castor canadensis*). To the east, the glaciers feed several tributaries of the Columbia River, including the Methow, Stehekin (Lake Chelan), Entiat, Wenatchee, and Cle Elum Rivers. The NCE receives average precipitation of 130 cm/yr just east of the Cascade crest, but orographic effects reduce precipitation to an average of only 25 cm/yr on the easternmost edge of the ecosystem (Raymond et al. 2014). Consequently, alpine meadows transition rapidly down the eastern slopes to semi-arid continental forests dominated by

Douglas-fir and ponderosa pine (*Pinus ponderosa*) and lowland valleys composed of shrublands and grasslands.

Water is abundant across the ecosystem, with >500 lakes and more than 10,000 km of rivers and streams. Combined with a wide variety of soil types, landforms, elevation, slopes, and aspects, the North Cascades Ecosystem provides habitat for diverse lifeforms including >2,000 vascular plant, >500 invertebrate, >200 bird, 78 mammal, 31 fish, 12 amphibian, and seven reptile species (Hoffman et al. 2015, Appendix A). The Skagit River is managed for natural salmon production and supports five native species of salmon. Chum (*Oncorhynchus keta*) and coho (*Oncorhynchus kisutch*) salmon spawn in large numbers on the Skagit River below the Gorge hydroelectric dam, as well as in the Nooksack River to the north, serving as an important food source for the bald eagles (*Haliaeetus leucocephalus*) that overwinter there in large numbers (Rubenstein et al. 2018). Similarly, the Methow and Wenatchee Rivers support salmon runs from the Columbia drainage, which also feed overwintering bald eagles. Black bears (*Ursus americanus*), raccoons (*Procyon lotor*), and coyotes (*Canis latrans*) also seasonally scavenge salmon carcasses along spawning rivers and streams throughout the ecosystem.

Humans have been a part of the North Cascades Ecosystem for at least 9,000 years (Hoffman et al. 2015). Most human activity in the core of the ecosystem today consists of recreational use by visitors (>4 million visits/year), subsistence use by Native American tribes and First Nations, management and research by administering agencies, and travel across four major highways that cross the otherwise largely roadless landscape. Several gateway communities persist around the edges of the ecosystem with low population densities (see USNPS/USFWS 2017:71).

## Future Climate in the North Cascades

The climate of the North Cascades Ecosystem reflects its proximity to the Pacific Ocean and its montane topography, with the maritime climate driving the western slope ecology and the orographic effects of the Cascade Range driving the more arid continental climate of the east (Littell et al. 2014). Under a changing climate, the North Cascades is expected to experience warming temperatures, more extreme seasonal patterns of precipitation (i.e., drier summers and wetter winters), reductions in snow pack, and increasing disturbance events (Raymond et al. 2014). The North Cascades Ecosystem Grizzly Bear Recovery Zone itself is projected to see a 3.1–3.3°C increase in mean annual temperature by the 2080s (2070–2099) under a moderate greenhouse gas scenario (RCP 4.5), and as much as 5.2–5.6 °C increase in mean annual temperature under a high greenhouse gas scenario (RCP 8.5), relative to 1970–1999 (Figure 2)[1]. The recovery zone is also projected to see decreases in snowpack by the end of the century under both the moderate and high greenhouse gas scenarios (Figure 3), particularly at lower elevations and on the western slopes. Projected increases in growing season length, winter and spring water surplus, summer water deficit, wildfire, and decreases in snow pack will likely to lead to substantial vegetation changes through the end of the century (Littell et al. 2014). These changes are in turn likely to affect grizzly bear foraging and denning behaviors, and thus could influence their population dynamics through time.

[1] Future changes in mean annual temperature were summarized for the North Cascades Grizzly Bear Recovery Zone using the *Integrated Scenarios of the Future Northwest Environment* (Mote et al. 2015). This project uses projections from 10 Global Climate Models (GCMs) statistically downscaled using the Multivariate Adaptive Constructed Analogs (MACA) method (Abatzoglou and Brown 2012). We simulated an ensemble of these 10 GCMs for two future greenhouse gas scenarios: Representative Concentration Pathway (RCP) 4.5 and RCP 8.5. RCP 4.5 was chosen because it represents a low emissions scenario in which emissions stabilize by mid-century and fall sharply thereafter; whereas RCP 8.5 represents a high emissions scenario that assumes continued increases in greenhouse gas emissions until the end of the 21st century.

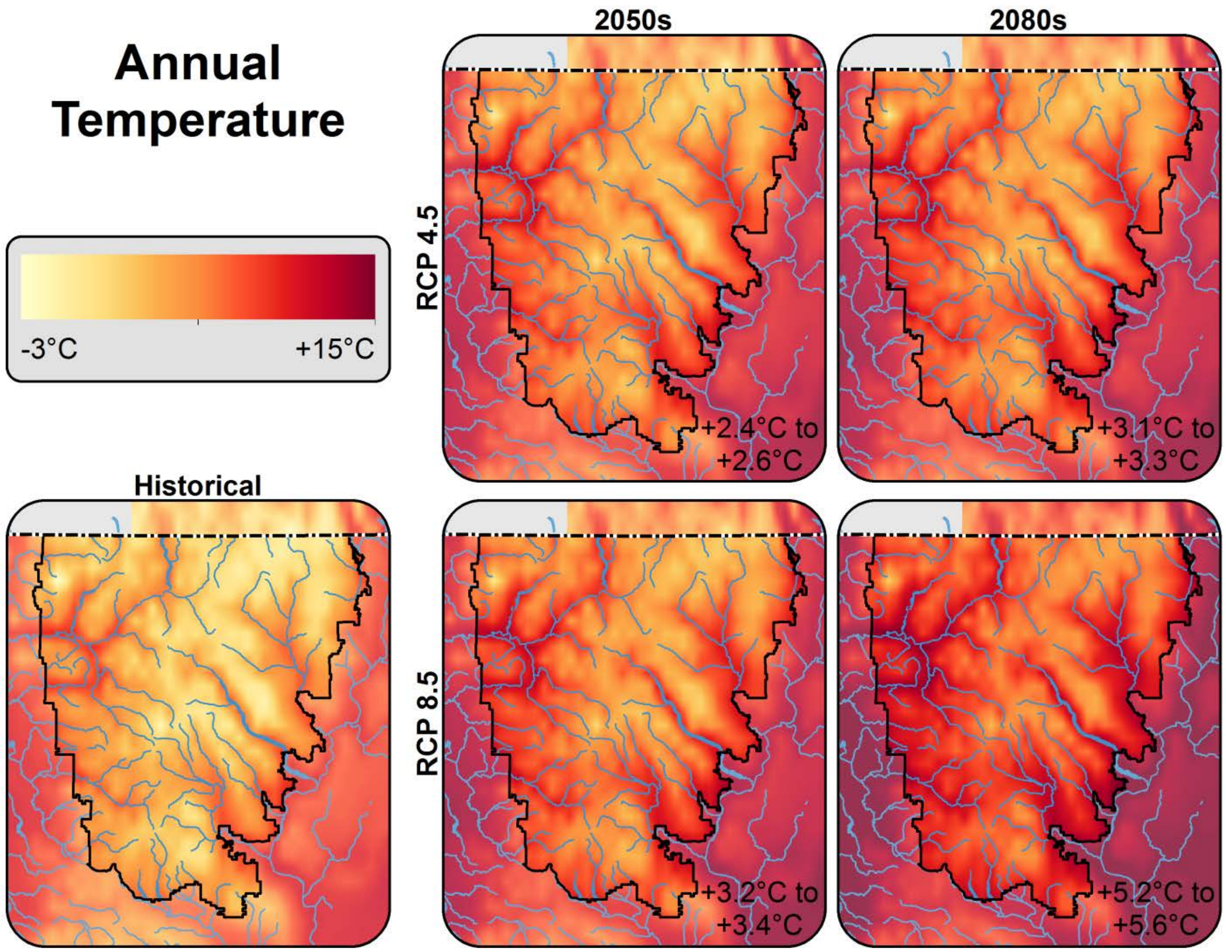


**Figure 2.** Projected mean annual temperature for the North Cascades Grizzly Bear Recovery Zone, relative to historical (1970–1999) temperatures. Projections are shown for the 2050s (2040–2069) and 2080s (2070–2099), and projections are included for two greenhouse gas scenarios: one low (RCP 4.5) and one high (RCP 8.5).

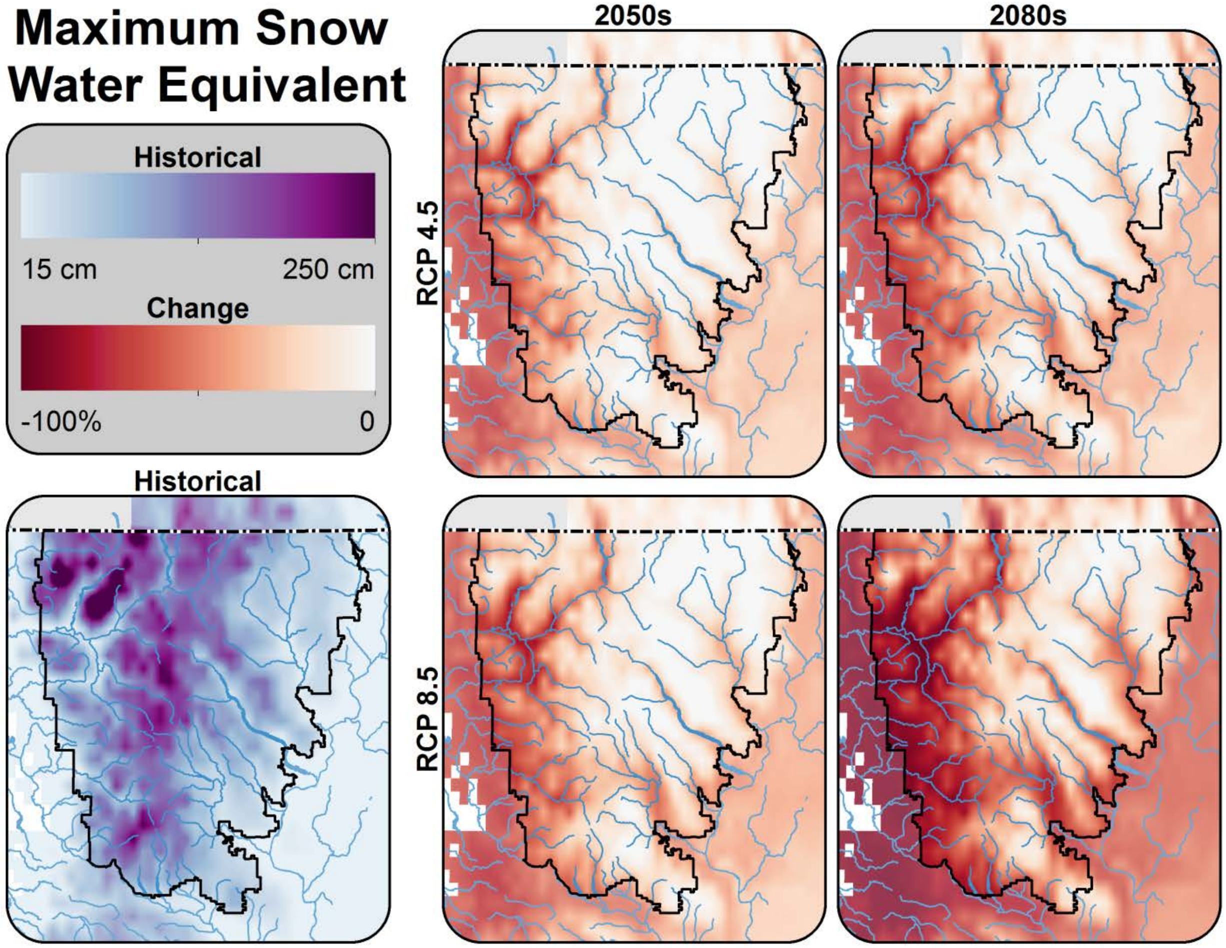


**Figure 3.** Projected change in snowpack, measured as maximum snow water equivalent, for the North Cascades Grizzly Bear Recovery Zone, relative to historical (1970–1999). Projections are shown for the 2050s (2040–2069) and 2080s (2070–2099), and projections are included for two greenhouse gas scenarios: one low (RCP 4.5) and one high (RCP 8.5).

Vegetation type and greenness can be good general indicators of grizzly bear food availability (Proctor et al. 2015, Lyons et al. 2018), and each of these is driven by climate (Littell et al. 2014). The dynamic global vegetation model MC2 is designed to simulate vegetation type, plant growth, biogeochemical cycles, and their responses to wildfire (Bachelet and Turner 2015, Bachelet et al. 2015). This model projects how four tree and shrub lifeforms (evergreen needleleaf, evergreen broadleaf, deciduous needleleaf, and deciduous broadleaf) and two graminoid lifeforms (C3 and C4 grasses and sedges) respond to changes in climate and atmospheric carbon dioxide concentration, including how vegetation competes for light, nitrogen, and available soil water. These simulations also estimate net primary production (greenness), decomposition, soil respiration, and nutrient release through time. Nitrogen inputs considered include release from organic matter turnover, wet and dry deposition, and nitrogen fixation. The MC2 model also uses these inputs to project future fire occurrence and its effects, including tree mortality and fire emissions (though models can also be run assuming fire suppression). It completes the simulated life cycles by simulating post-fire succession.

MC2 vegetation models suggest that conifer forest will remain the dominant vegetation biome across the North Cascades Grizzly Bear Recovery Zone through the end of the century, for a range of GCMs and greenhouse gas scenarios (Figure 4)[2]. However, loss of high elevation alpine vegetation and contraction of scrubland and woodland/savanna on the east slope of the recovery zone suggest a future reduction in the diversity of vegetation biomes present by the end of the century for all GCMs and greenhouse gas scenarios, relative to historical composition. Projected changes in the amount of cool mixed forest on the west slope, on the other hand, vary considerably by scenario, from increases to complete loss, as well as the development of warm mixed forest under some scenarios.

How these projected changes may influence future grizzly bear habitat quality requires consideration of both the specific plant and animal species bears rely on for food and the seasonal availability of those food sources, as well the complex relationships between natural processes and ecosystem features. Future research will spatially link dynamic vegetation models with grizzly bear population models (see Lyons et al. 2018) to better understand how climate change influences on vegetation abundance and distribution may alter grizzly bear distribution and abundance.

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[2] MC2 was run for 10 downscaled global circulation models (GCMs), using two RCPs provided by the Coupled Model Intercomparison Project 5 (CMIP5): RCP 4.5 (a low greenhouse gas scenario) and RCP 8.5 (a high greenhouse gas scenario) (Taylor et al. 2012). MC2 was run for three time periods: historical (1971–2000), 2050s (2040–2069), and 2080s (2070–2099). MC2 results are shown for the mode of the 10 GCMs, and also for two individual GCMs that bracket the range of climatic conditions projected across all individual GCMs: GFDL-ESM2G (a relatively warm and wet future) and MIROC-ESM-CHEM (a relatively hot and dry future) (Figure 2).

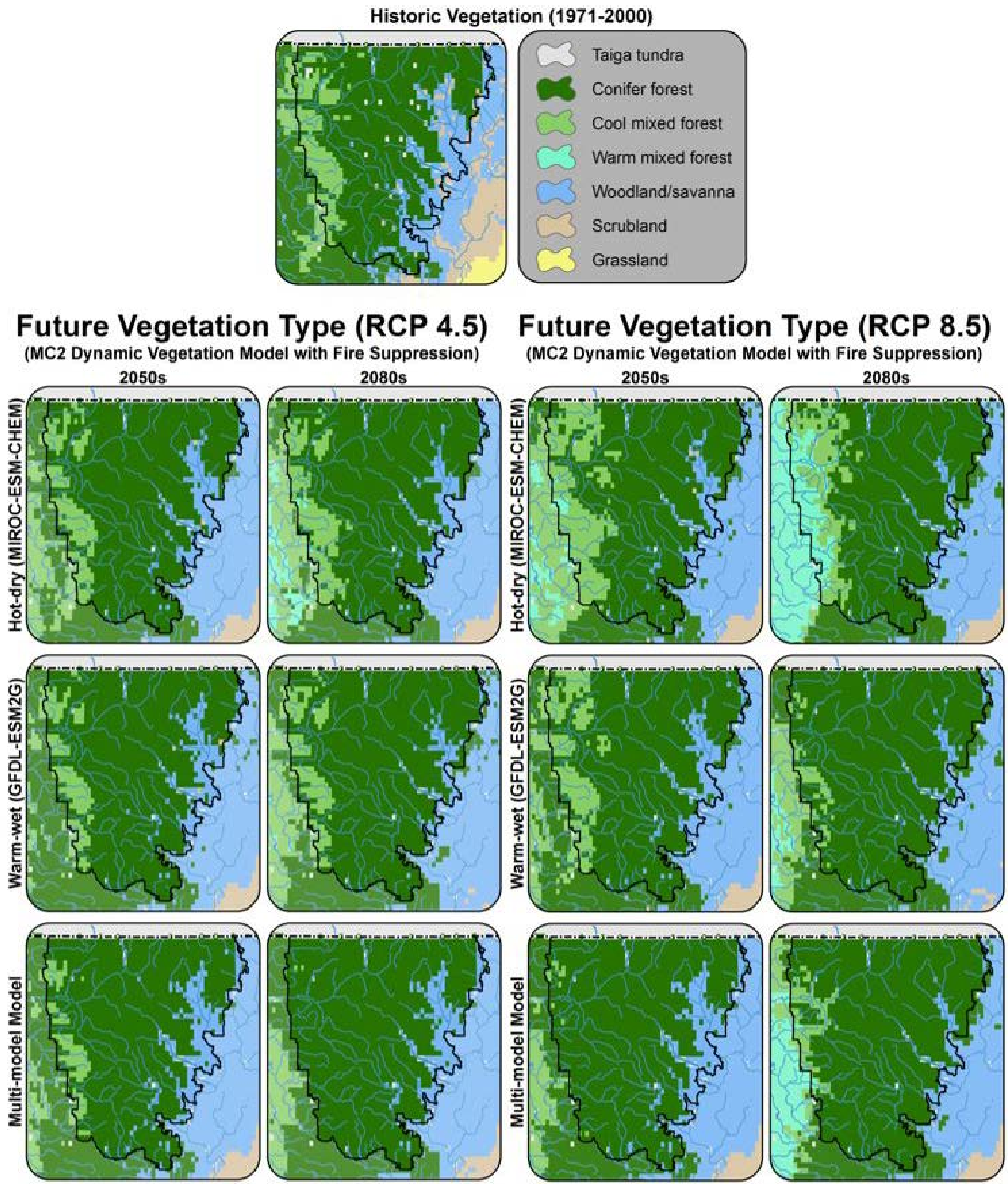


**Figure 4.** Projected changes in vegetation biomes from the MC2 dynamic global vegetation model with fire suppression for the North Cascades Grizzly Bear Recovery Zone. Changes are relative to historical conditions for two GCMs (MIROC-ESM-CHEM (hot-dry) and GFDL-ESM2G (warm-wet) under a low (RCP 4.5) and high (RCP 8.5) greenhouse gas scenario.

# Grizzly Bear Habitat Quality

## A Conceptual Model of Climate Relationships to Grizzly Bear Habitat Quality

Temperature and precipitation influence a wide array of natural processes such as length and warmth of the growing season, seasonal water surpluses and deficits, fire regimes, snow pack depth and persistence, and distribution and severity of pest and pathogen outbreaks (Raymond et al. 2014). These processes in turn affect the vegetation and animal species that comprise the diets of grizzly bears, which ultimately provide an important measure of habitat quality. Human activities and landscape features also influence grizzly bear habitat quality, including forest and road management, development, recreation, and agricultural and livestock management. Collectively these natural and anthropogenic influences will spatially shift through time as temperature and precipitation change and human populations grow and expand their footprint. These interactions are extremely complex and can be difficult to understand, model, and predict (see Ripple and Beschta 2012, for example).

Simplifying complex ecological systems using conceptual models can be helpful for better understanding how their primary components and key relationships may be impacted by climate change (Cross et al. 2012). We developed a conceptual model of climate change impacts on grizzly bear habitat quality in the North Cascades by reviewing the scientific literature and receiving input from the Interagency Grizzly Bear Committee (IGBC) North Cascades Ecosystem Subcommittee Technical Team, and the North Cascades Grizzly Bear Restoration Environmental Impact Statement Science Team (USFWS/NPS 2017) (Figure 5). Many relationships are identified simply as an effect because both positive and negative correlations occur between those components.

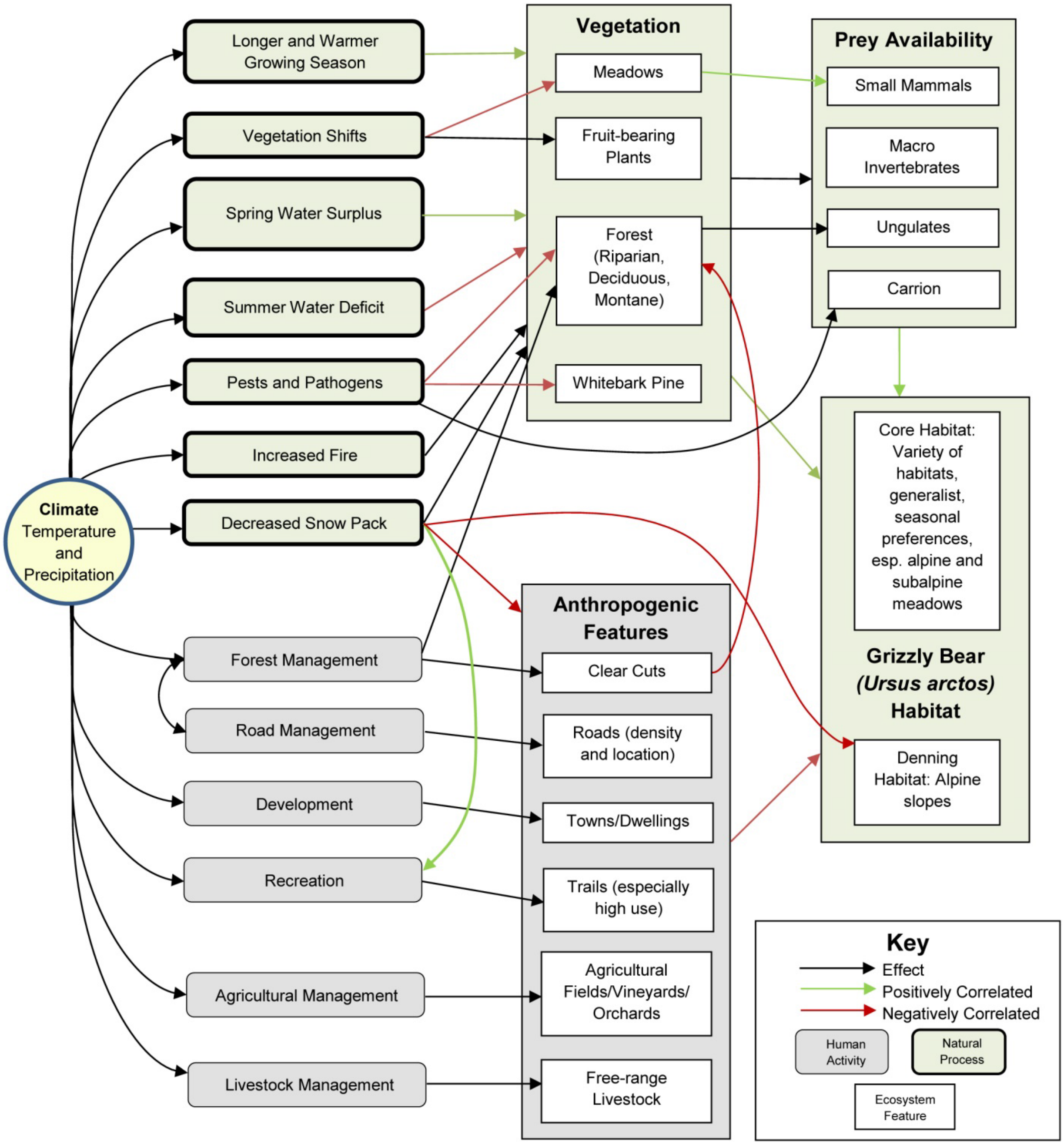


**Figure 5.** Conceptual model of potential climate change impacts on grizzly bear habitat quality in the North Cascades Ecosystem. Relationships shown with black arrows indicate either a neutral relationship or a complex relationship where both positive and negative correlations occur.

