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Clearwater River Subbasin (ID) Climate Change Adaptation Plan

Nez Perce Tribe Water Resources Division

Model Forestry Policy Program

Cumberland River Compact

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Foreword

In 2011, the Nez Perce Tribe's Water Resources Division (NPT WRD) applied for a small, one year educational scholarship grant from the Model Forest Policy Program (MFPP). The MFPP held monthly webinars that addressed the different elements of writing a climate change adaptation plan, based on case studies from communities around the country. Tribal staff organized a core technical team, composed of stakeholders in the region and, over the course of a year, developed the following climate change adaptation plan for the Clearwater River Subbasin. This project came about because NPT WRD recognized the need for increased awareness of climate change issues in the Clearwater River Subbasin. The plan that was developed is the result of a year of community team effort, deep and broad information gathering, critical analysis, and thoughtful planning. The NPT WRD used the strategies provided by the MFPP Climate Solutions University: Forest and Water Strategies program (CSU) to gather relevant regional data and develop an adaptation plan that addresses local climate risks, fits local conditions and culture, and takes advantage of identified opportunities. The main emphasis of this climate change adaptation plan was on forest and water resources, as well as the potential economic impacts of climate change on those resources. The goal of the adaptation plan is to act as a catalyst for the regional community to begin developing and implementing detailed adaptation strategies in order to better withstand the impacts of a changing climate upon the natural resources, economy and social structure of the Clearwater River Subbasin in the decades to come.

Acknowledgements

Climate Solutions University (CSU) would not have been possible without the major funding of The Kresge Foundation, which allowed CSU to develop the in-depth curriculum and provide grants for local community participation.

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Executive Summary

The Clearwater River Subbasin comprises much of the original homeland of the Nez Perce Tribe (Tribe) and still is the largest population center for the Tribe. Historically, the Nez Perce people were hunters and gatherers and thrived on abundant salmon, elk and deer, camas and other roots and berries. The protection of these resources is a fundamental mission of the Nez Perce Tribe. The first documented non-Indians to traverse this area were members of the Lewis and Clark expedition, who paddled down the Clearwater River in dugout canoes in 1805. Subsequently, other early explorers and fur traders used the Clearwater River as a convenient westward route. Henry Spalding established a mission near present-day Lapwai in the 1830s. The discovery of gold on a tributary to the Clearwater River brought in large numbers of settlers. Agriculture and logging became the main economic activities in the second half of the 19th and early 20th century (Sobota 2001). Because of dams built on the Columbia River and tributaries to the Clearwater River in the 20th century, salmon and steelhead runs have been drastically reduced from historical levels. Today, agriculture, timber production and mining are still important for the region, but recreation and tourism have also become major industries.

As atmospheric carbon has risen to record levels, the greenhouse gas effect is causing global average temperatures to rise. Across the country the effects are being felt in the form of seasonal shifts, extreme weather events, floods, droughts, storms, increased frequency and severity of forest fires, melting glaciers and rising sea levels. Agricultural growing zones are shifting and natural habitat and forest vegetation are shifting with them. Heat waves and changing disease patterns are also affecting wildlife, livestock and people.

The forests, mountains and rivers of the Clearwater River Subbasin are not immune to the effects of a changing climate. Air temperatures in the region have increased about 1.5 ˚F during the 20th century and models predict a future increase of +2.0 ˚F by 2020, +3.2 ˚F by 2040, and +5.3˚F by 2080 (CIG 2008). April 1st snowpack has decreased overall in the Pacific Northwest, with losses of 30-60% at many individual monitoring stations. Timing of peak spring runoff has shifted to earlier in the spring throughout the western United States, leading to reduced summer streamflows, increased competition for water, vulnerability to drought, increases in summer water temperatures and a higher risk of winter flooding. The changes already being seen are substantial, and by the end of the century we will likely be facing unprecedented changes to our natural environment and the economies that depend on it.

To address these climate induced risks, the Nez Perce Tribe collaborated with Climate Solutions University: Forest and Water Strategies Program (CSU) to create a climate change adaptation plan for the Clearwater River Subbasin. The intention was to better understand the projected local impacts of climate change and to identify some key adaptation strategies to best preserve the natural resources of the Clearwater River Subbasin. With the assistance of the CSU distance learning program and a local planning team, the Tribe conducted an assessment of local risks and opportunities related to local climate, forest, water and economic conditions. Based on the assessment findings, the Tribe developed a climate change adaptation plan that aims to begin the process of adapting to those climate impacts that cannot be avoided, by developing strategies to protect forest and water resources and ensure the economic stability of the region.

Some key risk assessment findings for the subbasin include:

- An increase in wildfire intensity and severity.
- Changes in the current distribution and composition of forest communities.
- An increase in number and distribution of invasive/destructive plant and insect species.
- Loss of productivity in key timber species.
- An increase in the elevation of typical winter snowline.
- Earlier spring peak streamflows.
- Higher summer water temperatures, and a decrease in water quality overall.
- A change in habitat types for fish and wildlife.
- Negative impact to non-irrigated farmland, from drier conditions in summer.
- An increase in wildfire suppression costs.
- Negative impacts to recreation and tourism.

The adaptation plan developed strategies to protect forest habitat and sustainably managed forest industry, protect water quality and quantity, and support long term economic viability for those whose livelihoods are dependent upon natural resources. A range of potential adaptive management actions exist, including the reduction of existing fuel loads in forests to lower the risk of high severity fires, increasing ecosystem connectivity to facilitate species migration and conserving and restoring adequate aquatic habitat to support ecosystem functions, to name a few.

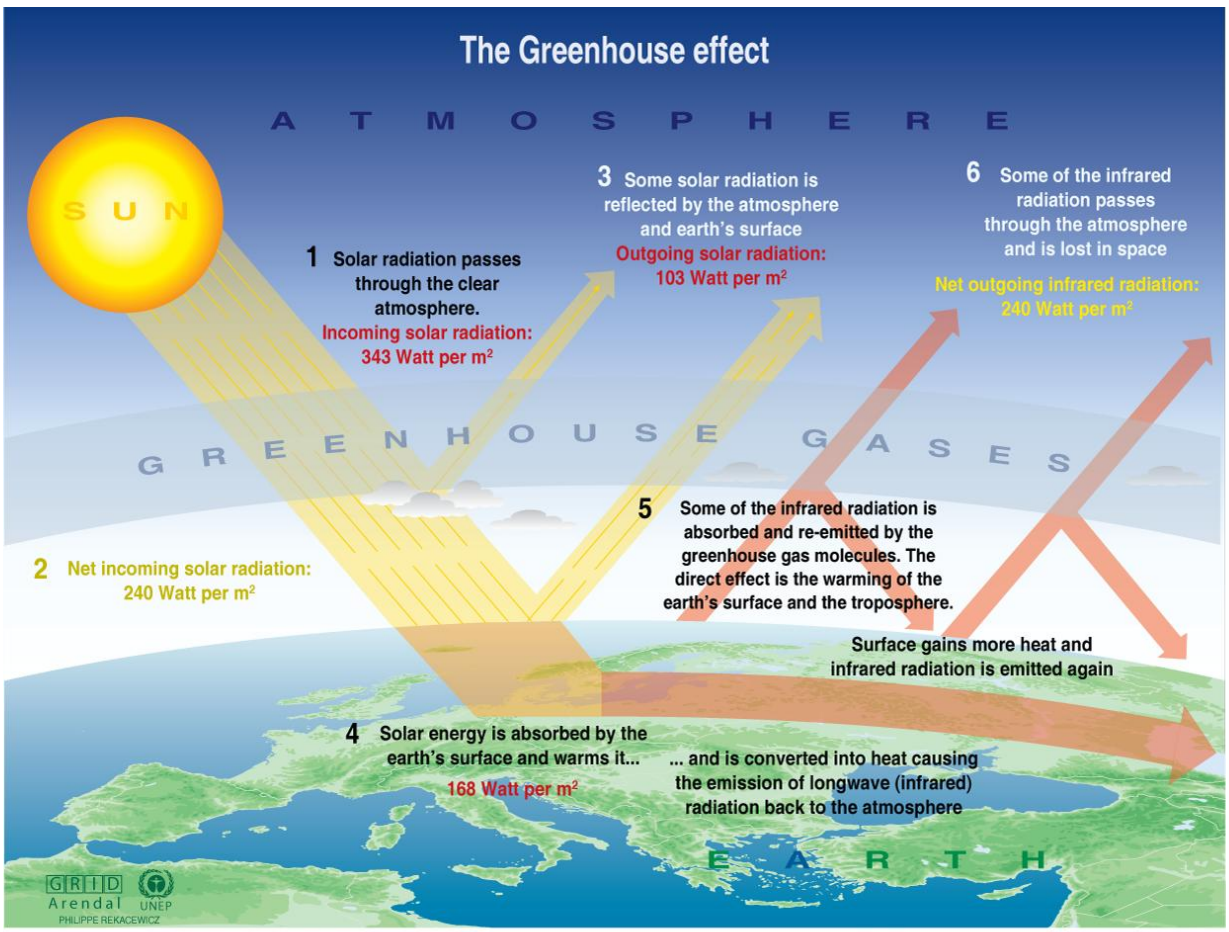
The major goals identified in the adaptation plan are to:

- Create partnerships to research local effects of climate change on water resources, forestry, and the economy.
- Include climate change adaptation assessment data, goals, and objectives into local and regional planning documents.
- Affect a change in planning and zoning regulations along waterways and restore the 100-year floodplain.
- Protect and restore water quality and quantity for human health and anadromous fish.
- Manage wildfire risk.
- Reduce and/or improve infrastructure in landslide-prone areas.
- Develop ecologically connected network of public and private lands to facilitate fish, wildlife and plant adaptation to climate change.

Implementation of the adaptation plan will be led by the Nez Perce Tribe in collaboration with a number of partnering agencies and organizations in the subbasin. As the goals and objectives are achieved in the coming years, the subbasin and its people will benefit from more resilient forest lands, clean and abundant water supply, healthy wildlife habitat, more sustainable farming, and communities more prepared to handle the weather, fire and health impacts of climate change.

Overview of Climate Change and Resource Management in the Clearwater River Subbasin

The purpose of this climate change adaptation plan is to assess risks and explore potential opportunities for addressing those risks in the Clearwater River Subbasin, both now and in the future, given that changes in our climate are inevitable. The fact that increases in greenhouse gases are changing our climate from historic conditions is now widely accepted (IPCC, 2007). Human activities are causing levels of greenhouse gases (such as carbon dioxide, methane, and nitrous oxide) in the atmosphere to increase, and predicted impacts to the Clearwater River Subbasin's forest and water resources appear to be occurring. Figure 1 below explains how solar energy is absorbed by the earth's surface, causing the earth to warm and to emit infrared radiation. The greenhouse gases then trap the infrared radiation, thus warming the atmosphere and creating the greenhouse effect.



Sources: Okanagan university college in Canada, Department of geography, University of Oxford, school of geography; United States Environmental Protection Agency (EPA), Washington; Climate change 1995, The science of climate change, contribution of working group 1 to the second assessment report of the intergovernmental panel on climate change, UNEP and WMO, Cambridge university press, 1996.

Figure 1. Greenhouse effect.

When discussing climate change, one must not confuse climate with weather. The difference between climate and weather is dependent upon time. **Weather** shows the condition of the atmosphere over a short period of time (hours, days) in a specific place. **Climate** describes how the atmosphere behaves over a long period of time (years, decades). Local or regional weather forecasts include temperature, humidity, wind, cloudiness, and expected precipitation over the next few days. Climate is the average of these weather conditions over many years. Some meteorologists like the saying that "climate is what you expect; weather is what you get", memorable words variously attributed to Mark Twain, Robert Heinlein, and others.

In practical terms, the climate for a particular city, state, or region tells you whether to pack short-sleeved shirts and shorts or parkas and mittens before you visit during a certain season, while the local weather forecast tells you if you'll want to wear the parka by itself or with an extra sweater today (http://www2.ucar.edu/climate/faq).

Climate change refers to changes in these long-term averages of daily weather. Measurements in the United States show that average temperatures have risen two degrees Fahrenheit over the last 50 years, while precipitation has increased five percent. Sea levels have risen by roughly eight inches over the past century, and oceans and lakes are becoming more acidic (GCCIUS 2009). These observed changes in our climate have been directly linked to the increasing levels of carbon dioxide and other greenhouse gases in the atmosphere. ***The changes already observed have been substantial, and by the end of the century we will likely be facing unprecedented changes to our natural environment and the economies that depend on it.***

Efforts to reduce the amount of greenhouse gas emissions are often referred to as **climate change mitigation**. While reducing the causes of climate change is crucial, mitigation on its own will not be enough to prevent the impacts to our climate, given the amount of greenhouses gases that have already been emitted into our atmosphere. This document is concerned with **climate change adaptation**, which has been defined as an “adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities” (IPCC WGII 2007). Adaptation involves dealing with the impacts of climate change and minimizing damages that cannot be avoided (by using drought-tolerant crop varieties, restricting development in floodplains, etc…). Adaptation actions are also most effective if they are developed and implemented by local communities, since resource and land-use decisions are primarily made at the local level.

Clearwater River Subbasin Overview

The Clearwater River Subbasin is approximately 9,350 square miles in size and extends 100 miles from north to south and 120 miles from west to east (Idaho/Washington border to Idaho/Montana border). The Clearwater River flows for 74.8 miles from the Bitterroot

Mountains on the Idaho-Montana border westward to the Idaho-Washington border, where it joins the Snake River at Lewiston. The subbasin is predominately forested, with areas of cropland and rangeland.

Elevations in the subbasin range from about 730 feet at the mouth of the Clearwater River to over 9,400 feet in the Selway/Bitterroot Mountains. The Clearwater River Subbasin is composed of valleys and canyons, hills and plateaus, and mountainous regions. The geographic distribution of these major land regions drives local microclimates, land cover types, and even population distributions within the subbasin. In the mountainous regions, land cover type is predominantly evergreen forest, whereas land cover on the hills and plateaus is predominantly cropland and pasture. The valleys are made up of grass and shrub land and also support the largest urban populations.

