Colville Tribes Natural Resources Climate Change Vulnerability Assessment

Prepared by the Climate Impacts Group, University of Washington
In partnership with the Confederated Tribes of the Colville Reservation

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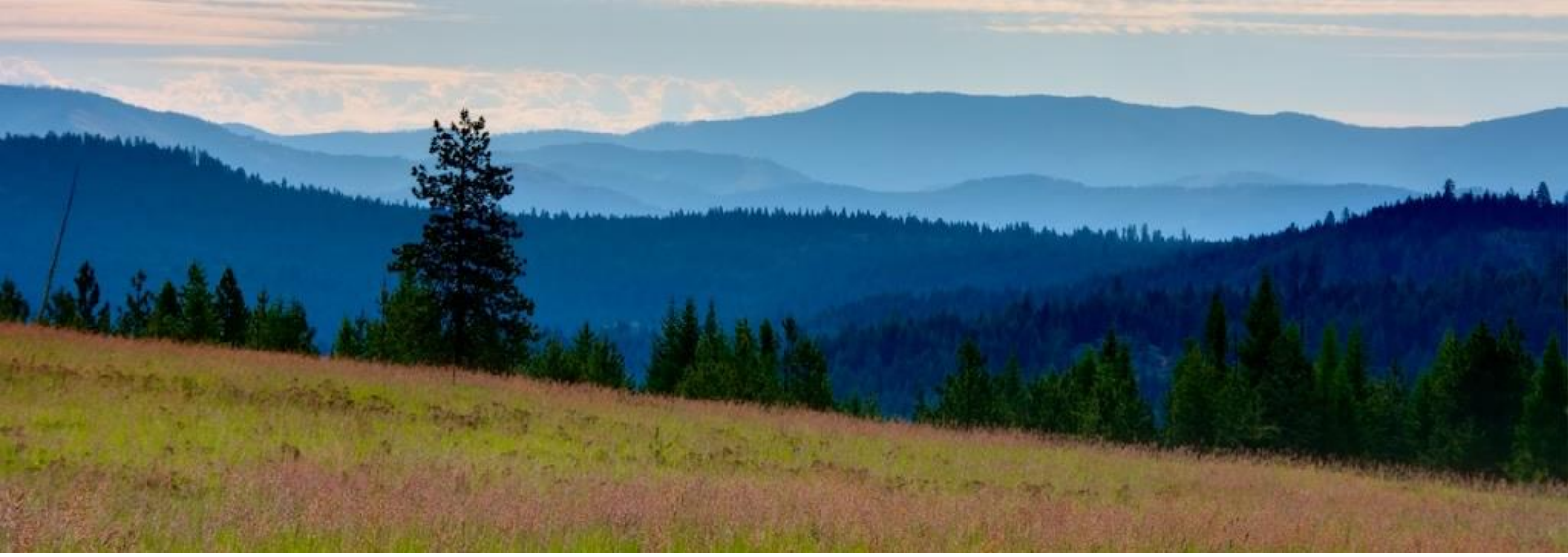

1. EXECUTIVE SUMMARY

The Confederated Tribes of the Colville Reservation have relied on the natural resources of their traditional territory to meet their subsistence and cultural needs for millennia. While the Tribes have always had to adapt to changes in their lands and waters, projected changes in climate over the coming century will present unique challenges to the many plants and animals of importance to the Tribes. Preparing for and mitigating these challenges require understanding which species will be most vulnerable to climate change, and why.

The Colville Tribes worked with the University of Washington Climate Impacts Group to assess the vulnerability of 72 plant and animal species of key importance to the Tribes. Together, they implemented a braided assessment approach integrating both Western science and the indigenous knowledge of Tribal elders. These knowledges were applied to the NatureServe Climate Change Vulnerability Index (CCVI) to assess the vulnerability of a diverse suite of species including mammals, birds, reptiles and amphibians, fish, a mollusk, plants, and a mushroom. They assessed vulnerability for the 2050s (2040-2069) and 2080s (2070-2099) across the Colville Tribes Traditional Territory, under both a low and a high greenhouse gas scenario.

A large proportion of the species assessed with the CCVI are expected to be extremely vulnerable by the end of the century under both low and high greenhouse gas scenarios (36% and 39%, respectively). However, vulnerability varies considerably among taxonomic groups; for example, most birds are expected to be less vulnerable, while most reptiles and amphibians and fishes are expected to be highly to extremely vulnerable. Salmonid fishes are among the most vulnerable, with the vast majority expected to be extremely vulnerable under both time periods and greenhouse gas scenarios.

Key sensitivities contributing to vulnerability across species include movement barriers (e.g., roads), limited mobility, potential human response to climate change (e.g., solar or wind farm installation), dependence on cool habitats, sensitivity to changes in aquatic habitat features, sensitivity to disturbance (e.g., wildfire), the potential for increased pressure from pathogens or competitors, and low genetic variation.

Knowing which priority species may be most vulnerable, and why, will be critical to supporting efforts by the Colville Tribes to promote the future resilience of their landscapes and communities.

2. INTRODUCTION

The Confederated Tribes of the Colville Reservation are composed of twelve federally-recognized tribes: Chelan, Chief Joseph Band of Nez Perce, Colville, Entiat, Lakes, Methow, Moses-Columbia, Nespelem, Okanogan, Palus, San Poil and Wenatchi. These Tribes have relied on the natural resources in their traditional territories to meet their subsistence and cultural needs for millennia. While the Tribes have always had to adapt to changes in their lands and waters, recent years have seen rising temperatures, falling snowpack, longer and more intense fire seasons, and other climate-driven changes that have presented unique challenges.

Future changes in climate are expected to have significant impacts on natural resources utilized by the Tribes for cultural, subsistence, and economic purposes. These will include warmer and drier summers, lower summer streamflows, and more frequent and intense natural disturbances (e.g., wildfire, floods, landslides). Each of these changes will affect the plants and animals that the Colville Tribes depend on for the health of their communities.

To help prepare for and mitigate these impacts, the Confederated Tribes of the Colville Reservation worked with the University of Washington Climate Impacts Group (CIG) to assess the vulnerability of key species for the Tribes. This assessment integrated both Western science and the indigenous knowledge of Tribal elders. These knowledges were used to assess—to the extent possible based on the availability of relevant information—the climate change exposures, sensitivities, and adaptive capacities of a diverse suite of important animals and plants. Knowing which species are expected to be most vulnerable, and why, will enhance the Tribes' ability to direct their resources and prepare for future changes, supporting the continued resilience of their communities and landscapes.

3. ASSESSMENT APPROACH

We assessed the vulnerability of priority species for the Colville Tribes using a braided approach incorporating both Western science and indigenous knowledge. These knowledges were drawn from the published scientific literature and databases, the technical expertise of CIG and Colville staff, and the indigenous knowledge of Colville Tribal elders. We assessed vulnerability for the middle and end of this century under low and high greenhouse gas scenarios. Key assessment steps are described below.

Step 1. Assessment Area Selection

Colville staff chose to assess species' vulnerability across the Traditional Territory of their twelve Tribes (Figure 1).[i] The Colville Tribes Traditional Territory stretches from the Blue Mountains north through the Columbia Basin and into the Okanagan Valley and Highlands. Data limitations north of the U.S.-Canada border resulted in a slightly smaller assessment area than the full Traditional Territory.

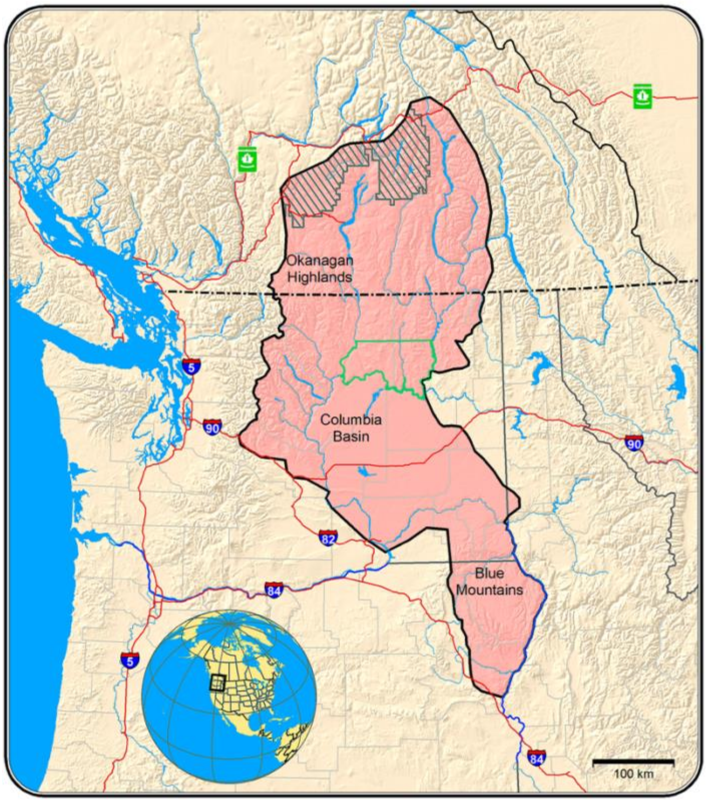

Figure 1. The Colville Tribes Traditional Territory[i] (pink); the assessment area spanned all but the hashed area at the northern edge, which was excluded due to data limitations.

[i] This map is not intended to show a definitive outline of the Colville Tribes Traditional Territory, but rather offers a general guide.

Step 2. Species Selection

The Colville Tribes Natural Resource Department worked together with Tribal members, other Tribal departments, and CIG to collaboratively develop a list of priority species of importance to the Tribes for inclusion in the vulnerability assessment (Table 1). The 72 species selected for assessment included mammals, birds, reptiles and amphibians, fish, a mollusk, plants, and a mushroom.

Step 3. NatureServe Climate Change Vulnerability Index (CCVI)

We used the NatureServe Climate Change Vulnerability Index (CCVI)[i] to quantitatively assess the climate change vulnerability of species with sufficient natural history information and range data.[1] Detailed description of the CCVI assessment methods and data sources is provided in Appendix A. A brief summary is provided below.

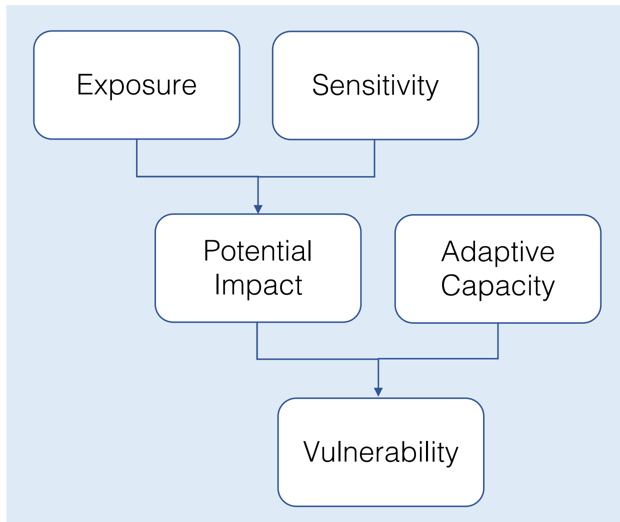

Figure 2. Components of vulnerability. The climate change vulnerability of a species is generally understood as being a product of its ***exposure*** to climate change (i.e., how much climate change it will experience), its ***sensitivity*** to climate change (i.e., how much a given change in climate will affect it), and its ***adaptive capacity*** (i.e., its ability to undergo changes that would help it respond). Figure modified from Glick et al. (2011).[2]

NatureServe's CCVI combines information on a species' projected climate change exposure, sensitivity, and adaptive capacity (Figure 2), to generate a relative ranking of vulnerability to climate change. It does this by scoring each species for a comprehensive suite of sensitivity and adaptive capacity factors that may contribute to its climate change vulnerability. A species' projected exposure to climate change is used along with its sensitivity scores to assign it one of six relative rankings of climate change vulnerability, from *Less Vulnerable* to *Extremely Vulnerable.*

We evaluated sensitivity and adaptive capacity scores for the CCVI using the primary literature and databases of species' natural history characteristics and other relevant information. We incorporated the local knowledge and expertise of the Tribes' Natural Resources staff during and following an interactive workshop. Finally, we incorporated the indigenous knowledge of Tribal elders using results of a 2017 survey documenting their observations of recent changes.

