Forest and Water Climate Adaptation:

A Plan for Whatcom County, WA

Nooksack Salmon Enhancement Association

Model Forest Policy Program
Cumberland River Compact

Foreword

In 2010, the Model Forest Policy Program (MFPP), the Cumberland River Compact, and the Nooksack Salmon Enhancement Association (NSEA) came together to create a climate adaptation plan for the community of Whatcom County, Washington. It came about because MFPP recognized the critical need for local community resilience against the impacts of climate change by protecting forest and water resources. This climate adaptation plan for Whatcom County, WA presents the results of a year of community team effort, deep and broad information gathering, critical analysis and thoughtful planning. NSEA took the local leadership role to engage with the Climate Solutions University: Forest and Water Strategies program (CSU) and lead their community toward climate resilience with an adaptation plan that addresses their local climate risks and fits their local conditions and culture. This achievement was made possible by the guidance and coaching of the Climate Solutions University: Forest and Water Strategies program (CSU) created by the Model Forest Policy Program in partnership with the Cumberland River Compact. The goal of CSU is to empower rural, underserved communities to become leaders in climate resilience using a cost effective distance learning program. The result of this collaborative effort is a powerful climate adaptation plan that the community can support and implement in coming years. The outcome will be a community that can better withstand impacts of climate upon their natural resources, economy and social structure in the decades to come.

Acknowledgements
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Executive Summary

Our climate is changing and the impacts of these changes will be ignored at our peril. Human activities, especially those related to the use of fossil fuels, have and will continue to change the composition of the Earth's atmosphere and consequently, climate conditions in Pacific Northwest during the 21st century. These changing climate conditions will likely be very different than those experienced in the past. The overwhelming scientific consensus is that human-induced climate change is among the most pressing environmental problems facing this generation, specifically the millenial generation and those to come.[18] Climate models for the Puget Sound region project that temperatures will increase between 0.2 - 1.0°F (0.1 - 0.6°C) per decade until 2050 and beyond. In addition there will be a slight increase in precipitation, especially during the fall and winter months. Here in Whatcom County climate change will jeopardize the health of our environment and our community, and fundamentally alter the way we interact with nature, how we get our food, how we make our living, and how we live along this beautiful coastline of Puget Sound.

In an effort to help the Whatcom County community protect our valuable forest, water, and other natural resources and address climate change issues by identifying local, on-the-ground solutions, the Nooksack Salmon Enhancement Association (NSEA) applied for and received grant funding from the Model Forest Policy Program (MFPP) to participate in the 2010 Climate Solutions University (CSU) program. The CSU program worked with six communities across the country in 2010 to guide them through a process of assessing local risks and opportunities related to forest, water and climate and then create a climate adaptation plan that works for the local conditions and culture. On behalf of the Whatcom County area, NSEA participated in this one year, intensive distance learning program along with communities from New Hampshire, Tennessee, New Mexico, Arizona, and Colorado.

NSEA is a community-based nonprofit organization dedicated to restoring sustainable wild salmon runs to Whatcom County, Washington. NSEA also focuses on ensuring high water quality and adequate habitat for wild salmon in the Nooksack River basin, which is critically important to the health of our local wild salmon runs. Recognizing the critical role that healthy forest cover plays in protecting salmon habitat, NSEA's core work promotes the maintenance of healthy forests in the upper watershed and riparian buffer zones in the lowlands; helping to conserve water resources, protect citizens from flooding and drought, sequester carbon, keep the economy vital, and maintain natural habitat for fish and wildlife as well. NSEA believes that preserving our natural resources and the services functioning ecosystems provide will play a vital role in solving our climate crisis.

As a result of the work with the Climate Solutions University, NSEA has come to learn that Whatcom County's natural resources and economy are extremely sensitive to changes in climate. Specifically, climate change impacts the management of Whatcom County water supplies, stormwater systems, flood zones, forests, fisheries, and agriculture. This has been indicated by the current observed patterns and extremes in temperature and precipitation as it relates to local climate change impacts. Each of these management sectors has adapted to the timing and length of the seasons, the range of temperatures, and the amount and frequency of precipitation that has been experienced in the past. The past, however, will no longer be able to provide us with an accurate forecast of the future. As temperature increases and precipitation patterns change, current management practices will not achieve the results for which they are designed. This is one of Whatcom County's largest climate change risks.

The creation of this climate adaptation plan was undertaken in order to ensure the resilience and adaptability of Whatcom County and the ecosystems of the Nooksack River basin. Through NSEA's work with CSU in-depth assessments of Whatcom County's water, forest, and economic resources were completed, as well as an assessment of Whatcom County's climate and the changes in climate that will occur in the future. Using the best available scientific data from these assessments, a risk analysis was completed and the sectors in which Whatcom County is particularly vulnerable were identified and are highlighted here.

Water Supply

Climate change impacts on water resources are integral to every sector within the community. The most important climate impact on water involves the timing and availability of water; leading to impacts on water supply systems, flood and stormwater management, forests, fisheries, and agriculture. Hydrologic changes will likely be most detrimental and acute during the summer, as water is projected to be less available, and in many cases will exacerbate existing conflicts over limited resources, especially in snowmelt-fed watersheds like the Nooksack River basin. Climate change will force resource managers and planners here in the Nooksack River basin to evaluate complex trade-offs between competing interests, such as irrigation for agriculture and instream flow for fish, and to adapt their systems to meet these demands in an altered physical environment.[1]

Flood and Stormwater Management

Increasing temperatures, earlier spring runoff, and small increases in winter precipitation will lead to increased flooding frequency in the Nooksack River basin. It is unclear how urban stormwater flooding may change in the future, as modeling the behavior of individual storms, and their potential response to climate change, is currently beyond the capabilities of global climate models.[1] However, land use changes stand to be the largest influencer of increased stormwater risk and heightened flooding potential as increased rainfall and pervious surface cover will push the limits of Whatcom County's existing stormwater infrastructure.

Forests

In response to increasing temperatures, some tree species like the Douglas-fir will shift their geographic range, migrating to higher elevations and latitudes. Other species may be unable to adapt and their numbers will decline, while new species from other regions and elevations may emerge and thrive. Increasing temperatures will likely create favorable conditions for fire and pest outbreaks, which will become more frequent and severe. [1] Economically, the forest industry may experience challenges related to climate change through fires, forest die-off, and changing species, which could lead to decreased profitability and economic challenges for Whatcom County. Degraded forest resources also adversely impact tourism, outdoor recreation, and wildlife habitat.

Salmon

Increasing stream and lake temperatures along with changes in the volume and timing of streamflow will create environmental conditions that are inhospitable to many Pacific Northwest cold water fish populations. Salmon, which are some of the region's most important and prized fish species, are at particular risk.[1] Most notably, changes in streamflow due to changes in precipitation patterns could scour salmon redds and/or cause streams to dry up and over-summer habitat to become scarce, resulting in decreased population sizes.

Agriculture

Increasing temperatures and atmospheric carbon dioxide concentrations will likely increase crop yields in the short term while soil moisture is sufficient and irrigation water is available. However, as soil moisture and the availability of water for irrigation decreases, crops could suffer more days of heat and moisture stress. The shifts in the timing of peak streamflow will reduce the availability of irrigation water during the summer when it is needed the most. The increasing temperatures may also enhance threats posed by crop pests and pathogens.[1] These impacts to Whatcom County's agriculture industry require an adaptive management approach in order to plan for changing conditions.

Economy

Each of the impacts to water, forest, fish and agriculture carry with them economic impacts. Whatcom County is heavily focused on natural resource-based livelihoods including tourism, fishing, and farming. Impacts to jobs, the tourism industry, infrastructure costs, and human health can carry high economic costs to communities. On the other hand, responding to climate change with resilience strategies can generate positive economic boosts for the community with jobs and avoided costs down the road.

Actions for Climate Resiliency

The risk assessment and planning process of this project illuminated clear risks that need to be addressed. Although we must recognize uncertainty and understand that further research into the specific impacts of climate change in the Nooksack River basin is necessary, NSEA has taken the liberty to outline a set of recommendations that could lay the groundwork for creating climate resiliency for Whatcom County. The primary goals identified for working towards climate adaptation in our community are:

A. Raise awareness of the need for climate change education for local and regional natural resource managers, city and county planners, and city and county council members.

B. Include climate adaptation strategies in WRIA 1 salmonid recovery planning, watershed planning, and other state, regional, and local forest and water resource management planning processes.

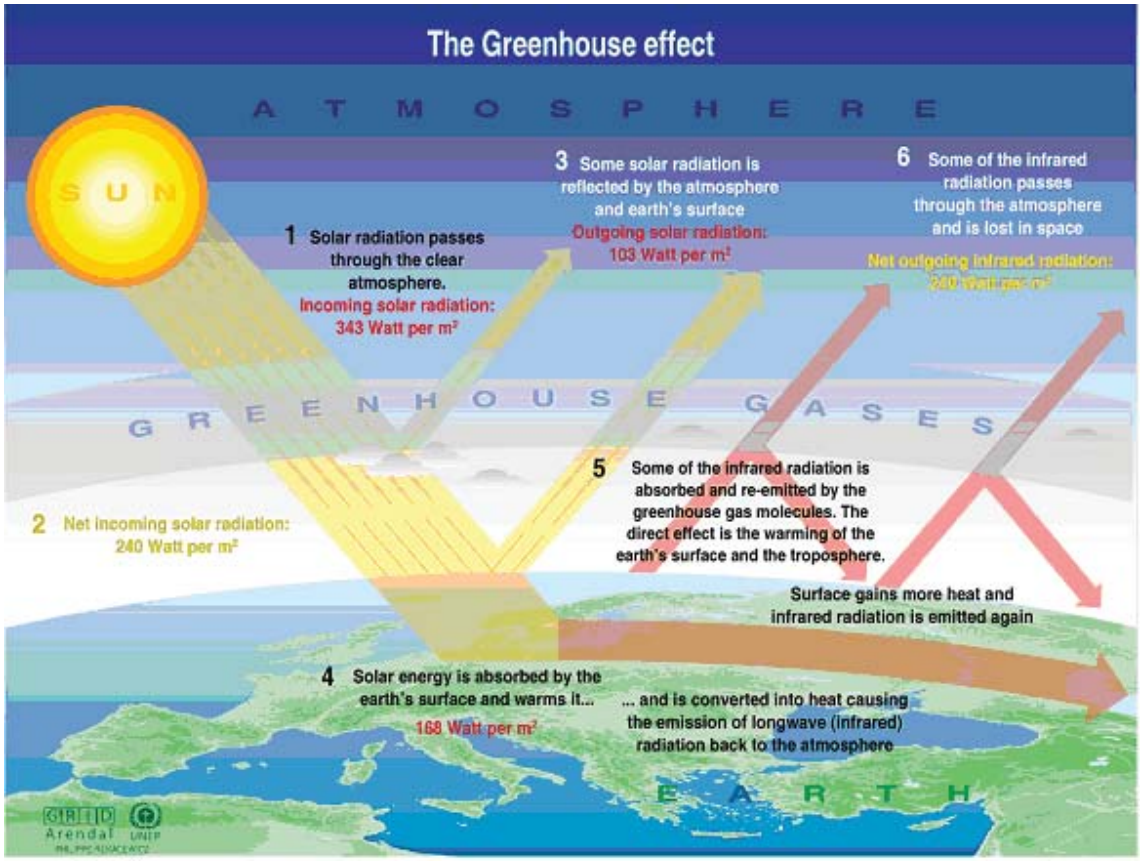
C. Educate the community about climate change impacts on Whatcom County's forest and water resources and climate adaptation strategies.