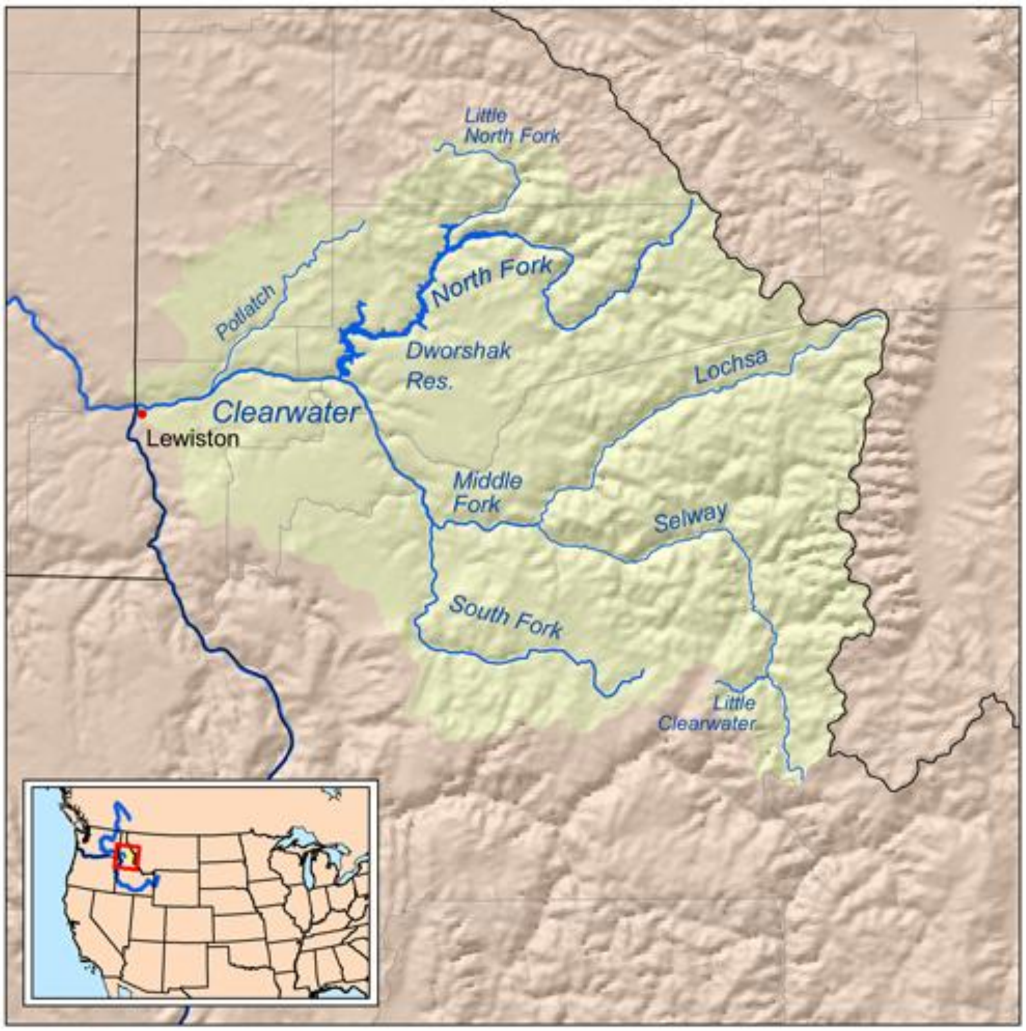


Figure 2. Clearwater River subbasin and major tributaries.
Source: http://en.wikipedia.org/wiki/File:Clearwateridrivermap.png.

The geologic record in the subbasin dates back 1.5 billion years, when marine sediments were deposited during the Precambrian period. The subbasin also contains metamorphic rocks of the same age or even older. The granites of the Idaho Batholith form the mountain ranges in the eastern part of the subbasin. During the Miocene period, the Columbia River basalt flows covered the area to a depth of 2800 feet. Subsequent folding and faulting created a relief of about 4000 feet (Ecovista 2003). The Palouse and Camas Prairies, in the Lower Clearwater region, were subsequently covered by windblown loess, which formed fertile but easily erodible soils. Much of this windblown loess was likely related to materials exposed by continental glaciations in what is now eastern Washington. Volcanic ash was deposited from eruptions of Mount Mazama (Crater Lake, Oregon) and several other Cascade Range volcanoes.

Approximately 60% of the subbasin is federally owned; the remaining acreage is a mixture of state, private and Nez Perce Tribal property. The difference in ownership can often represent a difference in land management policies and designations. It is important to understand the potential of current policies to conserve biodiversity under climate change, and to encourage more adaptive management when necessary, to facilitate species and ecosystem adjustments to climate change. A range of potential adaptive management actions exist, including the reduction of existing fuel loads in forests to lower the risk of high-severity fires, increasing ecosystem connectivity to facilitate species migration, and conserving and restoring adequate aquatic habitat to support ecosystem functions, to name a few.

The Clearwater River Subbasin comprises six counties: Nez Perce, Clearwater, Latah, Lewis, Idaho, and Shoshone, with Idaho and Clearwater counties having the greatest land area in the subbasin. The majority of the land in the subbasin is federally managed, followed by private ownership, Tribal ownership, and then state ownership. Ownership/management acreage is listed in Table 1, and graphically illustrated in Figure 3, below. The USDA Forest Service manages the Clearwater, Nez Perce, Bitterroot, and Shoshone National Forests in the subbasin.

Table 1. Approximate acreage owned or managed by various entities in the Clearwater River Subbasin.

Owner/Manager	Acreage (rounded to nearest 100)
Federal Government	
US Forest Service	3,725,800
US Bureau of Land Management	34,400
US Army Corps of Engineers	31,300
National Park Service	100
State Government	
Idaho Department of Lands	308,900
Idaho Department of Fish and Game	4,600
Nez Perce Tribe	121,700
Private	1,758,000

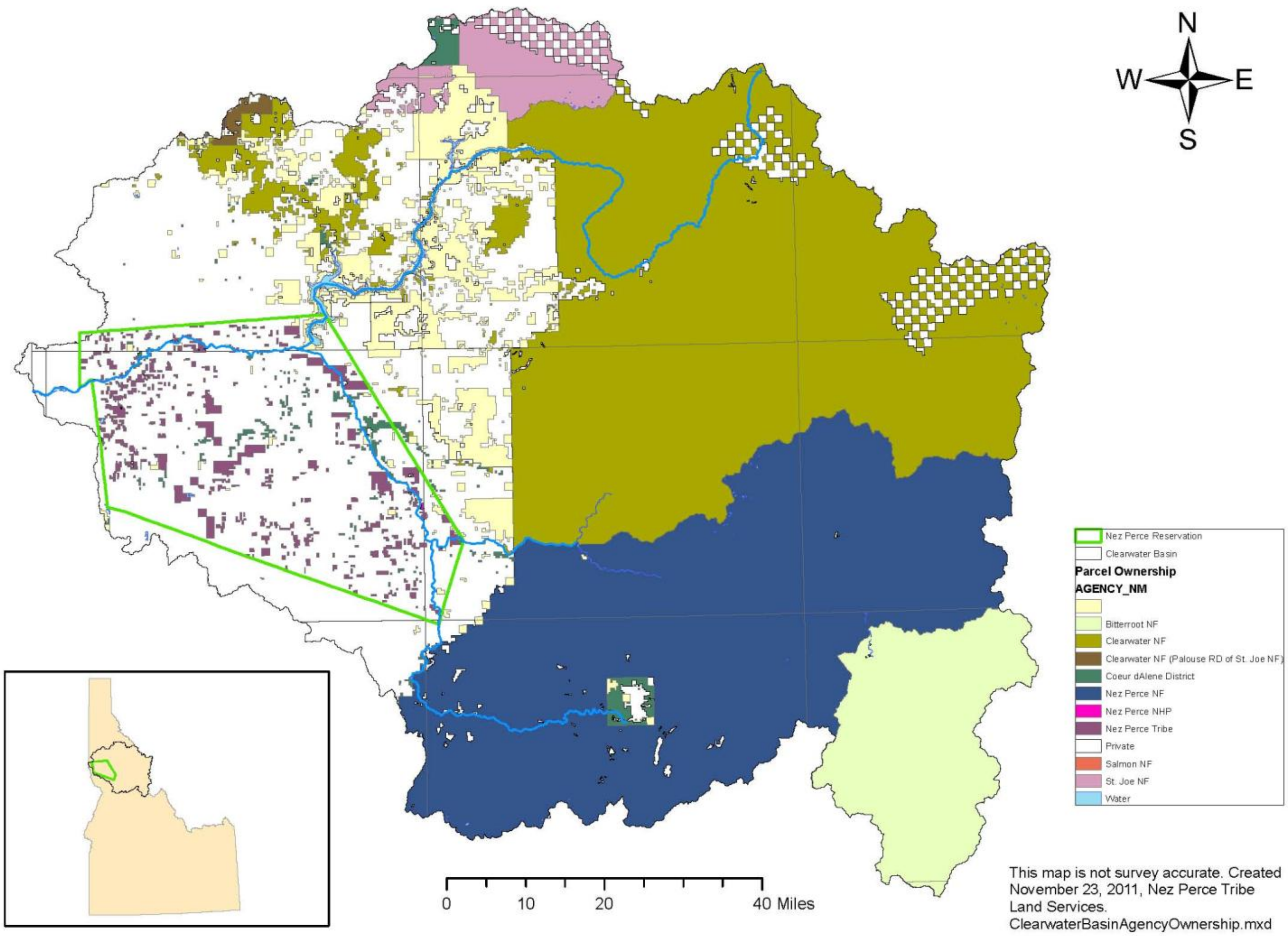


Figure 3. Land ownership in the Clearwater River Subbasin.

Resource Governance and Planning

The Clearwater River Subbasin has a number of land management agencies operating within it, and a number of management plans exist. Unfortunately, many of the existing management plans were written under the assumption that the climate, disturbance regimes and biotic communities would generally remain stable in the region. These management documents and policies should be revisited to ensure that they follow an adaptive management model that facilitates the adjustment by species and ecosystems to a changing climate. Table 2 lists some of the regional agencies, and a simplified summary of their role in addressing climate change, while Table 3 lists some of the existing management plans in the region. These lists are not comprehensive.

Table 2. Local governance structure (with jurisdiction or interest in climate change).

Name of Entity	***Role in addressing climate change***
United States Government:	
Natural Resources Conservation Service	BMPs for agriculture and forestry
Army Corps of Engineers	Dam management, wetlands regulations, 404 permits
Bonneville Power Administration	Dam operations and associated mitigation
U.S. Fish and Wildlife Service	Hatcheries, wildlife habitat, Endangered Species Act
U.S. Forest Service	Forest health, timber production, watershed mgmt.
Bureau of Land Management	Grazing leases and management, watershed mgmt.
NOAA-Fisheries	Anadromous fish issues
Clearwater Fish Hatchery	Salmon and steelhead production
State Government:	
Department of Parks and Recreation	Management of State parks
Department of Environmental Quality	Water quality assessment and regulation(TMDLs, 303(d) list, 401 permits)
Idaho Department of Fish and Game	Fish and wildlife population management
Idaho Department of Lands	State forestry management
Idaho Department of Water Resources	Water quantity assessment and regulation
Soil and Water Conservation Districts	Soil and water conservation, agricultural BMPs
County Government:	
Planning and Zoning	Floodplain ordinances
Parks and Recreation	County parks
Noxious Weed Control	Weed issues
City Government:	
Storm Water Program	Stormwater permitting and compliance
Wastewater Treatment Plants	Wastewater/NPDES issues
Drinking water departments	Drinking water supply and conveyance
Parks and Recreation	City parks
Tribal Government:	
Nez Perce Tribe Fisheries Department	Fish issues, watershed restoration
Nez Perce Tribe Natural Resources Department	Water resources, forestry, grazing leases, fire management, agriculture leases
Educational and Research Institutions:	
University of Idaho	Research, education and outreach
Lewis and Clark College	Research, education and outreach
Northwest Indian College	Education and outreach
Non-governmental Organizations:	
Palouse-Clearwater Environmental Institute	Stream restoration projects, environmental education
Friends of the Clearwater	Wildland protection
Framing our Community	Stream restoration projects

Figure 4. The Clearwater River near Kamiah. *Photo: Nez Perce Tribe.*

Table 3. Existing management plans that are relevant to Climate Change Adaptation planning in the Clearwater River Subbasin.

Authoring Agency	*Date*	*Title of Plan*
Tribal Plans:		
Nez Perce Tribe	1998	Unified Watershed Assessment and Watershed Restoration Priorities
Columbia River Inter-Tribal Fish Commission	1996	Columbia River Anadromous Fish Restoration Plan (Wy-Kan-Ush-Mi Wa-Kish-Wit)
Nez Perce Tribe and Nez Perce SWCD	2009	-Lapwai Creek Restoration Strategy -Big Canyon Creek Restoration Strategy
Nez Perce Forestry Division	1999	Forest Management Plan
Nez Perce Tribe		Strategic Plan
Federal Plans:		
U.S. Forest Service	1987	Clearwater and Nez Perce National Forest Plans
U.S. Forest Service and Bureau of Land Management	2002	Interior Columbia Basin Ecosystem Management Project
U.S. Fish and Wildlife Service	2003	Idaho Bull Trout Recovery Plan
U.S. Fish and Wildlife Service	2001	Lower Snake River Fish and Wildlife Compensation Plan

Bonneville Power Administration	2001	Endangered Species Act Implementation Plan for the Federal Columbia River Power System (FCRPS)
NOAA Fisheries	2000	FCRPS Biological Opinion and Basinwide Salmon Recovery Strategy
National Marine Fisheries Service	2011	Draft Snake River Salmon and Steelhead Recovery Plan
U.S. Army Corps of Engineers	2011	Dworshak Reservoir Public Use Plan, Ahsahka, Idaho
State Plans:		
Idaho Dept of Environmental Quality	2001	2002-2007 Strategic Plan, TMDLs
Idaho Dept of Water Resources	2004	SRBA Work Plans for Cottonwood Creek, Lawyer Creek and Lapwai Creek.
Idaho Dept of Fish and Game	1990-2001	Policy Plan, Strategic Plan, and various management plans
Idaho Water Resource Board	1996	Comprehensive State Water Plan for the North Fork Clearwater Basin
Idaho Water Resource Board	2003	Comprehensive State Water Plan for the South Fork Clearwater River Basin
Idaho Water Resource Board	2000	Dworshak Operation Plan
Idaho Dept of Transportation	2003	State Transportation Improvement Program
Latah, Nez Perce, Lewis, Clearwater counties		-Land Use Ordinances -Wildfire Protection Plans
Soil and Water Conservation Districts	2000-2001	Five-Year Management Plans
Idaho Soil and Water Conservation Commission	2003	Idaho Agricultural Pollution Abatement Plan
Idaho Soil and Water Conservation Commission		Agricultural TMDL Implementation Plans
Other Plans:		
Clearwater Basin Weed Management Area	2009	Annual Operating Plan
Northwest Power and Conservation Council	2005	Clearwater Subbasin Management Plan

Figure 5. The Clearwater River at the confluence with Big Canyon Creek. *Photo: Nez Perce Tribe.*

Protected Areas

About 47% (1.4 million acres) of the subbasin is designated as protected, either as inventoried roadless, wilderness, wild and scenic river corridors, or research natural areas. Most of the protected area is in the Selway, Lochsa, and North Fork Clearwater watersheds. Inventoried roadless areas account for 51% of the overall protected area (Ecovista, 2003), with 45% of the protected area being federally designated Wilderness.