## Vegetation and Food Availability

### *Meadows*

Wet montane meadows in the North Cascades represent an important food source for many herbivores because the gradually receding snow pack continually prompts new growth of grasses, sedges, and forbs when similar species at lower elevations are becoming mature, senescing, and less nutritious. Crude protein in high elevation graminoids has been reported as 50% higher than low elevation prairie grasses (Johnston et al. 1968). Grasses and sedges were found to be a staple food for grizzly bears, occurring in 35–73% of diet samples across a variety of habitat types in Montana (Mace and Jonkel 1986), and comprised 32% of scat volume in southeastern British Columbia (McLellan and Hovey 1995). There are over 200 species of grasses and sedges in the North Cascades and these common meadow plants are expected to be a widely utilized food for bears, particularly in late spring through early summer when berries are not yet available (Figure 6, Appendix A). In the Cabinet-Yaak Ecosystem of Montana, graminoids were the most dominant food during May and June (Kasworm and Thier 1993). Montane grasses were most utilized by bears in west-central Alberta, Canada, from late June to early August, whereas montane forbs were important for bears from early July to early August (Munro et al. 2006) (Figure 6).

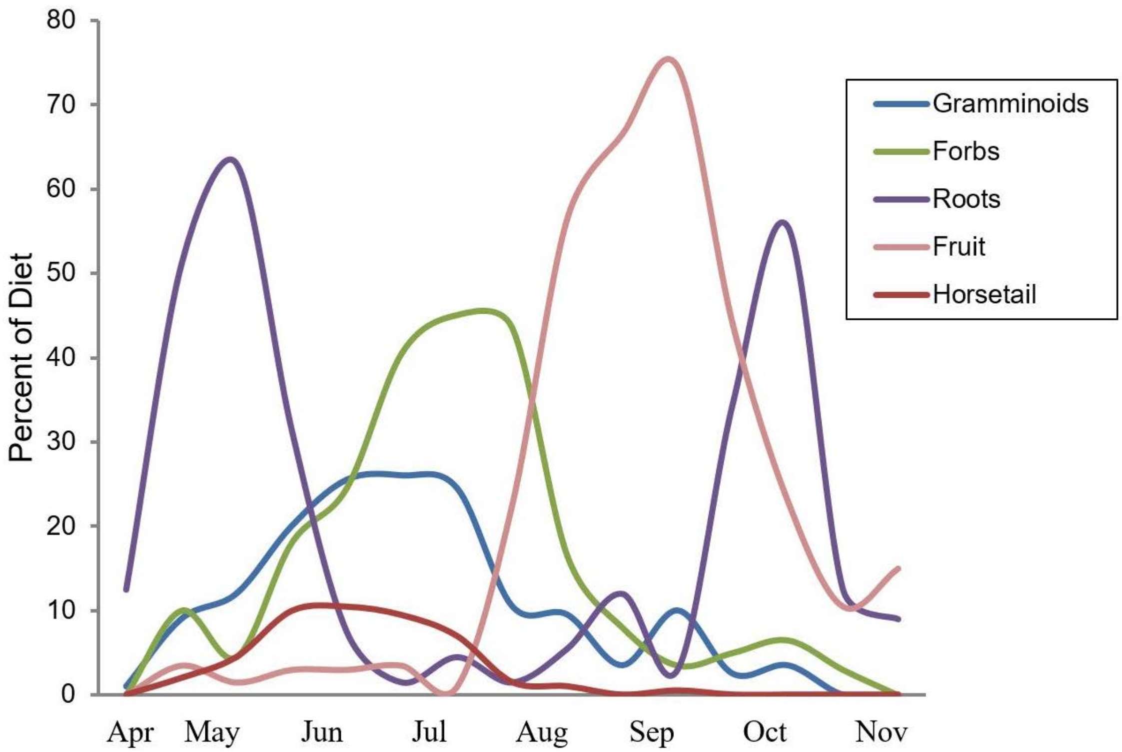


**Figure 6**. Phenology of interior grizzly bear diet comprised of plant-based foods, derived from McLellan and Hovey (1995) [southeastern British Columbia, Canada] and Munro et al. (2006) [west-central Alberta, Canada].

For grizzly bears in Glacier National Park and the Cabinet-Yaak Ecosystem, alpine meadows provided ample forage of yellow glacier lily (*Erythronium grandiflorum*) (Kasworm and Thier 1993, Tardiff and Stanford 1998), a species common in the Cascades. Digging for both glacier lilies and small mammals in montane meadows also influences plant community structure and nitrogen availability, consequently promoting future growth of grizzly bear foods (Tardiff and Stanford 1998). Clovers (Trifolium spp.) were the most commonly consumed forb in the Cabinet-Yaak Ecosystem (Kasworm and Thier 1993) and were also reported as an important dietary component across grizzly bear range (Mace and Jonkel 1986, McLellan and Hovey 1995, Munro et al. 2006). There are at least 23 Trifolium species in the Cascades (Appendix A).

Future warming is projected to lengthen the growing season and shorten the snow season in the North Cascades. These projected changes are likely to result in contraction of montane meadows because these habitats are primarily maintained by relatively short growing seasons and long duration of snow pack. Increased growing season length and decreased snow season length will facilitate the encroachment of woody plants and trees and will eventually transform some montane meadows into shrubs or montane forest (Littell et al. 2014). Such vegetation transformations are likely to reduce prevalence of some montane plants that comprise grizzly bear diet. This process will also negatively impact hoary marmots (*Marmota caligata*), golden-mantle ground squirrels (*Callospermophilus lateralis*), Columbian ground squirrels (*Urocitellus columbianus*) and American pikas (*Ochotona princeps*), which rely on alpine meadows and associated talus structure as their primary habitat. It is unknown if grizzly bears in the North Cascades would dig for small mammals like these more than opportunistically, but ground squirrels represent an important late summer and autumn source of protein for grizzly bears at more northern latitudes (Hechtel 1985, MacHutchon and Wellwood 2003), and were reported as an autumn diet component in Montana's Mission mountains (Servheen 1983) and Banff National Park, Alberta (Hamer and Herrero 1987a). Small mammals, including ground squirrels, mice, and marmots, were detected in 9–64% of grizzly bear scats, dependent on location in Montana (Mace and Jonkel 1986).

Avalanche chutes create important habitat for grizzly bears because they function to disturb soil and remove shrubs and trees in alpine areas, essentially creating growing space for many of the same plant foods, and small mammal habitat, that grizzlies seek in montane meadows. Some species like mountain sorrel (*Oxyria digyna*) thrive in avalanche chutes and have been reported as a common grizzly bear food, high in crude protein (Hamer and Herrero 1987a). The decreasing snow pack and changing phenology of spring melt projected under future climate scenarios for the North Cascades may change the seasonal availability of avalanche chute resources and their geomorphic impacts for bears (Butler 2012). It is unknown, however, if the projected decrease in snow pack will directly equate to decrease in avalanche frequency because warmer spring temperatures may increase avalanches where snow is present.

At lower elevations and eastern slopes of the Cascades, dry meadows also provide grasses, sedges, and forbs as grizzly bear forage, but the tuberous western sweet-vetch (*Hedysarum occidentale*) may be a key food source there. *Hedysarum* sp. are known to be an important spring and autumn food across inhabited grizzly bear range due to the plant's high starch content and availability when many other food sources are seasonally limited (Hechtel 1985, Mace and Jonkel 1986, Hamer and Herrero 1987a, McLellan and Hovey 1995, Munro et al. 2006) (Figure 6). Yellow sweet-vetch (*Hedysarum sulphurescens*) roots were detected in 83% of grizzly bear scats that were in the same food category during a diet study in Montana (Mace and Jonkel 1986). Climate driven vegetation shifts leading to encroachment of woody plants and trees into dry and lower elevation meadows may be similar to the same processes projected for montane meadows; however, the propensity for *Hedysarum* sp. to thrive in river cobble, dry gravel, and barren avalanche chutes may help this food source persist or thrive in many areas of the North Cascades.

All meadows may benefit from the projected increase in spring precipitation under some climate change scenarios in the Cascades, but montane spring precipitation falling as rain could quickly diminish snowpack and somewhat ameliorate the resource benefits of what is currently a more protracted phenology of montane plant emergence. The projected increases in temperature, declines in snow pack, and declines in summer precipitation will reduce soil moisture availability and may limit the productivity of low elevation meadow habitat. Increased fire frequency may transform some shrub and forest habitat into meadows, especially at low elevations, and in early successional stages may lead to greater availability of grasses, sedges, and forbs for bears. As these burned areas recover, fruit-bearing shrubs like huckleberry (*Vaccinium* spp.) may become more locally available.

#### *Fruit-bearing Plants*

The North Cascades supports many fruit-bearing plants that are critical foods for grizzly bears, especially in late summer and early autumn when bears enter hyperphagia and require enormous caloric intake (Figure 6). Sugar content in fruits such as buffaloberry (*Shepherdia* sp.) and grouseberry (*Vaccinium scoparium*) can be as high as 40%, which can quickly metabolize into fat (Craighead and Sumner 1982:70). Berry digestibility by bears can be as high as 72% (Welch et al. 1997). For bears with a primarily plant-based diet, berry productivity and consumption have been shown to correlate with reproductive success of females (Rogers 1976, Schwartz and Franzmann 1991). In Alaska, red elderberry (*Sambucus racemosa*) is such an important food for grizzly bears that when fruit became available several weeks earlier than normal, bears switched from feeding on spawning sockeye salmon (*Oncorhynchus nerka*) to elderberries (Barnes Jr. 1990, Deacy et al. 2017).

Huckleberry (*Vaccinium* spp.) are the most abundant fruit-bearing plants in the North Cascades Ecosystem, producing grizzly bear food across elevational gradients as well as wide spatial distribution. Mountain huckleberry (*V. membranaceum*) is common throughout mid to high elevations of the Cascades, in open shrub communities as well as wet and dry forest. This species comprised up to 80% of the fecal content for grizzly bears foraging in the mountains of Alberta, Canada, and was consumed primarily between late August and late September (Munro et al. 2006) (Figure 6). For bears in the same population but using lower elevation habitat, mountain huckleberry was consumed throughout August and September and comprised up to 63% of fecal content. Similarly, globe huckleberry (*V. globulare*) was present in 85% of grizzly bear scats on the south fork of Flathead River (Mace and Jonkel 1986).

Projected increases in air temperature, declines in summer precipitation, and decreases in snow pack are expected to result in longer periods of low soil moisture during the dry season across much of the North Cascades landscape (Littell et al. 2014). Low-elevation forests that are currently water limited, such as those found east of the Cascades, are likely to become drier or experience longer periods of water limitation in summer (Littell et al. 2014). This may lead to a decrease in production for some plants, increased mortality of seedlings, increased vulnerability to insects, and greater frequency and intensity of fire (Littell et al. 2010). As discussed above, the expected decrease in snow pack in the mountains may facilitate encroachment of shrubs, such as huckleberry, into higher elevation zones, leading to an expansion of the species. Likewise, the projected increase in fire also equates to successional release of these woody plant forms. Under a low emissions scenario (B1: Solomon et al.

2007, which is comparable to RCP 4.5), mountain huckleberry is projected to increase its current range across the west by 84-112% by the 2080's. Under a high emissions scenario (A2: Solomon et al. 2007, which is comparable to RCP 8.5), this species still was projected to increase its current range across the west by 66–78% by the 2080's (Roberts et al. 2014).

### ***Forests***

Forests represent important habitat for grizzly bears because they host a variety of plant- and animal-based foods across elevational and moisture gradients. Graminoids and forbs are common in forest understory and provide food for bears, but forests also host a variety of small mammals and ungulates that are prey. Seasonally important foods like horsetails (*Equisetum* spp.), cow parsnip (*Heracleum lanatum*), huckleberry, and an abundance of insects such as ants and termites are common in forests of the Cascades. Forest forbs were heavily selected for by grizzly bears in southeastern British Columbia, increasing from early May to a peak of 60–62% of scat volume by summer (McLellan and Hovey 1995). Cow parsnip, a common and widespread forb in low open forests, is high in crude protein content (22–31%) (Hamer and Herrero 1987a, Munro et al. 2006). Cow parsnip comprised 59% of total forb volume consumed by grizzly bears between late June and the end of July in southeastern British Columbia (McLellan and Hovey 1995), and about 19% of total forb volume consumed in the Cabinet-Yaak Ecosystem (Kasworm and Thier 1993). Horsetails are also common from subalpine forest to low forests, and form an important part of grizzly bear diet in spring and early summer (Servheen 1983, Mace and Jonkel 1986, Hamer and Herrero 1987a, McLellan and Hovey 1995, Munro et al. 2006) (Figure 6). Horsetails can provide crude protein similar to graminoids and cow parsnip (~23%) through early summer, but decrease in digestible energy and protein by later summer (Hamer and Herrero 1987a).

Grizzly bears have been reported feeding on tree cambium, stripping bark from live trees from early July to mid-August in Montana (Mace and Jonkel 1986). Tree species consumed in that study included subalpine fir (*Abies lasiocarpa*), spruce (*Picea* spp.), lodgepole pine (*Pinus contorta*), and Douglas-fir. The relative importance of tree cambium as grizzly bear food is unknown. Tree cambium may be under-reported as a dietary component due to difficulties in correctly identifying tree fiber content in scats. Forest health assessments in Washington identified a total 329 $km^2$ of forest (~ 209,000 trees) in 2017 that were primarily killed by black bear damage from bark striping (but note that this classification also included tree mortalities attributed to root disease and damage from porcupines (*Erethizon dorsatum*) and mountain beaver (*Aplodontia rufa*)) (Betzen et al. 2018). The ten year mortality average for bear-damaged trees in Washington is roughly 833 $km^2$/year, or 529,000 trees (Betzen et al. 2018), indicating tree cambium is a widely utilized food source for black bears and likely would be exploited by grizzly bears as well.

Forests of the Cascades are habitat for abundant mule deer (*Odocoileus hemionus*) and black-tailed deer (*Odocoileus hemionus columbianus*), which often winter in low valleys and riparian corridors and migrate seasonally to higher elevations. Elk (*Cervus canadensis*) are also locally abundant in areas of the Cascades, but not common through all areas of the mountains. Elk in recent years have continued to expand their range up the Skagit valley on the west slope of the Cascades, and are intermittently detected from the Canada border south across the ecosystem. The Colockum Elk herd in the southeastern porton of the ecosystem utilize the NCE as their primary summer habitat. Moose (*Alces alces*) are uncommon visitors to the west slope of the Cascades, but are present throughout much of the northeastern portion of the ecosystem. Mountain goats (*Oreamnos americanus*) are present throughout the Cascade Range and bighorn sheep (*Ovis canadensis*) range on the more arid eastern slopes. Grizzly bears are opportunistic hunters of ungulates, but may select for them during spring calving season when other foods are less available and ungulates are more vulnerable to depredation (Figure 7). Ungulates in general consist of roughly 40% or more apparent digestible protein, or nearly double the protein content available from graminoids, cow parsnip, or horsetail (McLellan and Hovey 1995).

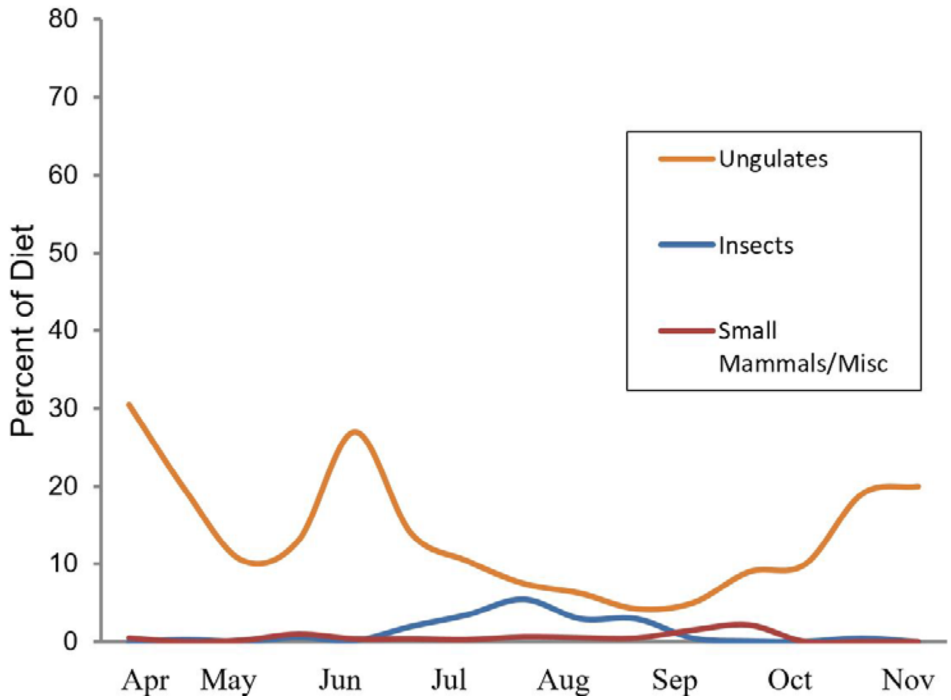


**Figure 7**. Phenology of interior grizzly bear diet comprised of animal-based foods, derived from McLellan and Hovey (1995) [southeastern British Columbia, Canada] and Munro et al. (2006) [west-central Alberta, Canada].

Grizzly bear use of ungulates varies widely by geographic area, but also by sex and age. Bears in lower snowfall areas (lower elevations) tended to have more meat in their diet, while large males ate more meat than females in Alberta, Canada (Mowat and Heard 2006). Likewise, in a captive study, smaller grizzly bears were able to gain weight faster on a plant-based diet than larger bears, suggesting that large bears may benefit by including more meat in their diet (Rode et al. 2001). Ungulates represented > 80% of female and >50% of male spring grizzly bear diet in the Yellowstone Ecosystem where large herds of ungulates were available (Fortin et al. 2013), but in an area more similar to the North Cascades where deer are the most common ungulate species, ungulates averaged <30% of grizzly bear diet, with an early June peak of 49% (fawning season) (Munro et al. 2006). Both sexes of grizzly bears in that Alberta study were more likely to feed on ungulates in closed forests, open forests, wet forests, and nonvegetated areas; whereas, only female bears selected ungulates primarily in wet forests (Munro et al. 2006). Deer formed a large proportion of grizzly bear diet in west-central Alberta even though elk were available, but elk were the primary ungulate prey in nearby Banff, even when deer were available (Hamer and Herrero 1987a). Like most foods, grizzly bears appear to select for ungulate species relative to abundance rather than species-specific attributes.

Forests also support an abundance of much smaller prey in the form of insects. In Banff National Park, 49% of grizzly bear fecal samples contained ants that were primarily foraged from dry forest habitats (Hamer and Herrero 1987a). In nearby west-central Alberta, ants were only found in 23% of grizzly bear scat samples and were primarily foraged in wet forest habitats (Munro et al. 2006). Grizzly bears were also documented excavating insects from rotten wood during the spring in the Mission Mountains, Montana (Servheen 1983). Use of ants as a food source by grizzly bears in the Flathead drainage of British Columbia peaked in mid-summer and was a relatively small component of overall diet at that time of year (McLellan and Hovey 1995), but insects in general were detected in 18–47% of scat samples from four areas around Glacier National Park (Mace and Jonkel 1986). Likewise, in the Cabinet-Yaak Ecosystem ants comprised 16% of grizzly bear diet, mostly consumed in July (Kasworm and Thier 1993). The precent of bear diet comprised of insects may be underestimated because the high digestibility of ant larvae and eggs reduce detectability in feces (Beeman and Pelton 1980). Insects could be an important food source for bears when no other animal protein is available because they are a source of certain amino acids that may not available from plant foods (Hamer and Herrero 1987a). There are at least 181 insect species identified as potential bear foods in the North Cascades, including at least 16 species of ants (Appendix A). Carpenter ants (*Camponotus* spp.) were highly preferred by brown bears in Sweden (Swenson et al.1999) and are common throughout the Cascades. Invertebrate prey could become a more utilized resource under future climate scenarios in the North Cascades due to projected increases in outbreaks of pests and consequent greater availability of coarse woody debris for insects to thrive in.

Tree pest and pathogen outbreaks are currently increasing in the Pacific Northwest (Betzen et al. 2018) and are predicted to continue this trend with projected climate changes (Littell et al. 2014). In 2017, tree mortality totaling roughly 800 $km^2$ (~2.47 million trees) of Washington forest was attributed to beetle infestation, and approximately 356 $km^2$ of conifer defoliation was attributed to western spruce budworm (*Choristoneura freeman*) and balsam woolly adelgid (*Adelges piceae*) (Betzen et al. 2018). There has been an increase in bark beetle damage on the eastern slope of the Cascades, with the highest peak tree mortality in Washington occurring in 2017 in eastern Chelan and Okanogan counties. Prevalent species like mountain pine beetle (*Dendroctonus ponderosae*), western pine beetle (*Dendroctonus brevicomis*), Douglas-fir beetle (*Dendroctonus pseudotsugae*), western hemlock looper (*Lambdina fiscellaria lugubrosa*), and fir engraver (*Scolytus ventralis*) are being joined by more recent outbreaks of species like California fivespined ips (*Ips paraconfusus*).