[i] Release 3.0.[1]

Table 1. A total of 72 species were evaluated in the vulnerability assessment. The NatureServe CCVI tool was used to calculate vulnerability rankings for 61 species; another 11 species [marked with an asterisk (*)] were given sensitivity scores but not vulnerability rankings due insufficient geographic range information. Twenty-two species [shown with a dagger (†)] were assessed for only the U.S. portion of the study area. Four non-native species [shown with a cross (✤)] were included in the assessment.

Mammals

American Badger (*Taxidea taxus*)
American Beaver (*Castor canadensis*)
American Marten (*Martes americana*)
Bighorn Sheep (*Ovis canadensis*)
Canada Lynx (*Lynx canadensis*)
Grizzly Bear (*Ursus arctos*)
Elk (*Cervus canadensis nelsoni*)*
Moose (*Alces alces*)
Mule Deer (*Odocoileus hemionus*)
Pronghorn Antelope (*Antilocarpa americana*)
White-Tailed Deer (*Odocoileus virginianus*)
White-Tailed Jackrabbit (*Lepus townsendii*)

Birds

Black-Backed Woodpecker (*Picoides arcticus*)
Common Loon (*Gavia immer*)
Golden Eagle (*Aquila chrysaetos*)
Great Gray Owl (*Strix nebulosa*)
Sharp-Tailed Grouse (*Tympanuchus phasianellus*)
White-Headed Woodpecker (*Leuconotopicus albolarvatus*)

Reptiles and Amphibians

Columbia Spotted Frog (*Rana luteiventris*)
Painted Turtle (*Chrysemys picta*)*
Tiger Salamander (*Ambystoma tigrinum*)
Western Toad (*Anaxyrus boreas*)

Fishes

Bull Trout (*Salvelinus confluentus*)†
Chinook, Fall Run (*Oncorhynchus tshawytscha*)†
Chinook, Spring Run (*Oncorhynchus tshawytscha*)†
Chinook, Summer Run (*Oncorhynchus tshawytscha*)†
Kokanee Salmon (*Oncorhynchus nerka*)
Sockeye Salmon (*Oncorhynchus nerka*)†
Steelhead, Summer Run (*Oncorhynchus mykiss*)†
Bridgelip Sucker (*Catostomus columbianus*)
Brook Trout (*Salvelinus fontinalis*)✤
Burbot (*Lota lota*)
Mountain Whitefish (*Prosopium williamsoni*)
Northern Pike (*Esox lucius*)✤
Northern Pike Minnow (*Ptychocheilus oregonensis*)
Pacific Lamprey (*Lampetra tridentada*)†
Redband Rainbow Trout (*Oncorhynchus mykiss*)
Smallmouth Bass (*Micropterus dolomieu*)✤
Walleye (*Sander vitreus*)✤
Westslope Cutthroat Trout (*Oncorhynchus clarkii lewisi*)
White Sturgeon (*Acipenser transmontanus*)

Mollusks

Western Pearlshell Mussel (*Margaritifera falcata*)*

Plants

Antelope Bitterbrush (*Purshia tridentate*)†
Arrowleaf Balsamroot (*Balsamorhiza sagittata*)†
Basin Wildrye (*Leymus cinereus*)†
Bitterroot (*Lewsia rediviva*)*
Black Camas (*Camiassia quamash*)*
Blue Elderberry (*Sambucus nigra ssp cerulea*)*
Bluebunch Wheatgrass (*Pseudoroegneria spicata*)†
Ceanothus (*Ceanothus velutinus*)†
Devil's Club (*Opopanax horridus*)†
Douglas Fir (*Pseudotsuga Menziessi var Glauca*)*
Idaho Fescue (*Festuca idahoensis*)†
Indian Potato (*Claytonia lanceolata*)*
Fernleaf Biscuitroot (*Lomatium dissectum*)†
Foamberry (*Shepherdia canadensis*)†
Lodgepole Pine (*Pinus contorta*)
Pacific Yew (*Taxus brevifolia*)
Paper Birch (*Betula papyrifera*)†
Ponderosa Pine (*Pinus ponderosa*)
Quaking Aspen (*Populus tremuloides*)
Scouler's Willow (*Salix scouleriana*)†
Service Berry (*Amelanchier alnifolia*)†
Thinleaf Huckleberry (*Vaccinium membranaceum*)†
Tule (*Schoenoplectus acutus*)*
Wapato (*Sagittaria latifolia*)*
Water Birch (*Betula occidentalis*)†
Western Redcedar (*Thuja plicata*)
Western Larch (*Larix occidentalis*)
Whitebark Pine (*Pinus albicaulis*)
Wood's Rose (*Rosa woodsii*)†

Mushrooms

Morel (*Morchella esculenta*)*

We calculated CCVI vulnerability rankings for both the 2050s (2040-2069) and 2080s (2070-2099) under both a low (RCP 4.5) and high (RCP 8.5) greenhouse gas scenario.[i]

Sixty-one species had sufficient information available to calculate a CCVI vulnerability ranking. For the majority of these species (39), we assessed CCVI vulnerability rankings at the scale of the Tribes' Traditional Territory. For another 22 of these species, we calculated CCVI vulnerability rankings for only the U.S. portion of the Traditional Territory due to limitations in species range data north of the U.S.-Canada border (see Table 1 for scale of assessment for each species; see Appendix A for additional information on species range data sources). Another 11 species had insufficient geographic range data to calculate their climate exposure (Table 1); for these, we calculated sensitivity and adaptive capacity scores, but did not calculate an overall vulnerability ranking.

We chose to use the CCVI for this assessment because it offers an efficient and consistent approach for assessing climate change vulnerability across a large, diverse suite of species such as those of importance to the Colville Tribes. In addition, the CCVI is freely available and frequently used (e.g., for assessments by other tribes, state and federal agencies, and non-governmental organizations); offers a relatively high degree of transparency and repeatability compared with other available tools; and has been shown to have relatively high accuracy compared to other assessment tools.[4] Finally, the comprehensive suite of sensitivity and adaptive capacity factors scored by the CCVI offers valuable information for guiding future climate change adaptation planning efforts.

[i] Greenhouse gas scenarios were developed by climate modeling centers for use in modeling global and regional climate impacts. This assessment uses two Representative Concentration Pathways (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).[3]

4. RESULTS

A large proportion of the 61 species assessed with the CCVI are expected to be extremely vulnerable by the end of the century under both low and high greenhouse gas scenarios (36% and 39%, respectively) (Figure 3). However, vulnerability varies considerably among taxonomic groups; for example, most birds are expected to be less vulnerable, while most reptiles and amphibians and fishes are expected to be highly to extremely vulnerable. Salmonid fishes are among the most vulnerable, with the vast majority expected to be extremely vulnerable under both time periods and greenhouse gas scenarios.

Across taxa, species vulnerabilities are generally expected to rise over time and with the higher greenhouse gas scenario. However, vulnerabilities for the higher greenhouse gas scenario are very similar for the 2050s and 2080s; this is because projected changes in temperature and moisture fall into the highest CCVI exposure categories (see Appendix A for more details) for both the 2050s and 2080s under a high greenhouse gas scenario, resulting in similar exposure for the two time horizons under a high greenhouse gas scenario.

Key sensitivities expected to promote vulnerability for many species include barriers to movement and limited mobility, dependence on cool habitats, reliance on specific hydrologic features or regimes, sensitivity to disturbance (e.g., wildfire), the potential for increased pathogen and/or competition pressure, and low genetic variation.

Summary results for all species and major taxonomic groups are described below. Detailed results for individual species can be found in the detailed table of sensitivity scores and vulnerability rankings in Appendix B. In addition, detailed fact sheets describing key sensitivities for each species can be found in Appendix D.

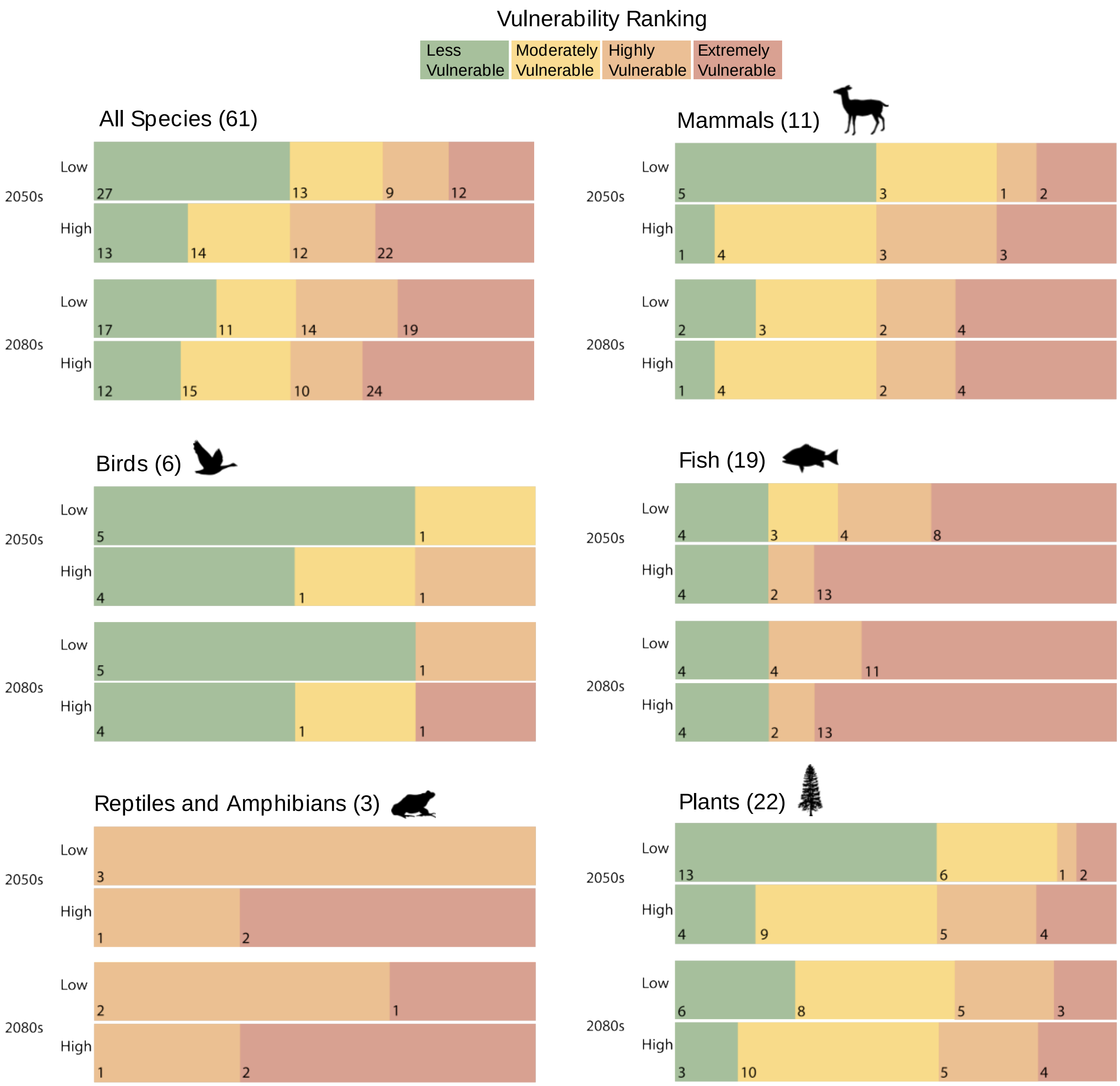

Figure 3. Summary of vulnerability rankings given to the 61 species that received CCVI vulnerability rankings, shown for all species assessed by the CCVI (top left) and grouped by taxon (remaining panels). Results are shown for the 2050s and 2080s under low (RCP 4.5) and high (RCP 8.5) greenhouse gas scenarios. The width of the segments in each bar reflects the proportion of species receiving each ranking for a given time period and greenhouse gas scenario; the number of species receiving each ranking is shown within each segment.