Climate in the Clearwater River Subbasin

Climate throughout most of the Clearwater River Subbasin is strongly influenced by warm, moist maritime air masses from the Pacific, except for the southernmost and high elevation eastern portions of the subbasin, which experience colder conditions more typical of the northern Rocky Mountains (Bugosh 1999). A general increase in precipitation occurs from west to east across the subbasin, coincident with increasing elevation (Stapp et al. 1984). Mean annual precipitation ranges from 12 inches at the confluence of the Clearwater and Snake Rivers to as high as 60 to 85 inches in the Bitterroot Mountains on the Selway-Bitterroot Divide. Due to colder average temperatures, winter precipitation above 4,000 feet falls largely as snow (McClelland et al. 1997). There is also a seasonal variability to precipitation patterns in the region, with very little precipitation occurring in the summer months. Average temperatures generally decrease as one moves from west to east in the subbasin, coinciding with increasing elevations.

Figure 6. South shore of the Clearwater River, west of Lenore, ID. *Photo: Nez Perce Tribe.*

The National Climatic Data Center (NCDC) has identified three distinct climate zones in the subbasin: North Central Prairie (zone 2); North Central Canyon (zone 3); and Central Mountains (zone 4). The North Central Prairie and North Central Canyon zones cover most of the privately and tribally owned lands in the subbasin, as well as most of the agricultural lands. The North Central Canyon zone consists of the low- and mid-elevation land found along the mainstem Clearwater River, upstream to its confluence with the Middle Fork Clearwater River. The North Central Prairie zone consists of the mid-elevation land surrounding the North Central Canyon zone, including both the Palouse and Camas Prairies. The Central Mountain zone is comprised primarily of higher-elevation forested lands, which are mostly owned by the USDA Forest Service. Figure 7 shows the climate zones found within the Clearwater River Subbasin.

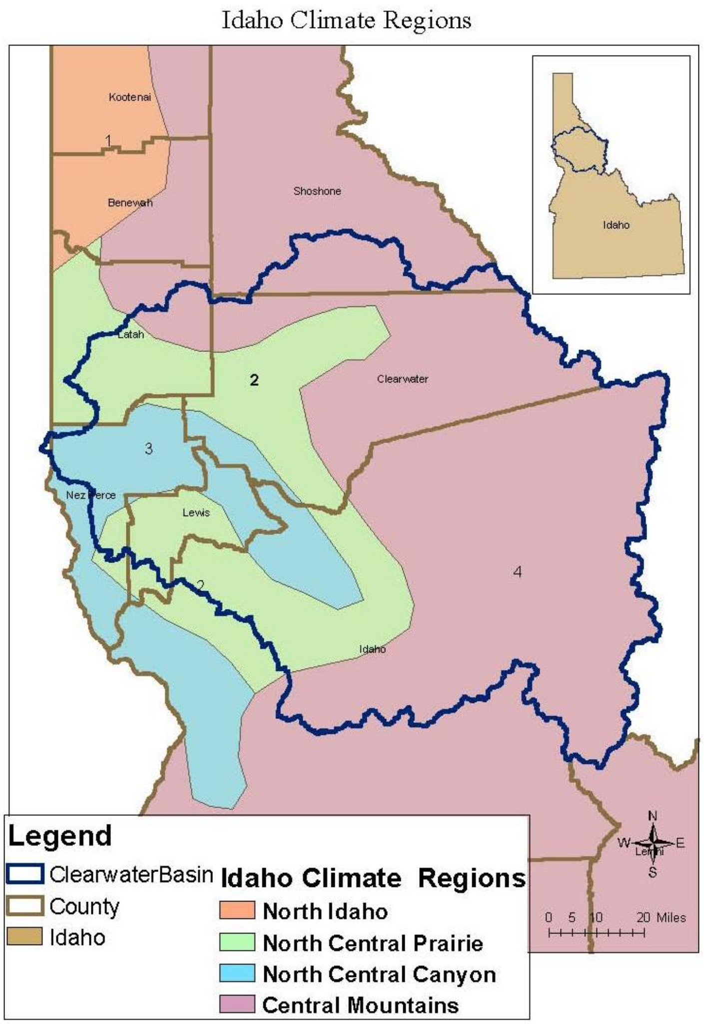


Figure 7. Climate Zones in the Clearwater subbasin.
Source: National Climate Data center map altered in GIS to focus on smaller section of Idaho; legend and Clearwater River subbasin outline added.

Year-to-Year Variability

Year- to-year climatic variability in the Pacific Northwest is primarily driven by El Nino/Southern Oscillation (ENSO) and the Pacific Decadal Oscillation (PDO), along with other unexplained influences. Understanding the effects of ENSO and PDO in the Clearwater River Subbasin helps to explain the year-to-year seasonal variability.

El Niño winters in the Pacific Northwest tend to be warmer and drier than average, whereas La Niña winters tend to be wetter and cooler (CIG, 2008). The Climate Impacts Group studied the average temperature and precipitation variations between El Niño and La Niña winters and found that average temperatures from December through June are approximately 0.7 to 2.7 °F higher during El Niño years vs. La Niña years and precipitation is about 14% less from October through March.

Pacific Decadal Oscillations have a warm phase and a cool phase. As the name implies, warm phase PDO winters are warmer and drier, whereas cool phase winters are colder and wetter. Temperatures from October through May are about 0.9 °F higher during the warm phase, while precipitation is about 10% less (CIG 2008).

Temperature

Historical temperature records in the subbasin used for modeling climate change are from 1971 to 2000. During this period, average winter temperatures ranged from 27.3 °F in the mountains to 34.6 °F in the low-lying areas, with average daily minimums ranging from 18.8 °F to 27.7 °F (NRCS 2010). Average summer temperatures ranged from 60.3 °F to 70 °F, with average daily maximum temperatures of 77.1 °F to 86 °F.

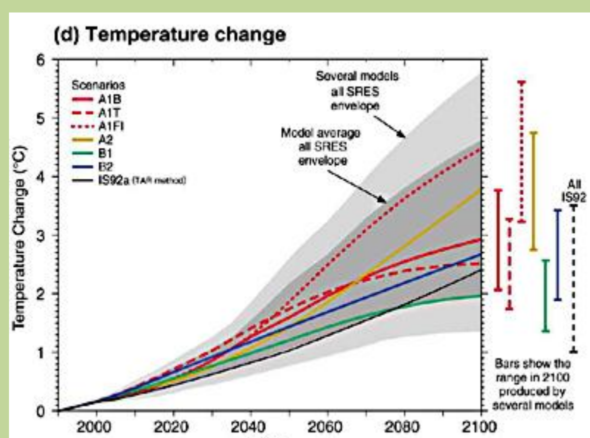
The Climate Impacts Group (CIG 2008) modeled temperature changes in the Pacific Northwest. Historically, temperatures have increased about 0.2 °F each decade during the 20th century (CIG 2008). Models that predict future temperature suggest that temperatures will be about 2.0 °F warmer by 2020, 3.2 °F warmer by 2040, and 5.3 °F warmer by 2080. The predicted warmer temperatures apply to all seasons. The further a model predicts into the future, the greater the variability, since changes in greenhouse gas and sulfate aerosol emissions predicted over time are based, in large part, on different assumptions concerning population growth, socioeconomic development, technological advances, and energy resources.

Year	Temperature °F	Precipitation %
2020	+2.0 (+1.1 to +3.3)	+1.3 (-9 to +12)
2040	+3.2 (+1.5 to + 5.2)	+2.3 (-11 to +12)
2080	+5.3 (+2.8 to +9.7)	+3.8 (-10 to +20)

Table 4. Predicted temperature and precipitation changes in the Columbia River Basin. *Source: Climate Impacts Group (CIG) 2008.*

Although climate change is a natural process, greenhouse gases generated by humans are certain to contribute to warming of the planet. Carbon dioxide concentrations are estimated to range from 549 to 790 parts per million by volume (ppmv) by 2100 (CIG 2008). The pre-industrial levels were 280 ppmv. These levels, both historic and projected, are used in developing two climate change scenarios (A1 and B1 families) with a multitude of variations within these family scenarios (Intergovernmental Panel on Climate Change (IPCC)). The A1family scenario assumes high emissions, peaking global populations, and greater energy needs being met by both fossil fuels and alternative energies. The B1 family scenario assumes lower levels of greenhouse gas emissions, peaking global populations, and improved clean, resource-efficient technologies.

Climate change models that predict temperature and precipitation are based on these family scenario assumptions. For more information on the models, see Chapter 8: Climate Models and Their Evaluation in the IPCC's Working Group I report, *The Physical Science Basis.*



Precipitation

Mean annual precipitation in the Clearwater River Subbasin ranges from about 12 inches in the lower elevations to over 90 inches in the mountains. Summers in the region are generally very dry, with the majority of the precipitation occurring during the winter months. The 4,000-foot elevation band is of significance in the region, with most of the precipitation above that elevation falling as snow, and typically remaining through late spring to early summer. Below the 4,000-foot elevation band, the probability of winter precipitation occurring as rain is much higher, making this area susceptible to rain-on-snow events that often lead to rapid melting of snow and extreme runoff events. Table 5 shows minimum, maximum and mean annual precipitation rates for the various assessment units in the Clearwater River Subbasin. Precipitation statistics for individual weather stations in these large assessment units may vary substantially. Figure 8 graphically depicts the current average annual precipitation rates in the subbasin.

Table 5. Mean annual precipitation rates in the Clearwater River Subbasin. *Source: Ecovista 2003.*

Assessment Unit	Min Precip. (in)	Max Precip. (in)	Mean Precip (in)
Lower Clearwater	11.0	57.0	25.7
S.F. Clearwater	25.0	53.0	36.0
Lolo/Middle Fork	23.0	75.0	40.2
Upper Selway	19.0	71.0	43.7
Lower Selway	27.0	61.0	41.6
Upper North Fork	31.0	97.0	59.0
Lower North Fork	23.0	87.0	43.1
Lochsa	27.0	81.0	53.0

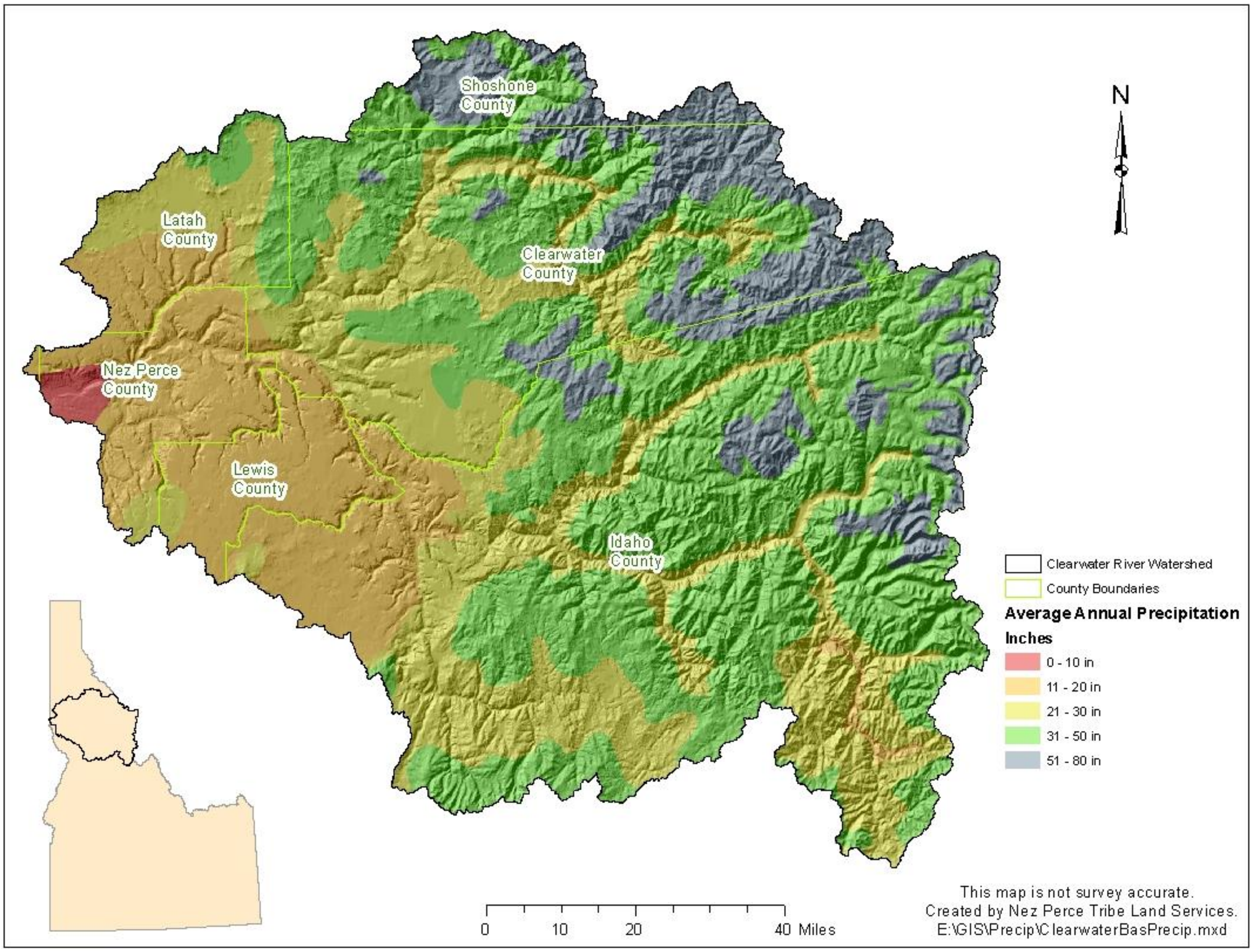


Figure 8. Average Annual Precipitation rates in the Clearwater River Subbasin.