It is clear that the time to act is now. Our choices about preparing for and adapting to climate change determine Whatcom County's resiliency to climate change in the future. If a strong effort is undertaken and maintained, this community will substantially reduce the risks of moderate to severe economic and ecological impacts and our vulnerability to climate change by developing and implementing a course of action to build climate change resiliency into our thinking and actions. As NSEA has a proven track record of being most effective in implementing education and outreach programs, the goals of this plan are focused on bridging the gap between science and decision making; raising awareness in the community regarding the issue of climate change and informing local policy makers and community leaders about these issues and the need to formulate an adaptation strategy for Whatcom County.

INTRODUCTION

This Climate Adaptation Plan provides information on human-induced climate change and how it will impact Whatcom County's natural resources and economy. This plan also recommends adaptation strategies to assist local natural resources managers, policy planners, and other decision makers in identifying which of their activities are sensitive and vulnerable to climate change. **The climate of the future is not likely to resemble the climate of the past, and planning to adapt to our future climate should begin now.** [1]

Human-induced climate change ("global warming") refers to the alteration of earth's energy balance resulting from the accumulation of greenhouse gases in the atmosphere. These gases, which include carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), act like a heat-trapping blanket that prevents the energy leaving the earth's surface from escaping to space and causes the global average temperature to rise (Figure 1). This trapped energy can also cause potentially significant changes in the timing and length of the seasons as well as the amount and frequency of precipitation. [1]



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: Accumulation of greenhouse gases in the atmosphere increases global mean surface air temperatures. Figure source: United Nations Environment Programme. GRID-Arendal. Vital Climate Graphics. ISBN: 8277010095.

Because of human activities, atmospheric CO_2 concentrations are currently higher than any other time in the past 400,000 years and are likely to be higher than any time in the past 20 million years. Fossil fuel burning is the primary source of anthropogenic (human-caused) CO_2 emissions, accounting for three-quarters of today's emissions. The remainder of the CO_2 comes predominantly from land use changes such as deforestation. Atmospheric concentrations of methane and nitrous oxide have also increased significantly. Methane's concentration has increased 151% since 1750, also exceeding any measurement for the last 400,000 years. Nitrous oxide's concentration has increased 17% since 1750, exceeding any level in at least the last 1,000 years.[1]

While the atmospheric burden of greenhouse gases has grown, globally averaged surface temperature has increased by 1.0 ± 0.4°F (0.6 ± 0.2°C) during the 20th century. This warming represents the largest increase in temperature of any century in at least the last 1,000 years. The warming has been uneven in time and space: nighttime temperatures have increased more than daytime temperatures, more warming has occurred at mid- and high latitudes than in the tropics, and more warming has occurred in the Northern Hemisphere than in the Southern Hemisphere. As a result, the earth's physical systems have changed: glaciers have retreated; sea-ice has been reduced in thickness and extent; snow cover has decreased; and sea-level has risen, caused by both the expansion of warmer ocean water and the addition of water from melting ice sheets. All of these temperature trends and impacts are consistent with and provide evidence for the human-induced greenhouse gas warming. Although some of the past century's warming may be due to natural causes, most of the warming occurring between 1950 and 2000 can be attributed to greenhouse gases from human activities. [1]

Given the prevalence and necessity of fossil fuel combustion and the atmospheric persistence of greenhouse gases (see Table 1), atmospheric greenhouse gas concentrations will likely continue increasing through the 21st century and with that, global temperatures. Precise projections of future greenhouse gas concentrations vary considerably based on various emissions scenarios; however, changes in emission patterns are dependent upon many factors such as population growth, energy use, the spread of technology, and the rate and reach of globalization. [1]

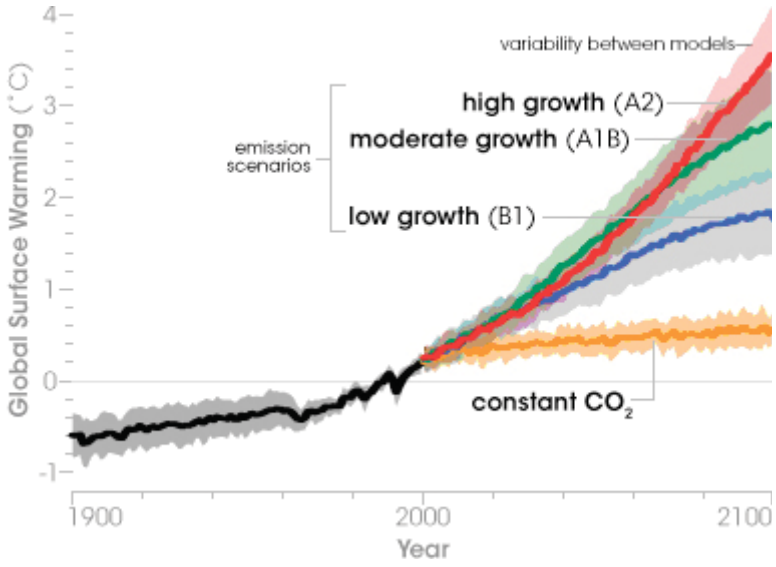


Figure 2: Emissions scenarios tying temperature to the concentration of greenhouse gasses in the atmopshere.[9]

The need to address the root of the problem, i.e., green house gas emissions so that the effects are not exacerbated is great. Mitigating or reducing greenhouse gas pollution is already a top priority for Whatcom County and Climate Action Plans for both the City of Bellingham and Whatcom County were adopted in 2007. With a focus on reducing emissions, many steps have been taken, including the installation of solar panels on Public Works buildings, the purchase of renewable energy credits for 100% of municipal operations electric power, the replacement of traffic signal lights with LED fixtures, the purchase of hybrid or alternative fuel vehicles, and the installation of a green roof on the new Art and Children's Museum.

Yet although the reduction of greenhouse gas emissions is critical, we cannot, at this time, afford the luxury of not preparing for the change in our climate that is already coming. We know that many impacts are inevitable and we must prepare for the changes that are already taking place while we work to avoid even worse effects in the future. A climate resilient community is one that takes proactive steps to prepare for (i.e., reduce the vulnerabilities and risks associated with) projected climate change impacts by reducing the vulnerabilities and risks associated with the impacts.[21]

The magnitude of climate impacts for the 21st century vary, but at the global level:

- **The 21st century will be warmer. The projected increase in global average temperature by 2100, relative to 1990, ranges from 2.5 to 10°F (1.4 to 5.8°C). Loss of sea-ice and snow cover will likely continue along with increases in sea level.**

- **The frequency of extreme warm events and intense precipitation events are projected to increase. The interiors of many continents are projected to experience drier conditions, especially during the summers.**

These changes will impact hydrological systems, ecosystems, agriculture, and human societies around the world and Whatcom County will not be immune. Adapting to these changes, or preparing for and coping with the effects of climate change, should be the overarching framework for the conservation and management of our natural resources and the built environment.

"Let us not waste our time in idle discourse! Let us do something, while we have the chance! It is not every day that we are needed. Not indeed that we personally are needed. Others would meet the case equally well, if not better. To all mankind they were addressed, those cries for help still ringing in our ears! But at this place, at this moment of time, all mankind is us, whether we like it or not. Let us make the most of it, before it is too late!"

- Samuel Beckett, *Waiting for Godot*

Synthesis of Risk Assessment Findings

Whatcom County has a unique set of environmental characteristics, key ecosystems, and patterns of dependence on natural resources. The following sections provide an overview of projected climate change impacts on Whatcom County, a summary of the risks and opportunities identified through an in-depth assessment of local forest, water, and economic resources, and recommendations for adaptation strategies to deal with the impacts of climate change.

Located in the northwest corner of Washington State just north of Puget Sound, Whatcom County covers an area of 2,504 square miles and is populated by more than 200,500 people. Whatcom County's terrain ranges from farmland and the Cascade Mountains on the east side to the Salish Sea and urban coastline on the west side. The principal city is Bellingham, with the smaller cities of Blaine, Everson, Ferndale, Lynden, and Sumas. The county also includes two American Indian reservations; the Lummi Nation on the Lummi Peninsula and Portage Island, and the Nooksack Indian Tribe, whose reservation is located along sections of the Nooksack River. Based on 1997 Whatcom County Planning Department figures, 82% of Whatcom County lands are forest and rural lands, 9% agricultural lands, 3% residential lands, 2% urbanized lands, and the remaining 4% consists of industrial, mining, and commercial developments. The federal lands of the Mt. Baker- Snoqualmie National Forest and North Cascades National Park make up the eastern two-thirds of the county.