Insect outbreaks are often related to climate, with warmer winter temperatures facilitating higher annual survival of some species, and warming temperatures and decreasing summer precipitation creating more habitat for other species (Bentz et al. 2010, Hicke et al. 2006, Littell et al. 2014). Such climate shifts also create more fuels for fires over large areas (Littell et al. 2014), and fire ignitions are strongly related to low spring snow pack in parts of the North Cascades (Cansler 2011). By the 2080s**,** fire in the Cascades is expected to burn an average of nearly four times the area that was burned between 1980–2006 (Littell et al. 2014). While fire is a natural ecosystem process in the Cascades, fire suppression by humans has increased forest fuels, which in turn has lead to more severe fires. Such fuel loads combined with increasing summer temperatures in the North Cascades are projected to result in a 29–41% increase in burn severity, as compared to 1971–2000 (Rogers et al. 2011). Such burns will locally change forest structure such as creating significant openings of the canopy and consequent irruption of graminoids and forbs that are grizzly bear foods. Such openings can also be beneficial to small mammal and ungulate populations across successional stages, which may further improve food resources for grizzly bears. Because of this regeneration and recolonization of nutritious foods, grizzly bears have been shown to strongly select for recently burned forest habitats with low to moderate burn severity (Hamer and Herrero 1987b). Fire in future climate scenarios is less expected to have profound impacts on the maritime western slopes of the North Cascades because with historic fire return intervals of >100 years, suppression activities have had less of an influence on forest structure and fuel profiles. The low probability of prolonged drought combined with high wind, low humidity, and high temperature are unlikely to be sufficient for drying fuels enough to support large fires (Littell et al. 2014).

Plant growth can be limited by climate, especially in environments like the North Cascades, where more than 75% of precipitation falls outside of the growing season (Littell et al. 2014). Both the wet maritime forest of the west slopes and semi-arid continental forests of the east slopes are projected to experience increased loss of late-successional forest, with more insect outbreaks and more intense and extensive wildfires, fragmenting remaining late-successional habitats. In the east, increased fire may cause more profound fragmentation of forest habitat. Increasing temperature and decreases in summer precipitation are likely to cause chronic water limitation in low elevation forests of the east, leading to unfavorable climate for some forest species. Climate favorable to Douglas-fir, for example, is expected to shift enough in some models such that 32% of current range becomes unfavorable for that species by the 2080s (Littell et al. 2014). Likewise, pine species under the same climate scenarios may only have 15% of their current range remaining with favorable climate. The dynamic vegetation models underlying these projections are, like all models, products of assumptions and uncertainties. Depending on the projection (e.g. warmest and driest vs. less warm and wettest), the expected future of species composition of North Cascades forests is variable. Most scenarios estimate the change in total tree species of the Pacific Northwest to be near balance (-5 to +10 species), but some scenarios project potential losses as high as 38 species (McKenney et al. 2011). Some species, like whitebark pine (*Pinus albicaulis*), have been reported as a locally important bear food in some parts of grizzly bear range and are declining due to very specific threats like blister rust disease (Kendall 1983, Mace and Jonkel 1986, Costello et al. 2014).

### *Whitebark Pine*

Whitebark pine have persisted with wildfire for thousands of years in the Cascades, and are generally well-equipped to survive low and moderate intensity burns (Agee 1994, Lillybridge et al. 1995, Williams et al. 1995, Keane and Arno 2001). Whitebark pine occurs throughout the high-elevation areas of the North Cascades. Within the montane forest, whitebark pine makes up less than 20% of the basal forested area (Rochefort et al. 2018), with the more dominant tree species being subalpine fir, silver fir, Engelmann spruce (*Picea engelmannii*) and mountain hemlock (*Tsuga mertensiana*). Whitebark pine is a long-lived species and trees do not reach full cone production until 60–100 years of age (Lewis 1971, McCaughley and Tomback 2001). Nutritional value of their seeds has been reported as 52% fat, 21% carbohydrate, and 21% protein, as well as containing minerals such as copper, zinc, iron, manganese, magnesium, and calcium (Lanner and Gilbert 1994). This translates into an energy content of roughly 6,800–7700 calories per gram (or 1 seed) (Hutchins and Lanner 1982, Tomback 1982), making it a highly valuable food for grizzly bears.

In Montana's eastern slope of the Rocky Mountains, whitebark pine seeds were an important source of protein for grizzly bears, and were detected in 15% of scat samples from that location; however, in the other three areas of the same study, whitebark pine seeds were only detected in 0.3–4% of scat samples (Mace and Jonkel 1986). Whitebark pine, though realtively common, did not occur in the 1,100 scat samples analyzed by McLellan and Hovey (1995) for grizzly bears in southeastern British Columbia, though one observation was made of a bear feeding on pine nuts. Use of whitebark pine seeds by grizzly bears appears to occur less often relative to other available food sources; however, accurately detecting whitebark pine in grizzly bear scat has proven challenging (Kendall 1983). All radio-collared grizzly bears in a Yellowstone study utilized whitebark pine as a food source (Kendall 1983), and subsequent studies demonstrated continued use of this food source by bears in Yellowstone (Costello et al. 2014).

Regardless of where and how frequently grizzly bears feed on whitebark pine seeds, it should be noted that bears access seeds from caches made by other species rather than attempting to climb and harvest seeds themselves (Kendall 1983). In a study of whitebark pine in the Bridger-Teton National Forests, Wyoming, Clark's nutcracker (*Nucifraga columbiana*) and red squirrel (*Sciurus vulgaris*) were most commonly observed foraging for nuts, and grizzly bears were never observed (Hutchins and Lanner 1982). This relationship implies that persistence of small mammals and birds is as important in future landscapes as is the presence of viable whitebark pine and/or fire. Clark's nutcrackers play a critical role in opening and caching whitebark pine cones (Hutchins and Lanner 1982): in North Cascades the Clark's nutcracker population appears to currently be stable, but they may be declining farther south in Washington (Ray et al. 2017).

The primary threat to whitebark pine is white pine blister rust disease, which is caused by the introduced pathogen *Cronartium ribicola*. This disease has contributed to whitebark pine decline across its range, which in turn has influenced habitat use and movements of grizzly bears (Costello et al. 2014). In 2016, only 18% of whitebark pines in Mount Rainier National Park, Washington, were free of blister rust infection, as were 35% at North Cascades National Park Service Complex (Rochefort et al. 2018). Forty-three percent and 21.4% of all monitored trees in that study died between 2004 and 2015, respectively in each park. As whitebark pine declined in Yellowstone, rates of bear mortality and bear-human conflicts increased, presumably because bears were forced to expand their knowledge of local food sources and search for additional high nutrition food (Costello et al. 2014). In other parts of their range, grizzlies thrive without use of whitebark pine and the lack of this resource has not been linked to bear-human conflict (Mace and Jonkel 1986, Hamer and

Herrero 1987a, McLellan and Hovey 1995). North Cascades observations of grizzly bears in modern times potentially associated them with open habitat and/or whitebark pine distribution (Rine et al. 2018), but it is unknown if translocated grizzly bears would select for whitebark pine as a primary food source in the North Cascades, especially if bears originate from habitats where whitebark pine is not currently utilized as a primary food source.

#### *Fish and Carrion*

Twenty-seven fish species have been documented in the North Cascades Ecosystem, including five spawning anadromous salmon species, as well as non-anadromous runs of sockeye salmon (*Oncorhynchus nerka*) (known as kokanee). Rainbow trout (*Oncorhynchus mykiss*) and westslope cutthroat trout (*Oncorhynchus clarkii lewisi*) are also present in the ecosystem. There is limited evidence that grizzly bears in the Cascades historically utilized fish as a primary food source across the ecosystem, in part because of the confounding presence of human settlements and human resource use around salmon spawning streams (Rine et al. 2018). Historically, interior grizzly bears were shown to acquire 46–87% of their metabolized carbon and nitrogen intake from plants and 13–54% from terrestrial meat sources; whereas in the Columbia River basin, grizzly bears received 10–64% from plants, 0–21% from terrestrial meat, and 30–90 % from salmon (Hilderbrand et al. 1996). While grizzly bear diets appear to have historically included salmon in the Columbia River basin, it remains unknown how much grizzlies historically selected for those resources throughout the North Cascades (Hilderbrand et al. 1996).

Grizzly bears translocated into the Cascades are not expected to select for salmon because they will be sourced from populations with non-piscivorous diets (USNPS/USFWS 2017). Fish were not reported as a grizzly bear diet component in Banff National Park (Hamer and Herrero 1987a), west-central Alberta (Munro et al. 2006), Montana's Mission mountains (Mace and Jonkel 1986), or even in southeastern British Columbia where spawning cutthroat trout (*Oncorhynchus clarkii*) were commonly available (McLellan and Hovey 1995). In Yellowstone, bears did feed on cutthroat trout, but fish represented one of the least consumed foods (<1% of diet). Even in interior areas where salmon were abundant, grizzlies were shown to intake a much smaller fraction of nutrients from fish when compared to coastal fishing bear populations, because berries provided more nutritional incentive in late summer (Mowat and Heard 2006). Bears are opportunistic feeders, however, and black bears in the North Cascades have been observed catching kokanee in the Stehekin River, salmon in the Wenatchee River, and have obtained fish in the Chilliwack River where sockeye salmon escapement can reach one million during strong runs (National Park Service, unpublished data).

Carrion from salmon spawning represent a readily available source of protein and lipids in the autumn and early winter, and black bears have been documented feeding on these carcasses in the North Cascades. Grizzly bears may encounter such carrion in some areas and would likely capitalize on them as well. Under future climate scenarios, water temperatures are projected to warm which will likely cause declines in cold-water salmonids (Mantua and Raymond 2014). As these water temperatures warm, a northward range expansion of the fluke *Nanophyetus salmincola*, and its endosymbiont (*Neorickettsia* spp.), may emerge in the North Cascades. It has already been detected in the Columbia basin drainage and south of the North Cascades. This fluke is carried by salmon, and *Neorickettsia* is known to cause salmon poisoning disease in animals that feed on salmon carcasses (Robbins et al. 2018). This disease is often lethal for bears and canids, and additional research is needed to determine if native black bears or canids, or source populations of grizzly bears, carry antibodies against the disease (Robbins et al. 2018).

Carrion from ungulates is an available source throughout the ecosystem due to existing populations of cougar (*Puma concolor*) and gray wolf (*Canis lupus*) regularly killing deer and elk, as well as occasional carcasses from animals that die during winter. Grizzly bears routinely take carcasses from other carnivores as they opportunistically encounter them (Garrott et al. 2013). Grizzly bear use of winter-killed ungulate carcasses was positively correlated to elevation and distance from roads, primarily because bears are first active at higher elevations when emerging from dens (Green et al. 1997). In the Cabinet-Yaak Ecosystem, grizzly bear diet included carrion and entrails synchronous with the big game hunting season, indicating bears were scavenging sites left by humans (Kasworm and Thier 1993). Likewise, grizzly bears were reported scavenging elk carcasses around Banff in the autumn, presumably in concert with availability from human activities (Hamer and Herrero 1987a).

Abundance of the most common ungulates, deer and elk, in the North Cascades Ecosystem is expected to change very little through projected future climate scenarios. These species are generally considered insensitive to climate change because they are habitat and forage generalists and possess the ability to move large distances to meet their lifecycle needs (Lawler et al. 2014). Milder winters and lower snow pack may be advantageous to cervids, as will increased forage from early successional stages of burned forest. Disease emergence, however, could play an indeterminate role in future ungulate population abundance. For example, a treponeme-associated hoof disease that has been detected in elk since the 1990s in Washington experienced an outbreak in 2008. This disease is believed to be both polymicrobial and polyfactorial, making it difficult to understand the precise role of environment, but it is believed the bacteria may persist in wet soils (Han and Mansfield 2014). The projected increase in spring precipitation may promote a favorable environment for diseases such as this to spread, ultimately resulting in higher ungulate morality and at least near term greater abundance of carrion as grizzly bear food. This particular disease is not believed to have any trophic implications for carnivores.

### Anthropogenic Features

Grizzly bears generally avoid humans and as such the occupied habitat of the two species has relatively little overlap at the landscape scale; however, humans travel, recreate, introduce species, dam rivers, and harvest resources at large scales in grizzly bear habitat, making the suite of impacts pervasive (Mattson 1990). The major anthropogenic features in the North Cascades Ecosystem are roads, trails, towns, clear cuts, agricultural fields and orchards, and domestic livestock (Figure 5). The most significant anthropogenic impact to grizzly bears is direct killing by humans, with 77–85% of 99 mortalities across British Columbia, Alberta, Washington, Idaho, and Montana, coming from intentional human action (McLellan et al. 1999). Few bears in that study were killed within park boundaries, illustrating the importance of protected areas.

Carnivore occupancy of habitat tends to increase with distance from roads (Baker and Leberg 2018). Such linear landscape features increase risk and decrease habitat quality for grizzly bears, as well as providing a conduit for human access that can lead to direct killing and human-bear conflict (Archibald et al. 1987, Mattson et al. 1987, McLellan and Shackleton 1988, Kasworm and Manley 1990, Mace and Waller 1996, Mace et al. 1999, Gaines et al. 2003, Singleton et al. 2004, Boulanger and Stenhouse 2014, Proctor et al. 2018). Roads in the North Cascades Ecosystem decreased grizzly bear habitat effectiveness by over 30% in models of current carrying capacity (Lyons et al. 2018). Trails also bring humans into grizzly bear habitat and have been shown to directly impact carnivore occupancy (Baker and Leberg 2018). Use of existing roads and trails is expected to steadily increase through time due to expanding human populations and encroaching distribution, but also may occur earlier in the spring with warming temperatures and decreased snow pack improving accessibility. The timing of bear denning could be altered by warmer autumn temperatures, decreased snowpack, and earlier snowmelt resulting in later den entry and earlier den exit, increasing the potential for human/bear conflicts in the fall and spring when natural food sources may be limited (Servheen and Cross 2010). This underscores the need for proper sanitation practices and education programs.

Climate change in the North Cascades may influence forest management strategies as tree composition changes, fuel management priorities change, and pest outbreaks occur. In areas experiencing intense wildfires, local ambient temperatures may rise substantially influencing how bears utilize these altered landscapes even when abundant forage is present (Pigeon et al. 2016). Some important bear foods (ants, *Equisetum* spp., *Hedysarum* spp., *Taraxacum* spp., *Trifolium* spp., and *Vaccinium* spp.) were all found to occur in significantly greater frequency in Alberta clearcut blocks as opposed to uncut forest, illustrating the effects of canopy defoliation (Nielsen et al. 2004). Forest management often includes road construction; however, the federal land management agencies in the North Cascades Grizzly Bear Recovery Area have been implementing a no net loss of core area policy since 1997 (USNPS/USFWS 2017). This 1997 agreement was further articulated in the Ross Lake National Recreation Area General Management Plan (USNPS 2012), which together aim to maintain contiguous high quality grizzly bear habitat by not increasing the amount of motorized roads and trails, or non-motorized roads and trails with high-intensity use.

Climate change projections for the North Cascades and across much of grizzly bear range indicate a general uphill migration of species, which may provide more bear foods as well as adequate denning habitat at higher elevations (Roberts et al. 2014). Contrastingly, lower elevations habitats are projected to decrease in summer species richness by as much as 50% by the 2080s (Roberts et al. 2014). In the North Cascades, this equates to a likely scenario of grizzly bears selecting for higher quality habitat that moves farther away from roads and human settlements through time. Some bears may persist at lower elevations, especially as bear density approaches carrying capacity. Decreases in food availability in other parts of grizzly bear range have been related to increased human-bear conflict as bears search for alternate foods (Mattson et al. 1992, Pease and Mattson 1999, Gunther et al. 2004, Costello et al. 2014).

## Conclusion

Future climate of the North Cascades is expected to expose grizzly bears to a range of changing resource conditions, but the species low sensitivity to changing climate and high adaptive capacity portends positive long-term outcomes if a successful founding population can be re-established. A broader geographic study of climate change and grizzly bear food resources determined that across their range, grizzly bears are expected to encounter persisting or increasing food resources under future climate projections (Roberts et al. 2014). However, both phenology and specificity of food species makes this generally positive outcome less clear. Critical foods during the spring, like *Hedysarum* spp. for example, may shift in distribution and abundance, leading to higher energetic expense for bears to acquire foods when they are weakest from long months of hibernation. Earlier green-up, however, may provide graminoids and forbs earlier than normal and mitigate the need for bears to search further for *Hedysarum*. An important part of the plant-based diet of grizzly bears includes flora that are associated with wetted soils where nutrient-rich plants like horsetails and cow parsnip grow, and changes in timing and phenology of precipitation may also influence distribution of those foods though time. Broader geomorphic processes, like landslides and avalanches, can have profound effects on many food resources sought after by grizzly bears, and such changes under future climate projections could substantially drive seasonal resource use in unpredictable ways (Butler 2012). The projected uphill shift of many grizzly bear foods could draw bears farther away from valleys, and therefore humans, in part mitigating some human-bear conflict as human populations grow and expand (Roberts et al. 2014). The exact trophic interactions of future biotic communities in the North Cascades will almost certainly present conservation and management challenges that are yet to be identified, making adaptive management strategies and decision support frameworks essential for effective resource stewardship and management.

The nature of grizzly bears to occupy large home ranges and change their movements to accommodate shifting food resources demands that adaptive management be considered at landscape scales. As such, a grizzly bear climate change vulnerability assessement and decision support framework was developed for the Cascades in 2017 (Lyons et al. 2017). Such tools are aimed at translating a range of climate uncertainties into a matrix of potential management strategies (Nelson et al. 2016). In addition to climate change impacts, such tools can help guide decision-makers using other key stressors such as habitat connectivity, phenology changes to denning period, and levels of human-bear conflict, to build a flexible and robust framework of response.

The ability of grizzly bears in the Cascades to adapt to changing conditions will ultimately depend on ecological connectivity. Maintaining or increasing habitat connectivity through time and changing climate can build ecosystem resiliency by accomodating species range shifts and reducing stressors (Krosby et al. 2010). The Washington-British Columbia Transboundary Climate-Connectivity Project was initiated in 2016 to address challenges in both climate connectivity science and political management boundaries, with a suite of focal species as examples (Krosby et al. 2016). The general outcomes demonstrated that not only is adaptive management at ecosystem scale difficult under uncertain climate futures, the models needed to understand processes and species implications are often species specific. Dialog across jurisdictional boundaries and desciplines will be critical for successful adaptive management at ecosystem scales.

A range of adaptive management tools and the development of a restoration strategy that incorporates public input and transparent management action will be essential for managers to successfully re-establish grizzly bears and help them persist through changing climate, shifting biotic communitites, evolving socio-political dynamics, and growing human presence on the landscape. The North Cascades Ecosystem remains one of the largest intact wild landscapes in the continental United States, and while projected increases in growing season length, winter and spring water surplus, summer water deficit, wildfire, and decreases in snow pack will likely to lead to substantial ecological changes in the coming decades, all evidence to date suggests that high quality grizzly bear habitat will persist, making grizzly bear population restoration a critical next step. Models such as MC2 can now be used to help quantify the carrying capacity of the North Cascades under different climate projections and will help further define adapative management goals and strategies.

## Literature Cited


Abatzoglou, J. T., and T. J. Brown. 2012. A comparison of statistical downscaling methods suited for wildfire applications. International Journal of Climatology 32:772–780.

Agee, J. K. 1994. Fire and weather disturbances in terrestrial ecosystems of the eastern Cascades. Gen. Tech. Rep. PNW-GTR-320. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. Portland, Oregon. 52 p.

Almack, J. A., W. L.Gaines, R. H. Naney, P. H. Morrison, J. R. Eby, G. F. Wooten, M. C. Snyder, S. H. Fitkin, and E. R. Garcia. 1993. North Cascades grizzly bear ecosystem evaluation. Final report. Interagency Grizzly Bear Committee. Denver, Colorado. 169 p.

Archibald, W. R., R. Ellis, and A. N. Hamilton. 1987. Responses of grizzly bears to logging truck traffic in the Kimsquit River valley, British Columbia. International Conference on Bear Research and Management 7:251–257.

Bachelet, D., and D. Turner (Eds.). 2015. Global vegetation dynamics: Concepts and applications in the MC1 model. AGU Geophysical Monographs 214. 210 p.

Bachelet, D., K. Ferschweiler, T. J. Sheehan, B. M. Sleeter, and Z. Zhu. 2015. Projected carbon stocks in the conterminous US with land use and variable fire regimes. Global Change Biology 21:4548–4560.

Baker, A. D., and P. L. Leberg. 2018. Impacts of human recreation on carnivores in protected areas. PLoS ONE 13:e0195436.

Barker, O. E. 2011. Foraging ecology of brown bears in the Mackenzie Delta region, NWT. M.S. Thesis. University of Alberta, Edmonton. 123 p.

Barnes, Jr., V. G. 1990. The influence of salmon availability on movements and range of brown bears on southwest Kodiak Island. International Conference on Bear Research and Management 8:305–313.

Beeman, L. E., and M. R. Pelton. 1980. Seasonal foods and feeding ecology of black bears in the Smoky Mountains. International Conference on Bear Research and Management 4:14

Bellard, C., C. Bertelsmeier, P. Leadley, W. Thuiller, and F. Courchamp. 2012. Impacts of climate change on the future of biodiversity. Ecology Letters 15:365–377.

Bentz, B. J., J. Régnière, C. J. Fettig, E. M. Hansen, J. L. Hayes, J. A. Hicke, R. G. Kelsey, J. F. Negron, and S. J. Seybold. 2010. Climate change and bark beetles of the Western United States and Canada; direct and indirect effects. BioScience 60:602–613.

Betzen, J., D. Churchill, J. Clark, K. Davis, A. Dozic, Z. Heath, C. Hershey, J. Hof, G. Kohler, P. Manzanares, et al. 2018. Forest Health Highlights in Washington - 2017. U.S. Department of

Agriculture / Washington State Department of Natural Resources Forest Health Program. Technical Report. Olympia, Washington. 41 p.

Blanchard, B. 1983. Grizzly bear-habitat relationships in the Yellowstone area. International Conference on Bear Research and Management 5:118–123.