Regional climate change models show highly variable trends in precipitation patterns geographically, with a general increase in summer moisture deficits, meaning longer and more intense summer dry periods. While interactions among snow cover, albedo, and regional topography make it difficult to accurately predict fine scale precipitation changes, models show that this region will generally see reduced snow packs and earlier runoff, reducing the water available for use by plants and aquatic ecosystems later in the growing season.

Snowfall

Snowfall in the Clearwater River Subbasin is largely dependent on elevation. As elevations increase, average winter temperatures drop and most of the precipitation above 4,000 feet falls as snow, where it generally remains until late spring or early summer. Below 4,000 feet, the probability that precipitation will fall as rain during the winter months is much higher, and rain-on-snow events are common from November through March, causing rapid melting of snowpack and extreme runoff events.

Snowfall records at Dworshak Fish Hatchery (1,000 ft elevation) from 1971-2000 show an average of 12.3 inches of snow each year (NRCS 2010). Elk River (2,920 ft elevation) receives an average of about 102 inches yearly, and areas of higher elevation in the subbasin receive over 250 inches annually. The number of days with 1 inch or more of snow on the ground range from 10 days per year in the lower elevations to 133 days per year in higher elevations (NRCS 2010).

Figure 9 below depicts the current (1971-2000) temperature patterns for November through March. The cold mean winter temperatures found in the high-elevation eastern portion of the subbasin is the reason why one-third of the contemporary annual precipitation falls when mean monthly winter temperatures are less than -2 ˚C, and a substantial portion (10%) falls when temperatures are less than -5 ˚C. However, with air temperatures being projected to increase by 3 to 4 ˚C by the end of the century, much of this snowfall could transition to rainfall (Graves 2008). Note that the lowest inset graph in the bottom left corner represents precipitation over the course of the entire year, not just during the winter months.

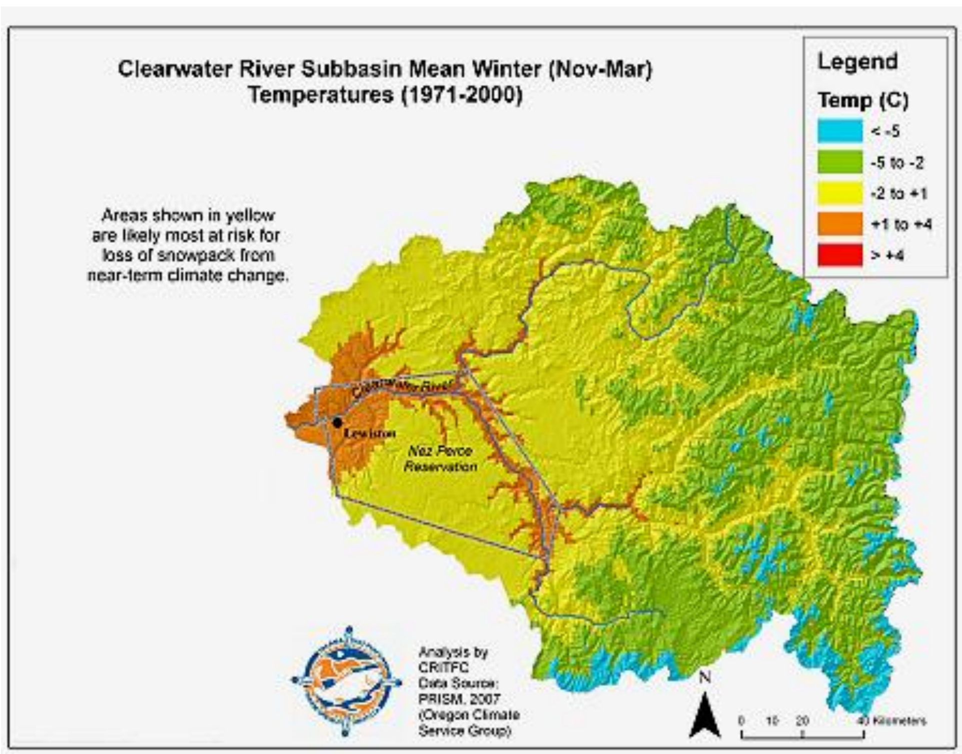


Figure 9. Current (1971-2000) temperature patterns for November through March in the Clearwater River Subbasin.

Resource Assessments

Forest Assessment

Over two-thirds of the total acreage of the Clearwater River Subbasin consists of evergreen forests (over four million acres) which are largely found in the eastern, mountainous portion of the subbasin. Most of this forested land is managed by the USDA Forest Service (over 3.7 million acres).

Historic Forest Conditions

Industrial forestry has occurred in the Clearwater River Subbasin since the late 19th century and was once a primary driver of the local economy. The most active logging in the subbasin occurred during the period after World War II until the early 1990s, with the peak occurring during the 1970s, when over 170 million board feet of timber was harvested annually. The number of trees removed from National Forest land, which comprises most of the forest in the subbasin, has declined significantly since then, due to a variety of factors, including depressed timber markets, restrictions related to Endangered Species Act (ESA) listed salmon stocks, and changes in Forest Service management policies. Much of the forested land outside of the National Forest is still actively managed however, with the combined 730,000 plus acres of land managed/owned by the Idaho Department of Lands (IDL) and Potlatch Corporation being the most intensively managed forest land in the subbasin, with substantial commercial harvest still occurring. The Bureau of Indian Affairs (BIA) managed forests on Tribal lands until 1988, when the Nez Perce Tribe's Forestry Division took over those duties. Today, forested Tribal lands are managed primarily for forest health and fuels reduction.

Extensive wildfires in 1910 and 1934 removed large areas of forest canopy. After these fires, national fire policies called for suppression. These years of fire suppression in forested areas have resulted in plant communitites that have greater biomass and less vigorous vegetative growth, with increased susceptibility to pathogens and wildfires of greater severity and size (Johnson 1998). Fire suppression has also resulted in an absence or reduction of early seral species or communities compared to historical ranges (Thompson 1999).

Since the 1990s, the management of federal forests has largely emphasized ecological goals, while timber production is still the primary goal on state-owned and private forest lands, generally. Forests regulate the timing and flow of surface and groundwater discharges to streams and rivers, they store and sequester carbon, protect water quality and quantity, provide wildlife habitat, provide recreational opportunities, and contribute to local economies. Wise management of the forests in the Clearwater River Subbasin will play a central role in both climate change mitigation and adaptation planning.

Figure 10. Young, mixed-conifer forest on southwest edge of subbasin. *Photo: Nez Perce Tribe.*

The distribution and abundance of vegetative cover types within the subbasin has changed over time. Timber harvest has impacted the extent and composition of some forest types such as open ponderosa pine (Nez Perce National Forest 1998). Overharvest and the introduction of blister rust have caused populations of western white pine, which was the dominant species in some parts of the subbasin, to be significantly decreased. Mesic forest species, including grand fir, have increased their range by filling the niche once occupied by the western white pine.

Effect of Climate Change on Forests

Climate is always changing, and the abundance and distribution of tree species changes individually in response to this climatic variability. A number of different vegetation change scenarios are possible for this region as a result of climate change. Higher elevation areas will likely experience less snowpack and longer, warmer growing seasons, which could translate to an increase in overall growth. Conversely, overall growth may well decrease at lower elevations, as reduced snowpack and earlier runoff lead to an earlier onset of summer drought conditions than is currently found in the region.

Studies by Boisvenue and Running (2010) have shown that forest growth in the Northern Rocky Mountains is primarily controlled by day length in winter months (November through February), temperature in spring and fall, and water during the warm summer months. At their test plots, overall productivity was found to be dependent upon moisture conditions during the main part of the growing season. In turn, moisture conditions are determined by a combination of spring, summer, and autumn temperatures, as well as summer precipitation levels and the previous winter's snow pack.

Increased Fire Potential

Early snowmelt resulting in low moisture levels in the summer not only reduces forest growth, but can also increase fire potential. Earlier drought conditions, caused by a shift forward in the regional hydrograph could lead to longer fire seasons, reduced average fuel moisture levels, and increased extent of wildfire overall.

Studies by Morgan et al. (2008) identify the mid-elevations in the Northern Rockies as having the greatest risk of climate-induced fire increases in the region and have also found that the timing of spring snow-melt can drive the intensity of fires.

Figure 11. From Forest Fire Gallery. *Photo: John McColgan, BLM.* ***2000.***

Invasive Species and Insect Infestations

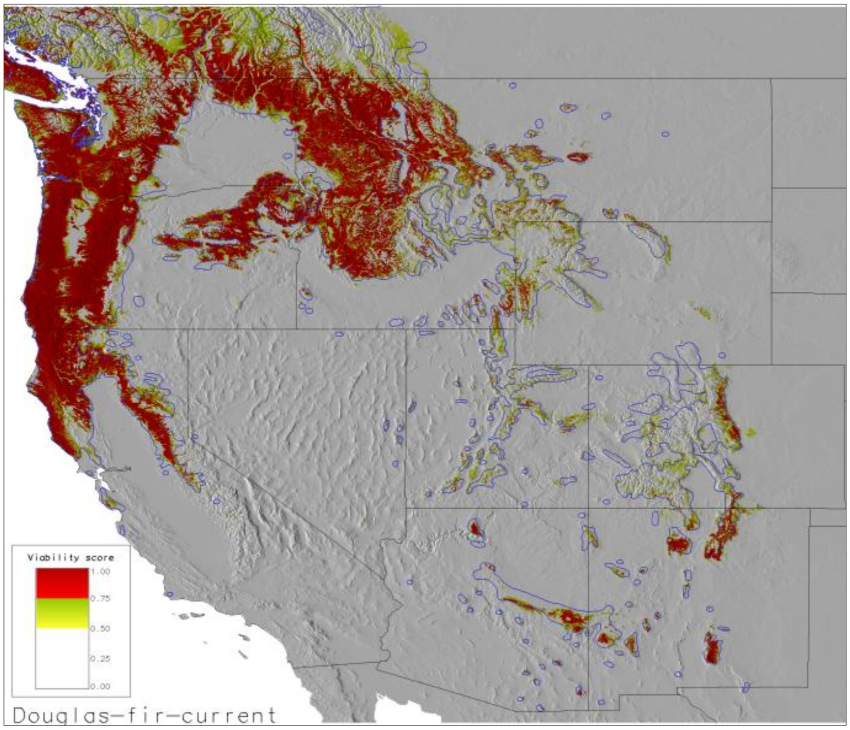
Figure 12. Yellow Starthistle
Source: http://en.wikipedia.org/wiki/Centaurea_solstitialis.

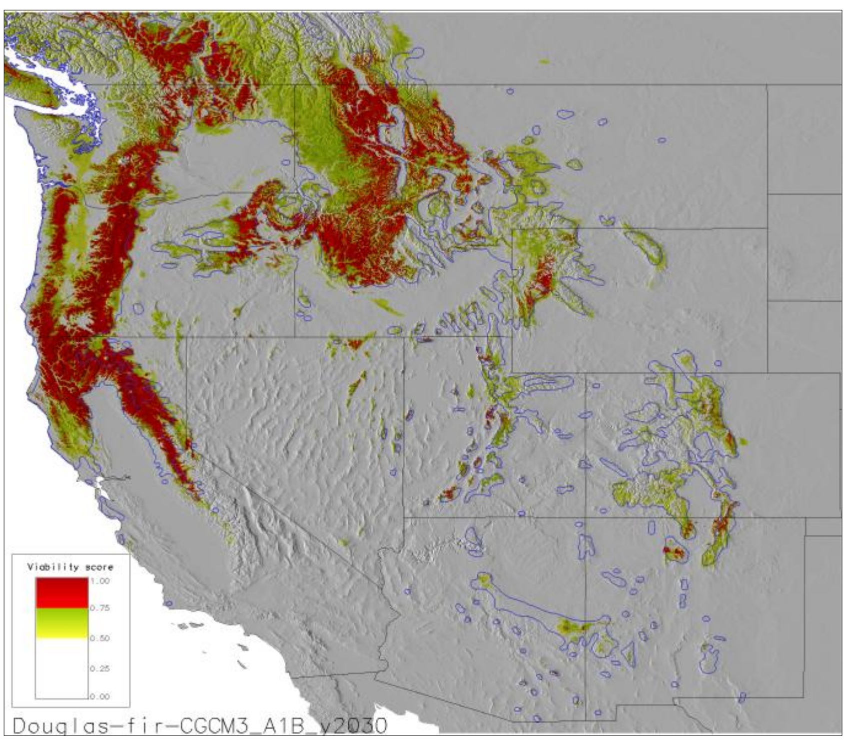
Invasive plants are highly competitive and have the potential to change the structure and function of ecosystems over large areas. In addition, they often increase the fuel loads in forest ecosystems and increase fire frequency. Climate change is altering the interactions among plant species and can create stress in native plant communities while providing opportunities for expansion by very adaptable invasive plant species. A Purdue University study published in the journal *Ecological Applications* showed that when yellow starthistle (*Centaurea solstitialis L.*) was exposed to increased carbon dioxide, precipitation, nitrogen, and temperature (all expected results of climate change) it responded by growing to six times its normal size in some cases, while other grassland species remained relatively unchanged (Dukes, et al. 2011). The decreased pasture production, lost water and control costs associated with invasive weeds already cause serious economic impacts to the region, and increases in invasive plant species will only compound those impacts. Experts suggest that yellow starthistle alone may already cause more than $12 million a year in economic impacts to the State of Idaho (Julia, et al. 2007).

