# Climate Change Assessment and Adaptation Plan

May 2017

A collaborative assessment conducted by the Shoshone-Bannock Tribe Fish and Wildlife Department, Adaptation International, the University of Washington's Climate Impact Group, and Oregon State University's Oregon Climate Change Research Institute.

The Shoshone-Bannock Tribes would like to acknowledge and thank the U.S. Department of the Interior, Bureau of Indian Affairs, for their generous funding contributions to this project.

The Shoshone-Bannock Tribes' Fish and Wildlife Department would like to acknowledge and thank its Climate Change Core Team Members for their time and dedication to this project. Their efforts have helped ensure that this Plan builds climate resilience for the Tribes.

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# Executive Summary

The Shoshone-Bannock Tribes, comprised of many bands of Shoshone and Bannock peoples whose very culture and history is intertwined with the lands in which they live, have historically subsisted through hunting and gathering. The Snake River Watershed, in present-day Idaho, continues to sustain the Tribes' cultural, spiritual, dietary, and economic needs. Climate change presents a threat to critical cultural resources, thereby also threatening the lifeways and wellbeing of the Tribes. This creates an urgent need to build climate resilience to protect and preserve these resources for future generations.

This climate change vulnerability assessment and adaptation plan outlines a collaborative 12-month project wherein a Climate Change Core Team of Tribal Staff (hereafter "Core Team") worked collectively with outside consultants (hereafter "project consultants") to assess climate vulnerability and identify adaptation actions for critical plant and animal species and their habitats. This project lays a foundation for building resilience among the Shoshone-Bannock Tribes and enhancing the resilience of natural resources that are an integral part of their culture. This report includes a summary of downscaled ***future climate projections*** for the project area, a detailed description of the ***vulnerability assessment process and outcomes***, discussion of the Tribes' ***adaptation planning process***, and a listing of the ***adaptation actions*** developed for the plant and animal species assessed.

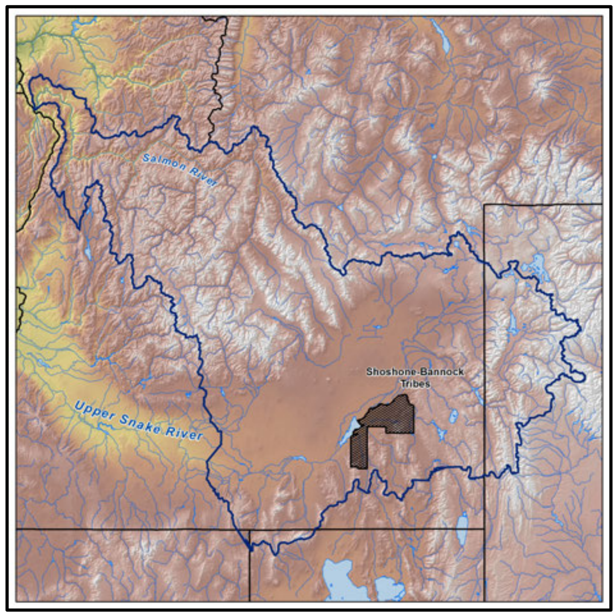


*Figure 1: Project boundaries for the Shoshone-Bannock Tribes' Vulnerability Assessment and Adaptation Plan are shown in dark blue. Total area encompasses 45,431 square miles and includes important natural resources both inside and outside the reservation boundaries. The Reservation is shown with hash mark shading.*

## Future Climate Projections

Across the entire project area, average annual temperatures are projected to increase under two future climate scenarios through the 21st century. Projected changes to water availability and seasonal streamflows in the Upper Snake River system are primarily due to warming air temperatures and declining snowpack. These changes will have direct and indirect effects on Shoshone-Bannock Tribes and the plant and animal species on which they rely.

## Vulnerability Assessment Process and Outcomes

Through a series of in-person meetings, the Core Team identified 35 plant and animal species, seven resource issues, and four habitats of concern for inclusion in this assessment. Thirty-four species were assessed quantitatively using NatureServe's Climate Change Vulnerability Index (CCVI); one additional species of concern was not analyzed due to lack of adequate data. In a one-day workshop, the project consultants and Core Team worked collaboratively to vet preliminary CCVI results and integrate local and traditional knowledge (as appropriate), which ultimately resulted in changes to some species' vulnerability rankings. Final CCVI results are shown below, where Extremely Vulnerable=(EV); Highly Vulnerable=(HV); Moderately Vulnerable=(MV); and Less Vulnerable (LV).

*Table 1: Vulnerability rankings for the 34 plant and animal species assessed quantitatively using the CCVI. Results are shown by species (rows) and for the two different climate scenarios (RCP 4.5 and RCP 8.5) for two different time periods (2050s and 2080s). Species with an asterisk (*) do not currently have available spatial data layers for species ranges. For these species, the project team assumed that the distribution of these species spans the entire assessment area. This assumption was vetted by Shoshone-Bannock tribal staff, and was determined to be appropriate except for Single-leaf Pinyon, which is confined to a small area in the southern portion of the domain.*

| Common Name | Taxon | Habitat | 2050s RCP4.5 | 2050s RCP8.5 | 2080s RCP4.5 | 2080s RCP 8.5 |
|---|---|---|---|---|---|---|
| Greater Sage-Grouse | Bird | Sagebrush Steppe | EV | EV | EV | EV |
| Black-tailed Jackrabbit | Mammal | | MV | HV | HV | HV |
| Wyoming Sage* | Plant | | HV | EV | EV | EV |
| Big Sagebrush | Plant | | MV | HV | HV | HV |
| Rubber Rabbitbrush* | Plant | | MV | HV | HV | HV |
| Cheatgrass* | Plant | | LV | LV | LV | LV |
| Bald Eagle | Bird | Riparian | MV | MV | MV | HV |
| Yellow-billed Cuckoo | Bird | | LV | LV | LV | LV |
| American Beaver | Mammal | | LV | LV | LV | LV |
| Black Cottonwood | Plant | | MV | MV | MV | HV |
| Redosier Dogwood | Plant | | LV | LV | LV | LV |
| Geyer's Willow | Plant | | LV | LV | LV | LV |
| Coyote Willow | Plant | | LV | LV | LV | LV |
| Moose | Mammal | Coniferous Forest | MV | HV | EV | EV |
| Quaking Aspen | Plant | | LV | MV | MV | MV |
| Single-leaf Pinyon* | Plant | | MV | EV | EV | EV |
| Mallard | Bird | Aquatic | LV | LV | LV | LV |
| Northern Leopard Frog | Amphibian | | HV | HV | HV | HV |
| Columbia Spotted Frog | Amphibian | | EV | EV | EV | EV |
| Pacific Lamprey | Fish | | EV | EV | EV | EV |
| Bull Trout | Fish | | EV | EV | EV | EV |
| Chinook Salmon | Fish | | EV | EV | EV | EV |
| Steelhead | Fish | | EV | EV | EV | EV |
| Yellowstone Cutthroat Trout | Fish | | EV | EV | EV | EV |
| Mountain Lion | Mammal | Generalists | LV | LV | LV | LV |
| Elk | Mammal | | MV | HV | HV | HV |
| Mule Deer | Mammal | | LV | MV | MV | MV |
| Golden Eagle | Bird | | LV | LV | LV | LV |
| Gopher Snake | Reptile | | LV | LV | LV | LV |
| Saskatoon* | Plant | | LV | MV | MV | MV |
| Common Chokecherry | Plant | | LV | LV | LV | LV |
| Thistle* | Plant | | LV | LV | LV | LV |
| Spotted Napweed* | Plant | | LV | LV | LV | LV |
| Russian Olive* | Plant | | LV | MV | MV | MV |

## Adaptation Planning Process and Actions

The final phase of the project focused on developing strategies and actions to increase the resilience of the habitats within which the 34-assessed species live. Given time and budget constraints, a subset of 11 focus species and their associated habitats were selected for adaptation planning. Due to the interconnected nature of the ecosystems and habitats on which these species depend, the focus of adaptation planning was on developing strategies and actions that would strengthen the climate resilience of habitats, thereby supporting the needs of the individual species. For example, actions that help protect, preserve, or restore Sagebrush Steppe habitat may increase the climate resilience of both Sage Grouse and Wyoming Sage. Sample actions to build resilience for Sagebrush Steppe habitat are shown below.

*Table 2: Select adaptation actions for Sagebrush Steppe habitat, which supports both Sage Grouse and Wyoming Sage, two species important to the Shoshone-Bannock Tribes.*

| Climate Concern | Select Adaptation Action | Timeframe |
|---|---|---|
| Wildfire | Incorporate climate change into fire-management plans (include wildfire projections if possible); anticipate more opportunities to use wildfire for resource benefit. | Immediate |
| Wildfire | Identify areas important for Wyoming Sage in situ gene conservation to provide a baseline for measuring fire impacts and informing post-fire planting/rehabilitation. | Medium-Term |
| Species Range Shifts | Coordinate among/across states and their federal counterparts to protect habitat core areas to promote large-scale, continuous sage grouse habitat that would be protected from further development. | Immediate |
| Increase in Invasive Species | Rehabilitate burned areas for using native plant materials or introduced materials, that encourage the long-term sustainability of native species, and as approved by Resource Managers. | Immediate |
| Reduce Non-Climate Stressors | Install fence markers or remove fences where sage-grouse mortality due to collision with fences is documented or likely to occur due to new fence placement (avoid new fences within 0.5 mile of a lek). | Immediate |
| Outreach and Education | Develop and expand education efforts for the public regarding invasive species impacts, such as improving identification of non-native species, encouraging the use of native species, and promoting the use of strategies to prevent and remove invasive species. | Immediate |

## Conclusions

The Shoshone-Bannock Tribes are already experiencing the impacts of climate change on their natural resources, landscapes, and people. By engaging in efforts to identify adaptation strategies and actions to minimize the negative effects of climate change, the Tribes have demonstrated their continued commitment to protecting their vital natural resources. The Tribes will continue to implement projects across landscapes in the near term and utilize the information in this report to plan long-term strategies and projects to build resilience. These efforts, will help ensure that culturally significant natural resources are preserved for future generations.

# 1.0 Introduction

The lives of the Shoshone-Bannock Tribes are intricately connected to the sacred waters of the Snake River and the lands which surround it. Historically, the Tribes (comprised of many bands of Shoshone and Bannock peoples) subsisted primarily as hunters and gatherers, traveling during the spring and summer seasons to collect foods for use throughout the year. They hunted wild game, fished the region's abundant and bountiful streams and rivers, and gathered native plants and roots such as the camas bulb. The natural resources of the Upper Snake River Watershed continue to sustain the dietary, cultural, spiritual, and economic needs of the Shoshone-Bannock Tribes of the Fort Hall Reservation.

More than 5,800 people hold membership with the Shoshone-Bannock Tribes.[1] When the Northern Paiutes left the Nevada, Oregon, and Utah regions for southern Idaho in the 1600s, they began to travel with the Shoshones in pursuit of buffalo. The Shoshone nation occupied an area stretching from Canada to California. The Northern Shoshone peoples came from across the Snake River, Upper Missouri, and Columbia River basins to Fort Hall during the Treaty era to permanently reside on the current reservation; living in harmony with the pulse of riverine ecosystems. They became known as the Bannocks and became permanent residents of the Snake River basin, while also occupying significant portions of southwest Montana and Wyoming.

### *The Shoshone-Bannock Reservation Area*

The Fort Hall Reservation is in the eastern Snake River Plain of southeastern Idaho, north and west of the town of Pocatello. In 1868 when the Reservation was established, it was 1.8 million acres, an amount that was reduced to 1.2 million acres in 1872 due to a survey error. The Reservation was further reduced to its current size (546,500 acres) through subsequent legislation and the allotment process.[2] The Fort Hall Reservation, the permanent home of the Tribes, is bordered to the north and northwest by the Snake and Blackfoot Rivers and the American Falls Reservoir border. In addition to vast populations of fish, the area is home to moose, deer, wild horses, and buffalo. The ecosystems of the Shoshone-Bannock Reservation area face ongoing environmental challenges, such as habitat loss, erosion of stream banks, warmer water temperatures, and siltation in spawning gravels brought on by unrestricted grazing and rapid flooding.

Climate change has the potential to fundamentally change the ecological processes that have defined and supported the Tribes' unique lifeways from time immemorial. For example, climate change may increase the risk of catastrophic wildfire across the reservation landscape. The Tribes have an obligation to promote a sustainable balance between development and natural resource sustainability, a calculus that becomes more complicated with climate change.

In response to the threat of climate change, the Shoshone-Bannock Tribes secured funding for this climate change vulnerability assessment and adaptation plan. This report outlines a collaborative 12-month project wherein a Climate Change Core Team of Tribal Staff worked collectively with outside consultants to assess climate vulnerability and identify adaptation actions for critical plant and animal species and their habitats to lay a foundation for building resilience among the Shoshone-Bannock Tribes.

### *Project Area*

For this climate change vulnerability assessment and adaptation plan, the Core Team selected an area of 45,431 square miles (Figure 1), which includes both the reservation itself, but also key man-made and natural resources within the Tribes' ancestral territory (e.g., American Falls Reservoir, the Teton Range). This project area was used to focus the analysis of the climate projections and the assessment of species-specific vulnerabilities. It should be noted this assessment was closely coordinated with the Upper Snake River Tribes' (USRT) climate change vulnerability assessment, which included a larger domain spanning the four USRT Tribes' homelands in Oregon, Nevada, and western Idaho.

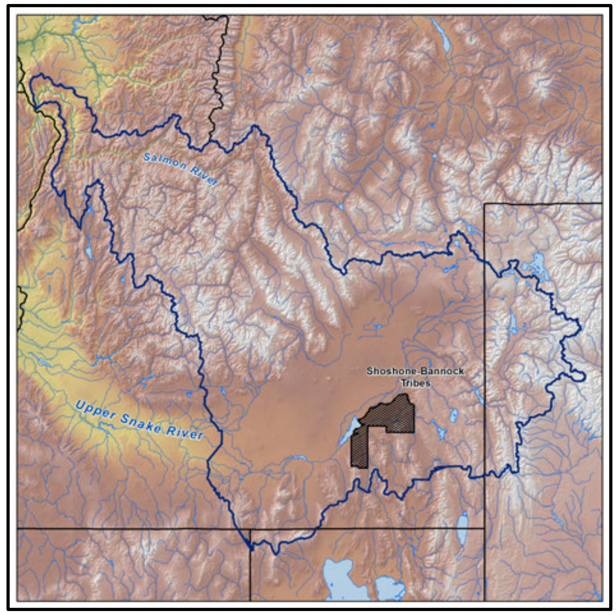


*Figure 2: Project boundary for the Shoshone-Bannock Tribes' Vulnerability Assessment and Adaptation Plan (dark blue line). The total area encompasses 45,431 square miles and includes important natural resources both inside and outside the reservation (dark shaded area).*

### *Purpose of This Report*

The purpose of this report is to summarize the process and outcomes of this 12-month long project that assessed climate vulnerability and identified adaptation actions for critical plant and animal species and their habitats. This effort and its resulting products lay a foundation for building resilience among the Shoshone-Bannock Tribes. This report includes a summary of ***future climate projections*** for the project area, a detailed description of the ***vulnerability assessment process*** and outcomes, and a discussion of ***adaptation planning*** that includes a suite of ***adaptation actions*** developed for the plant and animal species assessed.

