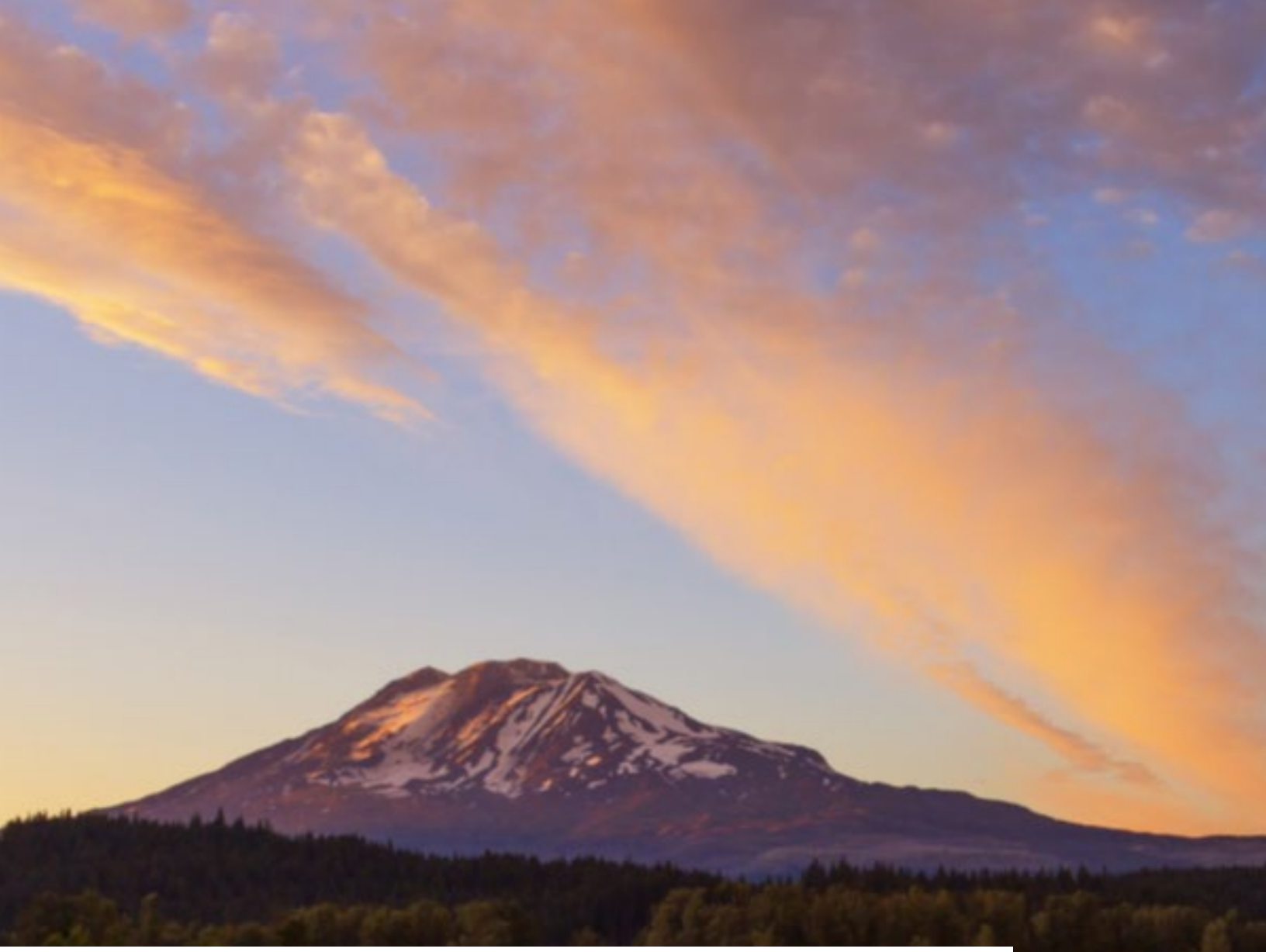

CLIMATE ACTION PLAN

for the Territories of the
Yakama Nation

APRIL 2019

Climate Action Plan for the Territories of the Yakama Nation

This Climate Action Plan was written primarily by Yakama Nation staff with research, writing, and facilitation support from

Cascadia Consulting Group, Inc.

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SAH Ecologia LLC
University of Washington - Climate Impacts Group
U.S. Forest Service, Pacific Northwest Research Station
Washington Department of Fish and Wildlife
Conservation Science Partners
Utah State University
BioAnalysts, Inc.
ICF

DEDICATION TO OUR CHILDREN

Our Yakama People came after everything the Creator made as we know it—the earth, water, foods, medicines, trees, and plants.

He made the animals and gave them their place here.

From that time on, we knew where these blessings came from and we gave thanks to the Creator for all of nature and the elements that took care of them—the rain, snow, sun, moon, stars, wind, and earth!

It is this belief, prayer, and following of our sacred ceremonies that have created a close relationship with these things, and they tell us when things are not right—not of this earth or the elements, but us as humans!

This Climate Action Plan is dedicated to you—our children—and to your children, and to all generations of Yakama to follow. Our elders, leaders, community, and staff have gathered this information and present it here today. We hope this knowledge will help our people understand what it will mean to be subject to climate change.

Using this knowledge, we must begin preparations to maintain our community and our natural resources. We must carry forward our culture and traditions for our tribes' future and for your own families' well-being.

For many generations, you will be challenged with a changing climate. But always remember, since time immemorial, we have looked to our elders for their wisdom and guidance, and within our children we will always see hope.

"Shxmyah" aka Edwin "Arlen" Washines

Yakama

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TRIBAL COUNCIL PROCLAMATION

Our climate is changing. The effects of climate change are being noticed by our own people. These changes, coupled with the rapid growth of cities; dams across our rivers; and unsustainable forestry, rangeland, and agricultural practices throughout our homelands, have drastically altered our traditional way of life, our foods, and many aspects of our culture. From the vast and growing body of information now available concerning climate change, we understand that its impacts on our people will continue and that our grandchildren will likely see profound and ever-increasing changes within their lifetimes.

The Yakama Nation is strong, and our strength is growing. We will continue to blend our traditional knowledge with newer innovations to honor, protect, enhance, and restore our many cultural resources. We will continue to thrive amidst an ever-changing world.

The issues in front of us are not unique to just the Yakama Nation but can be seen across all Indian nations. Although we find ourselves with an uncertain future, it is not a time to lament. We will work with other tribes and governments, and we will learn together. We must continue to make adjustments, as we have done since time immemorial on these lands which have always been our home.

We cannot know and anticipate at this time all of the changes to come—but we can start. Contained within these pages is the Climate Action Plan for the Territories of the Yakama Nation. This Plan provides a strong foundation for our next steps and sets them into motion. This Plan is more than just words and pictures. It describes much of our understanding of potential climate change impacts and establishes recommendations now, and into the future, for our tribal leadership to consider and for our tribal programs to implement. It is far from complete. We will continue to build from this initial work. Our actions are not an option—they are an obligation to our Creator and to our children.

The Yakama Nation Tribal Council directs all of our community and natural resource programs to continue to carefully assess future vulnerabilities and risks, many of which have been identified in this Climate Action Plan. And from our growing knowledge, to identify and implement actions that will build resilience and durability within these resources for generations to come. These considerations and actions go beyond our reservation lands and include all the territories of the Yakama Nation.

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OVERVIEW

The Yakama Nation set into motion a process to conduct a climate change vulnerability assessment and develop an action plan. Tribal staff and members have worked to better understand the projected climate change impacts that could affect the reservation, evaluate the existing and emerging challenges to natural and community resources in light of those impacts, and identify practical actions that could be taken to increase our resilience.

HOW IS OUR CLIMATE CHANGING?[1]

Changes in the regional climate that we have already observed include the following:

- **Average annual temperatures** in the Pacific Northwest increased by 1.3°F since 1895, and in 2015, the city of Yakima experienced its warmest June ever. This trend continues.
- **The growing season** has gotten longer, and there are fewer days with frost during spring and fall months.
- **Nearly all of the glaciers** in Washington State have retreated over the last century.
- **Peak streamflows** are happening earlier in the year in many locations, with runoff from snowmelt happening two to three weeks earlier than it did historically in many Pacific Northwest streams. Meanwhile, late summer streamflows are declining.
- **Our roots are emerging earlier** in the year and the salmon runs are changing.

Projected changes in the Yakima Basin and broader region include the following:

- **Daily high temperatures** in the Yakima Basin during July are expected to be 5.4°F to 7.7°F warmer by mid-century compared to the 1981-2010 average, with our hottest summer days reaching higher temperatures than what we have known in the past.
- **Average annual precipitation** is expected to increase slightly, but more precipitation will come in the winter and in heavier downpours. As a temperature-sensitive system, the Yakima Basin and much of our territories will experience less snow and more rain.
- **Streamflow** is expected to increase during the winter and decrease during the summer, with peak streamflows occurring four to nine weeks earlier by the 2080s.
- **Snowpack** in the Cascades is likely to continue declining, leading to a potential decrease of 30 percent by the 2020s and over 40 percent by the 2040s.

[1] Reported climate change impacts are based on science-backed research from the University of Washington Climate Impacts Group, U.S. Forest Service Pacific Northwest Research Station, and other institutions and partners. Sources are provided in each of the main sections on specific impacts on cultural resources.

HOW MIGHT OUR RESOURCES BE IMPACTED?

The following summarizes the vulnerability of our cultural resources to climate change impacts based on the assessment conducted by tribal staff, regional experts, and resource agencies.

Water: Demand for water is projected to increase with population growth, drier conditions, and higher temperatures. Water resources will become more vulnerable with a change from a snow-dominated to rain-dominated system and with minimal potential for deep aquifer recharge. Water conservation actions and irrigation efficiency upgrades may mitigate some impacts, but funding these substantial issues will be a challenge.

Forests: More severe fires burning a larger area is the greatest risk to forest resources. At low elevations, less moisture in the soil may limit tree growth, and shrub-steppe encroachment threatens forest habitat. Upper and mid-elevations are at risk of insect damage as increasing temperatures will support populations. Drought can stress trees, making them more vulnerable to insect and disease damage. However, some tree and forest species may benefit from warmer temperatures, if sufficient water is available.

Farmlands: Crops and the irrigation system are highly vulnerable to water limitations and drought. Temperature changes will limit which crops can be grown, may exacerbate pest impacts, and may contribute to invasive species becoming an issue in the future. There is potential for crop transition and diversification as an adaptive action, and irrigation system improvements will further support resilience.

Shrub-Steppe and Rangelands: Rangelands will be somewhat affected by drought, and they are vulnerable to increased fire disturbance and invasive species, both of which are difficult to adapt to. Under future conditions, there may be a transition from a native landscape to a different baseline, potentially with a shift or loss of roots, herbs, plants and other naturally occurring resources in some areas.

Roads and Transportation: With climate change, some changes will improve conditions for roads (e.g., less snow and ice), while others will worsen conditions (e.g., flooding, extreme heat days), but uncertainty remains about the degree of changes and impacts. Drier conditions and heat waves may require higher-performing materials and more frequent maintenance, both of which can increase costs.

Facilities: Many facilities are not exposed to heat, fire, or flood impacts, and all facilities with daily human use have air conditioning. Some buildings are older and most heating/cooling systems are nearing the end of their life. The tribe is retrofitting and upgrading facilities and

has funding to continue doing so. There is significant potential in providing emergency shelters/cooling centers for the tribal community.

Housing: Increased temperatures may not be a challenge, as all Yakama Nation Housing Authority facilities have air conditioning and recently upgraded electrical panels. Most housing parks are not prone to flooding, wildfires, or landslides. However, there are no existing emergency plans or back-up energy generation capacity, which introduces vulnerability to climate impacts and elevated temperatures. Limited funding to continue modernizing these facilities remains a challenge.

Air Quality: Drier and warmer conditions in the future are likely to increase the occurrence of dust storms and large forest fires, lowering air quality especially within reservation lands. There has been an increase in asthma and pollen allergies, which may continue into the future. There is short-term flexibility among the outdoor workforce to work indoors, but this capacity is limited in the long-term. Indoor air quality is being addressed with a funded program in development.

Emergency Services: Current emergency and health facilities and services are sufficient for existing and many emerging risks (e.g., more heat stroke, damage from environmental hazards). Policies and practices are currently in place to handle crises (e.g., health alerts, event cancellations), but communications are limited in closed area.

Floodplains, Rivers, and Fish: Projected increases in air temperature will also increase stream temperatures to levels that will be unhealthy for cool water fish, like lamprey, salmon, and trout. These temperatures may also promote population growth of warmer water fish like bass and Northern pikeminnow, which will compete with and prey on salmonids. Lower summer streamflows will stress riparian and floodplain vegetation in some areas.

Wildlife and Vegetation: Wildlife species that are confined to specific areas, like the pika in the higher mountains or salamanders within some wetlands, will be more vulnerable habitats are degraded or destroyed. Other migratory species may have a harder time moving if migration corridors or seasonal habitats (vegetation communities) are significantly altered. Many wildlife species are already severely disrupted and stressed by human encroachment or causes unrelated to climate change. Climate change will likely be another compounding element to their complex habitats and life histories.

The goal of this Yakama Nation Climate Action Plan is to honor, protect, enhance, and restore all human and natural resources that support historical, cultural, spiritual, and economic practices of the tribes. We will emphasize strategies that promote healthy communities, ecologies, and river systems to achieve this goal. We will protect tribal sovereignty and treaty rights and reclaim the precious resources and the environment on which they depend for our future generations.

WHAT STEPS CAN WE TAKE TO BE MORE CLIMATE RESILIENT?

In the climate action planning process, Yakama Nation staff identified strategies and actions to increase the resilience of each community and natural resource. The actions each fall under one of the following overarching objectives:

- **Implement on-site actions** to protect and improve resilience of our water, land, air, natural, cultural, and human resources.
- **Preserve and use traditional knowledge** and maintain active policy development, long-term planning, and appropriate enforcement of regulations to ensure effective adaptive management.
- **Encourage research, monitoring, and technical assessments** to understand our challenges and measure our progress.
- **Support outreach and education** for our children, communities, and governmental bodies.

1.0 INTRODUCTION

Climate change will affect all people of the Yakama Nation. More so, it will affect our children and all future generations. For this reason, the Yakama Nation Tribal Council has directed development of this Climate Action Plan. This document will help all of us better understand the specific threats that a changing climate will bring to our nation. As we learn more, our new knowledge will be included into this ever-changing story. More importantly, the Climate Action Plan will focus the light of our knowledge and guide our efforts towards the actions that are needed to protect and enhance our cultural resources, keeping them abundant and resilient to the forecasted changes for generations to come.

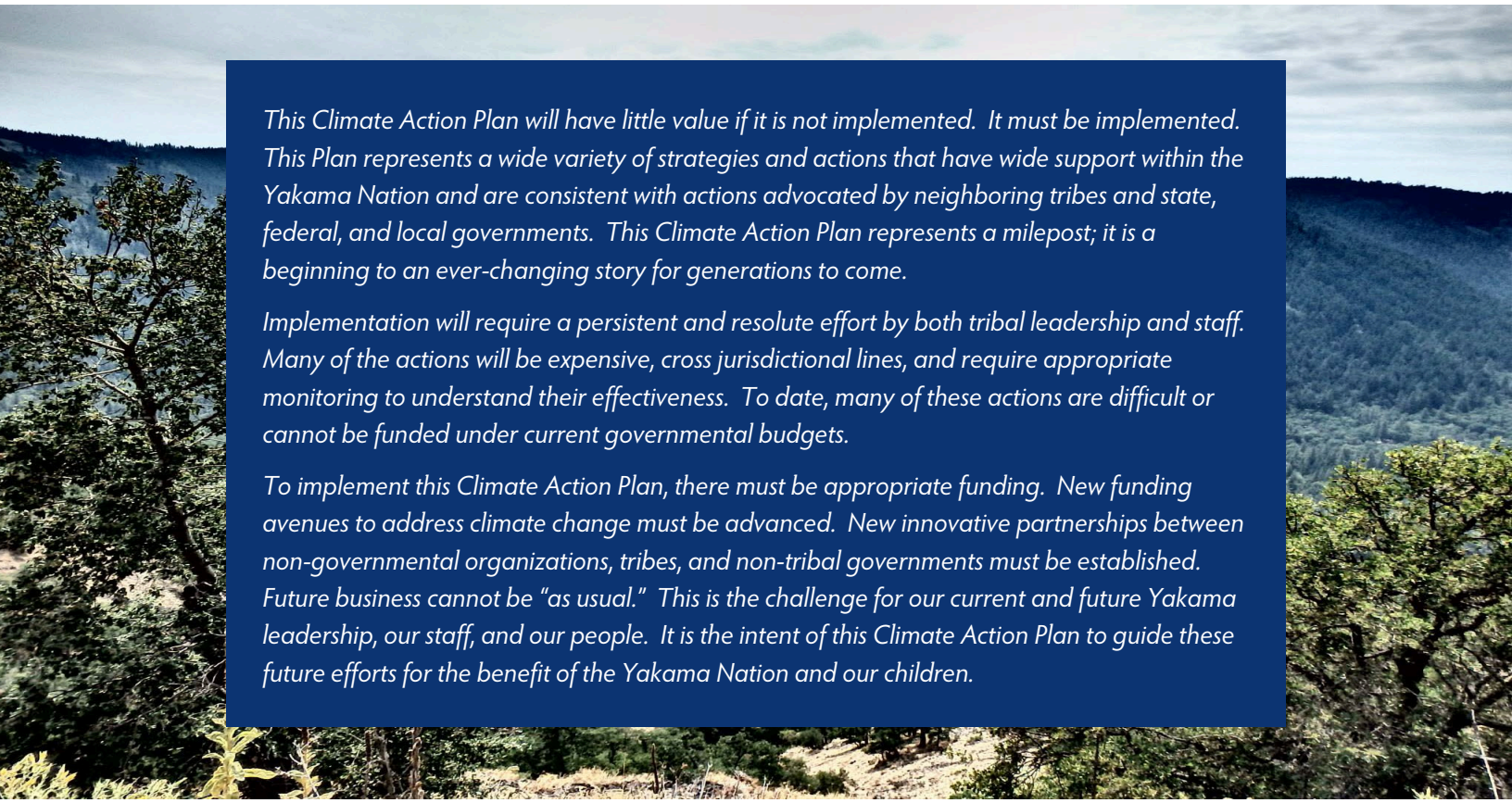
This Climate Action Plan contains five sections; each section is distinct from the others yet provides the foundation of our understanding and the path forward. The reader is reminded that each of these sections captures our understanding today. With the passing years, we will learn more. Periodically, each of these sections will be updated to reflect new learning and advocate for additional actions throughout our reservation and territories. The five sections are summarized below:

1. **Introduction:** Section 1 provides important information about who we are and how we are approaching the challenges of a changing climate. It reminds the reader of our long history on this land and our relationship with it. It also clarifies the purpose and goals of this document and lays out the underlying principles from which it is built. Importantly, Section 1 reminds the federal government of its special relationship with the Yakama Nation through the Treaty of 1855 and its fiduciary obligation to protect our cultural resources and to appropriately address climate change. The section concludes with a short summary of our planning process, providing context to the Cultural Resources Action Plans, which identify strategies to increase climate resilience for each of the resource sectors covered in this Climate Action Plan. The Cultural Resources Action Plans are included in Section 4.
2. **Anticipated Climate Impacts:** Section 2 provides a general understanding of what climate change is and anticipates the potential impacts on the cultural resources important to the Yakama Nation. Section 2 does not provide technical detail about why climate change is happening or information about modeling forecasts and global concerns. Many other useful documents are available and contain that information. These details do not need to be repeated here. Rather, the Climate Action Plan summarizes relevant findings from these documents, providing the background for proposed actions useful to the Yakama Nation.
3. **Cultural Resources Vulnerability Assessment:** Section 3 evaluates the cultural resources primarily within the Reserved Lands of the Yakama Nation, but in many cases relevant throughout the territories of the Yakama Nation. This evaluation focuses on resources identified as having a high potential for vulnerability to the consequences of climate change. We start with water, emphasizing the importance of water to the Yakama Nation and to all living things. From water, all other resources exist. For the benefit of organization, we identify three other general resource categories: 1) Infrastructure and Agriculture, 2) Health and Public Safety,

and 3) Lands and Natural Resources. Each of the resources within these categories are evaluated independently.

4. **Cultural Resources Action Plan:** Section 4 provides the outcomes from our assessments. This section describes general strategies and site-specific actions that can be implemented for each resource sector to continue protecting our cultural resources and increase resilience to climate change. This section is intended to be updated frequently to reflect additional actions that each of the different Yakama Nation resource programs may identify through our adaptive management processes.

5. **Technical Appendices:** Section 5 provides the scientific backdrop of the information contained in Sections 2 through 4. Our assessments are based upon the best available science and insights from our Yakama Nation staff, as well as professionals representing other governmental and non-governmental agencies. Section 5 provides the technical background which led to our conclusions about vulnerability, our concerns for our cultural resources, and the actions necessary to address these threats. The Technical Appendices will be updated, as needed, to support findings throughout the Climate Action Plan. Due to the extensive amount of information in the Appendices and the continuing changes and improvements of these technical documents, Section 5 is only available electronically online.



This Climate Action Plan will have little value if it is not implemented. It must be implemented. This Plan represents a wide variety of strategies and actions that have wide support within the Yakama Nation and are consistent with actions advocated by neighboring tribes and state, federal, and local governments. This Climate Action Plan represents a milepost; it is a beginning to an ever-changing story for generations to come.

Implementation will require a persistent and resolute effort by both tribal leadership and staff. Many of the actions will be expensive, cross jurisdictional lines, and require appropriate monitoring to understand their effectiveness. To date, many of these actions are difficult or cannot be funded under current governmental budgets.

To implement this Climate Action Plan, there must be appropriate funding. New funding avenues to address climate change must be advanced. New innovative partnerships between non-governmental organizations, tribes, and non-tribal governments must be established. Future business cannot be "as usual." This is the challenge for our current and future Yakama leadership, our staff, and our people. It is the intent of this Climate Action Plan to guide these future efforts for the benefit of the Yakama Nation and our children.

1.1 People of the Yakama Nation

> *All this for future generations yet unborn according to teachings by our elders.*

The Confederated Tribes and Bands of the Yakama Nation are a diverse people from many areas. We are the Kah-miltpah, Oche-Chotes, Palouse, Wenatchapam, Klickitat, Pesquose, See-ap-Cat, Yakama, Klinquit, Shyiks, Sk'in-pah, Kow-was-say-ee, Li-ay-was, and Wish-ham. Our tribes are strong and resilient people. For generations before the rise of the modern world, the lands of the Yakama extended in all directions. We used the entire land base, from the lands surrounding the Columbia River into and over the snow-peaked Cascade Mountains to the Pacific Ocean. We held our land as a trust given by the Creator for the use of the living and as a heritage to hold and protect for unborn generations. We will continue to flourish on our homelands for countless generations.

The Yakama people spent the coldest months in winter villages generally located on the valley floor, places with a relatively moderate climate. These areas provided a reliable source of wood and water and protection from cold winds. Villages were located on or near waterways, in places where a variety of resources could be obtained, including deer, elk, fish, and riparian and desert plants.

In the springtime, as soon as the first edible greens appeared above the ground, tribal people began moving across the countryside in search of fresh food resources. The people followed the melting snows upland and collected edible roots as they matured. Some tribal people would go to the rivers to fish. Others would remain in the mountains, following the maturing plants upslope until the huckleberry harvest in the fall. At that time, foods would be either stored or transported back to the winter village from both the mountains and the rivers, and people would settle in, once more living on stored foods and occasional fresh meat until the following spring.

Today, the reservation lands of the Yakama Nation are located within the Yakima River basin. The territories of the Yakama Nation—which consist of lands ceded by the Yakama Nation and all of the usual and accustomed areas where we fish, hunt, and gather foods and our medicines—extend well beyond the reservation boundaries. Much of the territories are all interconnected by Nch'i-Wana, the Big River, but they extend well beyond this river. Upriver, to the north, are the Methow, the Entiat, and the Wenatchee basins which drain the east slopes of the northern Cascade Mountains. Lower portions of Crab Creek

and the Snake River come in from the east. The territories continue downstream to Rock Creek, the Klickitat River, and the White Salmon, Little White Salmon, and Wind Rivers and then extend to the Washougal, Lewis, and Cowlitz basins. Although much of the focus of this initial Climate Action Plan is on the Yakima River basin and our reserved lands, the whole of the territories is contained within this document and within our long-term vision, as they are all important to the well-being of our people.

1.2 Purpose

Since time immemorial, the people of the Confederated Tribes and Bands of the Yakama Nation have lived on these lands and cared for the natural resources we share.

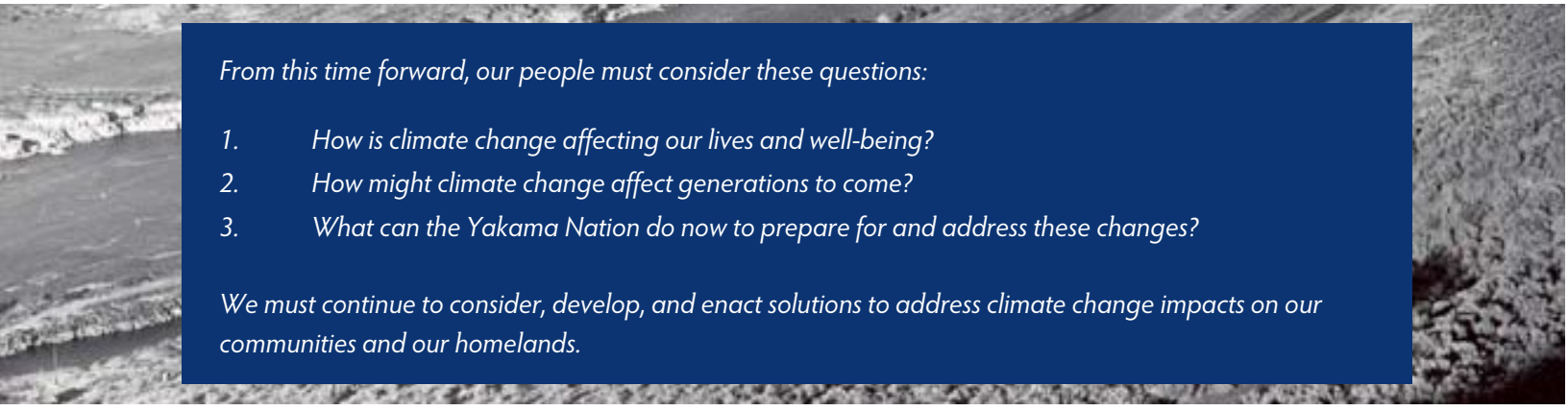
Our ancestors' spirits live on and guide us. They live through our traditions and our religion, handed down from one generation to the next. Our traditional knowledge and cultural practices reflect the natural cycles of our earth and reaffirm what we have learned from long-past elders.

Climate change is real and, unfortunately, the effects are in motion. We are witnessing changes in the seasons. Our roots and berries must be gathered sooner, and salmon returns are less predictable. Our people notice less snow in the mountains, and there is less cool water during the summer when it was once abundant. The changes we see may not bode well for our future. Over the years to come, we may lose natural resources that are important to our culture and our heritage. Some of these losses may be irreversible.

> *"Climate change affects our everyday life because we are connected to all of these natural resources. What affects them affects us." – Russel Jim*

The purpose of this Climate Action Plan is to (1) inform the people of the Yakama Nation of the threats that climate change brings upon us and (2) to implement substantive and directed actions that increase the resilience of all culturally important resources throughout all of the territories of the Yakama Nation.

This Action Plan is an important step for the Yakama Nation, helping us prepare for an uncertain future where a rapidly changing climate will disrupt long-held traditional cycles. It represents an ongoing collective effort by our governmental programs to identify (1) important resources and cultural components most likely to be impacted by climate change, (2) vulnerabilities of these resources to existing and emerging threats, (3) our current efforts to reduce detrimental impacts from climate change, and (4) other needed actions to increase resiliency. It establishes a framework for meaningful conversation between tribal leadership, tribal programs, and tribal members as well as collaboration with our federal, state, and other tribal partners.



From this time forward, our people must consider these questions:

1. *How is climate change affecting our lives and well-being?*
2. *How might climate change affect generations to come?*
3. *What can the Yakama Nation do now to prepare for and address these changes?*

We must continue to consider, develop, and enact solutions to address climate change impacts on our communities and our homelands.

1.3 Principles Guiding our Planning and Actions

Over the past decades a growing understanding of the importance of ecological systems and the services they provide have produced a variety of national and local laws and regulations. In a broad sense, this regulatory system is based upon a number of principles or assumptions that may no longer be true or reliable. As we consider our future, as with federal and state governments, it is important to describe the principles of our understanding and intentions so that we can better make sense of the solutions we are seeking.[2]

For example, current environmental and natural resource law assumes:

- Baseline conditions of various ecosystems are generally stationary.
- The basic idea of natural resource management is the preservation and/or restoration of ecosystems or species.
- Our management actions for habitats or species are generally predictable.
- Many environmental changes are reversible, can be managed, or can be mitigated.

However, with climate change, there may be a completely different perspective to consider. There remains great uncertainty, but our science seems to be suggesting new realities, such that:

- Baseline ecological conditions—even the very fabric of the ecosystem—may not remain stationary but are likely to change.
- Boundaries surrounding ecosystems will shift and, in some cases, systems will be lost.
- Many of these changes are presently unpredictable and may happen at an accelerated rate of change.

Given the above, the Yakama Nation Climate Action Plan recognizes a framework of consistent principles towards the implementation of our strategies and actions rather than working within a fixed regulatory solution. The Five Principles listed below (1) distinguish climate change impacts from other anthropogenic impacts and (2) strive to improve resilience and adaptive capacity in all our human and natural systems.

The impacts of climate change are being noticed by our people today, and our grandchildren will likely see profound effects upon our communities and our way of life.

We cannot know and anticipate all changes at this time, but we can prepare.

Together, we must look ahead and blend our traditional knowledge and cultural insights with newer innovations to create a future where the Yakama Nation will continue to thrive despite the changing climate.

[2] Section 1.3 is adapted from Robin K. Craig, "Stationary is Dead—Long Live Transformation," *Harvard Environmental Law Review* 34, no. 1 (2010).

FIVE PRINCIPLES FOR ADDRESSING CLIMATE CHANGE

Principle #1: Monitor and track everything all the time.

- We have very little idea what the exact climate change impacts will be, especially at the local level. We must understand (1) what changes are happening and (2) the rate of change.
- New laws can be written to replace bad laws. Law can and should promote the implementation of actions and related monitoring and research to guide large-scale and systematic learning to support adaptive management.

Principle #2: Eliminate or reduce stresses unrelated to climate change and promote resilience.

- Decontaminate land, air, and water and reduce new pollution as much as possible.
- Set more conservative, science-based sustainable harvest thresholds rather than taking the maximum amount possible.
- Get incentives right. Incorporate ecological services into economic considerations.
- Preserve and expand open space and ecosystem connectivity.

Principle #3: Plan for the long term with increased coordination.

- Avoid potential conflicts between human and species, ecosystem adaptation, and interactions between people and the environment.
- Incorporate climate change into all levels of planning.
- Consider a range of long-term futures.
- Increase policy, regulatory, and technical coordination across governmental bodies.
- Give meaningful weight to public rights in both public and private property.

Principle #4: Promote *principled flexibility* in goals and natural resource management.

- Maintain principles but change laws to allow flexibility in the face of changing conditions.
- Be serious about using adaptive management and change the laws to accommodate.
- Prefer “no regrets” options.
- Engage in robust decision-making that employs broad considerations and transparency.

Principle #5: Accept that climate change may be painful.

- Species may be lost, and ecosystems will transition.
- Difficult decisions will have to be made.
- A way to prioritize actions for social-ecological systems may be necessary.