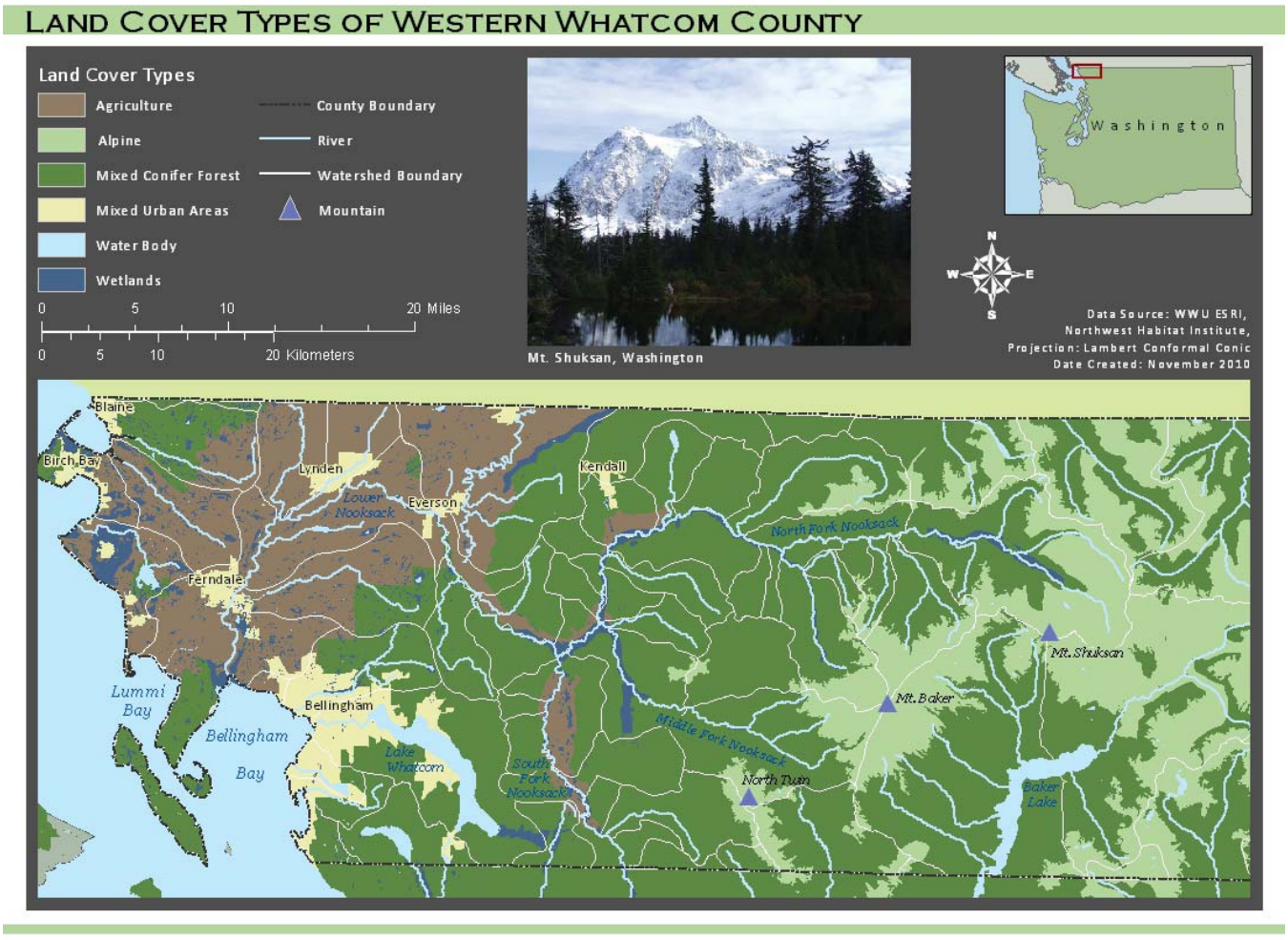


Figure 3: GIS map compiled by Madalyn Ohrt with information from the Western Washington University GIS Database and the Northwest Habitat Institute at http://www.nwhi.org/index/gisdata

Both urban and rural areas in Whatcom County are vulnerable to many projected climate change impacts, including declining mountain snow pack (which is directly linked to water supplies), increased risk of drought, sea level rise, and increased flooding in coastal areas and along freshwater stream systems. The following summarizes the current and projected specific climate changes in Whatcom County.

Climate Impacts Assessment

Air Temperature

Climate models project a warming rate in the Pacific Northwest of roughly 0.2-1.0°F (0.1-0.6°C) per decade at least to 2050, with an average warming of 1.8°F (1.0°C) by the 2020s and 3.0°F (1.7°C) by the 2040s, relative to 1970-1999 average temperature. The Puget Sound region has already warmed at a rate substantially greater than the global warming trend – the average annual temperature increased 2.3°F (1.3°C) during the 20th century – and much of this warming took place in the second half of the 20th century. Every climate record in the area has shown a warming trend and rural climate stations have warmed just as much as urban stations. Winter has warmed 2.7°F (1.5°C) just since 1950, and temperatures are projected to increase across all seasons with the greatest increase occurring in the summer months.

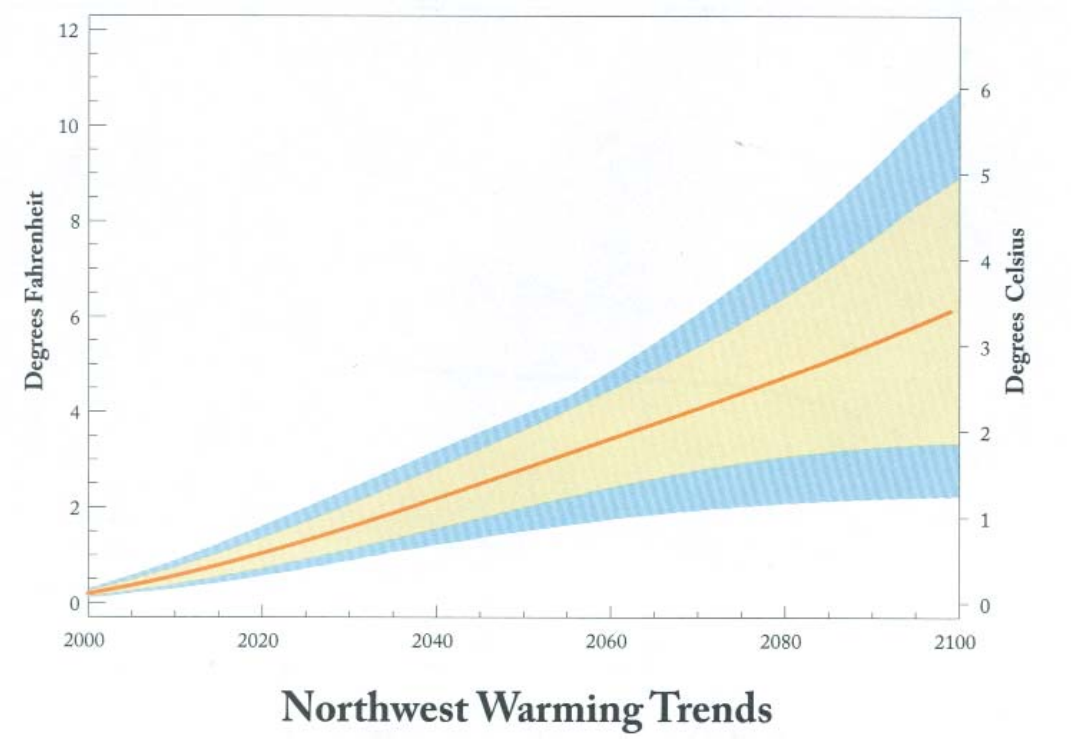


Figure 4: Projected changes in annually averaged temperature for the Pacific Northwest.[22]

Air temperature changes will significantly impact our sensitive ecosystems by increasing water temperatures; changing type, timing, and intensity of precipitation patterns; altering river and stream flows; increasing flooding; accelerating the rate of sea level rise; causing the loss of nearshore habitat; increasing the likelihood of algal blooms and low oxygen concentrations in bottom waters; putting salt marshes at risk; and putting further pressures on salmon. Temperature-driven shifts in plankton populations in Puget Sound could ripple through the food web, changing the composition of invertebrate, fish, and mammal communities. Glaciers in the Cascade and Olympic mountain ranges have already been retreating for 50-150 years. Approximately 50% of the ice cover in the North Cascades National Park has been lost in the past 100 years and locally, the Boulder Glacier on Mt. Baker has retreated 1,480 feet (450m) between 1987 and 2005. In addition, due to large amounts of debris becoming exposed by the retreat of glaciers and moving down slope in large precipitation events, stream beds are filling up with sediment downstream.

Precipitation

Changes in annual precipitation are less certain but most models project a slight increase in winter precipitation. Changes in extreme precipitation events are uncertain. The effect of warmer temperatures on winter snowpack and summer water supplies is a major concern in Whatcom County. Warmer winter temperatures are expected to lead to more winter precipitation falling as rain rather than snow, particularly in mid-elevation basins like the Nooksack River where average winter temperatures are currently near freezing. This will result in less winter snow accumulation, higher winter streamflows, earlier spring snowmelt, earlier peak spring stream flow, and lower summer streamflows in rivers that depend on snowmelt. These changes, combined with population growth and land use changes, are likely to increase existing conflicts among competing water uses, including urban water supplies, instream flows for salmon, irrigated agriculture, hydropower, navigation, and recreation.

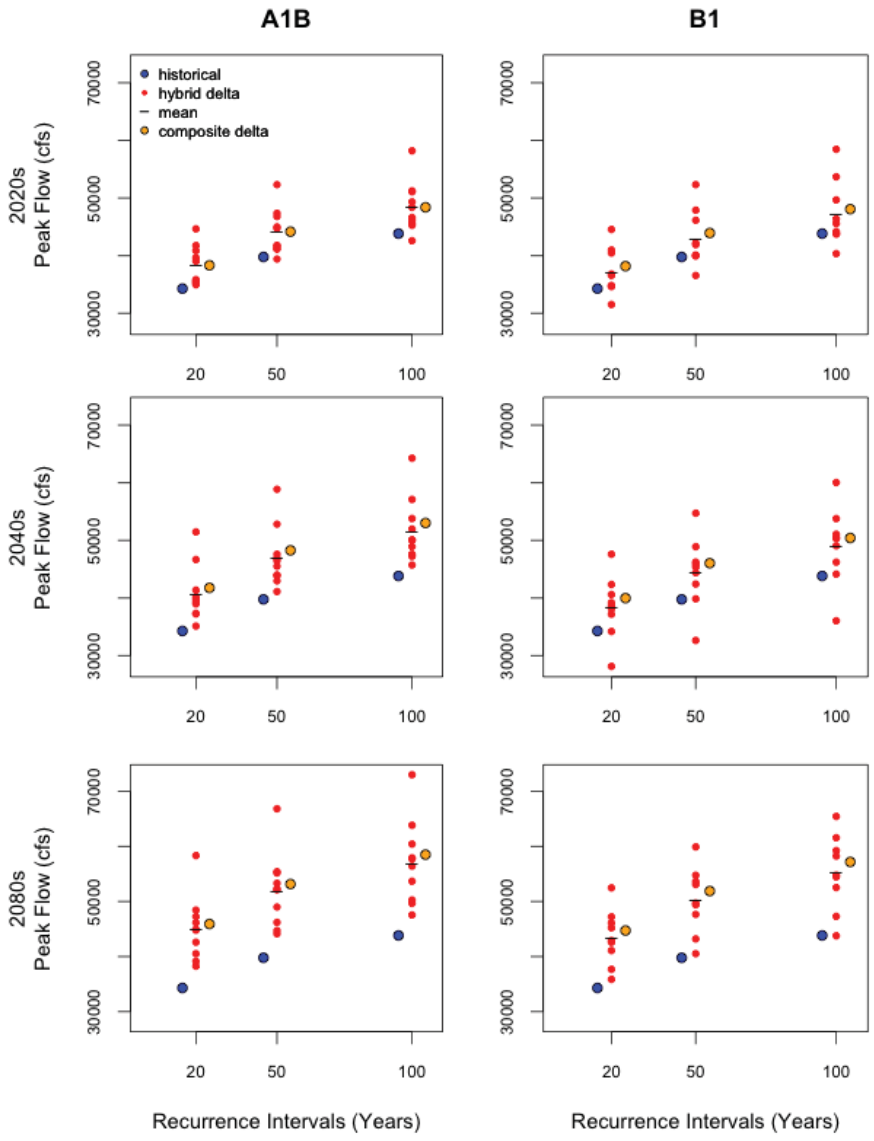


Figure 5: Projected peak flows of the Nooksack River modeled by the Climate Impacts Group based on two greenhouse gas scenarios.