## 2.0 Project Process

This collaborative vulnerability assessment expressly considered many of the plant and animal species, habitats, and resources that are important and valuable to Shoshone-Bannock Tribes. Climate change impacts on these resources have the potential to affect Tribal members' culture, spirituality, and lifeways. The collaboration involved the direct and ongoing participation of a select group of Shoshone-Bannock staff who formed a Climate Change Core Team. Combining the best available localized climate projections with traditional knowledge (as appropriate), tribal priorities, and local observations was central to the success of this assessment (Figure 3).

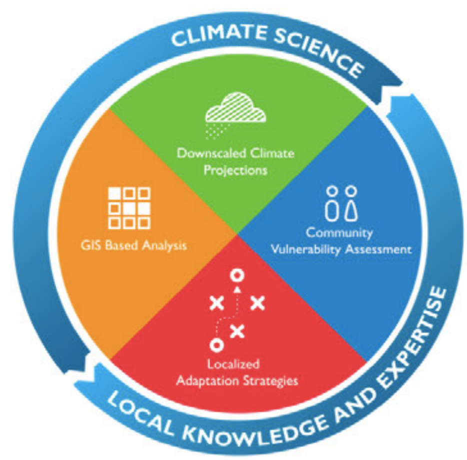


*Figure 3: The collaborative process used in this project combined the best available climate and biological science with local and traditional knowledge (as appropriate).*

This vulnerability assessment and adaptation planning process followed six key steps:

1. **Identify key species of concern.** Through a series of site visits and conference calls, the Core Team identified a suite of key plant and animal species of concern for inclusion in this assessment. Ultimately, 35 species, four habitats, and seven resource issues were included in the assessment.

2. **Analyze downscaled temperature and precipitation projections.** Downscaled temperature and precipitation projections for the project area are summarized in Section 3.0 of this report. It is important to note that this work built on the climate analysis recently completed for the USRT Climate Vulnerability Assessment. Project boundaries (domain), climate thresholds of interest, and hydrologic questions investigated were defined in collaboration with the Core Team during an in-person meeting at the start of the project.

3. **Calculate draft species-specific vulnerability rankings using the NatureServe Climate Change Vulnerability Index (CCVI).**[3] 34 key plant and animal species were assessed quantitatively using NatureServe's Climate Change Vulnerability Index tool. The results of this assessment formed the foundation for the discussions during the vulnerability assessment workshop. These detailed results are summarized in Section 4.0 of this report.

4. **Refine CCVI vulnerability rankings.** Through a day-long, collaborative vulnerability assessment workshop, the Core Team vetted the inputs and initial results of the CCVI assessment. Over the course of the day, the group delved into the species-specific sensitivities and adaptive capacities, refined those inputs based on local knowledge and traditional knowledge (as appropriate) and adjusted the rankings for sensitivity or adaptive capacity factors as needed. Following the workshop, the Climate Impacts Group re-ran the CCVI assessment for those species whose rankings had changed, and calculated the final relative vulnerability rankings. Detailed results are provided in Section 4.0 of this report.

5. **Focus adaptation planning efforts.** To make the best use of the time and resources available, the Core Team selected a set of 11 species on which to focus the adaptation planning phase of the project. The Shoshone-Bannock Tribes recognize the holistic and interconnected nature of ecosystems and the need for vibrant habitats to support individual species. Because of this, the 11 species were grouped by their primary habitats and the adaptation planning effort focused on identifying promising adaptation actions for each of these habitats. The detailed results are summarized in Section 5.0 of this report.

6. **Refine and customize adaptation actions.** Draft adaptation strategies and actions were collaboratively assessed and refined by the Core Team during a day-long adaptation planning workshop. Tribal staff-led discussions following the workshop further refined actions and examined additional aspects of implementation, including time frame for completion, financial cost, political feasibility, and cultural significance. This process resulted in a prioritized list of strategies, which are summarized in Section 5.0 of this report.

### *Building on the USRT Climate Vulnerability Assessment Project*

This project benefitted by following closely behind the Upper Snake River Tribes Foundation (USRT)'s Climate Change Vulnerability Assessment project (the results of which can be found at: www.uppersnakerivertribes.org/climate). The Shoshone-Bannock Tribes are members of USRT and actively participated in the USRT vulnerability assessment project. Building off this previous collaboration allowed the Shoshone-Bannock Tribes to go farther in their assessment and planning efforts. For example, species included in this project that had already been assessed using the same methodology for USRT (such as Chinook Salmon and Mule Deer) could be refined with much less effort, by simply reviewing their vulnerability rankings for specific factors and re-running the CCVI assessment for the smaller, more focused project boundaries. Through their internal process, the Shoshone-Bannock Tribes decided to include 15 USRT species in their assessment.

## 3.0 Climate Projections and Hydrology Overview

This project built off the initial analysis of climate projections completed for the Upper Snake River Basin as part of the USRT Climate Change Vulnerability Assessment. That assessment focused primarily on changes in temperature, precipitation, and moisture for a larger region and are summarized in the Upper Snake River Tribes Foundation Climate Change Vulnerability Assessment.[4] This assessment looked at how changes to those primary variables could affect regional wildfire risk, snowpack, stream temperatures, water availability, and the timing of streamflows and run-off. Building on that foundation allowed this project to go further into more specific local issues and evaluate changes to key variables that affect the species and ecosystems on which the Shoshone-Bannock depend.

### *Climate Projections*

Climate projections are not "forecasts" but rather attempts to answer a "what if?" question. These projections are simulations of *what* the climate might be like *if* society follows a particular greenhouse gas emissions trajectory. The amount of greenhouse gases in the atmosphere will ultimately depend on factors like global population growth, changes in global economic activity, and preferred energy sources, all of which are difficult to predict.

| Rate of Emissions | Scenario names |
|---|---|
| Low | RCP 4.5, B1 |
| Medium | A1B |
| Business as Usual | RCP 8.5 |

*Figure 4: Rate of Greenhouse Gas Emissions and associate emissions scenario name.*

The latest generation of global climate models uses a set of future scenarios called Representative Concentration Pathways (RCPs). Each RCP represents a trajectory of atmospheric concentrations of greenhouse gases to, and beyond, the end of the 21st century, and provides a flexible way of defining a set of climate futures that make a variety of socio-economic assumptions.[5] This report focuses on two of the four RCP scenarios: RCP 4.5 and RCP 8.5. RCP 4.5 represents a future where global agreements and policies work to dramatically reduce greenhouse gas emissions. In RCP 4.5, greenhouse gas emissions peak in the 2040s, then decline. The socio-economic assumptions of RCP 4.5 are largely aspirational, but still achievable with significant global action in the next decade. RCP 8.5 assumes continued dominance of fossil fuel energy sources, where global greenhouse gas emissions continue to increase at their present rate for the next several decades. RCP 8.5 is often colloquially referred to as the "business-as-usual" scenario. Together, RCP 4.5 and 8.5 provide a range of possible future global and regional temperatures and precipitation trends, with more significant changes projected in the RCP 8.5 scenario. The B1 and A1B scenarios represent similar but slightly different sets of projections and are also used in this project, though the focus is on the RCP scenarios. For this analysis, the Project Team analyzed downscaled climate projections for each of the four areas (sub-domains) shown in Figure 5.

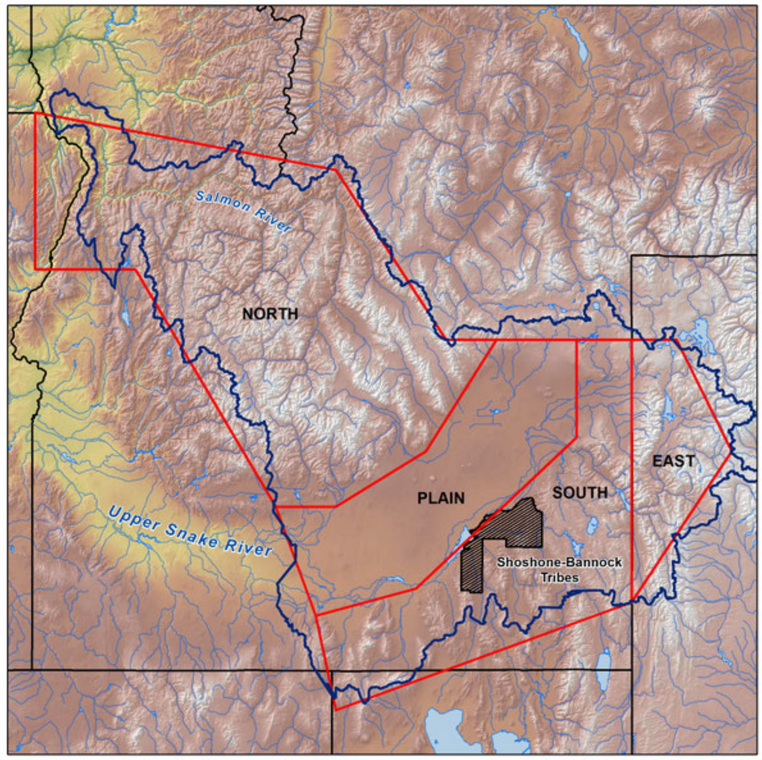

*Figure 5: Outline of the four sub-domains (outlined in red) used for the climate analysis overlaid on the project boundary (outlined in blue).*

While it is useful to understand global climate change projections, it is the regional and local projections that are most important for assessing the potential impacts to the habitats, plants, animal species, and other resources important to the Shoshone-Bannock Tribes. To develop regional projections of future climate, scientists downscale global climate model outputs using a series of statistical and/or dynamical (modeled) processes. This assessment presents the future regional projections of climate using a downscaled dataset called the Multivariate Adaptive Constructed Analogs (MACA).[6]

Since climate is considered the long- term (greater than 30-year) average of weather patterns for a specific location, it is important that changes be compared between multi-decadal periods. Throughout the report, projections were analyzed in reference to a baseline period (1950-2005, or for growing season length 1970-1999) for three future time periods: the 2020s (which represents the years 2010-2039), the 2050s (which represents the years 2040-2069), and the 2080s (which represents the years 2070-2099). While most of the figures in the next section focus on either the 2050s or the 2080s, the full set of projections for each domain and each time-period are available in the supplementary materials included with this report.

## *Future Change to the Shoshone-Bannock Project Area*

### Temperature

Across the entire project area, average annual temperatures are projected to increase under both future climate scenarios and for all time periods. RCP 4.5 (left column in Figure 6) shows a smaller magnitude of warming for both mid-century (2050s - first row) and late century (2080s - second row) than RCP 8.5 (right column Figure 6). Mid-century annual average temperature under RCP 8.5 (6.2-6.9°F) is projected to be similar to end of the century warming under RCP 4.5 (5.9-6.5°F). The highest projected annual temperature increases are expected under RCP 8.5 at the end of the century (bottom right panel) and may exceed 10°F. Figure 6 displays the average range of the 20 models.

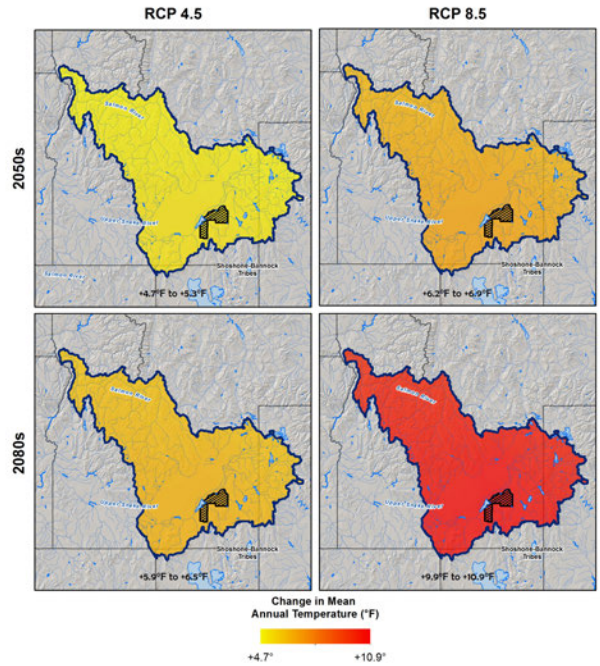


*Figure 6: Future projected change in temperature through 21st century in the full project domain.*

### Hydrology

Climate change is expected to have important impacts on water availability and seasonal streamflows in the Snake River system, primarily due to warmer temperatures and declining snowpack. These changes will have direct and indirect effects on the Shoshone-Bannock Tribes by affecting the amount of water available in the region for summer irrigation, instream flows for aquatic species, domestic water supply, hydropower production, and recreation.

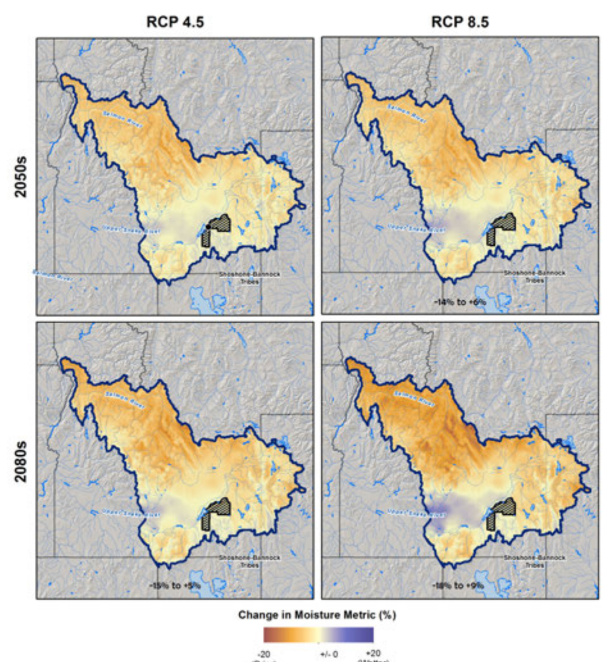


*Figure 7: Percentage change in the Hamon Moisture Metric (a consideration of evaporation and evapotranspiration). Change is shown by time-period (rows 2050s & 2080s) and climate scenarios (columns - RCP 4.5 left & RCP 8.5 right).*

Even with precipitation patterns staying relatively consistent (though still highly variable from year to year), the warmer temperatures are likely to increase evaporation & evapotranspiration. One way to consider these changes in a way that is important for species in the region is by looking at how they impact moisture availability. That impact can be seen in Figure 7 as a calculated change to the Hamon Moisture Metric[7] which considers both evaporation and evapotranspiration potential for the region. The general change is towards decreased moisture availability and drier soils. However, this impact is not consistent across the region as the more mountainous regions are projected to have less overall moisture available while a large portion of the Upper Snake River Plain is projected to have an overall increase in moisture availability.