1.4 Our Goal

Generations before the advance of the modern world, the lands of the Yakama extended in all directions along the Cascade Mountain Range to the Columbia River and beyond. We considered it land given in trust by the Creator for the use of our people and a heritage to be held and protected for unborn generations.

The goal of this Yakama Nation Climate Action Plan is to honor, protect, enhance, and restore all human and natural resources that support historical, cultural, spiritual, and economic practices of the tribes. We will emphasize strategies that promote healthy communities, ecologies, and river systems to achieve this goal. We will protect tribal sovereignty and treaty rights and reclaim the precious resources and the environment on which they depend for our future generations.

SPECIFIC GOALS FOR OUR RESOURCES

The following goals associated with climate change are identified for the cultural resources assessed in this Climate Action Plan:

- **Water:** There will be a secure, healthy, and sustainable supply of clean water for the beneficial uses of all cultural resources despite climate change impacts.
- **Roads and Transportation:** Tribal members will be able to travel safely and reliably to their destinations, and the Yakama Nation will be able to adequately, affordably, and sustainably construct and maintain roads within their purview in the context of a changing climate.
- **Facilities:** Tribal facilities will provide safe and comfortable places for community members to work, recreate, and take shelter during times of crisis, despite climate change.
- **Housing:** Tribal members will feel comfortable and safe in their homes despite future effects from climate change.
- **Farmlands:** Farmlands will be managed using practices and resources sustainably to grow crops that are resilient to a changing climate. Farmlands will provide a source of income for tribal landowners into the future.
- **Air Quality:** The air that we breathe will be clean and free of excessive smoke and other pollutants that come from the impacts of climate change.
- **Emergency Services:** Tribal members will have reliable access to health services and facilities for ongoing and emergency care to support their physical and mental well-being in the face of climate change impacts.
- **Forests:** Forest management will enhance and maintain a diversity of forest conditions, maintain sustainable production of commercial and noncommercial resources, and thereby maintain the forest resource as a dependable source of spiritual renewal, food and medicinal plants, revenue, and employment for the Yakama people in the context of climate change.

- **Shrub-Steppe and Rangelands:** Tribal members will have rangelands and use resources sustainably in the context of a changing climate to support culturally important foods and medicines and livestock production.
- **Floodplains, Rivers, and Fish:** Management of floodplain and riverine habitats throughout the territories of the Yakama Nation will enhance and maintain a diversity of environmental conditions, maintain sustainable use of these resources, and thereby maintain these resources as a dependable source of spiritual renewal, cultural practices, food and medicinal plants, revenue, and employment for the Yakama people.
- **Wildlife and Vegetation**: Management of wildlife and their habitats throughout the territories of the Yakama Nation will enhance and maintain a diversity of environmental conditions, maintain sustainable use of these resources, and thereby maintain these resources as a dependable source of spiritual renewal, cultural practices, food and medicinal plants, revenue, and employment for the Yakama people.

1.5 Relationship of this Plan to the Federal Government[3]

In 1855, the Yakama Nation negotiated a treaty with the United States that reserved the right to maintain our culture and the natural resources on which our culture depends—including, but not limited to, rights to water, land, natural foods, and medicines. We retain the right to continue our fishing practices and to continue our rights for hunting, gathering, and pasturing in our usual and accustom places, which include those places outside of the reservation and the ceded lands.

The right of the tribe is to govern our members and manage our territories and resources, which flows from our tribal sovereignty as recognized by treaty. The fact that treaties were made with Indian tribes reflects the United States' recognition of tribal sovereignty. The Supreme Court has described tribal governmental powers as "inherent powers of a limited sovereignty which have never been extinguished." The tribes' status as one of the three sovereigns (the other two are the states and the United States) is recognized in the Constitution and has been upheld by the courts since the early years of the Republic.

The United States has a trust and fiduciary responsibility to the Yakama Nation. The trust relationship is a legal doctrine which embodies the many promises made by the federal government to Indian tribes. Because the trust doctrine permeates every aspect of the federal government's relations with the Yakama Nation, the United States' trust obligations extend to all federal agencies. All federal actions and the implementation of federal statutory schemes affecting Indian people, land, or resources must be "judged by the most exacting fiduciary standards" according to the Supreme Court.

Our salmon, wildlife, and plants are our medicines and our spiritual and cultural identity.

The Creator put us here where these resources are and the salmon return. We are obligated to remain and protect this place.

These resources have been our primary food sources for thousands of years and continue to be the essential aspect of our nutritional health.

Historically, we were wealthy people because of a flourishing trade economy based upon many of these resources.

The salmon and many others are indicator species: as water and our lands become degraded, so too will we witness declines in the fish, elk, deer, roots, berries, and medicines that sustain us.

Because our tribal population is growing, the needs for these resources are more important than ever.

Without these resources and the salmon returning to our streams and rivers, we would cease to be Indian people.

[3] In Section 1.5, quoted text is borrowed, and the remaining content is adapted, from *Spirit of the Salmon: Wy-Kan-Ush-Mi Wa-Kish-Wit*, published by the Columbia River Inter-tribal Fish Commission [31].

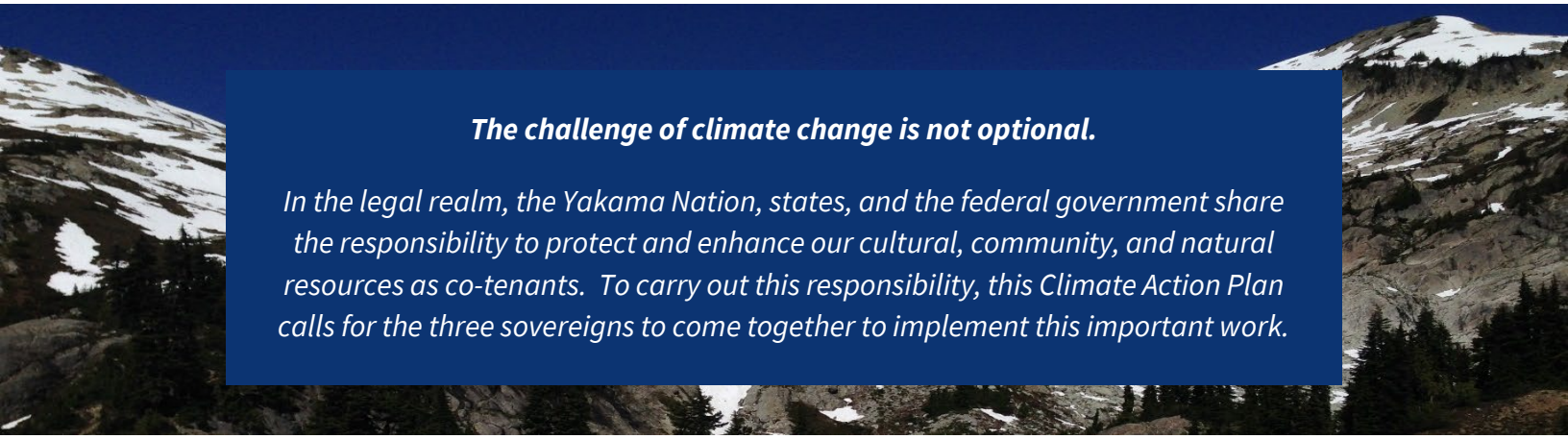
Kamiakin, Head Chief of the Yakama c. 1800-1878

Thus, the federal government and its implementing agencies owe an affirmative duty to use their expertise and authority—in meaningful consultation with the tribes—to safeguard natural resources that are of crucial importance to the tribal self-government and prosperity.

As is demonstrated throughout this Climate Action Plan, the countless resources important to the Yakama Nation are not only spread deep and far throughout our territories and our community—they are the lands, the water, and the air we breathe. Our resources include all of the plants and animals our Creator has provided for us, of which their care is our concern and our obligation.

Yakama Chief Owhi, one of the Treaty Signers

The Yakama Tribal Council calls upon the United States government branches and agencies to work with us to assess and document these findings and directs Yakama Nation staffs to work closely with other tribal, state, local governments, and non-governmental entities to find areas of common interests and support for future collaboration.



The challenge of climate change is not optional.

In the legal realm, the Yakama Nation, states, and the federal government share the responsibility to protect and enhance our cultural, community, and natural resources as co-tenants. To carry out this responsibility, this Climate Action Plan calls for the three sovereigns to come together to implement this important work.

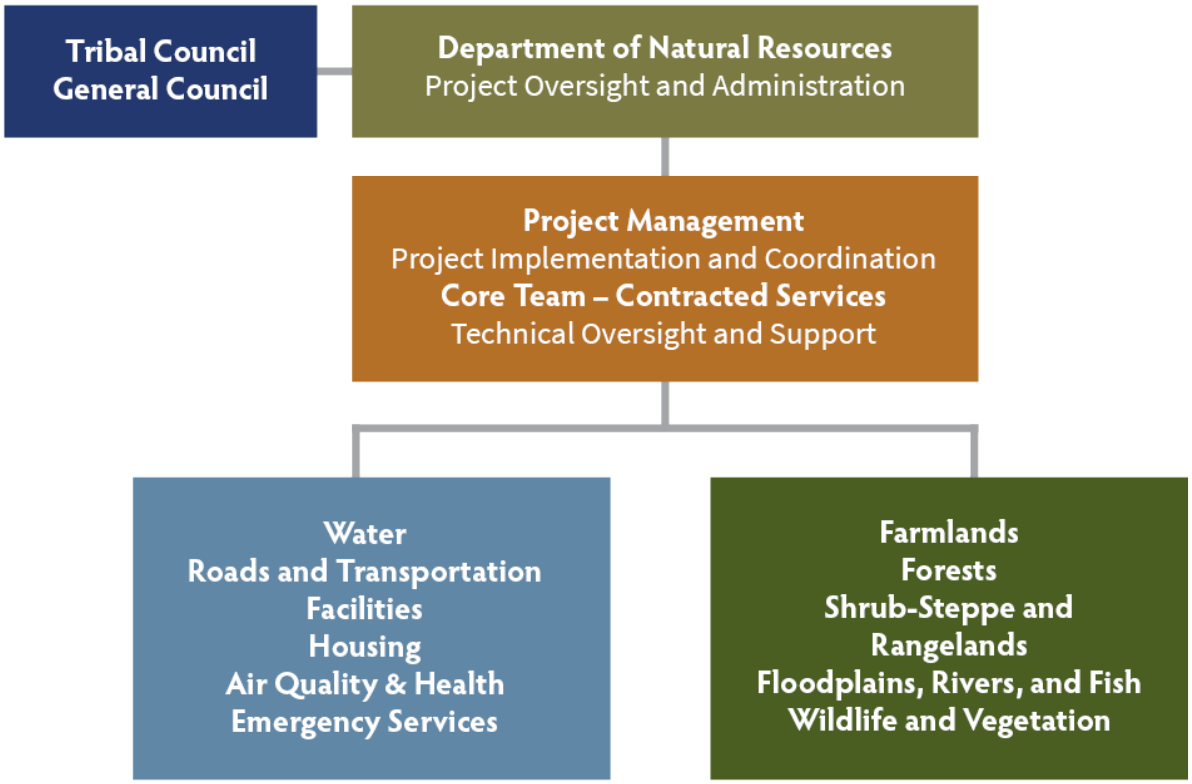
1.6 Description of Our Action Planning Process

We recognize that the efforts of the Yakama Nation alone—or any one entity alone—will not be enough to address the challenges of climate change. Ultimately, it will require a concerted, collaborative effort between tribal, local, state, federal, and non-governmental entities. Our approach to planning and implementation rests upon this central idea.

We also recognize that many of our tribal programs have already begun considering aspects of climate change as part of program planning and implementation. Our planning process not only considers newly available information, but also consolidates and highlights existing efforts.

Perhaps most importantly, our planning approach emphasizes the engagement of tribal members and our tribal natural and community resource programs. Priorities and recommended actions come from these engaged members and staff. The Yakama Nation leadership will use this information to consider and adopt both short-term actions and longer-term strategies and direct tribal programs to lead implementation. The diagram in Figure 1 summarizes the management structure for our climate action planning process and highlights the importance of engaging program staff from across a wide range of tribal departments.

Figure 1. Management structure for the Yakama Nation climate action planning process



SCOPE OF PLAN

This plan includes 11 cultural resources, or "sectors," listed in Table 1. We start with water, emphasizing the importance of water to the Yakama Nation and to all living things. From water, all other resources exist. For the benefit of organization, we identify three other general categories of resources: 1) Infrastructure and Agriculture, 2) Health and Public Safety, and 3) Lands and Natural Resources. Each of these categories are further divided into the 11 resource sectors. We recognize these categories and sectors are interrelated with many linkages between them. We use these linkages to identify strategies that benefit all of these resources.

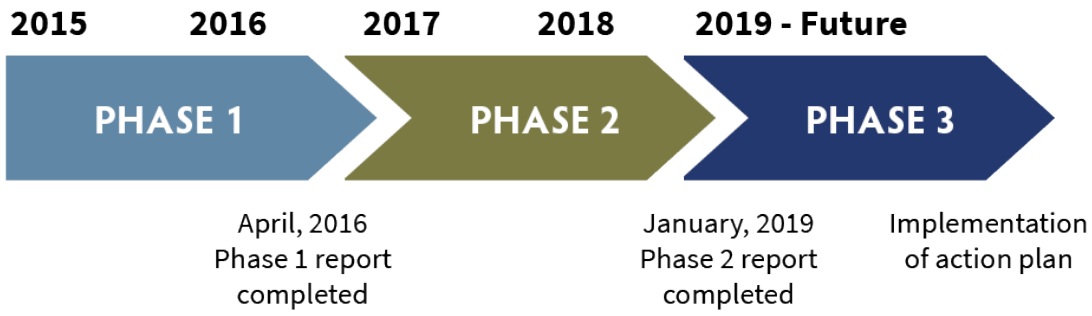
Table 1. Cultural resources included in the Climate Action Plan

Water	Infrastructure and Agriculture	Health and Public Safety	Lands and Natural Resources
• **Water**	• Roads and Transportation • Facilities • Housing • Farmlands	• Air Quality • Emergency Services	• Forests • Shrub-Steppe and Rangelands • Floodplains, Rivers, and Fish • Wildlife and Vegetation

Overview of Methods

Our approach to the climate action planning process takes a long-term view and follows a three-phase process. Together, the three phases cultivate a comprehensive vision, directing the capacity and sustained coordination from within the Yakama Nation towards continued analysis, planning, and implementation of necessary actions to address climate change over the next seven generations. The three-step process aligns with regional vulnerability assessment efforts by members of the Columbia Basin Partner Forum, the Cascadia Partner Forum, and other institutions. Figure 2 provides a general timeline of the process.

Figure 2. Timeline of climate action planning process



The **first phase** of the process involved a series of technical and planning workshops held between May and September of 2015. The technical workshops provided the basis for understanding climate

science, climate change projections, and some of the anticipated impacts on key resources and habitats in our region. The planning workshops enabled participants to brainstorm and discuss potential actions. Additional input was solicited through interviews. Departments also provided feedback on Phase 1 of the plan. The initial Climate Adaptation Plan (April 2016) was the outcome of the first phase.

During the **second phase** of the process, in 2017 and 2018, the Yakama Nation Core Work Group led the climate action planning process. The Work Group included staff members from programs under the Natural Resources Department and other tribal programs, including Engineering, Housing, Air Quality, and Health and Human Services. Throughout both phases, Work Group members and program managers engaged in workshops, smaller work groups, and multiple informal discussions.

In climate action planning processes, stakeholders choose to adopt a definition of vulnerability, which shapes the process and outcomes of the assessment. Figure 3 provides general definitions used by the Yakama Nation for the purposes of this plan.

In most cases, staff conducted the vulnerability assessment using a framework that was adapted from an existing decision-support tool (see Section 5, Technical Appendices, for more detail about the process of adapting the framework). Yakama Nation staff and other regional experts held discussions, supported by existing literature, through 2017 and 2018 to carry out the three main steps of the framework: (1) identify the unit of analysis for the resource and assess and rank the relative vulnerability to climate change impacts, (2) examine the relative vulnerability of resources and clarify management goals for the resource, and (3) select actions to implement to increase resiliency. Assessment outcomes included vulnerability scores for each of the cultural resources using the scale shown in Figure 4.

Defining Vulnerability

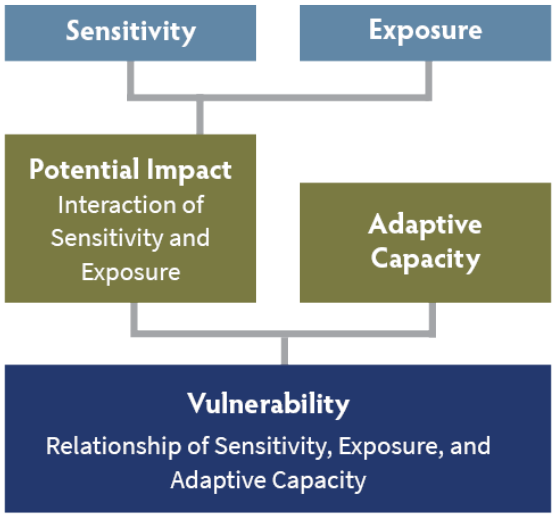
The IPCC defines vulnerability as a function of the sensitivity of a particular system to climate changes, its exposure to those changes, and its capacity to adapt to those changes [33].

Sensitivity is a measure of whether and how a species or system is likely to be affected by a given change in climate.

Exposure is a measure of how much of a change in climate and associated problems a species or system is likely to experience.

Adaptive capacity refers to the opportunities that may exist to ameliorate the sensitivity or exposure of that species or system.

Figure 3. Relationship between components of vulnerability



The IPCC's definition of vulnerability, summarized above, is a useful guide to the Yakama Nation's climate action planning process. For each of the community or natural resource sectors, you will see an overall vulnerability ranking (Level of Concern) as well as brief statements regarding the exposure and sensitivity of the resource. Vulnerability rankings for these sectors are determined from staff input. Adaptive capacity is addressed under the third heading, *Existing Programs that Contribute to Resilience*, discussed within each sector.

An additional layer that the Yakama Nation considered in these assessments is the *consequence* of action or inaction to protect a resource and minimize risk. The consequence of acting to protect an asset—be it roads, salmon habitat, or another resource—is the effort and costs of management. In contrast, the consequence of inaction includes the potential loss of that asset or resource as well as the costs that accrue in managing for that loss. Although consequence is not an explicit part of the IPCC's definition of vulnerability, it helps in understanding our Level of Concern for the resources and in prioritizing resilience strategies and actions.

It is important to emphasize the level of uncertainty associated with discussions, conclusions, and scores suggesting "vulnerability" of a resource to climate change. Given this uncertainty and recognizing the range of potential consequences to our resources, the Yakama Nation has chosen to express vulnerability, at this time, as a *"Level of Concern" for vulnerability of the resource*. In the future,

with additional monitoring and analysis and when specific changes become more pronounced, we will be better informed to more precisely describe vulnerability of local species or built systems. However, by expressing our Level of Concern today, we are able to identify our management interests, prepare for the worst, and remain hopeful for the best.

For the purposes of this document, we express vulnerability scores in the following manner:

- **High Concern**: Degradation to the resource is expected and likely significant. Management actions to address and/or reduce the potential severity of the degradation are likely to be extensive and, in some cases, may provide results that are uncertain or less than desired.
- **Moderate Concern**: Degradation to the resource is probable but the extent of the potential impact is uncertain. Management actions are anticipated and appropriate to support protection and enhancement of resource values.
- **Low Concern**: Degradation to the resource will likely be low and manageable. Actions to manage for potential impacts to the resource are foreseeable, practicable, and will likely have the intended results.

Our Level of Concern is simply expressed along a continuum, as shown in Figure 4 below.

Figure 4. Vulnerability score along a continuum of anticipated future change

The **third phase** of the climate action planning process will focus on implementing resilience actions that are identified in Phases 1 and 2. This phase will require considerable collaboration between policy and technical staff from many governmental and non-governmental entities to be successful. Phase 3 will begin in 2019 and continue over the long term. In the years to come, staff will review information from future assessments and results from implementing strategies and actions and will updated the Climate Action Plan as appropriate. As indicated earlier, broad, regional collaboration will be central in the success to build resilience to our resources, whether built or natural.

2.0 ANTICIPATED CLIMATE IMPACTS

2.1 Overview of Observed Changes to Date

The climate is changing in the Pacific Northwest. The average annual temperature increased by 1.3°F between 1895 and 2011 [1]. We have seen changes in the mountains; over the last century, nearly all the glaciers in Washington State have retreated. Agricultural conditions have changed as well. The number of frost-free days has increased by more than a month, on average, and the growing season has lengthened accordingly [1]. We are seeing changes in our rivers and streams. Peak streamflows are coming earlier in the year than they used to in many locations, and late summer streamflows are declining. These changes are consistent with what we expect to see based on regional projections of climate change, although natural variability also continues to play an important role in what we experience from year to year.

In 2015, the City of Yakima had the warmest June on record, and the Columbia River was the warmest it has been since 1950 [2]. Approximately one-quarter of a million salmon died, reportedly because of warm water and resulting diseases [3]. Wildfires brought "unhealthy" and "very unhealthy" air quality conditions to the communities of Toppenish, White Swan, and Yakima [4]. While the high temperatures and drought that we experienced in 2015 cannot be fully attributed to climate change, given the aforementioned role of natural variability and the influence of El Niño, recent experiences give us a picture of what we are likely to experience more often in the future as the climate continues to change.

2.2 Anticipated Future Changes

There are a number of scenarios that scientists use to project what might happen as a result of climate change. The scenarios make different assumptions about future greenhouse gas emissions. However, all of those scenarios project further warming in this century: between 4.3 to 5.8°F warmer on average in Washington State by the 2050s compared to the 1950-1999 period. In the Yakima Basin, average summer temperatures are expected to be 83 to 90°by mid-century, depending on what choices are made—locally, regionally, and globally—that affect the trend of greenhouse gas emissions [5]. These will be the averages; our hottest summer days will likely be even hotter than what we are used to.

When it comes to rain and snow, precipitation projections are uncertain. Climate scientists currently anticipate only slight increases in average annual precipitation, with more of that precipitation coming in the winter and in heavier downpours. Meanwhile, the Yakima Basin and many watersheds throughout our territories are temperature-sensitive systems, so warmer temperatures will mean less snow and more rain. We expect to see increasing winter flows and decreasing summer flows in the rivers. We also expect to see peak streamflows occurring four to nine weeks earlier in the 2080s than what we are used to seeing today [1]. Snowmelt runoff already happens two to three weeks earlier than it did historically in many streams in the Pacific Northwest [6].

All climate change scenarios show a continued decline in snowpack in the mountains. This could be about 30 percent decrease in snowpack in the Cascades by the 2020s and more than 40 percent decrease by the 2040s, compared to what we experienced in the last century [7].

Rising temperatures and changing precipitation patterns will also increase wildfire risk. The area likely to burn in the Columbia River Basin is projected to double by the 2020s, triple by the 2040s, and increase by a factor of five by the 2080s, compared to the median observed between 1916 and 2006 [8].

We know there are many existing pressures that are affecting the Yakama Nation's natural resources. Livestock, wild horses, and invasive plant species like cheatgrass, medusahead, and yellow starthistle are already having adverse impacts on the rangelands. The Hanford nuclear site and agribusiness runoff are affecting water quality in streams and rivers. Irrigation and lawn watering systems are putting heavy demand on available water. Fish passage has been hindered in many places by dams and culverts, and non-native, warmer water species proliferate. Climate change adds another stress on top of these current pressures.

The remainder of this report describes the vulnerability of the community and natural resources important to the Yakama Nation to expected climate change impacts. Impacts include increased stress for salmon, affecting juvenile survival and migration to spawning grounds; changes in the area of suitable habitat available for a variety of wildlife and plant species; increased water scarcity; issues concerning air quality and community health; and the potential for service disruptions and damage to tribal infrastructure. We recommend strategies and actions to help build our resilience in the face of these ongoing and emerging risks.

> *"We've seen the telltale signs of climate change for several years now. It will affect each and every living thing, including us. Everything depends on water for life—our foods, our salmon, our roots and berries. Many tribes will be affected." - Gerald Lewis, Tribal Council*

Table 2 summarizes many important climate variables and projections over the 21st century for the State of Washington. The table was originally developed by the State of Washington and is found within the *2015 Updated State Wildlife Action Plan*. The Yakama Nation appreciates its application to this Climate Action Plan.

Table 2. Summary of key climate factors and projected changes in Washington State[4]		
Climate Factor	**Projected Changes**	**Notes**
Air Temperature	Pacific Northwest (relative to 1970 – 1999). **2020s** • **Annual: +2.0°F** • **Summer: +2.3 – 3.1°F** • **Winter: +2.0 – 2.2°F** • **Spring: +1.8°F** • **Fall: +1.8 – 2.0°F** **2040s** • **Annual: +1.64°F** • **Summer: +3.4 – 4.9°F** • **Winter: +2.9 – 3.4°F** • **Spring: +2.5 – 3.1°F** • **Fall: +2.7 – 3.6°F** **2080s** • **Annual: +25.3°F** • **Summer: +5.4 – 8.1°F** • **Winter: +4.9 – 5.9°F** • **Spring: +3.8 – 5.0°F** • **Fall: +4.3 – 6.1°F**	Increased temperature of about 1.7°F over the past century. Increases will be most severe in summer months. Temperature swings are normal and expected but will be amplified by natural climatic patterns such as the El Niño-Southern Oscillation (ENSO) and the Pacific Decadal Oscillation (PDO).
Precipitation	Pacific Northwest (relative to 1970 – 1999). **2020s** • **Annual: +1% (-9 to +12%)[5]** • **Winter: +2% (-14 to +23%)** • **Summer: -6% (-30 to +12%)** **2040s** • **Annual: +2% (-11 to +12%)** • **Winter: +3% (-13 to +27%)** • **Summer: -8% (-30 to +17%)** **2080s** • **Annual: +4% (-10 to +20%)** • **Winter: +8% (-11 to +42%)** • **Summer: -13% (-38% to +14%)**	Changes to annual precipitation will be variable and dependent upon location. Projected overall decreases in summer precipitation. Changes in precipitation are normal and expected but will be amplified by natural climatic patterns such as the ENSO and PDO.

[4] Adopted and adapted from the *2015 Updated Washington State Wildlife Action Plan* [26].
[5] The projected change in percent of precipitation is followed, in parentheses, by the range or variability of change.

Table 2. Summary of key climate factors and projected changes in Washington State[4]		
Climate Factor	**Projected Changes**	**Notes**
Snowpack	Further declines (-53% to -65% by 2080). Snowpack losses will be greatest at lower elevations and more modest at higher elevations.	Significant declines (average 25% decrease) during latter half of 20th century.
Snowmelt	Will occur increasingly earlier by 2050.	Cascade Mountains: occurred 0-30 days earlier (depending on location) during latter half of 20th century.
Drought	Increasing across the state, particularly in summer, even with potential increases in winter precipitation.	Pacific Northwest: experienced several droughts since 2001. Droughts attributed to warmer temperatures, reduced snowpack and earlier snowmelt, and reduced winter and/or summer precipitation.
Streamflow and runoff	Earlier streamflow timing in snow-dominant and transient basins. Annual runoff is projected to increase slightly, with increases in winter streamflow and declines in summer streamflows. Potential shifts from snow-dominant to transient or rain-dominant basins.	Snow-dominant and transient basins: earlier snowmelt runoff, leading to lower summer base flows. Rain-dominant: variable depending on annual precipitation.
Wildfire risk	Increased fire frequency, severity, intensity, and total area burned. Magnitude of change will likely vary by eco-region, vegetation type, and suppression effort.	Wildfire frequency and extent have been increasing since the 1970s. Will be affected by continued fire suppression, drought, ENSO, and PDO.
Freshwater temperature	Increasing across the state, including increases in frequency and duration of unfavorable temperature events (periods with water temperatures >69.8°F).	Net increase from 1980-2009; summer warming rate increased 7.4°F per decade. Affected by changes in land use and land cover, low flows, and increased withdrawals.

3.0 CULTURAL RESOURCES VULNERABILITY ASSESSMENT

The resilience and prosperity of the Yakama Nation relies on healthy and sustainable natural and human-made resources. Our future is embedded within the land, air, and waters of our territories.

Section 3 discusses the existing challenges, the potential vulnerabilities, and associated resources vital to support our nation's vibrant future in a changing climate for each of the 11 sectors. A "vulnerability score" reflecting our Level of Concern about vulnerability is provided, which reflects the resources' *exposure* and *sensitivities* to climate change. This section also discusses existing Yakama Nation programs that significantly provide adaptive capacity to the resource to protect or increase its resilience.

3.1 Water

3.1.1 OVERVIEW OF RESOURCES

Water is life. Its importance cannot be overstated. Water is central to our religion, our culture, and our heritage, and it is essential to our health and our economy. The snow and the rain feed our streams and wetlands, which quench our thirst and sustain our fish, wildlife, foods, and medicines. Water is all things to all that are living and all yet to be born.

For the Yakama Nation, the agricultural sector accounts for most water use. Municipal use is a relatively small portion, and rangelands use minimal water, which is mostly from springs. Nearly all (over 95%) of water supply for irrigation of agricultural land is from surface water sources, comprised of off-reservation reservoirs and some small creeks and tributaries. Deep basalt wells historically supply some agricultural areas, but new wells in the basalt aquifers in certain areas are no longer permitted for irrigation. Currently there are no storage-specific reservoirs within the reservation boundary, and there are water shortages in the Bureau of Reclamation's Yakima Irrigation Project in approximately 14 percent of years [1]. During drought, there are practices in place to prioritize water rights, called pro-rationing, that reduces water for junior water rights holders before senior water rights holders. In areas of the reservation where water is diverted from tributary streams that do not have reservoirs, water demands outstrip water supply in most years. In these locations, instream flows for fish and aquatic

> *Land management practices, irrigation facilities, reservoirs and hydropower developments, transportation infrastructure, and flood control measures have completely altered natural streamflow patterns well beyond what might be expected from climate change. In the Yakima Basin, this includes the large reservoirs at the headwaters of the Yakima, Naches, and Tieton rivers.*

resources are established as a priority. Water use is then allocated by a system that accounts for adjudicated water rights and water permits obtained for beneficial uses defined by the Yakama Nation in its Water Code.

Existing Challenges to Resources

Since the time of our treaty, there have been many changes that have placed pressure on our water resources and pose additional challenges to preparing for climate change impacts.

Roads, railroads, and flood control dikes isolate overflowing streams from their floodplains, which accelerates runoff timing (Figure 5) and limits aquifer recharge. Around White Swan, springs and side channels dried up after a dike was installed in 1974. Recent efforts to reactivate the floodplain have generated some natural recharge, and although it is early, improvements are being seen.

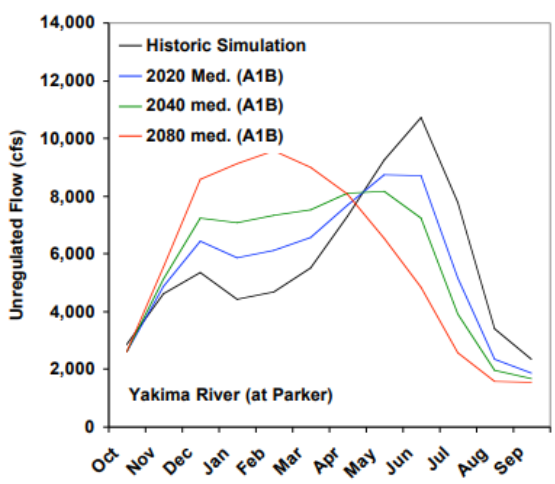


Figure 5. Anticipated changes in Yakima Basin streamflow timing and volumes in the 2020s, 2040s, and 2080s [13].