4.1 Birds

Most of the six birds assessed are estimated to be *Less Vulnerable* to climate change for both time periods and greenhouse gas scenarios (Table 2). This is largely due to their high mobility, which may allow them to move to more favorable environments as the climate changes. The exception to this is the sharp-tailed grouse, which is expected to be *Moderately Vulnerable* by the 2050s under a low greenhouse gas scenario, and *Extremely Vulnerable* by the end of the century under a high greenhouse gas scenario. This is primarily due to its sensitivities to movement barriers (e.g., roads, agriculture) and potential human response to climate change (e.g., wind and solar installations), as well as its low genetic variation – each of these may limit the sharp-tailed grouse's ability to respond to climate change.

Table 2. Vulnerability rankings given to the six bird species analyzed with the CCVI. Results are shown for the 2050s and 2080s under low (RCP 4.5) and high (RCP 8.5) greenhouse gas scenarios.

		2050s		2080s	
English Name	Latin Name	RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5
Sharp-Tailed Grouse	*Tympanuchus phasianellus*	MV	HV	HV	EV
Great Gray Owl	*Strix nebulosa*	LV	MV	LV	MV
Black-Backed Woodpecker	*Picoides arcticus*	LV	LV	LV	LV
Common Loon	*Gavia immer*	LV	LV	LV	LV
Golden Eagle	*Aquila chrysaetos*	LV	LV	LV	LV
White-Headed Woodpecker	*Leuconotopicus albolarvatus*	LV	LV	LV	LV

LV	Less Vulnerable
MV	Moderately Vulnerable
HV	Highly Vulnerable
EV	Extremely Vulnerable

4.2 Mammals

Vulnerability rankings for the 11 mammals assessed using the CCVI varied considerably by species (Table 3), but most are expected to be at least *Moderately Vulnerable* by the 2050s under a high greenhouse gas scenario. This is in part due to each species being sensitive to human-made barriers on the landscape (e.g., roads, development), which may make it difficult to move to more favorable environments as the climate warms.

Both American marten and Canada lynx are expected to be *Extremely Vulnerable* under all climate scenarios, for similar reasons: both are dependent on ice or snow for breeding or hunting; are sensitive to natural and human-made barriers on the landscape and to disturbance (e.g., wildfire); are adapted to relatively cool temperatures; and may experience increased competition from competitors under climate change. Additionally, Canada lynx may be sensitive due to a historical genetic bottleneck that may limit its ability to adapt.

Moose, mule deer, and white-tailed deer are also expected to be *Highly* to *Extremely Vulnerable* under future scenarios, due primarily to sensitivities to both movement barriers and to pathogens that may see increased occurrence or virulence under climate change; moose are additionally sensitive due to their dependence on cool temperatures.

Elk did not receive a CCVI ranking due to lack of geographic range information, but is also expected to be sensitive to both human made and natural movement barriers, and to have difficulty adapting due to low genetic variation. In addition, observations suggest that elk have not been adjusting their phenology (e.g., timing of breeding or migration) within the Colville Tribes Traditional Territory, which is expected to increase the species' sensitivity.

Table 3. Vulnerability rankings given to the eleven mammals analyzed with the CCVI, in descending order of vulnerability. Results are shown for the 2050s and 2080s under low (RCP 4.5) and high (RCP 8.5) greenhouse gas scenarios.

English Name	Latin Name	2050s		2080s	
		RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5
American Marten	*Martes americana*	EV	EV	EV	EV
Canada Lynx	*Lynx canadensis*	EV	EV	EV	EV
Moose	*Alces alces*	HV	EV	EV	EV
Mule Deer	*Odocoileus hemionus*	MV	HV	EV	EV
White-Tailed Deer	*Odocoileus virginianus*	MV	HV	HV	HV
White-Tailed Jackrabbit	*Lepus townsendii*	MV	HV	HV	HV
American Badger	*Taxidea taxus*	LV	MV	MV	MV
Grizzly Bear	*Ursus arctos*	LV	MV	MV	MV
Pronghorn Antelope	*Antilocarpa americana*	LV	MV	MV	MV
American Beaver	*Castor canadensis*	LV	MV	LV	MV
Bighorn Sheep	*Ovis canadensis*	LV	LV	LV	LV

LV	Less Vulnerable
MV	Moderately Vulnerable
HV	Highly Vulnerable
EV	Extremely Vulnerable

4.3 Reptiles and Amphibians

The three reptiles and amphibians assessed using the CCVI are all expected to be at least *Highly Vulnerable* to climate change under all scenarios (Table 4), with Columbia spotted frog and tiger salamander expected to be *Extremely Vulnerable* under a high greenhouse gas scenario by both the 2050s and 2080s. This is due to all three species being sensitive to both natural and human made barriers on the landscape (e.g., roads, development), which may make it difficult to move to more favorable environments as the climate warms. In addition, the species' reliance on aquatic habitats that may face early seasonal drying with future warming, as well as their sensitivity to disturbance (e.g., drought), are also expected to increase their vulnerability. Painted turtle did not receive a CCVI vulnerability ranking due to lack of geographic range information, but is also expected to share these sensitivities.

Table 4. Vulnerability rankings given to the three reptiles and amhibians analyzed with the CCVI, in descending order of vulnerability. Results are shown for the 2050s and 2080s under low (RCP 4.5) and high (RCP 8.5) greenhouse gas scenarios.

English Name	Latin Name	2050s		2080s	
		RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5
Columbia Spotted Frog	*Rana luteiventris*	HV	EV	EV	EV
Tiger Salamander	*Ambystoma tigrinum*	HV	EV	HV	EV
Western Toad	*Anaxyrus boreas*	HV	HV	HV	HV

LV	Less Vulnerable
MV	Moderately Vulnerable
HV	Highly Vulnerable
EV	Extremely Vulnerable

4.4 Fish

Fish were among the most vulnerable taxonomic groups assessed (Table 5). This is largely because the vast majority of salmonid fishes are expected to be *Extremely Vulnerable* under both time periods and greenhouse gas scenarios. This vulnerability is primarily due to sensitivity to natural and human-made barriers (e.g., dams); dependence on cool temperatures; sensitivity to changes in stream flow, particularly low summer flows and winter flooding; and sensitivity to pathogens and competitors (e.g., smallmouth bass, walleye, northern pike, and brown trout) that may benefit from future changes in climate. In addition, several species exhibit low genetic diversity that may challenge their ability to adapt to future conditions.

Four introduced fish species (brook trout, northern pike, smallmouth bass, and walleye) were assessed using the CCVI. Three of these species (northern pike, smallmouth bass, and walleye) are expected to be *Less Vulnerable* under both time periods and greenhouse gas scenarios. This *Less Vulnerable* ranking is due largely to the species' excellent dispersal abilities, broad dietary versatility, and lack of dependence on a specific disturbance regime. This ranking implies that the abundance or range of these three species will not change substantially by the 2050s or 2080s. The introduced brook trout is expected to be *Extremely Vulnerable* under both time periods and greenhouse gas scenarios. This *Extremely Vulnerable* ranking is primarily due to the brook trout's dependence on cool aquatic habitat, the occurrence of man-made barriers (e.g., dams), and sensitivity to disease. This *Extremely Vulnerable* ranking implies that the range or abundance of the brook trout will decrease substantially or disappear by the 2050s or 2080s.

Table 5. Vulnerability rankings given to the 22 fish species analyzed with the CCVI, in descending order of vulnerability. Results are shown for the 2050s and 2080s under low (RCP 4.5) and high (RCP 8.5) greenhouse gas scenarios.

English Name	Latin Name	2050s		2080s	
		RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5
Bull Trout	*Salvelinus confluentus*	EV	EV	EV	EV
Chinook, Fall Run	*Oncorhynchus tshawytscha*	EV	EV	EV	EV
Chinook, Spring Run	*Oncorhynchus tshawytscha*	EV	EV	EV	EV
Chinook, Summer Run	*Oncorhynchus tshawytscha*	EV	EV	EV	EV
Kokanee Salmon	*Oncorhynchus nerka*	EV	EV	EV	EV
Steelhead, Summer Run	*Oncorhynchus mykiss*	EV	EV	EV	EV
Brook Trout	*Salvelinus fontinalis*	EV	EV	EV	EV
Redband Rainbow Trout	*Oncorhynchus mykiss*	EV	EV	EV	EV
Westslope Cutthroat Trout	*Oncorhynchus clarkii lewisi*	EV	EV	EV	EV
Burbot	*Lota lota*	HV	EV	EV	EV
Mountain Whitefish	*Prosopium williamsoni*	HV	EV	EV	EV
Bridgelip Sucker	*Catostomus columbianus*	MV	EV	HV	EV
Pacific Lamprey	*Lampetra tridentada*	MV	EV	HV	EV
Sockeye Salmon	*Oncorhynchus nerka*	HV	HV	HV	HV
White Sturgeon	*Acipenser transmontanus*	MV	HV	HV	HV
Northern Pike	*Esox Lucius*	LV	LV	LV	LV
Northern Pike Minnow	*Ptychocheilus oregonensis*	LV	LV	LV	LV
Smallmouth Bass	*Micropterus dolomieu*	LV	LV	LV	LV
Walleye	*Sander vitreus*	LV	LV	LV	LV

LV	Less Vulnerable
MV	Moderately Vulnerable
HV	Highly Vulnerable
EV	Extremely Vulnerable

4.5 Mollusks

The western pearlshell mussel was the only mollusk included in the assessment. Due to lack of geographic range information it did not receive a CCVI vulnerability ranking. However, sensitivity scores suggest that its limited mobility and restriction to cold waters are likely to greatly increase its vulnerability. Its sensitivity to human-made barriers (e.g., dams) and changes in streamflow are also expected to increase its vulnerability. While lack of geographic range data prevented calculation of a CCVI vulnerability ranking, comparison with other species scores and exposure projections over the full study area suggests the mussel is likely to be highly to extremely vulnerable to climate change.

4.6 Plants

Plants are among the less vulnerable taxa assessed, and also among the most diverse in terms of their range of vulnerability rankings and underlying sensitivities (Table 6). Most plant species are expected to be *Less* to *Moderately Vulnerable* by the end of the century under both a low and high greenhouse gas scenario. However, both western redcedar and whitebark pine are expected to be *Extremely Vulnerable* for both time periods and greenhouse gas scenarios. Limited mobility is expected to greatly increase the vulnerability of a number of the more vulnerable plant species, including whitebark pine, antelope bitterbrush, western larch, and ceanothus. Several others are expected to be sensitive due to human-made barriers on the landscape, dependence on cool temperatures, disturbance (e.g., wildfire), and the potential for increased pressure from pathogens or pests.

Seven plant species (black camas, bitterroot, western spring beauty, Douglas-fir, tule, wapato, blue elderberry) did not receive a CCVI vulnerability ranking due to lack of geographic range data and lack of available range proxy data through the LANDFIRE dataset (see Appendix A for details). Two priority plant species, black lichen (*Bryoria fremontii*) and Indian carrot (*Perideridia gairdneri)*, were not analyzed in the assessment due to lack of species sensitivity information.

Table 6. Vulnerability rankings given to the 19 plant species analyzed with the CCVI, in descending order of vulnerability. Results are shown for the 2050s and 2080s under low (RCP 4.5) and high (RCP 8.5) greenhouse gas scenarios.

English Name	Latin Name	2050s		2080s	
		RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5
Whitebark Pine	*Pinus albicaulis*	EV	EV	EV	EV
Western Redcedar	*Thuja plicata*	EV	EV	EV	EV
Antelope Bitterbrush	*Purshia tridentate*	HV	EV	EV	EV
Thinleaf Huckleberry	*Vaccinium membranaceum*	MV	EV	HV	EV
Foamberry	*Shepherdia canadensis*	MV	HV	HV	HV
Idaho Fescue	*Festuca idahoensis*	MV	HV	HV	HV
Ponderosa Pine	*Pinus ponderosa*	MV	HV	HV	HV
Western Larch	*Larix occidentalis*	MV	HV	HV	HV
Ceanothus	*Ceanothus velutinus*	MV	HV	MV	HV
Basin Wildrye	*Leymus cinereus*	LV	MV	MV	MV
Bluebunch wheatgrass	*Pseudoroegneria spicata*	LV	MV	MV	MV
Fernleaf Biscuitroot	*Lomatium dissectum*	LV	MV	MV	MV
Lodgepole Pine	*Pinus contorta*	LV	MV	MV	MV
Pacific Yew	*Taxus brevifolia*	LV	MV	MV	MV
Quaking Aspen	*Populus tremuloides*	LV	MV	MV	MV
Service Berry	*Amelanchier alnifolia*	LV	MV	MV	MV
Paper Birch	*Betula papyrifera*	LV	MV	LV	MV
Wood's Rose	*Rosa woodsii*	LV	MV	LV	MV
Devil's Club	*Opopanax horridus*	LV	LV	LV	MV
Arrowleaf Balsamroot	Balsamorhiza sagittata	LV	LV	LV	LV
Scouler's Willow	*Salix scouleriana*	LV	LV	LV	LV
Water Birch	*Betula occidentalis*	LV	LV	LV	LV

LV	Less Vulnerable
MV	Moderately Vulnerable
HV	Highly Vulnerable
EV	Extremely Vulnerable

4.7 Mushrooms

The morel mushroom was the only fungus assessed, and did not receive a CCVI vulnerability ranking due to lack of geographic range data. The morel's limited mobility is expected to slightly increase its vulnerability. The lack of other sensitivities suggests the morel may be relatively less vulnerable to climate change.