Shoshone-Bannock staff identified additional changes that are important in determining species-specific climate vulnerabilities. These changes included: (1) length of the frost-free season, (2) heat wave frequency, (3) frequency of heavy precipitation events, (4) streamflow variability brought on by a diminished snowpack, and (5) increases in stream temperature.

### *Frost-Free Season*

The frost-free season is defined as the period between the last day of Spring when there is an overnight freeze (i.e., when the minimum daily temperature is at, or below, 32°F) and the first day of the following fall that dips below freezing (i.e., when the minimum daily temperature falls at, or below, 32°F).

The frost-free season in all subdomains lengthens appreciably as early as the 2020s under both RCP4.5 and RCP8.5. For example, in the Plain subdomain under RCP8.5, the frost-free season is projected to be 3 weeks longer by the 2020s than it has been historically (see Figure 8). By the 2080s, the frost-free season is projected to be 10 weeks longer (beginning six weeks sooner and ending four weeks later).

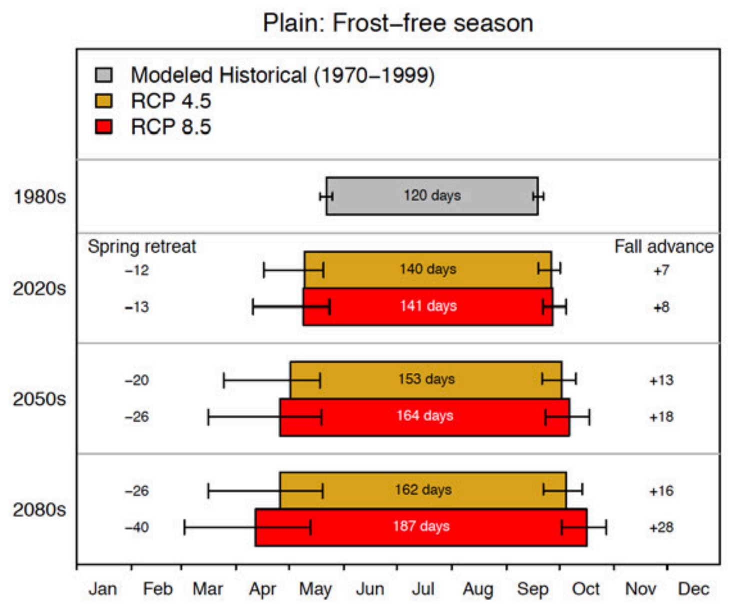


*Figure 8: Frost-free season in the Plain subdomain for the historical period (1970-1999; the "1980s") and under the RCP4.5 and RCP8.5 scenarios by the 2020s, 2050s, and 2080s. Shaded rectangles show the average from 20 climate model simulations and horizontal bars show the range from all climate model simulations. The values to each side of the rectangles show the change in frost-free season length relative to the historical (1970-1999) average.*

### Heat waves

A heat wave, for purposes of this study, is defined as a period of four to seven consecutive days with the maximum daily temperature at or above 100°F. More than seven consecutive days spent above this threshold is considered two (or more) back-to-back heat waves. The project team also examined "Winter heat waves". A winter heat wave occurs when the minimum daily temperature exceeds 35°F for four to seven consecutive days between December and February.

Both types of heat waves have historically been very rare, if not absent, in the study area. However, in the Plain subdomain, heat waves are projected to occur at least once per year on average under RCP4.5 and about five times per year by the 2080s under RCP8.5 (see Figure 9). Also by the 2080s, winter heat waves are projected to occur nearly twice per year under RCP 8.5 and about once every two years under RCP 4.5.

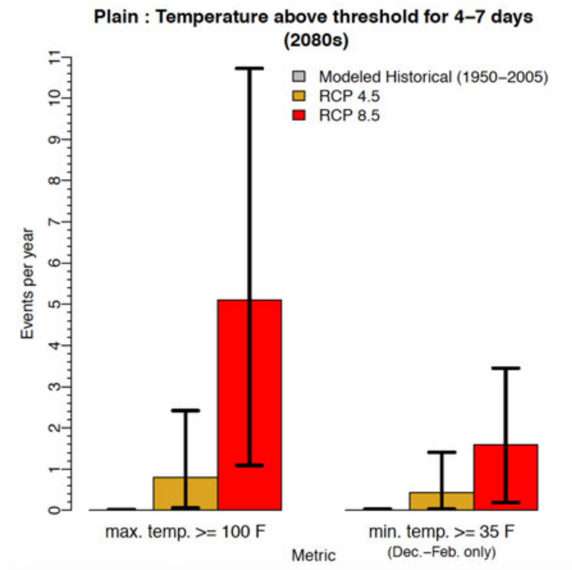


*Figure 9: Frequency of heat waves (left) and "winter heat waves" (right) in the Plain subdomain during the historical period (1950-2005 – shown in gray) and under the RCP4.5 (orange bars) and RCP8.5(red bars) scenarios by the 2080s. Shaded bars show the average from 20 climate model simulations and the vertical lines show the range from all climate model simulations.*

## Extreme precipitation

In this study, extreme precipitation events are daily precipitation totals equaling or exceeding one inch or three inches. Precipitation statistics were calculated first for each cell in the gridded dataset (2.5 x 2.5 miles) and then averaged over each subdomain. This is important because heavy precipitation events can be very localized, and analyses of extremes depend strongly on the size of area over which the precipitation is averaged. For example, while a single precipitation gauge may record over three inches in one day, it may not rain as much as three inches in one day averaged across an area as large 2.5 x 2.5 miles, much less over an area the size of one of this study's subdomains.

Thus, precipitation events of three inches or more do not appear in any subdomains in the historical period. In the future, they are projected to be very rare; only in the north and east subdomains do they appear but only once in 20 years, and then only by the 2080s under RCP 8.5.

Precipitation events of one inch or more become more common in all subdomains, but most so in the East domain (see Figure 10). Historically in this domain, these events would occur approximately three times a year. By the 2080s, the frequency of these events is projected to increase to four days a year under RCP 4.5 (a 33% increase) and to five days per year under RCP 8.5 (a 66% increase).

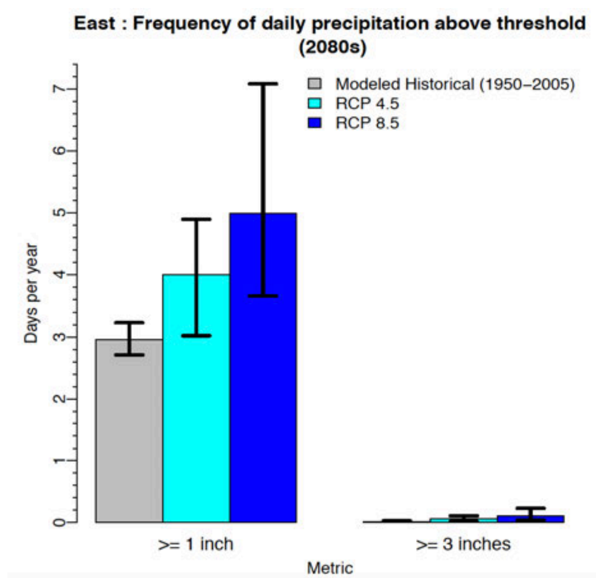


*Figure 10: Frequency of extreme precipitation events in the East subdomain during the historical period (1950-2005, gray bars) and under the RCP4.5 (light-blue bars) and RCP8.5 (dark-blue bars) scenarios by the 2080s. Shaded bars show the average from 20 climate model simulations and the vertical lines show the range from all climate model simulations.*

## Snowpack and streamflow

As expected under a warmer climate, snowpack is projected to diminish across the region. The largest reductions are seen in the North subdomain: April 1 snowpack [reported as equivalent amount of melted water in the snowpack, or snow-water-equivalent (SWE)] decreases by 20% and 40% by the 2080s under RCP4.5 and RCP8.5, respectively. In the East subdomain, reductions are smaller, because much of area remains below freezing for much of the winter even under increased temperatures. In the near future (2020s), the small increase in precipitation (as snow) in the East subdomain even counteracts the effect of increasing temperatures. April 1 snowpack has historically been used to approximate the maximum winter snowpack in the western U.S., and has been a useful index for reservoir operations. However, for the North domain, April 1 snowpack would no longer serve this purpose as March 1 snowpack exceeds April 1 snowpack by the 2080s.

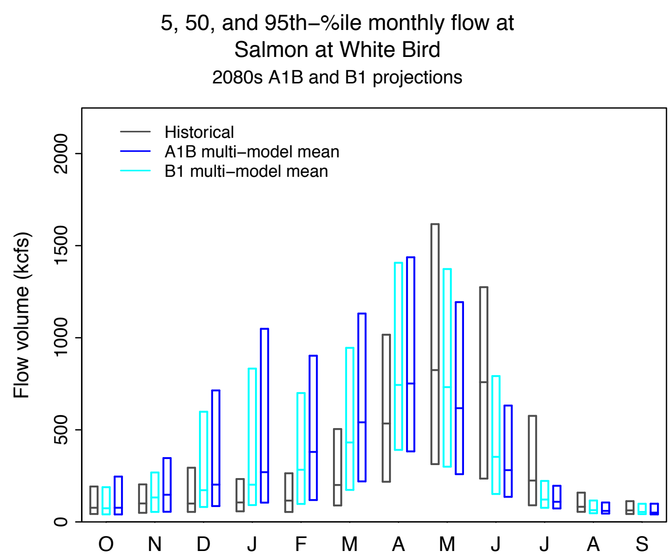


*Figure 11: Statistics of monthly naturalized flow from October (O) to September (S) for the Salmon River at White Bird for the historical period (the 1980s –black boxes) and under the A1B (dark-blue boxes) and B1 (light-blue boxes) scenarios by the 2080s. The bars show 5th, 50th, and 95th percentiles of monthly flow. Data source: Hamlet et al. (2010).*

Reductions in snowpack due to a greater proportion of winter precipitation falling as rain instead of snow, will shift peak streamflow earlier in the year, increase winter streamflow, and decrease spring and summer streamflows. Beyond these changes in long-term average flow, some locations may also experience large changes in flow variability. In basins where winter precipitation historically falls largely as snow, year-to-year variability in winter monthly flows is relatively small because the precipitation accumulates as snow instead of making its way to streams. This creates a winter flow regime that is relatively stable year-to-year. Using the Salmon River at White Bird as an example, this stability can be seen in Figure 11, which shows the small range in historical monthly flows through the winter months[8] (black boxes: O, N, D, J, F). Because its winter temperatures historically are just below freezing, the Salmon River Basin is poised to shift to receiving a substantially larger proportion of its winter precipitation as rain. This means that variability in winter flow becomes much more closely tied to variability in winter precipitation. For example, the year-to-year range in January flow may increase by a factor of ten. For aquatic species accustomed to a relatively stable winter flow regime, such a change could be very disruptive. However, not all locations in the Upper Snake River Basin would see changes in variability of this magnitude.

**Summer stream temperatures**

Summer stream temperatures are projected to rise as air temperatures rise. Along the Upper Snake River and its tributaries, this may result in summer temperatures reaching thresholds above which the aquatic environment ceases to provide suitable habitat for some species. As an example, Figure 12 shows river segments in which the August mean water temperature is projected to exceed 63.5°F by the 2040s.[9] This temperature threshold was chosen for illustrative purposes; 63.5°F temperature thresholds are representative of cold-water biota habitat needs and have been defined as an upper limit of suitability for Bull Trout,[10] though Bull Trout do not currently inhabit all streams in the Upper Snake River Basin.

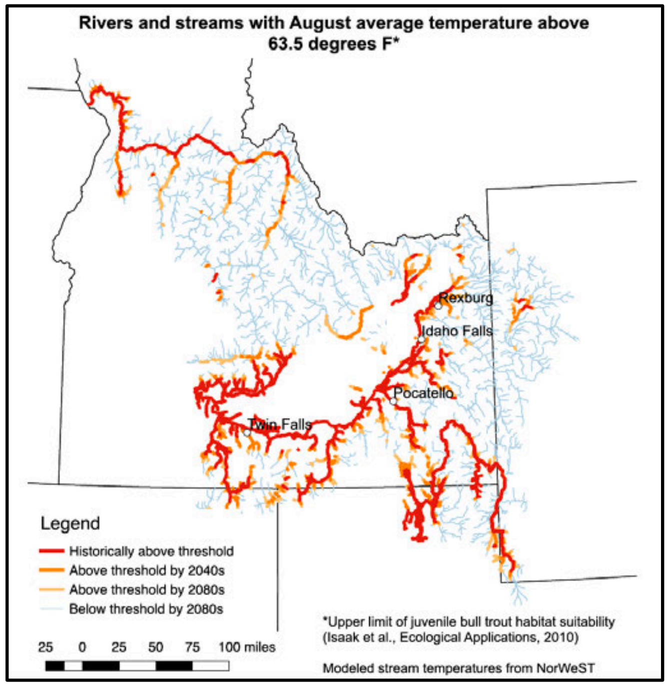


*Figure 12: Stream segments in the Upper Snake River with mean August temperature above the 63.5°F threshold historically (red) and by the 2040s (dark orange) and 2080s (light-orange) under the A1B scenario. Data source: Isaak et al. (2016).*

Projected increases in temperature as well as shifts in precipitation and associated hydrological changes will all affect the species and resources that the Tribes care about. These changes will create both direct and indirect changes that will impact aquatic species. Planning for these changes will require a focused shift in attention towards building resilience, supporting ecosystem and habitat health, decreasing non-climate stressors, and improving watershed retentive capabilities to help buffer these climate changes.

# 4.0 Vulnerability Assessment Process and Results

## *Identifying Species of Concern*

The project team initiated the vulnerability assessment by conducting a series of in-person meetings, site visits, and conference calls to identify key species of concern for the analysis.

*Figure 13: Shoshone-Bannock Tribal staff working to identify key species of concern during and in-person meeting held in April and August 2016.*

The result of this series of meetings was the identification of 18 plant species, 17 animal species, seven resource issues, and four habitats of critical concern (Table 3). The 35-species chosen include some species that were originally analyzed in the larger USRT project domain and reanalyzed for the Shoshone-Bannock project (shaded in gray in Table 1 below).