Irrigation has dewatered some streams to the point of drying them entirely. Dewatering of streams was a regular occurrence prior to the implementation of instream flow rules. In the Ahtanum and Toppenish tributary streams, fish are already stressed before base flow occurs in mid-summer or earlier because water levels are insufficient to meet the competing demands for fish and irrigation. The Wapato Irrigation Project runs inefficiently due to antiquated infrastructure and is more susceptible to drought than other nearby irrigation districts. Many farmers use emergency wells, but there is no guarantee these expensive endeavors will provide water. Groundwater withdrawals further stress fish because they reduce surface water levels in streams. Further complicating irrigation challenges, many shallow domestic wells use the same water as that used for irrigation recharge, making irrigation water conservation a determining factor in the water available for domestic use.

Groundwater, surface water, and soil contamination are also a concern in the Yakima Valley and broader Columbia River Basin. Listed contaminants (i.e., Section 303d of the Clean Water Act) include sediment, temperature, and pesticides in the lower Yakima River. Bacteria and nutrient levels have also raised concerns, as these constituents are indicators that other pollutants may be present. Certain toxics such as polychlorinated biphenyls (PCBs), polybrominated diphenyl ethers (PBDEs), the pesticide dichlorodiphenyltrichloroethane (DDT), and mercury are found at elevated concentrations in many locations and are known to produce adverse effects on fish, wildlife, and humans.

Negative effects of contaminants on reproduction, behavior, the immune system, and other aspects of

the biology of our fish and wildlife resources within the Columbia River Basin have been documented although not widely studied. In the Yakima Valley, excess application of pesticides, manure, and potential contaminants are carried into waterways through runoff. Dairies and feedlots also generate contaminants that enter waterways. We have also found legacy nitrates in the soil due to years of past use, which are slowly washing out of our soils now.

"Many valuable wetlands and smaller streams may be dry in the months when water is needed most."
- Workshop participant

Wetland plants and animals are particularly sensitive to small, permanent changes in conditions because they are located in a transition zone between aquatic and terrestrial environments [9]. As the climate changes, higher temperatures can lead to drying that reduces wetland size [10]. Shallow seasonal ponds, bogs, and fens that provide breeding grounds for amphibians and other animals may shrink or disappear [11].

3.1.2 ANTICIPATED VULNERABILITIES FROM CLIMATE CHANGE

Over the next 10 to 20 years and beyond, we could see many important changes to our water resources due to both existing stressors and climate change.

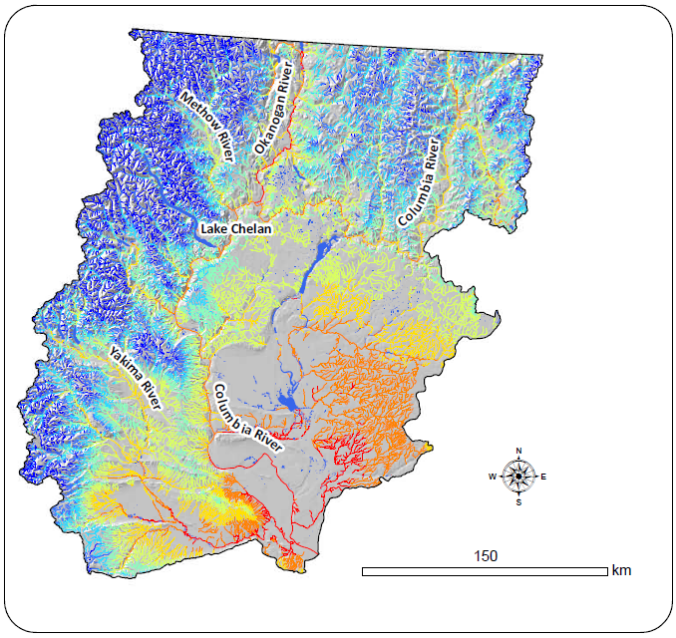
VULNERABILITY SCORE: HIGH CONCERN	
Exposure:	The transition to a rain-dominated system exposes fish, wildlife, and people to much lower summer water levels and potentially higher levels of water contamination.
Sensitivity:	We already experience water shortages some years throughout much of summer. We are therefore sensitive to even small future changes. Old irrigation infrastructure operates poorly under low-flow conditions and is sensitive to drought. Aquifer recharge is becoming a significant issue.

Increasing temperatures are expected to lead to more rain and less snow in the Yakima Valley. They will also bring a transition from a snow-dominated system with peak flows in the spring and snowpack available for summer water use to a rain-dominated system with peak flows in the winter and sharply reduced spring and summer flows. Figure 6 (below) illustrates modelled projections of increasing stream temperatures over time.

Along with population growth and minimal potential for deep aquifer recharge, higher temperatures and drier spring and summer conditions are likely to reduce water supply further. In turn, this is expected to increase existing competition for water for fish, wildlife, irrigation, and municipalities. Water conservation actions and increased irrigation efficiency may mitigate some impacts, but there is little certainty in funding and high-efficiency systems still require that water be available. For example, without changes in management practices, irrigation water shortages are projected in the Bureau of Reclamation's Yakima Irrigation Project within the Yakima basin in 43 to 68 percent of years by the end of this century [1].

NorWeST Stream Temperature
Modeled Mean August Stream Temperature

Upper Columbia, Yakima
Hydrologic Unit Codes
170200 and 170300



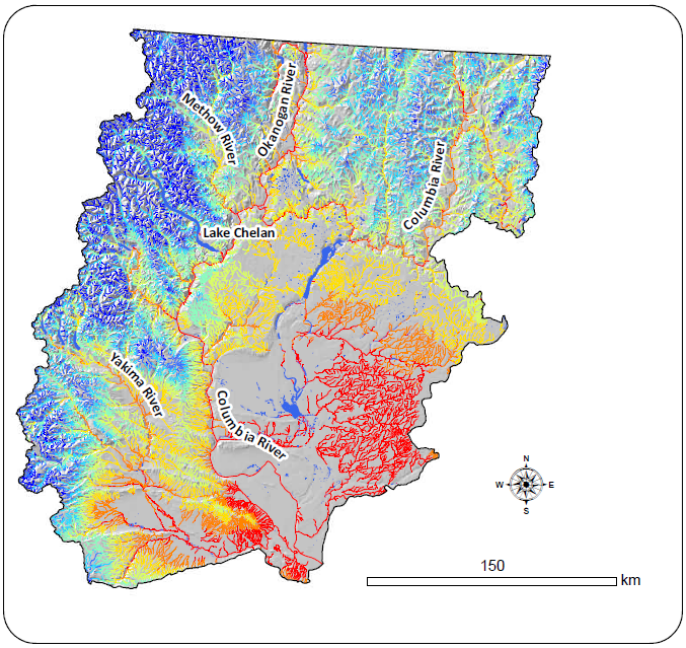
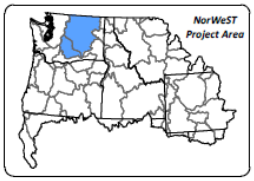


Figure 6. Modeled mean August stream temperatures. Years 1993-2011 represent today's baseline, as compared with projected stream temperatures for the 2040s. This trend continues into the 21st century. See Section 5, Technical Appendices, for more details.



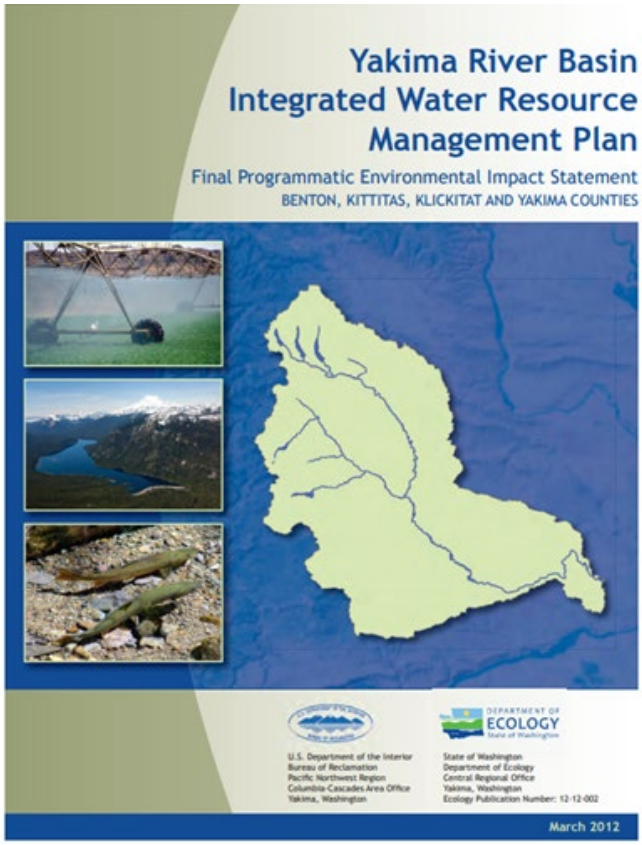
Rising temperatures, more intense storms, and droughts can also change the way contaminants interact with the environment. If storms are more intense or flooding or runoff increase compared to current conditions, contaminants trapped in sediment and soil such as pesticides, PCBs, and polyaromatic hydrocarbons (PAHs) may be released in greater quantities to water bodies, leading to more episodes of chemical contamination in watersheds. Exposure to contaminants is likely to make fish and other organisms more vulnerable to changes in climatic conditions. Likewise, climate-related stress makes organisms more sensitive to toxic contaminants. See the Section 4.10 in this report for more information on impacts to fisheries and floodplains.

3.1.3 EXISTING PROGRAMS THAT CONTRIBUTE TO RESILIENCE

The Yakama Nation is already taking actions to conserve water. These activities will be increasingly important in light of anticipated changes in the climate. Important activities include:

- We are implementing the **Yakima River Basin Integrated Water Resource Management Plan** (see Section 3.1.4 below for more details). Demonstrations of **low-water use native plants** in Yakima are part of that program.
- Implementation of the **2011 Water Resource Management Plan**.
- We are conducting water conservation planning, irrigation improvement, and operations changes to increase flows in the Yakima River Wapato Reach, and downstream as part of the **Yakima River Water Enhancement Project.**
- Some farmers on Yakama Nation lands employ **reuse of water or installed drip irrigation**.
- The Yakima Tributary Access and Restoration Program is working to **minimize water losses** along primary stretches of the Wapato Irrigation Project. To better understand current usage, staff are measuring water usage at various delivery points.
- We are **upgrading the irrigation system** and, at times, considering changes in water availability and volume, growing seasons, and hot months as part of that process.
- The Toppenish Creek Corridor Plan is one example of our efforts to use a **coordinated, interdisciplinary approach** to manage water in agricultural areas.
- Yakama Nation staff are undertaking **drought contingency planning**, including the use of drought decision-support tools. There are already practices in place to prioritize water rights during drought.
- As part of the Yakima River Basin Water Enhancement Project Basin Conservation Program, we have committed to **return about 100 cubic feet per second of conserved water into the Yakima River** to help offset anticipated reductions in summer flow.
- **Meadow restoration** through the Lincoln, Renchler, Piscoe and Starvation projects is improving species diversity and hydrologic resilience. Similar actions are occurring in Teepee Creek and other projects in Klickitat to restore channel-floodplains and meadows.
- **Aquifer recharge** on Agency and Toppenish creeks to raise water tables.

3.1.4 YAKIMA RIVER BASIN INTEGRATED WATER RESOURCES MANAGEMENT PLAN[6]



The Integrated Water Resource Management Plan (Integrated Plan) represents a comprehensive approach to water management in the Yakima River Basin. It is intended to meet the need to restore ecological functions in the Yakima River system and to provide more reliable and sustainable water resources for the health of the riverine environment and for agriculture and municipal and domestic needs. The Integrated Plan is also intended to provide the flexibility and adaptability to address potential climate changes and other factors that may affect the basin's water resources in the future. The Integrated Plan includes three components of water management in the Yakima basin—Habitat, Systems Modification, and Water Supply.

The intent of the Integrated Plan is to implement a comprehensive program that will incorporate all three components using seven elements to improve water resources in the basin, as discussed below.

The Integrated Plan is found at the following website:
https://fortress.wa.gov/ecy/publications/documents/1212002.pdf

Purpose

- Implement a comprehensive program of water resource and habitat improvements in response to existing and forecasted needs of the Yakima River basin.
- Develop an adaptive approach for implementing these initiatives and for long-term management of basin water supplies that contributes to the vitality of the regional economy and sustains the health of the riverine environment.

[6] All narrative included in this Section 3.1.4 are taken directly from: U.S. Department of the Interior and State of Washington Department of Ecology, "Integrated Water Resource Management Plan Benton, Kittitas, Klickitat, and Yakima Counties, Washington," Final Programmatic Environmental Impact Statement (March 2012).

The specific needs for the Yakima River Basin

- Resident and anadromous[7] fish:
    - Improved mainstem and tributary habitat, including habitat protection and enhancement, flow restoration, fish barrier removal, and screening diversions.
    - Access to habitat above major reservoirs, including both upstream and downstream passage.
    - Improved streamflows and habitat conditions to help fish withstand climate change impacts.

- Irrigation water supply:
    - Improved agricultural conservation, including reduction of seepage and evaporation from canals.
    - Minimally acceptable supply of water, defined as at least 70 percent of pro-ratable water rights during drought years.
    - Increased flexibility in the irrigation water supply to adapt to changes, including increased crop demand, earlier runoff, and more frequent droughts.

- Municipal and domestic water supply:
    - Improved water supply from both surface and groundwater to meet current and future municipal and domestic needs.
    - Increased flexibility in the water supply to adapt to changes, including increased demand, earlier runoff, and more frequent droughts.
    - Improved conservation and more efficient use of the water supply.
    - Improved mechanisms such as water marketing to help domestic users meet the "water budget neutral" requirement for new groundwater use.

Each of the key elements of the Integrated Plan support increasing resilience to water supply and water needs within the Yakima River Basin.

[7] Anadromous fish will live their adult lives in the ocean and return to fresh water to spawn.

3.2 Roads and Transportation

3.2.1 OVERVIEW OF RESOURCES

The Yakama Nation manages and maintains over 152 miles of paved and gravel roads on the reservation. In addition, the County, cities, and state manage some roads in the valley, and the federal BIA oversees roads in the closed area.

Tribal funding for transportation infrastructure is currently supported by the federal gas tax. The tribe has the option to utilize the Washington State gas tax as well but has not yet leveraged this opportunity.

Existing Challenges to Resources

Existing challenges to roads and transportation infrastructure include periodic dust storms and flooding that cause temporary road closures, but these have not yet been cause for significant concern. However, in the case of severe flooding, there may be challenges to evacuation and emergency response due to the fact that there are few alternative transportation routes for some cross-floodplain roads (e.g., Johnny Jim and Goldendale Roads).

In addition, road conditions vary across the reservation due to the overlap of jurisdictions. The tribally managed roads are generally in good condition, while some roads falling outside of the tribe's purview are in poorer condition.

3.2.2 ANTICIPATED VULNERABILITIES FROM CLIMATE CHANGE

VULNERABILITY SCORE: LOW CONCERN	
Exposure:	Some roads in the river valley are exposed to flooding and dust storms. All roads in the valley will be exposed to warmer, drier summer conditions.
Sensitivity:	Some parts of the community are more sensitive due to few alternative routes across the floodplain. If higher performance materials cannot be used due to costs, roads and other transportation infrastructure may be more sensitive to heat stress. Given sufficient budgets, most potential issues can be dealt with in a timely manner.

During the summer, higher temperatures and drier conditions may stress and reduce the lifespans of some infrastructure assets and degrade asphalt pavements more rapidly, creating a need for more frequent maintenance (e.g., shifting from the current 7-year cycle for asphalt roads to a 5-year cycle). Thermal stress may also slow asphalt curing time, increasing the time needed to perform road repairs. These changes could increase costs for road maintenance. Higher-performance materials that can withstand these conditions could be utilized, but such materials are more expensive.

Flooding is expected to occur more often in the fall and winter, instead of spring, as more rain and less snow falls in the Yakima Valley and as rainstorms become more sudden and more intense. Heavier flows and flooding can increase erosion and sedimentation and stress low-lying transportation infrastructure. Landslides may also become more frequent, leading to potential road closures, higher maintenance costs, and disrupted access in steep and vulnerable areas. Some portions of the community may be particularly sensitive if flooding occurs, as there are few alternative routes to crossing the floodplain.

Climate change impacts also present some potential benefits for transportation infrastructure and operations. Increasing winter temperatures will mean less snow, ice, and fewer rain-on-snow events, relieving significant sources of stress on roads and reducing the need for maintenance.

Although uncertainty remains about the degree of changes in climate and the resulting impacts on infrastructure, on balance, these anticipated emerging challenges and benefits would offset each other to some degree. We have therefore concluded that, on balance, roads and transportation will remain generally stable in light of climate change impacts.

3.2.3 EXISTING PROGRAMS THAT CONTRIBUTE TO RESILIENCE

- The tribe **designs roads to higher-than-minimum standards**, making them suitable for higher traffic volume that may occur with population growth. This may have co-benefits for climate resilience.
- The tribe conducts **maintenance on asphalt roads** every seven years, including applying a chip seal to protect the roads from moisture-caused buckling and other degradation.
- The Yakama Nation works with Yakima County to **manage floods on the mainstem of rivers**. The County prepares comprehensive flood zone management plans; climate change should be more explicitly integrated into those plans in the next update.
- The tribe purchases floodplain land, sets dikes back from the main channel, and removes infrastructure from flood zones to **support intact floodplains**.
- The tribe currently **designs infrastructure in consideration of heavy precipitation events**. Using models from the BIA, the tribe designs bridges to withstand 100-year storm events and culverts to withstand 50-year storm events, which is beyond the required minimums of 50 years and 25 years, respectively.

3.3 Facilities

3.3.1 OVERVIEW OF RESOURCES

The Yakama Nation manages 130 facilities on the reservation, 78 of which are owned by the tribe and the remaining 52 are owned by the federal BIA. The tribe manages various types of facilities, including churches, longhouses, warehouses, community centers, pump houses, guard stations, fire towers, and office buildings. Approximately 30 of the facilities are located on the central administrative campus of the Yakama Nation, and the remaining are located across the reservation.

Existing Challenges to Resources

Many facilities are older, with some constructed as early as the 1950s. As a result, these buildings are less energy efficient and more costly to heat and cool. Installing solar panels on these buildings to provide on-site electricity is not economically feasible due to their design, thus compromising a potential strategy to reduce long-term energy costs.

Many facilities do not have back-up energy generation capacity. Should a power outage occur, such as in the case of fire affecting the Yakima Power substation, their lack of electricity could pose a challenge to emergency services, especially in the case of larger facilities that would potentially serve as emergency shelters (e.g., longhouses).

3.3.2 ANTICIPATED VULNERABILITIES FROM CLIMATE CHANGE

VULNERABILITY SCORE: LOW CONCERN	
Exposure:	Few facilities are exposed to flooding, extreme heat, or wildfire. All facilities will be exposed to warmer temperatures but those do not pose major risks.
Sensitivity:	Cooling and energy efficiency retrofits are underway, but few facilities have back-up power capacity for use during emergencies. Provided sufficient budgets, most issues can be dealt with in a timely manner.

In the Yakima Basin, warmer summertime temperatures are likely to increase the need for air conditioning to provide relief for residents. All tribally managed facilities with daily human use have air conditioning. Other tribally managed facilities without air conditioning do not necessarily require it, such as warehouses or storage units. Although facilities may be equipped with air conditioning, the tribal budget may be challenged by increased operational costs at facilities as the demand for electricity is likely to go up in the summer when more intense heat leads to a need for more cooling capacity.

More frequent heavy precipitation events during the winter will pose an increased risk of flooding in the Yakima River Basin, but flooding is a lesser concern for facilities because of their siting. Only a small number of tribally managed facilities (estimated 10-15 buildings) are located close enough to streams to have greater exposure to flood damage in the case of a 100-year flood event, such as the one that occurred in the winter of 1996-1997. These facilities include Head Start in White Swan, the

Winter Lodge, housing units in Toppenish, and the Wapato Longhouse. Aside from the dozen or so buildings located in the 100-year floodplain, there are no other facilities exposed to flooding even during more frequent minor events.

Few facilities on the reservation are exposed to extreme heat or wildfire risk. This geographic advantage contributes to a lower vulnerability of facilities to climate change impacts.

3.3.3 EXISTING PROGRAMS THAT CONTRIBUTE TO RESILIENCE

- The tribe is continually retrofitting and **upgrading Heating, Ventilation, and Air Conditioning (HVAC)** systems in older buildings as these systems near the end of their useful lives, and the tribe has funding to continue doing so.
- In addition, the tribe **conducts renovations on its older building stock** to achieve energy efficiency savings. For example, renovations to the White Swan Community Center reduced energy use by 30 percent.
- Many tribal **facilities hold significant potential to serve as cooling centers and provide emergency shelter** to community members during heat waves and other crises, due to their air conditioning and capacity. For example, many longhouses could accommodate 200 people for sleeping if there were sufficient resources available for food, sleeping accommodations (e.g., blankets), and staffing.

3.4 Housing

3.4.1 OVERVIEW OF RESOURCES

The Yakama Nation manages 400 housing properties on the reservation, which are operated by the Yakama Nation Housing Authority (YNHA). One of the YNHA properties is the Adams View Housing Park, which is the largest tribal housing park on the West Coast. YNHA has plans to create 12 new housing developments, totaling over 300 new units, through 2023. In addition, a homeless shelter and domestic violence shelter are planned to be completed in 2019.

In addition to YNHA units, the reservation also has privately owned homes supported by the Housing and Urban Development (HUD) Department and 17 living quarters owned by the BIA, most of which are single-family dwellings.

Existing Challenges to Resources

The two largest challenges to YNHA development capacity are availability of and access to potable water and sewer services. In addition, YNHA staff have found the properties to experience overcrowding, and there is lack of regular maintenance due to tenant under-reporting of problems and limited staff capacity. Extreme weather events in recent years have increased heating and cooling bills for tenants, which has been a concern. YNHA has conducted outreach to encourage energy-saving behavior among tenants, which would mitigate the cost increases during more extreme weather events.

3.4.2 ANTICIPATED VULNERABILITIES FROM CLIMATE CHANGE

VULNERABILITY SCORE: LOW CONCERN	
Exposure:	Most housing is not located in an area at risk of flooding or wildfires. All housing will be exposed to prolonged, warmer temperatures.
Sensitivity:	Most, though not all, housing units have A/C, but rising energy costs and lack of back-up power capacity make residents more sensitive to extreme heat and electricity outages. Provided sufficient budgets, most issues can be dealt with in a timely manner.

When people do not have air conditioning (A/C) in their home, rising temperatures have the potential to increase incidences of heat-related illnesses like heat rash, heat exhaustion, and heat stroke. Since all YNHA projects have A/C and recently upgraded electrical panels, those tenants may be reasonably well-equipped to deal with some of these heat-related illnesses. However, few single-family homes on the reservation have A/C, posing a concern for those residents. The senior center has A/C to protect this particularly sensitive population, but there is a waitlist to secure a place at the center. In addition, higher cooling bills due to increasing summertime temperatures could pose a challenge to people's adaptive capacity, even if they already have an A/C unit installed.

Most YNHA parks are not prone to flooding, wildfires, or landslides. Although there is low exposure to these risks, the lack of an emergency management plan for housing and lack of back-up energy generation capacity create greater vulnerability to natural disasters or other crises, should they occur. Resilience could be increased with proactive planning and investments in back-up energy generation capacity, but this can be challenging given limited or uncertain funding.

3.5 Farmlands

3.5.1 OVERVIEW OF RESOURCES

The heart of the Yakama Nation reservation has productive, irrigated lands and a thriving agricultural sector. Adjacent to the Yakima River, Satus Creek, and Toppenish Creek are nearly 72,000 acres—approximately 90 percent of the farmland on the reservation—owned by tribal members and often leased to tenants that produce a wide variety of foods. Nearly all of these products are shipped to other places. It is estimated that less than 5 percent of food consumed on the reservation is grown here. Roughly $6-7 million are annually collected by tribal members for the use or rental of agricultural and other lands, offering a secondary income source for these tribal households. The secondary benefits to the local economy have not been quantified, but it is clear that the agricultural activities on the reservation are essential to the economy of the Yakama Nation.

Almost all farmlands (>95%) rely on irrigation. The BIA operates the Wapato Irrigation Project (WIP), which is a division of the larger Yakima Irrigation Project managed by the U.S. Bureau of Reclamation. The WIP provides nearly all of the surface water for irrigation on the reservation.

Existing Challenges to Resources

The greatest challenge to farmlands and agriculture is availability of irrigation water and functioning of irrigation infrastructure. In the Yakima Basin, approximately three years between 1979 and 1999 experienced water shortages that limited delivery to junior water right holders. Irrigation water shortages have already occurred in the Toppenish-Simcoe Unit west of White Swan.

Shortages place stress on the WIP infrastructure, which is antiquated and not designed to run at less than full capacity. As a result, periods of drought exacerbate the irrigation distribution inequalities, which was apparent during the 2015 drought when we had about 70 percent water supply for the project. These stresses can directly impact tribal revenues from our irrigated lands.

The WIP infrastructure is also stressed during times of flooding. For instance, the 1996 flood caused millions of dollars of damage. Although few farmlands are directly affected by flooding, they experience indirect impacts when the irrigation system blows out during these events.

Another concern for farmlands and agricultural productivity is insects and disease. Mormon crickets, native to the Yakima Basin, were problematic during the early 1970s. Though they are not currently an issue, there are signs that the population may be growing, in which case it could

cause major damage to crops and potentially lead to losses in yield.

3.5.2 ANTICIPATED VULNERABILITIES FROM CLIMATE CHANGE

VULNERABILITY SCORE: HIGH CONCERN	
Exposure:	Precipitation changes and increasing drought exposes farmlands and irrigation infrastructure to water shortages and stress. Increasing temperatures expose crops to more stress and altered growing seasons. Few farmlands are exposed to flooding impacts.
Sensitivity:	Farmers producing crops with high-water need and/or a more limited temperature range will be more sensitive to climate change impacts. Areas already dealing with water shortages will be more sensitive to those in the future, as will junior water right holders.

For our agricultural lands to continue to be productive and profitable, they must have a reliable and adequate supply of water. Climate change is likely to shift the patterns of rain and snow in our mountains and lower-elevation reserved lands. Changes in snowpack accumulation and melt rates, timing of runoff, streamflow, summer drought, winter flooding, changes in water temperature, and sedimentation are all important issues that must be considered. Farmlands across the reservation will be exposed to these changes.

Changes in precipitation patterns are expected to cause more water shortages. In the Columbia Basin, the surface water supply (unregulated) from June to October is projected to decline by 10.3% compared to historic supply between 1981 and 2011 [12]. This reduction during the season with the highest water demand is likely to increase water scarcity, despite a projected increase in surface water supply during the winter [12]. Climate change projections indicate an increase in the number of years when water shortages limit delivery to junior water right holders, reaching approximately 3 to 8 out of every 10 years by the 2080s under a low and medium emissions scenario, respectively [13]. Areas where irrigation water shortages are already a challenge, like the Toppenish-Simcoe Unit, will likely be more sensitive. As noted above, the aging irrigation system infrastructure is especially sensitive to stress from water shortage and will need improvements to increase resilience to increased occurrence of shortage.

The crops grown on the reservation are highly vulnerable to water limitations and drought. The demand for irrigation water is projected to be slightly higher under future conditions, regardless of projected changes to the growing season [13]. In consideration of more frequent and severe water shortages by the end of the century, crops will experience more severe water stress days more often, with declines in average yields and subsequent impacts on farmers' incomes [13]. The 2015 drought gave us a glimpse into the potential future.

Certainly, members of our agricultural industry have dealt with and are mindful of the effects of periodic drought on annual water management practices. However, a prolonged exposure to reduced water supplies will necessitate changes in agricultural practices and water use efficiencies. Water-thirsty crops may need to be transitioned to or diversified with others that are more drought-tolerant.

Investments and innovations in water use and efficiency may offset many of these effects. If water shortage is pronounced enough, it is possible that croplands will come out of production, which in turn will reduce rents paid to tribal members for use of their ancestral lands. Economic consequences will ripple throughout our local economy.

Regulatory policies will become even more important and may have pronounced effects. Enforcement of the tribal water code, particularly in light of changes in water supply, may lead to additional restrictions on irrigation wells and surface water pumping and more stress on existing irrigation systems. All of these things are complicated and will continue to require careful planning and implementation.

Temperature changes will also impact farmlands and agricultural productivity. The growing season for some crops that are produced on the reservation may change. For example, some climate models project the cherry season to lengthen by mid-century but then shorten by late century, while the apple season is projected to become shorter throughout the century [13]. Seasons for both fruits are expected to shift earlier in the year. Increasing temperatures may limit which crops can be grown. In addition, these changes could create more favorable conditions for native and invasive pests and disease that may have potential to cause significant damage if steps are not taken.

3.5.3 EXISTING PROGRAMS THAT CONTRIBUTE TO RESILIENCE

The Yakama Nation is currently doing many things to increase the efficiency of our irrigation water use and to build resilience within our agricultural ecosystems and industry. Additional water conservation and planning actions not specific to agriculture are noted in Section 3.1.

- Farmers have demonstrated **capacity to adapt to threats from insects and disease,** such as the steps hop farmers took to adapt to powdery mildew, a fungal disease.
- The tribe has completed **water conservation plans** and are implementing them in many areas of our reservation.
- The continued implementation of the **Yakima River Basin Water Enhancement Project and the Yakima Basin Integrated Water Resource Management Plan** will guide improvements to infrastructure, thereby increasing available water supply and water conservation.
- An **aquifer recharge project** implemented on Toppenish Creek has recently been expanded to Simcoe Creek.
- Implementation of the **Toppenish Corridor Enhancement Plan, irrigation demonstration projects, and FEMA floodplain and flood zone mapping** will continue to contribute to our long-term goals.

3.6 Air Quality

3.6.1 OVERVIEW OF RESOURCES

Historically, the most common cause of lower air quality in the Yakima Valley is dust due to wind erosion of soils on agricultural fields, which can occur as early as April each year. In some cases, dust storms can reduce visibility to a level that forces a temporary shut-down of activities. Local air quality is also commonly impacted by small brush fires on idle agricultural land, as well as range fires. Until more recently, smoke from larger forest fires (e.g., greater than 100 acres) occurred less frequently. Over the past few years, however, large and frequent wildfires throughout the western states and even British Columbia have been responsible for significantly reduced air quality on the reservation and throughout the territories of the Yakama Nation.

During the winter, the valley experiences an inversion on an approximately annual basis when cooler air in the valley becomes trapped underneath a layer of warmer air. During an inversion, which usually lasts from one to several weeks, there are generally dry and stagnant conditions in the valley, temporarily lowering air quality. During the spring and summer seasons, if there are windy conditions, grass and tree pollens and mold can become more concentrated in the air.

Existing Challenges to Resources

During dust storms and wildfires, air quality conditions can decrease to “unhealthy” and “very unhealthy” levels for the communities of Toppenish, White Swan, and Yakima [4]. Poor air quality has been shown to heighten allergies and asthma symptoms within the community, which we have increasingly experienced over the past few years. The tribe has a large outdoor workforce, which is especially vulnerable to low air quality when working outside for prolonged periods of time.

3.6.2 ANTICIPATED VULNERABILITIES FROM CLIMATE CHANGE

The air quality challenges already observed in the Yakima Valley are expected to continue in the context of climate change. Drier and warmer conditions are likely to increase occurrence of dust storms, although there is not yet a consensus among scientists about how climate change might affect wind. In addition, we anticipate seeing more years with large wildfires, which may persist through the later summer months and into the autumn. As a result, unsafe levels of smoke from local and regional wildfires will fill our sky with growing frequency. Resulting impacts on our health may

include increased cases of asthma, bronchitis, and pneumonia. Children suffering from these problems could miss more school days, while adults could miss more workdays.