5. KEY FINDINGS AND NEXT STEPS

5.1 Key Findings

Our assessment offers several key insights regarding the climate change vulnerability of species of importance to the Colville Tribes. These include:

- A large proportion of species of importance to the Colville Tribes is expected to be extremely vulnerable by the end of the century under both low and high greenhouse gas scenarios.
- Climate change vulnerability is expected to vary among and within taxonomic groups of species, but is generally higher over time and under a high greenhouse gas scenario.
- Key sensitivities seen across taxa include natural and human-made barriers to species movement (e.g., roads, dams), limited species mobility, adaptation to cool temperatures, sensitivity to changes in aquatic habitats, sensitivity to disturbance (e.g., wildfire), the potential for increased pressure from pathogens and/or competitors, and low genetic variation (which may limit adaptation).
- **Birds** are expected to be among the least vulnerable species, with most expected to be *Less Vulnerable* under all future scenarios. However, sharp-tailed grouse is expected to be *Extremely Vulnerable* by the end of the century under a high greenhouse gas scenario.
- **Mammal** vulnerability varies considerably by species, but most are expected to be at least *Moderately Vulnerable* by the 2050s under a high greenhouse gas scenario. American marten and Canada lynx are expected to be *Extremely Vulnerable* under all future scenarios, due in large part to their dependence on snow and cool temperatures.
- The three **reptiles and amphibians** assessed are all expected to be *Highly* to *Extremely Vulnerable* under both greenhouse gas scenarios and time horizons.

- **Fishes** are among the most vulnerable species assessed. In particular, the vast majority of salmonids are expected to be *Extremely Vulnerable* under all future scenarios due to a range of sensitivities, including dependence on cool temperatures.
- **Plants** exhibit a wide range of vulnerabilities, but most are expected to be *Less* to *Moderately Vulnerable* by the end of the century under both a low and high greenhouse gas scenario. Underlying sensitivities vary considerably by species.
- A number of information gaps were identified by the assessment. In particular, lack of sufficient geographic range data prevented calculation of an overall CCVI vulnerability ranking for 11 priority species and limited the scale of analysis to south of the U.S.-Canada border for another 22 species (see Table 1).

Detailed information on vulnerability rankings and underlying climate sensitivities can be found in the species fact sheets provided in Appendix D.

5.2 Key Information Gaps

A valuable additional product of this assessment is the identification of key information gaps that, if addressed, could improve our understanding of priority species' vulnerability and underlying drivers. For example, 11 of the 72 species assessed lacked sufficient GIS range data for measuring climate exposure, precluding calculation of an overall CCVI vulnerability ranking for such species (Table 1). Another 22 species did not have range data available for Canada, limiting the scale of their assessment to south of the U.S.-Canada border. Many plant species had range data available at the county scale or for individual sites (e.g., herbarium specimens), but measuring climate exposure requires accurate estimates of a species' full range within the assessment area. For some of these plant species (Table A3) we were able to develop proxy range data using a LANDFIRE dataset (see Appendix A for more details). Developing accurate GIS range maps for all species with limited geographic range data would improve our understanding of their climate change vulnerability within the Colville Tribes Traditional Territory.

In addition, most species evaluated in this assessment exhibited some degree of information limitation regarding their climate sensitivities and adaptive capacities. For example, many species lacked sufficient information regarding their phenological response to climate change, sensitivity to pathogens and enemies, and documented response to climate change (Appendix C). Addressing such data gaps would further increase our understanding of species vulnerability.

The CCVI tool itself has limitations in its ability to provide a comprehensive estimate and understanding of climate vulnerability for many species. One of the benefits of the CCVI is that it is highly prescriptive regarding what information can be included in the assessment and how this information is used to rank vulnerability. This makes CCVI rankings highly transparent and repeatable, but prevents incorporation of a range of additional information that may be relevant to understanding vulnerability for particular species. For example, the CCVI does not explicitly account for changes in stream temperature that may affect many fish species, and furthermore does not evaluate potential spatial variation in vulnerability across the analysis area. Detailed climate impacts summaries provided in the *Summary of Projected Changes in Physical Conditions Across the Colville Tribes Study Area*,[5] including maps of projected changes in stream temperature and other impacts, may be helpful in anticipating such spatial variation in vulnerability and identifying potential areas of refuge for particular species. In addition, only a small portion of the information provided by the Tribal elders' survey was applicable to the data requirements of the CCVI (see Appendix A for details); future work should explore the survey results in greater depth and the application of traditional knowledge to understanding climate impacts on Colville natural and cultural resources.

Information gaps identified as part of this assessment suggest important areas of future research for understanding climate risks to species of importance to the Colville Tribes. As these gaps are filled and additional information becomes available, species' climate change vulnerability rankings should be re-evaluated.

5.3 Next Steps: How Can This Assessment Be Used?

Vulnerability assessments have many uses. These include building capacity among assessment participants, informing adaptation planning, and raising broader awareness and support for future adaptation efforts.

Participation of Colville staff in the vulnerability assessment process – through workshops, webinars, and iterative rounds of feedback and revision throughout the analysis and product development – should be expected to enhance their capacity for incorporating climate change into their decision-making. By understanding expected changes in climate across the Colville Tribes Traditional Territory and species' vulnerabilities and underlying causes, Colville staff become more likely to consistently view their management decisions through an informed climate change lens, promoting their ability to enhance the resilience of the Tribes' natural and cultural resources.

This assessment also offers valuable information for future adaptation planning to address climate impacts on species of importance to the Colville Tribes. Understanding expected climate impacts, relative species vulnerabilities, and what drives these vulnerabilities – exposure, sensitivity, and/or adaptive capacity – allows consideration of which species may most benefit from management intervention and which management intervention may be most or least effective in reducing vulnerability. For example, sensitivity to human-made barriers on the landscape (e.g., roads, dams, development) was identified as a key contributor to the vulnerability of many of the species assessed. This points to future adaptation strategies and actions that may include a) identifying key movement barriers (e.g., specific roads or dams) and/or movement corridors (e.g., key linkages for maintaining and restoring movement across the landscape), and b) addressing these barriers through a suite of possible interventions known to mitigate barriers and promote species movement (e.g., installing wildlife road crossing structures, removing or mitigating fish passage barriers, or restoring or maintaining habitat corridors). In this way, the vulnerability assessment should form the foundation of future climate adaptation efforts by the Colville Tribes.

Finally, communication materials prepared as part of this assessment for Colville community members and youth will be valuable for raising awareness of climate impacts and community support for future adaptation efforts. The layman-friendly brochure prepared for Colville community members provides a high-level overview of expected changes in climate across the Colville Tribes Traditional Territory, describes the vulnerability assessment process and key findings, and offers suggestions for community involvement in resilience efforts.[6] The educational activity prepared for Colville youth offers a hands-on introduction to vulnerability assessment and adaptation planning using a small set of familiar plants and animals, and also provides suggestions for getting involved in resilience efforts.[7] Together, these outreach and education materials increase the accountability of this assessment to the Colville community members it is ultimately intended to benefit, while simultaneously building their capacity and support for future climate adaptation efforts.

We hope this assessment and its suite of products will act as a valued resource for the Colville Tribes' ongoing efforts to promote the resilience of their priority species and habitats, so that they may continue to meet the Tribes' economic, subsistence, and cultural needs into the future.

6. GLOSSARY[i]

Adaptive capacity The ability of humans and other species to adjust to potential damage, to take advantage of opportunities, or to respond to consequences.

Adaptation The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects.

Climate change Changes in average weather conditions that persist over multiple decades or longer. Climate change encompasses both increases and decreases in temperature, as well as shifts in precipitation, changing risk of certain types of severe weather events, and changes to other features of the climate system.

Greenhouse gas scenarios Quantitative illustrations of how the release of different amounts of climate altering gases and particles into the atmosphere from human and natural sources will produce different future climate conditions. Scenarios are developed using a wide range of assumptions about population growth, economic and technological development, and other factors.

Pathogen Microorganisms (such as a bacteria or viruses) that causes disease.

Phenology The pattern of seasonal life cycle events in plants and animals, such as timing of blooming, hibernation, and migration.

Resilience The degree to which a system is able to cope with a hazardous event or trend or disturbance, maintaining its essential function, identity and structure.

Sensitivity Degree to which a system is affected, either adversely or beneficially, by climate-related stimuli. The effect may be direct (e.g., a change in crop yield in response to a change in the mean, range, or variability of temperature) or indirect (e.g., damages caused by an increase in the frequency of coastal flooding due to sea-level rise).

Vulnerability Degree to which a system is susceptible to injury, damage, or harm.

[i] Definitions adapted from IPCC (2014)[8] and http://www.globalchange.gov/climate-change/glossary

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APPENDIX A – DETAILED DESCRIPTION OF CCVI ANALYSIS

A.1 NatureServe Climate Change Vulnerability Index (CCVI)

We used NatureServe's Climate Change Vulnerability Index (CCVI) to quantitatively assess species' relative vulnerability to climate change within the Colville Tribes Traditional Territory. The CCVI integrates information on a species' exposure to climate change (i.e., how much climate change it will experience), its sensitivity to climate change (i.e., how much a given change in climate will affect it), and its adaptive capacity (i.e., its ability to undergo changes that could reduce its vulnerability) to generate a relative ranking of vulnerability to climate change. Descriptions of the components of a species' vulnerability measured by the CCVI are provided below:

- ***Exposure to climate change.*** The CCVI uses projected changes in air temperature, moisture availability, and current species range data to estimate a species' *exposure* to climate change across the species range within the Colville Tribes Traditional Territory.
    - **Direct exposure** to climate change was assessed by calculating the percent of each species' range within the Colville Tribes Traditional Territory that is exposed to different magnitudes of projected change in air temperature and moisture availability.
    - **Indirect exposure** to climate change was assessed by evaluating how anthropogenic barriers, natural barriers, and climate change mitigation efforts may affect species evaluated in this assessment (Table A1).
- ***Sensitivity to climate change.*** A species' *sensitivity* to climate change was assessed by scoring a species against a suite of 14 factors (Table A1). Examples of sensitivity factors include a species' dietary versatility, dependence on ice or snow, and sensitivity to competition.
- ***Adaptive capacity to withstand climate change.*** A species' *adaptive capacity* was assessed by scoring the species against a suite of six factors (Table A1). Examples of adaptive capacity factors include genetic variation within a population, phenological responses to climate change, and dispersal or movement capabilities.

The suite of sensitivity and adaptive capacity factors were evaluated independently for each species and were assigned a categorical ranking classification defined by NatureServe's CCVI guidelines.[1] The five categorical ranking classifications include:

1. **Greatly Increase Vulnerability**
2. **Increase Vulnerability**
3. **Somewhat Increase Vulnerability**
4. **Neutral**
5. **Unknown**

Table A1. Indirect climate exposure and species-specific sensitivity and adaptive capacity factors.