Boulanger, J., and G. B. Stenhouse. 2014. The impact of roads on the demography of grizzly bears in Alberta. PLoS One 9:e115535

Bunnell, F. L., and T. Hamilton 1983. Forage digestibility and fitness in grizzly bears. Bears: Their Biology and Management 5:179–185.

Butler, D. R. 2012. The impact of climate change on patterns of zoogeomorphological influence: examples from the Rocky Mountains of the Western U.S.A. Geomorphology 157–158:183–191.

Cansler, C. A. 2011. Drivers of burn severity in the northern Cascade Range, Washington, USA. M.S. thesis. University of Washington, Seattle. 128 p.

Churkina, G., and S. W. Running. 1998. Contrasting climate controls on the estimated productivity of global terrestrial biomes. Ecosystems 1:206–215.

Costello, C. M., F. T. van Manen, M. A. Haroldson, M. R. Ebinger, S. L. Cain, K. A. Gunther, and D. D. Bjornlie. 2014. Influence of whitebark pine decline on the fall habitat use and movements of grizzly bears in the Greater Yellowstone Ecosystem. Ecology and Evolution 4:2004–2018.

Craighead, J. J., and J. S. Sumner. 1982. Evaluation of grizzly bear food plants, food categories, and habitat. Pages 43–85 in Craighead, J.J., Sumner, J.S., and G.B. Scaggs (Eds). Definitive system for analysis of grizzly bear habitat and other wilderness resources. Wildlife-Wildlands Institute Monograph 1. Missoula, Montana. 279 p.

Cristescu, B., G. B. Stenhouse, and M. S. Boyce. 2015. Grizzly bear diet shifting on reclaimed mines. Global Ecology and Conservation 4:207–220.

Cross, M. S., E. S. Zavaleta, D. Bachelet, M. L. Brooks, C. A. Enquist, E. Fleishman, L. J. Graumlich, C. R. Groves, L. Hannah, L. Hansen, et al. 2012. The Adaptation for Conservation Targets (ACT) framework: A tool for incorporating climate change into natural resource management. Environmental Management 50:341–351.

Deacy, W. W., J. B. Armstrong, W. B. Leacock, . T. Robbins, D. D. Gustine, E. J. Ward, J. A Erlenbach, and J. A. Stanford. 2017. Phenological synchronization disrupts trophic interactions between Kodiak brown bears and salmon. PNAS 114:10432–10437.

Fortin, J. K., C. C. Schwartz, K. A. Gunther, J. E. Teisberg, M. A Haroldson, M. A. Evans, and C. T. Robbins. 2013. Dietary adjustability of grizzly bears and American black bears in Yellowstone National Park. Journal of Wildlife Management 77: 270–281.

Gaines, W. L., R. H. Naney, P. H. Morrison, J. R. Eby, G. F. Wooten, and J. A. Almack. 1994. Use of Lansat multispectral scanner imagery and geographic information systems to map vegetation in the North Cascades grizzly bear ecosystem. Bears: Their Biology and Management 9:533–547.

Gaines, W. L., P. H. Singleton, and R. C. Ross. 2003. Assessing the cumulative effects of linear recreation routes on wildlife habitats on the Okanogan and Wenatchee National Forests. USDA Forest Service, Pacific Northwest Research Station. Seattle, Washington. PNW-GTR-586.

Garrott, R. A., D. R. Stahler, and P. J. White. 2013. Competition and symbiosis. Pages 94–108 in White, P.J. (Ed). Yellowstone's wildlife in transition. Harvard University Press. Cambridge, Massachusetts. 362 p.

Gilman, S. E., M. C. Urban, J. Tewksbury, G. W. Gilchrist, and R. D. Holt. 2010. A framework for community interactions under climate change. Trends in Ecology & Evolution, 25:325–331.

Green, G. I., D. J. Mattson, and J. M. Peek. 1997. Spring feeding on ungulate carcasses by grizzly bears in Yellowstone National Park. Journal of Wildlife Management 61:1040–1055.

Groffman, P. M., P. Kareiva, S. Carter, N. B. Grimm, J. Lawler, M. Mack, et al. 2014. Pages 195–219 *in* IPCC. Ch. 8: Ecosystems, biodiversity, and ecosystem services. Climate change impacts in the United States: The Third National Climate Assessment. Available at: https://nca2014.globalchange.gov.

Guilday, J. E. 1968. Grizzly bears from eastern North America. American Midland Naturalist: 247-250.

Gunther, K. A., M. A. Haroldson, K. Frey, S. L. Cain, J. Copeland, and C. C. Schwartz. 2004. Grizzly bear-human conflicts in the Greater Yellowstone ecosystem, 1992–2000. Ursus 15:10–22.

Gunther, K. A., R. R. Shoemaker, K. L. Frey, M. A. Haroldson, S. L. Cain, F. T. van Manen, and J. K. Fortin. 2014. Dietary breadth of grizzly bears in the Greater Yellowstone Ecosystem. Ursus 25:61–73.

Gyug, L. W. 1998. Assessment of grizzly bear populations, habitat use and timber harvest mitigation strategies in the North Cascades Grizzly Bear Population Unit, British Columbia. Okanagan Wildlife Consulting. Westbank, British Columbia. 38 p.

Hamer, D., and S. Herrero. 1987a. Grizzly bear food and habitat in the front range of Banff National Park, Alberta. Bears: Their Biology and Management 7:199–213.

Hamer, D., and S. Herrero. 1987b. Wildfire's influence on grizzly bear feeding ecology in Banff National Park, Alberta. Bears: Their Biology and Management 7:179–186.

Hamilton, A. N., and F. L. Bunnell. 1987. Foraging strategies of coastal grizzly bears in the Kimsquit River valley, British Columbia. Bears: Their Biology and Management 7:187–197.

Han, S., and K. G. Mansfield. 2014. Severe hoof disease in free-ranging Roosevelt elk (*Cervus elaphus roosevelti*) in southwestern Washington, USA. Journal of Wildlife Diseases 50:259–270.

Hechtel, J. L. 1985. Activity and food habits of barren-ground grizzly bears in arctic Alaska. M.S. thesis. University of Montana, Missoula. 74 p.

Hicke, J. A., J. A. Logan, J. Powell, and D. S. Ojima. 2006. Changing temperatures influence suitability for modeled mountain pine beetle (*Dendroctonus ponderosae*) outbreaks in the Western United States. Journal of Geophysical Research 111:G02019.

Hilderbrand, G. V., S. D. Farley, C. T. Robbins, T. A. Hanley, K. Titus, and C. Servheen. 1996. Use of stable isotopes to determine diets of living and extinct bears. Canadian Journal of Zoology 74:2080–2088.

Hoffman, R. L., A. Woodward, P. Haggarty, K. J. Jenkins, P. Griffin, M. J. Adams, J. Hagar, T. Cummings, D. Duriscoe, K. Kopper, et al. 2015. North Cascades National Park Service Complex Natural Resource Condition Assessment. Natural Resource Report NPS/NOCA/NRR—2015/901. National Park Service, Fort Collins, Colorado. 358 p.

Hutchins, H. E., and R. M. Lanner. 1982. The central role of Clark's nutcracker in the dispersal and establishment of whitebark pine. Oecologica 55:192–201.

Johnston, A. L. L. M. Bezeau, and S. Smoliak. 1968. Chemical composition and in vitro digestibility of alpine tundra plants. Journal of Wildlife Management 32:773–777.

Kareiva, P., J. G. Kingsolver, and R. B. Huey. 1993. Biotic interactions and global change. Sinauer Associates, Inc. Sunderland, Massachusetts. 480 p.

Kasworm, W. F., and T. M. Manley. 1990. Road and trail influences on grizzly bears and black bears in Northwest Montana. International Conference on Bear Research and Management 8:79–84.

Kasworm, W. F., T. G. Radandt, J. E. Teisberg, M. Proctor, and C. Servheen. 2014. Cabinet-Yaak Grizzly Bear Recovery Area 2013 research and monitoring progress report. U.S. Fish and Wildlife Service, Missoula, Montana. 110 p.

Kasworm, W. F., and T. J. Thier. 1993. Cabinet-Yaak ecosystem grizzly bear and black bear research 1992 progress report. U.S. Fish and Wildlife Service, Technical Report. Missoula, Montana. 76 p.

Keane, R. E., and S. F. Arno. 2001. Restoration concepts and techniques. Pages 367-400 *in* D. F. Tomback, S. F. Arno, and R. E. Keane (Eds.). Whitebark pine communities: Ecology and restoration. Island Press. Washington, DC.

Kendall, K. 1983. Use of pine nuts by grizzly and black bears in the Yellowstone area. Bears-Their Biology and Management 6:166–173.

Klinka, D. R., and T. E. Reimchen. 2002. Noctural and diurnal foraging behaviour of brown bears (*Ursus arctos*) on a salmon stream in coastal British Columbia. Canadian Journal of Zoology 80:1317–1322.

Krosby, M., J. Michalak, T. O. Robbins, H. Morgan, R. Norheim, G. Mauger, and T. Murdock. 2016. The Washington-British Columbia Transboundary Climate-Connectivity Project: Identifying climate impacts and adaptation actions for wildlife habitat connectivity in the transboundary region of Washington and British Columbia. Climate Impacts Group, University of Washington. Available at: https://nplcc.databasin.org/galleries/5a3a424b36ba4b63b10b8170ea0c915.

Krosby, M., J. Tewksbury, N. Haddad, and J. Hoekstra. 2010. Ecological connectivity for a changing climate. Conservation Biology 24:1686–1689.

Lanner, R. M., and B. K. Gilbert. 1994. Nutritive value of whitebark pine seeds and the question of their variable dormancy. Page 206–211 *in* W. C. Schmidt, and F.-K. Holtmeier (Eds.). Proceedings of the international workshop on subalpine stone pines and their environment: the status of our knowledge, 1992 September 5-11, St. Mortiz, Switzerland. U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Ogden, Utah. General Technical Report INT-GRT-309.

Lawler, J. J., C. L. Raymond, M. E. Ryan, M. J. Case, and R. M. Rochefort. 2014. Climate change, wildlife, and wildlife habitat in the North Cascade Range. Pages 177–234 *in* C. L. Raymond, D. L. Peterson, and R. M. Rochefort (Eds.). Climate change vulnerability and adaptation in the North Cascades region, Washington. U.S. Department of Agriculture, Forest Service, Portland, Oregon. General Technical Report PNW-GTR-892.

Leonard, J. A., R. K. Wayne, and A. Cooper. 2000. Population genetics of Ice Age brown bears. Proceedings of the National Academy of Sciences of the United States of America 97:1651–1654.

Lewis, M. E. 1971. Flora and major plant communities of the Ruby-East Humboldt Mountains with special emphasis on Lamoille Canyon. U.S. Department of Agriculture, Forest Service, Region 4, Humboldt National Forest. Elko, Nevada. 62 p

Lillybridge, T. R., B. L. Kovalchik, C. K. Williams, and B. G. Smith. 1995. Field guide for forested plant associations of the Wenatchee National Forest. Gen. Tech. Rep. PNW-GTR-359. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. Portland, Oregon. 335 p.

Littell, J.S., Oneil, E.E., and D. McKenzie. 2010. Forest ecosystems, disturbance, and climate change in Washington State, USA. Climatic Change 102:129–159.

Littell, J. S., C. L. Raymond, R. M. Rochefort, and S. L. Klein. 2014. Climate change and vegetation in the North Cascade Range. Pages 113–176 *in* C. L. Raymond, D. L. Peterson, and R. M. Rochefort (Eds.). Climate change vulnerability and adaptation in the North Cascades region, Washington. U.S. Department of Agriculture, Forest Service, Portland, Oregon. General Technical Report PNW-GTR-892.

Lyons, A. L. W. L. Gaines, J. Begley, and W. Kasworm. 2017. Grizzly bear climate change vulnerability assessment: Cascadia Partner Forum decision support framework. Washington Conservation Science Institute and U.S. Fish and Wildlife Service, Technical Report. Available at: https://www.sciencebase.gov/catalog/item/5a6f536de4b06e28e9caca39.

Lyons, A. L. W. L. Gaines, P. H. Singleton, W. F. Kasworm, M. F. Proctor, and J. Begley. 2018. Spatially explicit carrying capacity estimates to inform species specific recovery objectives: Grizzly bear (*Ursus arctos*) recovery in the North Cascades. Biological Conservation 222:21–32.

Mace, R. D., and C. J. Jonkel. 1986. Local food habits of the grizzly bear in Montana. Bears: Their Biology and Management 6:105–110.

Mace, R. D., and J. S. Waller. 1996. Grizzly bear distribution and human conflicts in Jewel Basin Hiking Area, Swan Mountains, Montana. Wildlife Society Bulletin 24:461–467.

Mace, R. D., J. S. Waller, T. L. Manley, K. Ake, and W. T. Wittinger. 1999. Landscape evaluation of grizzly bear habitat in western Montana. Conservation Biology 13:367–377.

MacHutchon, A. G., and D. W. Wellwood. 2003. Grizzly bear food habits in the northern Yukon, Canada. Ursus 14:225–235.

Mantua, N. J., and C. J. Raymond. 2014. Climate change, wildlife, and wildlife habitat in the North Cascade Range. Pages 235–270 *in* C. L. Raymond, D. L. Peterson, and R. M. Rochefort (Eds.). Climate change vulnerability and adaptation in the North Cascades region, Washington. U.S. Department of Agriculture, Forest Service, Portland, Oregon. General Technical Report PNW-GTR-892.

Mattson, D. J. 1990. Human impacts on bear habitat use. Bears: Their Biology and Management 8:33–56.

Mattson, D. J. 2004a. Exploitation of pocket gophers and their food caches by grizzly bears. Journal of Mammalogy 85:731–742.

Mattson, D. J. 2004b. Consumption of voles and vole food caches by Yellowstone grizzly bears: exploratory analyses. Ursus 15:218–226.

Mattson, D. J., B. M. Blanchard, and R. R. Knight. 1991. Food habits of Yellowstone grizzly bears, 1977–1987. Canadian Journal of Zoology 69:1619–1629.

Mattson, D. J., B. M. Blanchard, and R. R. Knight. 1992. Yellowstone grizzly bear mortality, human habituation, and whitebark-pine seed crops. Journal of Wildlife Management 56:432–442.

Mattson, D. J., R. R. Knight, and B. M. Blanchard. 1987. The effects of developments and primary roads on grizzly bear habitat use in Yellowstone National Park, Wyoming. International Conference on Bear Research and Management 7:259–273.

Mattson, D. J., and T. Merrill. 2002. Extirpations of grizzly bears in the contiguous United States, 1850–2000. Conservation Biology 16:1123–1136.

McCaughey, W. W., and D. F. Tomback. 2001. The natural regeneration process. Pages 105-120 *in* D. F. Tomback, S. F. Arno, and R. E. Keane (Eds.). Whitebark pine communities: Ecology and restoration. Island Press. Washington, DC.

McKenney, D. W., J. H. Pedlar, R. B. Rood, and D. Price. 2011. Revisiting projected shifts in the climate envelopes of North American trees using updated general circulation models. Global Change Biology 17:2720–2730.

McLellan, B. N., and F. W. Hovey. 1995. The diet of grizzly bears in the Flathead River drainage of southeastern British Columbia. Canadian Journal of Zoology 73:704–712.

McLellan, B. N., F. W. Hovey, R. D. Mace, J. G. Woods, D. W. Carney, M. L. Gibeau, W. L. Wakkinen, and W. F. Kasworm. 1999. Rates and causes of grizzly bear mortality in the interior mountains of British Columbia, Alberta, Montana, Washington, and Idaho. Journal of Wildlife Management 63:911–920.

McLellan, B. N., and D. M. Shackleton. 1988. Grizzly bears and resource extraction industries: Effects of roads on behavior, habitat use, and demography. Journal of Applied Ecology 25:451–460.

Mierendorf, R. R.1986. People of the North Cascades.U.S. National Park Service report, Pacific Northwest Region, Seattle, Washington.

Mote, P. W., J. T. Abatzoglou, D. P. Lettenmaier, D. Turner, D. E. Rupp, D. Bachelet, N. Coops, J. Kim, T. Sheehan, K. Ferschweiler, K. Hegewisch, B. Nijssen, and M. Stumbaugh. 2015. Integrated scenarios for the future northwest environment. USGS ScienceBase. Available at: https://www.sciencebase.gov/catalog/item/5006eb9de4b0abf7ce733f5c.

Mowat, G., and D. C. Heard. 2006. Major components of grizzly bear diet across North America. Canadian Journal of Zoology 84:473–489.

Munro, R. H. M., S. E. Nielsen, M. H. Price, G. B. Stenhouse, and M. S. Boyce. 2006. Seasonal and diel patterns of grizzly bear diet and activity in west-central Alberta. Journal of Mammalogy 87:1112–1121.

Nelson, R., M. Cross, L. Hansen, and G. Tabor. 2016. A three-step decision support framework for climate adaptation: Selecting climate informed conservation goals and strategies for native salmonids in the northern U.S. Rockies. Wildlife Conservation Society, EcoAdapt, Center for

Large Landscape Conservation. Bozeman, MT, USA. Available at: http://rmpf.weebly.com/cold-water-ecosystem-management-tool.html.

Nemani, R. R., C. D. Keeling, H. Hashimoto, W. M. Jolly, S. C. Piper, C. J. Tucker, R. B. Myneni, and S. W. Running. 2003. Climate driven increases in terrestrial net primary production from 1982 to 1999. Science 300:1560–1563.

Nielsen, S. E., R. H. M. Munro, E. L. Bainbridge, G. B. Stenhouse, and M. S. Boyce. 2004. Grizzly bears and forestry II: distribution of grizzly bear foods in clearcuts of west-central Alberta, Canada. Forest Ecology and Management 199:67–82.

North Cascades Grizzly Bear Recovery Team. 2004. Recovery plan for grizzly bears in the North Cascades of British Columbia. Ministry of Water, Land and Air Protection. Victoria, British Columbia. 60 pp.

Pacifici, M., V P. isconti, S. H. M. Butchart, J. E. M. Watson, F. M. Cassola, and C. Rondinini. 2017. Species' traits influenced their response to recent climate change. Nature Climate Change 7:205–208.

Pease, C. M., and D. J. Mattson. 1999. Demography of the Yellowstone grizzly bears. Ecology 80:957–975.

Pengelly, I., and D. Hamer. 2006. Grizzly bear use of pink Hedysarum roots following shrubland fire in Banff National Park, Alberta. Ursus 17:124–131.

Peterson, R. L. 1965. A well-preserved grizzly bear skull recovered from a late glacial deposit near Lake Simcoe, Ontario. Nature 208:1233.

Phillips, M. K. 1987. Behavior and habitat use of grizzly bears in northeastern Alaska. Bears: Their Biology and Management 7:159–167.

Pigeon, K. E., E. Cardinal, G. B. Stenhouse, and S. D. Côté. 2016. Staying cool in a changing landscape: The influence of maximum daily ambient temperature on grizzly bear habitat selection. Oecologica 181:1101–1116.

Pritchard, G. T., and C. T. Robbins. 1990. Digestive and metabolic efficiencies of grizzly and black bears. Canadian Journal of Zoology 68:1645–1651.

Proctor, M. F., B. N. McLellan, S G. B. tenhouse, G. Mowat, C. T. Lamb, and M. S. Boyce. 2018. Resource roads and grizzly bears in British Columbia and Alberta, Canada. Canadian Grizzly Bear Management Series, Resource Road Management. Trans-border Grizzly Bear Project. Kaslo, British Columbia.

Proctor, M. F., S. E. Nielsen, W. F. Kasworm, C. Servheen, T. G. Radandt, A. G. Machutchon, and M.S. Boyce. 2015. Grizzly bear connectivity mapping in the Canada-United States trans-border region. Journal of Wildlife Management 79:544–558.

Rausch, R. L. 1963. Geographic variation in size in North American brown bears, *Ursus arctos* L., as indicated by condylobasal length. Canadian Journal of Zoology 41:33-45.

Ray, C., J. F. Saracco, M. L. Holmgren, R. L. Wilkerson, R. B. Siegel, K. J. Jenkins, J. I. Ransom, P. J. Happe, J. R. Boetsch, and M. H. Huff. 2017. Recent stability of resident and migratory landbird populations in National Parks of the Pacific Northwest. Ecosphere 8:e01902.

Raymond, C. L., D. L. Peterson, and R. M. Rochefort (Eds). 2014. Climate change vulnerability and adaptation in the North Cascades region, Washington. U.S. Department of Agriculture, Forest Service, Portland, Oregon. General Technical Report PNW-GTR-892.

Rine, K. R., A. M. Braaten, J. G. Oelfke, and J. I. Ransom. 2018. A synthesis of historical and recent reports of grizzly bears (*Ursus arctos*) in the North Cascades Region. Natural Resource Report NPS/NOCA/NRR—2018/1662. National Park Service, Fort Collins, Colorado.

Ripple, W. J., and R. L. Beschta. 2012. Trophic cascades in Yellowstone: The first 15 years after wolf reintroduction. Biological Conservation 145:205–213.

Robbins, C. T., N. L. Woodford, G. G. Clyde, C. Minor, O. L. Nelson, M. M. Brewer, P. Khalife, and J. R. Hawley. 2018. Salmon poisoning disease in grizzly bears with population recovery implications. Journal of Wildlife Management Available at: https://doi.org/10.1002/jwmg.21502

Roberts, D. R., S. E. Nielsen, and G. B. Stenhouse. 2014. Idiosyncratic responses of grizzly bear habitat to climate change based on projected food resource changes. Ecological Applications 24:1144–1154.

Rochefort, R. M., S. Howlin, L. Jeroue, J. R. Boetsch, and L. P. Grace. 2018. Whitebark pine in the Northern Cascades: Tracking the effects of blister rust on population health in North Cascades National Park Service Complex and Mount Rainier National Park. Forests 9(5):244, doi: 10.3390/f9050244.

Rode, K. D., C. T. Robbins, and L. A. Shipley. 2001. Constraints on herbivory by grizzly bears. Oecologica 128:62–71.

Rogers, L. 1976. Effects of mast and berry crop failures on survival, growth, and reproductive success of black bears. Transactions of the 41st North American Wildlife and Natural Resources Conference 41:431–438.

Rogers, B. M., R. P. Neilson, R. Drapek, J. M. Lenihan, J. R. Wells, D. Bachelet, and B. E. Law. 2011. Impacts of climate change on fire regimes and carbon stocks of the U.S. Pacific Northwest. Journal of Geophysical Research 116:G03037.

Rubenstein, M. A., R. Christophersen, and J. I. Ransom. 2018. Trophic implications of a phenological paradigm shift: bald eagles and salmon in a changing climate. Journal of Applied Ecology. Available at: https://doi.org/10.1111/1365-2664.13286.