VULNERABILITY SCORE: MODERATE CONCERN	
Exposure:	The communities on the reservation are surrounded by agricultural lands, which causes frequent exposure to dust and smoke from brush fires. However, there is low exposure to wildfire smoke since the reservation is generally only affected when major forest fires occur to the north.
Sensitivity:	Outdoor workers are more sensitive with limited options to work indoors for more than a short period. Elders, young children, those with existing respiratory illnesses, and low-income households are also more sensitive to air quality impacts.

Rising temperatures will also bring an increase in the potential for heat-related illnesses like heat rash, heat exhaustion, and heat stroke. Our people spend a considerable amount of time outdoors, especially members of our outdoor workforce, where exposure is more of a concern. Additionally, pollen allergens could increase due to a longer pollination season [14]. We have already observed an increase in the frequency and severity of asthma and pollen allergies, a trend that may continue in the future with climate change impacts on air quality.

Some of our tribal members may be more vulnerable than others; we share particular concern for the elders, the very young, the infirm, the economically disadvantaged, and those who must labor outdoors. Our responses must be well-targeted to help those who are most vulnerable to ensure the burden and benefits from climate change impacts are equitably distributed among our community.

3.6.3 EXISTING PROGRAMS THAT CONTRIBUTE TO RESILIENCE

- During incidences of poor air quality, the tribal air quality staff **issue health alerts** to the community, which are communicated through public service announcements and school variable-messaging signs. If severe enough, workplaces and schools may close.
- The tribe **shuts down the closed area** during conditions of high fire risk, which helps mitigate the risk of starting new fires and in turn, the risk of smoke and associated impacts on air quality.
- There is **short-term flexibility for the tribal outdoor workforce** to complete indoor tasks during periods of poor air quality. However, there is limited long-term adaptive capacity for addressing this vulnerability.
- The tribe is developing their **indoor air quality program** with secured funding to address impacts from climate change on air quality in people's homes.

3.7 Emergency Services

3.7.1 OVERVIEW OF RESOURCES

Access to medical care, food and supplies, and support services on an ongoing basis as well as during times of crisis will be increasingly important as climate change impacts exacerbate existing risks and introduce new challenges to the community's health and wellbeing. Emergency management plans will need to be revisited from time to time to renew preparedness and coordination with local and regional partners. Our preparations must include response training for emerging and continuing threats and also consider initial and longer-term steps towards recovery from future adversities.

The Yakama Nation community is served by several medical facilities. The Yakama Service Unit, or Tribal Clinic, located in Toppenish, and the satellite clinic in White Swan provide ongoing care, including dental services, mental health care, optometry, and audiology. The Yakima Valley Farm Workers Clinic, also located in Toppenish, provides medical and dental services specifically for adults and children working in the agricultural industry. The Astria Toppenish Hospital, with 63 beds, provides the Yakama Nation community with a broader suite of medical services including emergency services, expanded surgery capacity, and maternity and pediatrics care. Significantly more capacity is available in Yakima. Most Yakama Nation community members have tribal or private insurance to access the medical services at these facilities.

Firefighting services are provided to the reservation from the cities of Toppenish and Wapato. In addition to putting out individual house fires, firefighting services offer relief as needed during regularly occurring range and agricultural fires.

Existing Challenges to Resources

Funding poses a challenge for emergency management more broadly. Currently there is no dedicated funding to support staffed emergency response centers that could shelter community members during times of natural disaster or other crises and provide basic food and supplies.

Another challenge is in firefighting services, as the fire district boundaries from the City of Toppenish and City of Wapato do not cover the entire reservation, leaving some areas at risk of not receiving adequate support when fires occur.

Although most community members have health insurance, the affordability of their insurance premiums may be jeopardized if federally funded subsidies are reduced. In particular, tribal insurance plan holders may have to use private insurance or pay out of pocket should this situation arise. These community members could be more sensitive to health issues that arise or are exacerbated by climate change impacts.

3.7.2 ANTICIPATED VULNERABILITIES FROM CLIMATE CHANGE

Existing medical and emergency facilities and services have sufficient capacity to manage existing risks and many anticipated future risks to the Yakama Nation community, including more heat stroke, heightened allergies, and increased risk of West Nile and other infectious diseases. The majority of these facilities are not exposed to flooding. The Toppenish fire station is in a flood zone but anticipated damage to the station from nuisance flooding in the future is minimal.

The community's capacity to increase resilience to climate change is limited by the lack of an emergency management plan that is coordinated across jurisdictions to provide shelter, food, and basic services during times of crisis. Likewise, limited public awareness about resources and actions to take during crises, as well as ongoing public health threats (e.g., seasonal poor air quality), reduces adaptive capacity.

VULNERABILITY SCORE: LOW CONCERN	
Exposure:	Medical and emergency facilities are not exposed to significant flooding or fire risk, ensuring their capacity to provide services during times of crisis.
Sensitivity:	Services are sufficient to address existing and emerging risks, but economic factors may make individuals more sensitive to health impacts. Cities' fire district boundaries leave some areas more sensitive to fire damage. Limited coordinated planning increases the community's sensitivity to crises in the future.

3.7.3 EXISTING PROGRAMS THAT CONTRIBUTE TO RESILIENCE

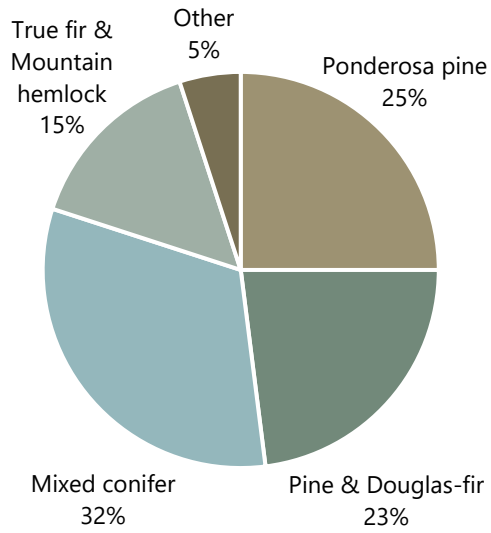
- Event cancellation and public communication **practices are in place to handle smaller health threats**, such as high heat days and poor air quality events, though communication is limited in the closed area.
- Community members usually seek **relief from short-term heat stress** by going to a store, the casino, or other public air-conditioned space. Some have indicated that they might use a community cooling center during longer heat waves if such a place was available.
- The tribe recently convened an ad-hoc flood preparation group of staff to prepare for **flooding impacts**.

3.8 Forests

3.8.1 OVERVIEW OF RESOURCES

The western part of the 1.37-million-acre Yakama reservation has approximately 740,000 acres of productive forest and woodland. Generally situated on the eastern slopes of the Cascade Mountains, these areas contain stands with different types of dominant species, as indicated in Figure 7. Mixed conifer stands contain species such as grand fir, Douglas-fir, and western larch. Other stand types consist of lodgepole pine, Engelmann spruce, western red cedar, and other minor species. Figure 8, below, shows the major forest habitat types of the Yakama Reservation. Approximately 228,000 acres are within the drier portion of the Yakama Forest, which includes the Oregon oak, ponderosa pine, Douglas-fir, and dry grand fir habitat types.

Figure 7. Forest species composition on the Yakama reservation

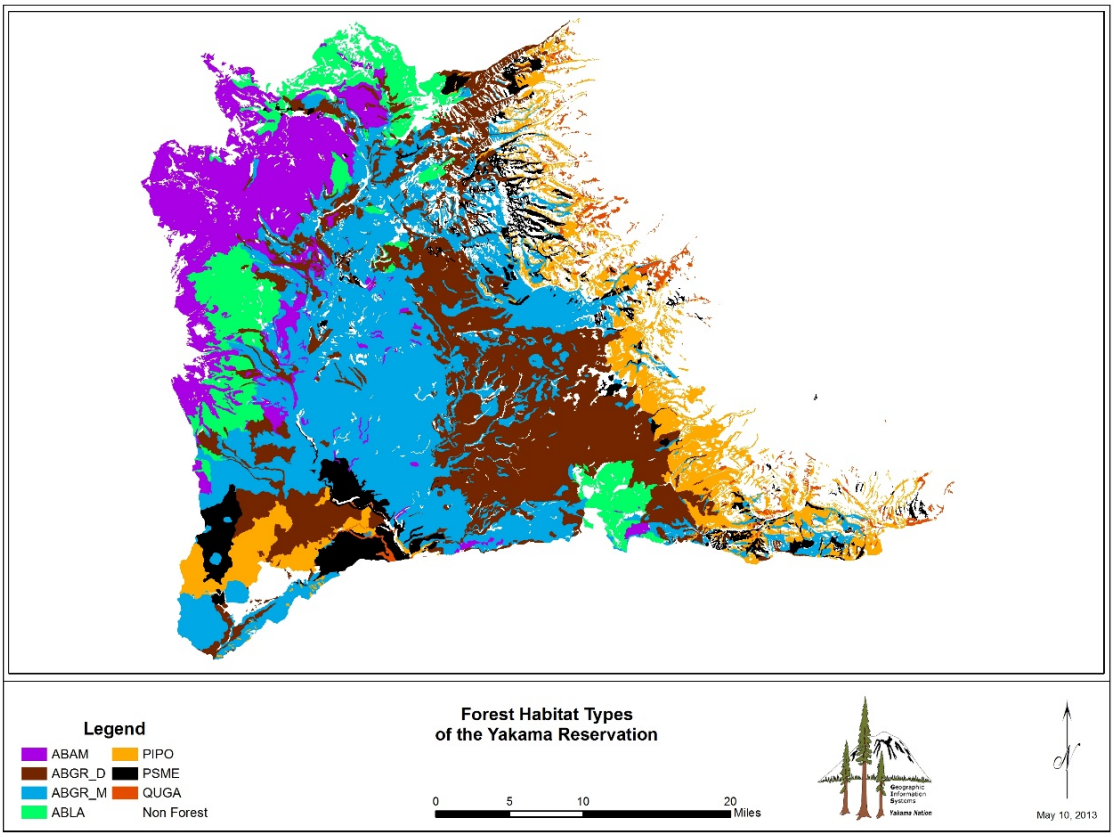


From a cultural perspective, forests provide foods and medicines that our ancestors have gathered and used since time immemorial. The Yakama timber resource, meanwhile, is essential to our economic, social, and cultural needs. The Yakama Nation has the largest volume of forestlands within the Bureau of Indian Affairs (BIA), containing an estimated 10 billion board feet of timber. The Yakama Nation generates a significant amount of revenue directly from the sale of timber, representing approximately 20 percent of the Tribe's total revenue. Timber is sold to Yakama Forest Products (YFP), a wholly owned Yakama tribal enterprise employing over 200 people, over 90 percent of whom are tribe-affiliated. More than 2,000 jobs are directly related to the Yakama forest and an estimated five times that many people benefit indirectly, including many tribal members who cut and sell firewood to supplement their income. The 2017 fiscal year budget for the federal branch of Forestry and YFP combined was approximately $15 million.

Existing Challenges to Resources

Over the last century, a number of changes in forest health have occurred on the Yakama reservation—very similar to the changes that have occurred throughout the inland west. Selective timber harvesting removed large ponderosa pine trees, leading to regeneration with grand fir and Douglas-fir. Livestock grazing changed the amount and species composition of ground vegetation. Less ground vegetation reduced amounts of fine fuels, which historically prevented surface fires from burning across the landscape.

Figure 8. Major forest habitat types within the Yakama Nation Administrative Forest



Forest Habitat Type	Abbreviation	Elevation
Oregon white oak	QUGA	Low
Ponderosa pine	PIPO	Low
Douglas-fir	PSME	Low
Grand fir, dry	ABGR_D	Low
Grand fir, moist	ABGR_M	Middle
Pacific silver fir	ABAM	High
Subalpine fir	ABLA	High

Practices to suppress natural fires also prevented fire from performing important ecosystem functions such as recycling nutrients, regulating species composition, and regulating forest stand densities.

In recent years, there has been some damage in the Yakama Forest caused by wildfire, insects, diseases, and wind. Two recent large wildfires, Mile Marker 28 in 2013 and Cougar Creek in 2015, resulted in 38,291 acres that burned at medium to high intensity. After the burned trees were salvaged, the burned acres were removed from the timber harvest schedule. These areas have been replanted but will require many decades to become productive again.

Insects and disease have been problematic as well. The western spruce budworm and mountain pine beetle epidemics resulted in large salvage operations to recover the value of dead and dying grand fir, Douglas-fir, and lodgepole pine. The resulting increased harvest volumes also affected the future harvest schedule. White pine blister rust is affecting whitebark pine, which is highly valuable for wildlife habitat.

3.8.2 ANTICIPATED VULNERABILITIES FROM CLIMATE CHANGE

The climate influences nearly all aspects of our forests, and changes in the climate are therefore expected to directly affect forest ecosystems. Temperature increases will be apparent, especially in winter. Drought duration and intensity are projected to increase.

These changes will impact forests differently depending on their elevations, age classes, species, and soil types. Increased mortality may occur in older forests. Warmer and possibly drier summers in Washington may increase tree growth at higher elevations but decrease growth in lower elevations and drier areas [15]. At low elevations, lower soil moisture will be a limiting factor, and habitats in these forests will be threatened by shrub-steppe encroachment. Reduced snow cover could also affect the soil moisture regime across forests. Overall, forests at the lower and upper timberlines will likely be exposed to modest degradation, while forests at middle elevations will likely remain generally stable.

Individual tree species vary in their tolerances to stress so it is expected that there will be a range of climatic impacts in the forest. Some forest species may not adapt well to anticipated changes and may therefore adjust their range or distribution northward or to higher elevations where the new climate is more suitable [16]. In contrast, some species may benefit from warmer temperatures. A vulnerability assessment of tree species that examined distribution, reproductive capacity, habitat affinity, adaptive genetic variation, and threats from insects and diseases indicates that the species common in the Yakama Forest that are most vulnerable to climate change impacts are whitebark pine, subalpine fir, Pacific silver fir, Oregon white oak, and grand fir (in order of decreasing vulnerability) [17].

Vulnerability Score:		
High Elevations	*Mid-Elevations*	*Low Elevations*
High Concern	**Moderate Concern**	**High Concern**
Exposure: Warmer and drier conditions may increase tree growth and support species migration in higher forests, but higher forests will continue to be more exposed to impacts from diseases and pests.	*Exposure:* Middle elevation forests will be exposed to warmer conditions and associated insect and disease risks but will face fewer limiting factors than higher or lower forests.	*Exposure:* Warmer and drier conditions may decrease tree growth in lower forests. These areas will be limited by soil moisture and habitat encroachment.
Sensitivity: Whitebark pine and subalpine fir are two high-elevation species more sensitive to climate change impacts **[17]**. Whitebark pine is more sensitive to temperature changes due to limited distribution and reproductive capacity as well as current stress from an existing disease, but it has high drought tolerance. Subalpine fir is more sensitive to precipitation changes and insect and disease risk due to limited reproductive capacity, adaptive genetic variation, and low drought tolerance.	*Sensitivity:* Species that will be especially sensitive to climate change impacts include Pacific silver fir and grand fir. Pacific silver fir has low adaptive genetic variation and low drought tolerance, making it more sensitive to precipitation changes [17]. Grand fir is more sensitive to heightened risk of insects and disease supported by warmer temperature and drought.	*Sensitivity:* Low-elevation Oregon white oak is more sensitive to temperature changes due to low adaptive genetic variation and limited reproductive capacity (dependent on animals for seed dispersal), though it is highly drought-tolerant [17].

Changes in climate can affect forest pest and disease responses in two fundamental ways: first, by lengthening or shortening the seasons when pests reproduce and complete their life cycles, and second, by weakening the host trees and leaving them more susceptible to insect attacks and plant disease. In particular, stress on trees from drought makes them more vulnerable to insect and disease damage. Specific effects in our region are difficult to predict at this time. For example, in some places in the Pacific Northwest, mountain pine beetles are projected to decline, and in other places they are expected to become more prevalent. On the Yakama reservation, forests in mid- and upper elevations will likely be more exposed to risks from increasing temperatures that support insect population growth than those at lower elevations.

Increased carbon dioxide within our atmosphere is also expected, which in turn could be beneficial to general plant growth and productivity. Although speculative at this time, this condition might actually help protect trees from pests and disease. Regardless, close monitoring and preparedness will continue to be an ever-increasing need as we move into an uncertain future.

Models suggest an increase in both area burned and biomass consumed in wildfire. Larger and more severe wildfires are expected with warmer temperatures and drier summer conditions [18]. Scientists project that the area burned annually in the Columbia Basin will double or even triple by the 2080s [18]. These impacts will incur significant costs to communities. More severe fires with larger extent of burned area is seen as the greatest risk to Yakama forest resources. Wildfire also bears implications for air and soil pollution. In addition to an air quality concern from smoke, when fire damage occurs at locations where harmful chemicals are located, it could result in toxic chemicals leaching into the local environment through the air and soil. One of the primary challenges for forest and wildfire managers today and in the future is to reduce the risk of stand replacement fires and the resulting catastrophic consequences. This will be especially challenging due to fuel buildup from fire suppression activities over many decades. The wildland-urban interface will require special attention to reduce fire hazards introduced by human activities.

Post-fire regeneration and restoration depends on the ability of seedlings to become established. Therefore, the impact of climate change on suitability for seedlings is important to consider. Only 15 percent of the area currently suitable for ponderosa pine, lodgepole pine, and whitebark pine in Washington is projected to remain suitable for all three species by the 2060s [19].

3.8.3 EXISTING PROGRAMS THAT CONTRIBUTE TO RESILIENCE

The Yakama Nation has taken an active role in managing and improving its forested lands, using an ecosystem approach, by implementing a complex and comprehensive Forest Management Plan (FMP).[8] All forested areas on the reservation, including the 114,000 acres owned by private or federal managers, must adhere to the FMP. The FMP is intended to:

- Enhance and maintain a diversity of forest conditions.
- Maintain sustainable production of commercial and noncommercial resources.
- Maintain the forest resource as a dependable source of spiritual renewal, food and medicinal plants, revenue, and employment for the Yakama people.

An important element of the FMP is the identification and explanation of five specific and distinct programs, which together aim to protect and enhance the forestlands of the Yakama reservation. These five programs are as follows:

- **Resource Protection Plan:** Provides direction for protecting the Yakama reservation forestland from fire, insects, diseases, and trespass.
- **Timber Management Program:** Provides direction for conducting timber management

[8] The FMP is a collaborative effort of the Yakama Nation and BIA natural resources programs, including Archaeology and Cultural Resources, Environmental Quality, Fisheries, Forestry, Range, Roads, Soil, Vegetation, Water Code, Water Resources, and Wildlife. The main topics within the FMP include, but are not limited to, big-game habitat, forest health, old growth, revenue and employment, threatened and endangered species, and water quality.

activities while protecting all resources.

- **Forest Development Program:** Provides direction for timber sale follow-up activities such as planting, pre-commercial thinning, fuel management, and prescribed burning.
- **Woodland Management Program:** Provides direction for managing woodland resources.
- **Human Resources Program:** Recruits Yakama Nation members into the forestry program and promotes their development as technicians and professionals.

In particular, forest management practices that increase the resilience of the Yakama Forest to climate change impacts include:

- **Fuel-load reduction** through post-fire replanting, slash and activity fuel burning after commercial timber sales and pre-commercial thinning, and hazardous fuel reduction projects along major roads.
- **Ongoing monitoring** projects, including the Continuous Forest Inventory, which has been monitoring diameter and height, growth, mortality, insects, disease, plant associations, and other parameters in 1,300 one-fifth-acre plots since 1959.
- **Seed stock** is collected and maintained for commercial species. With support from the U.S. Forest Service, the tribe is currently collecting seeds from healthy whitebark pines that exhibit resilience to blister rust.

3.9 Shrub-steppe and Rangelands

3.9.1 OVERVIEW OF RESOURCES

The shrub-steppe is a dominant and important landscape. It is a key component of our culture, providing essential foods and medicines to the Yakama people, and to our economy as livestock rangelands. The shrub-steppe is found throughout the eastern Yakama Nation territories, from the foothills of the Cascade Mountains to the Columbia River and continuing up to the intensively cultivated lands of the Columbia plateau. The typical shrub-steppe climate is relatively cold in the winter, with long periods of hot, dry days in the summer.

Shrub-steppe vegetation types cover over 1.8 million acres in this region and contain unique ecological communities in riparian areas, wetlands, sand dunes, and other micro-environments [20]. This landscape contains a variety of vegetation communities consisting of plants such as Wyoming big sagebrush, bitterbrush, currant, and serviceberry. The primary bunchgrasses include bluebunch wheatgrass and Idaho fescue. The soils tend to be shallow; some areas are grasslands historically maintained by fire. Stiff sagebrush and shrubby buckwheats are found together with Sandberg bluegrass. These lands of sage and grass support rare shrub-steppe plants and wildlife, including 30 wildlife species identified as priorities for conservation by the Washington State Department of Fish and Wildlife and 47 species of rare plants [20]. Important rivers and streams flow through these lands, including the Methow, Entiat, Wenatchee, and Yakima rivers; the Crab, Satus, Toppenish, and Rock creeks; and many others.

A portion of the shrub-steppe on the Yakama Nation reservation is used for rangelands. Of the Yakama Nation's 36 range units covering a total of 900,000 acres, approximately 400,000 acres are in open rangeland or shrub-steppe, while the remainder is in forest [21]. The Range Program administers grazing permits and manages livestock in order to help maintain rangelands that provide a number of different services and values. Approximately 30 percent of rangeland area owned by tribal members is permitted to other tribal members for grazing, while the remainder is permitted to non-tribal members. Leasing permits offer a secondary income source for these households.

Existing Challenges to Resources

Even in the absence of climate change, our shrub-steppe and rangelands have been subject to many pressures. Because of the natural abundance of many grasses throughout the shrub-steppe, European settlers used these lands extensively for cattle, then later for sheep grazing.

Cultivation for agriculture followed where it was practical. Throughout the entire period of these developments, numerous non-native species were introduced and have since flourished. As a result, the fragile shrub-steppe plant and animal communities have changed drastically over the past 150

years. Today, most of these lands continue to be used for agricultural purposes, with few large, connected areas left to persist in a natural or semi-natural state.

On our reservation, the overabundance of feral horses and, in some cases, the mismanagement of cattle continue to substantially alter our rangelands. The 2015 horse census estimated that close to 10,000 horses roamed freely about the reservation with little management. Their grazing habits favor the production of cheatgrass at the expense of native grasses. Due to their numbers, they compete with and deplete the abundance of food for many other wildlife species, such as sage grouse, deer, antelope and rabbits. Cattle and horses that dwell in sensitive riparian areas trample stream banks, which in turn accelerates erosion and disturbs many areas where we find our cultural foods and medicines. As a result, grazing is at times limited to ensure access to culturally important plant areas. These conditions are in place to promote both range and cultural uses of the shrub-steppe.

VULNERABILITY SCORE: HIGH CONCERN	
Exposure:	Precipitation changes expose rangelands to increased competition for water among native and non-native species. Increasing drought will also increase the risk of fire and changes in species composition in some eco-types.
Sensitivity:	Springs and other natural water sources are more sensitive to climate change impacts, as they are already under stress from horse and cattle populations. Areas that contain important cultural and medicinal plants will have greater consequences to the tribe if there are losses.

Wildfire is a significant challenge to our shrub-steppe and rangeland resources. Frequent large wildfires are removing large areas of sagebrush. Historically, natural fire occurred in these communities once every 30-100 years. Today, rangeland fires occur much more frequently, supported by fuel from cheatgrass and other invasive plants. In the wake of fires, cheatgrass is able to grow more readily, in turn supporting a more frequent occurrence of large fires. Most of these fires are human-caused, occurring near roads, military training ranges, and residential developments located near wildlands. After an area of rangeland is burned, it may be closed to grazing for at least three years, causing an impact on the ranchers, the tribal households that receive supplemental income from leasing, and the broader economy.

3.9.2 ANTICIPATED VULNERABILITIES FROM CLIMATE CHANGE

We have a limited understanding of how climate change may affect the shrub-steppe and the rangelands, but we know that it will add to the other stresses already mentioned. In general, we can expect that there will be a change in species composition, distribution, and abundance; changes in habitat suitability and invasive species; and an increased frequency of disturbance (such as fire or disease). However, we lack a clear understanding of how specific changes will be reflected on our shrub-steppe and rangelands.

Given the projected changes in precipitation patterns and temperatures, we expect that increasing water shortages will continue to draw livestock and horses to streams and wetlands for water. If

unmanaged, this activity could lead to overgrazing of plants in those areas, in turn damaging fragile aquatic and riparian ecosystems.

Our rangelands are directly affected by drought, though not as severely as farms. However, indirect effects of drought include the increased presence of conditions suitable for fire and the potential for the establishment and spread of invasive species. Water shortages, drought, fire, and invasive species could contribute to the loss of roots and naturally occurring food sources from the shrub-steppe, potentially making it difficult for tribal members to practice cultural traditions. Ultimately, these changes could lead to a transition from a native to a non-native baseline landscape.

Despite these concerns, it is also possible that we have reason for optimism. Many of the vegetative species may already be well-adapted for the warmer, drier conditions expected in the future. Climate change may also actually benefit our rangelands in some ways. Increases in carbon dioxide in the atmosphere, for example, may be favorable for many of the key species. Higher temperatures can also extend the growing season on rangelands at higher elevations.

Ongoing monitoring of the shrub-steppe and rangelands will be important to better understand how climate change affects these landscapes and how we can reduce the risks. In addition, continued research, learning, and preparation is needed to be ready to manage for detrimental impacts should they occur.

3.9.3 EXISTING PROGRAMS THAT CONTRIBUTE TO RESILIENCE

The Yakama Nation is already taking many actions to manage rangelands, reduce threats to the shrub-steppe ecosystem, and make these lands more resilient to climate change and other stressors.

- The Yakama Nation continues to work with the BIA to **determine how many cattle** to permit to ensure sustained, healthy functioning of the landscape.
- We help to **inform and update BIA grazing regulations** approximately every ten years.
- The Yakama Nation continues to undertake efforts to **manage the over-populated wild horses**.
- We are also engaged in **shrub-steppe restoration**, seeding native grasses, using herbicides to control cheatgrass, and planting native shrubs like sagebrush.

3.10 Floodplains, Rivers, and Fish

3.10.1 OVERVIEW OF RESOURCES

The floodplains are a dynamic feature on our landscapes. The vegetation within the floodplain is typically rich and diverse, particularly the riparian areas along the stream channel. Floodplains are critical for a wide variety of plant and animals. They connect the higher forests to the lower shrub-steppe ecosystems. In many ways, they are an ecosystem of their own. The rich and varied foods and resources found within the floodplains, riparian areas, and rivers are important to the Yakama people.

Salmon are perhaps the most important of our First Foods. According to our creation story, the salmon were the first to agree to care for the people. The First Foods nourish us, and we must protect them and the habitats that support them. Salmon represent a broad category of important species that includes steelhead, lamprey, freshwater mussels, trout, and other fish. We understand that bringing back our salmon will require us to restore a variety of important habitats that they need. These habitats include not just the river systems, but the riparian vegetation and the floodplains from the high elevations to their confluence with the Columbia River. This has become a high priority.

Existing Challenges to Resources

Climate change impacts are not the only pressures on our natural resources. Since the time of our treaty, there have been many changes. Land management practices, irrigation facilities and reservoirs, hydropower developments, and flood control measures have completely altered the floodplains and natural streamflow patterns well beyond what might be expected from climate change. For example:

- The proliferation of roads in our forested areas have accelerated water movement on the road surface, intercepting and concentrating sub-surface flows, picking up sediments and pollutants, and carrying all quickly into the stream.
- Irrigation has dewatered and, in some cases, entirely dried out some streams. Many other streams from which water is diverted for irrigation may someday have levels too low and be too warm to sustain healthy populations of cool-water species.
- Roads, railroads, and flood control dikes isolate overflowing streams from their floodplains. This not only accelerates runoff timing, but also reduces the ability for flooding rivers to recharge diminishing aquifers.
- Large reservoirs have long been developed in the headwaters of the Yakima, Naches, and Tieton rivers, significantly changing natural flow patterns and severely damaging our natural resources.

In sum, past and ongoing land and water practices throughout our territories continue to alter water runoff patterns and, in turn, affect natural biological and ecological cycles. Unfortunately, climate change will add to these concerns.

3.10.2 ANTICIPATED VULNERABILITIES FROM CLIMATE CHANGE

Streamflows throughout the territories of the Yakama Nation are highly dependent upon winter snowpack. As temperatures warm and these mountain systems become more rain-dominated, late summer flows are expected to decrease rapidly, as we have witnessed in recent drought years. Low flow conditions through summer and autumn will severely reduce and impair riparian areas and critical fish habitat. Low flows can also bring water temperatures to dangerous, if not lethal, levels and increase the concentration of contaminants—from agrochemicals, wastewater, pollutants, and other runoff—in rivers and streams.

VULNERABILITY SCORE: HIGH CONCERN	
Exposure:	Warmer summer stream temperatures and lower summer flows will reduce both habitat quality and quantity, especially for salmonid fish. Warmer waters may encourage increased disease and greater competition with, and predation by warm water fishes. Streams may see increased flooding in winter months. Riparian vegetation may be stressed with reduced late summer flows and reduced water tables.
Sensitivity:	All salmonids are sensitive to warmer water temperatures during summer months and higher winter flows, especially incubating eggs in nests. Many streams, riparian areas and floodplains are currently degraded and subject to increased degradation due to cumulative effects.

Today, there are water shortages in the Yakima Basin in approximately 14 percent of years. Towards the end of this century, we can expect that there will be water shortages for many irrigators in 43 to 68 percent of years if we don't change our management practices or take measures to increase resilience [1].

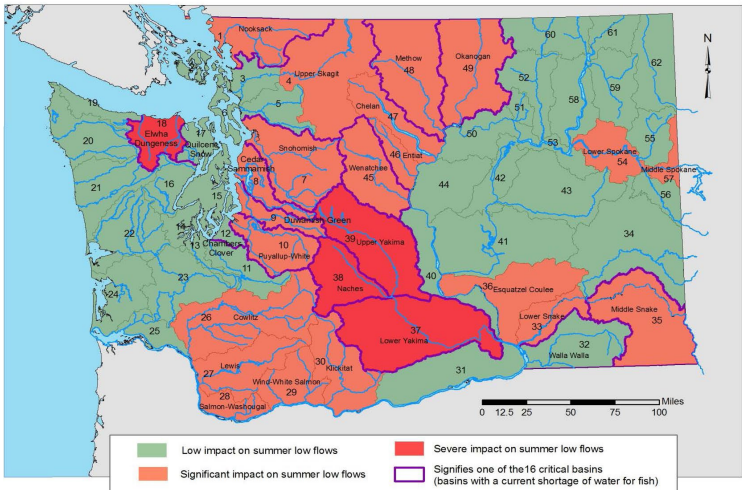


Figure 9. 2040 projected climate change impact on summer flows, by Water Resource Inventory Area (WRIA) [7]**.**

Figure 9, below, from the Yakima Basin Storage Alliance, shows that the Lower Yakima is one of 16 Water Resource Inventory Areas (WRIA) that already has a critical water shortage for fish and that climate change is expected to have a severe impact on summer low flows by 2040. By the 2080s, 19 percent more stream locations in eastern Washington are projected to experience weekly summer stream temperatures stressful to adult salmon (in excess of 67°F) [1].

With changes in river runoff patterns, we anticipate there will be increasing winter and spring floods that can reduce survival of fragile eggs, larvae, and very young age classes. More frequent flooding

may impact already-degraded fish habitat and destabilize channels. Without healthy riverine and floodplain vegetation and function, we can also expect a reduction in recharge to our important aquifers and wetlands.