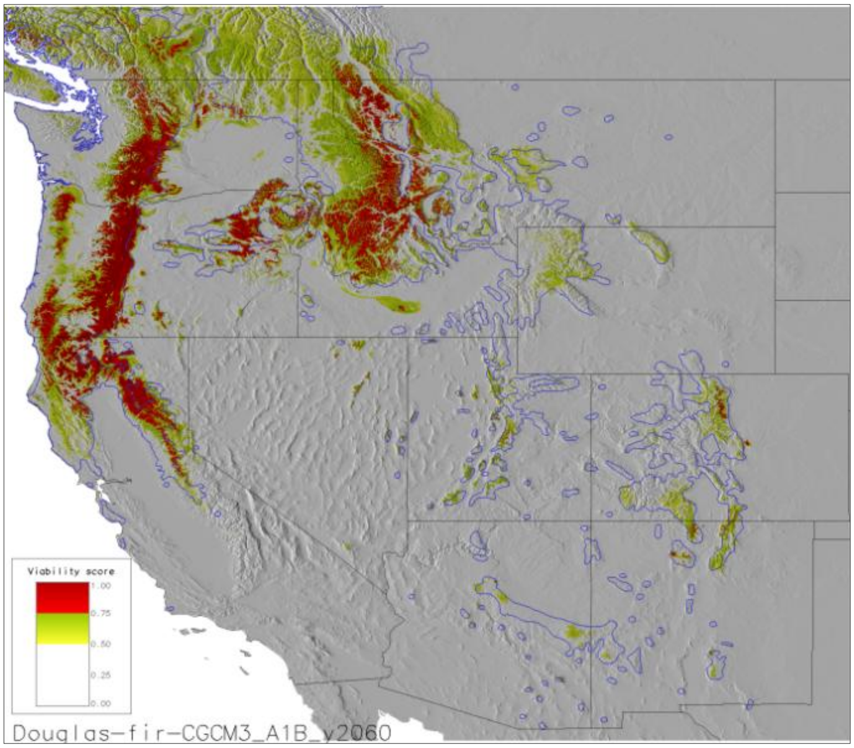
Figure 13. Pine Beetle.
Source: http://scodpub.wordpress.com/ 2010/03/15/pine-beetle-plague/.

Forest insect populations are also influenced by environmental conditions, and changes in climate can be expected to significantly alter the outbreak dynamics of certain species. In some cases, larger and more frequent insect outbreaks are expected to occur. Since 1990, native bark beetles have killed millions of trees from Alaska to southern California, and these recent outbreaks are the largest and most severe in recorded history. Temperature is one of the main drivers in the beetle's life history, influencing everything from the number of eggs laid by a single female, to over-winter survival rates and developmental timing. Elevated temperatures associated with climate change are expected to speed up reproductive cycles and reduce cold-induced mortality rates. Shifts in precipitation patterns and associated drought can weaken trees and make them more susceptible to bark beetle attacks.

Changes in climate in the Pacific Northwest will likely affect the distribution of tree species in the Clearwater River Subbasin. The USDA Forest Service Rocky Mountain Research Station has modeled changes in forest species for the western United States (http://www.fs.fed.us/rmrs/). Figure 14 shows the current (upper left) and predicted changes in Douglas fir (*Pseudotsuga menziesii*) habitat for the western United States (2030, 2060, 2090, respectively). The red values are the areas where Douglas fir is most viable. The model predicts that Douglas fir will only occur at the highest elevations by the end of the century. These same models predict that lodgepole pine (Pinus contorta) and Western larch (Larix occidentalis) will no longer occur in the subbasin by the end of the century. Projections for other tree species in the subbasin can be found at http://www.fs.fed.us/rmrs/.







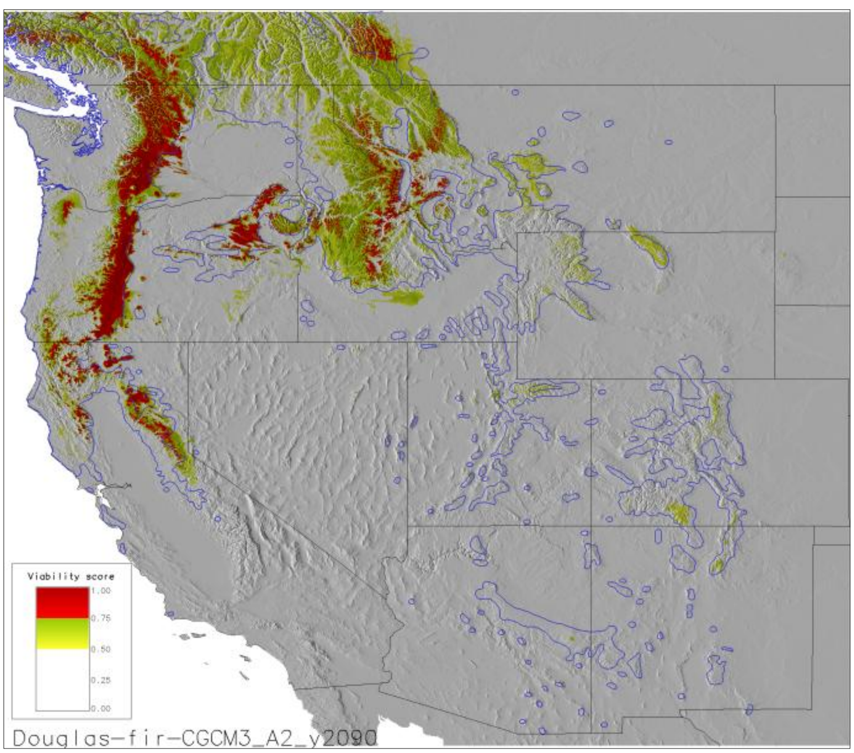


Figure 14. Modeled prediction of the habitat range for Douglas fir (current, 2030, 2060, and 2090, respectively).
Source: USDA Forest Service, Rocky Mountain Research Station.

Table 6. Predicted impacts to forests from climate change.

Wildfire	Increase in intensity and severity of fires.
	Earlier fire season.
Invasive/ Destructive Species	Increase in both invasive/destructive plant and insect species, as well as an increase in geographic extent of infestations.
Vegetation	Change in distribution of forest communities.
	Potential loss of important timber species.
	Loss of productivity in key timber species.
Wildlife	Change in distribution due to changes in forest vegetation and increased fires.

Water Assessment

The Clearwater River Subbasin encompasses more than 9,600 square miles of north-central Idaho and is home to over 30 species of fish, 19 of which are native. Nearly 12,000 linear miles of stream corridor are found within the subbasin. The Clearwater River Subbasin is surrounded by the Salmon River Subbasin to the south, the St. Joe and Palouse Subbasins to the north, and the Bitterroot Subbasin to the east. The Clearwater River's confluence with the Snake River is located on the Washington-Idaho border to the west, at the town of Lewiston.

Figure 15. Clear Creek, a tributary to the Middle Fork Clearwater River. *Photo: Nez Perce Tribe.*

The Clearwater River has five primary tributaries, the North and South Forks, the Lochsa, the Potlatch, and the Selway Rivers. The Clearwater River accounts for approximately eight percent of the flow of the Columbia River system annually at The Dalles, and seven percent of its annual flow at the mouth, and contributes roughly one-third of the Snake River's annual flow (Maughan 1972). The average annual (daily) flow of the Clearwater River near Spalding is 14,709 cubic feet per second (cfs), based on 38 years of USGS flow data (1972 – 2010). In all, there are 53 widely distributed gauging stations located in the Clearwater River Subbasin, although only a dozen or so are still in operation.

There are eight smaller watersheds found within the Clearwater River Subbasin, each with its own Hydrologic Unit Code (HUC). The 4th field HUCs found within the Clearwater River Subbasin include the Lower Clearwater (17060306), the Lower North Fork Clearwater (17060308), the Upper North Fork Clearwater (17060307), the Middle Fork Clearwater (17060304), the South Fork Clearwater (17060305), the Lochsa (17060303), the Lower Selway (17060302), and the Upper Selway (17060301) (Figure 16).

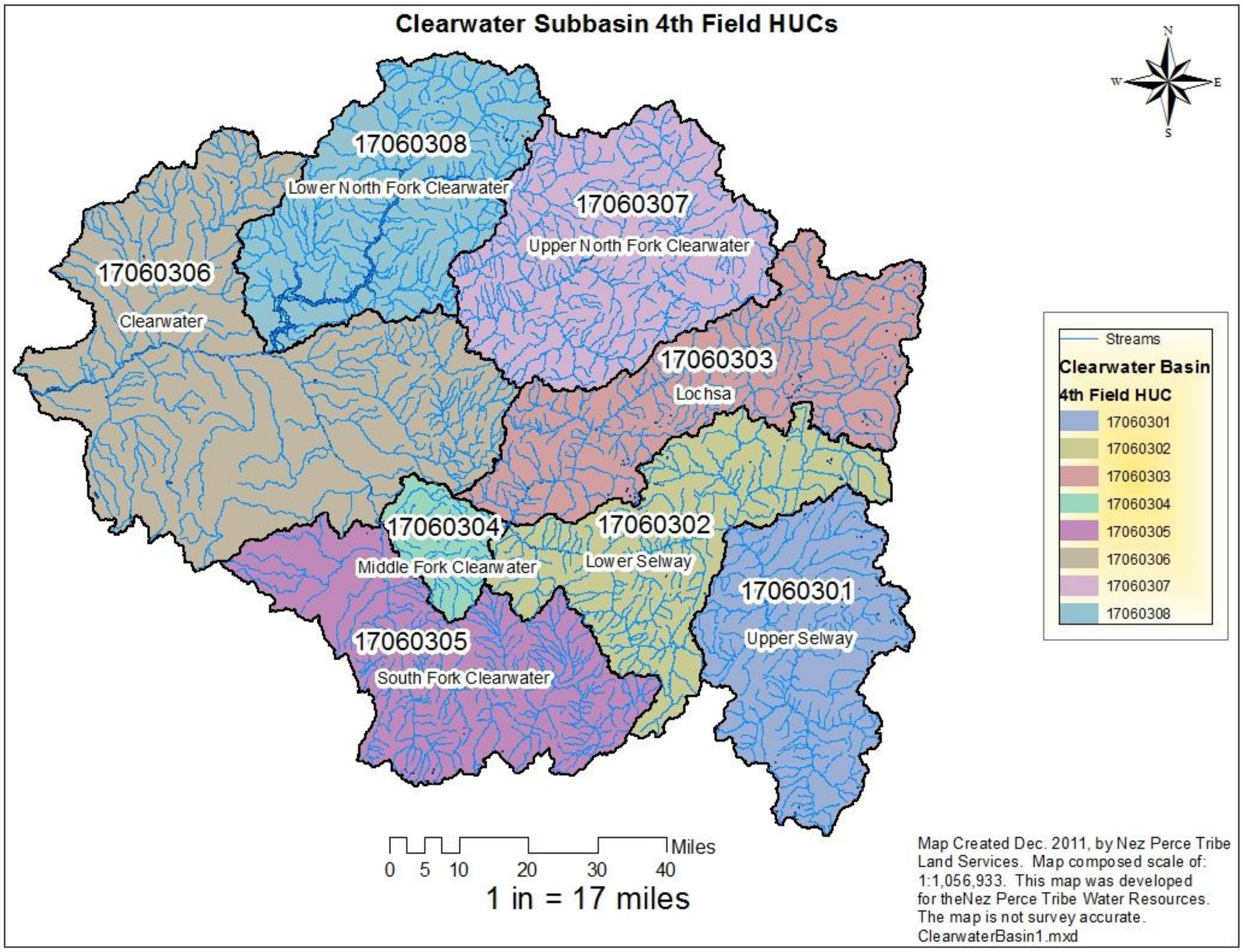


Figure 16. Clearwater River Subbasin 4th Code Hydrologic Unit Codes (HUCs).

Seventy dams currently exist within the boundaries of the Clearwater River Subbasin. The seven largest reservoirs in the subbasin are Dworshak, Reservoir A (Mann Lake), Soldiers Meadow, Winchester, Spring Valley, Elk River, and Moose Creek. Dworshak Dam, constructed in 1972 and located two miles above the mouth of the North Fork Clearwater River, is the largest water regulating facility in the subbasin, and the highest straight-axis concrete dam in the Western Hemisphere. In contrast to these regulated systems, which are found primarily in the lower areas of the subbasin, some of the largest remaining segments of roadless land in the lower forty-eight states are also found within the subbasin, primarily in the upper portion.

There is a large degree of variability in the hydrology of the Clearwater River Subbasin, due to differences in the type of precipitation an area primarily receives (i.e., rain or snow). As noted before, precipitation generally increases from west to east through the subbasin, corresponding with increasing elevations. Peak flows generally occur in May and June, while base flows occur in the late summer months of August and September. The exact timing is quite variable, with the earliest peak flows occurring in the low elevation upland areas, and the latest peak flows occurring in the higher-elevation upland areas. Mainstem tributaries generally experience peak flows in May, however. In late winter and early spring, it is typical for rain to fall on frozen or snow covered ground under 4,000 feet elevation, often resulting in substantial peaks in the hydrograph during this period of time, while snowmelt in higher elevation regions is usually released more slowly over time. Figure 17 shows the month of maximum discharge across the Clearwater River Subbasin.