*Table 3: Final list of species, habitats, and resources analyzed in the vulnerability assessment. Items in green are specific to the Shoshone-Bannock Tribes assessment, while those in grey were also analyzed as part of the Upper Snake River Tribes assessment. Issues assessed quantitatively with the CCVI tool are indicated with an "X"; others were assessed qualitatively.*

| Plant Species | Assessed with CCVI Tool |
|---|---|
| Wyoming Sage | X |
| Service Berry | X |
| Coyote Willow | X |
| Pinyon Pine | X |
| Rubber Rabbitbrush | X |
| Yampah "Wild Carrots" | |
| Noxious Weed: Thistle | X |
| Noxious Weed: Spotted Knapweed | X |
| Invasive Species: Cheat Grass | X |
| Invasive Species: Russian Olive Tree | X |
| Big Sagebrush | X |
| Chokecherries | X |
| Quaking Aspen | X |
| Geyers Willow | X |
| Redosier Dogwood | X |
| Black Cottonwood | X |
| Camus Root | X |
| Antelope Bitterbrush | X |

| Animal Species | Assessed with CCVI Tool |
|---|---|
| Yellowstone Cutthroat Trout | X |
| Sage Grouse | X |
| Yellow-billed Cuckoo | X |
| Bald Eagle | X |
| Northern Leopard Frog | X |
| Pacific Lamprey | X |
| Gopher Snake | X |
| Mallard Duck | X |
| Moose | X |
| Mountain Lion | X |
| Bull Trout | X |
| Mule Deer | X |
| Elk | X |
| Chinook Salmon | X |
| Beaver | X |
| Black-tailed Jackrabbit | X |
| Sockeye | X |

| Resource Issues |
|---|
| Gay Mine Restoration Site |
| Traditional Foods |
| Meadow Hay |
| Cattle |
| Wildfire |
| Asthma |
| Reservoirs |

| Habitats |
|---|
| Coniferous Forests |
| Aspen Forest |
| Sagebrush Steppe |
| Riparian |

## Overview

The NatureServe Climate Change Vulnerability Index[11] (CCVI) was used to analyze the climate change vulnerability of species selected by the Shoshone-Bannock Tribes. The CCVI tool utilizes data inputs that include projections of changes in air temperature and moisture availability (Figures 6 and 7), species range data, and species-specific life history characteristics. These data are used by the CCVI tool to calculate a species' relative vulnerability ranking using 23 distinct factors that affect the species' climate change exposure, sensitivity, and adaptive capacity. The CCVI tool defines *exposure* as the projected changes in climate (e.g., temperature and moisture) across the range of a species within the assessment area; *sensitivity* as the extent to which a species will respond to shifts in climate; and *adaptive capacity* as a species' ability to withstand environmental changes. Based on these calculations, species are assigned one of four climate change vulnerability rankings.

The CCVI tool was used to produce draft climate change vulnerability rankings for 34 of the 35 plant and animal species that had sufficient range and life history data. Only one species, the yampah (*Perideria gairdneri*), had insufficient data available to complete either a quantitative (CCVI) or qualitative analysis. Thus, while it is not included in these results, it remains an important species to the Tribes.

### NatureServe CCVI

The NatureServe CCVI is a Microsoft Excel-based tool that estimates a species' relative vulnerability to climate change within a given assessment area. The CCVI tool has several benefits: it is freely available for public download, relatively easily reproducible, and frequently used. These attributes may help to facilitate future updates to the climate change vulnerability assessment as additional information becomes available for the key plant and animal species of concern. In addition, results from this CCVI analysis can be easily compared to results of other assessments also using the CCVI, such as the assessment recently completed by the Upper Snake River Tribes Foundation. The CCVI tool highlights species-specific sensitivities that contribute to a species' vulnerability, offering detailed information to help guide future climate adaptation efforts. Direct climate exposure was measured by calculating the percent of each species' range within the assessment area that is exposed to different levels of projected change in temperature and moisture. Indirect exposure to climate change, as well as species-specific sensitivities and adaptive capacity, were evaluated using a suite of 23 variables (Table 4). Though the CCVI includes 27 species-specific factors, we did not evaluate the four factors related to the "Documented response to climate change" due to lack of readily available data, leaving a total of 23 species-specific factors for the assessment. Additional detail on data sources and quantitative and qualitative assessment methods are included in the supplementary materials accompanying this report.

*Table 4: Factors used to evaluate species' climate vulnerability in the CCVI analysis.*

| Factor | Description |
|---|---|
| ***Indirect Climate Exposure Factors*** | |
| Sea Level Rise | Effects of sea level rise on species habitat (not relevant for Shoshone-Bannock species) |
| Natural Barriers | Geographic features of the landscape that may restrict a species from naturally dispersing to new areas |
| Anthropogenic Barriers | Features of anthropogenically 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 50 years |
| Physiological Thermal Niche | Dependence on cool or cold habitats within the assessment area |
| Historical Hydrological Niche | Exposure to precipitation variation over the past 50 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 |
| 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) |
| Phenological Response | Phenological response to changing seasonal temperature and precipitation dynamics |

For each factor listed in Table 4, species were evaluated and assigned a categorical ranking in accordance with CCVI guidelines. The five available categories include 1) *Greatly Increases Vulnerability*, 2) *Increases Vulnerability*, 3) *Somewhat Increases Vulnerability*, 4) *Neutral*, and 5) *Unknown*. More than one categorical ranking can be selected to capture uncertainty or intermediate rankings regarding a species' sensitivity, adaptive capacity, or indirect climate exposure. In addition, the full range of categorical rankings are not available for all sensitivity factors, as all factors do not equally affect overall species vulnerability. For example, scores for "genetic variation" range only from *Neutral* to *Increase Vulnerability*. Direct and indirect exposure to climate change and species-specific sensitivities are used to calculate an overall numerical vulnerability index score. This score is then converted to a vulnerability ranking, based on threshold values. There are four possible vulnerability rankings:

- **Extremely Vulnerable (EV)**: Species abundance and/or range extent within the project area is extremely likely to substantially decrease or disappear.
- **Highly Vulnerable (HV)**: Species abundance and/or range extent within the project area is likely to decrease significantly.
- **Moderately Vulnerable (MV)**: Species abundance and/or range extent within the project area is likely to decrease.
- **Less Vulnerable (LV)**: Available evidence does not suggest that species abundance and/or range extent within the project area will change substantially, actual range boundaries may change.

These initial assessment findings for the 34 plant and animal species were reviewed and revised during the one-day vulnerability assessment workshop using the expertise and local and traditional knowledge (as appropriate) of the Shoshone-Bannock Core Team. Local knowledge was extremely valuable in modifying the draft rankings to account for local variance in exposure, sensitivity, and adaptive capacity. Factors captured by local experience included local changes in the landscape; observed interactions between species; and species' observed responses to extreme weather, climate change, and changes in habitat.

Following these meetings, the University of Washington's Climate Impacts Group (CIG) incorporated the suggested modifications to the CCVI inputs and re-ran the assessment for all affected species. Ultimately, incorporation of this information led to an adjustment of 12 individual factors affecting four species' vulnerability ranking.

## *Vulnerability Assessment Results for Species*

The final CCVI vulnerability rankings for the 34 plant and animal species assessed are provided in Table 5. Detailed rankings of individual factors are included in the supplementary materials for this report.

*Table 5: Vulnerability rankings for the 34 plant and animal species assessed quantitatively using the CCVI. Results are shown by species (rows) and for the two different climate scenarios (RCP 4.5 and RCP 8.5) for two different time periods (2050s and 2080s) Species with an asterisk (*) do not currently have available spatial data layers for their geographical ranges. For these species, the project team assumed that the distribution of these species spans the entire assessment area. This assumption was vetted by Shoshone-Bannock tribal staff, and was determined to be appropriate, except for Single-leaf Pinyon, which is confined to a small area in the southern portion of the domain.*

| Common Name | Taxon | Habitat | 2050s RCP4.5 | 2050s RCP8.5 | 2080s RCP4.5 | 2080s RCP 8.5 |
|---|---|---|---|---|---|---|
| Greater Sage-Grouse | Bird | Sagebrush Steppe | EV | EV | EV | EV |
| Black-tailed Jackrabbit | Mammal | | MV | HV | HV | HV |
| Wyoming Sage* | Plant | | HV | EV | EV | EV |
| Big Sagebrush | Plant | | MV | HV | HV | HV |
| Rubber Rabbitbrush* | Plant | | MV | HV | HV | HV |
| Cheatgrass* | Plant | | LV | LV | LV | LV |
| Bald Eagle | Bird | Riparian | MV | MV | MV | HV |
| Yellow-billed Cuckoo | Bird | | LV | LV | LV | LV |
| American Beaver | Mammal | | LV | LV | LV | LV |
| Black Cottonwood | Plant | | MV | MV | MV | HV |
| Redosier Dogwood | Plant | | LV | LV | LV | LV |
| Geyer's Willow | Plant | | LV | LV | LV | LV |
| Coyote Willow | Plant | | LV | LV | LV | LV |
| Moose | Mammal | Coniferous Forest | MV | HV | EV | EV |
| Quaking Aspen | Plant | | LV | MV | MV | MV |
| Single-leaf Pinyon* | Plant | | MV | EV | EV | EV |
| Mallard | Bird | Aquatic | LV | LV | LV | LV |
| Northern Leopard Frog | Amphibian | | HV | HV | HV | HV |
| Columbia Spotted Frog | Amphibian | | EV | EV | EV | EV |
| Pacific Lamprey | Fish | | EV | EV | EV | EV |
| Bull Trout | Fish | | EV | EV | EV | EV |
| Chinook Salmon | Fish | | EV | EV | EV | EV |
| Steelhead | Fish | | EV | EV | EV | EV |
| Yellowstone Cutthroat Trout | Fish | | EV | EV | EV | EV |
| Mountain Lion | Mammal | Generalists | LV | LV | LV | LV |
| Elk | Mammal | | MV | HV | HV | HV |
| Mule Deer | Mammal | | LV | MV | MV | MV |
| Golden Eagle | Bird | | LV | LV | LV | LV |
| Gopher Snake | Reptile | | LV | LV | LV | LV |
| Saskatoon* | Plant | | LV | MV | MV | MV |
| Common Chokecherry | Plant | | LV | LV | LV | LV |
| Thistle* | Plant | | LV | LV | LV | LV |
| Spotted Napweed* | Plant | | LV | LV | LV | LV |
| Russian Olive* | Plant | | LV | MV | MV | MV |

The habitats selected were assessed qualitatively using a combination of approaches. The sensitivity rankings came from the Climate Change Sensitivity Database (found at: www.climatechangessensitivity.org), a publically available, on-line database of climate change sensitivity estimates based on information from both peer-reviewed literature and expert knowledge of species and habitats. The project team used the downscaled climate projections analyzed for this project to assess the climate exposure for each habitat type and assign a relative vulnerability ranking. The results are summarized below in Table 6. This sensitivity information was combined with projected climate exposure for the study region to estimate a habitat vulnerability ranking of low, medium, or high.

*Table 6: Relative climate vulnerability rankings for Shoshone-Bannock habitats of concern, including scores for sensitivity to changes in temperature, precipitation, and other indirect climate factors, climate change exposure, and overall vulnerability ranking. Sensitives are ranked from 0-7 with 0 being not sensitive and 7 being highly sensitive.*

| Qualitatively Assesses Habitats | | | | | |
|---|---|---|---|---|---|
| **Habitat Type** | **Sensitivities** | | | **Exposure** | **Vulnerability Ranking** |
| | *Temperature Changes* | *Precipitation Change* | *Indirect Factors* | | |
| Sagebrush Steppe | 3 | 3 | 5 | High | Low/Moderate |
| Coniferous Forest | 5 | 4 | 4 | Moderate/High | Moderate |
| Riparian | 5 | 4 | 4 | Moderate | Moderate/High |
| Aspen | 6 | 7 | 6 | High | High |

Note that this qualitative habitat ranking result for Aspen Habitat differs from the quantitative CCVI ranking for quaking aspen (*Populus tremuloides*). This discrepancy is not surprising given the widely divergent methodologies employed by these two approaches (i.e., the NatureServe CCVI and the Climate Change Sensitivity Database). The habitat sensitivities were evaluated for the entire Pacific Northwest Region and the CCVI assessment was focused on the project area. In a study comparing the similarity of vulnerability rankings across varying assessments and methodologies, Lankford et al. (2014) found little agreement between three frequently used assessments, including the NatureServe CCVI and the Climate Change Sensitivity Database. Finally, the CCVI Assessment results are relative to all the species assessed. Quaking Aspen may indeed be affected by changing climate conditions, but they are not nearly as sensitive to the projected changes as many of the aquatic species assessed in this project.

All resource issues were qualitatively assessed through discussions with Tribal staff; results are described in Section 6.0 of this report.

# 5.0 Adaptation Planning Results

This final phase of the project focused on developing adaptation strategies and actions to increase the resilience of species and habitats. The Core Team selected 11 focus species for adaptation planning (Table 7). Given the holistic and interconnected nature of ecosystems and the habitats that these species depend on, the Core Team decided to focus on these species' primary habitats rather than the species themselves. They worked to develop strategies and actions that would strengthen the ability of each habitat to persist and thrive with changing climatic conditions, and thereby support the needs of select species within them. This is not to suggest that identified actions and strategies are going to ameliorate the impacts of climate change for *all* species within the habitat. Though, in general, actions that help protect, preserve, or restore the Sagebrush Steppe habitat are expected to increase the climate resilience of both Sage Grouse and Wyoming Sage.

*Table 7: Final habitat and species groupings selected for adaptation planning efforts.*

| Habitat: Sagebrush Steppe | Habitat: Coniferous Forest | Habitat: Generalists |
|---|---|---|
| Wyoming Sage | Pinyon Pine | Mule Deer |
| Sage Grouse | Aspen | Serviceberry |

| Habitat: Aquatic | Habitat: Riparian |
|---|---|
| Yellowstone Cutthroat Trout | Bald Eagle |
| Pacific Lamprey | Black Cottonwood |
| Chinook Salmon | |

Using this framework, the project team conducted a literature review to identify promising adaptation actions and strategies, and identified a suite of potential adaptation actions for each habitat. Where relevant, the team also identified additional species-specific adaptation actions. These draft actions were then presented to the Core Team in a day long, collaborative adaptation planning workshop wherein the group worked to customize and refine the strategies and actions so that they would ultimately be effective and useful for the Tribes. Separate staff-led discussions following the workshop further refined the list by examining and evaluating additional aspects of implementation, including time frame for completion, financial cost, political feasibility, and cultural significance. This process resulted in a prioritized list of strategies, which are summarized below for each habitat type and species grouping. The Tribes will use this process to produce more detailed adaptation strategies for additional species and is considered a 'living' planning process.