The elevation of summertime stream temperatures that cause thermal stress and migration barriers to salmon is projected to at least double for many areas in eastern Washington and along the lower Columbia River [1]. Direct consequences to fish from these changing conditions include thermal stress, increased pre-spawning mortality, loss of egg and milt viability, and increased susceptibility to disease and parasites. We will likely also observe changes in migration and life history patterns, increased competition for space and food with warm-water species such as bass and Northern pikeminnow, and alterations in aquatic food webs.

An example of altering migration patterns is that sockeye migrations are happening earlier; the median passage date is advancing at a rate of 1.5 days per decade. Earlier migration is linked to survival—sockeye that come in later, when temperatures are warmer, return less successfully [22]. However, earlier migration also means the sockeye spend less time in the ocean, leading to lower fat reserves. Therefore, the net impact of this change in sockeye migration patterns remains unclear. It remains to be seen whether the fish will eventually reach a point where they can no longer successfully adapt to changing conditions by shifting their migration behavior.

On rangelands, the water remaining in streams and wetlands will be a magnet to unmanaged livestock, increasing degradation of fragile aquatic and riparian ecosystems through overgrazing of the plants and trampling of the stream banks and wetlands. Continued reductions in water supply are likely, which will continue to cause competition for water between in-river use, municipalities, and agricultural interests. These issues are complicated by the ever-increasing populations and demands throughout the territories of the Yakama Nation.

Increasing wildfire risk is also likely to increase sediments in adjacent streams. These sediments can smother eggs and aquatic foods important for overall stream ecology and fish abundance.

3.10.3 EXISTING PROGRAMS THAT CONTRIBUTE TO RESILIENCE

The Yakama Nation Natural Resources Program, Fisheries Program, Forestry Program, Range Management Program, Water Resources Program and our partners have been working hard throughout our territories to conserve water, improve flood management, recover fish populations, and restore streams. These include activities to help salmon and other fish thrive despite stressors like stream degradation, physical obstructions, and irrigation diversions. Considerable investments have been made in the Upper Columbia, the Yakima, and the mid-Columbia regions, not only in development of our hatcheries to support recovery of salmon, sturgeon, and lamprey, but also in substantial and large-scale restoration actions that focus on holistic measures to protect and restore floodplains, riparian areas, fish habitats, and ecosystem function. Habitat restoration and salmon recovery actions are also occurring in the Lewis and Cowlitz sub-basins, consistent with the goals of the Lower Columbia Salmon Recovery Board and under the purview of hydropower settlement and relicensing agreements. The Yakama Nation is an active participant in many regional forums working to ensure fish recovery and passage throughout the territories, whether it be through Columbia River hydroelectric dams, irrigation facilities, or culverts in smaller headwater tributaries.

The Yakima River Basin Integrated Plan identifies a comprehensive approach to water resources and ecosystem restoration improvements in the Yakima River Basin. The Integrated Plan includes seven elements: reservoir fish passage, structural and operational changes to existing facilities, surface water storage, groundwater storage, habitat/watershed protection and enhancement, enhanced water conservation, and market reallocation. The Integrated Plan was developed to address a variety of water resource and ecosystem problems affecting fish passage, fish habitat, and agricultural, municipal, and domestic water supplies. For additional information, see Section 3.1.4.

Additionally, there are Yakama Nation projects to restore wetlands and riparian habitats along floodplains and streams in many watersheds, which have received financial support from the Bonneville Power Administration [23, 24]. Plans laid out two decades ago include a goal to protect, restore, and manage 27,000 acres of floodplain lands along the Yakima River and Satus and Toppenish creeks by purchasing large pieces of land and their water rights and establishing natural vegetation. Ongoing monitoring of vegetation and hydrology at these locations may provide early indications of climate change impacts and inform a discussion about management practices that may need to be adjusted.

Other substantive stream and floodplain restoration activities are also occurring in the Columbia Basin, including:

- **Changing adult fish collection sites and release locations** to colder water sources when temperatures rise.
- **Improving fish passage** at culverts throughout the territories.
- **Piloting the innovative Whooshh system,** which can help to enhance fish passage.
- **Collaborating with Kittitas Reclamation District** to improve flows in some tributaries.
- **Buying floodplain land**, moving dikes, and removing infrastructure from flood zones.
- Working to **minimize water losses** along primary stretches of the Wapato Irrigation Project and setting up measurement mechanisms at delivery points to better understand usage (Yakima Tributary Access and Restoration Program).
- **Implementing aquifer recharge** on Agency Creek and Toppenish Creek, new as of 2014. If successful, this could be considered for replication elsewhere. In the past couple of years, the tribe has also been trying to **raise water tables in the alluvial fan.**
- **Making contingency plans for drought** and using drought decision-support tools.
- **Implementing water conservation practices** such as drip irrigation and reuse; this is being done by some of the farmers on Yakama Nation lands. The tribe is also planning for **irrigation upgrades** and seeking funding for implementation.
- Working in the tributaries to **restore river-floodplain interactions and surface water-groundwater interactions.**
- Improving species diversity and hydrologic resilience through **meadow restoration** efforts, such as the recent Lincoln, Renchler, and Starvation projects.
- Making a commitment to put about **100 cubic feet per second** of conserved water into the river, following 1994 enhancement legislation that established the Basin Conservation Program. This will improve summer flows, helping to offset the drops that could occur as a result of climate change
- Pursuing a **coordinated interdisciplinary approach** to manage water in agricultural areas in collaboration with the Water Resources, Fisheries, and Engineering programs. One outcome has been the **Toppenish Creek Corridor Plan.**
- Emphasizing climate change within the **2011 Water Resource Management Plan.**
- **Working with Yakima County to manage the mainstem of rivers as they relate to floods.** The County puts together comprehensive flood zone management plans; climate change should be more explicitly integrated into those plans in the next update.
- **Transforming a degraded tributary into wetlands and beaver complexes** to restore river-floodplain and surface water-groundwater interactions. This work was led by the Fisheries and Wildlife Programs.

3.11 Wildlife and Vegetation

3.11.1 OVERVIEW OF RESOURCES

The territories of the Yakama Nation have a rich variety of ecosystems and a diversity of plant and wildlife communities. All native species are important to the Yakama people and central to our religion, culture, and heritage. Although the Yakamas are known as a salmon tribe, honoring both salmon and water, the Yakama people highly value roots, berries, deer, elk, and many others as "First Foods," which are celebrated at the beginning of their respective seasons.

Through the passing seasons of each year, our people move about the landscape, following the availability of First Foods, other foods, and medicines and using the various plants and animals for traditional clothing, tools, artistic works, and many other things essential to our culture. In addition, some animals and plants are important for economic reasons and/or indicators of ecosystem health.

Within the realm of our natural resources, everything is connected. The spring sun warms the land, after which insects appear and the swallows return. The osprey return from their winter homes, which coincides with the migrations of the fish. With the melting snow, deer and elk return to the cover of the forest and the fresh grasses and shrubs of the meadows. Essentially, all wildlife are connected to the vegetation of the riparian and wetland areas, the shrub-steppe, the forests, and the alpine areas. As such, management of our vegetation communities is essential to management of our wildlife.

Existing Challenges to Resources

Climate change is expected to stress our wildlife and vegetative resources. But there are already many ongoing challenges that stress these species. Describing all of the ongoing stressors to wildlife and vegetation would take volumes. We provide a brief and limited summary below.

Foremost is the extraordinary explosion of human industry and occupation over the landscape over a short period of time. Within the memory of our elders, floodplains were filled with braided stream channels, a diverse assortment of vegetation, and an abundance of wildlife species. Now, many of these floodplains are filled with large communities and occupied by roads, highways, agriculture and industry, wastelands, and buildings.

Where sagebrush and grassland ecosystems once stretched for as far as the eye could see, we now have irrigated fields containing one crop or another and have allowed cattle, sheep, and horses to overgraze our pastures. In many of these environments, invasive species such as knapweed, cheatgrass, and Russian olive are spreading and nearly impossible to control at a larger scale. Many of these landscapes have changed dramatically, and much of the wildlife have been diminished in numbers and in diversity.

Our forest ecosystems have changed from excessive logging practices and the development of roads. Past logging typically neglected the land once harvested—or, in many cases, did not implement best management practices to maintain healthy new timber stands. Over time, fires were suppressed, stands became too dense, and insect infestations and disease were prevalent. These factors have led to a significant decrease in many wildlife habitats. More recently, we experience the annual threat of extreme wildfire events that have the potential to destroy everything. These changes are a direct response to human interaction and management of our landscapes. In the next section, we will overlay the impacts of climate change with human interactions on our wildlife and vegetation.

3.11.2 ANTICIPATED VULNERABILITIES FROM CLIMATE CHANGE

Climate change impacts on wildlife and vegetation include potential loss of certain vegetation communities and wildlife habitats, shifts in species ranges and diversity, invasive species, impacts on the food web and on our First Foods, and ever-increasing fire risk. We continue to work to restore and manage our lands to increase resilience, yet we may need to modify and intensify our approach in the face of future climate conditions. The projected consequences of climate change will magnify the existing primary threats to our ecosystems. All of these impacts contribute to the slow decay of traditional Yakama culture.

In fragmented landscapes, climate change is altering habitat composition and the timing of plant development cycles. Areas suitable for many plant communities are expected to decline in the future. It is possible that a variety of plant and animal species will not be able to keep up with the climate and geographic shifts in these ecosystems. Local declines or complete loss of wildlife and the loss of migration corridors and connectivity between summer and winter habitats may become increasingly severe.

VULNERABILITY SCORE: HIGH CONCERN	
Exposure:	Vegetation communities will be exposed to warmer temperatures and changes in precipitation patterns. These changes could seasonally affect food resources for certain wildlife species and potentially affect connectivity of habitats.
Sensitivity:	Wildlife species display a wide range of adaptive capacities, and it is likely some species will be less impacted than others. Species that depend on higher snow fall, wetlands, and higher levels of connectivity between seasonal habitats, for example, may be more sensitive to climate impacts and have higher levels of vulnerability.

Ecosystems and places that may be particularly vulnerable include:

- Riparian areas, wetlands, and floodplains **essential for aquatic wildlife, waterfowl, other birds, beavers, otters, mink, and raccoons.**
- Shrub-steppe communities **that are home to numerous species, including sage grouse, sharp-tailed grouse, coyote, pronghorn, wintering elk and deer, and plants that provide important foods and medicine.**
- Mountain meadows **that are important for water storage and a rich variety of plant and animal species, such as camas, roots and herbs, pikas, wolverines, and foxes.**
- Forests communities, **which harbor huckleberries, roots, oaks, western gray squirrels, spotted owls, woodpeckers, fishers, bears, deer, elk, songbirds, and many other species.**
- Alpine and subalpine ecosystems and headwaters **that are important for water storage and home to local populations of whitebark pine, Clark's nutcracker, mountain goats, pikas, wolverines, ptarmigans, lynx, and the American marten.**

Although some animals like deer and elk seem to be more resilient and survive across many landscapes, from rangelands to fringe and forest, they may see changes in their critical habitats (including wintering areas) driven by the expansion of invasive species such as cheatgrass. A resulting decrease in native forage may increase competition and lead to diminished populations. Animals may turn to more vulnerable or less suitable forage such as riparian trees and shrubs, which may then be affected by overgrazing.

We have already observed earlier budding and flowering of plants and are concerned about potential impacts to migrating species, which depend upon the timing of these cycles. Changes in plant calendars also affect the timing of our feasts, which have occurred earlier over the years. Berries ripen quickly and die out faster than in the past, which affects not only our ability to gather, but also the broader food web. For example, if bears have less food available to them, they will be less able to store adequate fat for overwinter hibernation.

Our tradition has always been to periodically, yet routinely, use fire as a tool to protect the forest and refresh the many vegetation communities contained therein. Now, for too many years, fires have been suppressed, which disrupts the natural cycles. Resulting fuel loads are often too high and summers are becoming unusually hot and dry. Uncontrolled wildfire is now becoming too common, threatening the plant communities upon which many of our wildlife species depend. Meanwhile, we continue to see increasing outbreaks of forest disease and bug infestations.

3.11.3 EXISTING PROGRAMS THAT CONTRIBUTE TO RESILIENCE

The Yakama Nation has taken great steps towards holistic management approaches that are consistent with our heritage and cultural interests. This is demonstrated through our management plans as well as through our fish, wildlife, law and order, and other codes protecting these resources. We have made progress towards management of our riparian areas and controlling invasions of Russian olive. Restoration activities have improved thousands of acres of riparian and shrub-steppe habitats and have reconnected dozens of miles of anadromous streams to their floodplains and surrounding wetlands. Integration of multiple resource interests continues to improve within our forestry practices. Our wildlife program is reintroducing sage grouse and pronghorn, managing elk and deer, and monitoring migratory waterfowl, horses, and bighorn sheep. Our ability to inventory and learn about the status and trends concerning our resources, including future effects from climate change, continues to improve.

Additional initiatives that the Yakama Nation Wildlife, Range, and Vegetation Resources Management Program is undertaking that are already contributing to climate resilience (or that could be modified or expanded to help build climate resilience) include:

- **Conducting meadow assessments** to evaluate stressors and their impacts on meadow condition and continuing ongoing efforts to remove invasive trees. Sporadic funding for this program has made it difficult to ensure its robustness.
- **Adjusting the terms of agricultural leases** to include clauses that protect wildlife habitat.
- **Managing riparian and wetland habitats** with an eye to protecting local waterfowl and other wetland residents like beaver, otter, and mink. Habitat management should more explicitly consider future climate change projections to ensure a better understanding of how these changes could present additional risks to key species and their habitats.
- **Purchasing farm properties** from willing landowners in order to convert agricultural land in riparian areas back into native habitat and shift farmland to non-riparian zones.
- **Protecting habitats and biodiversity by tackling invasive plant species** through an Integrated Weed Management Plan for the Yakama Reservation and a Priority Invasive Plant List. Key plants on this list include the scotch thistle, Japanese knotweed, purple loosestrife, yellow starthistle, and Russian olive. If we can better understand how climate change could intensify or counteract the spread of these and other invasive plants, we can better optimize our management decisions. The impacts of some invasive species—such as the Russian olive, which puts pressure on water reserves—may also be exacerbated by climate change impacts that affect water and other resource availability [25].
- **Assisting tribal members in the lower valley—White Swan, Wapato, and Toppenish—through the Nuisance Animal Management Program.** For example, the program can trap bears and release them farther away from populated areas [26]. The program may need to be expanded if climate change impacts at other elevations and in primary habitats drive large mammals to make more inroads into human communities.

These efforts are critical but will likely not be enough over time. We will need to continue integrating climate resilience actions into all of our ongoing and future planning and implementation.

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4.0 CULTURAL RESOURCES ACTION PLANS

Introduction

As stated in Section 1.2, the purpose of this document is **(1) to inform the people of the Yakama Nation of the threats that climate change brings upon us** and **(2) to begin substantive and directed actions that increase the resilience of all culturally important resources throughout all the territories of the Yakama Nation.** Section 2 briefly describes our understanding about how the climate is changing and some of the overall impacts it will have over our lands. In Section 3, we provided much greater detail about the vulnerabilities our people and our cultural resources face. With this information, we are better informed on how to continue our work to protect, enhance, and substantively increase the resilience of our resources towards the long-term impacts of climate change.

Section 4 contains many strategies that the Yakama Nation intends to implement over the years to come. Additional site-specific actions are found in the Section 5 Appendices. These actions are a result of a great deal of attention and considerations that link current climate projections to future issues.

The Action Plans in this section are intended to be revisited from time to time. As we continue to increase our knowledge and understanding through monitoring and collaboration with our many partners, adaptive management will inform both technical and policy work. It is through this approach that we will preserve our culture and our heritage by looking seven-generations forward and planning for the uncertain events we see on the horizon.

The goal of this Yakama Nation Climate Action Plan is to honor, protect, enhance, and restore all human and natural resources that support historical, cultural, spiritual, and economic practices of the tribes.

We will emphasize strategies that promote healthy communities, ecologies, and river systems to achieve this goal. We will protect tribal sovereignty and treaty rights and reclaim the precious resources and the environment on which they depend for our future generations.

To accomplish the important work before us, the Yakama Nation Tribal Council encourages all tribal members and our leadership to continue educating themselves and to act by keeping in mind the following:

- The Yakama Nation will remain **actively involved as a sovereign government** in national and international climate change discussions and negotiations and continue to pressure national governments to reduce emissions.
- The Yakama Nation will continue to work with other indigenous nations **to protect treaty rights, particularly in the context of a changing climate.**
- Tribal members will **educate each other and be educated on the present and future effects of climate change** on our homeland and will continue to be engaged in our progress towards these new challenges.
- The Yakama Nation will continue to **develop and strengthen relationships with neighboring governments and communities** regarding the protection and restoration of our resources. Collaborative actions may include long-term land use planning and continued improvements in emergency management for future extreme weather events.
- The Yakama Nation will develop and **implement strategies to unite tribes and communities** around long-term renewable energy capacity, resource utilization, habitat protection, and resource restoration in order to increase climate resilience while maintaining a strong economic base.
- The Yakama Nation will be **prepared for impacts on culturally significant plant and animal species** throughout the territories of the Yakama Nation.
- The Yakama Nation will protect, **enhance, and secure future sources of culturally important foods and sources of fresh water** to meet the future needs of our tribal communities and economies.

YAKAMA NATION CLIMATE CHANGE ACTION PLAN

4.1 Water Resources

Water is central to our lives. It is, in essence, all things within our culture and ourselves. The importance to the Yakama Nation of clean and plentiful water cannot be described on this page, or within any document. It is a gift from our Creator from which life itself is created.

One of the two most important effects from climate change will be the way we receive our water and the timing of the snow or rainfall. The other important effect will be increased summer temperatures, which will intensify our need for water. We already live in an environment where there is greater demand for water than is available. As the communities within the territories of the Yakama Nation continue to grow and the effects of climate change become more pronounced, future generations will face unprecedented challenges in water conservation and management.

Our future strategies must integrate the many governmental and non-governmental institutions that share this common concern, and these strategies must incorporate restoration of natural hydrological processes through (1) active and innovative improvements in our water storage and delivery, (2) efficiency in water use, and (3) long-term monitoring towards improved knowledge and resilience.

DESCRIPTION OF THE ANALYSIS AREA

The focal area is the Yakima River Basin, including tributary streams on the Yakama Nation reservation lands (Satus and Toppenish creeks) as well as the Naches-Tieton tributaries. Many of the strategies and actions included in this section also apply to all waters within the territories of the Yakama Nation.

PRIMARY FEATURES THAT DESCRIBE OUR WATER RESOURCES

To understand and to manage our water resources holistically, we must recognize the fundamental parts. By recognizing these parts, we can identify specific strategies and actions to improve resilience and to address our long-term monitoring needs. Through this knowledge, we are able to develop regional solutions through collaboration with the many other management entities responsible for water management.

Glaciers and Snowpack

Throughout the territories of the Yakama Nation, much of the available water comes in the form of snow. Over long periods of time, much of this water has accumulated on the mountains in the glaciers, which provide abundant cooler water in the later summer and autumn months. From these glaciers, we see a slow release of the water from the mountains into the lower valleys. From time immemorial, this natural cycle has provided an abundance of life-giving resources to the Yakama people. With climate change, we now see the glaciers receding and the precipitation falling more as rain, rather than snow.

Seasonal snowpack is very important to water supply, instream flows for fish, and other benefits. More than three-quarters of our precipitation falls from October to May, much of it as snow in the mountains. Snow acts as a natural reservoir that stores water during the winter, releasing it as melt water during the dry summer. Studies have shown that melting snow generates runoff at higher rates than rainfall; this means that the predicted reduction of snowfall and snowpack will likely reduce runoff, as well as change the timing of runoff.

Rivers and Streams

In the higher elevations, smaller tributary streams collect the melting snow and rain, then combine these waters into our rivers. The rivers bring life to our people. We depend on these rivers to bring our salmon back to their native spawning grounds. Many foods and resources are found along the river corridors and floodplains, and this is where we have maintained many of our communities for countless centuries. But these places have changed greatly during the recent years. In the upper basins, great reservoirs have been created and, within the floodplains, much human industry and occupation has destroyed the natural flow of the water and many of the resources on which our past ancestors thrived. We expect that climate change, along with many other stressing factors, will continue to change the natural flow of the rivers and the quality of the water.

Wetlands

The territories of the Yakama Nation provide many lakes and wetlands that contribute to the rich diversity of our heritage and to their ecosystems. These areas support many species—many which cannot live anywhere else. For most of the spring and summer growing seasons, the water is found above the surface supporting vegetation such as sedge, bulrush, rushes, pondweed, and others. A variety of birds and mammals depend up these areas for water and to find food. Several amphibian species rely completely on these areas for their existence. Wetlands have already been destroyed or extensively damaged by unregulated grazing, agriculture, roads, and invasive species. Climate change will likely change the water tables, and we are concerned we may lose many of our wetlands completely. We are afraid for the loss of species associated with these important habitats and changes in these ecosystems.

Aquifers and springs

Aquifers are underground layers of water-bearing rocks. These rocks or unconsolidated layers of silt, sand, and gravel have cracks and spaces that contain or transmit water and air. Water can move from place to place underground, as well as to the surface to feed streams and springs, or extracted by wells drilled by people. Aquifers can contain vast amounts of water, which is often cool and very clean. When found near the surface, water flows from the earth—called springs—which contribute to our wetlands and our rivers. These underground water resources are very important. Wells are drilled into the aquifers and clean water is pumped out. Aquifers are recharged from rain and melting snow, but this happens at different rates depending on many factors, including soil types, geology, and the amount and intensity of precipitation or melting. We do not yet fully understand how climate change may affect this resource. This will need to be monitored closely and actions to protect and enhance our aquifers are a high priority.

IMPORTANT CHANGES TO MONITOR AND TRACK

The impacts of climate change will intensify our current challenges in managing water resources in Washington. Watersheds within the territories of the Yakama Nation were historically a mix of rain and snow in winter, but these will likely become more rain-dominated. We do not know, and it is difficult to predict what will happen over time. Careful monitoring is required to understand not only the rate of change, but what we must do to protect this precious resource.

Glaciers and Snowpack

- There will continue to be reductions in the amount of water naturally stored in snowpack and glaciers due to rising temperatures and increasing winter runoff.

Aquifers and Springs

- With prolonged or more intense summer air temperatures, we expect excessive water withdrawals from aquifers and rivers beyond that which is sustainable year after year.
- Declining late summer streamflow and reduced aquifer recharge will increase demand for water, more intense competition for scarce water resources, and more conflicts among water users.
- Increases in winter rainfall will pose additional challenges for managing reservoirs for flood control, fish, and hydropower.

Wetlands and Lakes

- With increasing drought, we can expect to see wetlands degrade and dry up sooner in the year—maybe completely.
- With increasing summer temperatures, water use will increase, which could affect the aquifers as well as associated wetlands.
- Livestock use in wetlands will increase and without sufficient control will continue to degrade water quality, habitat function, and other species use.

Rivers and Streams

- More frequent and intense floods will change the stream channel characteristics—potentially degrading the overall river channel. This could increase the likelihood of flooding beyond the channel banks and expose homes and other structures to damage or destruction.
- Increased frequency of droughts will reduce streamflows and will contribute to increases in water temperatures. These factors will contribute to changes in stream and riparian ecology and reduce water available for other beneficial uses.
- Reduced flows during the summer and autumn months may change the species composition and distribution of riparian vegetation—many of which have high value to the Yakama people for food, medicine, and other uses.
- Changes in the timing of streamflows will affect salmon life cycles, including the destruction of nests, reduction in seasonal movement for juvenile fish, or the loss of adult migration corridors due to lack of summer water quality and quantity, among other things.

Reservoirs and Irrigation

- Multiple disturbances to wetlands from reservoir and irrigation management practices over time may contribute to loss of species, habitats, and ecosystems.

4.1.1 WATER RESOURCES ACTION PLAN

GOAL **There will be a secure, healthy, and sustainable supply of clean water for the beneficial uses of all cultural resources despite climate change impacts.**

OBJECTIVE **IMPLEMENT ON-SITE ACTIONS TO PROTECT AND IMPROVE RESILIENCE OF OUR WATER RESOURCES.**

The following **Strategies** have been identified to support this **Objective**:

1. **Implement the Yakima River Basin Water Resources Management Plan.**
2. **Support Recommended Adaptation Strategies and Actions – Water Resources**, as documented by the Washington Department of Ecology.9
3. **Identify and encourage water conservation measures in residences and towns** in collaboration with the public and local municipalities. Water conservation measures may include, but are not limited to, promoting water reuse, converting existing landscaping, and establishing policies to encourage or require native and/or drought-tolerant landscaping, including replacing lawns.
4. **Make use of the strategies and collaboration mechanisms** in the Yakima River Basin Integrated Water Resource Management Plan; potentially expand the Plan to make sure climate change impacts are more explicitly considered.
5. **Decrease pollutants released into water bodies.** Use environmentally friendly alternatives to pesticides and improve efficiencies in diversion, conveyance, delivery, and use of water to minimize return flows and toxic materials back into rivers.
6. **Increase resilience of stream** crossings, including culverts and bridges, to higher peak flows.
7. **Where feasible, reduce roads or road systems within the floodplains** to reduce flooding of roads and stream crossings.
8. **Manage and reduce sediment** generated by roads.
9. **Increase upland storage using innovative techniques** such as restoring and maintaining healthy beaver populations and developing analog structures to store surface water and local aquifers.
10. **Restore function of watersheds** by reconnecting floodplains to river channels, supporting aquifer recharge and groundwater dependent ecosystems, reducing drainage efficiency of

[9] See State of Washington Department of Ecology, "Preparing for a Changing Climate: Washington State's Integrated Climate Response Strategy," Publication No. 12-01-004 (April 2012).

upland roads and channelized streams, maximizing valley water storage, and reducing fire hazard.

The following are specific **Actions** to be completed associated with these **Strategies**.

Location: *Yakima River Basin (adopted from the Integrated Plan)*

Structural and Operational Changes Element (Systems Modification Component)

- *Cle Elum Pool Raise, Kittitas Reclamation District Canal Modifications*
- *Keechelus-to-Kachess Pipeline*
- *Subordinate Power at Roza Dam and Chandler Powerplants*
- *Wapatox Canal Improvements*

Surface Water Storage Element (Water Supply Component)

- *Wymer Dam and Pump Station*
- *Kachess Reservoir Inactive Storage*
- *Bumping Lake Reservoir Enlargement*
- *Study of Columbia River Pump Exchange with Yakima Storage*

Enhanced Water Conservation Element (Water Supply Component)

- *Agricultural Conservation Program*
- *Municipal and Domestic Conservation Program*

OBJECTIVE

PRESERVE TRADITIONAL ECOLOGIC KNOWLEDGE AND MAINTAIN ACTIVE POLICY DEVELOPMENT, LONG-TERM PLANNING, AND APPROPRIATE ENFORCEMENT OF REGULATIONS TO eNSURE EFFECTIVE ADAPTIVE MANAGEMENT.

The following **Strategies** have been identified to support this **Objective**:

1. **Implement the Yakima River Basin Water Resources Management Plan.**
2. **Update the 2011 Yakama Nation Water Resources Management Plan to further consider climate change.**
3. **Develop policy recommendations for the Water Code** to specifically address irrigation wells and surface allocation on tribal lands.
4. **Work closely with the State of Washington** in the implementation of the Strategies and Actions identified in the 2012 **"Preparing for a Changing Climate: Washington State's Integrated Climate Response Strategy."**
5. **Encourage and incentivize the use of meters.**
6. **Increase coordination within the communities to understand the extent of wells and their impact on flows**. Promote tying such wells to mandatory conservation.
7. **Evaluate the need to develop integrated water resource management plans** for each sub-basin and incorporate climate change considerations into those plans.
8. Provide input to municipalities' **drinking water management plans** to encourage consideration of potential for diminished supplies under climate change and the need for long-term climate adaptation strategies.
9. **Develop a plan to improve water storage** through continued and expanded recharge within the Toppenish and Simcoe Creek alluvial fans.
10. **Develop a plan to improve the network of real-time water and weather stations** (e.g., gauging stations, snow telemetry (SNOTEL), local weather), which are fundamental for drought and flood warning and forecasting, water supply forecasting and monitoring, and long-term water resources planning.
11. **Consider developing a new tribal drinking water management plan**. Integrate climate change information into the plan to ensure sustainable resources in the long term.
12. **Plan and prepare** for more frequent and severe flood events.
13. **Increase resilience by reducing stressors** such as human population encroachment on floodplains and increased efforts to reduce non-native, noxious species.

OBJECTIVE

BY INTEGRATING TRADITIONAL ECOLOGICAL KNOWLEDGE, ENCOURAGE RESEARCH, MONITORING, AND TECHNICAL ASSESSMENTS TO UNDERSTAND OUR CHALLENGES AND MEASURE OUR PROGRESS.

The following **Strategies** have been identified to support this **Objective**:

1. **Conduct a groundwater study** to determine the impacts of excessive aquifer drawdown on flows to Toppenish and Simcoe creeks and associated drainages.
2. **Use new and update existing models to improve seasonal water supply forecasts** and thereby inform irrigation allocation, drought declaration, and planning, regulation and distribution of instream flows to various users and cultural resources.
3. **Evaluate the long-term adequacy of water delivery infrastructure** to ensure that changes in *hydrological* patterns (e.g., increases in flooding frequency or reduction of late summer water availability) can be anticipated and managed effectively.
4. **Continue to monitor changes in the amount of water stored in snowpack and glaciers** due to rising temperatures and increasing winter runoff. Add additional monitoring sites as warranted.
5. **Develop a long-term monitoring strategy that integrates annual flow, hydrologic patterns, water temperatures, and the presence and relative abundance of fish and other aquatic organisms** to measure potential encroachment of warmer-adapted species into historically cooler waters.
6. **Monitor and prioritize** areas for wetlands and meadow management.

OBJECTIVE

SUPPORT OUTREACH AND EDUCATION FOR OUR CHILDREN, COMMUNITIES, AND GOVERNMENTAL BODIES.

The following **Strategies** have been identified to support this **Objective**:

1. **Develop and employ curriculum for students at various educational levels** that illustrate and teach children why climate change is occurring, how cultural resources may change, and how students can become meaningfully engaged in gaining a better understanding and contribute to the protection and resilience of our important water resources.
2. **Develop materials for tribal membership and general public education** that demonstrate the cultural and economic values of floodplains, riparian habitat, aquifers, rivers, and aquatic resources. Identify the specific messages intended for the various audiences and an effective array of tools to convey these messages.
3. **Prepare outreach materials, meet regularly, and work closely** with local and regional elected officials, agency policy representatives, non-governmental organizations, and staff

about the cultural interests of the Yakama Nation. Develop long-term and effective collaborative relationships and actions to protect and enhance resilience of our natural resources.

4. **Consolidate technical findings of research, monitoring, and evaluation** to inform adaptive management processes that inform ongoing climate change discussions and policy direction.
5. **Increase resilience of water supply** by developing a community-based approach to water conservation at all levels of community organization.
6. **Coordinate with local and regional toxics cleanup regulators** to update climate change adaptation planning and implementation guidance.

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4.2 Roads and Transportation

DESCRIPTION OF THE ANALYSIS AREA

The analysis and implementation area is the Yakama Nation Reservation.

IMPORTANT CHANGES TO MONITOR AND TRACK

- Higher peak flows will lead to increased road damage at stream crossings.
- Higher peak flows will lead to increased damage and disrupted access to facilities and cultural and historical resources.
- Higher peak flows and flood frequency may increase damage to trails and bridges, requiring more maintenance, replacement, or closures.
- Increased landslides will lead to more road closures, higher maintenance costs, and disrupted access.
- Increased trail failures will be associated with erosion and landslides.
- Soil saturation will increase, which will increase the need for trail maintenance.
- Trail and bridge failures will increase risk to public safety.
- Increased flooding will lead to fewer campgrounds, greater use of alternative campgrounds, greater use of fewer facilities, and reduced services.
- Increased length of the snow-free season will increase demand for access.
- Increased flooding of roads and culverts will increase sedimentation in streams.
- Lower summer flows, higher winter peak flows, earlier peak flows, and lower groundwater recharge will cause higher demand and competition for water by municipalities and agriculture.
- Shift in hydrologic regime involving changes in timing and magnitude of flows will lead to lower summer flows and higher, more frequent winter flows.