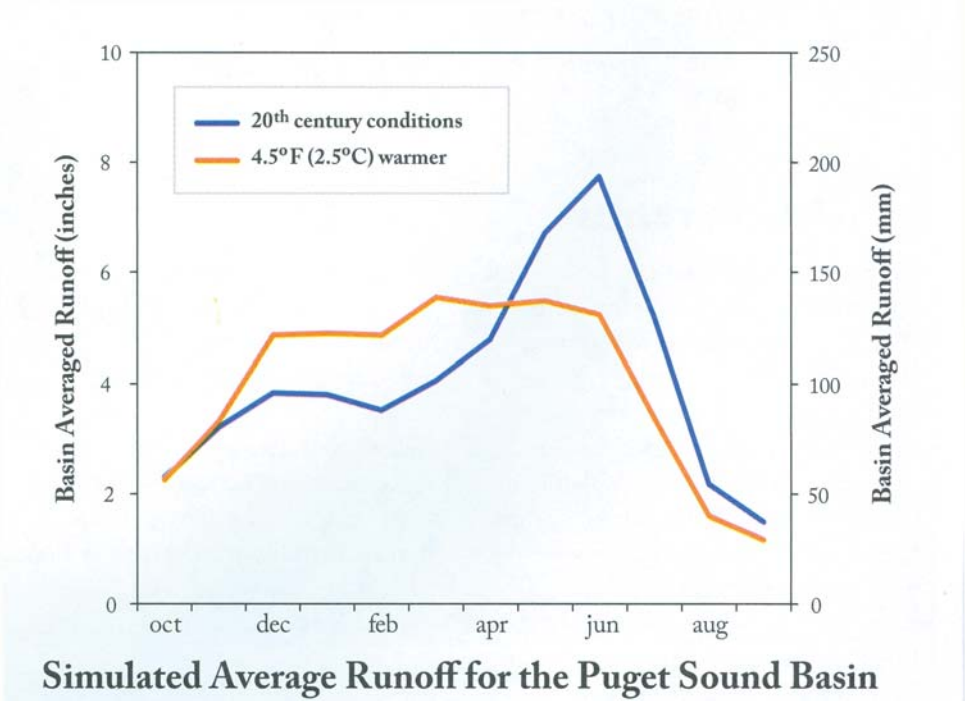


Figure 6: Simulated average runoff for the Puget Sound basin, for 20th century climate (blue) and for a warming of 4.5°F (2.5°C) (orange), which could occur as early as the 2040s but probably not until later in the century. Note the projected declining summer flow, which matches observed changes.[22]

Salmon

Central to NSEA's mission, climate change will greatly affect salmon – a culturally and economically significant resource – across all life stages, both in freshwater and saltwater, as a result of changes in the timing and volume of streamflow and ocean acidification. Projected increases in winter flooding, decreased summer and fall streamflows, and warmer summer water temperatures will further degrade freshwater and estuary salmon habitat. The duration of periods that cause thermal stress and migration barriers to salmon is projected to at least double and perhaps quadruple by the 2080s for most streams and lakes, which will increase the rates of pre-spawn mortality for Chinook salmon and steelhead trout.[15] These changes will cause severe problems for our already stressed salmon stocks, including federally protected stocks listed under the Endangered Species Act and will likely lead to widespread violations of water quality standards adopted under the Clean Water Act. Although salmon have been able to adapt to great changes in climate and environment in the past, maintaining diversity in salmon populations will be key to the survival of the species.

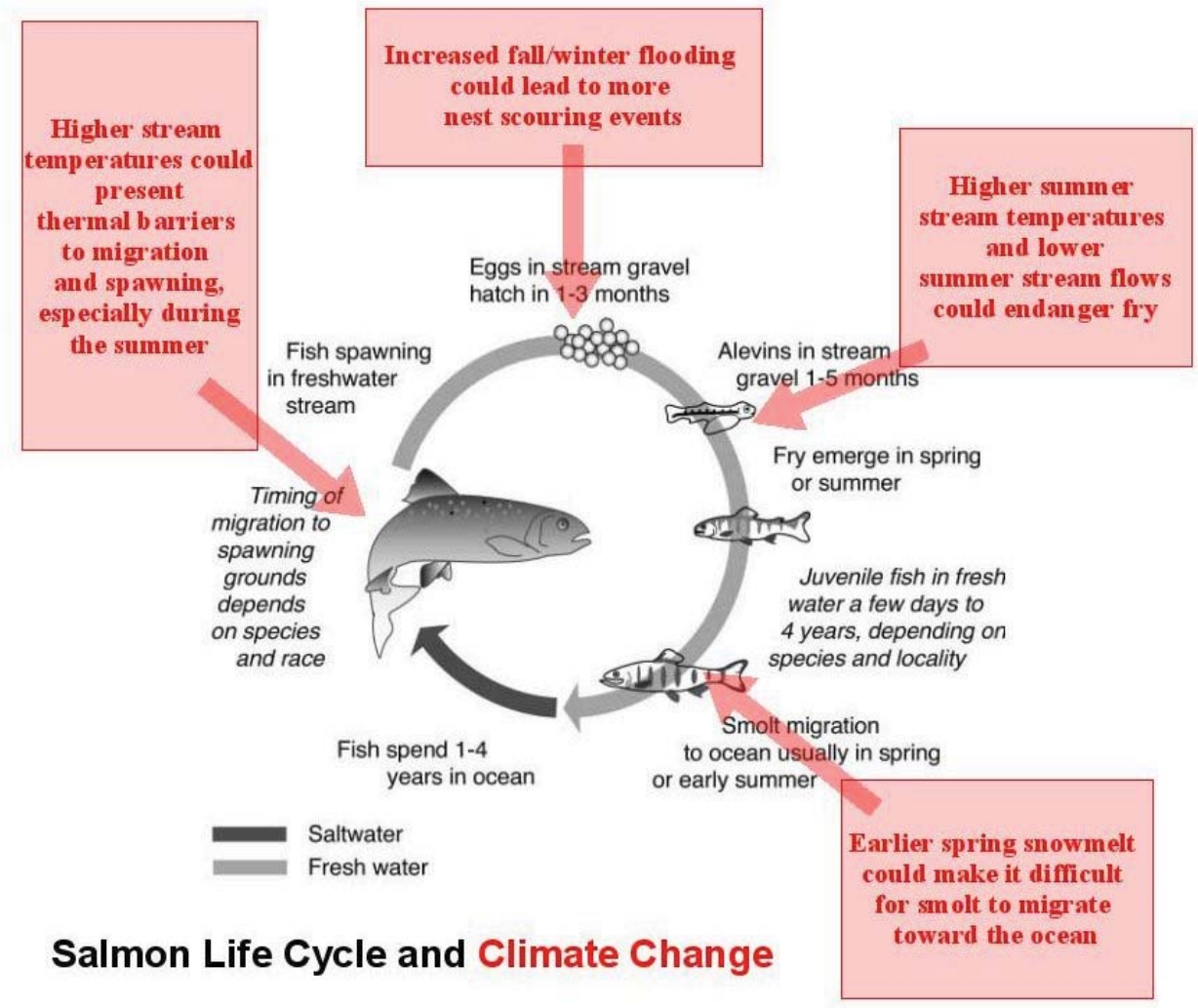


Figure 7: Salmon life cycle and climate change. Salmon have a unique life cycle that exposes them to the effects of climate change across many seasons and habitats. The red boxes explain how projected temperature and hydrologic changes may impact salmon during various phases of their life cycle. [1]

Forests and Coasts

The projected impacts of climate change on our forests will vary over time in Whatcom County, but an increased risk of fire will be caused by an eventual decrease in soil moisture and snowpack. Our forests could also become vulnerable to insects such as the mountain pine beetle as climate conditions continue to change. Sea level rise will shift coastal beaches inland and threaten nearshore forested habitat. The increased erosion of unstable bluffs will require substantial infrastructure investments to protect. The ports of Whatcom County will likely be able to accommodate rising sea level at their facilities, but adapting low-lying coastal transportation networks that serve port facilities (e.g., trains) will be a significant challenge. Shellfish production in the state will also possibly be negatively impacted by increasing ocean temperatures and acidity, shifts in disease and growth patterns, and more frequent harmful algal blooms.[8]

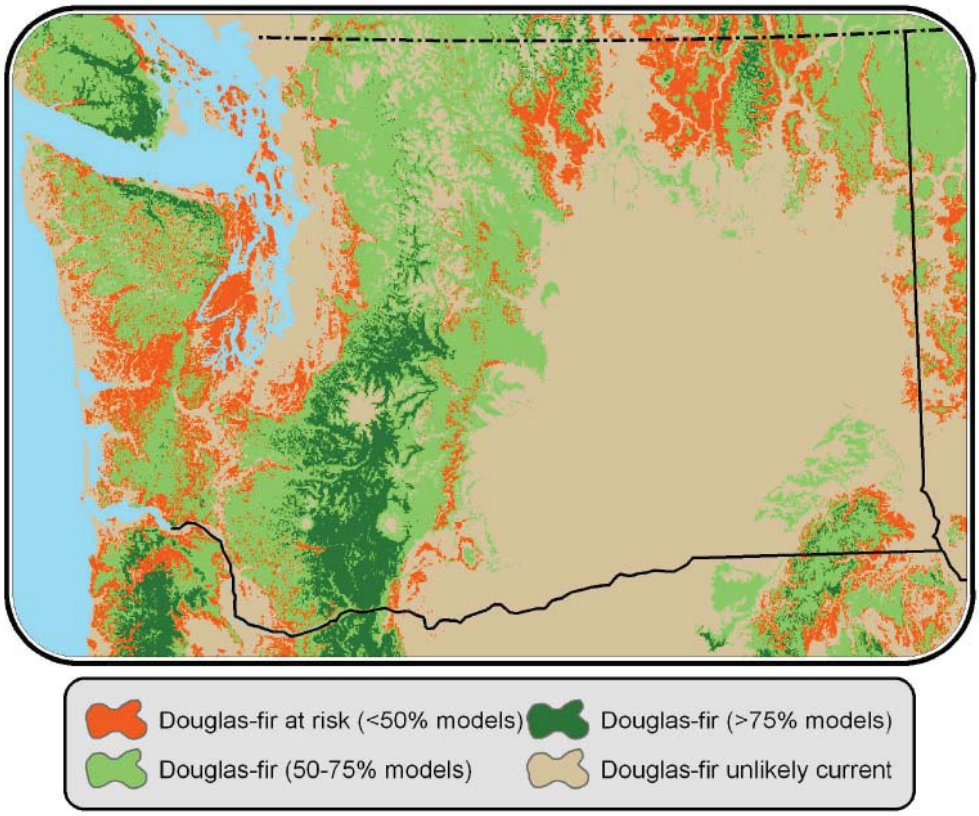


Figure 8: Change in area for which climate is suitable for Douglas-fir in the 2060s. Orange indicates area where fewer than 50% of the statistical models suggest climate appropriate or Douglas-fir presence in the 2060s. Dark green indicates areas where more than 75% of statistical models agree that climate is approrpriate for Douglas-fir.[19]