## *Sagebrush Steppe*

Sagebrush steppe is an arid ecosystem in the Intermountain West whose distribution is strongly controlled by seasonal temperatures. While sagebrush steppe ecosystems do experience warm, dry summers, projected increases in air temperatures could further reduce soil moisture levels through increasing potential evapotranspiration. Sagebrush steppe ecosystems are sensitive to indirect effects of climate change such as invasive species and shifts in fire regimes. Cheatgrass invasion into sagebrush steppe ecosystems has increased fire frequency by acting as a continuous, highly flammable, fuel source that enables fires to cover a larger area and burn more frequently.[12] While sagebrush species typically re-establish following a disturbance, a decreasing fire interval makes it harder for sagebrush to establish following disturbance, further promoting cheatgrass spread. Two species of concern for the Shoshone-Bannock Tribes within this habitat area are ***Sage Grouse*** and ***Wyoming Sage***. In Table 8 are strategies and actions which benefit both the habitat itself, as well as the critical species within it. All *actions* have been ranked by priority within each *strategy* group.

## *Aquatic*

Aquatic habitats support species of critical importance to the Shoshone-Bannock Tribes, and include springs, seeps, creeks, rivers, and other water-dependent ecosystems within the project area. Aquatic habitats are generally sensitive to changing climate conditions. Human activities such as restoring and maintaining riparian areas and limiting groundwater withdrawals can help reduce projected increases in stream temperatures.[13] Three species of concern for the Shoshone-Bannock Tribes that utilize this habitat type include ***Yellowstone Cutthroat Trout***, ***Pacific Lamprey*** and ***Chinook Salmon***. Table 9 includes strategies and actions that benefit both the habitat itself, as well as the critical species within it. *Actions* have been by priority within each *strategy* group.

### Riparian

Riparian areas are the terrestrial habitats found immediately alongside rivers and streams. In the relatively dry landscape of the Upper Snake River Watershed, riparian areas and their associated waterways provide essential water resources for plants and animals. Healthy riparian systems rely on an appropriate range of water temperatures, volumes, and quality. Two species of concern for the Shoshone-Bannock Tribes that utilize this habitat type are ***Bald Eagle*** and ***Black Cottonwood***. Table 10 includes strategies and actions that benefit both the habitat itself, as well as the critical species within it. *Actions* have been ranked by their priority within each *strategy* group.

### Coniferous Forest

The mixed conifer forests found within the Upper Snake River Watershed are sensitive to warming temperatures, as reduced soil moisture availability may negatively affect more drought-sensitive species, leading to shifts in species composition and habitat structure. These forests are also sensitive to the indirect effects of climate change; for example, declining snowpack and warming air temperatures are likely to increase the likelihood of stand-replacing fires and insect outbreaks (e.g., bark beetle and western spruce budworm). These risks are amplified in those forests largely composed of fire-intolerant species. Two forest species of concern for the Shoshone-Bannock Tribes are ***Pinyon Pine*** and ***Aspen***. In Table 11 below are strategies and actions which benefit both the habitat itself, as well as the critical species within it. *Actions* have been ranked by priority within each *strategy* group.

### Habitat Generalists

Two key species of concern for the Shoshone-Bannock Tribes – ***Mule Deer*** and ***Serviceberry*** – are habitat generalists: they depend on and can be found in a wide variety of habitats. Tables 12 and 13, below, include strategies and actions expected to benefit these species. *Actions* have been ranked in order of their priority within each *strategy* group. These species are also likely to benefit from many of the actions identified for the various habitats they utilize.

*Table 8: Adaptation Actions for Sagebrush Steppe Habitat, including adaptation actions specific to Sage Grouse and Wyoming Sage.*

| ADAPTATION OBJECTIVES | ADAPTATION STRATEGIES | ADAPTATION ACTIONS | PRIORITIZATION CRITERIA | | | |
|---|---|---|---|---|---|---|
| | | | Summary Score | Timeframe for Implementation (immediate > 3 years medium 3-5 years, long-term 5+ years) | Notes: Legal Feasibility | Notes: Cultural Significance |
| **Objective 1: Plan and prepare for increases in frequency and severity of wildfires.** | SAGE-1: Plan and prepare for greater area burned. | Incorporate climate change into fire-management plans (wildfire projections); anticipate more opportunities to use wildfire for resource benefit. | 18 | immediate | no permit | high |
| | | Identify areas important for Wyoming Sage in situ gene conservation (quantifiable measurement) to provide a baseline for measuring fire impacts and informing post-fire planting/rehabilitation. | 18 | medium | no permit | high |
| | | Increase production of native plants for post-fire plantings (reduce the potential for anthropogenic impacts). | 17 | medium | requires EC | medium |
| | SAGE-2: Increase resilience of existing vegetation by reducing hazardous fuels and forest density and maintain low densities. | Increase interagency communication of shared fire risk (between tribes and other natural resource managers in the region). | 17 | immediate | no permit | medium |
| | SAGE-3: Increase resilience through post-fire management. | Consider climate change in post-fire rehabilitation and determine where native seed may be needed for post-fire planting. Enhance plans for post-fire responses for large fires (i.e., limiting cheatgrass spread, looking at burn severity, replant when needed, keeping cattle out of burned area). | 17 | immediate | component EC | medium |
| | | Monitor post-fire regeneration to determine what can be expected after large fires and to inform emergency stabilization and long term restoration efforts. | 17 | medium | component EC | low |
| | | Experiment with planting native species to compete with invasive species post-fire. | 14 | long-term | no permit | high |
| | SAGE-4: Manage vegetation to reduce fire severity and fire patch size; protect fire refugia. | Map and identify (through GIS and remote sensing) processes/conditions that create fire refugia or areas less prone to fire. | 16 | medium | component EC | medium |
| | SAGE-5: Manage landscapes to encourage fire to play a natural role. | Identify, create, and/or retain fuel breaks at strategic locations. | 15 | long-term | requires EC | low |
| **Objective 2: Prepare for climate-driven shifts in habitat and species distributions.** | SAGE-6: Prevent loss of relict populations of vascular and nonvascular species. | Engage in mapping areas where sagebrush could be established or re-established (relict ranges). *Underway.* | 18 | medium | no permit | high |
| | SAGE-7: Support movement of Sagebrush habitat and species. Monitor and detect change in survival, species composition, and mortality of sagebrush. | Plant species from future climate appropriate seed zones. | 18 | medium | component EC | high |
| | | Identify if there is a need for additional plots to gather trend information over time, targeting areas where changes are expected. | 17 | long term | no permit | low |
| | | Consider assisted migration to help Wyoming Sage Brush keep pace with suitable climate parameters. | 17 | long-term | component EC | high |
| | SAGE-8: Increase habitat connectivity. | Coordinate among/across states and between states and their federal counterparts to protect habitat core areas to promote large-scale, continuous sage grouse habitat that would be protected from further development. | 16 | immediate | no permit | low |
| | | Identify, maintain and restore corridors that span elevation gradients to facilitate the dispersal of shrub steppe species into cooler, higher elevation habitats as the climate warms. | 16 | long-term | component EC | medium |
| | | Diminish habitat fragmentation through human-related disturbances including habitat conversion to other land use types, overgrazing, energy development and roads which disrupt the habitat. Work instead to preserve large scale, continuous habitat protected from development. Engage private landowners in efforts to preserve sagebrush habitat. | 15 | immediate | component EC | high |
| **Objective 3: Increase resilience to future changes by reducing existing stressors.** | SAGE-9: Establish conservation and protected areas to expand the area of suitable sagebrush habitat under future climate conditions. | Pilot rotation for pastures from grazing (near occupied leks) during periods of fastest growth of dominant perennial grasses and forbs, as this enhances reproduction in sagebrush steppe (e.g. paid deferments through conservation programs). | 16 | long-term | requires EC | low |
| | | Ensure that new and existing livestock troughs and open water storage tanks are fitted with ramps to facilitate the use of and escape from troughs by sage-grouse and other wildlife. | 13 | immediate | no permit | low |
| | | Install fence markers or remove fences where sage-grouse mortality due to collision with fences is documented or likely to occur due to new fence placement (avoid new fences within 0.5 mile of a lek). | 12 | immediate | no permit | medium |
| | SAGE-10: Increase resilience by promoting native species and drought-adapted native species. | Work to reestablish Wyoming Sage Brush where it is desired through seed imprinting, seed broadcasting or seed plugs. | 17 | long-term | component EC | high |
| | | Use native plant species that will be robust to climate change (e.g., drought-adapted species) in restoration projects. | 19 | medium | component EC | high |

| ADAPTATION OBJECTIVES | ADAPTATION STRATEGIES | ADAPTATION ACTIONS | PRIORITIZATION CRITERIA | | | |
|---|---|---|---|---|---|---|
| | | | Summary Score | Timeframe for Implementation (immediate > 3 years medium 3-5 years, long-term 5+ years) | Notes: Legal Feasibility | Notes: Cultural Significance |
| **Objective 4: Increase invasive species control efforts to decrease wildfire risk, protect Wyoming Sage Brush regeneration, and provide for Sage Grouse habitat.** | SAGE-11: Increase invasive species control efforts. | Increase coordination between other tribes and natural resource managers/agencies in the region and enhance funding for invasive species management. | 16 | immediate | no permit | medium |
| | | Initiate early detection and rapid response programs (e.g. chemical, biological applications, mechanical removal, prevention methods [e.g. wash stations]) by establishing baseline conditions for invasive species and insects both on and off Tribal lands. | 14 | immediate | requires EC | low |
| | | Identify and target known sources/vectors for invasive species (e.g., rock pits, weed-free materials for restoration). | 12 | medium | no permit | low |
| | SAGE-12: Prevent invasive species from establishing after disturbances. | Rehabilitate burned areas for the ecological site using native plant materials or introduced materials, that encourage the long term sustainability of native species, and as approved by Resource Managers. | 19 | immediate | component EC | medium |
| | | Consider strategies regarding prevention and spread of invasive species in all phases of restoration, construction, and other projects (e.g., planning, implementation, monitoring). | 17 | immediate | no permit | low |
| | SAGE-13: Prevent widespread outbreaks of invasive species or pathogens. | Continue to maintain permits for aggressive treatment of invasive species (e.g., burning and herbicide). | 14 | immediate | requires EC | low |
| | | | | | | |
| **Objective 5: Increase monitoring and evaluation efforts to protect habitat and species.** | SAGE-14. Monitor and detect change in species composition, distribution, seedling survival, and mortality of sagebrush in sagebrush steppe habitats. | Conduct baseline assessment of sagebrush steppe habitat and design long-term trend monitoring programs for sage brush steppe habitats adding additional plots as needed. | 16 | medium | component EC | low |
| | | Identify and focus monitoring on sensitive habitats and species in priority regions and prioritize these habitats for active management, acquisition, and protection across jurisdictional boundaries. | 14 | medium | component EC | low |
| | | | | | | |
| **Objective 6: Enhance outreach and educational activities** | SAGE-15. Enhanced outreach and education on Sagebrush Steppe Issues. | Develop and expand education efforts for the public regarding wildfire reduction efforts on the Wildland Urban Interface. | 18 | immediate | no permit | high |
| | | Develop and expand education efforts for the public regarding invasive species impacts, such as improving identification of non-native species, encouraging the use of native species, and promoting the use of strategies to prevent and remove invasive species. | 18 | immediate | no permit | medium |
| | | Conduct outreach and education to policy-level tribal decision-makers about the Adaptation Planning efforts. | 18 | immediate | no permit | high |
| | | Conduct outreach and education to all land users (e.g. ranchers) about the Adaptation Planning efforts. | 18 | immediate | no permit | high |
| | | Consider program to engage citizen scientists to help with invasive species monitoring, detection, and response efforts (e.g. LEO network). | 13 | immediate | no permit | low |
| | | Conduct outreach and education to nurseries regarding selling invasive species and addressing invasive seeds and pathogens in native plantings. | 13 | immediate | no permit | low |

*Table 9: Adaptation Actions for Freshwater Aquatic Habitat, including resilience building actions for Yellowstone Cutthroat Trout, Pacific Lamprey, and Chinook Salmon.*

| ADAPTATION OBJECTIVES | ADAPTATION STRATEGIES | ADAPTATION ACTIONS | PRIORITIZATION CRITERIA | | | |
|---|---|---|---|---|---|---|
| | | | Summary Score | Timeframe for Implementation (immediate > 3 years medium 3-5 years, long-term 5+ years) | Notes: Legal Feasibility | Notes: Cultural Significance |
| **Objective 1: Increase resilience of freshwater habitats to shifts in winter hydrologic regimes.** | FW-1: Improve flood storage capacity to maximize the benefits of spring flows. | Work with key state and federal agencies to continue to protect, enhance and restore natural channel migration zones (e.g. Fort Hall Bottoms). | 17 | medium | EC required | medium |
| | | Work with private landowners, key state and federal agencies to set back dikes, remove armoring, and address other barriers that limit floodplain connectivity. | 15 | medium | EC required | low |
| | FW-2: Increase fish habitat resilience to higher winter streamflows by restoring stream structure and ecological function. | Increase use of logjams where feasible to provide refugia during high flow events. | 17 | medium | EC required | medium |
| | | Explore landscape water retention projects to protect habitat against extreme runoff events and low flow/high temperature events (eg. Increase and/or reconnect floodplain habitat to streams and rivers, alternate tillage practices) (e.g. Bannock Creek). | 14 | immediate | component EC | high |
| | FW-3: Develop better information about winter streamflow regimes. | Review and evaluate stream monitoring network and identify locations for additional streamflow and temperature monitoring. | 13 | immediate | no permit | low |
| **Objective 2: Increase resilience of freshwater habitats to declining summer flows and warming stream temperatures.** | FW-4: Increase aquatic habitat resilience to low summer flows and warming stream temperatures. | Restore beaver habitat and beaver populations to maintain summer base flows and reduce water temperatures. | 19 | immediate | no permit | high |
| | | Increase stream complexity to provide refugia during low flow events (i.e., maintain woody material and/or bolders in the stream reach) *In the Tributary Management Plan.* | 19 | long-term | EC required | high |
| | | Maintain or restore riparian vegetation to limit channel exposure to solar radiation *In the Tributary Management Plan* | 18 | medium | EC required | high |
| | | Restore riparian areas to maintain summer base flows and reduce water temperatures, and consider riparian treatments that enhance these benefits *In the Tributary Management Plan.* | 18 | long-term | EC required | high |
| | | Prevent livestock grazing in the riparian zone (i.e., install localized fencing) and other ecologically sensitive zones *In the Tributary Management Plan.* | 17 | long-term | component EC | medium |
| | FW-5: Increase understanding of how summer streamflow regimes, thermal heterogeneity, and cold water refugia could be affected by climate change. | Identify and monitor stream temperatures, cold water refugia, springs, and groundwater input to springs in the Upper Snake watersheds and identify river stretches with highest potential for thermal blockages and reduce potential for blockage where possible. | 14 | immediate | no permit | medium |
| | | Research and evaluate the influences of lakes, ditches, hyporheic zones, glacier and snow melt and groundwater on stream temperatures, and how climate change could affect those influences. | 12 | medium | no permit | medium |
| | FW-6: Increase understanding of thermal tolerance of fish species. | Research and monitor fish use of thermal refugia; evaluate and include a cold water standard to help protect aquatic fish species. | 13 | immediate | no permit | medium |
| | FW-7: Implement water conservation approaches that increase summer streamflows and buffer against rising stream temperatures. | Develop and implement watershed-specific headwater flow and temperature protection plans. | 18 | medium | EC required | high |
| | | Work with stakeholders to identify opportunities for water conservation practices in sensitive areas/priority watersheds. | 15 | immediate | no permit | medium |
| | | Identify priority watersheds to work with partners to meter water withdrawals to better quantify how much water is being used within the ShoBan assessment area. | 15 | immediate | no permit | low |
| | | Reduce or eliminate thermal water pollution from human sources (i.e. irrigation returns). | 13 | medium | component EC | low |
| | | Identify cold-water storage sources for application at critical periods. | 11 | medium | no permit | low |
| | FW-8: Reduce migration/dispersal barriers to fish populations (e.g., culverts, dams, etc.). | Ensure appropriate site characterization to develop adequate barrier mitigation measures for action implementation. | 17 | long-term | component EC | low |
| | | Investigate fish passage technologies and opportunities (e.g., design of fish friendly culverts, bottomless arches and bridge), and ensure these are implemented where necessary. | 15 | medium | component EC | low |
| | | Assess the feasibility and benefit of removing unneeded or marginal barriers that block salmon from headwater habitats (i.e., removing low-value dams, acquiring water to restore de-watered streams and protect thermal refugia, accelerate culvert replacements). | 13 | long-term | no permit | low |
| | | Use stored cold water, additional ladders, ladder improvements, and ladder maintenance to enhance mainstem adult passage; incorporate 24-hour video fish counting. | 12 | long-term | component EC | low |
| | | Require experimental fish passage (dam modification, capture technologies, or both) in federal license renewals for relevant private dams. | 11 | long-term | component EC | medium |
| | | Assess the feasibility and potential benefits of removing aged and/or unprofitable tributary dams in the lower Snake River to reopen tributary habitat to anadromous fish. | 9 | long-term | EC required | low |