4.2.1 ROAD AND TRANSPORTATION ACTION PLAN

GOAL **Tribal members will be able to travel safely and reliably to their destinations, and the Yakama Nation will be able to adequately, affordably, and sustainably construct and maintain roads within their purview in the context of a changing climate.**

OBJECTIVE **IMPLEMENT ON-SITE ACTIONS TO PROTECT AND IMPROVE RESILIENCE OF OUR ROADS AND TRANSPORTATION RESOURCES.**

The following **Strategies** have been identified to support this **Objective**:

1. Consider climate change when prioritizing and assessing the viability of transportation infrastructure projects such as new or improved roads and bridges. Consider enlarging road crossings and culverts to prepare for flooding. Assess whether proposed new assets will be viable in the coming decades as the climate changes, and adjust materials and design as needed to increase their resilience.
2. Continue to increase maintenance of roads and other transportation infrastructure. For example, conduct more frequent storm drain and culvert cleaning, debris removal, and performance monitoring.

The following are specific **Actions** to be implemented associated with these **Strategies**.

- **Develop policy towards the design of roadway infrastructure to anticipate future conditions associated with climate change.**
- **Continue to monitor roadway conditions and make road maintenance an annual priority to ensure resilience and public safety.**
- **Continue to identify specific transportation needs and issues relative to climate change.**

OBJECTIVE **MAINTAIN ACTIVE POLICY DEVELOPMENT, LONG-TERM PLANNING, AND APPROPRIATE ENFORCEMENT OF REGULATIONS TO ENSURE EFFECTIVE ADAPTIVE MANAGEMENT.**

The following **Strategies** have been identified to support this **Objective**:

1. **Develop a plan for alternative emergency routes** to enable people to get to their destinations when roads are flooded or otherwise impacted by extreme weather events. When the plan is in place, develop outreach materials and public service announcements to inform the tribal community.
2. **Climate change should be integrated with Yakima County flood management** associated with all county roads within the reservation.

The following are specific **Actions** to be implemented associated with these **Strategies**.

- **Model future local traffic loads and patterns for transport origins and destinations.**
- **Research historical climatic and weather events affecting local transportation systems and anticipate potential for reoccurrence.**
- **Anticipate worst-case scenarios in planning, design, and maintenance for severe seasonal weather conditions.**
- **Determine tribal preparedness and emergency actions needed to improve evacuation procedures on all reservation roads.**

OBJECTIVE ENCOURAGE RESEARCH, MONITORING, AND TECHNICAL ASSESSMENTS TO UNDERSTAND OUR CHALLENGES AND MEASURE OUR PROGRESS.

The following **Strategies** have been identified to support this **Objective**:

1. **Learn about and test new materials** for roads and other infrastructure assets that might perform better under current and future climate conditions.

The following are specific **Actions** to be implemented associated with these **Strategies**.

- **Monitor new construction and maintenance materials and practices being implemented to deter the effects of climate change.**
- **Continue to follow highway industry standards for materials and infrastructure.**
- **Use proven materials and practices in future projects.**

OBJECTIVE SUPPORT OUTREACH AND EDUCATION FOR OUR CHILDREN, COMMUNITIES, AND GOVERNMENTAL BODIES.

The following **Strategies** have been identified to support this **Objective**:

1. **Explore opportunities to collaborate with the County** on planning for climate change impacts on roads, including roads that are maintained by the County.

The following are specific **Actions** to be implemented associated with these **Strategies**.

- **Plan for climate change impacts to county and state roads, as well as its effects upon the tribal transportation system.**
- **Invite county, state, and regional transportation planning organizations to participate in tribal transportation and climate adaption planning efforts.**

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4.3 Facilities

DESCRIPTION OF THE ANALYSIS AREA

The analysis and implementation area is the Yakama Nation Reservation.

4.3.1 FACILITIES ACTION PLAN

GOAL **Tribal facilities will provide safe and comfortable places for community members to work, recreate, and take shelter during times of crisis, despite climate change**.

OBJECTIVE **IMPLEMENT ON-SITE ACTIONS TO PROTECT AND IMPROVE RESILIENCE OF OUR FACILITIES RESOURCES.**

The following **Strategies** have been identified to support this **Objective**:

1. **Work with cities, schools, and churches to ensure availability of public emergency shelters and cooling centers** and consider offering additional spaces at tribal facilities if necessary.

OBJECTIVE **MAINTAIN ACTIVE POLICY DEVELOPMENT, LONG-TERM PLANNING, AND APPROPRIATE ENFORCEMENT OF REGULATIONS TO ENSURE EFFECTIVE ADAPTIVE MANAGEMENT.**

The following **Strategies** have been identified to support this **Objective**:

1. **Consider climate change impacts when planning operations, budgets, and new assets; rehabilitating existing assets; and when determining the relative priority of proposed projects.** Consider whether the proposed enterprise or infrastructure asset can reasonably be anticipated to be viable and sustainable in the coming decades as the climate changes, and plan for measures to increase its resilience.
2. **Consider the need for redundant power** and acquire generators for emergency shelters, if needed, to accommodate system disruptions due to flooding and more frequent storms.

OBJECTIVE ENCOURAGE RESEARCH, MONITORING, AND TECHNICAL ASSESSMENTS TO UNDERSTAND OUR CHALLENGES AND MEASURE OUR PROGRESS.

The following **Strategies** have been identified to support this **Objective**:

1. **Develop a plan for emergency management, including designated facilities for shelter and the roles and responsibilities of tribal staff.** Educate Tribal staff about the plan and their roles.
2. **Inventory current conditions of tribal building stock,** determine the best use of buildings, and assess the need for increasing energy efficiency. Develop a plan to carry out these changes, including retrofitting, adjusting use, and increasing operational efficiency.

OBJECTIVE SUPPORT OUTREACH AND EDUCATION FOR OUR CHILDREN, COMMUNITIES, AND GOVERNMENTAL BODIES.

The following **Strategies** have been identified to support this **Objective**:

1. **Develop outreach and education materials** that will inform the tribal community about near-term and longer-term climate change threats and the available resources and facilities available to them in case of crises.

YAKAMA NATION CLIMATE CHANGE ACTION PLAN

4.4 Housing

DESCRIPTION OF THE ANALYSIS AREA

The analysis and implementation area is the Yakama Nation Reservation.

4.4.1 HOUSING ACTION PLAN

GOAL **Tribal members will feel comfortable and safe in their homes despite future effects from climate change.**

OBJECTIVE **IMPLEMENT ON-SITE ACTIONS TO PROTECT AND IMPROVE RESILIENCE OF OUR HOUSING RESOURCES.**

The following **Strategies** have been identified to support this **Objective**:

1. **Evaluate the need to improve or retrofit tribal housing**, especially for those most vulnerable to temperature or precipitation extremes.
2. Ensure appropriate and easy **access to potable water and sewer**.
3. **Develop more effective ways to improve tenant participation** in reporting maintenance issues and energy efficiency practices.

The following are specific **Actions** to be implemented associated with these **Strategies**.

1. Identify means for additional funding to improve Yakama Nation Housing Authority staff capacity to respond to reports of maintenance and other improvement issues.

OBJECTIVE **MAINTAIN ACTIVE POLICY DEVELOPMENT, LONG-TERM PLANNING, AND APPROPRIATE ENFORCEMENT OF REGULATIONS TO ENSURE EFFECTIVE ADAPTIVE MANAGEMENT.**

The following **Strategies** have been identified to support this **Objective**:

1. **Improve back-up energy generation capacity and emergency plans** for Yakama Nation Housing Authority parks and to ensure coordinated support for tenants during times of crisis.
2. **Pursue additional funding opportunities** or revenue streams to support YNHA management and maintenance.

OBJECTIVE ENCOURAGE RESEARCH, MONITORING, AND TECHNICAL ASSESSMENTS TO UNDERSTAND OUR CHALLENGES AND MEASURE OUR PROGRESS.

The following **Strategies** have been identified to support this **Objective**:

1. **Develop means for private Yakama Nation HUD houses to monitor housing conditions** and potential repairs and find additional support for repairs and resilience improvements.
2. **Evaluate the need among the greater tribal community for housing, access to water and sewer**, and public level of support for resilience-building repairs and retrofits.

OBJECTIVE SUPPORT OUTREACH AND EDUCATION FOR OUR CHILDREN, COMMUNITIES, AND GOVERNMENTAL BODIES.

The following **Strategies** have been identified to support this **Objective**:

1. **Develop outreach and education materials** that will inform the tribal community of the real and potential dangers of climate change and help the community prepare for these changes.
2. **Develop education and outreach activities** for Yakama Nation Housing Authority tenants and the tribal community at large to encourage energy conservation in the home.

YAKAMA NATION CLIMATE CHANGE ACTION PLAN

4.5 Farmlands

DESCRIPTION OF THE ANALYSIS AREA

The analysis area is within the Yakama Nation reservation lands.

4.5.1 FARMLANDS ACTION PLAN

GOAL **Farmlands will be managed using practices and resources sustainably to grow crops that are resilient to a changing climate. Farmlands will provide a source of income for tribal landowners into the future.**

OBJECTIVE **IMPLEMENT ON-SITE ACTIONS TO PROTECT AND IMPROVE RESILIENCE OF OUR FARMLAND RESOURCES.**

The following **Strategies** have been identified to support this **Objective**:

1. **Evaluate opportunities to improve real-time forecasting of soil moisture content and local weather conditions** to improve efficiencies in water delivery and other agricultural practices. Identify ways to improve retention of soil moisture, such as appropriate application of manure or other organic materials.
2. **Evaluate the costs and benefits associated with implementing technological improvements that would automate the entire Wapato Irrigation Project (WIP) District** to improve delivery timing, water conveyance, and use efficiency, and then implement prioritized improvements.
3. **Install devices to accurately measure water use at all turn-outs** and throughout the Wapato Irrigation Project system at appropriate locations.
4. **Partner with agricultural extension offices** to encourage sustainable farming practices that are aligned with future climate conditions to prevent the overuse of pesticides and fertilizer.
5. **Find new high-value crops** that can withstand higher temperatures and use less water (20” or less per season). Incentivize farmers to plant those crops.

OBJECTIVE MAINTAIN ACTIVE POLICY DEVELOPMENT, LONG-TERM PLANNING, AND APPROPRIATE ENFORCEMENT OF REGULATIONS TO ENSURE EFFECTIVE ADAPTIVE MANAGEMENT.

1. **Improve enforcement capabilities** to control unauthorized water use throughout the WIP District.
2. **Plan for long-term staffing needs for WIP District operations** that will support a high level of efficiency in water delivery, system operations, maintenance, and enforcement.
3. **Develop strategies that acknowledge potential future water savings** and provide alternate uses for this additional water, including community consumption, benefits to native fish and aquatic species, alternative crop production practices, and alternative options for industry and commerce.

OBJECTIVE ENCOURAGE RESEARCH, MONITORING, AND TECHNICAL ASSESSMENTS TO UNDERSTAND OUR CHALLENGES AND MEASURE OUR PROGRESS.

The following **Strategies** have been identified to support this **Objective**:

1. **To support recharge of aquifers, evaluate the ability to apply water to croplands outside of the normal growing season** in years when excess water is available.
2. **Continue to evaluate and implement all best management practices** (BMPs) to improve efficiencies in water use on crops, including choosing hybrids or other heat-resistant crop varieties best suited to arid land agriculture, using drip systems to optimize water and nutrient applications, using plastic covers between vegetable crops to reduce water loss and growth of noxious weeds, and making improvements to soil conditions to increase water retention. Explore funding opportunities to support implementation of BMPs, such as re-directing Natural Resources Conservation Service (NRCS) funding.
3. **Continue to explore opportunities for increasing irrigation efficiency** and returning diverted water back into stream channels during critical flow periods. Look at the Wapato Irrigation Project and the Rosa Project, for example, as places that may have the largest difference in temperature between withdrawal and returns.
4. **Evaluate locations, costs, and benefits associated with building one or more re-regulating reservoirs** in strategic locations within the WIP District. Consider undertaking a storage assessment to understand the potential of the Wapato Irrigation Project or other sources (e.g., the Yakima River) to provided irrigation water to the Toppenish-Simcoe Unit.
5. **Evaluate the potential for lost land and agricultural revenues** due to climate change to highlight the challenge and motivate action. Reclaim lands for non-agricultural use.

6. **Evaluate the potential impacts of climate change on bees and other important pollinators.** Explore whether there are other native insects and bees (besides honeybees) that could be used and understand their relative levels of resilience to climate change impacts.

OBJECTIVE SUPPORT OUTREACH AND EDUCATION FOR OUR CHILDREN, COMMUNITIES, AND GOVERNMENTAL BODIES.

The following **Strategies** have been identified to support this **Objective**:

1. **Engage farmers in research and outreach efforts and develop educational programs and materials** that can be distributed to members of the tribal and agricultural communities to provide information about potential climate change vulnerabilities or opportunities. These materials should include water conservation practices, opportunities for rain water collection, and use of gray water where appropriate. They should also explore alternative energy sources and distribution mechanisms such as the use of solar panels.

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4.6 Air Quality

DESCRIPTION OF THE ANALYSIS AREA

The analysis and implementation area is the Yakama Nation Reservation.

4.6.1 AIR QUALITY ACTION PLAN

GOAL **The air that we breathe will be clean and free of excessive smoke and other pollutants that come from the impacts of climate change.**

OBJECTIVE **IMPLEMENT ON-SITE ACTIONS TO PROTECT AND IMPROVE RESILIENCE OF OUR AIR QUALITY.**

The following **Strategies** have been identified to support this **Objective**:

1. **Inventory water withdrawal sites for fire suppression and dust management use** on tribal roads and lands. Describe their anticipated future capacity and availability with projected diminished water supplies.
2. **Increase indoor fitness and exercise opportunities for adults** at facilities that can serve as cooling centers as well as alternatives to outdoor activity during times of low air quality.

OBJECTIVE **MAINTAIN ACTIVE POLICY DEVELOPMENT, LONG-TERM PLANNING, AND APPROPRIATE ENFORCEMENT OF REGULATIONS TO ENSURE EFFECTIVE ADAPTIVE MANAGEMENT.**

The following **Strategies** have been identified to support this **Objective**:

1. **Establish tribal workforce policies to protect outdoor workers** in times of high heat or wildfire smoke (e.g., providing masks or other protective equipment or establishing limits on amount of time spent outside).
2. **Continue working with schools** on plans for handling excessive smoke or dust and possible protocols around canceling outdoor events.
3. **Develop and implement a smoke management plan**, including regulating outdoor burn

permits, to manage smoke events from wildfire and prescribed burns and reduce impacts on community members and outdoor workers.

4. **Work closely with the State of Washington** to implement the strategies and actions identified in Washington State's 2012 Integrated Climate Response Strategy.

OBJECTIVE ENCOURAGE RESEARCH, MONITORING, AND TECHNICAL ASSESSMENTS TO UNDERSTAND OUR CHALLENGES AND MEASURE OUR PROGRESS.

The following **Strategies** have been identified to support this **Objective**:

1. **Work with the Washington State Department of Health, Washington State Department of Ecology, community hospitals, and health organizations** to monitor and forecast heat waves and smoke-related air quality issues.

OBJECTIVE SUPPORT OUTREACH AND EDUCATION FOR OUR CHILDREN, COMMUNITIES, AND GOVERNMENTAL BODIES.

The following **Strategies** have been identified to support this **Objective**:

1. **Continue implementing public awareness and outreach campaigns** that notify people about how to get information about, prepare for, and respond to extreme heat and wildfire smoke events, as well as strategies for reducing or mitigating symptoms of allergies and asthma.
2. **Develop and implement campaigns for indoor air quality** issues and strategies.

YAKAMA NATION CLIMATE CHANGE ACTION PLAN

4.7 Emergency Services

DESCRIPTION OF THE ANALYSIS AREA

The analysis and implementation area is the Yakama Nation Reservation

4.7.1 EMERGENCY SERVICES ACTION PLAN

GOAL **Tribal members will have reliable access to health services and facilities for ongoing and emergency care to support their physical and mental well-being in the face of climate change impacts.**

OBJECTIVE **IMPLEMENT ON-SITE ACTIONS TO PROTECT AND IMPROVE RESILIENCE OF OUR EMERGENCY SERVICES.**

The following **Strategies** have been identified to support this **Objective**:

1. **Inventory the availability of cooling centers** for use on extreme heat days by community members who don't have air conditioning at home. Partner with other jurisdictions to identify additional facilities and educate tribal members about their options.
2. **Review current research on climate change impacts on health and educate community** about relevant impacts (e.g., put out an informational sheet when we hear about new outbreaks or risks).
3. **Install more permanent and more noticeable road markers in the closed area** so people can evacuate in times of wildfire or other emergency.
4. **Explore ways to provide generators and Meals Ready-to-Eat (MREs) for tribal facilities** that could be designated as emergency shelters.

OBJECTIVE **MAINTAIN ACTIVE POLICY DEVELOPMENT, LONG-TERM PLANNING, AND APPROPRIATE ENFORCEMENT OF REGULATIONS TO INSURE EFFECTIVE ADAPTIVE MANAGEMENT.**

The following **Strategies** have been identified to support this **Objective**:

1. **Collaborate with other fire districts** to develop a plan for coordinated and comprehensive fire management coverage across the reservation.
2. **Formalize a standing committee on flood preparedness.**
3. **Develop a field safety training for outdoor staff** (Natural Resources, Engineering, Transportation) about symptoms and response for heat stroke, heat exhaustion, and asthma attacks. Provide the training at the start of the field season each year.
4. **Work closely with the State of Washington** to implement the strategies and actions identified in Washington State's Integrated Climate Response Strategy.

OBJECTIVE ENCOURAGE RESEARCH, MONITORING, TECHNICAL ASSESSMENTS TO UNDERSTAND OUR CHALLENGES AND MEASURE OUR PROGRESS.

The following **Strategies** have been identified to support this **Objective**:

1. **Assess the capacity of local clinics** to respond to emerging health threats and to integrate climate preparedness into their hazard response plans and daily operations. Talk to doctors and nurses about how climate change can affect allergen abundance and disease vectors and what they will need to be prepared.

OBJECTIVE SUPPORT OUTREACH AND EDUCATION FOR OUR CHILDREN, COMMUNITIES, AND GOVERNMENTAL BODIES.

The following **Strategies** have been identified to support this **Objective**:

1. **Sign up for the Northwest Climate and Health Network** and use it to share and gather information, resources, opportunities, and best practices (http://listsmart.osl.state.or.us/mailman/listinfo/nw-climate-and-health).
2. **Talk with nearby jurisdictions about collaboration** on emergency planning and potential emergency shelters (e.g., schools).

YAKAMA NATION CLIMATE CHANGE ACTION PLAN

4.8 Forests

The forests on the eastside of the Cascade Mountains run through central Washington and the south and western portions of the Yakama Nation. These forests contain extensive and diverse landscapes of great cultural significance. Our people have always gone to the forests for our spiritual, social, and cultural needs. Forests provide many foods, medicines, and resources that are collected throughout the year. And, more recently, these forests have contributed timber products and jobs for our people and to the economy of the Yakama Nation.

Our huckleberry fields are one of many resources central to our culture. For countless centuries our people have travelled into the forests to camp and to harvest huckleberries and many other types of food and medicinal plants while enjoying the cool and refreshing environments the forest offers. Our water comes from these lands. Salmon and many other animals depend upon this cool, clean water. Since time immemorial, the Yakama people have managed and cared for these forests. We are very much a part of them.

There is great natural complexity and diversity of the many types of forests found within the Territories of the Yakama Nation. Additionally, these forests are now managed through many private, state, and federal agencies under a wide variety of goals and regulatory frameworks. Because of this complexity, the Yakama Nation calls on local, state, and federal forest managers to work collaboratively across the landscape to better protect our future forests and build resilience towards the specific effects that climate change may bring.

IMPORTANT FEATURES OUR FORESTS

As we consider potential effects from climate change, we must consider the important features of a forest. The forest is complex, so we need to simplify the landscape into manageable units that have important characteristics in common. The most basic unit is called a "habitat-type" and within the Yakama Forest, there are seven different habitat-types. These habitat-types are shown in Section 3.8.1, Figure 8.

Habitat-types are described by the dominant tree species, but there are many other tree and plant species included in any one forest stand within that habitat-type. This is known as the composition of the forest. Within the seven habitat-types in the Yakama Forest, 55 different plant groupings, or associations are recognized. There is great species diversity in the Yakama Forest. Where and how each of these species or plant associations are located throughout the forest is known as its

distribution. Having a larger and complex distribution pattern is important for the long-term persistence of the plant species.

The size (geographic area) of the timber stand and the density of the vegetation within that stand are also important features. The size of a stand is important for many reasons, for example, for the economic value of its timber, for useable wildlife habitat, or for its contribution to species and ecological diversity over the landscape. The density of a stand is important because it is a measure of how closely trees are growing together and how much light penetrates the forest canopy and contributes to the shrub or understory vegetation near the ground. Density contributes to wildlife habitat and helps keep water cool along the streams and rivers. Stand density also plays a very important role in allowing snowfall to reach the forest floor and accumulate. This is a complicated process but contributes to soil moisture and in many cases, the health of the timber stand.

Accumulations of snags (standing dead trees) and down woody material (logs on the ground) are essential features of a healthy forest. Snags and downed woody debris provide nesting, roosting, and feeding habitat for many wildlife species. Over 60 species of birds and mammals on the Yakama Forest use snags for nesting or shelter. Some sensitive species on the Yakama Forest that are snag-dependent include the flammulated owl, Vaux's swift, pileated woodpecker, Lewis woodpecker, acorn woodpecker, Williamson's sapsucker, black-backed woodpecker, three-toed woodpecker, white-headed woodpecker, and western bluebird.

Health of the vegetation along the streams and rivers (called riparian areas) is a very important feature of the forest as the vegetation helps shade the stream, keeping the water cool. Riparian woodlands are valuable for stream bank protection and maintenance of water quality and habitat for many wildlife and plant species of cultural significance.

DESCRIPTION OF THE ANALYSIS AREA

We distinguish three forest zones, each with their own unique characteristics. All of these trees and habitats are found within the Yakama Forest but are also widely represented throughout the east slopes of the Cascade Range.

Higher elevation forests are the subalpine forests. Here, the spring-summer growing season is shorter and summer temperatures are typically cooler. Snowpack covers the ground from November through April, or longer. The trees of these forests consist of subalpine fir, silver fir, hemlock, whitebark pine, and other prevalent species.

Lower elevations consist of the drier coniferous forests and woodlands. These forests maintain large stands of ponderosa pine, Douglas-fir, and Oregon white oak along the lower vegetative boundaries.

At the mid-elevations, we recognize the moist-mixed conifer forests that are somewhat intermediate to the higher and lower elevations and consist of a wide variety of species such as Douglas-fir, grand fir, western larch, western hemlock, and many other tree and shrub species. Within this elevation band, as well as in the higher and lower elevations, wetlands are present which allow for stands of

aspen and black cottonwood.

IMPORTANT CHANGES TO MONITOR AND TRACK

It is important to keep in mind that, on a broad scale throughout the territories of the Yakama Nation, forest health suffers from past management decisions that have neglected post-harvest stand health, excluded fire from the system, and increased destructive insects and disease. The effects of climate change will likely make things worse.

The following statements capture much of our concern from which resiliency actions are identified in the Forest Climate Action Plan.[10]

General Trends

- Changes are expected in species composition, relative abundance, and species distribution patterns.
- Increased warming, drought, and wildfire will stress trees, reduce tree vigor, and increase susceptibility to insects and pathogens with increased potential for large and extensive outbreaks, particularly of non-native insects and pathogens.
- The frequency and scale of these disturbances will likely increase in area and severity with climate change.
- There will be increased opportunity for exotic and non-native species to establish, and habitats on the east side of the Cascades are potentially more susceptible.
- Fragmented plant or tree populations and rare species that have limited distribution or smaller population sizes may be lost due to shifting vegetative patterns over time.
- Areas with limited species and genetic diversity will likely be more susceptible to climate change stressors like limited moisture and higher temperatures.
- There may be an increase in hazard trees that threaten people and infrastructure.

[10] Adopted and adapted from Adaptation Partners' Climate Change Adaptation Library for the Western United States [32].

Higher Elevations

- Higher temperatures may increase stress for some species in the colder upland and subalpine forests.
- Over a longer timeframe, there may be a loss of subalpine areas for traditional uses of plant species.
- The distribution of subalpine forests is likely to shift as a result of increasing temperatures with climate change. Because these forest types often already exist in marginal habitat and soil conditions, these shifts may be more northerly. These species or communities may not be able to move upslope to adjust.
- With shifts in temperature and moisture, there may be increased tree growth, regeneration, and establishment at the upper tree line for certain forest species. Some of these species may be migrating upwards from the mid-elevation temperate forests.

Given the complex ownership and jurisdictional landscape of the territories of the Yakama Nation, resource managers will need to find new and innovative ways to increase collaboration. Professional institutions such as the Great Northern Landscape Conservation Collaborative, the Washington Wildlife Habitat Connectivity Working Group National Climate Assessment, Climate Science Centers, and Regional Integrated Science and Assessment partnerships, for example, should be maintained and strengthened to meet this objective.

Lower Elevations

- Because of the reduction of snowpack and increased summer temperatures, we expect increased forest drought, resulting in additional tree stress and decreased growth, vigor, and forest productivity at lower elevation forests.
- Climate change will lead to a loss of large ponderosa pines through increased risk of stand-replacing wildfire and mortality from drought. These losses may be most noticed near the lower boundaries and lower tree lines.

4.8.1 FOREST ACTION PLAN

GOAL

Forest management will enhance and maintain a diversity of forest conditions, maintain sustainable production of commercial and noncommercial resources, and thereby maintain the forest resource as a dependable source of spiritual renewal, food and medicinal plants, revenue, and employment for the Yakama people in the context of climate change.

OBJECTIVE

IMPLEMENT ON-SITE ACTIONS TO PROTECT AND IMPROVE RESILIENCE OF OUR FORESTRY RESOURCES.

The following **Strategies** have been identified to support this **Objective**:

1. **Interpret existing watershed models describing forestry and snowpack interactions** to project changes in runoff, temperature, and precipitation and inform changes in forest management practices to maximize water retention, including prioritization of areas for watershed protection [27]. Continue developing models as new information becomes available.
2. **Continue fuel-reduction efforts,** including restoring natural disturbance regimes through prescribed fire to augment natural processes and mimic natural patterns for specific ecological systems.
3. **Survey and map whitebark pine** [17]. This species has the most restricted range of all species on the reservation.
4. **Manage stand density through thinning** to enhance biodiversity and decrease mortality, especially at low elevation in preparation for soil moisture limitations [17]. When conducting treatments, select for stress-tolerant species and genotypes.
5. **Continue the regeneration planting program** to ensure establishment of desired species at the desired density.
6. **Continue the seed collection and propagation program in collaboration with other tribal, state, and private nurseries,** including assessing the viability of seed in storage to ensure planting can be done on a regular basis to ensure productivity in the future [17, 27]. Focus on seeds and genotypes that will be more resilient to climate change impacts.
7. **Facilitate migration of species** to higher elevations, including Douglas-fir, spruce, and white pine, and ensure forest management practices support their establishment and growth.
8. **Control and eradicate existing infestations of non-native and invasive species**, pests, and pathogens, and reduce risk of new occurrences.
9. **Identify and prioritize funding opportunities** to support climate change adaptation efforts [27].

OBJECTIVE

PRESERVE TRADITIONAL ECOLOGIC KNOWLEDGE AND MAINTAIN ACTIVE POLICY DEVELOPMENT, LONG-TERM PLANNING, AND APPROPRIATE ENFORCEMENT OF REGULATIONS TO ENSURE EFFECTIVE ADAPTIVE MANAGEMENT.

The following **Strategies** have been identified to support this **Objective**:

1. **Continue the existing Continuous Forest Inventory monitoring program,** including permanent monitoring plots at all elevations, to monitor changes in tree growth, survival, and reproduction [17, 27]. Use GIS data to identify and map critical connectivity gaps, areas of refugia, and high-priority areas for conservation in a changing climate, based on habitat and cover type.
2. **In collaboration with other state and federal management agencies, continue to conduct climate change vulnerability and risk assessments for priority forest species,** including commercial and culturally significant species, under a range of climate change scenarios and ensure forest management practices reduce vulnerability and mitigate risk [27].
3. **Incorporate climate change impacts into management plans,** including the Forest Management Plan, Invasive Weeds Management Plan, and Fire Management Plan. Develop species-specific management approaches to address impacts, as necessary [27].

OBJECTIVE

BY INTEGRATING TRADITIONAL ECOLOGICAL KNOWLEDGE, ENCOURAGE RESEARCH, MONITORING, AND TECHNICAL ASSESSMENTS TO UNDERSTAND OUR CHALLENGES AND MEASURE OUR PROGRESS.

The following **Strategies** have been identified to support this **Objective**:

1. **Ensure post-fire bare area emergency rehabilitation (BAER) plans consider climate change impacts** more explicitly and include protocols and techniques that promote forest ecosystem resilience and facilitate adaptation under a range of possible future conditions.
2. **Consider joining or creating a cooperative tree seed bank** to conserve genetic diversity and **consider expanding the seed collection program to include culturally significant species** beyond commercially important species [17].
3. **Ensure management practices continue to protect streams, riparian areas, and other aquatic habitats** as centers of habitats and biodiversity. Maintain riparian vegetation to maintain cool stream temperatures.
4. **Monitor for a change or reduction in size and hydro-period of wetlands,** paying attention to nutrient availability, productivity, species composition of important foods, medicines and riparian obligate species.

OBJECTIVE SUPPORT OUTREACH AND EDUCATION FOR OUR CHILDREN, COMMUNITIES, AND GOVERNMENTAL BODIES.

The following **Strategies** have been identified to support this **Objective**:

1. **Increase awareness and capacity among tribal resource professionals** about climate change impacts and opportunities to address them through collaboration, such as the Landscape Conservation Cooperative [27].
2. **Implement education and outreach activities** to engage tribal members and non-tribal public to increase their understanding of projected climate change impacts on forest resources important to the Yakama Nation [27].

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YAKAMA NATION CLIMATE CHANGE ACTION PLAN

4.9 Shrub-Steppe and Rangelands

The lands characterized as shrub-steppe stretch from the foothills of the Cascade Mountains east, across great expanses of land within the Columbia Basin. Although arid, it is diverse in its ecosystems, species, and resources important to the Yakama Nation. The extensive uplands range from true shrublands, through steppe to dry grasslands. Soils also vary, driving some of these changes in vegetation, even including very sandy soils that, carried by wind, support active dune systems. In places where moisture accumulates, either at low points as it flows downhill, or because underground aquifers are accessible to plants' roots, riparian and wetland habitats flourish, supporting a wide array of plant and animal species.

From our growing awareness of the potential impacts from climate change to our natural resources and rangelands found within the shrub-steppe environments, this Climate Action Plan is an important step in addressing serious threats to our culture and to our heritage. We recognize that the Yakama Nation cannot implement the necessary actions alone. Because of the complexity of these issues, the Yakama Nation calls on local, state, and federal land and resource managers to work collaboratively across the landscape to better protect our natural resources and build resilience towards the specific effects that climate change may bring.