Agriculture

Impacts on agriculture will vary with the frequency and severity of extreme cold conditions and the availability of water for irrigation; most likely our berry, corn, and dairy farmers will see an increase in productivity early on due to the fertilization effect of increased carbon dioxide levels, but as water resources grow scarce crops will suffer and there may also be an increase competition with weeds and vulnerability to pests.[4]

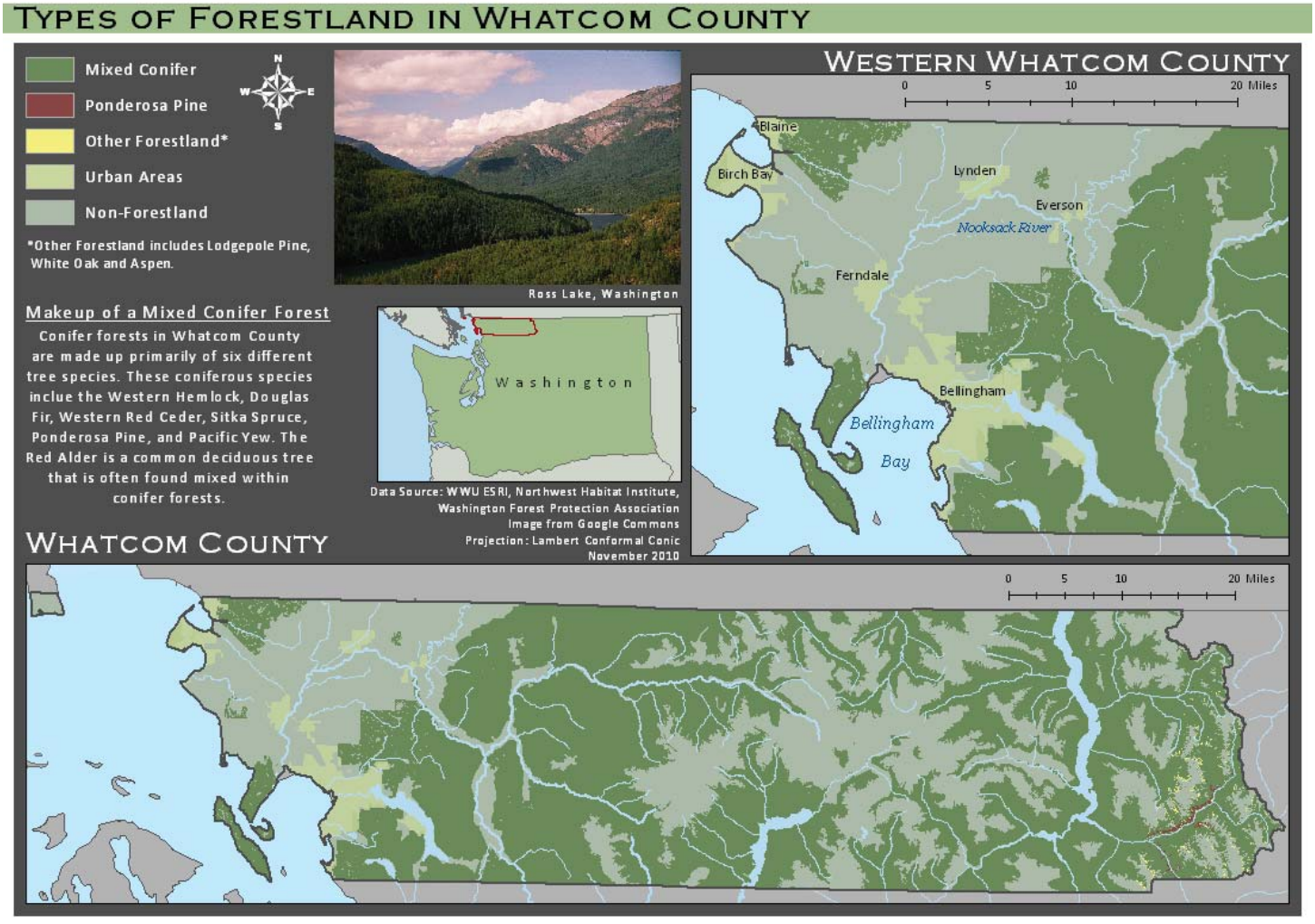
Energy

In the energy sector annual hydropower production (assuming constant installed capacity) is projected to decline slightly due to small changes in annual stream flow, but seasonal changes will be substantial. On the demand side, population growth is expected to increase winter heating demand even as winter temperatures warm. Summer cooling demand is expected to increase significantly – on the order of 363-555% by the 2040s – due to the combined effects of population growth and warmer summer temperatures.[7] Climate change in Whatcom County will also likely lead to significantly more heat and air pollution-related deaths throughout this century, particularly among the elderly, poor, and other vulnerable populations.

Forest Resources Assessment

Whatcom County is located within the Pacific Lowland Mixed Forest Province and the plant communities and habitats reflect the relatively mild climate of this ecoregion. Historically, most of Whatcom County was forest and approximately 80% of the landscape is still categorized as forested and/or rural lands.[30] Conifer species dominate our forest ecosystems (except in riparian areas that experience frequent flooding or other large disturbances where hardwood species are abundant) and these dense stands of Douglas-fir trees were what brought California miners north to Bellingham Bay to log in the early 1850's. This fir tree is one of the most widespread tree species in the state, the most important economically, and possibly one of the more climate-sensitive species regionally.[13]

Figure 9: GIS map compiled by Madalyn Ohrt with information from the Western Washington University GIS Database and the Northwest Habitat Institute at http://www.nwhi.org/index/gisdata



Logging in British Columbia [Photo credit: Alberni Environmental Coalition, http://www.portaec.net/library/forestry/index.html]

More than two-thirds of Whatcom County's forested lands are owned by the federal, state, or local government; the majority located within the boundaries of the Mt. Baker-Snoqualmie National Forest and the North Cascades National Park. Of the privately owned timberlands, more than half are the properties of small forest land owners. Although in recent years there has been a declining trend in timber harvest and in conversion from forest to non-forest, forested land in Whatcom County is still at risk. Roughly half of all forest stands are made up of trees 80 years or older, but our forests are in a state of decline. This has been the trend in the past and unfortunately is projected to continue in the future. Today tree canopy covers only 38% or 438,926 acres of western Whatcom County, but it is mature forests like these that are able to sequester carbon and could potentially turn a profit for Whatcom County in the carbon market.

The forests of our area are currently limited only by energy (light and temperature), and tree growth in energy-limited ecosystems appears to be responding positively to warming temperatures over the past 100 years.[16] The lush old-growth forests of Whatcom County have as much biomass per square mile as any place on earth. However, as the overall expected change is decreasing water availability for plants in the summer, forests will eventually experience droughts causing a loss in biodiversity, decrease in seedling establishment, a loss of productivity (especially at lower elevations), and constraining distribution. Outbreaks of wildfire and infestations of the mountain pine beetle are also of particular concern as our climate warms.

Current forest practices rules and riparian zone protection rules fall under the jurisdiction of the Washington Department of Natural Resources (DNR) and Whatcom County. Forest Practices and Road Rules provide guidelines for DNR in regards to timber harvest, building or repairing forest roads and culverts, and protecting water quality and riparian habitat. The Riparian Rules are the core of the Whatcom County Critical Areas Ordinance (CAO). The CAO address geologically hazardous zones, frequently flooded areas, critical aquifer recharge areas (CARAs), wetlands (both freshwater and estuarine), and fish and wildlife habitat conservation areas (HCAs).[29] While the Best Available Science (BAS) required and used in creating this regulation recommends a minimum buffer of 150 ft. along both freshwater and marine shorelines, most buffer zones in the county do come close to meeting this recommendation. Compliance monitoring of the forest practices rules is also currently, by and large, voluntary.

Whatcom County's forests are particularly valuable because of the ecosystems services they provide and their ability to act as carbon sinks. Our forested lands also play a large role in Whatcom County's tourism industry as more than 100,000 people from around the world visited the Mt. Baker-Snoqualmie National Forest and nearly 350,000 people visited the North Cascades National Park in 2009.[17] The recession of glaciers, the increase in forest fires, and overall decline of the health of forests in Whatcom County as a result of climate change will negatively impact the amount of tourism to these destinations in our area.

Ross Lake in North Cascades National Park [Photo Credit: Stehekin Landing Resort]

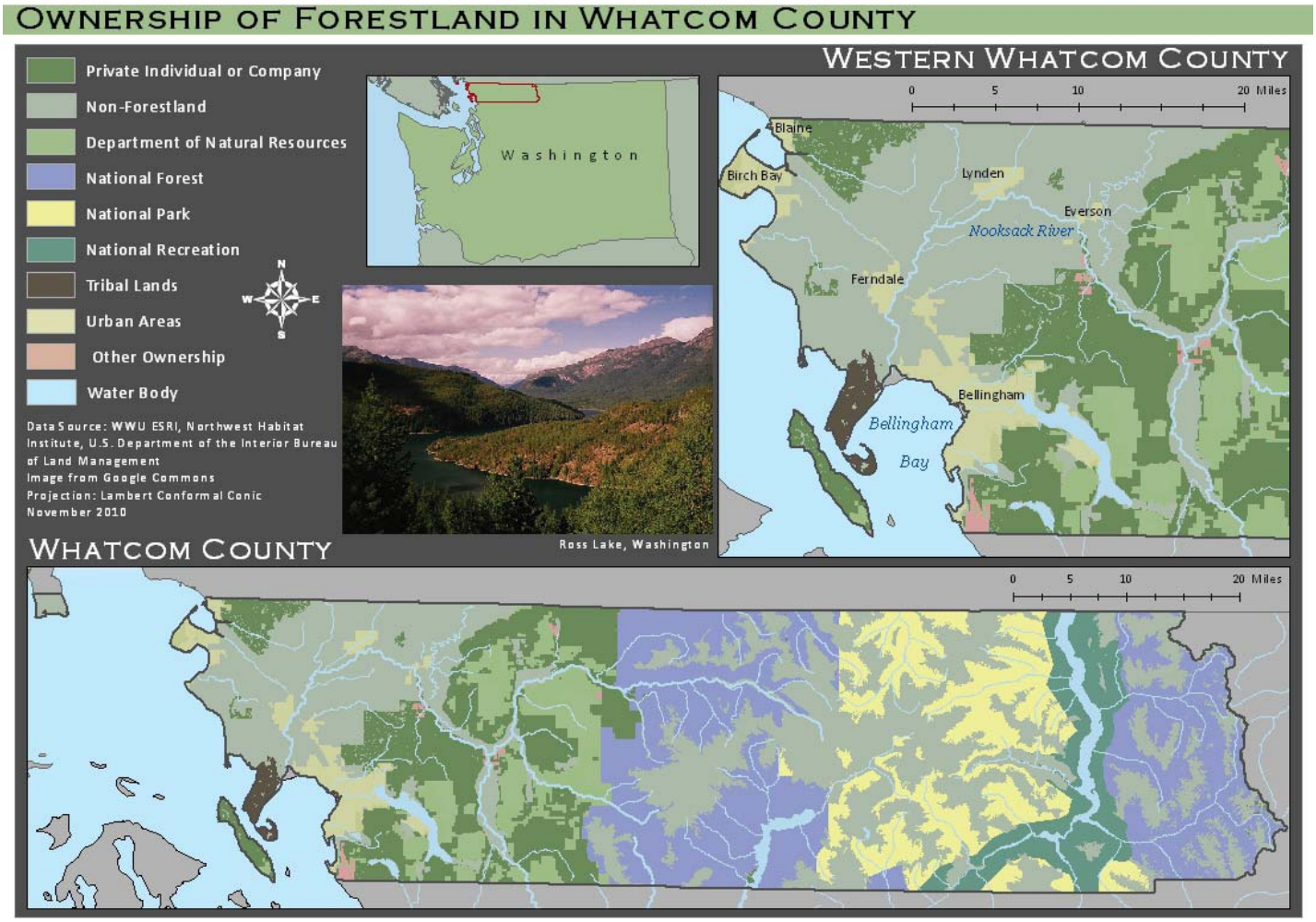


Figure 10: GIS map compiled by Madalyn Ohrt with information from the Western Washington University GIS Database and the Northwest Habitat Institute at http://www.nwhi.org/index/gisdata