Schneider, S. H., T. L. Root, and M. Van Putten. 2002. Wildlife responses to climate change: North American case studies. Washington DC: Island Press. 350 p.

Schwartz. C. C., and A. W. Franzman. 1991. Interrelationships of black bears to moose and forest succession in the northern coniferous forest. Wildlife Monographs 113:1–58.

Servheen, C. 1983. Grizzly bear food habits, movements, and habitat selection in the Mission Mountains. Journal of Wildlife Management 47:1026–1035.

Servheen, C. 1999. Bears: status survey and conservation action plan, Vol. 44. IUCN, Gland, Switzerland.

Servheen, C., and M. Cross. 2010. Climate change impacts on grizzly bears and wolverines in the Northern U.S. and Transboundary Rockies: Strategies for Conservation. Report on a workshop held September 13–15, 2010 in Fernie, British Columbia. 23 pp.

Singleton, P. H., W. L. Gaines, and J. F. Lehmkuhl. 2004. Landscape permeability for grizzly bear movements in Washington and southwestern British Columbia. Ursus 15:90–103.

Sizemore, D. 1980. Foraging strategies of the grizzly bear as related to its ecological energetics. M.S. Thesis, University of Montana, Missoula. 67 pp.

Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K. B. Averyt, M. Tignor, and H. L. Miller (Eds.). 2007. IPCC, Climate change 2007: The physical science basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.

Stephenson, N. L. 1990. Climatic control of vegetation distribution in the role of the water balance. American Naturalist 135:649–670.

Stirling, I., and A. Derocher. 1990. Factors affecting the evolution and behavioral ecology of the modern bears. Bears: Their Biology and Management 8:189–204.

Storer, T. I., and L. P. Tevis Jr. 1955. California grizzly. University of California Press, Berkley, California.

Swenson, J. E., A. Jansson, R. Riig, and F. Sandegren. 1999. Bears and ants: myrmecophagy by brown bears in central Scandinavia. Canadian Journal of Zoology 77:551–561.

Tardiff, S. E., and J. A. Stanford. 1998. Grizzly bear digging: effects on subalpine meadow plants in relation to mineral nitrogen availability. Ecology 79:2219–2228.

Taylor, K. E. R. J. Stouffer, and G. A. Meehl. 2012. An overview of CMIP5 and the experiment design. Bulletin of the American Meteorological Society 93:485–498.

Thackeray, S. J., P. A. Henrys, D. Hemming, J. R. Bell, M. S. Botham, S. Burthe, P. Helaouet, D. G. Johns, I. D. Jones, D. I. Leech, et al. 2016. Phenological sensitivity to climate across taxa and trophic levels. Nature 535:241–245.

Tomback, D. F. 1982. Dispersal of whitebark pine seeds by Clark's nutcracker: a mutualism hypothesis. Journal of Animal Ecology 51:451–467.

U.S. Fish and Wildlife Service (USFWS). 1993. Grizzly bear recovery plan. U.S. Fish and Wildlife Service. Missoula, Montanta. 181 p.

U.S. Fish and Wildlife Service (USFWS). 1997. Grizzly bear recovery plan: North Cascades Ecosystem recovery chapter. U.S. Fish and Wildlife Service. Missoula, Montana. 24 p.

U.S. Geological Survey. 2018. Biodiversity Information Serving Our Nation (BISON) database. Available at: https://bison.usgs.gov (accessed 2018-07-24).

U.S. National Park Service. 2012. Ross Lake National Recreation Area general management plan. North Cascades National Park Service Complex. Sedro-Woolley, Washington. 164 p.

U.S. National Park Service and U.S. Fish and Wildlife Service (USNPS/USFWS). 2017. Draft grizzly bear restoration plan/environmental impact statement. North Cascades Ecosystem. U.S. Department of the Interior, Washington D.C. 198 pp.

Welch, C. A., J. Keay, K. C. Kendall, and C. T. Robbins. 1997. Constraints on frugivory by bears. Ecology 78:1105–1119.

Williams, C. K., B. F. Kelley, B. G. Smith, and T. R. Lillybridge. 1995. Forest plant associations of the Colville National Forest. Gen. Tech. Rep. PNW-360. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. Portland, Oregon. 375 p.

# Appendix A. Potential grizzly bear foods present in the North Cascades Ecosystem

**Table A-1.** Potential grizzly bear (*Ursus arctos*) foods present in the North Cascades Ecosystem (list of occurrence data sources can be found in Table A-2). Due to analytical limitations or quality of fecal or isotopic data, many studies have only identified foods at the Order, Family, or Genus level. Species present in the North Cascades Ecosystem that match sources at these higher taxonomic levels are considered potential foods because they are closely related or very similar in lifeform to those reported as foods. Aggregated rows that list number of species present by Order, Family, or Genus do not include any members that are listed separately at a lower taxonomic level (For example, the single row denoting "Genus *Abies* (firs): 3 species" does not include *Abies lasiocarpa* that is listed separately because it was documented as a food source at the species level).

| Category | Scientific Name | Common Name | Lowest Level Taxomony Match | Source |
| --- | --- | --- | --- | --- |
| Vascular Plant | *Abies lasiocarpa* | subalpine fir | Species | Blanchard 1983, Mace and Jonkel 1986, Gunther et al. 2014 |
| Vascular Plant | *Abies* spp. | 3 species (firs) | Genus | Blanchard 1983, Mace and Jonkel 1986, Gunther et al. 2014 |
| Vascular Plant | *Achillea millefolium* | common yarrow, western yarrow | Species | Fortin et al. 2013, Gunther et al. 2014, Cristescu et al. 2015 |
| Vascular Plant | *Actaea elata* | tall bugbane | Genus | Gunther et al. 2014 |
| Vascular Plant | *Actaea rubra* | red baneberry | Species | Gunther et al. 2014 |
| Vascular Plant | *Agoseris aurantiaca* | orange agoseris, mountain dandelion | Species | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Agoseris* spp. | 5 species (agoserises) | Genus | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Agropyron cristatum* | crested wheatgrass | Species | Almack et al. 1993, Fortin et al. 2013 |
| Vascular Plant | *Agropyron dasystachyum* | thickspike wheatgrass | Species | Almack et al. 1993, Fortin et al. 2013 |
| Vascular Plant | *Agrostis gigantea* | redtop | Species | Sizemore 1980, Almack et al. 1993, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Agrostis* spp. | 13 species (bentgrasses) | Genus | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | Alismatales | 13 species (water plantains) | Order | Gunther et al. 2014 |
| Vascular Plant | *Allium schoenoprasum* | chives | Species | Almack et al. 1993 |
| Vascular Plant | *Allium* spp. | 11 species (onions) | Genus | Gunther et al. 2014 |

| Category | Scientific Name | Common Name | Lowest Level Taxomony Match | Source |
|---|---|---|---|---|
| Vascular Plant | *Amaranthus* spp. | 3 species (pigweeds) | Genus | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | Amaryllidaceae: *Narcissus* spp. | daffodil, narcissus | Family | Gunther et al. 2014 |
| Vascular Plant | *Amelanchier alnifolia* | Saskatoon serviceberry | Species | Sizemore 1980, Servheen 1983, Mace and Jonkel 1986, Almack et al. 1993, Kasworm and Thier 1993, Gunther et al. 2014, Kasworm et al. 2014 |
| Vascular Plant | *Amelanchier* spp. | 3 species (serviceberries) | Genus | Sizemore 1980, Servheen 1983, Mace and Jonkel 1986, Kasworm and Thier 1993, Gunther et al. 2014, Kasworm et al. 2014 |
| Vascular Plant | *Andropogon gerardii* | big bluestem | Genus | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Angelica arguta* | angelica | Species | Sizemore 1980, Almack et al. 1993, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Angelica canbyi* | Canby's angelica | Genus | Sizemore 1980, Mace and Jonkel 1986, Kasworm and Thier 1993, McLellan and Hovey 1995 |
| Vascular Plant | *Angelica genuflexa* | kneeling angelica | Species | Sizemore 1980, Almack et al. 1993, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Angelica lucida* | seacoast angelica | Genus | Sizemore 1980, Mace and Jonkel 1986, Kasworm and Thier 1993, McLellan and Hovey 1995 |
| Vascular Plant | *Antennaria* spp. | 16 species (pussytoes) | Genus | Fortin et al. 2013 |
| Vascular Plant | Apiaceae | 19 species (parsleys, chervils) | Family | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Aquilegia* spp. | 4 species (columbines) | Genus | Gunther et al. 2014 |
| Vascular Plant | *Arabis* spp. | 13 species (rockcresses) | Genus | Gunther et al. 2014 |
| Vascular Plant | Araceae | 5 species (duckweeds) | Family | Sizemore 1980, Gunther et al. 2014 |

| Category | Scientific Name | Common Name | Lowest Level Taxomony Match | Source |
|---|---|---|---|---|
| Vascular Plant | *Aralia nudicaulis* | wild sarsparilla | Species | Munro et al. 2006, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | Araliaceae | 2 species (ivy) | Family | Munro et al. 2006, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Arctostaphylos* spp. | 3 species (manzanitas) | Genus | Mace and Jonkel 1986, Kasworm and Thier 1993, Munro et al. 2006, McLellan and Hovey 1995, Gunther et al. 2014, Cristescu et al. 2015 |
| Vascular Plant | *Arctostaphylos uva-ursi* | bearberry, kinnikinnick | Species | Mace and Jonkel 1986, Almack et al. 1993, Kasworm and Thier 1993, Munro et al. 2006, McLellan and Hovey 1995, Gunther et al. 2014 |
| Vascular Plant | *Arnica cordifolia* | heartleaf arnica | Species | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Arnica* spp. | 14 species (arnicas) | Genus | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Artemisia* spp. | 19 species (sagebrushes) | Genus | Fortin et al. 2013 |
| Vascular Plant | Asparagaceae | 9 species (asparagus, hyacinth) | Family | Gunther et al. 2014 |
| Vascular Plant | Asparagales | 6 species (irises, blue-eyed grasses) | Order | Gunther et al. 2014 |
| Vascular Plant | *Aster* spp. | 6 species (asters) | Genus | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | Asteraceae | 195 species (asters, daisy) | Family | Fortin et al. 2013 |
| Vascular Plant | Asterales | 15 species  (bellflowers) | Order | Fortin et al. 2013 |
| Vascular Plant | *Astragalus miser* | timber milkvetch | Species | Gunther et al. 2014 |
| Vascular Plant | *Astragalus robbinsii* | Robbins' milkvetch | Species | Almack et al. 1993, Gunther et al. 2014 |
| Vascular Plant | *Astragalus cicer* | chickpea milkvetch | Species | Gunther et al. 2014, Cristescu et al. 2015 |
| Vascular Plant | *Astragalus* spp. | 15 species (milkvetches) | Genus | Gunther et al. 2014 |

| Category | Scientific Name | Common Name | Lowest Level Taxomony Match | Source |
|---|---|---|---|---|
| Vascular Plant | *Athyrium alpestre* | alpine ladyfern | Genus | Sizemore 1980 |
| Vascular Plant | *Athyrium distentifolium* | alpine ladyfern | Genus | Sizemore 1980 |
| Vascular Plant | *Athyrium filix-femina* | common ladyfern | Species | Sizemore 1980 |
| Vascular Plant | *Avena fatua* | common wild oat | Genus | Kasworm and Thier 1993, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Avena sativa* | wild oats | Species | Kasworm and Thier 1993, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Balsamorhiza sagittata* | arrowleaf balsamroot | Species | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Balsamorhiza* spp. | 3 species (balsamroots) | Genus | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | Berberidaceae | 5 species (barberry, vanilla leaf) | Family | Kasworm and Thier 1993, Gunther et al. 2014 |
| Vascular Plant | *Berberis* spp. | 4 species (barberrys) | Genus | Kasworm and Thier 1993, Gunther et al. 2014 |
| Vascular Plant | *Betula* spp. | 7 species (birches) | Genus | Gunther et al. 2014 |
| Vascular Plant | Betulaceae | 6 species (alders) | Family | Gunther et al. 2014 |
| Vascular Plant | *Bistorta bistortoides* | American bistort | Species | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Bistorta vivipara* | alpine bistort | Species | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | Boraginaceae | 54 species (borges, forget-me-nots) | Family | Gunther et al. 2014 |
| Vascular Plant | *Boykinia occidentalis* | coastal brookfoam | Species | Phillips 1987, Almack et al. 1993, Gunther et al. 2014 |
| Vascular Plant | *Brassica* spp. | 4 species (mustards) | Genus | Gunther et al. 2014 |
| Vascular Plant | Brassicaceae | 119 species (mustards, rockcresses, drabas) | Family | Gunther et al. 2014 |

| Category | Scientific Name | Common Name | Lowest Level Taxomony Match | Source |
|---|---|---|---|---|
| Vascular Plant | Brassicales | 3 species (mustards and allies) | Order | Gunther et al. 2014 |
| Vascular Plant | *Bromus carinatus* | California brome | Species | Almack et al. 1993, Kasworm and Thier 1993, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Bromus* spp. | 18 species (bromes) | Genus | Almack et al. 1993, Kasworm and Thier 1993, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Bromus vulgaris* | Columbia brome | Species | Almack et al. 1993, Kasworm and Thier 1993, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Calamagrostis canadensis* | bluejoint reedgrass | Species | Almack et al. 1993, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Calamagrostis rubescens* | pinegrass | Species | Almack et al. 1993, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Calamagrostis* spp. | 6 species (reedgrasses) | Genus | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Calamagrostis stricta* | slim-stem small reedgrass | Species | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Camassia leichtlinii* | Suksdorf's large camas | Genus | Gunther et al. 2014 |
| Vascular Plant | *Camassia quamash* | camas | Species | Gunther et al. 2014 |
| Vascular Plant | Caprifoliaceae | 3 species (honeysuckles) | Family | Gunther et al. 2014 |
| Vascular Plant | *Carex athrostachya* | slenderbeak sedge | Species | Sizemore 1980, Mace and Jonkel 1986, Phillips 1987, Servheen 1983, Almack et al. 1993, Kasworm and Thier 1993, Fortin et al. 2013, Gunther et al. 2014, Kasworm et al. 2014 |

| Category | Scientific Name | Common Name | Lowest Level Taxomony Match | Source |
|---|---|---|---|---|
| Vascular Plant | *Carex concinnoides* | northwestern sedge | Species | Sizemore 1980, Mace and Jonkel 1986, Phillips 1987, Servheen 1983, Almack et al. 1993, Kasworm and Thier 1993, Fortin et al. 2013, Gunther et al. 2014, Kasworm et al. 2014 |
| Vascular Plant | *Carex geyeri* | Geyer's sedge | Species | Sizemore 1980, Mace and Jonkel 1986, Phillips 1987, Servheen 1983, Almack et al. 1993, Kasworm and Thier 1993, Fortin et al. 2013, Gunther et al. 2014, Kasworm et al. 2014 |
| Vascular Plant | *Carex macrochaeta* | longawn sedge | Species | Sizemore 1980, Mace and Jonkel 1986, Phillips 1987, Servheen 1983, Almack et al. 1993, Kasworm and Thier 1993, Fortin et al. 2013, Gunther et al. 2014, Kasworm et al. 2014 |
| Vascular Plant | *Carex nigricans* | black alpine sedge | Species | Sizemore 1980, Mace and Jonkel 1986, Phillips 1987, Servheen 1983, Almack et al. 1993, Kasworm and Thier 1993, Fortin et al. 2013, Gunther et al. 2014, Kasworm et al. 2014 |
| Vascular Plant | *Carex praticola* | northern meadow sedge | Species | Sizemore 1980, Mace and Jonkel 1986, Phillips 1987, Servheen 1983, Almack et al. 1993, Kasworm and Thier 1993, Fortin et al. 2013, Gunther et al. 2014, Kasworm et al. 2014 |
| Vascular Plant | *Carex raynoldsii* | Raynold's sedge | Species | Sizemore 1980, Mace and Jonkel 1986, Phillips 1987, Servheen 1983, Almack et al. 1993, Kasworm and Thier 1993, Fortin et al. 2013, Gunther et al. 2014, Kasworm et al. 2014 |

| Category | Scientific Name | Common Name | Lowest Level Taxomony Match | Source |
|---|---|---|---|---|
| Vascular Plant | *Carex rostrata* | beaked sedge | Species | Sizemore 1980, Mace and Jonkel 1986, Phillips 1987, Servheen 1983, Almack et al. 1993, Kasworm and Thier 1993, Fortin et al. 2013, Gunther et al. 2014, Kasworm et al. 2014 |
| Vascular Plant | *Carex sitchensis* | Sitka sedge | Species | Sizemore 1980, Mace and Jonkel 1986, Phillips 1987, Servheen 1983, Almack et al. 1993, Kasworm and Thier 1993, Fortin et al. 2013, Gunther et al. 2014, Kasworm et al. 2014 |
| Vascular Plant | *Carex* spp. | 108 species (sedges) | Genus | Sizemore 1980, Mace and Jonkel 1986, Phillips 1987, Servheen 1983, Almack et al. 1993, Kasworm and Thier 1993, Fortin et al. 2013, Gunther et al. 2014, Kasworm et al. 2014 |
| Vascular Plant | Caryophyllaceae | 72 species (pinks, sandworts, chickweed) | Family | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | Caryophyllales | 18 species (succulents) | Order | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Castilleja* spp. | 16 species (paintbrushes) | Genus | Almack et al. 1993, Gunther et al. 2014 |
| Vascular Plant | Celastraceae | 2 species (grass of Parnassus) | Family | Gunther et al. 2014 |
| Vascular Plant | *Cerastium* spp. | 8 species (chickweeds) | Genus | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Chamerion angustifolium* | fireweed | Species | Gunther et al. 2014 |
| Vascular Plant | *Chamerion latifolium* | dwarf fireweed | Genus | Gunther et al. 2014 |
| Vascular Plant | *Chenopodium* spp. | 11 species (goosefoots) | Genus | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Chimaphila menziesii* | little prince's pine | Genus | Mace and Jonkel 1986, Almack et al. 1993, Kasworm and Thier 1993, Gunther et al. 2014 |

| Category | Scientific Name | Common Name | Lowest Level Taxomony Match | Source |
|---|---|---|---|---|
| Vascular Plant | *Chimaphila umbellata* | pipsissewa | Species | Mace and Jonkel 1986, Almack et al. 1993, Kasworm and Thier 1993 |
| Vascular Plant | *Cicuta douglasii* | Douglas' waterhemlock | Species | Sizemore 1980, Almack et al. 1993, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Cirsium arvense* | Canada thistle | Species | Almack et al. 1993, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Cirsium edule* | edible thistle | Species | Almack et al. 1993, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Cirsium scariosum* | meadow thistle | Species | Almack et al. 1993, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Cirsium* spp. | 4 species (thistles) | Genus | Almack et al. 1993, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Claytonia lanceolata* | lanceleaf springbeauty | Species | Sizemore 1980, Mace and Jonkel 1986, Mattson et al. 1991, Almack et al. 1993, Mattson 2004a, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Claytonia megarhiza* | alpine springbeauty | Species | Almack et al. 1993 |
| Vascular Plant | *Claytonia* spp. | 7 species (springbeauties) | Genus | Mace and Jonkel 1986, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Clematis* spp. | 4 species (clematises) | Genus | Gunther et al. 2014 |
| Vascular Plant | *Corispermum pallasii* | Pallus bugseed | Genus | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Corispermum villosum* | hairy bugseed | Genus | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | Cornales | 5 species (blazingstars) | Order | Mace and Jonkel 1986 |
| Vascular Plant | *Cornus canadensis* | bunchberry dogwood | Species | Sizemore 1980, Mace and Jonkel 1986, Almack et al. 1993, Cristescu et al. 2015 |

| Category | Scientific Name | Common Name | Lowest Level Taxomony Match | Source |
|---|---|---|---|---|
| Vascular Plant | *Cornus florida* | flowering dogwood | Genus | Sizemore 1980, Mace and Jonkel 1986 |
| Vascular Plant | *Cornus nuttallii* | Pacific dogwood | Species | Sizemore 1980, Mace and Jonkel 1986, Almack et al. 1993 |
| Vascular Plant | *Cornus sericea* | western dogwood | Species | Sizemore 1980, Mace and Jonkel 1986, Almack et al. 1993, Gunther et al. 2014 |
| Vascular Plant | *Cornus unalaschkensis* | Alaskan bunchberry | Genus | Mace and Jonkel 1986 |
| Vascular Plant | *Crataegus douglasii* | Douglas' hawthorn | Species | Servheen 1983, Almack et al. 1993, Gunther et al. 2014 |
| Vascular Plant | *Crataegus* spp. | 6 species (hawthorns) | Genus | Servheen 1983, Almack et al. 1993, Gunther et al. 2014 |
| Vascular Plant | *Crepis* spp. | 13 species (hawksbeards) | Genus | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Cucurbita* spp. | gourds | Genus | Gunther et al. 2014 |
| Vascular Plant | Cucurbitaceae | 3 species (cucumbers) | Family | Gunther et al. 2014 |
| Vascular Plant | Cupressaceae | 3 species (cedars) | Family | Blanchard 1983, Mace and Jonkel 1986, Gunther et al. 2014 |
| Vascular Plant | Cyperaceae | 20 species (bulrushes, spikerushes, ) | Family | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Danthonia* spp. | 3 species (oatgrass) | Genus | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Danthonia unispicata* | onespike oatgrass | Species | Almack et al. 1993, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Dasiphora fruticosa* | shrubby cinquefoil | Species | Gunther et al. 2014 |
| Vascular Plant | *Daucus carota* | Queen Anne's lace | Species | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Daucus pusillus* | American wild carrot | Genus | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Delphinium* spp. | 11 species (larkspurs) | Genus | Mace and Jonkel 1986, Gunther et al. 2014 |