IMPORTANT FEATURES OF OUR SHRUB-STEPPE AND RANGELANDS

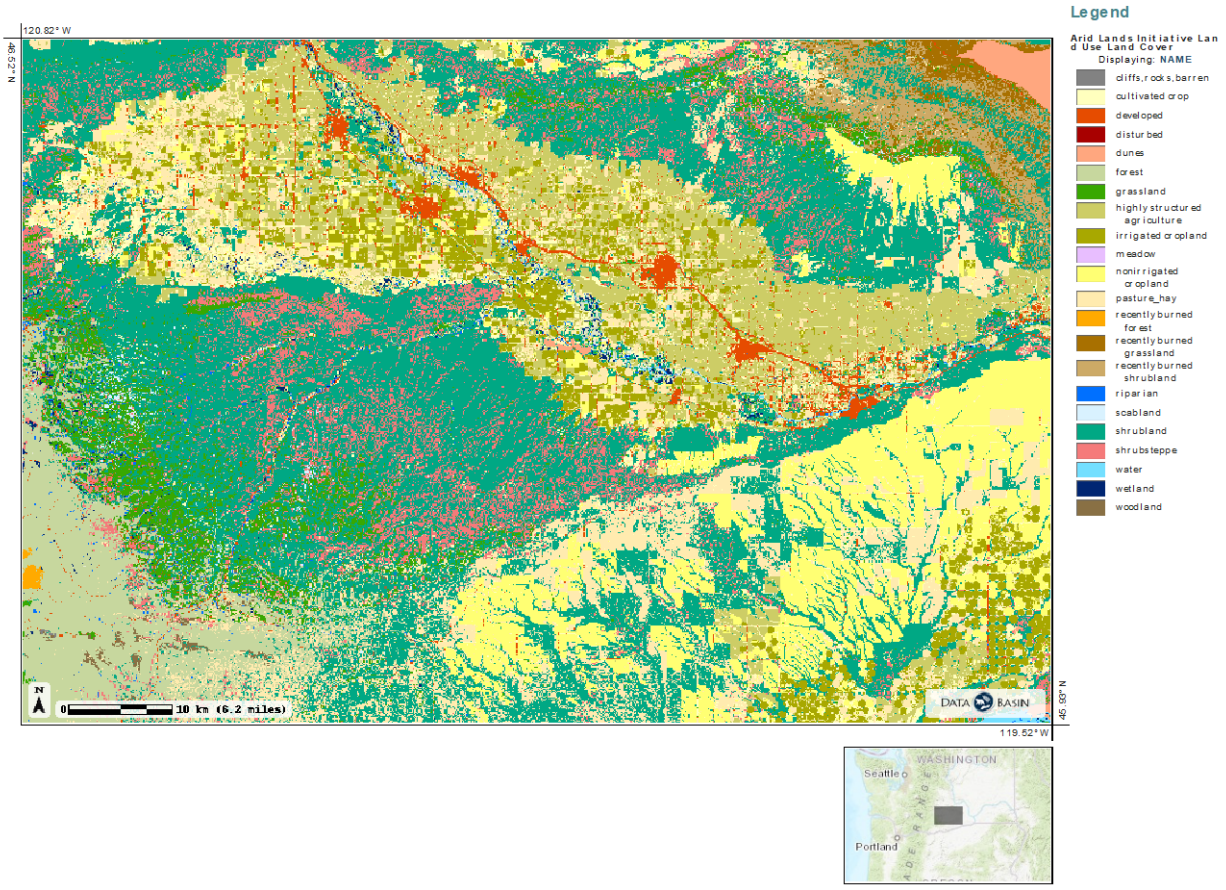
The shrub-steppe and rangelands that characterize the lower elevations of the Yakama reservation are diverse, thanks to varied elevation, gradients in precipitation, and variations in soil types and topographical features. This diversity is expressed through a variety of shrub-steppe and grassland ecological systems, or habitat types, with different abundance of plant functional types—shrubs, bunchgrasses, forbs—and different species dominating each functional group. Across the reservation, shrublands and shrub-steppe habitats dominate the landscape, with smaller areas supporting scabland shrublands, dunes, and grasslands (Figure 10).

The condition of these habitats varies as well. Fires tend to eliminate the shrub layer, and if they are too frequent, may transform shrub-steppe lands into grasslands. Both the legacy of past grazing and current overgrazing—including by feral horses—also impact the condition of these rangelands. For example, overgrazing has favored the expansion of invasive annual grasses such as cheatgrass. This expansion of non-native annuals interacts with other issues, like fire, as abundant cheatgrass favors more frequent fires, sometimes leading to impacts on the native bunchgrasses, and to further

increases in cheatgrass abundance.

This shrub-steppe and grassland landscape is intersected by vegetation that depends on accumulated moisture, such as riparian woodlands and shrublands along creeks and draws, as well as dispersed meadows and depressional wetlands (Figure 10). The additional moisture in these habitats supports greater plant productivity and other functions, leading these systems to provide disproportionate amounts of services and values compared to the surrounding arid uplands.

Figure 10. Map of habitat types in and around the Yakama Reservation [28].



Shrub-Steppe Habitats: These habitats have similar structural characteristics, yet encompass different plant associations, depending on the site—its precipitation, soils, topographical position—and on fire history. Shrub-steppe habitats are dominated by perennial bunchgrasses and forbs (over 25% cover), have an open but moderately dense shrub layer, and support biological soil crusts that can cover up to 90 percent or more without disturbance. Common shrub (sage brush) species include *Artemisia tridentata* var. *tridentata* in drier sites, *Artemisia tripartita* in moister and cooler areas, and *Purshia tridentata* in sandy or rocky areas, including in the transition with the dry forest. Some shrub-steppe habitats are characterized by other, smaller shrubs, like *Grayia spinosa*. Dominant grass species also vary depending on soils and climatic variables, with *Pseudoroegneria spicata*

accompanying big sagebrush in drier sites, *Festuca idahoensis* in moister sites, and *Hesperostipa comata* in sandy sites.

Historically, fire maintained a patchy distribution of shrubs and occurred with sufficiently low frequency that the shrubs could reestablish between burns (rather than convert to a grassland), and the bunchgrasses, forbs, and biological crusts maintained the integrity of the system in the interim. Overgrazing, disturbances that impact the biological soil crusts, and invasion by *Bromus tectorum* can lead to degradation of shrub-steppe habitats, in turn leading to decreased plant diversity and decreases in the diversity and abundance of birds and other animals it supports. In addition, many deep-soil shrub-steppe areas have been converted to agriculture, fragmenting the remaining habitats.

Grasslands: The distinguishing feature of grasslands is the lack of the shrub layer, generally due to frequent fire combined with a lack of seed source. Vegetation is dominated by perennial bunchgrasses and forbs, and the soil between these plants is rarely bare, but rather covered with mosses and lichens; biological soil crusts are very important in these habitats. Grass species can be similar to those found in the shrub-steppe habitats, but may also include species like *Achnatherum hymenoides*, *Elymus elymoides*, *Elymus lanceolatus* ssp. *Lanceolatus*, *Koeleria macrantha*, or *Poa secunda*.

Fire is a critical ecological process that maintains grasslands in the region. Other disturbances have in some sites degraded the condition of these grasslands. Overgrazing, invasion by annual exotic species (like cheatgrass), alteration of the fire regime, and disturbance of the soil surface all have impacted the condition of the grassland and its ability to provide the services and values important to the Yakama Nation. Deeper soil grasslands are rare, as they have mostly been converted to agriculture. This conversion also contributes to fragmentation of these habitats, another component of degradation.

Scabland Shrublands: These habitats occur on shallow, rocky soils (called lithosols) and though they have similar components to the shrub-steppe habitats, they are characterized by low vegetation cover. These open habitats have a shrub layer composed of dwarf-shrubs and sub-shrubs, including *Artemisia rigida*, *Eriogonum thymoides* and other buckwheat species. The bunchgrasses and forbs also have low cover, with the dominant bunchgrass being the short *Poa secunda*. Forbs are scattered but diverse, including vibrant spring wildflowers and species of particular cultural value, such as bitterroot. As in other habitat types, the biological soil crusts cover the bare ground between plants in the absence of disturbance.

These scabland shrublands are sensitive habitats and can be greatly impacted by soil disturbance. Sometimes such disturbance is natural, due to frost-heaving or the action of small mammals and their predators. Vegetation cover is generally too low for fire to carry, so lithosols (shallow, not well-formed soils) tend to create “islands” within extensive burns. These soils do not support agriculture, and so much of the original lithosols still remain as shrublands. Other development, such as wind and solar energy, however, are impacting these habitats and the species they support.

In addition to the more extensive upland habitats described above, the Yakama reservation includes other smaller patches of unique habitats, as well as riparian areas, meadows, and depressional wetlands that are scattered throughout the landscape. Topographical features such as cliffs and talus slopes create sparsely vegetated areas that have unique habitat characteristics for some wildlife species, such as nesting locations for ferruginous hawks and other raptors. Areas with high sand content, actively moving with the wind, or stabilized by native vegetation, create dune habitats that also provide unique characteristics important for some species. And though they cover small extents, wetter systems like meadows, wetlands, and riparian areas support a disproportionate number of plant and animal species and contribute significantly to the tribe's cultural resources.

DESCRIPTION OF THE ANALYSIS AREA

For the initial analysis supporting this Climate Action Plan, our focus has been on the shrub-steppe and rangelands of the Yakama Nation, the Yakima Training Center, and Joint Base Lewis-McCord. This analysis is relevant to many shrub-steppe environments within the territories of the Yakama Nation and actions identified herein are considered to be important and appropriate throughout the shrub-steppe, grassland, and scabland environments.

MONITORING AND MANAGEMENT ACTIONS[11]

With changes in temperature and moisture regimes, there may be an increased opportunity for non-native species to establish and compete with native vegetation. The following monitoring and management actions should be taken to address changing conditions as appropriate:

- Consider increasing non-native species control efforts.
- Prevent invasive plants from establishing after disturbances.
- Monitor and prevent widespread outbreaks of invasive species or pathogens.
- Map existing plant communities and maintain integrity of native plant populations.
- Mitigate consequences of large disturbances by planning ahead.
- Determine potential resilience of different locations and actively restore less resilient sites.

With changes in temperature and moisture regimes, it is likely that significant changes in species distribution and ecological patterns will shift. The following actions should be considered to address these shifts:

[11] Largely adopted and adapted from Adaptation Partners' Climate Change Adaptation Library for the Western United States [32].

- Map and monitor changes in both vegetative and animal species presence and population health to measure the rate and extent of observable changes.
- Plan to accommodate these changes in ensuring connectivity and ecological health for species movements and maintenance of migrations.
- Map and closely monitor rare species and/or disjunct populations to provide for informed management decisions in the future.
- Consider genetic management approaches to ensure diversity within local populations.

Given the complex ownership and jurisdictional landscape of the territories of the Yakama Nation, resource managers will need to find new and innovative ways to increase collaboration. Professional institutions such as the Arid Lands Initiative, Great Northern Landscape Conservation Collaborative, the Washington Wildlife Habitat Connectivity Working Group National Climate Assessment, Climate Science Centers, and Regional Integrated Science and Assessment partnerships, for example, should be maintained and strengthened to meet this objective.

Higher temperatures will likely increase fire disturbance, especially during prolonged periods of drought. Management will need to increase monitoring and activities that advance the following objectives:

- Increase resilience of native sagebrush-grass ecosystems.
- Maintain vigorous growth of native shrub, perennial grass, and other perennial species.
- Manage for soil conditions to avoid increased runoff.

4.9.1 SHRUB-STEPPE AND RANGELANDS ACTION PLAN

GOAL **Tribal members will have rangelands and use resources sustainably in the context of a changing climate to support culturally important foods and medicines and livestock production.**

OBJECTIVE **IMPLEMENT ON-SITE ACTIONS TO PROTECT AND IMPROVE RESILIENCE OF OUR SHRUB-STEPPE AND RANGELAND RESOURCES.**

The following **Strategies** have been identified to support this **Objective**:

1. **Accelerate the implementation of the Horse Management Plan** to enhance environmental benefits and long-term resilience to climate change for severely depressed native species and plant communities throughout the areas where wild horses persist.
2. **Accelerate implementation of known rangeland best management practices** such as preventing livestock from unplanned entry into riparian, wetland, and natural spring sites; providing designated water sources in uplands and other suitable areas; and increasing protection measures and enhancements that will increase climate resilience.
3. **Evaluate and identify areas** where shrub-steppe communities are relatively healthy and warrant special protection and areas that should be prioritized for restoration. Revisit general protection and restoration strategies and specific actions that could be employed.
4. **Consider designing a native plant nursery and seed bank** to support long-term restoration efforts. Identify focal species such as grasses, berries, and roots that are important for ecosystem health as well as sources of cultural foods and medicines.
5. **In restoration projects, emphasize the use of plant species that will be robust** in the face of climate change.
6. Implement actions identified in the **2015 Updated Washington State Wildlife Action Plan**.

OBJECTIVE **PRESERVE TRADITIONAL ECOLOGIC KKNOWLEDGE AND MAINTAIN ACTIVE POLICY DEVELOPMENT, LONG-TERM PLANNING, AND APPROPRIATE ENFORCEMENT OF REGULATIONS TO ENSURE EFFECTIVE ADAPTIVE MANAGEMENT.**

The following **Strategies** have been identified to support this **Objective**:

1. **Update and implement the 2009 Integrated Weed Management Plan** to account for potential changes or increases in invasive species due to climate change impacts.
2. **Periodically review and revise grazing policies,** including timing and allotments, to increase the resilience of native sagebrush-grass and similar ecosystems.

OBJECTIVE

BY INTEGRATING TRADITIONAL ECOLOGICAL KNOWLEDGE, ENCOURAGE RESEARCH, MONITORING, AND TECHNICAL ASSESSMENTS TO UNDERSTAND OUR CHALLENGES AND MEASURE OUR PROGRESS.

The following **Strategies** have been identified to support this **Objective**:

1. **Study how vegetation patterns in our region might change over time**, drawing conclusions about how these changes may impact important non-native species and wildlife abundance and distribution. Use these findings to adjust rangeland management practices.
2. **Develop a long-term integrated monitoring, evaluation, and reporting program** to track the status and trends of important vegetative species and communities and inform management decisions. As this program is developed, make the function and staffing requirements.

OBJECTIVE

SUPPORT OUTREACH AND EDUCATION FOR OUR CHILDREN, COMMUNITIES, AND GOVERNMENTAL BODIES.

The following **Strategies** have been identified to support this **Objective**:

1. **Identify appropriate public outreach approaches** and related materials to inform stakeholders of the rationale behind improved rangeland management practices that account for future climate change.
2. **Develop appropriate materials to inform the tribal community and tribal leadership** of the vulnerabilities of tribal rangeland and natural resources, climate change risks, and potential consequences of management decisions.

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YAKAMA NATION CLIMATE CHANGE ACTION PLAN

4.10 Floodplains, Rivers, and Fish

The territories of the Yakama Nation are blessed with an abundance of cool, clean water flowing from the northern and Cascade mountain ranges into the vast arid landscapes of the Columbia River Basin. These rivers and wetlands are contained within diverse floodplain and riparian ecologies providing a rich variety of foods, medicines, and natural resources important to the Yakama Nation.

With our growing awareness of the potential impacts from climate change to our natural resources and the riparian and aquatic species, this Climate Action Plan is an important step in addressing serious threats to our culture and to our heritage. We recognize that the Yakama Nation cannot implement all of the necessary actions alone. Because of the complexity of these issues, the Yakama Nation calls on local, state, and federal managers to work collaboratively across the landscape to better protect our natural resources and build resilience towards the specific effects that climate change may bring.

IMPORTANT FEATURES OF OUR FLOODPLAINS AND RIVERS

For the purposes of this Climate Action Plan, it is important to characterize and describe fundamental but important features of these resources. By understanding these, we can better tie the actions identified for implementation to the threats imposed by climate change.

The river systems within the territories of the Yakama Nation that shape our landscape and provide such diversity in life forms and ecosystems are simply a collection of the smaller tributary streams originating primarily from the snow fields in the high mountains. Over countless years, the rivers swell and flood during the spring melt, forming wide floodplains where these systems are allowed to expand across the landscape. During the drier summer months as the rivers recede, water stored within these floodplains, often just below the surface, steadily continues to flow into the river. This additional water is cool, often plentiful, and important to aquatic life.

Scattered throughout the floodplain and along the river's edge are thick stands of riparian vegetation, often containing cottonwoods, dogwood and alders, and an extraordinary variety of shrubs and forbs. In the mountains, conifers are also found along the stream edge. When these and other larger trees fall into the river, they help form complex and often deep pools important to many fish and other aquatic species for rearing and cover. Beavers are a vital component of a river system. Beaver dams within the rivers help provide the pool habitats and diversity necessary for a healthy ecosystem. Riparian vegetation provides shade from the sun, keeping the water cool and adding stability to the

river banks, helping to maintain lower sediment levels that, in excess, can kill fish eggs and smother insects important for food.

Within the river itself, nature displays a range of channel shapes and types, sometimes narrow and steep or sometimes wide and flat. The variety and complexity of pools and riffles each lend themselves to an even wider variety of life forms that live within these waters. The inherent diversity and complexity in rivers, the riparian areas, and the floodplains are why these resources are so important to life itself.

Photo by Tom Ring, Yakama Nation staff

Unfortunately, over the past 100+ years, human development has simplified many of these river systems with roads, railways, agriculture, communities, and many other aspects of economic growth. This development seems only to continue. Coupled with climate change, it is apparent our river and floodplain systems are at great risk of even greater degradation.

DESCRIPTION OF THE ANALYSIS AREA

For this assessment, we identified three areas for analysis: the mid-Columbia tributary streams (Rock Creek and Klickitat, Wind, Little White, and White Salmon rivers), Yakima River Basin, and the Upper Columbia (Methow, Entiat, and Wenatchee rivers). These distinctions are made primarily because of the considerations associated with salmon and other fishes.

IMPORTANT CHANGES TO MONITOR AND TRACK[12]

Increasing water temperature will occur earlier in the summer months and will continue later into the autumn, and high temperatures will increase over historic norms. The following conditions will likely affect biological attributes within the riverine and wetlands environments:

- Increased thermal heterogeneity in streams and increased thermal stress on many life stages of fish and aquatic species.
- More favorable conditions for diseases, parasites, and non-native fish species.
- Altered aquatic food web dynamics.
- Altered phenology and species interactions (e.g., predation, competition) of riverine and wetland obligate species.
- Smaller range of potential habitat.

[12] Largely adopted and adapted from Adaptation Partners' Climate Change Adaptation Library for the Western United States [32].

There may be a shift in hydrologic regime involving changes in timing and magnitude of flows. Anticipated changes include:

- Lower summer flows and higher, more frequent winter flows.
- More frequent and intense droughts and floods.
- Increased peak flows, leading to scouring in habitats containing fish nests (redds), which can kill eggs or may wash juveniles farther downstream into unfavorable habitats.
- Lower low flows will reduce fish habitat quality and may create barriers to fish movement and migrations.
- Lower low flows will increase pre-spawn mortality for spring and summer run salmon and steelhead.
- Alter how certain habitats function, affecting the life cycle, survival, and reproductive success of aquatic and semi-aquatic invertebrate and amphibian species.
- Increases in winter precipitation and flooding, posing additional challenges for managing reservoirs for flood control, fish, and hydropower.
- Increases in conflicts among water users and demands on water resources, intensifying our current challenges in managing water resources.
- Sedimentation in streams will increase as fire area and fire severity increase, which can smother fish eggs or aquatic insects and other organisms which provide important foods for other species.
- Changes in precipitation patterns and temperature regimes may reduce the size and hydro-period important for wetlands, nutrient cycles, and species that are obligates to these fragile habitats.

Given the complex ownership and jurisdictional landscape of the territories of the Yakama Nation, resource managers will need to find new and innovative ways to increase collaboration. Professional institutions such as the Arid Lands Initiative, Great Northern Landscape Conservation Collaborative, the Washington Wildlife Habitat Connectivity Working Group National Climate Assessment, Climate Science Centers, and Regional Integrated Science and Assessment partnerships, for example, should be maintained and strengthened to meet this objective.

4.10.1 FLOODPLAIN, RIVER, AND FISH ACTION PLAN

GOAL

Management of floodplain and riverine habitats throughout the territories of the Yakama Nation will enhance and maintain a diversity of environmental conditions, maintain sustainable use of these resources, and thereby maintain these resources as a dependable source of spiritual renewal, cultural practices, food and medicinal plants, revenue, and employment for the Yakama people.

OBJECTIVE

IMPLEMENT ON-SITE ACTIONS TO PROTECT AND IMPROVE RESILIENCE OF OUR FLOODPLAIN, RIVER, AND FISHERIES RESOURCES.

The following **Strategies** have been identified to support this **Objective**: *(Site specific actions are listed in Section 5, Appendices.)*

1. **Implement the Yakima River Basin Integrated Water Resources Management Plan.**
2. **Increase spawning and rearing habitat resilience** by protecting and/or restoring floodplain and riparian structure and function. Reduce threats from roads and infrastructure in the floodplain.
3. **Protect and improve instream habitat resilience by reducing sediment input,** particularly generated by roads, degraded floodplain/riparian systems, and wildfire.
4. **Increase stream resilience to lower summer flows** by increasing stream complexity, improving stream structure, and managing uplands to retain water and snow in order to slow spring snowmelt and runoff.
5. **Increase resilience of native fish species** by reducing barriers to native species and removing non-native species.
6. **Manage—and adjust, as necessary—practices at hatcheries** to manage fish stocks for increased resilience in the context of anticipated climate change impacts. For example, change adult collection sites and release locations to colder water sources as needed; take juveniles to facilities in cooler locations; vary release dates relative to streamflows; and develop guidance for hatchery facility managers that takes into account anticipated climate variability and change.
7. **Incorporate technologies in genetics** to ensure that populations retain appropriate diversity across the full range of the species.
8. **Continue to implement opportunities and evaluate new ways for improving irrigation efficiency** and returning diverted water back into stream channels during critical flow periods.
9. **Identify opportunities for reallocation and redistribution of water in critical basins**

through water transfers, water transactions, water markets, and water banks, with the goal of increasing streamflow to benefit fisheries and riparian habitats.

10. **Increase instream flows** with dry-season water conservation and reduce withdrawals from streams.

OBJECTIVE

PRESERVE TRADITIONAL ECOLOGIC KNOWLEDGE AND MAINTAIN ACTIVE POLICY DEVELOPMENT, LONG-TERM PLANNING, AND APPROPRIATE ENFORCEMENT OF REGULATIONS TO ENSURE EFFECTIVE ADAPTIVE MANAGEMENT.

The following **Strategies** have been identified to support this **Objective**: *(Site specific actions listed in Section 5, Appendices.)*

1. Through the **Yakima Basin Integrated Water Resources Management Plan and other planning forums**, continue to find innovative ways to conserve and protect water resources that promote long-term benefits to the Yakama people.
2. **Promote similar long-term Integrated Water Resource planning for each of the watersheds within the territories of the Yakama Nation** and focus these plans on implementing actions that increase resource resiliency and are consistent with this Climate Action Plan.
3. **Work with state and local resource managers to** incorporate climate change considerations for species, habitats, and ecosystem processes into planning and regulatory activities related to implementation of the Growth Management Act, Shoreline Management Act, Watershed Management Act, State Environmental Policy Act, and other state goals and policies.[13]
4. **Update all relevant natural resource plans** to incorporate new findings and management direction to address climate change and increase resilience of species and ecosystems.
5. **Continue to integrate our knowledge of other environmental stressors** like human encroachment on the floodplains and invasive species with impacts from climate change.
6. **Remain active in state and federal legislative affairs** that promote long-term funding at larger landscapes for implementation of important resilience actions and maintain appropriate enforcement of regulations that protect our cultural resources.
7. **Evaluate the potential to purchase water rights** to be used exclusively for riparian, aquatic, and fishery benefits.
8. **Aggressively seek funding to build capacity for climate change planning, coordination, and restoration actions that focus on holistic measures** to protect and restore species

[13] See State of Washington Department of Ecology, "Preparing for a Changing Climate: Washington State's Integrated Climate Response Strategy," Publication No. 12-01-004 (April 2012).

habitats and ecosystem function important to cultural use and values.

9. **Find new and innovative ways to increase coordination and collaboration** in resource management, integrating planning and actions, where appropriate, through increased cost-share opportunities and sharing of new knowledge and technologies.

10. **Plan for and prepare periodic program reviews** of ongoing and planned activities associated with climate change and ensure future activities are aligned with monitoring information and new projections of temperature, precipitation, and potential biological/ecological responses.

OBJECTIVE

BY INTEGRATING TRADITIONAL ECOLOGICAL KNOWLEDGE, ENCOURAGE RESEARCH, MONITORING, AND TECHNICAL ASSESSMENTS TO UNDERSTAND OUR CHALLENGES AND MEASURE OUR PROGRESS.

The following **Strategies** have been identified to support this **Objective**: *(Site specific actions listed in Section 5, Appendices.)*

1. **Develop a long-term integrated monitoring, evaluation, and reporting program**—that clearly identifies the intended function and staffing requirements—to track the status and trends of fish, floodplain and fish habitats, and hydrologic resources.

2. **Preform and document landscape-scale technical assessments and prioritization** of key habitat restoration needs and activities throughout the territories of the Yakama Nation.

3. **Develop a long-term monitoring strategy that integrates annual flow/hydrologic patterns, water temperatures, and fish/aquatic organism presence and relative abundance** to measure potential encroachment of warmer-adapted species into historically cooler waters preferred by cool water species.

4. **Develop and implement a long-term monitoring strategy to identify cool water seeps and refuges for fish and other aquatic species in rivers and streams**, especially during warming summer months. Develop and implement restoration strategies that **protect and enhance these areas** and monitor results of these activities.

5. **In stream reaches where important spawning and rearing habitats are established, implement a long-term monitoring program** to evaluate trends and rate of changes in stream morphology, particularly as it relates to ecologic function and important habitats of focal species.

6. **Continue to use and improve in the development of life cycle models** and increase collection of relevant information to support these models. Begin to use these models to better understand and project potential changes in fish productivity and abundance over time.

7. **Continue active research into reintroduction of fish species** into areas currently blocked from historical spawning and rearing streams, such as those areas blocked by reservoirs. **Implement reintroduction** and carefully monitor outcomes of these efforts.

OBJECTIVE SUPPORT OUTREACH AND EDUCATION FOR OUR CHILDREN, COMMUNITIES, AND GOVERNMENTAL BODIES.

The following **Strategies** have been identified to support this **Objective**: *(Site specific actions listed in Section 5, Appendices.)*

1. **Develop and employ curriculum for students at various educational levels** that illustrate and teach children why climate change is occurring, how cultural resources may change, and how students can become meaningfully engaged in gaining a better understanding and contribute to the protection and resilience of our important resources.
2. **Continue to find useful, appropriate, and interesting ways to communicate traditional ecological knowledge** that can be used to protect and enhance resiliency of our cultural resources.
3. **Develop materials for tribal membership and general public education** that demonstrate the cultural and economic values of floodplains, riparian, rivers, and aquatic resources. Identify the specific messages intended for the various publics and an effective array of tools to convey these messages.
4. **Prepare outreach materials, meet regularly, and work closely** with local and regional elected officials, agency policy representatives, non-governmental organizations, and staff about the cultural interests of the Yakama Nation. Develop long-term and effective collaborative relationships and actions to protect and enhance resilience of our natural resources.
5. **Consolidate technical findings of research, monitoring, and evaluation to inform adaptive management** processes that inform ongoing climate change discussions and policy direction.

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YAKAMA NATION CLIMATE CHANGE ACTION PLAN

4.11 Wildlife and Vegetation

Our wildlife has always been abundant throughout the territories of the Yakama Nation. All species are important, all are a part of our Creators plan. We have been blessed with a rich diversity extending from the high alpine peaks of the Cascade Mountains to the low elevations of the arid Columbia shrub-steppe and the moist lower Columbia River watersheds.

From our growing awareness of the potential impacts from climate change to our natural resources and wildlife species, this Climate Action Plan for wildlife and vegetation communities is an important step in addressing serious threats to our culture and to our heritage. We recognize that the Yakama Nation cannot implement the necessary actions alone. Because of the complexity of these issues, the Yakama Nation calls on local, state, and federal wildlife managers to work collaboratively across the landscape to better protect our natural resources and build resilience towards the specific effects that climate change may bring.

IMPORTANT FEATURES OF OUR WILDLIFE AND VEGETATION

When we speak of our wildlife, we recognize a vast and complex array of different animals from birds to bears, from the rattlesnake to salamanders, insects, beavers, and bats. Regardless of all these differences, there are many commonalities that we must continue to recognize if we are to be successful in our care of these animals and all the plants that are important to the Yakama Nation.

For all animals to persist, we must protect and enhance the habitats they use for mating and reproducing. For example, nesting habitats for the sage grouse and fawning areas for the deer must be understood and monitored to ensure they are plentiful, suitable, and dispersed amongst the landscape to maintain healthy populations. The quality and the quantity of these habitats are not only important for successful reproduction, but also critical with regards to the summer and winter ranges when these species must find sufficient foods to remain strong and to care for themselves and their offspring.

Although some species are confined to a certain area throughout the year, many use large tracts of land to find food, shelter from the elements and from predators, and to find their mates. The lands these species use, regardless of how little or how vast, the lands must be connected in a way that allows the species to travel safely from one point to the next. In most cases, this connectivity is from vegetation corridors. From our understanding today, vegetation patterns will likely shift over time. Coupled with ever growing human populations and invasive species, changes in vegetation patterns will leave uncertainty in the persistence of long-established travel routes for many species. When and where these shifts in vegetation may occur is central to our long-term management of these lands.

Given the complex ownership and jurisdictional landscape of the territories of the Yakama Nation, resource managers will need to find new and innovative ways to increase collaboration. Professional institutions such as the Great Northern Landscape Conservation Collaborative, the Washington Wildlife Habitat Connectivity Working Group National Climate Assessment, Climate Science Centers, and Regional Integrated Science and Assessment partnerships, for example, should be maintained and strengthened to meet this objective.

We know many things about the inter-relationships of many species, but there is much we do not understand. Of specific interest, relative to climate change, is the study of biological cycles that occur annually for both plants and animals. This study, called phenology, links such things as when a huckleberry might flower and when insects, such as bees, are present to pollinate these plants. It relates the budding of plants to the last freeze of the year, or the timing of migrating birds with the availability of food. It relates the timing of hibernation for the bear to the onset of winter. With climate change, we know the seasons will be altered, but it is difficult to know how the various species will respond. Careful monitoring of biological cycles and many other aspects of the environment is vital to understand the types and rate of changes we will witness.

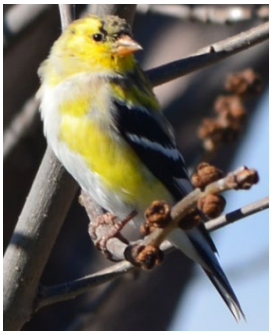
DESCRIPTION OF THE ANALYSIS AREA

Our wildlife species and their habitats span the entire territories of the Yakama Nation. The analysis area ranges from the high elevation alpine to the lower elevations of the Columbia River covering forests, shrub-steppe and grasslands, meadows, wetlands, and floodplains. All of these habitats, and the plants and animals that occupy them, are important to the Yakama Nation and are included in this analysis.

IMPORTANT CHANGES TO MONITOR AND TRACK[14]

Climate change will impact habitat types in different ways. The following sections describe impacts relevant to wildlife and vegetation according to three categories of habitat found on the Yakama Nation reservation, as well as impacts to species health and populations irrespective of habitat types.

Forested Habitats



- More insect outbreaks and fire will increase loss of late-successional forest habitat and connectivity.
- Higher temperature and increasing drought will stress some species in meadows, wetlands, and moist mixed conifer forests.
- A warmer climate will potentially convert drier ponderosa pine stands to grassland.
- Higher temperature may increase stress for some species, especially rare species in cold upland and subalpine forests.
- Changes in temperature and moisture regimes will result in loss of subalpine areas for traditional uses of plant species.
- Tree establishment in subalpine meadows decreases forage for various species, like American pika and marmot.