Factor	Description
Indirect Climate Exposure Factors	
Sea Level Rise	Effects of sea level rise on species habitat
Natural Barriers	Geographic features of the landscape that may restrict a species from naturally dispersing to new areas
Anthropogenic Barriers	Features of human-altered landscapes (urban or agricultural areas, roads, dams, culverts) that may hinder dispersal for terrestrial and aquatic species
Climate Change Mitigation	Effects of land use changes resulting from human responses to climate change (seawall development, wind farm, biofuel production)
Species Sensitivity and Adaptive Capacity Factors	
Dispersal / Movement	Ability of species to disperse or migrate across the landscape to new locations as conditions change over time
Historical Thermal Niche	Exposure to temperature variation over the past 30 years
Physiological Thermal Niche	Dependence on cool or cold habitats within the assessment area
Historical Hydrological Niche	Exposure to precipitation variation over the past 30 years
Physiological Hydrological Niche	Dependence on a specific precipitation or hydrologic regime
Disturbance	Dependence on a specific disturbance regime likely to be impacted by climate change
Dependence on Ice / Snow	Dependence on ice, ice-edge, or snow-cover habitats
Restriction to Uncommon Geologic Features	Dependence on specific substrates, soils, or physical features such as caves, cliffs, or sand dunes
Interspecific Interactions:	
Habitat Creation	Dependence on another species to generate habitat
Dietary Versatility	Breadth of food types consumed; dietary specialists vs. generalists (animals only)
Pollinator Versatility	Number of pollinator species (plants only)
Propagule Dispersal	Dependence on other species for propagule dispersal
Sensitivity to Pathogens or Natural Enemies	Pathogens and natural enemies (e.g., predators, parasitoids, herbivores, and parasite vectors) that can increase or become more pathogenic due to climate change
Sensitivity to Competition from Native or Non-Native Species	Species may suffer when competitors are favored by changing climates
Interspecific Interactions	Other interspecific interactions not including diet, pollination, and habitat creation
Genetic Variation	Measured genetic variation (high, medium, low)
Genetic Bottlenecks	Occurrence of bottlenecks in recent evolutionary history
Reproductive System	A plant's reproductive system may serve as a proxy for a species' genetic variation or capacity to adapt to novel climatic conditions (plants only)
Documented Response:	
Phenological Response*	A documented phenological response to changing seasonal temperature and precipitation dynamics.
Documented Response	This factor pertains to the degree to which a species is known to have responded to recent climate change (e.g., range contraction, phenology).

*Scoring criteria for this factor modified to include the indigenous knowledge of Tribal elders (see methods).

More than one of these categorical ranking classifications can be selected to indicate intermediate classification or to capture uncertainty surrounding a species' indirect exposure, sensitivity, or adaptive capacity. In addition, not all sensitivity and adaptive capacity factors are able to receive the full range of categorical responses, as they do not all equally affect overall species vulnerability. For example, scores for the adaptive capacity factor "Genetic Variation" range only from *Neutral* to *Increase Vulnerability*, and do not include the *Greatly Increase Vulnerability* classification.

The CCVI combines a species' direct exposure to climate change, indirect exposure to climate change, and species-specific sensitivity and adaptive capacity rankings to generate a numerical sum quantifying a species' relative vulnerability to climate change (Figure A1). This numerical sum is then translated to one of five possible overall vulnerability rankings (Table A2).

Table A2. CCVI Vulnerability rankings, abbreviations, and definitions.

Ranking	Abbreviation	Definition
Extremely Vulnerable	**EV**	Abundance and/or range extent within geographical area assessed extremely likely to substantially decrease or disappear by 2050 or 2080.
Highly Vulnerable	**HV**	Abundance and/or range extent within geographical area assessed likely to decrease significantly by 2050 or 2080.
Moderately Vulnerable	**MV**	Abundance and/or range extent within geographical area assessed likely to decrease significantly by 2050 or 2080.
Less Vulnerable	**LV**	Available evidence does not suggest that abundance and/or range extent within the geographical area assessed will change substantially by 2050 or 2080.
Insufficient Evidence	**IE**	Information entered about a species' vulnerability is inadequate to calculate an overall vulnerability ranking.[i]

[i] The index will calculate a species' score with a little as 13 responses to the sensitivity and adaptive capacity factors.

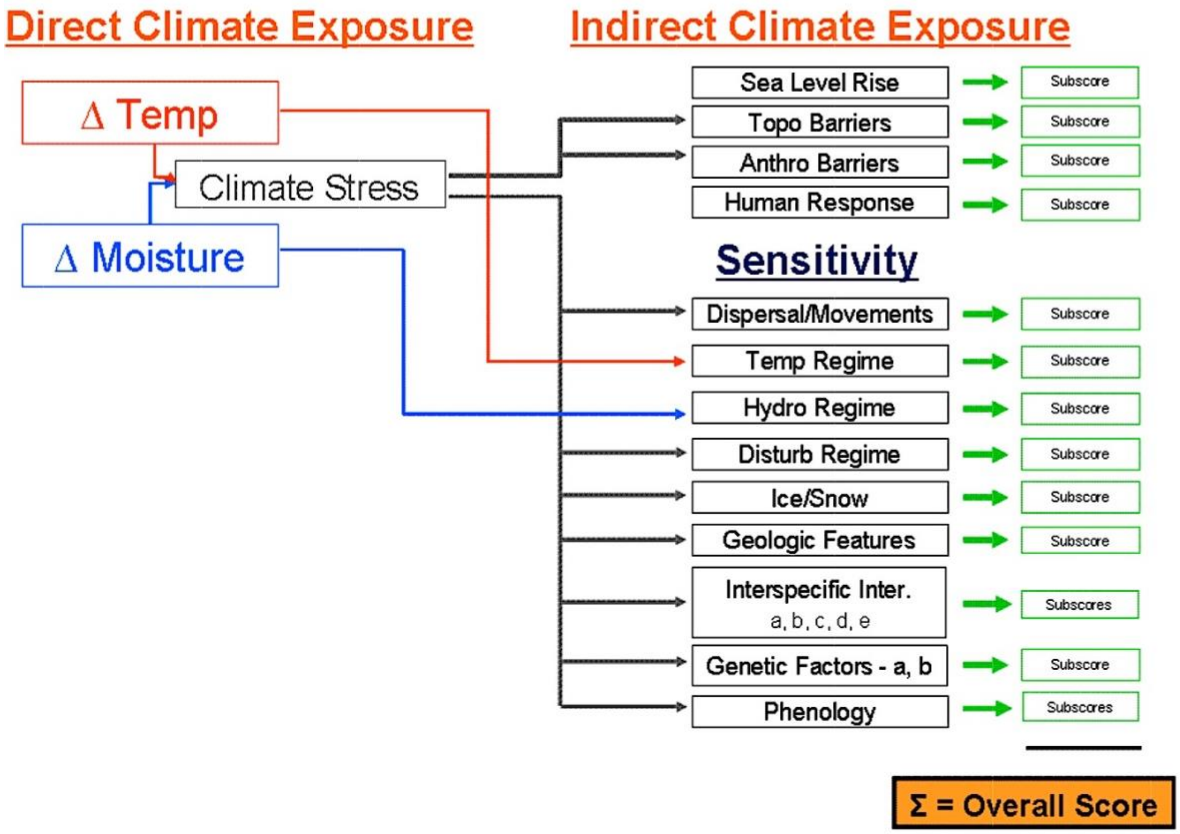

Figure A1. Components of the NatureServe Climate Change Vulnerability Index (CCVI). The CCVI measures climate change vulnerability based on direct exposure to local climate change (e.g., changes in temperature and moisture), indirect climate exposure (e.g., topographic barriers), and species sensitivity factors (e.g., dispersal capacity). The products of exposure and sensitivities generate subscores, which are summed to generate a species' overall vulnerability score. Figure reproduced from Young et al. (2015).[1]

A.2 Data Sources and Climate Data

To generate estimates of a species' direct climate exposure, indirect climate exposure, sensitivity, and adaptive capacity, the CCVI requires several data inputs including species range data and life history information; observed climate data; and projected changes in temperature, and moisture availability. Key data sources are shown in Table A2.

While species-specific life history information was largely derived from databases, the primary literature, and "gray literature" (e.g., theses, dissertations, agency reports), the Colville Tribes' Natural Resources staff also provided information and expertise via personal communication during and following project workshops. In addition, Tribal elders provided information on observed changes in climate and species via a 2017 survey conducted by the Colville Tribes. Survey results were used to score the *Phenological Response* factor; this was the only CCVI factor for which the survey offered applicable information. To accommodate information provided by the elders survey, scoring criteria for *Phenological Response* were modified slightly

Table A2. Primary data types and sources used in CCVI analysis.

Data Type	Source
Temperature Projections	MACA
Moisture Projections	MACA
Historic Temperature	MACA
Historic Moisture	MACA
Species Distributions	IUCN (http://www.iucnredlist.org/technical-documents/spatial-data); GECSC: Tree Species Distribution Map for North America (http://gec.cr.usgs.gov/data/little/); LANDFIRE/GAP Land Cover Map Unit Descriptions (https://www.landfire.gov/vegetation.php)
Species Life History	NatureServe Explorer (http://explorer.natureserve.org/); Sensitivity Database (http://climatechangesensitivity.org/); The Birds of North America Online (http://bna.birds.cornell.edu/bna/species); USDA Forest Service (https://www.feis-crs.org/feis/); Primary literature (peer-reviewed journals); Gray literature (e.g., theses, dissertations, agency reports); Colville Tribes staff/members (*personal communication*)

by removing the requirement that an observed change "is significantly less than that of other species in similar habitats or taxonomic groups," as that information was not collected in the surveys or available elsewhere. Input from Tribal staff and elders increased the accuracy of the assessment by including local technical expertise and indigenous knowledge from within the Colville Tribes Traditional Territory.

Many priority plant species included in this study do not have available GIS range data. To address this gap, we used the LANDFIRE Existing Vegetation Type (EVT) layer, which uses vegetation map units derived from NatureServe's ecological systems classification. The EVT layer maps vegetation types across the contiguous United States and lists plant associations with vegetation types. To develop proxy range data for priority plant species lacking GIS range data, we mapped all vegetation types associated with a species within the assessment area and used this combined area as its proxy range. EVT was used to develop proxy range data for 15 priority plant species evaluated in this assessment (Table A3).

We calculated CCVI scores for two time horizons: the 2050s (2040-2069) and the 2080s (2070-2099). We used temperature and moisture datasets from the Multivariate Adaptive Constructed Analogs (MACA) project, which are drawn from a statistically downscaled global climate model (GCM) from the Coupled Model Intercomparison Project 5 (CMIP5).[i] Projections were generated for the 2050s and the 2080s using a low [Representative Concentration Pathway (RCP) 4.5] and a high (RCP 8.5) greenhouse gas scenario.

[i] Taylor, K.E. et al. 2012. An overview of CMIP5 and the experiment design. *Bulletin of the American Meteorological Society,* 93(4), 485-498, doi: 10.1175/BAMS-D-11-00094.1

Table A3. The 15 priority plant species for which proxy range data was generated using the LANDFIRE Existing Vegetation Type layer.

Antelope Bitterbrush (*Purshia tridentate*)	Devil's Club (*Opopanax horridus*)	Scouler's Willow (*Salix scouleriana*)
Arrowleaf Balsamroot (*Balsamorhiza sagittata*)	Idaho Fescue (*Festuca idahoensis*)	Service Berry (*Amelanchier alnifolia*)
Basin Wildrye (*Leymus cinereus*)	Fernleaf Biscuitroot (*Lomatium dissectum*)	Thinleaf Huckleberry (*Vaccinium membranaceum*)
Bluebunch Wheatgrass (*Pseudoroegneria spicata*)	Foamberry (*Shepherdia canadensis*)	Water Birch (*Betula occidentalis*)
Ceanothus (*Ceanothus velutinus*)	Paper Birch (*Betula papyrifera*)	Wood's Rose (*Rosa woodsii*)

We calculated projected changes in moisture availability using an AET:PET moisture metric. The moisture metric is a ratio between projected actual evapotranspiration (AET) and potential evapotranspiration (PET). PET was calculated based on the output for a Variable Infiltration Capacity (VIC) model.[i] Projected changes in the moisture metric were generated for the 2050s and the 2080s under both a low (RCP 4.5) and high (8.5) greenhouse gas scenario.

For the CCVI analysis we used ten different climate datasets. These include two observed data sets and eight data sets for projected changes in climate.