Water Resources Assessment

Watershed Characteristics and Governance

The majority of Whatcom County (about 88% or 1,239 square miles) is within Water Resource Inventory Area (WRIA) 1 (Nooksack) or the Nooksack River Basin (HUC 17110004). The WRIA 1 drainage area includes the Nooksack River, five coastal sub-basins, and two Fraser River sub-basins. Approximately 830 square miles in the eastern part of the county drain south and east to the Upper Skagit River (WRIA 4) and Methow River (WRIA 48) watersheds. Part of southwestern Whatcom County drains south to the Lower Skagit/Samish River watershed (WRIA 3). Entities with jurisdiction in the Nooksack River watershed include the Lummi Nation, Nooksack Indian Tribe, Public Utility District No. 1 of Whatcom County (PUD), Washington Department of Ecology (DOE), Washington Department of Fish and Wildlife (WDFW), Whatcom County, and the cities of Bellingham, Everson, Ferndale, Lynden, and Nooksack. These groups also make up the members of the WRIA 1 Watershed Management Team.

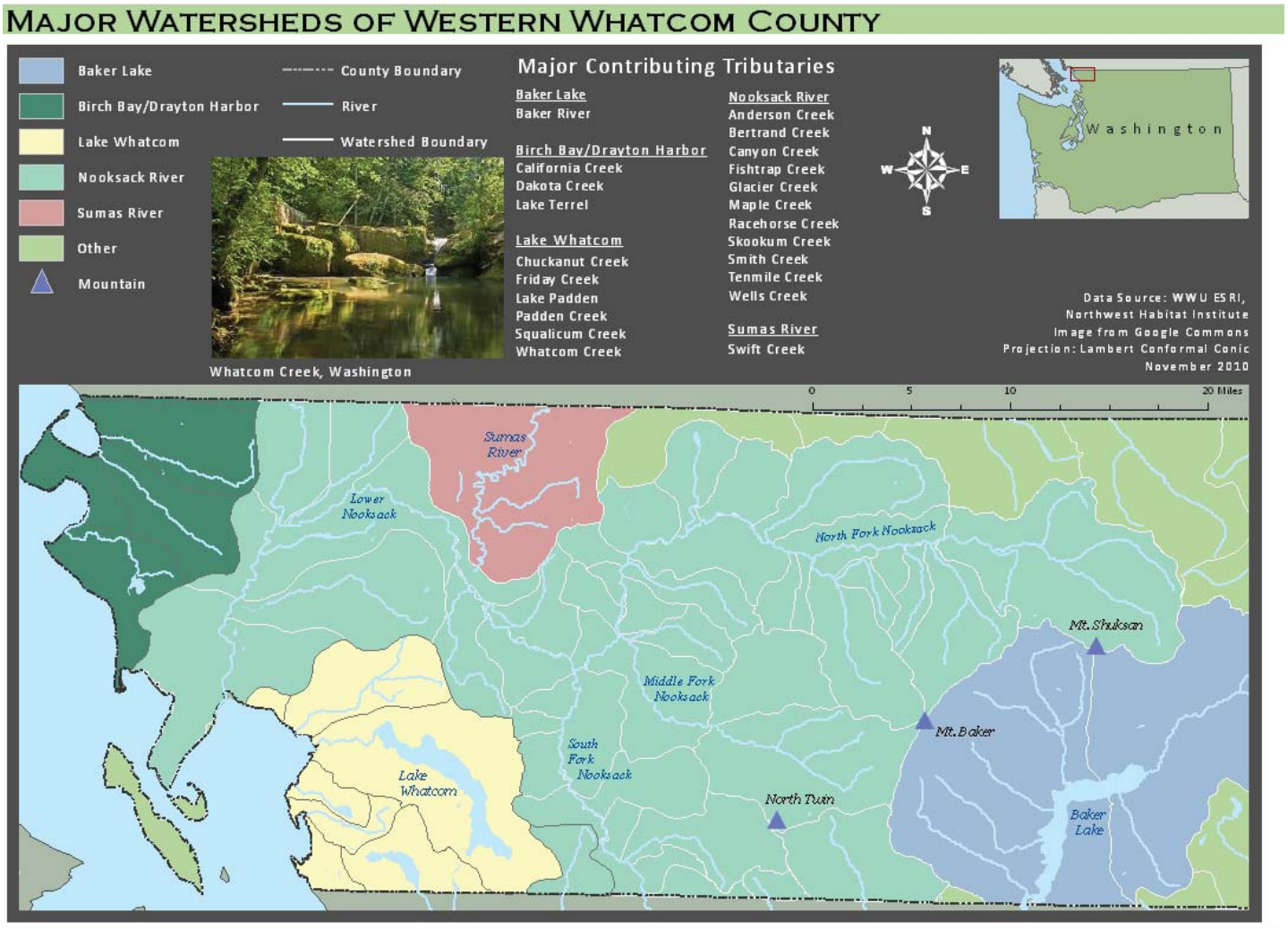


Figure 11. GIS map compiled by Madalyn Ohrt with information from the Western Washington University GIS Database and the Northwest Habitat Institute at http://www.nwhi.org/index/gisdata

There is a large amount of water and water bodies in Whatcom County, including water both above and below the surface of the ground. The aquifer systems of WRIA 1 can be classified into two types (i.e., surficial aquifers and non-surficial aquifers). The principal surficial aquifers (i.e., the uppermost, saturated zone, typically an unconfined water-table condition) are grouped into three aquifer units[32]: the Sumas-Blaine aquifer, the Upper Valley aquifers, and the Discontinuous surficial aquifers. The largest portion of WRIA 1 is characterized as non-surficial aquifers. It is important to note that Whatcom County's water sources come from two different places i.e., the surface and the ground, and that this requires that there be two different strategies to ensure that water supplies are able to meet the demand. Protecting areas where water is recharged into the ground and riparian buffers along existing surface waters is critical.

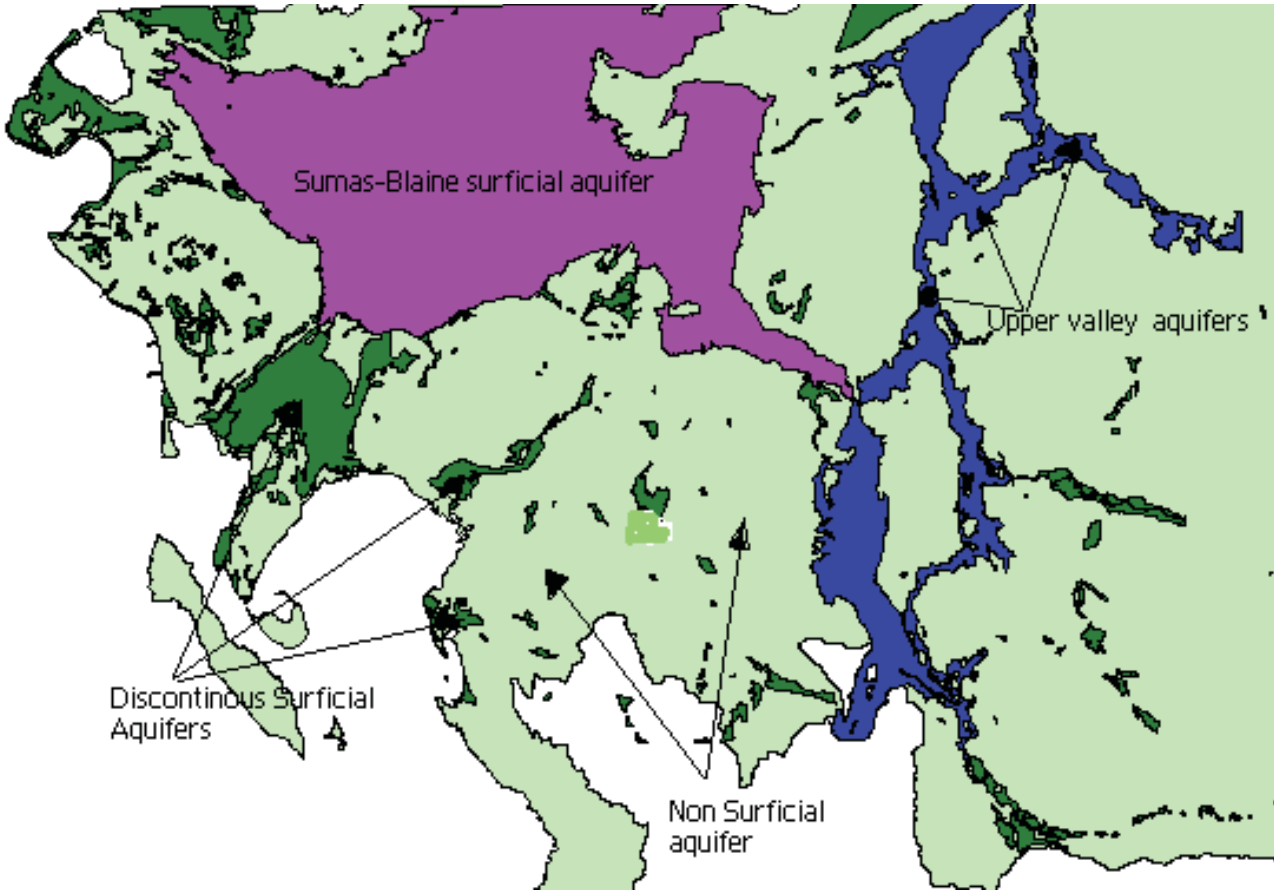


Figure 12: Aquifer systems of WRIA 1[32]

Freshwater Habitat

Within Whatcom County, there are 16 major lakes (including Whatcom, Samish, Terrell, Cain, Reed, and Wiser), dozens of smaller lakes, 3,012 miles of rivers and streams and their estuaries, over 37,000 acres of wetlands, aquifers containing an undetermined amount of groundwater, and 134 miles of marine shoreline. The Nooksack River, with its North, Middle, and South Forks, is the primary river in Whatcom County. Primary streams include the Black Slough and Bertrand, California, Canyon, Clearwater, Dakota, Fishtrap, Glacier, Hutchinson, Kendall, and Terrell creeks. Primary streams in the city of Bellingham include Padden, Squalicum, and Whatcom creeks. In the city of Bellingham, Whatcom Creek is a popular sportsfishing stream and has several parks located along its banks. Lake Whatcom is the drinking water source for over 85,000 residents of Whatcom County (about half the county's population) and holds about 250 billion gallons of water. Both Lake Whatcom and Lake Padden are also popular recreation areas with parks, trails, fishing docks, and boat launches. In the county, Lake Samish is a popular recreation area with parks and boat launches and Lake Terrell is a popular sportsfishing destination. The North Fork of the Nooksack River is also used recreationally by fishermen and both commercial and private whitewater rafters and kayakers. The South Fork of the Nooksack River is a sportsfishing and recreation destination as well, especially in the summer months as tubing a section of this river is very popular when the weather is hot.