Riverine, Wetlands, and Floodplain Habitats

- Decreased stream flow reduces riparian vegetation and affects food supply and habitat structure for riparian and wetland obligate species.
- Higher temperature will alter phenology and species interactions (e.g., predation, competition, pollination) of riparian, wetland obligates, and many other species
- Increased temperature will cause a decrease in critical water levels and soil moisture, which likely will affect wetland nutrient levels and episodic acidification and lead to more disease, and decreased prey for amphibian species.
- Reduction in water over the landscape will promote additional pressure and degradation of habitats by both range and wild ungulates (hoofed mammals such as deer) on wetlands and

[14] Largely adopted and adapted from Adaptation Partners' Climate Change Adaptation Library for the Western United States [32].

riparian areas.

Shrub-Steppe and Rangelands

- Higher wildfire frequency will reduce shrub species and native grasses and increase dominance of non-native species, especially cheatgrass.
- Changes in temperature and moisture regimes will promote changes in seasonal soil moisture with changes in species distribution and shifting ecological patterns.
- Changing vegetative patterns will likely change connectivity between habitats for certain species that are obligated to daily or seasonal migratory patterns.
- The quality and quantity of range forage will likely diminish.

Species Health and Populations

- A general loss in habitat and changing dynamics in predator-prey relationships.
- Changes in temperature and moisture regimes will increase opportunities for non-native species establishment and likely change native species composition, relative abundance, and distribution patterns.
- Higher temperature will increase prevalence of disease and fungal and bacterial infections, causing increased animal mortality.
- Higher temperature and increased disturbance will cause shifts in species ranges and loss of species functional types.
- Timing in various life history events will shift and, in some cases, may lose important synchronized timing with other species. Examples of timing shifts include polarization or changes to availability of certain foods.
- Area of summer range for ungulate species will decrease.

4.11.1 WILDLIFE AND VEGETATION ACTION PLAN

GOAL

Management of wildlife and their habitats throughout the territories of the Yakama Nation will enhance and maintain a diversity of environmental conditions, maintain sustainable use of these resources, and thereby maintain these resources as a dependable source of spiritual renewal, cultural practices, food and medicinal plants, revenue, and employment for the Yakama people.

OBJECTIVE

IMPLEMENT ON-SITE ACTIONS TO PROTECT AND IMPROVE RESILIENCE OF OUR WILDLIFE AND VEGATATIVE RESOURCES.

The following **Strategies** have been identified to support this **Objective**:

1. **Gather more detailed information** to understand climate vulnerabilities and risks to native species and develop recommendations to address these issues. Continue to consolidate and summarize the status and trend of the threatened, endangered, and sensitive species found within the territories and partner with agencies and universities on research to better understand how climate change will exacerbate threats to these species.
2. **Protect and enhance priority floodplains and riparian areas** that provide habitat for riparian-dependent species and important foods and medicines that could be adversely impacted by climate change.
3. **Use beaver to help restore wetland, riparian, and floodplain habitat.** Recognize the importance of beavers as a keystone species to the wetland, stream, and riparian ecosystems and one that can help with water storage in the context of a changing climate and changing hydrology. Develop a comprehensive plan that will reintroduce, enhance, and maintain beaver populations on the reservation lands. Identify places throughout the Planning Area where these pilot efforts should be expanded.
4. **Consider operating plant nurseries and seed banks** that can support reseeding and reforestation efforts in response to future wildfires, ecosystem restoration actions, and other climate adaptation strategies. Collect seeds of native plants and plants that are expected to be resilient to the future climate.
5. **Increase resilience of late-successional habitat** and surrounding habitats.
6. **Increase resilience of native sagebrush-grassland communities** through continued improvements in grazing strategies, use of controlled burns, and management of non-native species.
7. **Continue to pursue efforts to implement a substantially increased controlled burn program** in priority areas.
8. **Continue to evaluate and identify connectivity corridors** and protect and enhance these

corridors to increase resilience for animal migrations and movements.

9. **Develop range-shift models** for focal species and important vegetation communities to better prepare for future management actions.
10. **Incorporate technologies in genetics** to ensure that populations retain appropriate diversity across the full range of the species.
11. **Identify areas and vegetation communities that may already be resilient** to future changes and protect them as future refuges for various species, especially rare or disjunct species.
12. **Conserve winter range** for ungulate species.
13. **Increase conservation efforts in wetland management** and implement innovative actions to maintain or improve wetland function and productivity.
14. Implement actions identified in the **2015 Updated Washington State Wildlife Action Plan**.
15. Implement actions identified in the **2012 "Preparing for a Changing Climate: Washington State's Integrated Climate Response Strategy."**

OBJECTIVE

PRESERVE TRADITIONAL ECOLOGIC KNOWLEDGE AND MAINTAIN ACTIVE POLICY DEVELOPMENT, LONG-TERM PLANNING, AND APPROPRIATE ENFORCEMENT OF REGULATIONS TO ENSURE EFFECTIVE ADAPTIVE MANAGEMENT.

The following **Strategies** have been identified to support this **Objective**:

1. **Remain active in state and federal legislative affairs** that promote long-term funding at larger landscapes for implementation of important resilience actions and maintain appropriate enforcement of regulations that protect our cultural resources.
2. **Work with state and local resource managers to** incorporate climate change considerations for species, habitats, and ecosystem processes into planning and regulatory activities related to implementation of the Growth Management Act, Shoreline Management Act, Watershed Management Act, State Environmental Policy Act, and other state goals and policies.[15]
3. **Update all relevant natural resource plans** to incorporate new findings and management direction to address climate change and increase resilience of species and ecosystems.
4. **Aggressively seek funding to build capacity for climate change planning, coordination, and for restoration actions that focus on holistic measures** to protect and restore species habitats and ecosystem function important to cultural use and values.

[15] See State of Washington Department of Ecology, "Preparing for a Changing Climate: Washington State's Integrated Climate Response Strategy," Publication No. 12-01-004 (April 2012).

5. **Find new and innovative ways to increase coordination and collaboration** in resource management, integrating planning and actions, where appropriate, through increased cost-share opportunities and sharing of new knowledge and technologies.
6. **Incorporate as policy directives increased efforts to reduce non-climate stressors** such as human development in critical wildlife habitats, expansion of noxious and non-native species, and increases of toxic materials throughout our environment.
7. **Plan for and prepare periodic Program Reviews** of ongoing and planned activities associated with Climate Change and ensure future activities are aligned with monitoring information and new projections of temperature, precipitation, potential biological/ecological responses.
8. **Continue to integrate our knowledge of other environmental stressors** like human encroachment on the floodplains and invasive species with impacts from climate change.
9. **Remain active in state and federal legislative affairs** that promote long-term funding at larger landscapes for implementation of important resilience actions and maintain appropriate enforcement of regulations that protect our cultural resources.
10. Continue to work to address the issues associated with **uncontrolled wild horse populations** on the reservation lands, as these are an additional stressor that interacts with climate change pressures on vegetation and habitat.
11. **Incorporate climate change considerations into management plans** for protecting sensitive and vulnerable species.
12. **Evaluate long-term funding needs** to staff and appropriately fund wildlife activities associated with climate change.

OBJECTIVE

BY INTEGRATING TRADITIONAL ECOLOGICAL KNOWLEDGE, ENCOURAGE RESEARCH, MONITORING, AND TECHNICAL ASSESSMENTS TO UNDERSTAND OUR CHALLENGES AND MEASURE OUR PROGRESS.

The following **Strategies** have been identified to support this **Objective**:

1. **Develop an inventory and monitoring plan** to continue tracking the range, distribution, and viability of important species in the context of a changing climate.
2. **Seek to better understand habitat connectivity needs in the context of climate change.** Analyze the relationship between culturally important wildlife indicator species and the associated vegetative characteristics on which they depend throughout the annual cycle. Relate this analysis to future climate change projections with an emphasis on understanding connectivity of various habitats through migration corridors and the overall projected ecological health of these communities. At a minimum, this analysis should consider the

following vegetation types: alpine/subalpine, mixed pine and fir dominant forests, shrub-steppe, prairie/rangelands, and agricultural/irrigated lands.

3. **Monitor predators (e.g., bears and cougars) and develop a safety awareness campaign** related to large predator interactions with communities, as large predators may interact more with human populations as development continues and their habitats are affected by climate change.

4. **Increase monitoring of species** that are expected to be sensitive to climate change, such as amphibians and species that are listed or identified as a species of concern.

OBJECTIVE SUPPORT OUTREACH AND EDUCATION FOR OUR CHILDREN, COMMUNITIES, AND GOVERNMENTAL BODIES.

The following **Strategies** have been identified to support this **Objective**: *(Site specific actions listed in Section 5, Appendices.)*

1. **Develop and employ curriculum for students at various educational levels** that illustrate and teach children why climate change is occurring, how cultural resources may change, and how students can become meaningfully engaged in gaining a better understanding and contribute to the protection and resilience of our important resources.

2. **Continue to find useful, appropriate, and interesting ways to communicate traditional ecological knowledge** that can be used to protect and enhance resiliency of our cultural resources.

3. **Develop materials for tribal membership and general public education** that demonstrate the cultural and economic values of wildlife and vegetation. Identify the specific messages intended for the various publics and an effective array of tools to convey these messages.

4. **Prepare outreach materials, meet regularly, and work closely** with local and regional elected officials, agency policy representatives, non-governmental organizations, and staff about the cultural interests of the Yakama Nation. Development long-term and effective collaborative relationships and actions to protect and enhance resilience of our natural resources.

5. **Consolidate technical findings of research, monitoring, and evaluation to inform adaptive management** processes that inform ongoing climate change discussions and policy direction.

REVIEW OF SECTION 5, APPENDICES

Section 5 of the Climate Action Plan for the Territories of the Yakama Nation (CAP) contains the technical appendices. These materials contain many products specifically related to this CAP in various stages of completion. Due to the size and complexity of these materials, they are not provided in written form as a distributed component of this document. Many of these materials are available online and upon request. The following lists many important products which may be of interest to the reader. These products are referred to and were used in the development of the technical appendices for the CAP.

Beaver Restoration Assessment Tool (BRAT) for the Middle Columbia – Hood Watersheds, Oregon and Washington. ***Complete.*** Wheaton, J. and Macfarlane, W. Utah State University. BRAT models the capacity of the landscape to support dam-building activity by beaver (Macfarlane et al. 2017). Capacity estimates come from five main lines of evidence: (1) a reliable water source, (2) stream bank vegetation conducive to foraging and dam building, (3) vegetation within 100 m of edge of stream to support large beaver colonies, (4) likelihood that dams could be built across the channel during low flows, and (5) the likelihood that a dam is capable of withstanding typical floods.

Climate Change Adaptation Library for the Western United States. Adaptation Partners, Developed with expertise from the U.S. Forest Service, updated November 2018, http://adaptationpartners.org/library.php.

Development and integration of life-cycle models for Yakima River O. mykiss: a tool for prioritizing habitat restoration actions and projecting climate change effects. ***Complete.*** April 11, 2018. Developed for the Yakama Nation by Washington Dept. Fish and Wildlife, Neala Kendall lead author and Chris Frederiksen, Yakama Nation.

Focal Species Library: ***Incomplete.*** Species represented in this Library have been identified as high priority for long-term monitoring. These species are representative of the habitats they occupy during either or both breeding and non-breeding seasons. With future updates of this Climate Action Plan it is likely this list will be expanded to include additional priority species.

Guide to Assessing Climate Change Impacts on Tribally Important Plants using Traditional / Expert-based Knowledge. ***First Draft Complete***. Integrated approach to assess tribally important plant species using the Three-Step Decision Support Framework, and the System for Assessing Vulnerability of Species to Climate Change for rapid development of climate-informed Species Management Action Plans.

Looking to the past and to the future to inform meadow restoration on the Yakama Reservation. ***Complete.*** June 30, 2018. Prepared for the Yakama Nation by Conservation Science Partners, Climate Impacts Group. Lead authors include Meghan Halabisky, PhD – Postdoctoral Scientist, Conservation Science Partners; Se-Yeun Lee, PhD – Research Scientist, Climate Impacts Group, University of Washington; Sonia A. Hall, PhD – Associate Scientist, Conservation Science Partners

Halabisky, M., Lee, S.-Y., Hall, S.A. 2018. Looking to the past and to the future to inform meadow restoration on the Yakama Reservation. Report prepared by Conservation Science Partners and the Climate Impacts Group, University of Washington, for the Wildlife, Range and Vegetation Resources Management Program of The Confederated Tribes and Bands of the Yakama Nation. Toppenish, Washington. 73 pages.

Long-Term Monitoring Strategies (to be developed): ***Incomplete***. Monitoring strategies important for supporting resilience and gathering updated information about climate trends and vulnerability status of key resources and species.

Potential Climate Change Responses of Summer Steelhead in the Satus and Toppenish Watersheds. ***Complete***. September, 2018. Prepared for the Yakama Nation by ICF, Greg Blair, lead author.

ICF and Yakama Nation. 2018. Potential Climate Change Responses of Summer Steelhead in the Satus and Toppenish Watersheds. September, 2018. (ICF Project # 00123.17). Prepared for Yakama Nation, Toppenish, WA.

Site Specific Protection, Enhancement and Restoration Actions for floodplains, riparian areas and in-stream for the Ceded Lands of the Yakama Nation. ***In Progress.*** A list of protection and restoration projects to benefit floodplain function and riparian / salmonid habitats.

Yakama Nation Monitoring Framework to Assess Salmonid Responses to Enhancement Actions and Climate Change, ***Complete***. March 1, 2017. Prepared for the Yakama Nation by BioAnalysts, Inc. Eagle Idaho, Tracy Hillman, lead author.

Hillman, T., B. Rogers, K. Murdoch, T. Iverson, and B. Rose. 2017. Monitoring framework to assess salmonid response to enhancement actions and climate change. Report to the Yakama Nation, Toppenish, WA.

KEY TERMS

The following definitions are primarily derived from the EPA Glossary of Climate Terms, the USDA Forest Service Climate Change Glossary, the Intergovernmental Panel on Climate Change (IPCC), the U.S. Fish and Wildlife Service TEK Fact Sheet (2011), Preparing for Climate Change: A Guidebook for Local, Regional, and State Governments, and the Saint Regis Mohawk Tribe Climate Adaptation Plan.

Adaptation: Actions in response to actual or expected climate change and its effects, that lessen harm or exploit beneficial opportunities. It includes reducing the vulnerability of people, places, and ecosystems to the impacts of climate change.

Adaptive capacity: The opportunities that may exist to ameliorate the sensitivity or exposure of that species or system.

Climate: The average pattern for weather over a period of months, years, decades, or longer in a specific place.

Climate change: Any significant change in measures of climate (such as temperature, precipitation, or wind) lasting for an extended period of time (decades or longer). Climate change may result from natural factors and processes and from human activities that change the atmosphere's composition and land surface.

Climate-resilient community: A community that takes proactive steps to prepare for (i.e., reduce the vulnerabilities and risks associated with) climate change impacts.

Exposure: The nature and degree to which a system is exposed to significant climate variations.

Greenhouse gas (GHG): Any gas that absorbs infrared radiation in the atmosphere; examples include carbon dioxide, methane, nitrous oxide, ozone, and water vapor.

Measure of resilience: A quantitative or qualitative judgment that you make and track over time to determine how well your actions meet the preparedness goals you have set.

Peak streamflow: The maximum instantaneous discharge of a stream or river at a given location.

Preparedness action: The activity or activities that your government or community undertakes to achieve its preparedness goals.

Preparedness goal: What you want to accomplish in your priority planning areas through preparedness action.

Priority planning areas: The planning areas which your community or government determines to be

most important for focusing your preparedness efforts, based on your community's vulnerabilities to climate change and associated risks.

Projection: A potential future evolution of a quantity or set of quantities, often computed with the aid of a model. Projections are different from predictions in that projections involve assumptions concerning, for example, future socioeconomic and technological developments that may or may not be realized.

Resilience: The ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration, or improvement of its essential basic structures and functions.

Sensitivity: The degree to which a built, natural, or human system is directly or indirectly affected by changes in climate conditions (e.g., temperature and precipitation) or specific climate change impacts (e.g., sea level rise, increased water temperature). If systems in a planning area are likely to be affected as a result of projected climate change, then that system should be considered sensitive to climate change. For instance, a community of coldwater fish at the southern edge of its range is highly sensitive to changes in climate because even a slight warming may make its habitat unsuitable. In turn, regional economies based on fisheries solely targeting those fish would also be highly sensitive to changes in climate.

Stressor: A chemical or biological agent, environmental condition, external stimulus, or an event that causes stress to an organism.

Systems: The built, natural, and human networks that provide important services or activities within a community or region. Built systems are networks of facilities, buildings, and transportation infrastructure like roads and bridges. Natural systems are ecological networks of fish, wildlife, and natural resources like water. Human systems are networks of public health clinics, courts, and government.

Traditional Ecological Knowledge (TEK): The evolving knowledge acquired by indigenous and local peoples over hundreds or thousands of years through direct contact with the environment. This knowledge is specific to a location and includes the relationships between plants, animals, natural phenomena, landscapes, and timing of events that are used for lifeways, including but not limited to hunting, fishing, trapping, agriculture, and forestry.

Vulnerability: The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. It is a function of the sensitivity of a particular system to climate changes, its exposure to those changes, and its capacity to adapt to those changes.

BIBLIOGRAPHY

[1] A. K. Snover, G. S. Mauger, L. C. Whitely Binder, M. Krosby and I. Tohver, "State of Knowledge Report: Climate Change Impacts and Adaptation in Washington State," University of Washington Climate Impacts Group, Seattle, 2013.

[2] Yakima Herald-Republic and The Associated Press, "High temps add up to Yakima's warmest June on record," *Yakima Herald,* 1 July 2015.

[3] D. Fears, "As salmon vanish in the dry Pacific Northwest, so does Native heritage," *The Washington Post,* 30 July 2015.

[4] R. Courtney, "Hazy days: Fires leave local skies a murky mess," *Yakima Herald,* 2 August 2015.

[5] S. W. Hostetler and J. R. Alder, "USGS National Climate Change Viewer," US Geological Survey, 2013. [Online]. Available: https://www2.usgs.gov/climate_landuse/clu_rd/nccv.asp.

[6] D. Isaak, "Stream Climate Trends and Aquatic Resource Vulnerability on the Nez Perce-Clearwater National Forests," in *U.S. Forest Service, Rocky Mountain Research Station*, 2015.

[7] H. Adelsman and J. Ekrem, "Preparing for a Changing Climate: Washington State's Integrated Climate Response Strategy," Washington State Department of Ecology, 2012.

[8] J. S. Littell, E. E. Oneil, D. McKenzie, J. A. Hicke, J. A. Lutz, R. A. Norheim and M. M. Elsner, "Forest ecosystems, disturbance, and climatic change in Washington State, USA," *Climate Change,* 2010.

[9] V. Burkett and J. Kusler, "Climate Change: Potential Impacts and Interactions in Wetlands of the United States," *Journal of the American Water Resources Association,* vol. 36, no. 2, pp. 313-320, 2000.

[10] National Wildlife Federation and Washington Department of Fish and Wildlife, "Climate Change Effects on Freshwater Aquatic and Riparian Habitats in Washington State," National Wildlife Federation and Washington Department of Fish and Wildlife, 2011.

[11] M. Ryan, "Modeling climate change effects on the hydrology of North Cascades wetland ecosystems," National Park Service.

[12] Washington State Department of Ecology, "Columbia River Basin Long-Term Water Supply and Demand Forecast," Olympia, WA, 2016.

[13] J. Vano, M. Scott, N. Voisin, C. Stockle, A. Hamlet, K. Mickelson, M. McGuire Elsner and D. Lettenmaier, "Climate change impacts on water management and irrigated agriculture in the Yakima River Basin, Washington, USA," *Climatic Change,* vol. 102, pp. 287-317, 2010.

[14] R. Noss, "Beyond Kyoto: Forest Management in a Time of Rapid Climate Change," *Conservation Biology,* vol. 15, no. 3, pp. 578-590, 2001.

[15] A. S. Weed, B. J. Bentz, M. P. Ayres and T. P. Holmes, "Geographically Variable Response of Dendroctonus ponderosae to Winter Warming in the Western United States,," *Landscape Ecology,* vol. 30, no. 6, pp. 1075-1093, 2015.

[16] B. J. Bentz, J. Regniere, C. J. Fettig, E. M. Hansen, J. L. Hayes, J. A. Hicke, R. G. Kelsey, J. F. Negron and S. J. Seybold, "Climate Change and Bark Beetles of the Western United States and Canada: Direct and Indirect Effects," *BioScience,* vol. 60, no. 8, pp. 602-613, 2010.

[17] W. Devine, C. Aubry, A. Bower, J. Miller and N. Maggiulli Ahr, "Climate change and forest trees in the Pacific Northwest: a vulnerability assessment and recommended actions for national forests," U.S. Department of Agriculture, Forest Service, Pacific Northwest Region, Olympia, WA, 2012.

[18] C. L. Raymond, D. L. Peterson and R. M. Rochefort, "Climate change vulnerability and adaptation in the North Cascades region, Washington," U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, 2014.

[19] Washington Department of Ecology, "Climate Change and the Columbia River Basin," [Online]. Available: http://www.ecy.wa.gov/programs/wr/cwp/cr_climate.html. [Accessed 2 February 2016].

[20] Yakama Nation Wildlife, Range and Vegetation Resources Management Program, "Nuisance Animal Management," [Online]. Available: https://www.ynwildlife.org/nuisanceanimalprogram.php. [Accessed 2 February 2016].

[21] Washington Department of Fish and Wildlife and the National Wildlife Federation, "Summary of Climate Change Effects on Major Habitat Types in Washington State," 2011.

[22] M. L. Keefer, C. A. Peery and M. J. Heinrich, "Temperature-mediated en route migration mortality and travel rates of endangered Snake River sockeye salmon," *Ecology of Freshwater Fish,* vol. 17,

pp. 136-145, 2008.

[23] Yakima Basin Storage Alliance, "Attempts at Drought Relief in the Yakima Basin," [Online]. Available: http://ybsa.org/. [Accessed 2 February 2016].

[24] Yakama Nation Wildlife, Range, and Vegetation Resources Management Program, "Wetlands and Riparian Restoration Project," 3 May 2011. [Online]. Available: http://www.ynwildlife.org/wetlandsmainpage.php. [Accessed 2 February 2016].

[25] P. Glick, B. A. Stein and N. A. Edelson, "Scanning the Conservation Horizon: A Guide to Climate Change Vulnerability Assessment," National Wildlife Federation, Washington, D.C., 2011.

[26] Washington Department of Fish and Wildlife, "Washington State Wildlife Action Plan," Olympia, Washington, 2015.

[27] Forest Technical Team, National Fish, Wildlife and Plants Climate Adaptation Strategy, "Forest Ecosystems Background Paper," Association of Fish and Wildlife Agencies, Council on Environmental Quality, Great Lakes Indian Fish and Wildlife Commission, National Oceanic and Atmospheric Administration, and U.S. Fish and Wildlife Service, 2012.

[28] Arid Lands Initiative, "Arid Lands Initiative's land cover map," DataBasin, 2014. [Online]. [Accessed 11 May 2018].

[29] J. Kusler, "Common Questions: Wetland, Climate Change, and Carbon Sequestering," Associaion of State Wetland Managers, Inc., and the International Institute for Wetland Science and Public Policy, 2006.

[30] Columbia River Inter-tribal Fish Commission, "Spirit of the Salmon: Wy-Kan-Ush-Mi Wa-Kish-Wit, The Columbia River Anadromous Fish Restoration Plan of the Nez Perce, Umatilla, Warm Springs, and Yakama Tribes," 2014.

[31] Adaptation Partners, "Climate Change Adaptation Library for the Western United States," Adaptation Partners and U.S. Forest Service, 2018.

[32] B. Metz, O. R. Davidson, P. R. Bosch, R. Dave and L. A. Meyer, "Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change," Intergovernmental Panel on Climate Change (IPCC), United Kingdom and New York, USA, 2007.

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OTHER IMPORTANT RESOURCES

Many important documents and entities are referenced in our Climate Action Plan. The Yakama Nation recognizes the importance of their individual and collective contributions and supports many of the recommended strategies and actions, where offered. We are grateful for their contributions to our expanding knowledge and we incorporate many of their findings into our work. Many of these important resources include, but are not limited to the following:

Organizations and Collaboratives

Great Northern Landscape Conservation Collaborative. Columbia Basin Partnership Forum. *https://greatnorthernlcc.org/*

Cascadia Partner Forum. *https://cascadiapartnerforum.org*

Arid Lands Initiative. *aridlandsinitiative.org/*

Climate Impacts Group. *https://cig.uw.edu/*

Pacific North West Tribal Climate Change Network. *https://tribalclimate.uoregon.edu/network/*

Columbia River Inter-Tribal Fish Commission. *https://www.critfc.org/*

Databases and Online Forums

NorWest Stream Temp. *https://www.fs.fed.us/rm/boise/AWAE/projects/NorWeST.html*

ClimateAquaticsBlog. *https://groups.google.com/forum/?hl=en#!forum/climateaquaticsblog*

Plans and Strategies

Great Northern Landscape Conservation Cooperative Science Plan, 2015 – 2019. Finn, S. Yvette Converse, Tom Oliff, Matt Heller, Rick Sojda, Erik Beever, Sergio Pieruissi, Jen Watkins, Nina Chambers and Scott Bischnke.

NOAA Fisheries Climate Science Strategy. Jason S. Link, Roger Griffis, Shallin Busch (Editors). U.S. Dept. of Commerce, NOAA Technical Memorandum NMFS-F/SPO-155. 2015.

Preparing for a Changing Climate. Washington State's Integrated Climate Response Strategy. Department of Ecology. State of Washington. Publication No. 12-01-004. April, 2012.

20-Year Forest Health Strategic Plan, Easter Washington. Washington State Dept. of Natural Resources.

Washington States Integrated Climate Change Response Strategy. Interim Recommendations from Topic Group 3. Species, Habitats and Ecosystems (TAG3). February, 2011.

Yakima River Basin Integrated Water Resources Management Plan. Final Programmatic Environmental Impact Statement. U.S. Department of Interior, Bureau of Reclamation. Washington Department of Ecology, State of Washington, USA. Ecol;ogy Publication Number 12-12-002. March, 2012. *http://www. usbr. gov/pn/programs/vrbwep/2011 integrated plan/index.html.*

Forest Management Plan. Yakama Reservation. U.S. Department of Interior; Bureau of Indian Affairs. Yakama Agency Branch of Forestry. Yakama Nation. September, 2005.

Assessments, Scientific Articles, and Reports

Stream Temperature Variability: Why it Matters to Salmon. Science Findings. U.S. Department of Agriculture. Forest Service. Issue 163, July 2014.

Water Resource Impacts in the Pacific Northwest. Climate Facts. U.S. Department of Agriculture, Forest Service. 2012.

Vegetative Change in the Pacific Northwest. Climate Facts. U.S. Forest Service – Pacific Northwest Region. 2012.

Climate Change in the Northwest: Implications for Our Landscapes, Waters, and Communities. Dalton, M.M., P.W. Mote, and A.K. Snover [Eds.]. Washington, DC: Island Press. 2013.

Climate change and forest trees in the Pacific Northwest: a vulnerability assessment and recommended actions for national forests. Devine, W.; Aubry, C.; Bower, A.; Miller, J.; Maggiulli Ahr, N. Olympia, WA: U.S. Department of Agriculture, Forest Service, Pacific Northwest Region. 102 p. 2012. *http://ecoshare.info/projects/ccft/*

Climate change and forest trees in the Pacific Northwest: guide to vulnerability assessment methodology. Devine, W.; Aubry, C.; Miller, J.; Potter, K.; Bower, A. Olympia, WA: U.S. Department of Agriculture, Forest Service, Pacific Northwest Region. 49 p. 2012. *http://ecoshare.info/projects/ccft/*

Climate change effects on stream and river temperatures across the northwest U.S. from 1980–2009 and implications for salmonid fishes. Isaak, D. J. S. Wollrab, D. Horan, G. Chandler. U.S. Forest Service, Rocky Mountain Research Station, Air, Water, and Aquatics Program—Boise Aquatic Sciences Lab, 322 E. Front St., Suite 401, Boise, ID 83702, USA

Uncertainty and Extreme Events in Future Climate and Hydrologic Projections for the Pacific Northwest: Providing a Basis for Vulnerability and Core / Corridor Assessments. Jeremy S. Littell, Guillaume S. Mauger, Eric P. Salathé, Alan F. Hamlet, Se-Yeun Lee, Matt R. Stumbaugh, Marketa Elsner, Robert Norheim, Eric R. Lutz, and Nathan J. Mantua. Climate Impacts Group. July 2013.

Climate Change in the Northwest: Implications for Our Landscapes, Waters, and Communities. M.M., P.W. Mote, and A.K. Snover [Eds.]. Washington, DC: Island Press. 2013.

Climate change effects on vegetation in the Pacific Northwest: a review and synthesis of the scientific literature and simulation model projections. Peterson, David W.; Kerns, Becky K.; Dodson, Erich K. Gen. Tech. Rep. PNWGTR-900. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 183 p. 2014.

Climate change vulnerability and adaptation in the North Cascades region, Washington. Raymond, Crystal L.; Peterson, David L.; Rochefort, Regina M., eds. Gen. Tech. Rep. PNW-GTR-892. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 279 p. 2014.

Climate Change Impacts and Adaptation in Washington State: Technical Summaries for Decision Makers. Snover, A.K, G.S. Mauger, L.C. Whitely Binder, M. Krosby, and I. Tohver. State of Knowledge Report prepared for the Washington State Department of Ecology. Climate Impacts Group, University of Washington, Seattle. 2013. *http://cses.washington.edu/db/pdf/snoveretalsok816.pdf*

The ecology and management of moist mixed-conifer forests in eastern Oregon and Washington: a synthesis of the relevant biophysical science and implications for future land management. Stine, Peter; Hessburg, Paul; Spies, Thomas; Kramer, Marc; Fettig, Christopher J.; Hansen, Andrew; Lehmkuhl, John; O'Hara, Kevin; Polivka, Karl; Singleton, Peter; Charnley, Susan; Merschel, Andrew; White, Rachel. Gen. Tech. Rep. PNW-GTR-897. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 254 p. 2014.

Summary of Climate Change Effects on Major Habitat Types in Washington State. Washington Department of Fish and Wildlife and the National Wildlife Federation. July, 2011.

- Forests, Alpine, and Western Prairie Habitats.
- Shrub-Steppe and Grassland Habitats
- Freshwater and Aquatic Riparian Habitats

Washington Connected Landscapes Project: Analysis of the Columbia Plateau Ecoregion. Washington Wildlife Habitat Connectivity Working Group (WHCWG). Washington's Department of Fish and Wildlife, and Department of Transportation, Olympia, WA. 2012.

The Washington Climate Change Impacts Assessment. Climate Impacts Group. M. McGuire Elsner, J. Littell, and L Whitely Binder (eds). Center for Science in the Earth System, Joint Institute for the Study of the Atmosphere and Oceans, University of Washington, Seattle, Washington. 2009. *http://www.cses.washington.edu/db/pdf/wacciareport681.pdf*

Climate Change Adaptation Library for the Western United States. Information in the Library is derived from climate change vulnerability assessments conducted by Adaptation Partners. *http://adaptationpartners.org.*

DRAFT Climate Change Vulnerability and Adaptation in Southwest Washington. J.L. Hudec, J.E. Halofsky, D.L. Peterson, and J.J. Ho. U.S. Department of Agriculture, Forest Service. Pacific Northwest Research Station. Portland, Oregon. General Technical Report PNW-GTR-May 15, 2018

Climate Change Impacts on Columbia Basin Fish and Wildlife. Independent Scientific Advisory Board. ISAB Climate Change Report. ISAB 2007-2. May 11, 2007.

Climate Change 2014, Synthesis Report. IPCC Fifth Assessment Synthesis Report. November, 2014.