Projected changes in annual temperature (relative to 1970-1999) were categorized using a categorical binning structure defined in the NatureServe Guidelines. There are six categorical temperature bins:

1. >6.0° F (>3.3° C)
2. 5.5-6.0° F (3.1-3.3° C) warmer
3. 5.1-5.5° F (2.8-3.1° C) warmer
4. 4.5-5.0° F (2.5-2.7° C) warmer
5. 3.9-4.4° F (2.2-2.4° C) warmer
6. < 3.9° F (2.2° C) warmer

Projected changes in the annual moisture metric (a unitless ratio) were classified using a categorical binning structure. Lower negative values denote more net drying. There are six categorical moisture metric bins:

1. < -0.119

[i] Gao, H., Q. Tang, X. Shi, C. Zhu, T. J. Bohn, F. Su, J. Sheffield, M. Pan, D. P. Lettenmaier, and E. F. Wood, 2010: Water Budget Record from Variable Infiltration Capacity (VIC) Model. In *Algorithm Theoretical Basis Document for Terrestrial Water Cycle Data Records* (in review).

2. -0.097 - (-0.119)
3. -0.074 - (-0.096)
4. -0.051 - (-0.073)
5. -0.028 - (-0.050)
6. >-0.028

A.3 Data Processing

We first classified each of the eight exposure layers (e.g., annual temperature and annual moisture) into the respective categorical binning systems defined above. Next, we clipped each of these eight exposure layers (now overlaid with NatureServe's defined binning system) to the Colville Tribes Traditional Territory. This step ensured that we solely considered the exposure data (i.e., projected change in temperature and moisture availability) within the assessment area boundary. Projected exposure bins for the study area are shown in Figures A2-A3. To calculate exposure for each species, we clipped the eight exposure layers bounded at the Traditional Territory to each species' geographical range. This step ensured that we solely examined exposure data across the range of a specific species within the Traditional Territory.

A.4 Additional Climate Variables Not Included in the CCVI

The CCVI does not consider all of the climate change impacts likely to affect species' vulnerability to climate change in the Colville Tribes Traditional Territory. Therefore, we developed a supplemental report, *Summary of Projected Changes in Physical Conditions Across the Colville Tribes Study Area*,[i] that highlights projected changes in a range of climate-relevant variables selected collaboratively by UW Climate Impacts Group and the Colville Tribes Natural Resource staff. Variables considered in the report include:

- Maximum summer temperature
- Minimum winter temperature
- Heat waves
- Seasonal precipitation
- Heavy rainfall events
- Seasonal runoff
- Stream temperature (August)
- Snowpack (April and May)

[i] Case, M., Krosby, M., and R. Norheim. 2017. Summary of Projected Changes in Physical Conditions Across the Colville Tribes Study Area. Climate Impacts Group, University of Washington.

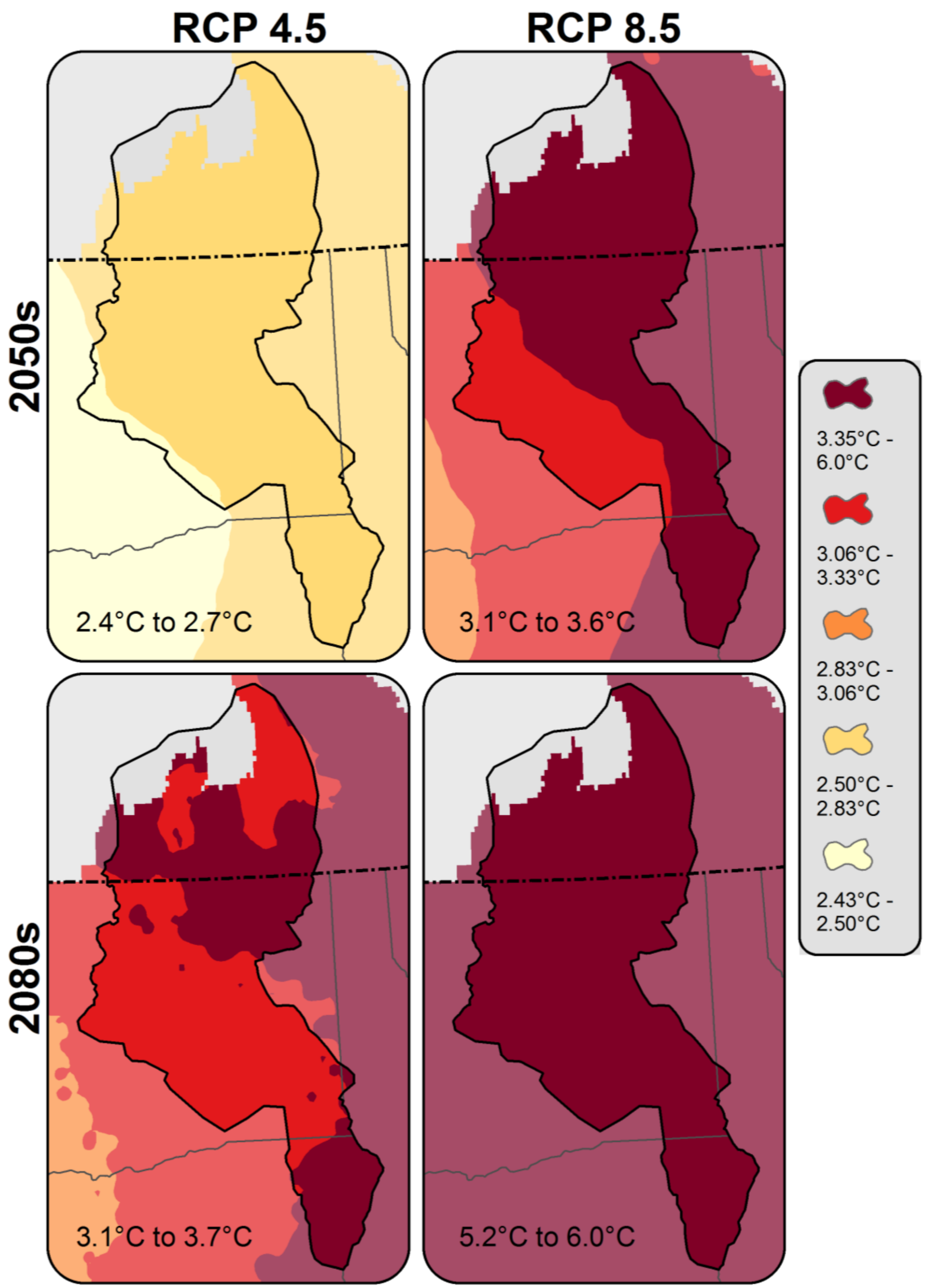

Figure A2. Projected change in mean annual temperature for the Colville Tribes Traditional Territory categorized using the binning structure defined in the NatureServe Guidelines.[1] Projections were generated for the 2050s and 2080s under a low (RCP 4.5) and high (RCP 8.5) greenhouse gas scenario. Projected changes outside of the study area are shown in muted colors.

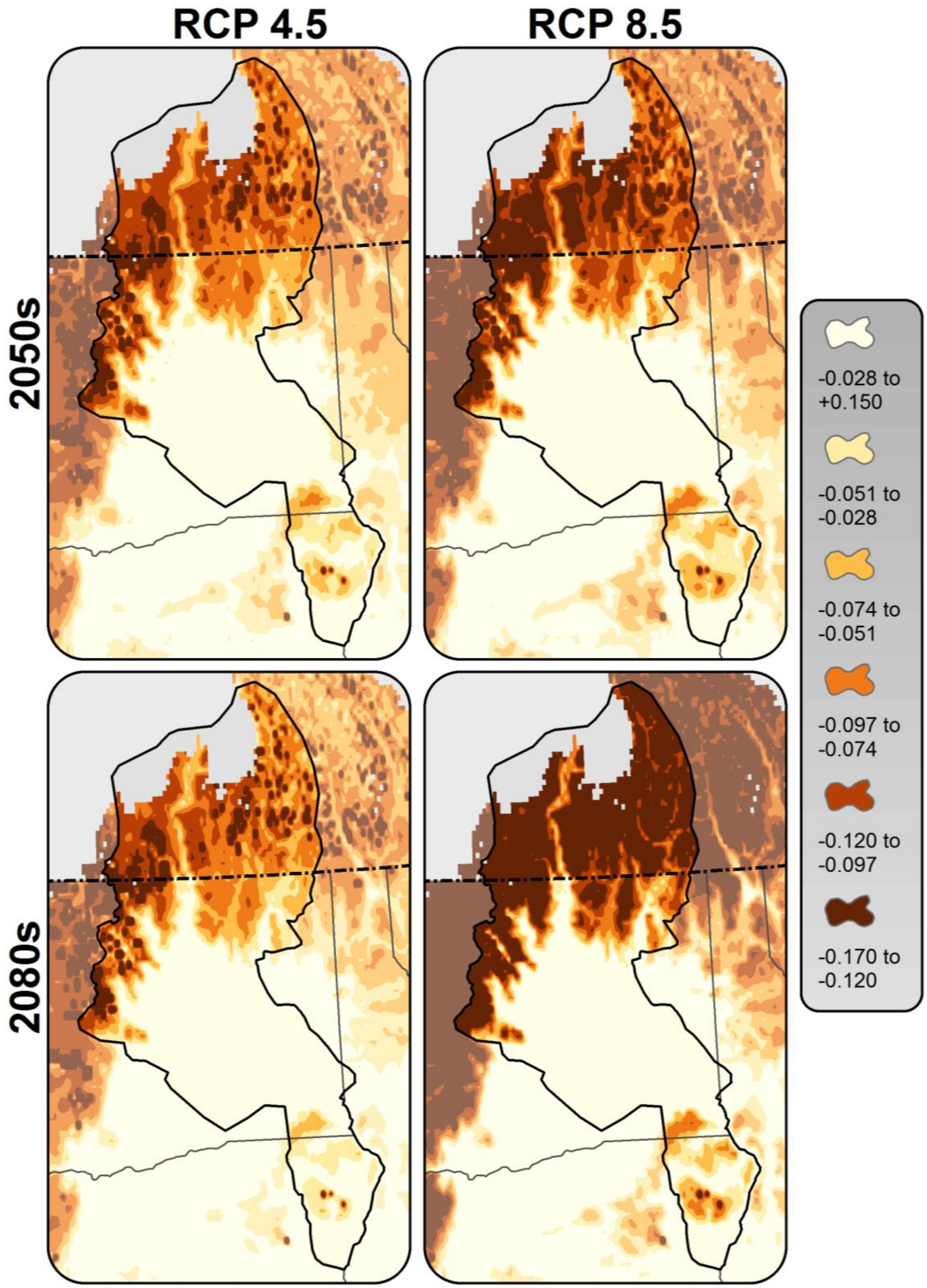

Figure A3. Projected change in moisture for the Colville Tribes Traditional Territory categorized using the binning structure defined in the NatureServe Guidelines.[1] Projections were generated for the 2050s and 2080s under a low (RCP 4.5) and high (RCP 8.5) greenhouse gas scenario. Projected changes outside of the study area are shown in muted colors.

APPENDIX B – SENSITIVITY AND VULNERABILITY RESULTS

Indirect climate exposure, sensitivity, and adaptive capacity scores for each species are provided in the tables below. Detailed descriptions of each factor can be found in Table A1.