| ADAPTATION OBJECTIVES | ADAPTATION STRATEGIES | ADAPTATION ACTIONS | PRIORITIZATION CRITERIA | | | |
|---|---|---|---|---|---|---|
| | | | Summary Score | Timeframe for Implementation (immediate > 3 years medium 3-5 years, long-term 5+ years) | Notes: Legal Feasibility | Notes: Cultural Significance |
| **Objective 3: Reduce the impact of non-native species on freshwater habitats.** | FW-9: Stop the arrival and spread of non-native species to reduce the risk of invasive species. | Maintain or construct cleaning and inspection stations to prevent spread of invasive species, where appropriate. | 16 | immediate | EC required | high |
| | | Remove or control aquatic invasive species (i.e. New Zealand mud snails, quagga mussels, purple loosestrife). | 15 | immediate | EC required | high |
| | | Research and evaluate how invasive riparian and aquatic species could be affected by climate change. | 13 | immediate | no permit | high |
| **Objective 4: Reduce the impact of diseases and parasites on freshwater habitats.** | FW-10: Improve monitoring for fish disease and parasites. | Certify releases of fish from artificial production as disease free. | 15 | immediate | component EC | low |
| | | Collaborate and standardize fish health survey methods among agencies. | 13 | immediate | component EC | low |
| **Objective 5: Increase understanding of the link between climate change and shifts in water quality.** | FW-11: Improve understanding of changes in water quality in response to climate change. | Begin improving in-channel stream conditions for anadromous fish by improving or eliminating land-use practices that degrade watershed quality. | 17 | medium | EC required | medium |
| | | Improve mainstem and tributary water quality by eliminating sources of toxic pollution and by reducing discharges of other contaminants to meet water quality criteria for salmonids and pacific lamprey across all life stages. | 16 | long-term | EC required | high |
| | | Continue to invest in monitoring surface and ground water quality and quantity parameters such as dissolved oxygen, nutrients, pH, turbidity, and sedimentation in response to decrease flows and increased stream temperatures. | 15 | immediate | component EC | low |
| **Objective 6: Species Specific: monitor, and where appropriate, restore freshwater habitat and reintroduce or supplement chinook, lamprey, and Yellowstone Cutthroat trout habitat.** | FW-12: Monitor and where appropriate, recover salmonid and lamprey populations through recovery efforts driven by population supplementation and reintroduction. | Follow and Implement appropriate Fort Hall Tributary Management and Fish Management Plans to protect, enhance and restore habitat for native salmonids. | 17 | immediate | EC required | high |
| | | Use supplementation to reintroduce salmon or help rebuild populations to watersheds from which they have been eliminated, or are under a high risk of extinction. | 17 | long-term | EC required | high |
| | | Manage for life history and genetic diversity among salmonid populations. | 15 | medium | component EC | high |
| | | Closely monitor tributary salmon production and escapement to improve management. | 14 | immediate | component EC | high |
| | | Supplement and/or augment interior lamprey populations by reintroduction and translocation of adults and juveniles into areas where they are severely depressed or extirpated. | 13 | long-term | EC required | medium |
| | | Continue research and establish long term monitoring around macroinvertebrate community including aquatic species and other species in the trophic level to respond to the shift in taxa. | 13 | long-term | EC required | low |
| | | Collaborate with NOAA on the recovery of fall run of Chinook Salmon above the Hells Canyon Dam Complex (e.g., evaluate feasibility of adult and juvenile fish passage to and from spawning and rearing sites). | 8 | long-term | EC required | high |
| | FW-13: Restore habitat necessary to the survival of salmonids. | Restore mainstem, floodplain, and estuary habitats to more natural conditions where possible, which will reduce predation rates on migrating juvenile salmon and provide more rearing and resting habitat. | 19 | medium | EC required | medium |
| **Objective 7: Increase outreach and education for freshwater species.** | FW-14: Increase public education regarding vulnerable species. | Develop and expand education efforts for the public regarding invasive species impacts, such as improving identification of non-native species, encouraging the use of native species, and promoting the use of strategies to prevent and remove invasive species. | 19 | immediate | no permit | medium |
| | | Consider program to engage citizen scientists to help with invasive species monitoring, detection, and response efforts (e.g. LEO network). | 19 | immediate | no permit | medium |
| | | Conduct outreach and education to policy-level tribal decision-makers about the Adaptation Planning efforts. | 17 | immediate | no permit | medium |
| | | Increase human health advisory efforts to the public regarding fish consumption and toxins through increased coordination with the Idaho Health & Welfare website. | 14 | immediate | no permit | high |
| **Objective 8: Increase understanding of how changing seasonal temperature or precipitation influence freshwater species phenology.** | FW-15: Improve understanding of changes in, and implications of, phenological changes and species interactions. | Monitor phenological changes and species interactions in riparian and aquatic species. | 20 | long-term | component EC | low |

*Table 10: Adaptation Actions for Riparian Habitat, including resilience building actions for Black Cottonwood and Bald Eagle.*

| ADAPTATION OBJECTIVES | ADAPTATION STRATEGIES | ADAPTATION ACTIONS | PRIORITIZATION CRITERIA | | | |
|---|---|---|---|---|---|---|
| | | | Summary Score | Timeframe for Implementation (immediate > 3 years medium 3-5 years, long-term 5+ years) | Notes: Legal Feasibility | Notes: Cultural Significance |
| **Objective 1: Increase resilience of riparian habitats to increasing regional drought.** | RIP-1: Maintain and enhance riparian forest productivity regardless of tree species; focus on functional ecosystems and processes. | Identify restoration areas to plant native riparian species (i.e. hand planting/cuttings). | 18 | immediate | EC required | medium |
| | | Work with private, state and federal agencies to promote the restoration of natural stream and river flooding to maintain riparian areas and provide flow rates high enough for Cottonwood germination. | 16 | medium & long-term | EC required | high |
| | RIP-2: Store more water on the landscape to reduce impacts to riparian habitats. | Increase beaver populations to create more wetland habitat. | 18 | immediate | no permit | high |
| | RIP-3: Protect and increase instream flows. | Restore riparian vegetation and prevent soil compaction and wetland destruction. | 17 | immediate | EC required | high |
| **Objective 2: Plan and prepare for increased rates of erosion.** | RIP-4: Decrease erosion potential by reseeding and restoration, which can be used following disturbances and for vulnerable exposed soil surfaces (near roads, or after fire). | Restore and revegetate riparian plant communities where needed to store sediment and maintain channel geomorphology. | 18 | immediate | EC required | high |
| | | Implement streambank stabilization and floodplain restoration techniques to help reduce bank erosion from higher flows (i.e. Bannock Creek, the Bottoms). | 16 | medium | EC required | medium |
| | | Continue and expand monitoring of existing riparian communities using GIS/remote sensing. | 15 | medium | no permit | low |
| | | Develop a geospatial layer of debris flow potential for pre-fire planning. | 14 | medium | component EC | low |
| | | Link stream inventory with topographic, geomorphic, and vegetation layers to assess existing hazard and risk for flooding and erosion. | 13 | medium | component EC | low |
| **Objective 3: Prepare for unavoidable shifts in the distribution of riparian species and habitats.** | RIP-5: Prevent loss of relict populations of vascular and nonvascular riparian species | Identify areas where riparian relict plants could be established or re-established (i.e. black cottonwood). | 17 | medium | EC required | medium |
| | RIP-6: Monitor and detect change in seedling survival, species composition, and mortality of mature trees in subalpine forests. | Use Forest Inventory and Analysis plot information to determine trends in riparian forests. | 13 | immediate | no permit | medium |
| | RIP-7: Increase late-successional habitat area and habitat quality. | Identify important habitat manipulations for promoting late-successional stage (e.g., thinning and prescribed burns on the Fort Hall Bottoms) based on monitoring. | 19 | immediate | no permit | high |
| | | Identify priority areas for acquisition, protection, and restoration. | 17 | immediate | no permit | medium |
| **Objective 4: Prepare to monitor changes in species phenology.** | RIP-8: Increase resilience of riparian habitat by preserving biodiversity. | Continue to create, promote, and protect legacy structures in riparian forests which will provide current or future nest structure for the Bald Eagle. | 20 | immediate | no permit | high |
| | | Protect critical riparian areas and promote connectivity. | 17 | medium | EC required | medium |
| | | Examine biotic associations that promote resistance and resilience to a changing environment. | 13 | long-term | no permit | low |
| | RIP-9: Monitor and prioritize regions for riparian management. | Identify and focus monitoring on sensitive riparian habitats and species (e.g. frogs, yellow billed cuckoo) in priority regions and expand long-term monitoring programs. | 17 | medium | no permit | medium |
| **Objective 5: Limit the impact of increased sediment transport on riparian habitats.** | RIP-10: Reduce water turbidity levels by reducing sediment loading and facilitating sediment deposition. | Increase channel to floodplain connectivity to allow for sediment deposition. | 20 | medium | EC required | medium |
| | | Work with partners to monitor and identify areas prone to road failure, unstable slopes, and mass wasting and how these areas might be impacted by climate change. | 14 | immediate | component EC | low |
| | | Manage cultivated and riparian areas to maximize sediment retention and reduce erosion. | 14 | immediate | component EC | low |

| ADAPTATION OBJECTIVES | ADAPTATION STRATEGIES | ADAPTATION ACTIONS | PRIORITIZATION CRITERIA | | | |
|---|---|---|---|---|---|---|
| | | | Summary Score | Timeframe for Implementation (immediate > 3 years medium 3-5 years, long-term 5+ years) | Notes: Legal Feasibility | Notes: Cultural Significance |
| **Objective 6: Increase resilience of riparian habitats to invasive species through early detection, response, and prevention.** | RIP-11: Increase invasive species control efforts. | Survey and map invasive riparian and aquatic species. | 18 | medium | no permit | low |
| | | Implement early detection and rapid response for invasive species and insects both on and off Tribal lands. | 18 | immediate | EC required | low |
| | | Decrease resilience of existing invasive species with appropriate management practices (e.g., weed removal). | 18 | immediate | EC required | low |
| | | Identify and target known sources/vectors for invasive species (e.g., streambank restoration using weed free materials/sanitary fill). | 16 | immediate | component EC | low |
| | | Coordinate invasive species management, funding, and support between other tribes and natural resource managers/agencies in the region. | 16 | medium | no permit | low |
| | | Work to reduce/eliminate Russian olive encroachment (as well as other exotic plants) which can reduce recruitment of black cottonwood. | 15 | immediate | EC required | low |
| | | Consider strategies regarding prevention and spread of invasive species in all phases of projects (e.g., planning, implementation, monitoring). | 12 | immediate | component EC | low |
| | | | | | | |
| **Objective 7: Enhance climate outreach and education.** | RIP-12: Enhance outreach and educational activities around riparian issues. | Develop and expand education efforts for the public regarding invasive species impacts, such as improving identification of non-native species, encouraging the use of native species, and promoting the use of strategies to prevent and remove invasive species. | 19 | immediate | no permit | medium |
| | | Develop and implement education efforts for the public regarding irrigation efficiencies. Identify restoration areas and promote best practices for irrigation methods in those areas. | 17 | immediate | no permit | medium |
| | | Conduct outreach and education to policy-level tribal decision-makers about the Adaptation Planning efforts. | 17 | immediate | no permit | medium |
| | | Consider program to engage citizen scientists to help with invasive species monitoring, detection, and response efforts (e.g. LEO network). | 17 | immediate | no permit | medium |