| Category | Scientific Name | Common Name | Lowest Level Taxomony Match | Source |
|---|---|---|---|---|
| Vascular Plant | *Deschampsia cespitosa* | tufted hairgrass | Species | Almack et al. 1993, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Deschampsia danthonioides* | annual hairgrass | Genus | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Deschampsia elongata* | slender hairgrass | Genus | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | Dipsacales | 7 species (seablushes and valerians) | Order | Gunther et al. 2014 |
| Vascular Plant | *Disporum* spp. | 3 species (fairy bells) | Genus | Mace and Jonkel 1986, Almack et al. 1993, Gunther et al. 2014 |
| Vascular Plant | Elaeagnaceae: *Elaeagnus multiflora* | goumi sweet scarlet | Family | Servheen 1983, Mace and Jonkel 1986, Hamer and Herrero 1987a, MacHutchon and Wellwood 2003, Munro et al. 2006, McLellan and Hovey 1995, Gunther et al. 2014 |
| Vascular Plant | Elaeagnaceae: *Elaeagnus umbellata* | autumn olive | Family | Servheen 1983, Mace and Jonkel 1986, Hamer and Herrero 1987a, MacHutchon and Wellwood 2003, Munro et al. 2006, McLellan and Hovey 1995, Gunther et al. 2014 |
| Vascular Plant | *Elodea canadensis* | Canadian waterweed | Genus | Gunther et al. 2014 |
| Vascular Plant | *Elymus glaucus* | blue wildrye | Species | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Elymus* spp. | 10 species (wheatgrasses) | Genus | Fortin et al. 2013 |
| Vascular Plant | *Elymus trachycaulus* | slender wheatgrass | Species | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Empetrum nigrum* | black crowberry | Species | Phillips 1987, Almack et al. 1993, MacHutchon and Wellwood 2003, Cristescu et al. 2015 |
| Vascular Plant | *Epilobium angustifolium* | fireweed | Species | Almack et al. 1993, Gunther et al. 2014, Cristescu et al. 2015 |

| Category | Scientific Name | Common Name | Lowest Level Taxomony Match | Source |
|---|---|---|---|---|
| Vascular Plant | *Epilobium ciliatum* | fringed willowherb | Species | Gunther et al. 2014 |
| Vascular Plant | *Epilobium* spp. | 21 species (willowherb) | Genus | Gunther et al. 2014 |
| Vascular Plant | *Equisetum* spp. | 7 species (horsetails) | Genus | Sizemore 1980, Servheen 1983, Mace and Jonkel 1986, Phillips 1987, Hamer and Herrero 1987a, Almack et al. 1993, Munro et al. 2006, MacHutchon and Wellwood 2003, Gunther et al. 2014, Cristescu et al. 2015 |
| Vascular Plant | *Equisetum arvense* | field horsetail | Species | Sizemore 1980, Servheen 1983, Mace and Jonkel 1986, Phillips 1987, Hamer and Herrero 1987a, Almack et al. 1993, Munro et al. 2006, MacHutchon and Wellwood 2003, Gunther et al. 2014 |
| Vascular Plant | *Equisetum fluviatile* | water horsetail | Species | Sizemore 1980, Servheen 1983, Mace and Jonkel 1986, Phillips 1987, Hamer and Herrero 1987a, Almack et al. 1993, Munro et al. 2006, MacHutchon and Wellwood 2003, Gunther et al. 2014 |
| Vascular Plant | *Equisetum hyemale* | scouringrush horsetail | Species | Sizemore 1980, Servheen 1983, Mace and Jonkel 1986, Phillips 1987, Hamer and Herrero 1987a, Almack et al. 1993, Munro et al. 2006, MacHutchon and Wellwood 2003, Gunther et al. 2014 |
| Vascular Plant | Ericaceae | 34 species (laurels, salal, wintergreens) | Family | Gunther et al. 2014 |
| Vascular Plant | Ericales | 66 species (collomias, shootingstars, phloxes) | Order | Gunther et al. 2014 |
| Vascular Plant | *Ericameria bloomeri* | Bloomer's goldenbush | Species | Fortin et al. 2013 |
| Vascular Plant | *Ericameria nauseosa* | rubber rabbitbrush | Species | Fortin et al. 2013 |

| Category | Scientific Name | Common Name | Lowest Level Taxomony Match | Source |
|---|---|---|---|---|
| Vascular Plant | *Eriogonum* spp. | 13 species (buckwheat) | Genus | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Eriophorum* spp. | 5 species (cottongrasses) | Genus | Phillips 1987, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Eriophorum vaginatum* | tussock cottongrass | Species | Almack et al. 1993 |
| Vascular Plant | *Erythronium grandiflorum* | yellow avalanche-lily | Species | Sizemore 1980, Servheen 1983, Mace and Jonkel 1986, Almack et al. 1993, Kasworm and Thier 1993, Tardiff and Stanford 1998, McLellan and Hovey 1995, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Erythronium montanum* | white avalanche-lily | Species | Sizemore 1980, Servheen 1983, Mace and Jonkel 1986, Almack et al. 1993, Kasworm and Thier 1993, Tardiff and Stanford 1998, McLellan and Hovey 1995, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Erythronium oregonum* | giant white fawnlily | Genus | Sizemore 1980, Servheen 1983, Mace and Jonkel 1986, Kasworm and Thier 1993, Tardiff and Stanford 1998, McLellan and Hovey 1995, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Erythronium revolutum* | mahogany fawnlily | Genus | Sizemore 1980, Servheen 1983, Mace and Jonkel 1986, Kasworm and Thier 1993, Tardiff and Stanford 1998, McLellan and Hovey 1995, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Eurybia* spp. | 4 species (asters) | Genus | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | Fabaceae | 33 species (trefoils, locusts, brooms) | Family | Gunther et al. 2014 |
| Vascular Plant | Fagales | 9 species (oak, walnut, beech) | Order | Gunther et al. 2014 |

| Category | Scientific Name | Common Name | Lowest Level Taxomony Match | Source |
|---|---|---|---|---|
| Vascular Plant | *Festuca altaica* | northern rough fescue | Species | Almack et al. 1993, Fortin et al. 2013 |
| Vascular Plant | *Festuca idahoensis* | Idaho fescue | Species | Almack et al. 1993, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Festuca* spp. | 15 species (fescues) | Genus | Fortin et al. 2013 |
| Vascular Plant | *Fragaria chiloensis* | beach strawberry | Genus | Kasworm and Thier 1993, Gunther et al. 2014, Cristescu et al. 2015 |
| Vascular Plant | *Fragaria vesca* | woodland strawberry | Species | Almack et al. 1993, Kasworm and Thier 1993, Gunther et al. 2014 |
| Vascular Plant | *Fragaria virginiana* | Virginia strawberry | Species | Almack et al. 1993, Kasworm and Thier 1993, Gunther et al. 2014, Roberts et al. 2014 |
| Vascular Plant | *Fritillaria pudica* | yellow bell | Species | Almack et al. 1993 |
| Vascular Plant | *Galium* spp. | 14 species (bedstraws) | Genus | Gunther et al. 2014 |
| Vascular Plant | *Galium triflorum* | fragrant bedstraw | Species | Gunther et al. 2014 |
| Vascular Plant | Gentianales | 17 species (gentians) | Order | Gunther et al. 2014 |
| Vascular Plant | Geraniaceae: *Erodium cicutarium* | redstem stork's bill | Family | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Geranium* spp. | 8 species (geraniums) | Genus | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Geranium viscosissimum* | sticky purple geranium | Species | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Geum* spp. | 3 species (avens) | Genus | Gunther et al. 2014 |
| Vascular Plant | *Geum triflorum* | prairie smoke | Species | Gunther et al. 2014 |
| Vascular Plant | *Hedysarum alpinum* | American Hedysarum | Species | Almack et al. 1993 |

| Category | Scientific Name | Common Name | Lowest Level Taxomony Match | Source |
|---|---|---|---|---|
| Vascular Plant | *Hedysarum* spp. | Hedysarum | Genus | Servheen 1983, Mace and Jonkel 1986, Phillips 1987, Hamer and Herrero 1987a, MacHutchon and Wellwood 2003, Munro et al. 2006, Pengelly and Hamer 2006, McLellan and Hovey 1995, Gunther et al. 2014, Cristescu et al. 2015 |
| Vascular Plant | *Hedysarum occidentale* | western Hedysarum | Species | Almack et al. 1993 |
| Vascular Plant | *Hedysarum sulphurescens* | yellow Hedysarum | Species | Almack et al. 1993 |
| Vascular Plant | *Helianthus annuus* | common sunflower | Species | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Helianthus* spp. | 3 species (sunflowers) | Genus | Gunther et al. 2014 |
| Vascular Plant | *Heracleum lanatum* | common cow parsnip | Species | Sizemore 1980, Servheen 1983, Mace and Jonkel 1986, Hamer and Herrero 1987a, Almack et al. 1993, Kasworm and Thier 1993, Munro et al. 2006, McLellan and Hovey 1995, Fortin et al. 2013, Gunther et al. 2014, Kasworm et al. 2014, Cristescu et al. 2015 |
| Vascular Plant | *Heracleum mantegazzianum* | giant hogweed | Genus | Sizemore 1980, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Heracleum maximum* | cow parsnip | Genus | Sizemore 1980, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Heracleum sphondylium* | common hogweed | Species | Sizemore 1980, Almack et al. 1993, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Heterotheca villosa* | hairy false goldenaster | Species | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Heuchera cylindrica* | alpine alumroot | Species | Gunther et al. 2014 |
| Vascular Plant | *Heuchera* spp. | 4 species (alumroots) | Genus | Gunther et al. 2014 |

| Category | Scientific Name | Common Name | Lowest Level Taxomony Match | Source |
|---|---|---|---|---|
| Vascular Plant | *Hieracium gracile* | slender hawkweed | Species | Almack et al. 1993, Fortin et al. 2013 |
| Vascular Plant | *Hieracium* spp. | 14 species (hawkweeds) | Genus | Almack et al. 1993, Fortin et al. 2013 |
| Vascular Plant | *Hordeum brachyantherum* | meadow barley | Species | Almack et al. 1993, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Hordeum* spp. | 3 species (barleys) | Genus | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | Hydrocharitaceae | 4 species (waternymphs) | Family | Gunther et al. 2014 |
| Vascular Plant | Hydrophyllaceae | 18 species (phaceilas, alplily) | Family | Gunther et al. 2014 |
| Vascular Plant | *Hydrophyllum capitatum* | ballhead waterleaf | Species | Gunther et al. 2014 |
| Vascular Plant | *Hydrophyllum fendleri* | white waterleaf | Genus | Gunther et al. 2014 |
| Vascular Plant | *Hydrophyllum tenuipes* | Pacific waterleaf | Genus | Gunther et al. 2014 |
| Vascular Plant | *Juncus filiformis* | thread rush | Species | Almack et al. 1993, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Juncus parryi* | Parry rush | Species | Almack et al. 1993, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Juncus* spp. | 32 species (rushes) | Genus | Almack et al. 1993, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Juniperus communis* | common juniper | Species | Blanchard 1983, Mace and Jonkel 1986, Almack et al. 1993, Gunther et al. 2014 |
| Vascular Plant | *Juniperus occidentalis* | western juniper | Genus | Blanchard 1983, Mace and Jonkel 1986, Gunther et al. 2014 |
| Vascular Plant | *Juniperus scopulorum* | Rocky Mountain juniper | Species | Blanchard 1983, Mace and Jonkel 1986, Gunther et al. 2014 |
| Vascular Plant | *Lactuca sativa* | lettuce | Species | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Lactuca* spp. | 5 species (lettuces) | Genus | Fortin et al. 2013, Gunther et al. 2014 |

| Category | Scientific Name | Common Name | Lowest Level Taxomony Match | Source |
|---|---|---|---|---|
| Vascular Plant | Lamiales | 65 species (mints, deadnettles, monkeyflowers) | Order | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Lathyrus* spp. | 10 species (peas) | Genus | McLellan and Hovey 1995, Gunther et al. 2014, Cristescu et al. 2015 |
| Vascular Plant | *Ligusticum canbyi* | Canby's licorice-root | Species | Mace and Jonkel 1986, Almack et al. 1993, Kasworm and Thier 1993, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Ligusticum grayi* | Gray's licorice-root | Genus | Mace and Jonkel 1986, Almack et al. 1993, Kasworm and Thier 1993, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Ligusticum verticillatum* | northern licorice-root | Species | Almack et al. 1993 |
| Vascular Plant | Liliaceae | 10 species (mariposa lilies) | Family | Gunther et al. 2014 |
| Vascular Plant | Liliales: *Smilax glauca* | glaucous-leaved greenbriar | Order | Gunther et al. 2014 |
| Vascular Plant | *Linnaea borealis* | twinflower | Species | Gunther et al. 2014 |
| Vascular Plant | *Lomatium ambiguum* | Wyeth biscuitroot | Species | Servheen 1983, Mace and Jonkel 1986, Mattson et al. 1991, Almack et al. 1993, Kasworm and Thier 1993, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Lomatium cous* | cous biscuitroot | Species | Servheen 1983, Mace and Jonkel 1986, Mattson et al. 1991, Almack et al. 1993, Kasworm and Thier 1993, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Lomatium dissectum* | fernleaf biscuitroot | Species | Servheen 1983, Mace and Jonkel 1986, Mattson et al. 1991, Almack et al. 1993, Kasworm and Thier 1993, Fortin et al. 2013, Gunther et al. 2014 |

| Category | Scientific Name | Common Name | Lowest Level Taxomony Match | Source |
|---|---|---|---|---|
| Vascular Plant | *Lomatium* spp. | 15 species (parsleys) | Genus | Servheen 1983, Mace and Jonkel 1986, Mattson et al. 1991, Almack et al. 1993, Kasworm and Thier 1993, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Lomatium triternatum* | nineleaf biscuitroot | Species | Servheen 1983, Mace and Jonkel 1986, Mattson et al. 1991, Almack et al. 1993, Kasworm and Thier 1993, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Lonicera ciliosa* | orange honeysuckle | Species | Almack et al. 1993, Gunther et al. 2014 |
| Vascular Plant | *Lonicera hispidula* | pink honeysuckle | Genus | Gunther et al. 2014, Cristescu et al. 2015 |
| Vascular Plant | *Lonicera involucrata* | black twin-berry | Species | Almack et al. 1993, Sizemore 1980, Gunther et al. 2014 |
| Vascular Plant | *Lonicera utahensis* | Utah honeysuckle | Species | Almack et al. 1993, Gunther et al. 2014 |
| Vascular Plant | *Lupinus nootkatensis* | lupine | Species | Almack et al. 1993, Gunther et al. 2014 |
| Vascular Plant | *Lupinus* spp. | 29 species (lupines) | Genus | Gunther et al. 2014 |
| Vascular Plant | *Luzula glabrata* | smooth woodrush | Species | Almack et al .1993, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Luzula* spp. | 10 species (woodrushes) | Genus | Almack et al .1993, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | Lycopodiaceae | 5 species (clubmosses) | Family | Kasworm and Thier 1993, Gunther et al. 2014 |
| Vascular Plant | *Lycopodium* spp. | 8 species (clubmosses) | Genus | Kasworm and Thier 1993, Gunther et al. 2014 |
| Vascular Plant | *Lysichiton americanus* | American skunk cabbage | Genus | Sizemore 1980, Gunther et al. 2014 |

| Category | Scientific Name | Common Name | Lowest Level Taxomony Match | Source |
|---|---|---|---|---|
| Vascular Plant | *Lysichitum americanum* | western skunk cabbage | Species | Sizemore 1980, Almack et al. 1993, Gunther et al. 2014 |
| Vascular Plant | *Mahonia repens* | creeping barberry | Genus | Almack et al. 1993, Kasworm and Thier 1993, Gunther et al. 2014 |
| Vascular Plant | *Maianthemum dilatatum* | false lily of the valley | Genus | Gunther et al. 2014 |
| Vascular Plant | *Maianthemum racemosum* | false solomon's-seal | Genus | Almack et al. 1993, Gunther et al. 2014 |
| Vascular Plant | *Maianthemum stellatum* | star-flowered lily of the valley | Species | Almack et al. 1993, Gunther et al. 2014 |
| Vascular Plant | Malpighiales | 15 species (spurges, Johnsworts) | Order | Gunther et al. 2014 |
| Vascular Plant | *Malus fusca* | Oregon crabapple | Species | Servheen 1983, Mace and Jonkel 1986, Almack et al. 1993, Gunther et al. 2014 |
| Vascular Plant | *Malus prunifolia* | plumleaf crabapple | Species | Servheen 1983, Mace and Jonkel 1986, Almack et al. 1993, Gunther et al. 2014 |
| Vascular Plant | *Malus purpurea* | purple crabapple | Species | Servheen 1983, Mace and Jonkel 1986, Almack et al. 1993, Gunther et al. 2014 |
| Vascular Plant | *Matricaria discoidea* | pineapple weed | Species | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Medicago lupulina* | black medick | Genus | Munro et al. 2006, Gunther et al. 2014, Cristescu et al. 2015 |
| Vascular Plant | *Medicago polymorpha* | burclover | Genus | Munro et al. 2006, Gunther et al. 2014, Cristescu et al. 2015 |
| Vascular Plant | Melanthiaceae: *Stenanthium occidentale* | western featherbells | Family | Gunther et al. 2014 |
| Vascular Plant | Melanthiaceae: *Trillium petiolatum* | Idaho trillium | Family | Gunther et al. 2014 |
| Vascular Plant | *Melica spectabilis* | purple oniongrass | Species | Mace and Jonkel 1986, Almack et al. 1993, Fortin et al. 2013, Gunther et al. 2014 |

| Category | Scientific Name | Common Name | Lowest Level Taxomony Match | Source |
|---|---|---|---|---|
| Vascular Plant | *Melica* spp. | 5 species (oniongrass) | Genus | Mace and Jonkel 1986, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Melilotus* spp. | 3 species (sweet-clovers) | Genus | Gunther et al. 2014, Cristescu et al. 2015 |
| Vascular Plant | *Mertensia ciliata* | tall fringed bluebells | Species | Almack et al. 1993, Gunther et al. 2014 |
| Vascular Plant | *Mertensia* spp. | 5 species (bluebells) | Genus | Almack et al. 1993, Gunther et al. 2014 |
| Vascular Plant | *Mitella breweri* | Brewer's miterwort | Species | Almack et al. 1993, Gunther et al. 2014 |
| Vascular Plant | *Mitella* spp. | 5 species (miterworts) | Genus | Almack et al. 1993, Gunther et al. 2014 |
| Vascular Plant | *Monotropa hypopithys* | pinesap | Genus | Gunther et al. 2014 |
| Vascular Plant | *Monotropa uniflora* | Indian pipe | Species | Gunther et al. 2014 |
| Vascular Plant | *Montia* spp. | 5 species (minerslettuces) | Genus | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | Montiaceae | 7 species (lewisias) | Family | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Muhlenbergia filiformis* | pullup muhly | Genus | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Muhlenbergia richardsonis* | mat muhly | Genus | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | Myrtales | 5 species (loosestrife) | Order | Gunther et al. 2014 |
| Vascular Plant | Onagraceae | 18 species (groundsmokes, evening primroses) | Family | Gunther et al. 2014 |
| Vascular Plant | *Oplopanax horridus* | devils club | Species | Sizemore 1980, Almack et al. 1993, Munro et al. 2006, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | Orchidaceae | 19 species (orchids) | Family | Gunther et al. 2014 |
| Vascular Plant | Orobanchaceae | 11 species (broomrapes) | Family | Fortin et al. 2013, Gunther et al. 2014 |

| Category | Scientific Name | Common Name | Lowest Level Taxomony Match | Source |
|---|---|---|---|---|
| Vascular Plant | *Osmorhiza berteroi* | mountain sweet cicely | Species | Sizemore 1980, Mace and Jonkel 1986, Almack et al. 1993, Kasworm and Thier 1993, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Osmorhiza depauperata* | blunt-fruit sweet-cicely | Genus | Mace and Jonkel 1986, Almack et al. 1993, Kasworm and Thier 1993, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Osmorhiza occidentalis* | sweetanise, western sweetroot | Species | Sizemore 1980, Mace and Jonkel 1986, Almack et al. 1993, Kasworm and Thier 1993, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Osmorhiza purpurea* | purple sweetroot | Genus | Mace and Jonkel 1986, Almack et al. 1993, Kasworm and Thier 1993, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Oxyria digyna* | alpine mountainsorrel | Species | Hamer and Herrero 1987a, Almack et al. 1993, MacHutchon and Wellwood 2003, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Oxytropis campestris* | Cusick's locoweed | Genus | Almack et al. 1993, Gunther et al. 2014 |
| Vascular Plant | *Paxistima myrsinites* | boxleaf | Species | Gunther et al. 2014 |
| Vascular Plant | *Pedicularis bracteosa* | bracted lousewort | Species | Fortin et al. 2013, Gunther et al. 2014, Cristescu et al. 2015 |
| Vascular Plant | *Pedicularis* spp. | 4 species (louseworts) | Genus | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Penstemon* spp. | 22 species (beardtongues) | Genus | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Penstemon wilcoxii* | Wilcox's penstemon | Species | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Perideridia gairdneri* | common yampah | Species | Almack et al. 1993, Mattson 2004a, Fortin et al. 2013, Gunther et al. 2014 |

| Category | Scientific Name | Common Name | Lowest Level Taxomony Match | Source |
|---|---|---|---|---|
| Vascular Plant | *Persicaria amphibia* | water knotweed | Species | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Persicaria* spp. | 7 species (smartweed) | Genus | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Petasites frigidus* | arctic sweet coltsfoot | Genus | Almack et al. 1993, Fortin et al. 2013 |
| Vascular Plant | *Petasites japonicus* | Japanese sweet coltsfoot | Genus | Almack et al. 1993, Fortin et al. 2013 |
| Vascular Plant | *Phleum alpinum* | alpine timothy | Species | Almack et al. 1993, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Phleum pratense* | common timothy | Species | Almack et al. 1993, Kasworm and Thier 1993, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Picea engelmannii* | Englemann spruce | Species | Blanchard 1983, Mace and Jonkel 1986, Almack et al. 1993, Gunther et al. 2014 |
| Vascular Plant | *Picea sitchensis* | Sitka spruce | Genus | Blanchard 1983, Mace and Jonkel 1986, Gunther et al. 2014 |
| Vascular Plant | Pinaceae | 4 species (larch and hemlock) | Family | Blanchard 1983, Mace and Jonkel 1986, Almack et al. 1993, Gunther et al. 2014 |
| Vascular Plant | Pinales: *Taxus brevifolia* | Pacific yew | Order | Blanchard 1983, Mace and Jonkel 1986, Gunther et al. 2014 |
| Vascular Plant | *Pinus albicaulis* | whitebark pine | Species | Blanchard 1983, Kendall 1983, Mace and Jonkel 1986, Mattson et al. 1991, Almack et al. 1993, Fortin et al. 2013, Costello et al. 2014, Gunther et al. 2014 |
| Vascular Plant | *Pinus contorta* | lodgepole pine | Species | Blanchard 1983, Mace and Jonkel 1986, Almack et al. 1993, Gunther et al. 2014 |
| Vascular Plant | *Pinus monticola* | western white pine | Species | Blanchard 1983, Mace and Jonkel 1986, Almack et al. 1993, Gunther et al. 2014 |