The wetlands, fields, streams, riparian areas, and uplands of Whatcom County support many species of fish and wildlife including several federally listed endangered species. Native fish including all five species of Pacific salmon and steelhead occur in lakes, rivers, and streams along with bull trout and Dolly Varden. Ducks such as bufflehead and goldeneye winter in the County, and other bird species such as scoters, snow geese, trumpeter swans, canvasbacks, cormorants, grebes, loons, and other migrating waterfowl pass through every spring and fall as they travel between their breeding grounds in Alaska and Canada and their wintering grounds in California and Mexico. Climate change is already forcing fish and wildlife to change the timing and patterns of their migrations, as well as the locations in which the over-summer and/or over-winter, and continued changes in temperatures and hydrologic regimes will only continue this trend.

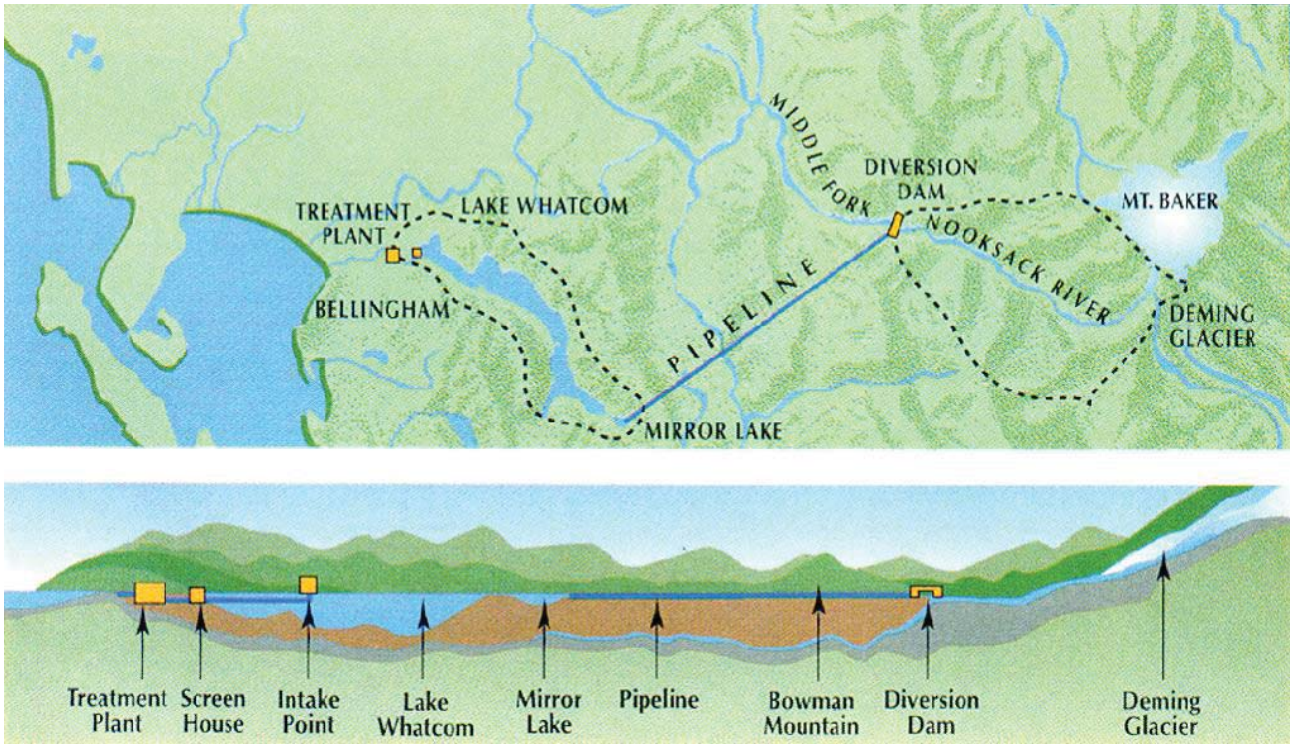


Figure 13: Lake Whatcom and the City of Bellingham Water Supply Diversion.[12]

Population Growth and Water Use

Population growth in the Nooksack River Basin is projected to be 38% between 2000 and 2020, with most of this growth concentrated in the cities of Bellingham, Blaine, and Lynden. Currently the city of Bellingham's residential per capita water usage averages approximately 105 gallons per capita per day (gpcd). This figure is just above the national average of 101 gallons per capita per day (gpcd) for a non-conserving home. An estimated 70% of daily per capita use is attributed to indoor water usage and 30% for outdoor use. Water use has varied in the past 20 years depending on weather and conservation efforts. From 1990 to 2007, Bellingham saw a 41% increase in water services and population. Despite these increases, average daily water production has been able to remain steady, fluctuating by approximately 2% on average, which is equal to the 2% average annual population growth rate during the same time.

A decline in the available water supply in Lake Whatcom as a result of climate change impacts would require that Bellingham residents reduce their water usage. Water quantity, however, will not be the only issue facing the citizens of Bellingham as water quality will also continue to be an issue of concern. There is already heavy development and human usage along the west and north sides of Lake Whatcom. As of 2007, the population of the Lake Whatcom watershed was roughly 15,000 people or 6,500 homes. In 1998, Lake Whatcom water quality failed to meet state dissolved oxygen standards and was placed on Washington's 303(d) list of polluted waters. In addition to the lake failing to meet dissolved oxygen standards due to phosphorus loading, 11 of Lake Whatcom's tributary streams failed to meet state water quality standards for fecal coliform bacteria. In response to this listing, a Total Maximum Daily Load (TMDL) study was completed by DOE to determine the amount of phosphorus and fecal coliform reduction needed to return the lake to acceptable water quality standards.

Currently there are 91 water bodies in Whatcom County on the 303(d) list as impaired. The pollutant of highest concern in both Whatcom County's freshwater and marine ecosystems is fecal coliform bacteria. Temperature and dissolved oxygen levels are the other water quality parameters of concern our local streams. Land use density does not necessarily determine the level of pollutants, but certain pollutants are associated with urban streams such as copper, zinc, and oil levels influenced by nearby road and stormwater runoff. Rural streams tend to have higher levels of nutrients and bacteria associated with fertilizer and manure application on farm fields.[25] Although TMDLs have been assessed for many streams listed on the 303 (d) list, climate change will

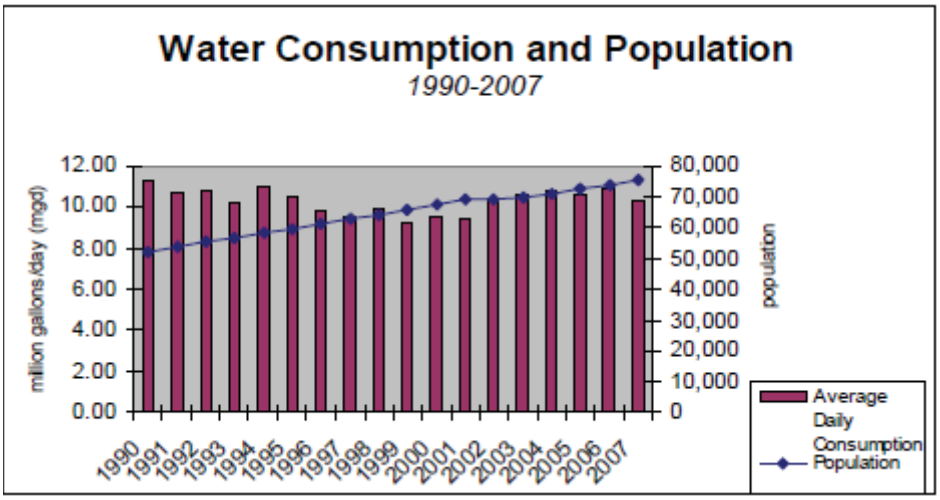


Figure 14: Water consumption and population in the city of Bellingham.[2]

Historical Demand			
Year	ADD (mgd)	MDD (mgd)	PHD (mgd)
2000	9.48	15.84	23.76
2001	9.46	15.33	23.00
2002	10.38	17.91	26.87
2003	10.63	19.52	29.28
2004	10.81	20.69	31.04
2005	10.60	17.77	26.66
2006	10.85	19.38	29.07
2007	10.32	18.34	27.51

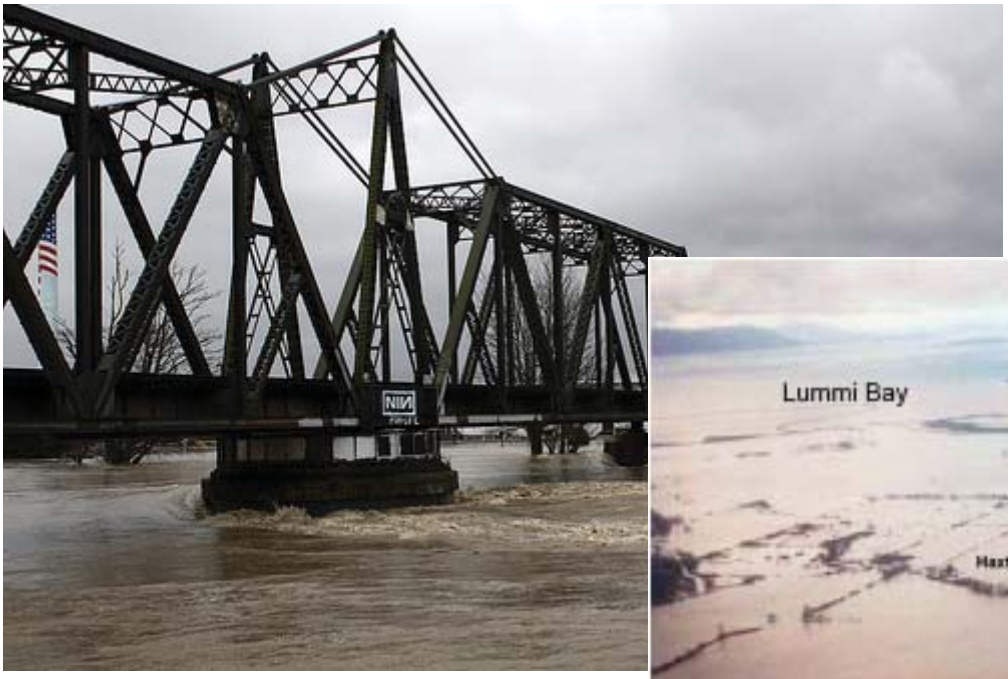
Table 1: Historical water demand in Bellingham Mgd equals million gallons per day. Average Daily Demand (ADD) represents average daily water production, including unaccounted used throughout the year, and is used to estimate the total annual amount of supply needed. Maximum Daily Demand (MDD) represents the day of the year during which the maximum water usage occurs as a result of customer consumption.[2]

Bellingham Water Demand Projections with and without Conservation				
	Without Conservation		With Conservation	
	ADD	MDD	ADD	MDD
Current Year	10.32	19.81	--	--
2014	14.20	27.26	12.54	24.08
2028	19.27	37.00	16.99	32.63
Note: Demands in mgd.				