*Table 11: Adaptation Actions for Coniferous Forest Habitat, including resilience building actions for Pinyon Pine and Aspen.*

| ADAPTATION OBJECTIVES | ADAPTATION STRATEGIES: | ADAPTATION ACTIONS | PRIORITIZATION CRITERIA | | | |
|---|---|---|---|---|---|---|
| | | | Summary Score | Timeframe for Implementation (immediate > 3 years medium 3-5 years, long-term 5+ years) | Notes: Legal Feasibility | Notes: Cultural Significance |
| **Objective 1: Prepare for and limit the effects of more frequent or intense droughts and wildfires.** | FOR-1. Use native as well as drought and future temperature tolerant species in restoration efforts post disturbance. | Experiment with native species from other elevations/ latitudes, and/or introduce drought tolerant species for reseeding and restoration. | 14 | long-term | EC required | medium |
| | | | | | | |
| **Objective 2: Prepare for shifts in the distribution of forest species and habitats.** | FOR-2. Prevent loss of culturally important populations of vascular and nonvascular species. | Protect, restore, connect, and enhance climate refugia (e.g., colder north-facing aspects of hard to access areas). | 17 | medium | EC required | high |
| | FOR-3. Increase habitat connectivity. | Prepare for tree species migration by managing for multiple species across large landscapes. | 18 | immediate | EC required | high |
| | | Continue to acquire new tribal properties for conservation and where possible, expand or adjust protected areas to incorporate greater diversity of topographic and climatic conditions to allow for shifts in species distributions in response to climate change. | 16 | medium | EC required | high |
| | | Increase extent of protected areas; collaborate with neighbors regarding priority areas for treatments (e.g., removing dispersal barriers) and land acquisitions. | 15 | medium | EC required | medium |
| | FOR-4. Increase habitat quality and biodiversity. | Continue to protect legacy structures. | 17 | immediate | no permit | high |
| | | Continue to restore degraded sites and identify priority areas for acquisition, protection and restoration. (both within and across jurisdictions). | 16 | long-term | EC required | low |
| | | Continue to thin stands / prescriptive burning to promote tree vigor, complex forest structure, and produce future legacy structures. Consider ungulate pressure in areas and how it will affect the success of regeneration. | 15 | immediate | EC required | medium |
| | | | | | | |
| **Objective 3: Species specific resilience or survival strategies.** | FOR-5. Protect existing and potential future habitat. | Increase connectivity to and among potential climate refugia. | 17 | medium | EC required | medium |
| | FOR-6. Reduce browsing pressure on aspen. | Continue to create exclosures using fencing or jackstraw (heavy tree-fall) to encourage aspen regeneration. | 18 | immediate | EC required | high |
| | FOR-7. Protect and spread aspen. | Separate roots of aspen. | 11 | long-term | EC required | low |
| | | | | | | |
| **Objective 4: Limit the effect of invasive species to enhance the natural resilience of forest habitats.** | FOR-8. Increase invasive species control efforts. | Implement early detection and rapid response for insects both on and off Tribal lands. | 18 | medium | no permit | low |
| | | Coordinate invasive species management, funding, and support between other tribes and natural resource managers/agencies in the region. | 18 | immediate | EC required | low |
| | | Identify and target known sources/vectors for invasive species. | 18 | immediate | EC required | low |
| | FOR-9. Prevent widespread outbreaks of invasive species or pathogens. | Maintain permits for aggressive treatment of invasive species (e.g., burning and herbicide). | 16 | immediate | EC required | low |
| | | Identify and promote early-successional natives that may be able to compete with non-natives. | 16 | medium | no permit | low |
| | | Reduce existing invasive species populations with appropriate management practices (e.g., weed removal). | 15 | immediate | EC required | low |
| | | Apply herbicides and other direct eradication methods to select invasive species when necessary. | 15 | medium | EC required | low |
| | FOR-10. Increase forest landscape resilience to large and extensive insect or pathogen outbreaks. | Design forest gaps that create establishment opportunities for unaffected species (e.g., meadow) or different forest species (e.g., alder, cedar). | 17 | medium | EC required | medium |
| | | Consider planting desired species in addition to relying on natural regeneration and migration, when necessary. | 16 | long-term | EC required | medium |
| | | Monitor insect/pathogen infestations using technology (drone, remote sensing/GIS) to map the extent and progression of the infestation. | 14 | medium | component EC | low |

| ADAPTATION OBJECTIVES | ADAPTATION STRATEGIES: | ADAPTATION ACTIONS | PRIORITIZATION CRITERIA | | | |
|---|---|---|---|---|---|---|
| | | | Summary Score | Timeframe for Implementation (immediate > 3 years medium 3-5 years, long-term 5+ years) | Notes: Legal Feasibility | Notes: Cultural Significance |
| **Objective 5: Enhance forest health to increase resilience to disturbance.** | FOR-11. Increase resilience of forest stands to disturbance by increasing tree vigor. | Identify priority areas for protecting pinyon pine and aspen; consider removal of competing conifers and vegetation. | 17 | immediate | EC required | medium |
| | | Instead of thinning for late-successional forest conditions, also consider thinning/creating gaps to promote a more complex vertical forest structure that allows for native understory development and increased diversity. | 15 | medium | EC required | low |
| | FOR-12. Promote diverse native species and forest structure. | Practively plant and replant with native seedings in restoration areas and post disturbance in re-growth areas. | 17 | immediate | component EC | high |
| | | | | | | |
| **Objective 6: Invest in Monitoring, Evaluation, and Research to better understand how changing climate conditions are affecting forests, aspen, and pinyon pine.** | FOR-13. Monitor and Update management plans. | Periodically review and revise the Forest Inventory to balance harvest of forest health. | 15 | long-term | EC required | low |
| | | Expand long-term monitoring programs and share data. | 13 | medium | component EC | low |
| | | | | | | |
| **Objective 7: Enhance outreach and education efforts within the tribal community to build climate literacy and support for future actions.** | FOR-14. Community Engagement. | Conduct outreach and education to all land users (e.g. ranchers) about the Adaptation Planning efforts. | 19 | immediate | no permit | medium |
| | | Develop and expand education efforts for the public regarding wildfire reduction efforts on the wildland urban interface. | 18 | immediate | no permit | high |
| | | Conduct outreach and education to policy-level tribal decision-makers about the Adaptation Planning efforts. | 18 | immediate | no permit | medium |
| | | Develop and expand education efforts for the public regarding invasive species impacts, such as improving identification of non-native species, encouraging the use of native species, and promoting the use of strategies to prevent and remove invasive species. | 18 | immediate | no permit | medium |

*Table 12: Adaptation Actions for Mule Deer.*

| ADAPTATION OBJECTIVES | ADAPTATION STRATEGIES | ADAPTATION ACTIONS | PRIORITIZATION CRITERIA | | | |
|---|---|---|---|---|---|---|
| | | | Summary Score | Timeframe for Implementation (immediate > 3 years medium 3-5 years, long-term 5+ years) | Notes: Legal Feasibility | Notes: Cultural Significance |
| **Objective 1: Prepare for and limit the effects of more frequent or intense droughts.** | MD-1: Ensure water availability for Mule Deer Populations. | Ensure that water distribution is maintained in areas where freestanding water is documented to be important to Mule Deer. | 14 | medium | no permit | high |
| **Objective 2: Prepare for unavoidable shifts in the distribution of species and habitats.** | MD-2: Enhance the quality current habitat. | Ensure that security cover requirements for Mule Deer are incorporated in all restoration plans developed to improve Mule Deer habitat. | 18 | immediate | component EC | medium |
| | | Identify and map critical Mule Deer habitat (including calving, winter, summer, and yearlong) and work with public and private land managers to protect and enhance those areas. | 17 | medium | no permit | medium |
| | | Based on Mule Deer habitat requirements, use future climate projections (i.e., snow or lack of moisture) to develop maps of future critical areas for Mule Deer. | 16 | medium | no permit | high |
| | | Assure future availability of habitats where Mule Deer are most secure from heat stress by undertaking conservation initiatives such as conservation easements, mitigation banking, and others deemed viable. | 14 | long-term | no permit | medium |
| | MD-3: Improve habitat connectivity. | Locate passage structures in proximity to existing or traditional travel corridors or routes (Singer and Doherty 1985, Bruinderink and Hazebroek 1996), and in proximity to natural habitat | 12 | long-term | EC required | low |
| | | To maximize use by deer and other wildlife, passage structures should be located away from areas of high human activity and disturbance. For established passage structures in place >10 years, Clevenger and Waltho (2000) found that structural design characteristics were of secondary influence to ungulate use compared to human activity. | 11 | long-term | EC required | low |
| | MD-4: Decrease human development pressure on Mule Deer Habitat. | Evaluate road densities and ensure that road densities are not adversely impacting Mule Deer habitat, particularly during times when fawns are being born and reared. | 17 | immediate | no permit | medium |
| | | Limit human development impacts on important Mule Deer habitats. | 16 | medium | component EC | medium |
| **Objective 3: Prepare for shifts in phenology and/or enhanced competition.** | MD-5: Limit interaction and competition between Mule Deer and Elk. | Identify locations/situations where Mule Deer and Elk competitive interactions may exist (i.e., winter range) and develop recommendations to reduce conflict between the species. | 13 | medium | no permit | medium |
| **Objective 4: Increased risk of pathogens/disease.** | MD-6: Monitor and decrease the affect of pathogens/disease on Mule Deer. | Develop a west-wide Mule Deer disease and parasite monitoring plan that recommends standardized surveillance, testing, data storage and reporting procedures. | 13 | immediate | no permit | high |
| | | Track Mule Deer mortality and determine the root cause of the mortality. | 13 | immediate | no permit | low |
| | | Provide comprehensive technical training to biologists and managers on disease and parasite detection, identification, surveillance, monitoring, and management. | 12 | immediate | no permit | low |
| **Objective 5: Monitoring species status, distribution.** | MD-7: Develop and enhance monitoring and data gathering. | Monitor Mule Deer buck: doe ratios on a 3-year moving average to better account for annual variation. | 16 | immediate | no permit | low |
| | | Host an annual meeting with other agencies and resource managers such as state agencies, federal agencies, local resource managers, tribal resource managers, and others to discuss and coordinate Mule Deer management. | 14 | immediate | no permit | medium |
| | | Monitor the effects of harvest levels on population demographics and abundance. Use monitoring data to set and adjust harvest rates, timing, duration of hunts, and bag limits to achieve population objectives. | 14 | immediate | component EC | low |
| | | Digitally map current mule deer distributions. | 11 | medium | no permit | low |
| **Objective 6: Outreach and Education.** | MD-8: Enhance outreach and education. | Develop a landowner's guide to Mule Deer management and disseminate across the reservation. | 16 | immediate | no permit | medium |
| | | Educate the public about potential changes in Mule Deer populations due to climate change. | 14 | immediate | no permit | high |
| | | Develop and distribute educational materials to department leadership and public on climate impacts on Mule Deer and need for healthy habitat, travel management, and sustainable winter ranges. | 14 | immediate | no permit | medium |

*Table 13: Adaptation Actions for Serviceberry.*

| ADAPTATION OBJECTIVES | ADAPTATION STRATEGIES | ADAPTATION ACTIONS | PRIORITIZATION CRITERIA | | | |
|---|---|---|---|---|---|---|
| | | | Summary Score | Timeframe for Implementation (immediate > 3 years medium 3-5 years, long-term 5+ years) | Notes: Legal Feasibility | Notes: Cultural Significance |
| **Objective 1: Prepare for and limit the effects of more frequent or intense droughts and wildfires.** | SB-1: Use native species (particularly drought- and heat-tolerant ones) in post-disturbance restoration efforts. | Use traditional species mix including Service Berries for reseeding and restoration. | 20 | immediate | component EC | high |
| | SB-2: Maintain and enhance forest productivity regardless of tree species; focus on functional ecosystems and processes. | Manage species densities to maintain tree and bush (understory) vigor and growth potential. | 18 | immediate | requires EC | high |
| | SB-3: Support drought adapted and drought tollerant plants. | Identify and promote individual Service Berries that exhibit adaptation to water stress and collect seed for future regeneration. | not scored - technical feasibility unknown | medium | no permits | high |
| | | | | | | |
| **Objective 2: Create more forest openings and other suitable habitat for service berries.** | SB-4: Increase habitat connectivity. | Determine if a program supporting assisted migration of Service Berry is necessary; develop one if it is. | 19 | immediate | no permit | high |
| | | Increase extent of protected areas; collaborate with neighbors regarding priority areas for treatments (e.g., removing dispersal barriers) and land acquisitions. | 17 | medium | requires EC | medium |
| | | Acquire new tribal properties for conservation and, where possible, expand or adjust protected areas to incorporate greater diversity of topographic and climatic conditions to allow for shifts in species distributions in response to climate change. | 16 | medium | requires EC | medium |
| | | Prepare for species migration by managing for multiple species across large landscapes. | 16 | long-term | requires EC | medium |
| | SB-5: Enhance growth and productivity of Service Berries. | Implement thinning within anthropogenic openings to encourage understory shrub growth and maximize productivity. | 14 | long-term | requires EC | low |
| | | Where appropriate, use prescribed fire to promote more frequent and less intense fires that enhance Service Berry reestablishment. | 13 | long-term | requires EC | medium |
| | | | | | | |
| **Objective 3: Increase resilience to future changes by reducing existing stressors.** | SB-6: Reduce grazing and browsing pressure from cattle and other animals. | Create protected areas for service berry growth, removed or fenced off from cattle and range land. | 18 | medium | requires EC | high |

# 6.0 Resource Issues of Concern

The resource issues described in this section highlight significant questions about the future of important ecological processes in the Snake River basin that have sustained the Shoshone and Bannock peoples for centuries. This project was not able to fully explore every resource issue given time and budget constraints. However, by building on the Core Team's new knowledge of landscape level effects of climate change, it is possible for Tribal staff to develop specific adaptation strategies and actions for species or resources on or around the reservation. Tribal staff identified additional resource concerns, including mine reclamation, traditional medicines and foods, water storage, agricultural, and human health. Each of these resources are an important part of Tribal members' daily lives. This project focused on larger landscape level issues, so the following resource-related topics will require attention in future planning efforts by Tribal staff.

## *Gay Mine Restoration Site*

*Figure 14: Gay Mine Restoration Site.*

The Fort Hall Reservation is home to rich deposits of phosphorous, a key mineral used to develop agricultural products, interspersed among the rock formations along the eastern uplands. In the mid-twentieth century, the Shoshone-Bannock Tribes entered into mineral leasing agreements to mine those minerals with several companies. Mining activities lasted for approximately fifty years and the result of those mining activities remain present on the landscape today.

Climate change has the potential to increase the frequency of extreme events, including wildland fire, particularly in sagebrush steppe and grassland type habitats that are common throughout the Gay Mine site. Currently, the design for restoration includes populating the contours of reclaimed sites with shallow rooted grass for range production, likely increasing the vulnerability of these reclamation actions over the long term to wildfire. Further, there may be increases in disturbance due to more frequent wildfire and a higher risk of invasive species colonization. As a general strategy, future reclamation and site management plans should include plans for rapid response invasive species and wildfire mitigation measures to protect investments in restoration actions.

The Gay Mine site was mined over decades, often without the protections offered by contemporary environmental regulations, so reclamation efforts have included contouring the accessible parts of the mine area and leaving large pits or highwalls after mining was complete. Most soils in the area were already classified as moderate to highly erodible soils. With the removal of deep rooted shrubs like sagebrush and bitterbrush, the area became more susceptible to erosion. Tribal staff have observed significant erosion events in the past several years during extreme weather events throughout the mine site, with concerns about erosion running through the open pits and across the remaining high walls. Future planning for reclamation should characterize unconsolidated mine tailings for risk of contaminants into adjacent perennial watersheds and develop erosion or sediment control plans for the entire mine area.