| Category | Scientific Name | Common Name | Lowest Level Taxomony Match | Source |
|---|---|---|---|---|
| Vascular Plant | *Pinus ponderosa* | ponderosa pine | Genus | Blanchard 1983, Mace and Jonkel 1986, Almack et al. 1993, Gunther et al. 2014 |
| Vascular Plant | Plantaginaceae | 48 species (plantains, speedwells) | Family | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Platanthera* spp. | 14 species (orchids) | Genus | Gunther et al. 2014 |
| Vascular Plant | *Poa alpina* | alpine bluegrass | Species | Sizemore 1980, Servheen 1983, Mace and Jonkel 1986, Hamer and Herrero 1987a, Phillips 1987, Mattson et al. 1991, Almack et al. 1993, Kasworm and Thier 1993, MacHutchon and Wellwood 2003, Munro et al. 2006, McLellan and Hovey 1995, Fortin et al. 2013, Kasworm et al. 2014, Gunther et al. 2014 |
| Vascular Plant | *Poa pratensis* | Kentucky bluegrass | Species | Almack et al. 1993, Kasworm and Thier 1993, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Poa* spp. | 28 species (bluegrasses) | Genus | Sizemore 1980, Servheen 1983, Mace and Jonkel 1986, Hamer and Herrero 1987a, Phillips 1987, Mattson et al. 1991, Kasworm and Thier 1993, MacHutchon and Wellwood 2003, Munro et al. 2006, McLellan and Hovey 1995, Fortin et al. 2013, Kasworm et al. 2014, Gunther et al. 2014 |
| Vascular Plant | Poaceae | 94 species (grasses) | Family | Fortin et al. 2013 |
| Vascular Plant | Poales | 6 species (cattails and burr-reeds) | Order | Fortin et al. 2013 |
| Vascular Plant | Polygonaceae | 6 species (knotweeds) | Family | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Polygonum bistortoides* | American bistort | Species | Almack et al. 1993, Fortin et al. 2013, Gunther et al. 2014 |

| Category | Scientific Name | Common Name | Lowest Level Taxomony Match | Source |
|---|---|---|---|---|
| Vascular Plant | *Polygonum douglasii* | Douglas' knotweed | Species | Almack et al. 1993, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Polygonum* spp. | 21 species (knotweeds) | Genus | Almack et al. 1993, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Polygonum viviparum* | alpine bistort | Species | Almack et al. 1993, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | Polypodiales | 37 species (ferns and maidenhairs) | Order | Sizemore 1980 |
| Vascular Plant | *Populus* spp. | 5 species (poplars) | Genus | Almack et al. 1993, Gunther et al. 2014 |
| Vascular Plant | *Potamogeton alpinus* | alpine pondweed | Species | Gunther et al. 2014 |
| Vascular Plant | *Potamogeton natans* | floating pondweed | Species | Gunther et al. 2014 |
| Vascular Plant | *Potamogeton nodosus* | longleaf pondweed | Species | Gunther et al. 2014 |
| Vascular Plant | *Potamogeton* spp. | 15 species (pondweeds) | Genus | Mattson et al. 2005, Gunther et al. 2014 |
| Vascular Plant | Potamogetonaceae: *Stuckenia pectinata* | sago pondweed | Family | Gunther et al. 2014 |
| Vascular Plant | Potamogetonaceae: *Zannichellia palustris* | horned pondweed | Family | Gunther et al. 2014 |
| Vascular Plant | *Potentilla* spp. | 22 species (cinquefoils) | Genus | Gunther et al. 2014 |
| Vascular Plant | *Prosartes hookeri* | drops-of-gold | Genus | Gunther et al. 2014 |
| Vascular Plant | *Prosartes smithii* | largeflower fairybells | Genus | Gunther et al. 2014 |
| Vascular Plant | *Prosartes trachycarpa* | roughfruit fairybells | Species | Gunther et al. 2014 |
| Vascular Plant | *Prunus emarginata* | bitter cherry | Species | Servheen 1983, Mace and Jonkel 1986, Almack et al. 1993, Gunther et al. 2014 |
| Vascular Plant | *Prunus* spp. | 5 species (wild cherries and chokecherries) | Genus | Servheen 1983, Mace and Jonkel 1986, Almack et al. 1993, Gunther et al. 2014 |

| Category | Scientific Name | Common Name | Lowest Level Taxomony Match | Source |
|---|---|---|---|---|
| Vascular Plant | *Prunus virginiana* | western chokecherry | Species | Servheen 1983, Mace and Jonkel 1986, Almack et al. 1993, Gunther et al. 2014 |
| Vascular Plant | *Pseudoroegneria spicata* | bluebunch wheatgrass | Species | Almack et al. 1993, Fortin et al. 2013 |
| Vascular Plant | *Pseudotsuga menziesii* | Douglas fir | Species | Blanchard 1983, Mace and Jonkel 1986, Almack et al. 1993, Gunther et al. 2014 |
| Vascular Plant | *Pteridium aquilinum* | western brackenfern | Species | Sizemore 1980, Almack et al. 1993 |
| Vascular Plant | *Pyrola minor* | snowline wintergreen | Genus | Gunther et al. 2014 |
| Vascular Plant | *Pyrola secunda* | sidebells pyrola | Species | Gunther et al. 2014 |
| Vascular Plant | Ranunculaceae | 22 species (buttercups) | Family | Gunther et al. 2014 |
| Vascular Plant | Ranunculales | 11 species (poppies, bleeding heart) | Order | Gunther et al. 2014 |
| Vascular Plant | *Ranunculus acriformis* | mountain sharp buttercup | Species | Almack et al. 1993, Gunther et al. 2014 |
| Vascular Plant | *Ranunculus acris* | tall buttercup | Species | Almack et al. 1993, Gunther et al. 2014 |
| Vascular Plant | *Ranunculus* spp. | 26 species (buttercup) | Genus | Almack et al. 1993, Gunther et al. 2014 |
| Vascular Plant | Rhamnaceae | 4 species (buckthorns) | Family | Kasworm and Thier 1993, Gunther et al. 2014 |
| Vascular Plant | *Ribes bracteosum* | stink currant | Species | Sizemore 1980, Mace and Jonkel 1986, Almack et al. 1993, Kasworm and Thier 1993, Gunther et al. 2014 |
| Vascular Plant | *Ribes cereum* | wax currant | Species | Sizemore 1980, Mace and Jonkel 1986, Kasworm and Thier 1993, Gunther et al. 2014 |
| Vascular Plant | *Ribes lacustre* | prickly currant | Species | Almack et al. 1993, Gunther et al. 2014 |
| Vascular Plant | *Ribes* spp. | 11 species (currants) | Genus | Sizemore 1980, Mace and Jonkel 1986, Kasworm and Thier 1993, Gunther et al. 2014, Cristescu et al. 2015 |

| Category | Scientific Name | Common Name | Lowest Level Taxomony Match | Source |
|---|---|---|---|---|
| Vascular Plant | *Ribes triste* | red currant | Species | Sizemore 1980, Mace and Jonkel 1986, Kasworm and Thier 1993, MacHutchon and Wellwood 2003, Gunther et al. 2014 |
| Vascular Plant | *Ribes viscosissimum* | sticky currant | Species | Sizemore 1980, Mace and Jonkel 1986, Almack et al. 1993, Kasworm and Thier 1993, Gunther et al. 2014 |
| Vascular Plant | *Rosa acicularis* | prickly wild rose | Species | Almack et al. 1993 |
| Vascular Plant | *Rosa gymnocarpa* | dwarf rose | Species | Mace and Jonkel 1986, Almack et al. 1993, Gunther et al. 2014 |
| Vascular Plant | *Rosa* spp. | 4 species (roses) | Genus | Mace and Jonkel 1986, Almack et al. 1993, Gunther et al. 2014, Cristescu et al. 2015 |
| Vascular Plant | *Rosa woodsii* | Wood's rose | Species | Mace and Jonkel 1986, Almack et al. 1993, Gunther et al. 2014 |
| Vascular Plant | Rosaceae | 39 species (roses) | Family | Gunther et al. 2014 |
| Vascular Plant | Rosales | 4 species (hackberry, nettles) | Order | Gunther et al. 2014 |
| Vascular Plant | Rubiaceae: *Kelloggia galioides* | milky kelloggia | Family | Gunther et al. 2014 |
| Vascular Plant | *Rubus idaeus* | red raspberry | Species | Sizemore 1980, Almack et al. 1993, Munro et al. 2006, Gunther et al. 2014, Cristescu et al. 2015 |
| Vascular Plant | *Rubus parviflorus* | thimbleberry | Species | Almack et al. 1993, Gunther et al. 2014 |
| Vascular Plant | *Rubus pedatus* | strawberryleaf raspberry | Species | Almack et al. 1993, Gunther et al. 2014 |
| Vascular Plant | *Rubus spectabilis* | salmonberry | Species | Almack et al. 1993, Gunther et al. 2014 |
| Vascular Plant | *Rubus* spp. | 13 species (blackberries) | Genus | Almack et al. 1993, Gunther et al. 2014 |

| Category | Scientific Name | Common Name | Lowest Level Taxomony Match | Source |
|---|---|---|---|---|
| Vascular Plant | *Rumex* spp. | 16 species (docks) | Genus | Almack et al. 1993, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Ruppia cirrhosa* | spiral ditchgrass | Species | Gunther et al. 2014 |
| Vascular Plant | *Ruppia maritima* | widgeongrass | Genus | Gunther et al. 2014 |
| Vascular Plant | *Salix* spp. | 35 species (willows) | Genus | Almack et al. 1993, Munro et al. 2006, Gunther et al. 2014 |
| Vascular Plant | *Sambucus cerulea* | blue elderberry | Genus | Sizemore 1980, Almack et al. 1993, Gunther et al. 2014, Deacy et al. 2017 |
| Vascular Plant | *Sambucus nigra* | elderberry | Genus | Sizemore 1980, Gunther et al. 2014, Deacy et al. 2017 |
| Vascular Plant | *Sambucus racemosa* | red elderberry | Species | Sizemore 1980, Gunther et al. 2014, Deacy et al. 2017 |
| Vascular Plant | Saxifragaceae | 33 species (saxifrages) | Family | Gunther et al. 2014 |
| Vascular Plant | Saxifragales | 21 species (saxifrages, stonecrops) | Order | Gunther et al. 2014 |
| Vascular Plant | *Scirpus atrocinctus* | blackgirdle bulrush | Genus | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Scirpus cyperinus* | woolgrass | Genus | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Scirpus microcarpus* | panicled bulrush | Species | Sizemore 1980, Almack et al. 1993, Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Selaginella* spp. | 3 species (spikemosses) | Genus | Gunther et al. 2014 |
| Vascular Plant | *Senecio* spp. | 12 species (ragworts) | Genus | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Senecio triangularis* | arrowleaf groundsel | Species | Almack et al. 1993, Fortin et al. 2013, Gunther et al. 2014, Cristescu et al. 2015 |

| Category | Scientific Name | Common Name | Lowest Level Taxomony Match | Source |
|---|---|---|---|---|
| Vascular Plant | *Shepherdia canadensis* | russet buffaloberry | Species | Servheen 1983, Mace and Jonkel 1986, Hamer and Herrero 1987a, Almack et al. 1993, MacHutchon and Wellwood 2003, Munro et al. 2006, McLellan and Hovey 1995, Gunther et al. 2014, Cristescu et al. 2015 |
| Vascular Plant | Solanales | 9 species (bindweeds and dodders) | Order | Gunther et al. 2014 |
| Vascular Plant | *Solidago* spp. | 8 species (goldenrods) | Genus | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Sonchus arvensis* | creeping sowthistle | Genus | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Sonchus asper* | prickly sow thistle | Genus | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Sonchus oleraceus* | annual sowthistle | Species | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Sorbus aucuparia* | European mountain-ash | Genus | Mace and Jonkel 1986, Gunther et al. 2014 |
| Vascular Plant | *Sorbus scopulina* | Cascade mountain-ash | Species | Sizemore 1980, Mace and Jonkel 1986, Almack et al. 1993, Kasworm and Thier 1993, Gunther et al. 2014 |
| Vascular Plant | *Sorbus sitchensis* | western mountain-ash | Species | Sizemore 1980, Mace and Jonkel 1986, Almack et al. 1993, Kasworm and Thier 1993, Gunther et al. 2014 |
| Vascular Plant | *Sporobolus cryptandrus* | sand dropseed | Genus | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Stipa occidentalis* | western needlegrass | Genus | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Streptopus amplexifolius* | claspleaf twistedstalk | Species | Almack et al. 1993, Gunther et al. 2014 |
| Vascular Plant | *Streptopus lanceolatus* | twistedstalk | Genus | Gunther et al. 2014 |
| Vascular Plant | *Streptopus streptopoides* | small twistedstalk | Genus | Gunther et al. 2014 |
| Vascular Plant | *Symphoricarpos albus* | common snowberry | Species | Almack et al. 1993, Gunther et al. 2014 |

| Category | Scientific Name | Common Name | Lowest Level Taxonomy Match | Source |
|---|---|---|---|---|
| Vascular Plant | *Symphoricarpos* spp. | 3 species (snowberries) | Genus | Gunther et al. 2014 |
| Vascular Plant | *Taraxacum ceratophorum* | horned dandelion | Species | Sizemore 1980, Servheen 1983, Almack et al. 1993, Kasworm and Thier 1993, McLellan and Hovey 1995, Fortin et al. 2013, Kasworm et al. 2014 |
| Vascular Plant | *Taraxacum officinale* | common dandelion | Species | Sizemore 1980, Servheen 1983, Almack et al. 1993, Kasworm and Thier 1993, Munro et al. 2006, McLellan and Hovey 1995, Fortin et al. 2013, Kasworm et al. 2014, Cristescu et al. 2015 |
| Vascular Plant | *Taraxacum* spp. | 3 species (dandelions) | Genus | Sizemore 1980, Servheen 1983, Almack et al. 1993, Kasworm and Thier 1993, McLellan and Hovey 1995, Fortin et al. 2013, Kasworm et al. 2014 |
| Vascular Plant | *Thalictrum occidentale* | western meadow-rue | Species | Gunther et al. 2014 |
| Vascular Plant | *Thalictrum venulosum* | veiny-leaf meadow-rue | Genus | Gunther et al. 2014 |
| Vascular Plant | *Thlaspi arvense* | field pennycress | Species | Gunther et al. 2014 |
| Vascular Plant | *Thlaspi montanum* | alpine pennycress | Genus | Gunther et al. 2014 |
| Vascular Plant | *Tiarella ovatum* | coolwort | Species | Almack et al. 1993 |
| Vascular Plant | *Tiarella trifoliata* | threeleaf foamflower | Species | Almack et al. 1993, Gunther et al. 2014 |
| Vascular Plant | *Tragopogon dubius* | yellow salsify | Species | Fortin et al. 2013 |
| Vascular Plant | *Tragopogon porrifolius* | common salsify | Genus | Fortin et al. 2013 |
| Vascular Plant | *Tragopogon pratensis* | meadow salsify | Genus | Fortin et al. 2013 |
| Vascular Plant | *Trifolium hybridum* | alsike clover | Species | Almack et al. 1993, Gunther et al. 2014 |
| Vascular Plant | *Trifolium longipes* | longstalk clover | Species | Almack et al. 1993, Gunther et al. 2014 |

| Category | Scientific Name | Common Name | Lowest Level Taxomony Match | Source |
|---|---|---|---|---|
| Vascular Plant | *Trifolium pratense* | red clover | Species | Sizemore 1980, Servheen 1983, Mattson et al. 1991, Almack et al. 1993, Kasworm and Thier 1993, Munro et al. 2006, McLellan and Hovey 1995, Fortin et al. 2013, Gunther et al. 2014, Kasworm et al. 2014 |
| Vascular Plant | *Trifolium repens* | white clover | Species | Almack et al. 1993, Gunther et al. 2014 |
| Vascular Plant | *Trifolium* spp. | 19 species (clovers) | Genus | Sizemore 1980, Servheen 1983, Mattson et al. 1991, Almack et al. 1993, Kasworm and Thier 1993, Munro et al. 2006, McLellan and Hovey 1995, Fortin et al. 2013, Gunther et al. 2014, Kasworm et al. 2014, Cristescu et al. 2015 |
| Vascular Plant | *Trillium ovatum* | Pacific trillium | Species | Almack et al. 1993, Gunther et al. 2014 |
| Vascular Plant | *Triticum aestivum* | common wheat | Genus | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Vaccinium caespitosum* | dwarf bilberry | Species | Mace and Jonkel 1986, Hamer and Herrero 1987a, Almack et al. 1993, Kasworm and Thier 1993, Fortin et al. 2013, Gunther et al. 2014, Cristescu et al. 2015 |
| Vascular Plant | *Vaccinium membranaceum* | thinleaf huckleberry | Species | Hamer and Herrero 1987a, Almack et al. 1993, Kasworm and Thier 1993, Munro et al. 2006, Fortin et al. 2013, Gunther et al. 2014, Cristescu et al. 2015 |

| Category | Scientific Name | Common Name | Lowest Level Taxomony Match | Source |
|---|---|---|---|---|
| Vascular Plant | *Vaccinium ovalifolium* | oval-leaf blueberry | Species | Sizemore 1980, Servheen 1983, Mace and Jonkel 1986, Almack et al. 1993, Hamer and Herrero 1987a, Phillips 1987, Kasworm and Thier 1993, MacHutchon and Wellwood 2003, Munro et al. 2006, McLellan and Hovey 1995, Fortin et al. 2013, Gunther et al. 2014, Kasworm et al. 2014 |
| Vascular Plant | *Vaccinium parvifolium* | red huckleberry | Species | Sizemore 1980, Servheen 1983, Mace and Jonkel 1986, Hamer and Herrero 1987a, Phillips 1987, Almack et al. 1993, Kasworm and Thier 1993, MacHutchon and Wellwood 2003, Munro et al. 2006, McLellan and Hovey 1995, Fortin et al. 2013, Gunther et al. 2014, Kasworm et al. 2014 |
| Vascular Plant | *Vaccinium scoparium* | grouse whortleberry, grouseberry | Species | Hamer and Herrero 1987a, Almack et al. 1993, Kasworm and Thier 1993, Fortin et al. 2013, Gunther et al. 2014, Cristescu et al. 2015 |
| Vascular Plant | *Vaccinium* spp. | 3 species (berries) | Genus | Sizemore 1980, Servheen 1983, Mace and Jonkel 1986, Hamer and Herrero 1987a, Phillips 1987, Almack et al. 1993, Kasworm and Thier 1993, MacHutchon and Wellwood 2003, Munro et al. 2006, McLellan and Hovey 1995, Fortin et al. 2013, Gunther et al. 2014, Kasworm et al. 2014, Cristescu et al. 2015 |

| Category | Scientific Name | Common Name | Lowest Level Taxomony Match | Source |
|---|---|---|---|---|
| Vascular Plant | *Vaccinium uliginosum* | bog blueberry | Species | Hamer and Herrero 1987a, Phillips 1987, Almack et al. 1993, Kasworm and Thier 1993, MacHutchon and Wellwood 2003, Gunther et al. 2014, Cristescu et al. 2015 |
| Vascular Plant | *Vahlodea atropurpurea* | mountain hairgrass | Species | Fortin et al. 2013, Gunther et al. 2014 |
| Vascular Plant | *Valeriana sitchensis* | Sitka valerian | Species | Cristescu et al. 2015 |
| Vascular Plant | *Veratrum californicum* | false hellebore | Genus | Sizemore 1980, Almack et al. 1993, Gunther et al. 2014 |
| Vascular Plant | *Veratrum viride* | green false hellebore | Species | Sizemore 1980, Almack et al. 1993, Gunther et al. 2014 |
| Vascular Plant | *Viburnum edule* | squashberry | Species | Sizemore 1980, Almack et al. 1993, McLellan and Hovey 1995, Gunther et al. 2014 |
| Vascular Plant | *Viburnum lentago* | nannyberry, sweet viburnum | Genus | Sizemore 1980, McLellan and Hovey 1995, Gunther et al. 2014 |
| Vascular Plant | *Viburnum opulus* | American cranberrybush, mooseberry | Genus | Sizemore 1980, McLellan and Hovey 1995, Gunther et al. 2014 |
| Vascular Plant | *Viola glabella* | pioneer violet | Species | Almack et al. 1993, Gunther et al. 2014 |
| Vascular Plant | *Viola* spp. | 17 species (violets) | Genus | Almack et al. 1993, Gunther et al. 2014 |
| Vascular Plant | Woodsiaceae | 6 species (oakferns) | Family | Sizemore 1980, Almack et al. 1993 |
| Vascular Plant | *Xerophyllum tenax* | bear grass | Species | Almack et al. 1993 |
| Fungi | Agaricaceae | 13 species (basidiomycete mushrooms) | Family | Gunther et al. 2014 |
| Fungi | Agaricales | 78 species (excluding Family Agaricaceae) | Order | Gunther et al. 2014 |

| Category | Scientific Name | Common Name | Lowest Level Taxomony Match | Source |
|---|---|---|---|---|
| Fungi | Boletaceae | 4 species (bolete mushrooms) | Family | Fortin et al. 2013, Gunther et al. 2014 |
| Fungi | *Boletus chrysenteron* | red cracked bolete | Genus | Fortin et al. 2013, Gunther et al. 2014 |
| Fungi | *Calvatia lycoperdoides* | puffball | Genus | Gunther et al. 2014 |
| Fungi | *Lactarius deliciosus* | saffron milk cap | Genus | Gunther et al. 2014 |
| Fungi | *Lactarius* spp. | 7 species (milk caps) | Genus | Gunther et al. 2014 |
| Fungi | *Morchella australiana* | Australian morel | Genus | Gunther et al. 2014 |
| Fungi | *Morchella elata* | black morel | Genus | Gunther et al. 2014 |
| Fungi | Morchellaceae | 1 species (ascomycete mushrooms) | Family | Gunther et al. 2014 |
| Fungi | Pezizales | 20 species (Pezizales mushrooms) | Order | Gunther et al. 2014 |
| Fungi | *Rhizopogon* spp. | 4 species (false truffles) | Genus | Fortin et al. 2013, Gunther et al. 2014 |
| Fungi | *Russula* spp. | 10 species (russulas) | Genus | Gunther et al. 2014 |
| Fungi | Russulales | 6 species (russuloid mushrooms) | Order | Gunther et al. 2014 |
| Fungi | *Suillus* spp. | 4 species (larch boletes) | Genus | Fortin et al. 2013, Gunther et al. 2014 |
| Fungi | *Tricholoma* spp. | 4 species (Tricholoma mushrooms) | Genus | Gunther et al. 2014 |
| Fungi | Tricholomataceae | 32 species (mushrooms) | Family | Gunther et al. 2014 |
| Mammal | *Alces alces* | moose | Species | Sizemore 1980, Mace and Jonkel 1986, Hamer and Herrero 1987a, Kasworm and Thier 1993, MacHutchon and Wellwood 2003, Munro et al. 2006, McLellan and Hovey 1995, Fortin et al. 2013, Gunther et al. 2014, Kasworm et al. 2014, Cristescu et al. 2015 |
| Mammal | *Aplodontia rufa* | mountain beaver | Order | Phillips 1987, Munro et al. 2006, Gunther et al. 2014 |