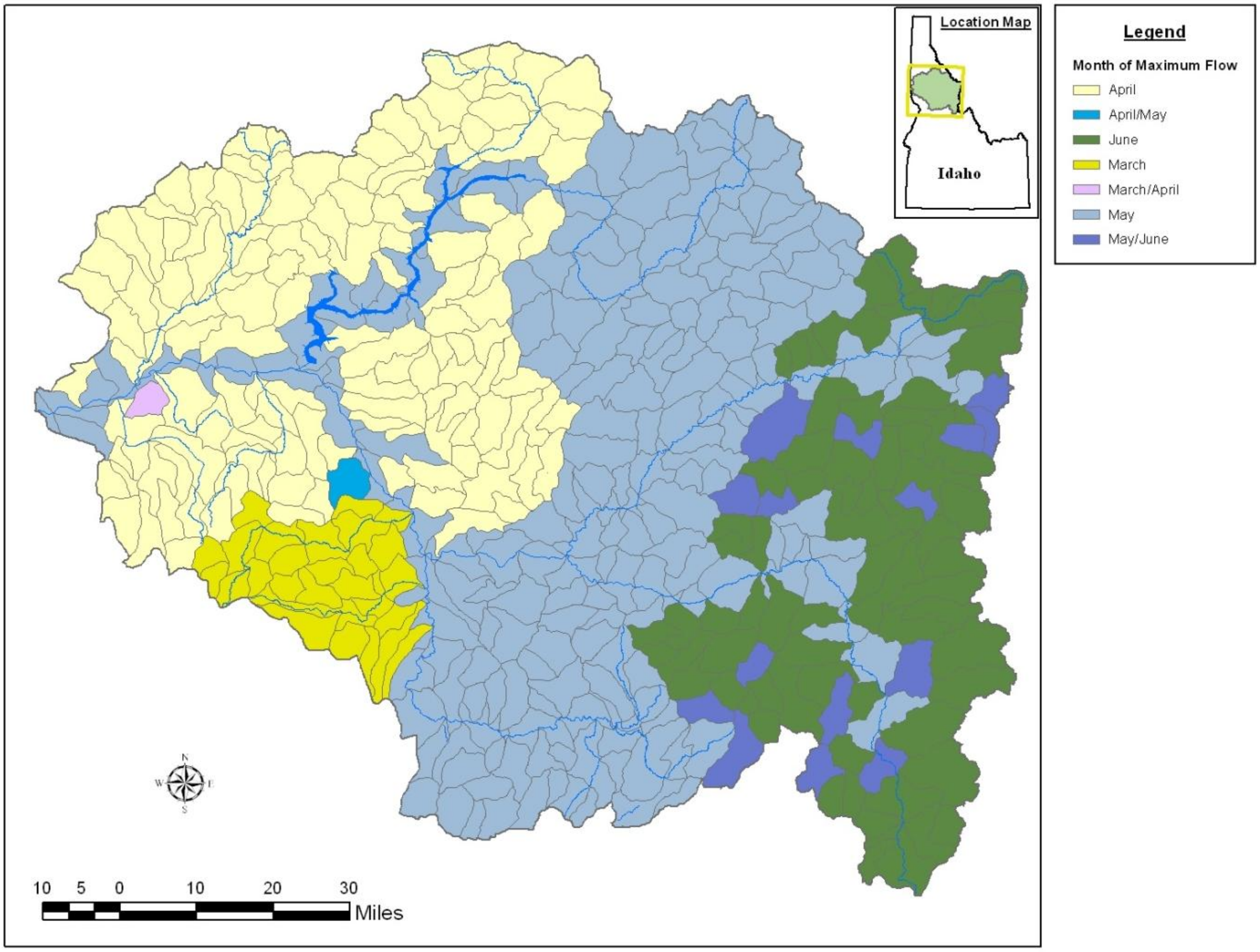


Figure 17. Timing of maximum monthly discharge across the Clearwater River Subbasin.
Source: Nez Perce Tribe.

The Clearwater River Subbasin contains many wetlands associated with the Clearwater River and its tributary streams, as well as isolated wetlands, such as seasonally wet meadows. These wetlands have many important ecological functions, including:

- Improving water quality by filtering out pollutants.
- Reducing flood frequency and severity by storage of excess water.
- Maintaining base flow in adjacent streams by releasing stored water.
- Providing habitat for amphibians and reptiles, as well as many species of birds and mammals.
- Providing numerous wetland plant species that are culturally important to the Nez Perce Tribe.

Because of their shallow water depth, wetlands are especially susceptible to the effects of higher summer temperatures, earlier runoff and lower stream flows that are predicted for this region as a result of climate change. If an increased number of wetlands dry out annually, the substantial benefits they provide to the watershed will be lost and the effects of climate change on those drainages may be compounded.

Figure 18. Wetland in Clearwater River Subbasin, near Orofino. *Photo: Nez Perce Tribe.*

Water Quality

In addition to affecting the amount of available water, climate change is also expected to reduce overall water quality, due to higher summer water temperatures and changes in the timing, intensity and duration of precipitation events. Higher temperatures can lead to reduced dissolved oxygen levels, which can have a detrimental effect on aquatic organisms. Water temperature controls the physiology, behavior, distribution, and survival of freshwater organisms, and even slight temperature changes can affect these functions (Elliot, 1994). A possible increase in frequency and intensity of rainfall during fall and winter months could produce more overall pollution and sedimentation entering waterways, as well as an increased possibility of flooding in winter and early spring.

The federal Clean Water Act (CWA), adopted in 1972, requires that all states restore their waters to be “fishable and swimmable.” Section 303(d) of the CWA lists those waters that are considered water quality impaired and are not meeting their designated beneficial uses, such as cold water habitat, salmonid spawning, recreation, and domestic water supply. Section 303(d) of the CWA requires states, territories, and authorized tribes to develop lists of impaired waters. These impaired waters do not meet water quality standards that are set for them, even after point sources of pollution have installed the minimum required levels of pollution control technology.

The law requires that these controlling jurisdictions establish priority rankings for water on the 303(d) list and develop Total Maximum Daily Loads (TMDL) for them. A TMDL is simply a calculation of the maximum amount of a pollutant that a waterbody can receive and still safely meet water quality standards. Excessive summertime temperatures constitute the largest pollutant in the Clearwater River Subbasin, but excess nutrient, sediment and bacteria loading are also major concerns, and all have the potential to increase as a result of climate change. Figure 16 shows the streams in the subbasin that have a completed TMDL, along with the 303(d) listed streams still in need of one.

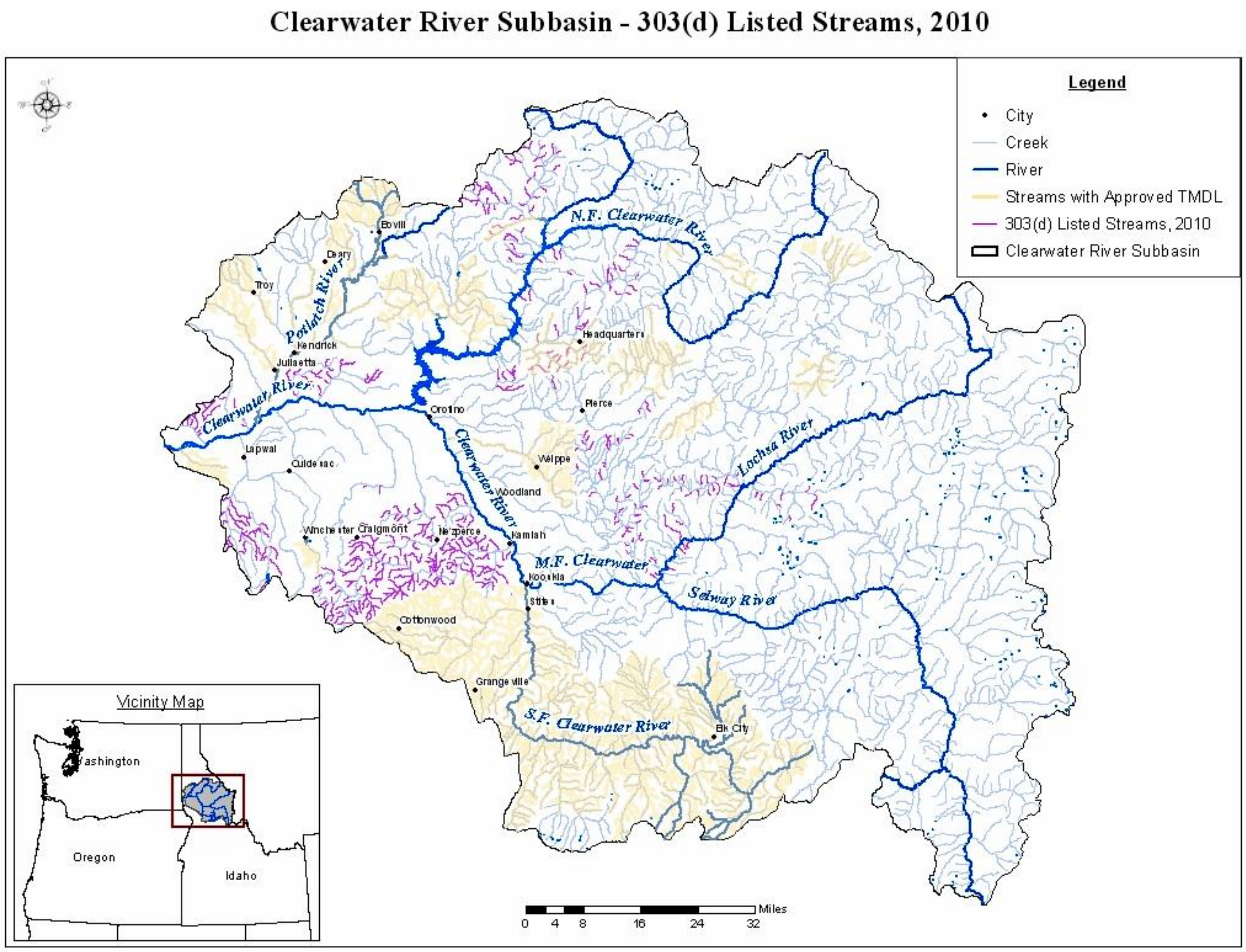


Figure 19. Clearwater River Subbasin 303(d) Listed Streams, 2010. *Source: Nez Perce Tribe.*

Snow Water Equivalent (SWE)

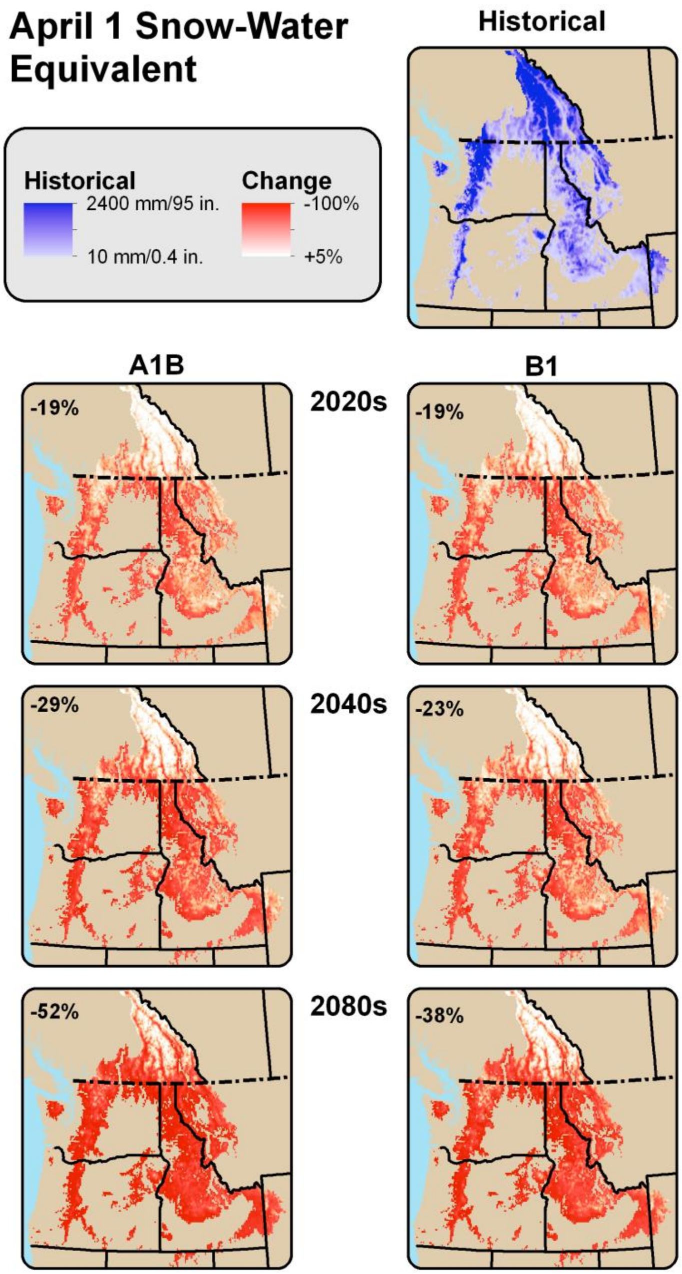


Figure 20. SWE projected decline over time. *Source: CIG.*

Snow Water Equivalent (SWE) is a common snowpack measurement that refers to the amount of water contained within the snowpack. It can be thought of as the depth of water that would theoretically result if you melted the entire snowpack instantaneously. The Clearwater River Subbasin is classified as a snow-dominant watershed, based on the main form of precipitation it receives throughout the year. In this region, snow is the primary mechanism for storing water, and it relies heavily on melting snow to provide water in the summer, when relatively little precipitation falls.

At most locations, substantial declines in SWE have occurred over the past 50 years. Largest percentage losses have occurred at lower elevations (below 1000m), a pattern that is consistent with observed increases in temperature during winter and early spring. In many locations the reductions in SWE occurred in spite of likely increases in precipitation (Mote 2003).

Regional climate change scenarios project a significant decline in snowpack for the subbasin in the coming decades, with more winter precipitation falling as rain. This reduction in peak snow accumulation will have significant implications for regional hydrology, including more runoff in winter, earlier peak flows in spring, and reduced water availability in summer. Snowpack in higher-elevation areas could actually increase if overall precipitation increases, as is predicted. But since the area of high elevation is relatively small when placed in the context of the entire Clearwater River Subbasin, the total snow pack is still expected to decline. Figure 21 shows the predicted shift in the peak runoff at The Dalles, on the Columbia River, in 2050, as simulated by several climate models. Note the higher winter flows, reduced spring/summer flows, and the shift in the hydrograph (CIG 2000).