## *Traditional Foods and Medicines*

Throughout the homeland of the Shoshone and Bannock peoples, climate change could influence established ecological processes that allowed native plants to flourish in the Snake River basin by allowing non-native invasive species to gain a foothold or expand throughout the region. While not directly assessed in this project, in many cases, the loss of native plants translates to the loss of traditional foods and medicines, an important component of tribal culture, spirituality, and community health. Often traditional foods and medicines are viewed holistically, with the consumption of the traditional food having a medicinal value for the person consuming it.

During the assessment process, several traditional foods were evaluated, including pinyon pine and serviceberry, which had sufficient quantitative data for inclusion in the CCVI based vulnerability assessment. One important species, *yampah,* did not have adequate literature to develop a quantitative ranking. A component of the landscape level planning for the native habitats described above was intended to develop an implementation framework for improving the sustainability and resiliency of all native plant communities within that habitat type. As an example, *yampah* (wild carrots) are typically found in riparian and/or wet meadow habitat that are influenced by the development of complex watersheds from beavers, instream structures, and adequate access to a floodplain during seasonal run-off.

From a qualitative perspective, developing low-risk implementation actions like exclosure fencing or stream rehabilitation improves the conditions that allow a traditional food/medicine like *yampah* to thrive. The purpose of developing a prioritization matrix for restoration actions that focuses on larger habitat types across the landscape is to value all species within the community and maximizes opportunities for sustainable harvest of traditional foods/medicines for the Tribal community. Implementation of landscape level efforts will be closely coordinated with staff and community members to improve their access to important resources and to develop restoration actions if conditions on the ground no longer support resources they once did due to anthropogenic modification or climate change.

## *Asthma*

Asthma is a non-curable chronic disease of the airways that affects the ability to breathe and can be controlled through medical management and avoidance of asthma triggers.[14] Some common asthma triggers related to climate include outdoor air pollution, pollen, mold, and smoke from wildfires or burning wood or grasses.[14] In the face of a changing climate, a central concern is that these conditions may become more common and cause additional respiratory impacts to tribal members with asthma.

Key climate change issues for asthma include:

- Increasing frequency or severity of wildfires (wildfire smoke can trigger or worsen asthma);
- Increasing summer temperatures and shifting precipitation patterns may increase drought conditions and related dust storms, which can trigger or worsen asthma; and
- Warming temperatures and shifting precipitation patterns may increase allergens that can trigger or worsen asthma.[14]

Asthma has high health costs due to hospitalizations, missed work or school days, and in severe cases, loss of life. The Centers for Disease Control and Prevention estimates that nationally, asthma is the fourth leading cause of work absenteeism and diminished work productivity for adults.[14]

Wildfire and Air Pollution

The most damaging component of wildfire smoke is particulate matter. The tiny size of the particulates means they can move directly into the bloodstream, allowing the body to interact with complex chemicals adhered to the particulates.[15] Particulates under 2.5µm in aerodynamic diameter ($PM_{2.5}$) are especially toxic because they can penetrate deeply into lung tissue, with lasting effects from a single exposure.

The observations and projections in this report point to continued summer warming, continued summer drying of plants and soils, and an extended wildfire season. These changes would likely increase regional particulate matter and both exacerbate and create asthma health effects in the local population. Along with fine particulates, wildfire smoke also contains the precursors to ozone ($O_3$). During warm summer days, these precursors can create ground level $O_3$, which is known to worsen asthma and other lung conditions.[16] Even without wildfires, ground-level $O_3$ and particulate matter are expected to increase with climate change.

Dust Pollution

As with wildfire smoke, the most health-damaging components of dust are particles under 2.5µm in aerodynamic diameter and up to 10µm in diameter ($PM_{10}$). Increase in this type of air pollution in Idaho is associated with increased healthcare treatment for acute upper and lower respiratory illnesses.[17] The observations and projections in this report point to continued summer warming, continued summer drying of plants and soils, and potential increased risk of dust storms.

Allergens

For asthmatics, whose asthma attacks are triggered by exposure to allergens such as pollen and molds, climate-driven increases in temperatures and shifting seasons has been shown to increase pollen production, circulation, and dispersion.[18] Projected climate changes are expected to contribute to increasing levels of some airborne allergens, with associated increases in asthma episodes and other allergic illnesses.[19]

### *Meadow Hay*

Meadow hay is an important component of livestock management on the Fort Hall Reservation, with the Fort Hall Bottoms comprising a significant source of feed for livestock throughout the winter months. Conditions in the Fort Hall Bottoms have been influenced by a variety of factors including: groundwater diversions, invasive species, and changing growing seasons. Hay meadows have recently experienced a decline in the quantity and quality of grass production due to drought conditions and a change from snow to a mix of rain and snow throughout the winter months.

Meadow hay did not receive an overall vulnerability ranking in this project as the CCVI tool is not designed for managed or cultivated species like the grasses meadow hay is derived from. This resource concern was assessed qualitatively for the reservation. The primary concerns for maintaining a sustainable yield of meadow hay are a lower water table throughout the Fort Hall Bottoms that limits water access for shallow rooted plants. The rise of noxious and invasive species has also directly affected the quality of this resource.

Warming temperatures are already directly affecting agricultural production[20] and changing precipitation patterns could further exacerbate these issues by leading to an increase in groundwater diversions above the Fort Hall Bottoms. Indirect impacts, such as increases in pests and pathogens due to warmer temperatures, are also of concern, because they affect crop timing, location, and productivity.[20] These have troubling implications for the nutrition of agricultural feed. As the EPA states:

> *Increases in atmospheric [carbon dioxide] $CO_2$ can increase the productivity of plants on which livestock feed. However, studies indicate that the quality of some of the forage found in pasturelands decreases with higher $CO_2$. As a result, cattle would need to eat more to get the same nutritional benefits.*[21]

In addition, with projected increases in summer temperature and declines in summer precipitation, there may be fewer grasses on which to graze while livestock are on reservation rangelands,[21] thereby increasing the need to grow meadow hay to support cattle ranching during critical winter months. Climate change models suggest that dryland agriculture in hay fields without irrigation could decline,[22] while irrigated hay fields could benefit from warmer temperatures, especially after mid-century.[23] This assumes that there will be enough water available to continue irrigation and that the Tribes would support an emphasis on livestock production over the sustainability of ecological processes in sensitive areas like the Fort Hall Bottoms.

Extreme events may pose the largest unknown risk to future crop productivity. The impact of events such as wildfires and the associated post-event impacts of weed proliferation, pests, and diseases, could significantly increase losses in agricultural productivity.[20] Future planning efforts should focus on building resilient and sustainable hay meadows in the Fort Hall Bottoms, while promoting conservation efforts to protect sensitive species that also utilize meadow habitats.

### *Water Storage*

One of the primary economic drivers for Southeast Idaho, and the Fort Hall Reservation, is the production of agricultural products like wheat and potatoes. This industry requires significant investments in water storage and delivery infrastructure to maintain a steady supply of contracted water and secure our Tribal reserved water rights. Many of the water storage projects were developed in the early decades of the twentieth century by the Bureau of Reclamation and may not be adequate for the projected impacts of climate change. The Tribes identified water project planning as a component of this assessment process, however there was not time to adequately address this issue quantitatively for adaptation planning purposes.

Fortunately, an alternate planning process is already underway through the Tribes' Water Resources Department to comprehensively evaluate the necessary infrastructure to ensure sustainable delivery of contracted water to agriculture producers. Generally speaking, total precipitation in the region is not expected to vary significantly from historic trends but the form (e.g., snow versus rain) of that precipitation will require a change in water management paradigms. From a broader perspective, the impacts to the region from a changing climate will focus on the shift from the current approach (large spring runoff events being stored in large reservoir systems) to managing facilities for rain driven events throughout the year. One issue that will require a more detailed planning effort is careful monitoring of groundwater resources, particularly those already showing strain from drought and groundwater withdrawals for agricultural purposes. Tribal staff will continue to coordinate with contractors to share the results of this assessment as the continual evaluation of water storage and delivery infrastructure for the Fort Hall Reservation is conducted. Discussions throughout this project about the contemporary water management system leads Tribal staff to believe that future efforts to promote water conservation efforts, improve delivery systems, and adjust system management will be necessary to have access to sustainable sources of water.

### *Reservoirs*

Tribal staff expressed concern about the impacts of climate change, specifically drought, on the reservoir systems, which are central to providing water to the region. As a result, the Water Resources Department staff were active participants in the discussions that occurred throughout this project. Due to the size and complexity of this hydrologic challenge, it is outside the scope of this climate vulnerability assessment and adaptation plan. However, a separate, comprehensive project is underway as of this report's publication (expected completion September 2017) investigating the impacts of drought on the region's water resources. The project is being completed by outside consultants in tandem with the Shoshone-Bannock Tribes' Water Resources Department and brings critical information to the Tribes about historical occurrences of and future projections of drought in the region. Further, drought scenario-based modeling of the region's capacity, incorporating streamflow and reservoir storage measurements, will be conducted to document the cultural, economic, and water resource effects of these droughts. Ideally, this project will support water use planning and climate resilience efforts for high risk areas. This effort to plan for drought impacts on reservoirs can be incorporated into planning efforts and other climate adaptation actions described in this plan.

### *Cattle*

Tribal cattle producers and the Tribes' Range Program report that cattle are not gaining weight on reservation rangeland like they have in the past. Cattle are losing weight during drought events and are having difficulty finding nutritious foods on rangeland as native plant abundance decreases and noxious weeds become more prevalent. Wildfires also diminish the availability of nutritious feed on the landscape. Significant disturbances frequently increase the prevalence of annual grasses across the burned area. Drought conditions and the reduction, or disappearance, of water flows from some springs have forced cattle owners to use alternative water supplies for their cattle. Shifts in the timing of grass growth has also decreased the effectiveness of rangeland management, as the traditional synchronization of grass yield and cattle access is becoming less reliable. Cattle prefer wet-meadow areas of the landscape, but their presence there, without appropriate protections to sensitive habitats, can have negative repercussions on water quality and water availability that ultimately impact the cattle themselves. In many instances, ranchers are just barely turning a profit, making them highly sensitive to changes in their herd's health and weight.

Cattle as a species did not receive an overall vulnerability ranking in this project, as the CCVI tool is not designed for domesticated species. The climate change vulnerability of cattle was therefore investigated qualitatively. Climate change effects on cattle and ranching include the decreasing reliability of water supplies, increasing risk of wildfire in rangelands, increasing heat stress on cattle, potential increases in disease and pathogens, and the reduced quality of feed. Collectively, these impacts can have economic implications for Tribal producers by increasing the time and resources required to access quality rangelands and reach finish weights. These changes could also decrease leasing revenue for individual Tribal allottees.

Increasing summer temperatures, more extreme heat events, and the potential for increases in pathogens and parasites are climate change-related factors that directly influence cattle's physiological health. High temperatures (particularly heat events that occur in spring and early summer when cattle are less acclimated to heat)[24] can increase the risk of heat stress. Heat stress results in higher respiration rates, increasing body temperature, reduced food intake, and reduced performance.[25] Mortality can occur with more severe heat events, such as those that last three or more days.[24] Cattle at higher risk of heat stress include: newly arrived cattle that may have already been stressed by weaning, processing, or transportation; finished or nearly finished cattle, especially heifers; cattle that have been sick in the past and may have some preexisting lung damage; black or very dark-hided cattle; heavy bred cows that will calve sometime during the summer; older cows; and cattle which may be thin due to inadequate nutrition.[26]

Night-time cooling and access to shade, water, and active cooling (e.g., spray cooling) are important tools for limiting the effects of heat events on cattle. Warmer seasonal temperatures may also increase the survivability of pathogens and parasites by creating conditions more favorable to their reproduction, survival, and transmission. This includes diseases transmitted between livestock, as well as transmission of diseases between wild species and livestock. Climate change may facilitate these transmissions by altering wild animal distribution, movement, and feeding patterns.[27]

### *Rangelands*

In addition to direct impacts on cattle physiology, climate change will affect cattle and ranching practices through impacts to rangelands. These impacts include decreases in sagebrush steppe habitat utilized as rangeland across the Snake River basin. Climate changes that directly affect rangeland include a lengthening of the growing season, changes in plant productivity, shifts in rangeland species, reduced nutritional value of rangelands, the potential spread of invasive species, and increases in wildfire risk.

Projected changes in plant productivity and distribution vary with temperature, elevation, and carbon dioxide levels. Increasing temperatures, declining snowpack, and earlier snowmelt are expected to lead to earlier spring greening and a lengthening of the growing season, particularly in cooler, higher elevation rangelands.[27] These changes may also allow for migration of rangeland plant communities to higher elevations.[27]

In contrast to cooler locations, productivity in warmer, lower elevation rangelands may decline. A key issue in these lower elevation rangelands is increasing summer drought stress, which is expected to reduce the reproductive viability of native perennials.[27] Over-grazing and increasing fire frequency (whether due to climate change or fire management practices) can also affect productivity and lead to shifts in rangeland species.[28]

Some plant species (including some species of weeds) may benefit from higher levels of carbon dioxide in the atmosphere, which can stimulate plant productivity through increased efficiencies in photosynthesis and water use.[27] Annual grasses, like cheatgrass, are most likely to benefit from the higher atmospheric carbon dioxide concentrations and varying precipitation regimes due to their growth cycle. The proliferation of annual grasses across the Fort Hall Reservation continues to be a concern for natural resource managers and livestock producers because it is fundamentally changing the forage base for these animals.

# 7.0 Conclusions

The natural resources of the region are intimately intertwined with the lifeways and wellbeing of the Shoshone-Bannock Tribes. Yet, these critically important resources are already being affected by changing climate conditions and these changes not only affect the species and habitats that are important to the Tribes, but the people themselves.

By acknowledging, researching, and ultimately working to address the many ways that climate change will affect the Tribes, the Shoshone-Bannock Tribes have taken a significant step toward becoming more resilient. This climate change vulnerability assessment and adaptation plan is the first step in an on-going process to continue to respond to and prepare for the impacts of a changing climate. It serves a foundation for future efforts and the Tribes. The adaptation strategies and actions collaboratively developed through this project are a starting point and provide a framework for the development of additional strategies and actions for other important species and habitats that the Tribes depend on throughout the region.

Key next steps will include integrating specific adaptation strategies and actions into on-going planning and management efforts as well as regular monitoring and evaluation of the effectiveness of action to build resilience. This project and the on-going efforts and commitment by the Tribes to work together to build climate resilience will ensure that these and many other culturally significant natural resources are preserved for generations to come.

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