| Category | Scientific Name | Common Name | Lowest Level Taxomony Match | Source |
|---|---|---|---|---|
| Mammal | *Callospermophilus lateralis* | golden mantled ground squirrel | Species | Phillips 1987, MacHutchon and Wellwood 2003, Munro et al. 2006, Gunther et al. 2014 |
| Mammal | Canidae: *Vulpes vulpes* | red fox | Family | Gunther et al. 2014 |
| Mammal | *Canis latrans* | coyote | Species | Gunther et al. 2014 |
| Mammal | *Canis lupus* | gray wolf | Species | Gunther et al. 2014 |
| Mammal | Carnivora | 6 species (carnivores) | Order | Gunther et al. 2014 |
| Mammal | *Castor canadensis* | North American beaver | Species | Servheen 1983, Phillips 1987, Mace and Jonkel 1986, Gunther et al. 2014, Cristescu et al. 2015 |
| Mammal | *Cervus elaphus* | elk | Species | Mace and Jonkel 1986, Hamer and Herrero 1987a, Kasworm and Thier 1993, Munro et al. 2006, McLellan and Hovey 1995, Fortin et al. 2013, Gunther et al. 2014, Kasworm et al. 2014, Cristescu et al. 2015 |
| Mammal | *Clethrionomys gapperi* | southern red-backed vole | Species | Phillips 1987, Munro et al. 2006, Gunther et al. 2014 |
| Mammal | Cricetidae: *Neotoma cinerea* | bushy-tailed woodrat | Family | Phillips 1987, Munro et al. 2006, Gunther et al. 2014 |
| Mammal | Cricetidae: *Phenacomys intermedius* | western heather vole | Family | Phillips 1987, Munro et al. 2006, Gunther et al. 2014 |
| Mammal | Cricetidae: *Synaptomys borealis* | northern bog-lemming | Family | Phillips 1987, Munro et al. 2006, Gunther et al. 2014 |
| Mammal | *Erethizon dorsatum* | porcupine | Genus | Phillips 1987, Munro et al. 2006, Gunther et al. 2014 |

| Category | Scientific Name | Common Name | Lowest Level Taxomony Match | Source |
|---|---|---|---|---|
| Mammal | Leporidae: *Lepus americanus* | snowshoe hare | Family | Mace and Jonkel 1986, Gunther et al. 2014, Cristescu et al. 2015 |
| Mammal | Leporidae: *Sylvilagus floridanus* | eastern cottontail | Family | Mace and Jonkel 1986, Gunther et al. 2014, Cristescu et al. 2015 |
| Mammal | *Marmota caligata* | hoary marmot | Genus | Mace and Jonkel 1986, Phillips 1987, MacHutchon and Wellwood 2003, Munro et al. 2006, Gunther et al. 2014 |
| Mammal | *Marmota flaviventris* | yellow-bellied marmot | Species | Mace and Jonkel 1986, Phillips 1987, MacHutchon and Wellwood 2003, Munro et al. 2006, Gunther et al. 2014 |
| Mammal | *Microtus longicaudus* | long-tailed vole | Genus | Mace and Jonkel 1986, Phillips 1987, MacHutchon and Wellwood 2003, Mattson 2004b, Gunther et al. 2014 |
| Mammal | *Microtus montanus* | montane vole | Species | Mace and Jonkel 1986, Phillips 1987, MacHutchon and Wellwood 2003, Mattson 2004b, Gunther et al. 2014 |
| Mammal | *Microtus oregoni* | creeping vole | Genus | Mace and Jonkel 1986, Phillips 1987, MacHutchon and Wellwood 2003, Mattson 2004b, Gunther et al. 2014 |
| Mammal | *Microtus richardsoni* | North American water vole | Genus | Mace and Jonkel 1986, Phillips 1987, MacHutchon and Wellwood 2003, Mattson 2004b, Gunther et al. 2014 |
| Mammal | *Microtus townsendii* | Townsend's vole | Genus | Mace and Jonkel 1986, Phillips 1987, MacHutchon and Wellwood 2003, Mattson 2004b, Gunther et al. 2014 |
| Mammal | Mustelidae | 7 species (weasels) | Family | Cristescu et al. 2015 |
| Mammal | *Ochotona princeps* | American pika | Species | Mace and Jonkel 1986, Gunther et al. 2014 |

| Category | Scientific Name | Common Name | Lowest Level Taxomony Match | Source |
|---|---|---|---|---|
| Mammal | *Odocoileus hemionus* | black-tailed deer, mule deer | Species | Mace and Jonkel 1986, Hamer and Herrero 1987a, Mattson et al. 1991, Kasworm and Thier 1993, Munro et al. 2006, McLellan and Hovey 1995, Fortin et al. 2013, Gunther et al. 2014, Kasworm et al. 2014, Cristescu et al. 2015 |
| Mammal | *Odocoileus virginianus* | white-tailed deer | Species | Mace and Jonkel 1986, Hamer and Herrero 1987a, Mattson et al. 1991, Kasworm and Thier 1993, Munro et al. 2006, McLellan and Hovey 1995, Gunther et al. 2014, , Kasworm et al. 2014, Cristescu et al. 2015 |
| Mammal | *Ondatra zibethicus* | muskrat | Species | Phillips 1987, Munro et al. 2006, Gunther et al. 2014, Cristescu et al. 2015 |
| Mammal | *Oreamnos americanus* | mountain goat | Species | Fortin et al. 2013, Gunther et al. 2014 |
| Mammal | *Ovis canadensis* | bighorn sheep | Species | Fortin et al. 2013, Gunther et al. 2014, Cristescu et al. 2015 |
| Mammal | *Peromyscus keeni* | Keen's mouse | Genus | Servheen 1983, Phillips 1987, Munro et al. 2006, Fortin et al. 2013, Gunther et al. 2014 |
| Mammal | *Peromyscus maniculatus* | deermouse | Species | Servheen 1983, Phillips 1987, Munro et al. 2006, Fortin et al. 2013, Gunther et al. 2014 |
| Mammal | Rodentia: *Mus musculus* | house mouse | Order | Phillips 1987, Munro et al. 2006, Gunther et al. 2014, Cristescu et al. 2015 |

| Category | Scientific Name | Common Name | Lowest Level Taxomony Match | Source |
|---|---|---|---|---|
| Mammal | Rodentia: *Rattus norvegicus* | brown rat, norway rat | Order | Phillips 1987, Munro et al. 2006, Gunther et al. 2014, Cristescu et al. 2015 |
| Mammal | Rodentia: *Zapus princeps* | western jumping mouse | Order | Phillips 1987, Munro et al. 2006, Gunther et al. 2014, Cristescu et al. 2015 |
| Mammal | Rodentia: *Zapus trinotatus* | Pacific jumping mouse | Order | Phillips 1987, Munro et al. 2006, Gunther et al. 2014, Cristescu et al. 2015 |
| Mammal | Sciuridae: *Glaucomys sabrinus* | northern flying squirrel | Family | Phillips 1987, MacHutchon and Wellwood 2003, Munro et al. 2006, Gunther et al. 2014 |
| Mammal | *Sciurus griseus* | western gray squirrel | Genus | Phillips 1987, MacHutchon and Wellwood 2003, Munro et al. 2006, Gunther et al. 2014, Cristescu et al. 2015 |
| Mammal | Soricidae | 6 species (shrews) | Family | Cristescu et al. 2015 |
| Mammal | *Spermophilus saturatus* | Cascade golden-mantled ground squirrel | Genus | Phillips 1987, MacHutchon and Wellwood 2003, Munro et al. 2006, Gunther et al. 2014, Cristescu et al. 2015 |
| Mammal | *Tamias amoenus* | yellow-pine chipmunk | Genus | Phillips 1987, MacHutchon and Wellwood 2003, Munro et al. 2006, Gunther et al. 2014, Cristescu et al. 2015 |
| Mammal | *Tamias minimus* | least chipmunk | Species | Phillips 1987, MacHutchon and Wellwood 2003, Munro et al. 2006, Gunther et al. 2014, Cristescu et al. 2015 |

| Category | Scientific Name | Common Name | Lowest Level Taxomony Match | Source |
|---|---|---|---|---|
| Mammal | *Tamias townsendii* | Townsend's chipmunk | Genus | Phillips 1987, MacHutchon and Wellwood 2003, Munro et al. 2006, Gunther et al. 2014, Cristescu et al. 2015 |
| Mammal | *Tamiasciurus douglasii* | Douglas squirrel | Genus | Phillips 1987, Kasworm and Thier 1993, MacHutchon and Wellwood 2003, Munro et al. 2006, Gunther et al. 2014, Cristescu et al. 2015 |
| Mammal | *Tamiasciurus hudsonicus* | red squirrel | Species | Phillips 1987, Kasworm and Thier 1993, MacHutchon and Wellwood 2003, Munro et al. 2006, Gunther et al. 2014, Cristescu et al. 2015 |
| Mammal | *Thomomys talpoides* | northern pocket gopher | Species | Phillips 1987, Mattson 2004a, Munro et al. 2006, Gunther et al. 2014 |
| Mammal | *Urocitellus columbianus* | Columbian ground squirrel | Species | Servheen 1983, Hamer and Hererro 1987a, Cristescu et al. 2015 |
| Mammal | *Ursus americanus* | American black bear | Species | Gunther et al. 2014 |
| Bird | Anatidae | 17 species (ducks and geese) | Family | Gunther et al. 2014 |
| Bird | Galliformes: *Callipepla californica* | California quail | Order | Gunther et al. 2014 |
| Bird | *Meleagris gallopavo* | wild turkey | Species | Servheen 1983, Gunther et al. 2014 |
| Bird | Passeriformes | 116 species (songbirds) | Order | Gunther et al. 2014 |
| Bird | Phasianidae: *Bonasa umbellus* | ruffed grouse | Family | Servheen 1983, Gunther et al. 2014 |
| Bird | Phasianidae: *Dendragapus fuliginosus* | sooty grouse | Family | Servheen 1983, Gunther et al. 2014 |
| Bird | Phasianidae: *Dendragapus obscurus* | dusky grouse | Family | Servheen 1983, Gunther et al. 2014 |
| Bird | Phasianidae: *Falcipennis canadensis* | spruce grouse | Family | Servheen 1983, Gunther et al. 2014 |

| Category | Scientific Name | Common Name | Lowest Level Taxomony Match | Source |
|---|---|---|---|---|
| Bird | Phasianidae: *Lagopus leucura* | white-tailed ptarmigan | Family | Servheen 1983, Gunther et al. 2014 |
| Bird | Phasianidae: *Phasianus colchicus* | ring-necked Pheasant | Family | Servheen 1983, Gunther et al. 2014 |
| Bird | *Sturnus vulgaris* | European starling | Species | Gunther et al. 2014 |
| Amphibian | Anura: *Anaxyrus boreas* | western toad | Order | Gunther et al. 2014 |
| Amphibian | Anura: *Ascaphus truei* | coastal tailed frog | Order | Gunther et al. 2014 |
| Amphibian | Anura: *Rana aurora* | northern red-legged frog | Order | Gunther et al. 2014 |
| Amphibian | Anura: *Rana cascadae* | Cascades frog | Order | Gunther et al. 2014 |
| Amphibian | Anura: *Rana luteiventris* | Columbia spotted frog | Order | Gunther et al. 2014 |
| Amphibian | *Pseudacris regilla* | Pacific chorus frog | Genus | Gunther et al. 2014 |
| Fish | *Catostomus catostomus* | longnose sucker | Species | Barker 2011, Gunther et al. 2014 |
| Fish | *Catostomus columbianus* | bridgelip sucker | Genus | Barker 2011, Gunther et al. 2014 |
| Fish | *Catostomus macrocheilus* | largescale sucker | Genus | Barker 2011, Gunther et al. 2014 |
| Fish | Cypriniformes: *Mylocheilus caurinus* | peamouth | Order | Barker 2011, Gunther et al. 2014 |
| Fish | Cypriniformes: *Ptychocheilus oregonensis* | northern pikeminnow | Order | Barker 2011, Gunther et al. 2014 |
| Fish | Cypriniformes: *Rhinichthys cataractae* | longnose dace | Order | Barker 2011, Gunther et al. 2014 |
| Fish | Cypriniformes: *Richardsonius balteatus* | redside shiner | Order | Barker 2011, Gunther et al. 2014 |
| Fish | *Oncorhynchus aguabonita* | golden trout | Genus | Klinka and Reimchen 2002, Barker 2011, Fortin et al. 2013, Gunther et al. 2014 |

| Category | Scientific Name | Common Name | Lowest Level Taxomony Match | Source |
|---|---|---|---|---|
| Fish | *Oncorhynchus clarkii* | cutthroat trout | Species | Klinka and Reimchen 2002, Barker 2011, Fortin et al. 2013, Gunther et al. 2014 |
| Fish | *Oncorhynchus gorbuscha* | pink salmon | Species | Sizemore 1980, Barnes Jr. 1990, Klinka and Reimchen 2002, Barker 2011, Fortin et al. 2013, Gunther et al. 2014 |
| Fish | *Oncorhynchus keta* | chum salmon | Species | Sizemore 1980, Barnes Jr. 1990, Klinka and Reimchen 2002, Barker 2011, Fortin et al. 2013, Gunther et al. 2014 |
| Fish | *Oncorhynchus kisutch* | coho salmon, silver salmon | Species | Barnes Jr. 1990, Klinka and Reimchen 2002, Barker 2011, Fortin et al. 2013, Gunther et al. 2014 |
| Fish | *Oncorhynchus mykiss* | rainbow trout, steelhead | Genus | Klinka and Reimchen 2002, Barker 2011, Fortin et al. 2013, Gunther et al. 2014 |
| Fish | *Oncorhynchus nerka* | sockeye salmon, kokanee | Species | Sizemore 1980, Barnes Jr. 1990, Klinka and Reimchen 2002, Barker 2011, Fortin et al. 2013, Gunther et al. 2014, Deacy et al. 2017 |
| Fish | *Oncorhynchus tshawytscha* | Chinook salmon, king salmon | Species | Barnes Jr. 1990, Klinka and Reimchen 2002, Barker 2011, Fortin et al. 2013, Gunther et al. 2014 |
| Fish | Salmonidae: *Prosopium coulterii* | pygmy whitefish | Family | Barker 2011 |
| Fish | Salmonidae: *Prosopium williamsoni* | mountain whitefish | Family | Barker 2011 |
| Fish | Salmonidae: *Salvelinus confluentus* | bull trout | Family | Barker 2011 |
| Fish | Salmonidae: *Salvelinus fontinalis* | brook trout | Family | Barker 2011 |
| Fish | Salmonidae: *Salvelinus malma* | dolly varden | Family | Barker 2011 |

| Category | Scientific Name | Common Name | Lowest Level Taxomony Match | Source |
|---|---|---|---|---|
| Fish | Salmonidae: *Salvelinus namaycush* | lake trout | Family | Barker 2011 |
| Insect | Noctuidae | *Orthosia* spp. (Orthosia moths) | Family | Servheen 1983, Mattson et al. 1991 |
| Insect | Apidae: *Diadasia diminuta* | globe mallow bee | Family | Gunther et al. 2014 |
| Insect | *Apis mellifera* | honey bee | Species | Gunther et al. 2014 |
| Insect | *Bombus* spp. | 11 species (bumble bees) | Genus | Sizemore 1980, MacHutchon and Wellwood 2003, Gunther et al. 2014 |
| Insect | *Camponotus herculeanus* | hercules ant | Species | Hamer and Herrero 1987a, Mattson et al. 1991, Kasworm and Thier 1993, Munro et al. 2006, Gunther et al. 2014, Kasworm et al. 2014 |
| Insect | *Camponotus modoc* | western carpenter ant | Species | Hamer and Herrero 1987a, Mattson et al. 1991, Kasworm and Thier 1993, Munro et al. 2006, Gunther et al. 2014, Kasworm et al. 2014 |
| Insect | *Camponotus novaeboracensis* | New York carpenter ant | Genus | Hamer and Herrero 1987a, Mattson et al. 1991, Kasworm and Thier 1993, Munro et al. 2006, Gunther et al. 2014, Kasworm et al. 2014 |
| Insect | *Camponotus vicinus* | carpenter ant | Species | Hamer and Herrero 1987a, Mattson et al. 1991, Kasworm and Thier 1993, Munro et al. 2006, Gunther et al. 2014, Kasworm et al. 2014 |
| Insect | Coleoptera | 332 species (beetles) | Order | Gunther et al. 2014, Cristescu et al. 2015 |
| Insect | Diptera | 31 species (flies) | Order | Gunther et al. 2014 |

| Category | Scientific Name | Common Name | Lowest Level Taxomony Match | Source |
|---|---|---|---|---|
| Insect | *Formica neorufibarbis* | Formica ant | Species | Hamer and Herrero 1987a, Mattson et al. 1991, Kasworm and Thier 1993, Munro et al. 2006, Gunther et al. 2014, Kasworm et al. 2014 |
| Insect | *Formica* spp. | 4 species (Formica ants) | Genus | Hamer and Herrero 1987a, Mattson et al. 1991, Kasworm and Thier 1993, Munro et al. 2006, Gunther et al. 2014, Kasworm et al. 2014 |
| Insect | Formicidae | 3 species (ants) | Family | Hamer and Herrero 1987a, Mattson et al. 1991, Kasworm and Thier 1993, Munro et al. 2006, Gunther et al. 2014, Kasworm et al. 2014, Cristescu et al. 2015 |
| Insect | Hymenoptera | 30 species (sawflies, wasps, bees, and ants ) | Order | Servheen 1983, MacHutchon and Wellwood 2003, Fortin et al. 2013, Gunther et al. 2014 |
| Insect | *Lasius alienus* | cornfield ant | Genus | Hamer and Herrero 1987a, Mattson et al. 1991, Kasworm and Thier 1993, Munro et al. 2006, Gunther et al. 2014, Kasworm et al. 2014 |
| Insect | *Lasius pallitarsis* | Formica ant | Genus | Hamer and Herrero 1987a, Mattson et al. 1991, Kasworm and Thier 1993, Munro et al. 2006, Gunther et al. 2014, Kasworm et al. 2014 |
| Insect | *Lasius vestitus* | Formica ant | Genus | Hamer and Herrero 1987a, Mattson et al. 1991, Kasworm and Thier 1993, Munro et al. 2006, Gunther et al. 2014, Kasworm et al. 2014 |
| Insect | Lepidoptera | 51 species (butterflies) | Order | Servheen 1983, Mattson et al. 1991 |

| Category | Scientific Name | Common Name | Lowest Level Taxomony Match | Source |
|---|---|---|---|---|
| Insect | *Leptothorax muscorum* | Formica ant | Genus | Hamer and Herrero 1987a, Mattson et al. 1991, Kasworm and Thier 1993, Munro et al. 2006, Gunther et al. 2014, Kasworm et al. 2014 |
| Insect | *Leptothorax rugatulus* | Formica ant | Genus | Hamer and Herrero 1987a, Mattson et al. 1991, Kasworm and Thier 1993, Munro et al. 2006, Gunther et al. 2014, Kasworm et al. 2014 |
| Insect | *Myrmica incompleta* | Formica ant | Genus | Hamer and Herrero 1987a, Mattson et al. 1991, Kasworm and Thier 1993, Munro et al. 2006, Gunther et al. 2014, Kasworm et al. 2014 |
| Insect | Noctuidae: *Apamea amputatrix* | yellow-headed cutworm moth | Family | Servheen 1983, Mattson et al. 1991 |
| Insect | Scarabaeidae | 4 species (scarab beetles) | Family | Gunther et al. 2014 |
| Spider/Scorpion | Araneae | 34 species (spiders) | Order | Gunther et al. 2014 |

**Table A-2.** Sources of data for species occurrence in the North Cascades Ecosystem (U.S. Geological Survey 2018).

| **Institution** | **Collection** |
|---|---|
| Canadian Biodiversity Information Facility | Brassicaceae of Canada |
| Canadian Museum of Nature | Canadian Museum of Nature Herbarium |
| Centro Internacional de Agricultura Tropical (CIAT) | Global database for the distributions of crop wild relatives |
| Conservatoire et Jardin botaniques de la Ville de Genève | Geneva Herbarium General Collection |
| Cornell University | Lab of Ornithology (eBird - verified dataset) |
| European Molecular Biology Laboratory (EMBL) | Geographically tagged INSDC sequences |
| iNaturalist.org | iNaturalist Research-grade Observations |
| Missouri Botanical Garden | Tropicos Specimen Data |
| National Museum of Natural History, Smithsonian Institution | NMNH Extant Specimen and Observation Records |
| Naturalis Biodiversity Center | Naturalis Biodiversity Center - Botany Leiden |
| Ohio State University | Museum of Biological Diversity |
| Royal Botanic Garden Edinburgh | Royal Botanic Garden Edinburgh Living Plant Collections |
| Royal Botanic Gardens, Kew | Royal Botanic Gardens, Kew - Herbarium Specimens |
| The New York Botanical Garden | Herbarium - Vascular Plant Collection |
| U.S. Department of Agriculture | PLANTS Database |
| U.S. National Park Service | NPSpecies database |
| U.S. National Park Service | North Cascades National Park Service Complex – Wildlife Database |
| U.S. National Plant Germplasm System | U.S. National Plant Germplasm System Collection |
| U.S.Forest Service | Forest Inventory and Analysis - Trees (Public Lands) |
| Université Laval | Herbier Louis-Marie - Collection de plantes vasculaires |
| University of Alabama | Biodiversity and Systematics, Herbarium |
| University of Alberta | E. H. Strickland Entomological Museum |
| University of Alberta | University of Alberta Vascular Plant Herbarium |
| University of British Columbia (UBC) | UBC Herbarium, Vascular Plant Collection |
| University of California - Santa Barbara | Marine Science Institute Paleobiology Database |
| University of Connecticut | George Safford Torrey Herbarium |
| University of Kansas Biodiversity Institute | R. L. McGregor Herbarium Vascular Plants Collection |

| Institution | Collection |
|---|---|
| University of Washington | Burke Museum: UW Herbarium, Vascular Plant Collection |
| Utah State University | USU-UTC Specimen Database |
| Vanderbilt University | Bioimages |
| VegBank | Vegetation Plot Database |
| Yale University Peabody Museum | Botany Division |

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