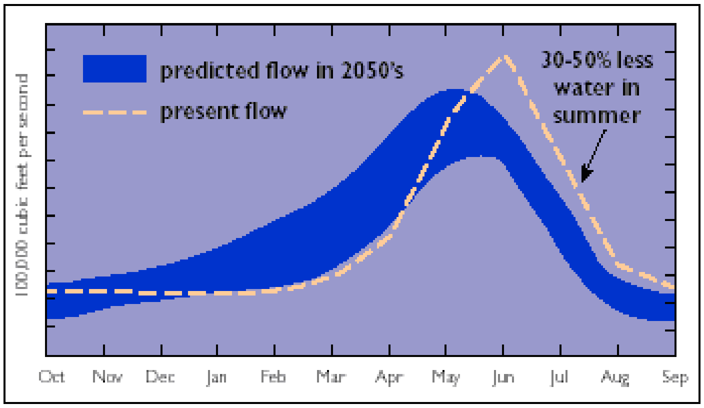


Figure 21. Naturalized Columbia River streamflow at The Dalles, currently and in 2050. The blue band indicates the upper and lower bounds of projected average streamflow in the 2050s.
Source: CIG 2011.

This shift toward earlier spring snowmelt-derived streamflow has been observed across western North America since the late 1940s (Wahl, 1992; Aguado, et al. 1992). This regional consistency in observed changes, along with the concurrent increase in average annual air temperatures, indicates that climate change is likely the primary cause of this shift in peak streamflow timing.

Figure 22. Culvert and stream damage after a flash flood, 2010. *Photo: Casey McCormack.*

Recent research has predicted that native cutthroat trout, indigenous to this region, will be hard hit by climate change and will see a significant decline in length of suitable habitat due to associated increases in stream temperature, changes in the flow regime, and changes to biotic interactions (Wenger, et al. 2011). Changing runoff patterns and winter flood events can significantly impact critical life stages of salmonids, which are attuned to the timing of stream flows. A higher frequency of severe winter flooding will result in increased egg and alevin mortality owing to gravel scour, especially for fall and winter spawning species. Because thermal and flow regimes are so fundamentally important to aquatic ecosystems, it is imperative that we assess the changes that have already occurred and predict those changes that likely will occur as a result of our changing climate.

Table 7. Predicted impacts to water resources from climate change

Timing	Earlier spring peak flows.
	Decrease in summer streamflows, due to earlier runoff.
Water Quality	Higher summer water temperatures.
	Increase in overall pollutant loads due to increased winter storm events.
Snow Water Equivalent (SWE)	Decline in SWE.
	Shift from snow-dominated to rain-dominated systems in some areas.
	Increase in elevation of typical winter snowline.
Wildlife	Decline in habitat for fish, amphibians, birds and mammals.
	Additional stress to fish from increased water temperatures and decreases in dissolved oxygen concentrations

Economic Assessment

The natural resources found within the Clearwater River Subbasin provide a wide range of services and products to the people residing in the region, which ultimately drive the local economies. Clean water, flood control, recreation, tourism, forestry, agriculture, and cultural heritage are but a few of the benefits provided. The impacts of climate change on species composition and distribution, and overall effects on ecosystems, are expected to have significant implications for communities and economies in the region.

This economic assessment is limited in scope, and more detailed analysis needs to be done in order to adequately evaluate the true value of ecosystem services to the region, as well as the potential loss in those services as a result of climate change. For this general analysis, Shoshone County was omitted, since only a small portion of it falls within the Clearwater River Subbasin. Analysis of Latah County was included, but only approximately half of the county is within the Clearwater River Subbasin, and since the town of Moscow, which is in Latah County, has economic statistics that differ substantially from other communities in the subbasin, one must be cautious when interpreting the data.

All data came from the U.S. Department of Commerce, both from their census and economic analysis divisions. Headwaters Economics software was used to create the socioeconomic profiles for the counties (http://headwaterseconomics.org/).

Demographics

The five-county region had a population of 104,496 in 2009, which was an increase of 15.6% from 1990. Latah County had the largest relative change in population (23.9%) and Clearwater County had the smallest (-5.2%).

Table 8. Population trends in the Clearwater River Subbasin. *Source: **Headwaters Economics EPT-HDT**.*

Population, 2009

	Clearwater County, ID	Idaho County, ID	Latah County, ID	Nez Perce County, ID	Lewis County, ID	Clearwater Subbasin
Population (2009)	8,043	15,461	38,046	39,211	3,735	104,496
Population (2000)	8,886	15,450	34,884	37,397	3,741	100,358
Population (1990)	8,485	13,830	30,714	33,860	3,515	90,404
Population Change (1990 - 2009)	-442	1,631	7,332	5,351	220	14,092
Population Percent Change (1990 - 2009)	-5.2%	11.8%	23.9%	15.8%	6.3%	15.6%

Median age increased in all five counties from 1990 to 2000: in Nez Perce County from 35.5 to 38.1 (7.3%), in Clearwater County from 37.5 to 41.7 (11.2%), in Idaho County from 36.5 to 42.3

(15.9%), in Lewis County from 36.6 to 42.5 (16.1%), and in Latah County from 27.3 to 27.9. The stability seen in median age of residents in Latah County is largely a function of the University of Idaho being located in Moscow.

In 2000, most residents in the subbasin were in the 20- to 24-year age range. From 1990 to 2000, the age group that saw the largest increase was from 45 to 49 years, and the age category that decreased the most was from 30 to 34 years. Education levels were highest in Latah County, where 41% of residents over the age of 25 had a Bachelor's degree or higher, with 9% not having a high school degree. The lowest education levels were found in Clearwater County, where 13.4% had a Bachelor's degree or higher, with 19.9% having no high school degree. Overall, in 2000, 24.2% of residents in the Clearwater River Subbasin possessed a Bachelor's degree or higher, with 13.9% of residents having no high school degree. By comparison, the national average is 24.4% of residents having a Bachelor's degree or higher, with 19.6% of residents having no high school degree.

Income Range

The average per capita income in the region in the year 2000 ranged from $14,411 in Idaho County to $18,544 in Nez Perce County. In the five-county region, 12.6% of households had an income of less than $10,000, with 9.1% of families falling below the poverty line. Idaho County had the most families below poverty, at 12.5%, while Latah County had the least, at 7.9%. Over 36% of households had an income between $35,000 and $75,000.

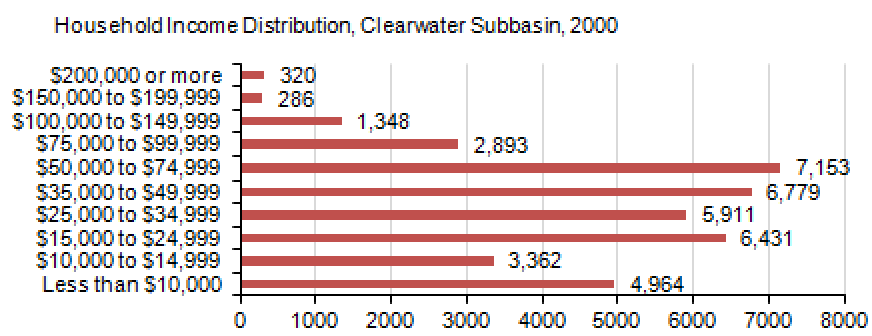


Figure 23. Household income distribution in Clearwater River Subbasin, 2000.
Source: *Headwaters Economics EPT-HDT.*

Employment

Table 9 describes historical employment change by industry for the region. From 1970 to 2000, jobs in services-related industries showed a 116% increase, while jobs in the government sector had a 79% increase. Non-service related jobs had a more modest increase of 6% during this time frame.

Table 9. Historical employment change by industry. *Source:* ***Headwaters Economics EPT-HDT***.

Employment by Industry, 1970-2000

	1970	1980	1990	2000	Change 1990-2000
Total Employment (number of jobs)	36,635	46,337	50,907	61,843	10,936
Non-services related	*13,181*	*13,831*	*13,048*	*13,971*	923
Farm	3,291	3,188	2,568	2,863	295
Agricultural services, forestry, fishing & other	440	572	687	*1,150*	463
Mining (including fossil fuels)	*102*	*78*	*209*	*232*	23
Construction	2,200	1,968	1,969	*2,910*	941
Manufacturing (including forest products)	7,148	8,025	7,615	6,815	-800
Services related	15,285	22,431	25,876	*33,042*	7,166
Transportation & public utilities	1,591	2,174	1,962	2,823	861
Wholesale trade	1,081	1,766	1,586	*1,707*	121
Retail trade	5,810	7,573	9,105	10,521	1,416
Finance, insurance & real estate	1,512	2,310	2,316	*3,692*	1,376
Services	5,291	8,608	10,907	14,299	3,392
Government	8,165	10,077	11,985	14,606	2,621
Percent of Total					% Change 1990-2000
Total Employment					21.5%
Non-services related	*36.0%*	*29.8%*	*25.6%*	*22.6%*	7.1%
Farm	9.0%	6.9%	5.0%	4.6%	11.5%
Agricultural services, forestry, fishing & other	1.2%	1.2%	1.3%	*1.9%*	67.5%
Mining (including fossil fuels)	*0.3%*	*0.2%*	*0.4%*	*0.4%*	11.0%
Construction	6.0%	4.2%	3.9%	*4.7%*	47.8%
Manufacturing (including forest products)	19.5%	17.3%	15.0%	11.0%	-10.5%
Services related	41.7%	48.4%	50.8%	*53.4%*	27.7%
Transportation & public utilities	4.3%	4.7%	3.9%	4.6%	43.9%
Wholesale trade	3.0%	3.8%	3.1%	*2.8%*	7.7%
Retail trade	15.9%	16.3%	17.9%	17.0%	15.6%
Finance, insurance & real estate	4.1%	5.0%	4.5%	*6.0%*	59.4%
Services	14.4%	18.6%	21.4%	23.1%	31.1%
Government	22.3%	21.7%	23.5%	23.6%	21.9%

All employment data are reported by *place of work*. Estimates for data that were not disclosed are shown in *italics* in the table above.

Employment data before 2001 was organized according to the Standard Industrial Classification (SIC) system. Data from 2001 onward was organized according to the North American Industrial Classification system (NAICS). For this reason, these data sets should not be considered continuous, but rather should be evaluated independently. Table 10 describes the employment change by industry from 2001-2009, using the newer NAICS. One can see that services-related industries grew in the region, while both government and non-services related industries declined.

Table 10. Changes in employment by industry in Clearwater River Subbasin, 2001-2009.
Source: Headwaters Economics ***EPT-HDT*** *.*

Employment by Industry, 2001-2009

	2001	2009	Change 2001-2009
Total Employment (number of jobs)	59,961	62,721	2,760
Non-services related	*11,204*	*11,020*	-184
Farm	2,784	2,864	80
Forestry, fishing, & related activities	*975*	*836*	-139
Mining (including fossil fuels)	*227*	*268*	41
Construction	2,930	3,023	93
Manufacturing	4,288	4,029	-259
Services related	*33,456*	*36,702*	3,246
Utilities	*133*	*164*	31
Wholesale trade	*1,222*	*1,161*	-61
Retail trade	7,343	7,485	142
Transportation and warehousing	*1,959*	*1,696*	-263
Information	*791*	*860*	69
Finance and insurance	*2,092*	2,615	523
Real estate and rental and leasing	*1,400*	2,256	856
Professional and technical services	2,226	*2,695*	469
Management of companies and enterprises	572	*373*	-199
Administrative and waste services	1,276	*1,416*	140
Educational services	*443*	*659*	216
Health care and social assistance	5,811	*7,096*	1,285
Arts, entertainment, and recreation	869	1,008	139
Accommodation and food services	4,239	4,255	16
Other services, except public administration	*3,081*	*2,964*	-117
Government	14,392	14,134	-258

Percent of Total

			% Change 2001-2009
Total Employment			4.6%
Non-services related	*18.7%*	*17.6%*	-1.6%
Farm	4.6%	4.6%	2.9%
Forestry, fishing, & related activities	*1.6%*	*1.3%*	-14.2%
Mining (including fossil fuels)	*0.4%*	*0.4%*	18.1%
Construction	4.9%	4.8%	3.2%
Manufacturing	7.2%	6.4%	-6.0%
Services related	*55.8%*	*58.5%*	9.7%
Utilities	*0.2%*	*0.3%*	23.2%
Wholesale trade	*2.0%*	*1.9%*	-5.0%
Retail trade	12.2%	11.9%	1.9%
Transportation and warehousing	*3.3%*	*2.7%*	-13.4%
Information	*1.3%*	*1.4%*	8.7%
Finance and insurance	*3.5%*	4.2%	25.0%
Real estate and rental and leasing	*2.3%*	3.6%	61.2%
Professional and technical services	3.7%	*4.3%*	21.1%
Management of companies and enterprises	1.0%	*0.6%*	-34.8%
Administrative and waste services	2.1%	*2.3%*	11.0%
Educational services	*0.7%*	*1.1%*	48.7%
Health care and social assistance	9.7%	*11.3%*	22.1%
Arts, entertainment, and recreation	1.4%	1.6%	16.0%
Accommodation and food services	7.1%	6.8%	0.4%
Other services, except public administration	*5.1%*	*4.7%*	-3.8%
Government	24.0%	22.5%	-1.8%

All employment data are reported by *place of work*. Estimates for data that were not disclosed are shown in *italics*.

Potential Effects of Climate Change on the Region's Economy

Agriculture

In 2009, farms employed approximately 4.6% of the workforce in the subbasin, compared to only 1.5% in the U.S. The majority of farms in the subbasin raise crops (including grain and oilseed); the second-largest sector is beef cattle ranching. In 2009, Lewis County had the largest percentage of total farm employment and the largest percentage of total earnings from farm earnings, while Shoshone Co. had the smallest percentage of both of these parameters. In 2007, Lewis Co. had the largest percentage of land area (80.3%) in farms, and Shoshone Co. the smallest (0.2%). Over the past 40 years, farm employment has decreased by 13%.

Agriculture in this region is almost exclusively non-irrigated dryland farming. Climate change will likely force agricultural producers in this region to adapt to longer growing seasons, reduced summer precipitation, and increasingly competitive weeds.