Sensitivity Scores:

(1) Greatly Increase Vulnerability:	GI
(2) Increase Vulnerability:	Inc
(3) Somewhat Increase Vulnerability:	SI
(4) Neutral:	N
(5) Unknown	U

CCVI Rankings (Index):

(1) Extremely Vulnerable:	EV
(2) Highly Vulnerable:	HV
(3) Moderately Vulnerable:	MV
(4) Less Vulnerable:	LV

English Name	Species	Taxonomic Group	Sea level rise	Natl barriers	Anth barriers	CC mitigation	Dispersal/Movement	Hist. thermal niche	Physiol. thermal niche	Hist. hydrol. niche	Physiol. hydrol. niche	Disturbance	Ice/snow	Phys habitat	Other spp for habitat	Diet	Pollinators	Other spp. dispersal	Pathogens/enemies	Competition	Other spp interaction	Genetic variation	Gen bottleneck	Reproductive system	Phenol response	Doc response	2050s		2080s	
																											RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5
Mammals																														
Canada Lynx	*Lynx canadensis*	Mammal	N	SI	Inc	N	N	N	Inc	N	N	Inc	GI	N	N	Inc	N/A	N	U	SI	N	SI	N/A	N/A	U	U	EV	EV	EV	EV
American Marten	*Martes americana*	Mammal	N	SI	Inc	N	N	N	SI	N	N	Inc	GI	N	N	N	N/A	N	U	SI	N	U	N	N/A	U	U	EV	EV	EV	EV
Moose	*Alces alces*	Mammal	N	N	SI	N	N	N	Inc	N	SI	N	N	N	N	N	N/A	N	SI	N	N	U	N	N/A	U	U	HV	EV	EV	EV
Mule Deer	*Odocoileus hemionus*	Mammal	N	N	SI	SI	N	N	N	N	N	N	N	N	N	N	N/A	N	SI	N	N	N	N/A	N/A	Inc	U	MV	HV	EV	EV
White-Tailed Jackrabbit	*Lepus townsendii*	Mammal	N	N/SI	Inc	SI	N	N	N	N	N	U	N	N	SI	N	N/A	N	U	U	N	U	U	N/A	U	U	MV	HV	HV	HV
White-Tailed Deer	*Odocoileus virginianus*	Mammal	N	N	SI	SI	N	N	N	N	N	N	N	N	N	N	N/A	N	SI	N	N	U	N	N/A	U	U	MV	HV	HV	HV
American Badger	*Taxidea taxus*	Mammal	N	N	SI	SI	N	N	N	N	N	SI	N	N	N	N	N/A	N	U	N	N	N	N/A	N/A	U	U	LV	MV	MV	MV
Grizzly Bear	*Ursus arctos*	Mammal	N	N	Inc	N	N	N	N	N	N	N	N	N	N	N	N/A	N	N	N	N	SI	N/A	N/A	U	U	LV	MV	MV	MV
Pronghorn Antelope	*Antilocapra americana*	Mammal	N	N	Inc	N	N	N	N	N	N	N	N	N	N	N	N/A	N	U	N	N	SI	N/A	N/A	U	U	LV	MV	MV	MV
American Beaver	*Castor canadensis*	Mammal	N	N	SI	N	N	N	N	N	SI	N	N	N	N	N	N/A	N	SI	N	N	U	N/A	N/A	U	U	LV	MV	LV	MV
Bighorn Sheep	*Ovis canadensis*	Mammal	N	N	SI	SI	N	N	N	N	N	N	N	N	N	N	N/A	N	U	N	N	N	N/A	N/A	U	U	LV	LV	LV	LV
Elk	*Cervus canadensis nelsoni*	Mammal	N	N	SI	SI	N	U	N	U	N	N	N	N	N	N	N/A	N	U	N	N	SI	N/A	N/A	Inc	U				
Birds																														
Sharp-Tailed Grouse	*Tympanuchus phasianellus*	Bird	N	N	SI	SI	N	N	N	N	N	N	N	N	N	N	N/A	N	U	U	N	SI	N/A	N/A	U	U	MV	HV	HV	EV
Great Gray Owl	*Strix nebulosa*	Bird	N	N	N	N	N	N	N	N	N	SI	N	N	SI	N	N/A	N	U	U	N	U	SI	N/A	U	U	LV	MV	LV	MV
Black-Backed Woodpecker	*Picoides arcticus*	Bird	N	N	N	N	N	N	N	N	N	SI	N	N	SI	N	N/A	N	U	U	N	N	N/A	N/A	U	U	LV	LV	LV	LV
Golden Eagle	*Aquila chrysaetos*	Bird	N	N	N	SI	N	N	N	N	N	N	N	N	N	N	N/A	N	SI	N	N	N	N/A	N/A	N	N	LV	LV	LV	LV
White-Headed Woodpecker	*Leuconotopicus albolarvatus*	Bird	N	N	N	N	N	N	N	N	N	SI	N	N	N	N	N/A	N	U	U	N	U	U	N/A	U	U	LV	LV	LV	LV
Common Loon	*Gavia immer*	Bird	N	N	N	N	N	N	N	N	N	U	N	N	N	N	N/A	N	U	U	N	U	U	N/A	U	U	LV	LV	LV	LV
Reptiles and Amphibians																														
Columbia Spotted Frog	*Rana luteiventris*	Amphibian	N	SI	SI	N	SI	N	N	N	Inc	SI	N	N	N	N	N/A	N	Inc	N	N	Inc	N/A	N/A	U	U	HV	EV	EV	EV
Tiger Salamander	*Ambystoma tigrinum*	Amphibian	N	SI	SI	N	SI	N	N	N	Inc	SI	N	N	SI	N	N/A	N	SI	U	N	N	N/A	N/A	U	U	HV	EV	HV	EV
Western Toad	*Anaxyrus boreas*	Amphibian	N	SI	Inc	N	N	N	N	N	Inc	SI	N	N	SI	N	N/A	N	Inc	U	N	N	N/A	N/A	N	N	HV	HV	HV	HV
Painted Turtle	*Chrysemys picta*	Reptile	N	SI	SI	N	N	U	N	U	SI	SI	N	N	N	N	N/A	N	U	U	N	U	N/A	N/A	U	U				
Fish																														
Steelhead, Summer Run	*Oncorhynchus mykiss*	Fish	N	SI	Inc	SI	N	N	GI	N	GI	SI	N	N	N	Inc	N/A	N	Inc	SI	N	Inc	N/A	N/A	U	U	EV	EV	EV	EV
Chinook, Spring Run	*Oncorhynchus tshawytscha*	Fish	N	SI	Inc	SI	N	N	GI	N	Inc	Inc	N	N	N	Inc	N/A	N	Inc	SI	N	SI	N/A	N/A	Inc	U	EV	EV	EV	EV
Bull Trout	*Salvelinus confluentus*	Fish	N	SI	Inc	SI	N	N	GI	N	Inc	Inc	N	N	N	N	N/A	N	Inc	Inc	N	SI	N/A	N/A	U	U	EV	EV	EV	EV
Chinook, Fall Run	*Oncorhynchus tshawytscha*	Fish	N	N	Inc	SI	N	N	Inc	N	SI	SI	N	N	N	Inc	N/A	N	Inc	SI	N	SI	N/A	N/A	Inc	U	EV	EV	EV	EV
Chinook, Summer Run	*Oncorhynchus tshawytscha*	Fish	N	N	Inc	SI	N	N	Inc	N	SI	SI	N	N	N	Inc	N/A	N	Inc	SI	N	SI	N/A	N/A	Inc	U	EV	EV	EV	EV
Redband Rainbow Trout	*Oncorhynchus mykiss gairdnerii*	Fish	N	SI	Inc	SI	N	N	Inc	N	Inc	SI	N	N	N	N	N/A	N	Inc	SI	N	N	N/A	N/A	U	U	EV	EV	EV	EV
Brook Trout	*Salvelinus fontinalis*	Fish	N	SI	Inc	SI	N	N	Inc	N	SI	SI	N	N	N	N	N/A	N	Inc	SI	N	U	N	N/A	U	U	EV	EV	EV	EV
Kokanee Salmon	*Oncorhynchus nerka*	Fish	N	SI	Inc	SI	N	N	SI	N	SI	SI	N	N	N	N	N/A	N	Inc	SI	N	U	N	N/A	U	U	EV	EV	EV	EV
Westslope Cutthroat Trout	*Oncorhynchus clarki lewisi*	Fish	N	SI	Inc	SI	N	N	Inc	N	Inc	Inc	N	N	N	N	N/A	N	Inc	SI	N	N	N/A	N/A	U	U	EV	EV	EV	EV
Burbot	*Lota lota*	Fish	N	SI	Inc	N	N	N	Inc	N	N	U	N	N	N	N	N/A	N	SI	SI	N	U	N	N/A	U	U	HV	EV	EV	EV
Mountain Whitefish	*Prosopium williamsoni*	Fish	N	SI	Inc	SI	N	N	SI	N	SI	SI	N	N	N	N	N/A	N	Inc	U	N	U	N	N/A	U	U	HV	EV	EV	EV
Sockeye Salmon	*Oncorhynchus nerka*	Fish	N	SI	Inc	SI	N	N	GI	N	GI	SI	N	N	N	Inc	N/A	N	Inc	SI	N	U	U	N/A	Inc	U	HV	HV	HV	HV
White Sturgeon	*Acipenser transmontanus*	Fish	N	U	Inc	N	N	N	GI	N	Inc	N	N	N	N	N	N/A	N	U	U	N	SI	N/A	N/A	U	U	MV	HV	HV	HV
Bridgelip Sucker	*Catostomus columbianus*	Fish	N	SI	Inc	SI	N	N	SI	N	SI	SI	N	N	N	N	N/A	N	U	N	N	U	N	N/A	U	U	MV	EV	HV	EV
Pacific Lamprey	*Lampetra tridentata*	Fish	N	N	Inc	SI	N	N	GI	N	U	U	N	N	N	N	N/A	N	U	U	N	U	U	N/A	U	U	MV	EV	HV	EV
Walleye	*Sander vitreus*	Fish	N	N	Inc	SI	N	N	N	N	SI	N	N	N	N	N	N/A	N	U	N	N	U	N	N/A	U	U	LV	LV	LV	LV
Northern Pike	*Esox lucius*	Fish	N	N	Inc	SI	N	N	N	N	N	N	N	N	N	N	N/A	N	N	N	N	U	N	N/A	U	U	LV	LV	LV	LV
Northern Pikeminnow	*Ptychocheilus oregonensis*	Fish	N	N	Inc	SI	N	N	N	N	N	N	N	N	N	N	N/A	N	N	N	N	U	N	N/A	U	U	LV	LV	LV	LV
Smallmouth Bass	*Micropterus dolomieu*	Fish	N	N	Inc	SI	N	N	N	N	N	N	N	N	N	N	N/A	N	N	N	N	U	N	N/A	U	U	LV	LV	LV	LV
Mollusc																														
Western Pearl Shell Mussel	*Margaritifera falcata*	Mollusc	N	N	Inc	N	GI	U	GI	U	SI	U	N	N	N	N	N/A	N	U	U	N	U	U	N/A	U	U				

English Name	Species	Taxonomic Group	Sea level rise	Natl barriers	Anth barriers	CC mitigation	Dispersal/Movement	Hist. thermal niche	Physiol. thermal niche	Hist. hydrol. niche	Physiol. hydrol. niche	Disturbance	Ice/snow	Phys habitat	Other spp for habitat	Diet	Pollinators	Other spp. dispersal	Pathogens/enemies	Competition	Other spp interaction	Genetic variation	Gen bottleneck	Reproductive system	Phenol response	Doc response	2050s RCP 4.5	2050s RCP 8.5	2080s RCP 4.5	2080s RCP 8.5
Plants																														
Whitebark Pine	*Pinus albicaulis*	Plant	N	N	N	N	GI	N	SI	N	N	SI/Inc	SI	N	N	N/A	N/A	Inc	SI	U	N	SI	N/A	N/A	U	U	EV	EV	EV	EV
Western Redcedar	*Thuja plicata*	Plant	N	N	SI	N	SI	N	N	N	SI	SI	N	N	N	N/A	N/A	N	SI	SI	N	Inc	N/A	N/A	U	U	EV	EV	EV	EV
Antelope Bitterbrush	*Purshia tridentata*	Plant	N	N	SI	N	GI	N	N	N	N	Inc	N	N	N	N/A	N	SI	U	U	SI	N	N/A	N/A	U	U	HV	EV	EV	EV
Thinleaf Huckleberry	*Vaccinium membranaceum*	Plant	N	N	N	SI	N	N	SI/Inc	N	N	N	SI	N	N	N/A	N	N	SI	U	N	U	U	SI	U	U	MV	EV	HV	EV
Idaho Fescue	*Festuca idahoensis*	Plant	N	N	SI	N	Inc	N	N	N	N	N/SI	N	N	N	N/A	N/A	N	U	Inc	N	N	N/A	N/A	U	U	MV	HV	HV	HV
Ponderosa Pine	*Pinus ponderosa*	Plant	N	N	N/SI	N	Inc	N	N	N	N	N/SI	N	N	N	N/A	N/A	N	Inc	N	N	N	N/A	N/A	U	U	MV	HV	HV	HV
Western Larch	*Larix occidentalis*	Plant	N	N	N	N	GI	N	SI	N	N	N	N	N	N	N/A	N/A	N	SI	N	N	N	N/A	N/A	U	U	MV	HV	HV	HV
Foamberry	*Shepherdia canadensis*	Plant	N	N	N	SI	N	N	SI	N	N	N	N	N	N	N/A	U	N	U	U	N	U	U	N	Inc	U	MV	HV	HV	HV
Ceanothus	*Ceanothus velutinus*	Plant	N	N	N	SI	GI	N	N	N	N	N	N	N	N	N/A	N	N	U	U	N	U	U	U	U	U	MV	HV	MV	HV
Fernleaf Biscuit Root	*Lomatium dissectum*	Plant	N	SI	SI	N	U	N	N	N	N	U	N	N	N	N/A	N	N	U	Inc	N	U	U	N	U	U	LV	MV	MV	MV
Lodgepole Pine	*Pinus contorta*	Plant	N	N	N	N	SI/Inc	N	SI	N	N	N	N	N	N	N/A	N/A	N	SI	N	N	U	U	N/A	U	U	LV	MV	MV	MV
Pacific Yew	*Taxus brevifolia*	Plant	N	N	N	N	N	N	N	N	SI	SI	N	N	N	N/A	N/A	N	N	SI	N	N	N/A	N/A	U	U	LV	MV	MV	MV
Quaking Aspen	*Populus tremuloides*	Plant	N	N	N	N	U	N	SI	N	SI	N	N	N	N	N/A	N/A	N	SI	N	N	N	N/A	N/A	U	U	LV	MV	MV	MV
Basin Wildrye	*Leymus cinereus*	Plant	N	N	SI	N	U	N	N	N	N	N	N	N	N	N/A	N/A	N	U	Inc	N	U	U	N/SI	U	U	LV	MV	MV	MV
Bluebunch Wheatgrass	*Pseudoroegneria spicata*	Plant	N	N	SI	N	U	N	N	N	N	U	N	N	N	N/A	N/A	N	U	Inc	N	N	N/A	N/A	U	U	LV	MV	MV	MV
Service Berry	*Amelanchier alnifolia*	Plant	N	N	N	SI	N	N	Inc	N	N	N	N	N	N	N/A	N	N	U	N	N	U	U	N	N	U	LV	MV	MV	MV
Wood’s Rose	*Rosa woodsii*	Plant	N	N	N	SI	N	N	SI	N	SI	N	N	N	N	N/A	N	N	U	N	N	U	U	N	U	U	LV	MV	LV	MV
Paper Birch	*Betula papyrifera*	Plant	N	N	N	N	Inc	N	N	N	SI	N	N	N	N	N/A	N/A	N	U	N	N	N	N/A	N/A	U	U	LV	MV	LV	MV
Devils Club	*Oplopanax horridus*	Plant	N	N	N	N	N	N	N	N	Inc	N/SI	N	N	N	N/A	N	N	U	U	N	U	U	N	U	U	LV	LV	LV	MV
Arrowleaf Balsamroot	*Balsamorhiza sagittata*	Plant	N	N	SI	N	N	N	N	N	N	N	N	N	N	N/A	N	N	U	Inc	N	U	U	N	U	U	LV	LV	LV	LV
Water Birch	*Betula occidentalis*	Plant	N	N	N	N	N	N	N	N	SI	SI	N	N	N	N/A	N/A	N	U	U	N	U	N	N/A	U	U	LV	LV	LV	LV
Scouler’s Willow	*Salix scouleriana*	Plant	N	N	N	SI	N	N	N	N	N	N	N	N	N	N/A	N	N	U	U	N	U	U	N	U	U	LV	LV	LV	LV
Black Camas	*Camassia quamash*	Plant	N	N	N	N	Inc	U	N	U	SI	SI	N	N	N	N/A	N	N	U	U	N	U	U	Inc	Inc	U				
Bitterroot	*Lewisia rediviva*	Plant	N	N	N	N	N	U	N	U	N	N	N	N	N	N/A	N/A	N	U	U	N	U	U	N	Inc	U				
Western Spring Beauty	*Claytonia lanceolata*	Plant	N	N	SI	N	SI	U	N	U	SI	N	N	N	N	N/A	N	N	U	U	N	U	U	N	U	U				
Douglas Fir	*Pseudotsuga menziesii var glauca*	Plant	N	N	N	N	SI	U	N	U	N	SI	N	N	N	N/A	N/A	N	U	U	N	U	U	U	U	U				
Tule	*Schoenoplectus acutus*	Plant	N	N	N	N	N	U	N	U	SI	N	N	N	N	N/A	N/A	N	N	U	N	U	U	N	U	U				
Wapato	*Sagittaria latifolia*	Plant	N	N	N	N	N	U	N	U	SI	U	N	N	N	N/A	N	N	U	U	N	U	U	N	U	U				
Blue Elderberry	*Sambucus nigra*	Plant	N	N	N	N	N	U	N	U	N	N	N	N	N	N/A	U	U	U	N	N	U	U	N	U	U				
Mushroom																														
Morel Mushroom	*Morchella esculenta*	Plant	N	N	N	N	SI	U	N	U	N	N	N	N	N	N	N/A	N	U	U	N	U	U	N	U	U				

APPENDIX C – SUMMARY OF INFORMATION GAPS

This table summarizes information gaps encountered during the CCVI analysis. *Information Available* indicates sufficient data to evaluate a species for a CCVI factor; *Non-Applicable* indicates a CCVI factor that is not applicable for a given species (e.g., "number of pollinators" for a mammal). *Unknown* indicates an information gap for a CCVI factor.

In addition to CCVI factors, we added a column for GIS range data availability. Data gaps in this column reflect species for which insufficient range data prevented calculation of a CCVI vulnerability ranking. Species for which GIS range data is limited to the U.S. portion of the Colville Tribes Traditional Territory are shown in Table 1, and species for which proxy range data was calculated using the LANDFIRE vegetation layer are shown in Table A3.

Key:

(1) Information Available:

(2) Unknown:

(3) N/A:

English Name	Species	Taxonomic Group	GIS Range Data	Sea level rise	Natl barriers	Anth barriers	CC mitigation	Dispersal/Movement	Hist. thermal niche	Physiol. thermal niche	Hist. hydrol. niche	Physiol. hydrol. niche	Disturbance	Ice/snow	Phys habitat	Other spp for habitat	Diet	Pollinators	Other spp. dispersal	Pathogens/enemies	Competition	Other spp interaction	Genetic variation	Gen bottleneck	Reproductive system	Phenol response	Doc response
Mammals																											
American Marten	*Martes americana*	Mammal																									
Canada Lynx	*Lynx canadensis*	Mammal																									
Moose	*Alces alces*	Mammal																									
Mule Deer	*Odocoileus hemionus*	Mammal																									
White-Tailed Deer	*Odocoileus virginianus*	Mammal																									
White-Tailed Jackrabbit	*Lepus townsendii*	Mammal																									
American Badger	*Taxidea taxus*	Mammal																									
Grizzly Bear	*Ursus arctos*	Mammal																									
Pronghorn Antelope	*Antilocapra americana*	Mammal																									
American Beaver	*Castor canadensis*	Mammal																									
Bighorn Sheep	*Ovis canadensis*	Mammal																									
Elk	*Cervus canadensis nelsoni*	Mammal																									
Birds																											
Sharp-Tailed Grouse	*Tympanuchus phasianellus*	Bird																									
Great Gray Owl	*Strix nebulosa*	Bird																									
Black-Backed Woodpecker	*Picoides arcticus*	Bird																									
Common Loon	*Gavia immer*	Bird																									
Golden Eagle	*Aquila chrysaetos*	Bird																									
White-Headed Woodpecker	*Leuconotopicus albolarvatus*	Bird																									
Reptiles and Amphibians																											
Columbia Spotted Frog	*Rana luteiventris*	Amphibian																									
Tiger Salamander	*Ambystoma tigrinum*	Amphibian																									
Western Toad	*Anaxyrus boreas*	Amphibian																									
Painted Turtle	*Chrysemys picta*	Reptile																									
Fish																											
Bull Trout	*Salvelinus confluentus*	Fish																									
Chinook, Fall Run	*Oncorhynchus tshawytscha*	Fish																									
Chinook, Spring Run	*Oncorhynchus tshawytscha*	Fish																									
Chinook, Summer Run	*Oncorhynchus tshawytscha*	Fish																									
Kokanee Salmon	*Oncorhynchus nerka*	Fish																									
Brook Trout	*Salvelinus fontinalis*	Fish																									
Redband Rainbow Trout	*Oncorhynchus mykiss gairdnerii*	Fish																									
Steelhead, Summer Run	*Oncorhynchus mykiss*	Fish																									
Westslope Cutthroat Trout	*Oncorhynchus clarki lewisi*	Fish																									
Burbot	*Lota lota*	Fish																									
Mountain Whitefish	*Prosopium williamsoni*	Fish																									
Sockeye Salmon	*Oncorhynchus nerka*	Fish																									
White Sturgeon	*Acipenser transmontanus*	Fish																									
Bridgelip Sucker	*Catostomus columbianus*	Fish																									
Pacific Lamprey	*Lampetra tridentata*	Fish																									
Northern Pike	*Esox lucius*	Fish																									
Northern Pikeminnow	*Ptychocheilus oregonensis*	Fish																									
Smallmouth Bass	*Micropterus dolomieu*	Fish																									
Walleye	*Sander vitreus*	Fish																									
Mollusc																											
Western Pearl Shell Mussel	*Margaritifera falcata*	Mollusc																									

English Name	Species	Taxonomic Group	GIS Range Data	Sea level rise	Natl barriers	Anth barriers	CC mitigation	Dispersal/Movement	Hist. thermal niche	Physiol. thermal niche	Hist. hydrol. niche	Physiol. hydrol. niche	Disturbance	Ice/snow	Phys habitat	Other spp for habitat	Diet	Pollinators	Other spp. dispersal	Pathogens/enemies	Competition	Other spp interaction	Genetic variation	Gen bottleneck	Reproductive system	Phenol response	Doc response
Plants																											
Western Redcedar	*Thuja plicata*	Plant																									
Whitebark Pine	*Pinus albicaulis*	Plant																									
Antelope Bitterbrush	*Purshia tridentata*	Plant																									
Thinleaf Huckleberry	*Vaccinium membranaceum*	Plant																									
Idaho Fescue	*Festuca idahoensis*	Plant																									
Ponderosa Pine	*Pinus ponderosa*	Plant																									
Western Larch	*Larix occidentalis*	Plant																									
Foamberry	*Shepherdia canadensis*	Plant																									
Ceanothus	*Ceanothus velutinus*	Plant																									
Basin Wildrye	*Leymus cinereus*	Plant																									
Bluebunch Wheatgrass	*Pseudoroegneria spicata*	Plant																									
Fernleaf Biscuit Root	*Lomatium dissectum*	Plant																									
Lodgepole Pine	*Pinus contorta*	Plant																									
Pacific Yew	*Taxus brevifolia*	Plant																									
Quaking Aspen	*Populus tremuloides*	Plant																									
Service Berry	*Amelanchier alnifolia*	Plant																									
Paper Birch	*Betula papyrifera*	Plant																									
Wood's rose	*Rosa woodsii*	Plant																									
Devils Club	*Oplopanax horridus*	Plant																									
Arrowleaf Balsamroot	Balsamorhiza sagittata	Plant																									
Scouler's Willow	*Salix scouleriana*	Plant																									
Water Birch	*Betula occidentalis*	Plant																									
Bitterroot	*Lewisia rediviva*	Plant																									
Blue Elderberry	*Sambucus nigra*	Plant																									
Black Camas	*Camassia quamash*	Plant																									
Douglas Fir	*Pseudotsuga menziesii var glauca*	Plant																									
Indian Potato	*Claytonia lanceolata*	Plant																									
Tule	*Schoenoplectus acutus*	Plant																									
Wapato	*Sagittaria latifolia*	Plant																									
Mushroom																											
Morel Mushroom	*Morchella esculenta*	Plant																									

APPENDIX D – SPECIES FACT SHEETS

Fact sheets are provided for each species included in the assessment. Fact sheets include each species' CCVI vulnerability rankings (for those with sufficient data) and a summary of the rationale and underlying information behind the species' sensitivity scores.