Forestry

Over two-thirds of the Clearwater River Subbasin is forested, and many residents of the subbasin rely on these forests for their livelihoods. A major pulp and paper mill is located in Lewiston, and several smaller sawmills also operate within the region. But timber is not the only source of revenue generated by forests in the subbasin. Forest-based recreation and tourism as well as the collection of associated forest products, such as Christmas trees, huckleberries, mushrooms, and firewood also generate a substantial revenue stream. Also, the increased risk of catastrophic wildfires from drier conditions and less healthy forests will mean more money must be spent to actively manage for forest health, in firefighting personnel, deployment assets, and other associated fire suppression costs.

Fishing

In 2001 over 147,000 adult spring Chinook crossed over Lower Granite Dam on the Snake River. At least a quarter of these fish were heading to the Clearwater River Subbasin in Idaho. By the time the season ended in August, over 24,000 fish had been harvested by sportsmen and tribal fishers. Over 61,000 angler trips resulted in 24 million dollars of direct angler expenditures in the Clearwater River Subbasin. Large steelhead runs in recent years also had substantial economic benefits in the subbasin (Clearwater Subbasin Inventory, 2003). Decreases in suitable fish habitat, increases in stream temperature, changes in flow regimes, and changes to biotic interactions as a result of climate change could have serious implications for the fishery resources of the Clearwater River Subbasin.

Recreation/Tourism

Recreation is an important part of the overall economy in the Clearwater River Subbasin. Though no figures specific to the region were available, active outdoor recreation in all of Idaho:

• Supports 37,000 jobs across Idaho

• Generates $154 million in annual state tax revenue

• Produces $2.2 billion annually in retail sales and services across Idaho – more than 5% of gross state product.

Twenty-two percent of Idaho's population participates in fishing, 16% in paddling, and 16% in snow sports (Outdoor Industry Foundation). Clearwater and Idaho counties experienced a growth in travel and tourism employment of 29% since 1998, which was higher than in the rest of the state, as well as nationally (Headwaters Economics, 2009). In 2009, almost 20% of the subbasin's jobs were in travel- and tourism-related businesses.

Figure 24. Rafting on the Lochsa River. *Photo: Jenifer Harris.*

With so much of the Clearwater River Subbasin being in National Forest land, primitive recreation opportunities are numerous. From the moist cedar forests of the Selway River drainage to the rugged peaks of the Bitterroot Mountains, this vast, diverse area includes breathtaking scenery, large federally designated wilderness areas, abundant wildlife, and miles of streams and rivers. Rafting is a major industry in the Clearwater River Subbasin, with many adventurers braving the Lochsa River, Selway River, and North Fork Clearwater River. Climate change could have negative effects on this economic base, as catastrophic wildfire potential becomes more of a reality, base flow conditions in popular rafting rivers come earlier and shorten the season, and changes in species distribution affect hunting opportunities.

Synthesis of Opportunities

Numerous opportunities exist throughout the Clearwater River Subbasin to implement climate change adaptation strategies. This report is just a first step towards the development of more detailed analyses and site-specific adaptation strategies. Rather than simply responding to climate-related changes as they occur, efforts should be made to assess potential impacts and develop specific adaptation strategies to counter them. This exercise should be seen as a form of risk management, with the understanding that building capacity now will reduce vulnerability in the future. Table 11 below is a risk matrix that was created in order to help identify some of the potential impacts of climate change on the forest, water, and economic resources of the Clearwater River Subbasin. For each section, an overall risk score (high, medium, low) was determined based on the potential effects of climate change to the region, as detailed in the scientific literature. The probability of the impact occurring was predicted, the region's adaptive capacity was ranked, and some primary goals and objectives were listed. This risk matrix is in no way comprehensive and it will be up to individual communities and land managers to identify and rank the threats that are particular to their land bases.

Table 11. Clearwater River Subbasin climate change risk matrix

Forestry	**Risk Score**	**Probability**	**Adaptive Capacity**	**Goal**	**Objectives**
1. Fire Severity	medium	unknown	high	To avoid catastrophic wildfires	Increase targeted prescribed burning; educate homeowners regarding WUI zone; provide analysis of high risk areas to stakeholders.
2. Insects	med/high	med/high	low	To contain or reduce spread of infestations	Provide education; map current and future projections of insect infestations; treat current infestations; research into more effective control methods.
3. Change in species Composition	low	med/high	medium	To maintain forest health	Minimize opportunities for invasive species to take hold; research into genetically modified species that are more resistant to these changes; economic analysis of potential impacts to timber markets/tourism.
4. Invasive Plants	high	high	low	To minimize spread of current invasive weeds and stop introduction of new invaders	Inventory/mapping of current infestations; maintain forest health to limit opportunities for invasives; treatment (both chemical and biological); provide education.
5. Landslides	medium	medium	high	Reduce/improve infrastructure in landslide prone areas	Identify and prioritize structures for improvement; build capacity to more effectively deal with landslide events; reduce overall miles of road.
Water	**Risk Score**	**Probability**	**Adaptive Capacity**	**Goal**	**Objectives**
1. Quantity/timing of runoff.	high	med/high	low	To protect/restore wetlands and riparian areas to help regulate summer flows and provide more storage.	Education; active restoration; zoning/rules regarding wetland/riparian buffer protection; evaluate alternative crop rotations.
2. Water quality	high	high	medium	To protect and restore water quality	Education; active restoration; zoning/rules regarding wetland/riparian buffer protection; evaluate alternative crop rotations; encourage conservation practices; actively manage disturbed lands to reduce erosion; model changes in temperature in subwatersheds in order to prioritize management/restoration activities.
4. Flooding	high	high	high	Minimize threat to human communities	Look at modifying local flood plain ordinances to reflect future conditions; restore floodplain connectivity; protect/restore wetlands and riparian areas to help regulate summer flows and provide more storage and slower release of water; work with municipal and county hazard specialists to develop regional response plans/assessments.

5. ESA listed fish health	medium	med/high	medium	to maintain viable populations of ESA listed fish.	increase quality and quantity of habitat; restore migration corridors for anadromous species; improve water quality.
<u>Economics</u>	**Risk Score**	**Probability**	**Adaptive Capacity**	**Goal**	**Objectives**
1. Fishing	low/med.	med/high	medium	**1.** To maintain healthy fish populations for the Nez Perce people. **2.** To maintain healthy fish populations to support sport fishing.	Increase quality and quantity of habitat; restore migration corridors for anadromous species; improve water quality.
2. Timber Resources	med/high	med/high	medium	To maintain sustainable timber operations in the region.	Manage risks to timber resources (fire, disease, insects, drought, etc…); maintain forest health; evaluate forest management plan for suitability.
3. Agriculture	low	medium	med/high	To adapt farming practices to a changing climate.	Research: crop rotations, disease control, pest control, etc…
4. Recreation/tourism	high	medium	high	To maintain economic inputs of recreation/tourism in the region.	Manage risks to the resource base listed above; active restoration; educate local policy makers on the potential economic impact of climate change on recreation/tourism.

Action Plan

The risk matrix above was used in the development of an action plan, which consists of a list of:

1. Goals and objectives (steps) to accomplish those goals.
2. Strategies to accomplish the goals and objectives.
3. Specific actions to implement objectives.
4. Measures to track progress in the implementation of the action plan.

The goals are broken out by category−general, water resources, and forest resources−and describe specific actions that will be taken to continue working towards a better understanding of the vulnerabilities of the Clearwater River Subbasin and the opportunities for adaptive management and planning that exist.

General

Goal 1. Create partnerships to research local effects of climate change on water resources, forestry, and the economy.

Objective: Bring together appropriate parties, including Universities, federal and state agencies, nonprofit organizations, and other relevant parties conducting climate change research in the subbasin.

Strategy: Hold semi-annual conferences where entities can share information.

Measure: Number of attendees at each meeting, and quality of information provided.

Goal 2. Include climate change adaptation assessment data, goals, and objectives into local and regional planning documents.

Objective: Incorporate climate change adaptation language into the Nez Perce Tribe's Integrated Resource Management Plan (IRMP), which is currently under development.

Strategy: Attend monthly IRMP meetings and emphasize the inclusion of adaptation strategies into the document.

Measure: Number of meetings attended and inclusion of climate change adaptation language and planning in the final document.

Objective: Incorporate climate change adaptation language and Tribal concerns into Nez Perce and Clearwater National Forest Plans.

Strategy: Meet with USDA Forest Service personnel to determine the schedule for upcoming Forest Plan revisions and to identify common resource concerns.

Measure: Successful meetings with USDA Forest Service staff and inclusion of Tribal concerns and adaptation strategies into updated Forest Plans.

Water Resources

Goal 1. Affect a change in planning and zoning regulations along waterways and restore the 100- year floodplain.

Objective: Educate county officials on potential flood zones under climate change scenarios and provide alternatives to current floodplain management practices.

Strategy: Model floodplain scenarios under climate change conditions.

Strategy: Map potential flood zones under these conditions.

Strategy: Develop policy and ordinances to restrict construction in the 100-year floodplain.

Strategy: Develop restoration strategies for floodplains with an emphasis on levee removal.

Measure: Completion of floodplain modeling scenarios.

Measure: Development of site-specific restoration plans.

Measure: Number of presentations given to regional officials.

Measure: Documentation of changes made to existing ordinances.

Goal 2. Protect and restore water quality and quantity for human health and aquatic organisms.

Objective: Protect and restore springs and wetlands to abate peak flooding, maintain base flows, and improve water quality.

Strategy: Identify and map historic wetlands.

Strategy: Prioritize springs and wetlands for protection and restoration based on cost/benefit analysis.

Strategy: Provide education and outreach on the importance of wetlands for water storage in a rain-dominated climate.

Measure: Development of historic wetland maps.

Measure: Development of a prioritization matrix or model.

Measure: Development and distribution of educational materials.

Objective: Abate potential increase in stream temperatures.

Strategy: Work with the Army Corps of Engineers to allow more vegetation and shade along levees through their variance process.

Strategy: Restore adequate vegetation along stream corridors to provide the maximum amount of shade possible.

Strategy: Protect riparian vegetation from future impacts through land management policies and actions.

Measure: Riparian vegetative analysis on key waterways, comparing current and potential natural vegetation (PNV) densities.

Measure: Meet with land management agencies to foster cooperative partnerships to limit impacts on riparian zones and to increase riparian buffers, where feasible.

Forest Resources

Goal 1. Manage wildfire risk in the wildland-urban interface (WUI) zone.

Objective: Provide homeowner education regarding fuels reduction and materials support to implement fuels reduction when possible.

Strategy: Identify organizations and agencies already providing this service and help to identify and fill gaps in existing programs.

Measure: Development of list with all organizations that have a fire education program, and development of cooperative partnerships with those organizations.

Objective: Implement suitability analysis for homebuilding in forested areas.

Strategy: Identify areas of high risk, based on fuel loadings, slope, aspect, and other topographic considerations, and create GIS coverage highlighting areas of risk.

Goal 2. Reduce and/or improve infrastructure in landslide-prone areas.

Objective: Identify and prioritize structures for improvement, including road crossings, road prisms, relief culverts and drain ditches, through mapping and soil surveys.

Strategy: Coordination with county road departments, federal agencies, Idaho Department of Lands, and other entities to consolidate existing data.

Strategy: Where data gaps exist, seek funding to collect needed information.

Measure: Amount and quality of existing data gathered.

Measure: Ability to find funding to supplement existing data.

Objective: Improve road crossings and road prism to reduce the potential for failure.

Strategy: Identify partners and funding sources to implement road improvement projects.

Measure: Number of road miles and crossings improved.

Objective: Reduce overall miles of roads throughout the landscape.

Strategy: Identify and prioritize roads suitable for obliteration.

Strategy: Seek partnerships and funding to implement road obliteration projects.

Measure: Number of road miles decommissioned.

Goal 3. Develop ecologically connected network of public and private lands to facilitate fish, wildlife and plant adaptation to climate change.

Objective: Identify existing large-scale areas of contiguous, intact ecosystems and encourage land managers to prioritize their conservation.

Strategy: Coordination with federal, State and local land managers to identify and conserve areas of contiguous forest and manage those lands to encourage representation and redundancy of all vegetation mosaics and disturbance regimes.

Strategy: Where data gaps exist, seek funding to collect needed information.

Measure: Identification, mapping, and evaluation of large blocks of contiguous forests in the region, as well as the associated management plans for those areas.

Outcomes

Implementation of the Clearwater River Subbasin Climate Change Adaptation Plan will take a concerted effort by land managers, municipalities, and citizens within the subbasin. This plan is not a recipe book for how this region should adapt to a changing climate, rather it is a call to action for those living in the subbasin to begin assessing the vulnerabilities that are unique to their communities and lands and developing adaptation strategies to minimize impacts and potentially lower long-term costs. In many cases, vulnerability assessments may show that the impacts of climate change consist of more extreme versions of what communities are already experiencing. Getting out in front of these problems now with proactive planning can save money in the long-term, while solving the problems that currently exist.

Proactive management can also reduce future risk by modifying current policies and practices that increase vulnerability to the effects of climate change. For example, using models to redefine the 100-year flood plain in light of expected changes in hydrology could lead to updated zoning ordinances that limit development in areas that are expected to be at high risk for increased flooding, thereby saving money and potentially lives.

This plan will act as a living document for the Nez Perce Tribe and others in the region to use and to expand upon. Several ideas for future iterations of this plan have already been discussed, including involved coordination between the Nez Perce Tribe Fisheries Department, Idaho Department of Fish and Game and the U.S. Fish and Wildlife Service regarding hatchery management. Potential adaptation strategies to come out of this coordination might include augmentation of summer water supply and changes in fish release schedules in response to changing flow regimes and water temperature. A more robust discussion of keystone and endangered wildlife species would also be beneficial in the development of additional adaptation strategies, as would a discussion of Tribal treaty rights and the potential effects climate change might have on the resources guaranteed by those treaty rights.

Successful implementation of this adaptation plan will lead to on-the-ground improvements to water quality and quantity, along with an increased awareness of the overall impacts of climate change to the region. It will also facilitate successful partnerships among the many stakeholders in the subbasin.

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