Table 2: Water demand projections in Bellingham with and without conservation efforts. Mgd equals millions of gallons per day.[2]

most likely require that these are adjusted as streamflows, especially in the summer months, decrease while pollutant inputs do not. The inability of our local streams to meet state water quality standards implies a hardship for the fish and wildlife that call these waters home, as well as for the human populations that get their drinking water from these water bodies.

In an effort to enhance salmon habitat and decrease stressors on over-summering salmon and trout populations, both the Lummi Nation and the Nooksack Indian Tribe are currently working to establish instream flow goals for WRIA 1, but there is a confidentiality agreement associated with these negotiations that limits the information that can be shared at this time. This effort is a step in the right direction to ensure the resiliency of Whatcom County's rivers and streams, and further water quality monitoring is also recommended.



Flooding at Nooksack River bridge in Ferndale in November of 2010
[Photo source: NSEA]

Flooding in Nooksack River delta in 1990
[Photo source: Lummi Nation]

Drought and Flooding

Major flooding occurs on a fairly infrequent basis in the Nooksack River basin, usually between late October and early February. The severity and frequency of sever flooding has been increasing, however, and there have been four major flood events in the past 20 years; two in November of 1990, one in January of 2009, and one in November of 2010. These large-scale flood events caused the closure of multiple major roads, flooded thousands of acres of farm, residential, and tribal reservation lands, and damaged private residences and businesses. Coastal flooding in Puget Sound is also a concern as the frequency and intensity of severe storms is likely to increase with climate change. In December of 2000, a storm combining 70 mph winds and a high tide of 10.5 ft was estimated to have caused approximately $750,000 in damages along the Sandy Point Peninsula.[14] Though the 100-year floodplain of the Nooksack River was mapped by the Federal Emergency Management Agency (FEMA), much of it was over 30 years ago. Currently these maps are being updated across Washington State, but the current modeling effort is, needless to say, coarse at best, and the 500-year floodplain has never been mapped.[6]

Annual precipitation varies greatly across Whatcom County, depending on elevation. In the lowlands rainfall varies from 30-40 inches. East toward the Cascade Mountains precipitation increases, and at the Mt. Baker summit precipitation averages 140 inches, adding to the snow pack and glaciers year round.[28] As such, there have been no major drought events in the past 20 years, though water conservation measures have been implemented on and off during this time period.

Economic Resources Assessment

More than 6,664,195 people live in the Evergreen State and the number is growing every day. Whatcom County is populated by more than 200,500 people, and our population is also swelling. Most of the county's residents live in the western third of Whatcom County (including some 85,000 residents in the city of Bellingham). Between 1990 and 2000 our state's population grew by 21% - a growth rate nearly 60% above the national average[26] - and increased again by 13% between 2000 and 2009. During that same period Whatcom County's population increased by 16% and our growth rate is projected to increase again by 9% in the next five years, 18% in the next ten years, 30% in the next 15 years, and more than 261,000 people are expected to call our area home by the year 2030.[27]

Before the 1960s, Whatcom County's economy was primarily based on natural resources, including timber, fisheries, and agriculture. Over the past 50 years, the economy has diversified. In 1999, the service sector provided 27% of the county's jobs, followed by retail at 19%, government (including schools) at 12%, and manufacturing at 11%[32]. Currently the top ten employers in Whatcom County are still by and large social service organizations/agencies including St. Joseph's hospital, Western Washington University, the Bellingham School District, Whatcom County, the City of Bellingham, and the Ferndale School District. Revenues for the county are made up largely of taxes and intergovernmental revenues.

Many Whatcom County residents also make a living in the tourism and outdoor recreation industries. Thousands of people from around the world are attracted by the healthy forests, clear streams, and scenic mountain vistas and travel far and wide to ski, fish, hunt, hike, and view wildlife in their natural habitats. Industries generated and dependent on these visitors include the Mt. Baker-Snoqualmie National Forest, the Mt. Baker Ski Area, whale watching, sea-kayaking and sailing in the northern Puget Sound, and white-water rafting. Though a small percentage of residents still work in natural resource extraction (logging, mining, and fishing), many direct natural resource dependent livelihoods in our community now involve outdoor recreation specialties like guiding trips, sport instruction, selling sporting goods, and site maintenance.

Photo source: Whatcom Farm Friends

Photo source: Whatcom Farm Friends

Photo source: Whatcom Farm Friends

Photo source: Northwest Paddling

The primary economic engines and revenue sources in Whatcom County are agriculture, primarily dairy and berry farms, and tourism. Agriculture in Whatcom County makes up 3.6% of employment and 2.4% of total wages. Although the employment and wages are small, agriculture is an important economic driver as Whatcom County produces 75% of the nation's raspberries.[20] Though Whatcom County's economy is in many ways tied to natural resources and these resources are dependent the availability of water, Whatcom County has the second highest economic resiliency (based on a calculation of economic specialization) in Washington State[3]. However, it is important to recognize that climate change will impact our economic sector and that as we will be seeing hot years, dry years, and wet years, having the flexibility necessary to thrive during these variations in climate is essential.

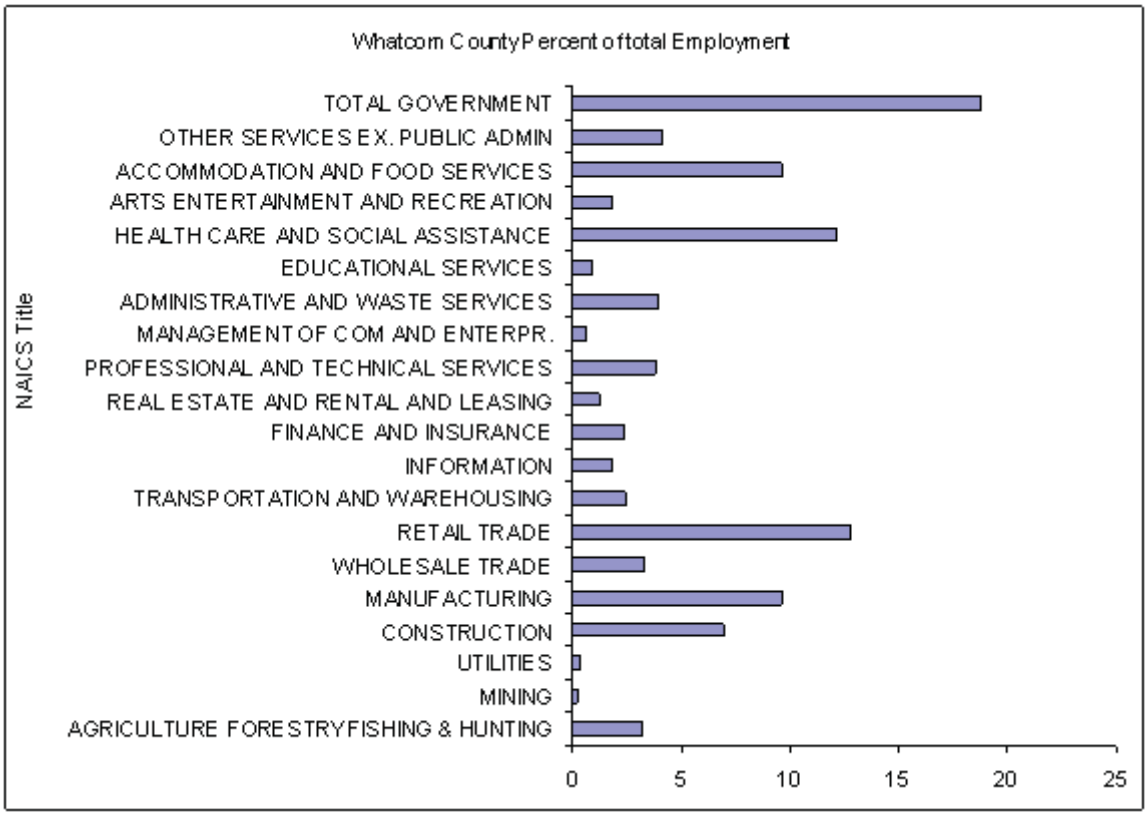


Figure 15: Percent of total employment in Whatcom County 2009[24]

Synthesis of Opportunities

Whatcom County can be proactive in enhancing the resilience and adaptation of ecosystems and their services in the face of climate change. A wide range of opportunities are available to address the risks and vulnerabilities identified through the resource assessments. It is important to note that many of these vulnerabilities currently exist and will not be created by climate change, but the exacerbated by climate change. Table 3 below provides recommendations for a framework of adaptation for sectors including water supply and hydrology, urban stormwater infrastructure, coasts, forests, salmon, and agriculture.

Sector at Risk	Adaptation Strategy	Examples of Adaptation Actions and Activities that Build Adaptive Capacity
Water Supply and Hydrology	Develop new or alternate water supplies	Develop advanced wastewater treatment capacity for water reuse ("gray water" or "purple pipe") • Implement new technologies such as reverse osmosis for desalination • Encourage rainwater harvesting to provide water supply for residential and commercial buildings
	Reduce demand/ improve efficiency	Increase water conservation measures • Price water to encourage conservation in summer • Reduce outdoor landscape water demands (e.g., promote drought tolerant landscaping) • Update building codes to require highest efficiency plumbing fixtures (e.g. dual flush toilets) • Meter water use • Provide financial incentives (e.g., tax breaks, rebates) for switching to more efficient manufacturing processes, irrigation practices, and appliances • Reduce system losses (repair pipes, line irrigation canals)
	Increase ability to transfer water between uses and users	Use water banks, water pools, and water markets to facilitate the reallocation of water resources in times of shortage • Remove obstacles to flexible water reallocation in existing water law and water policy • Factor in climate change impacts in renegotiations of transboundary water agreements
	Prepare for drought	Create a drought management plan to prepare for changing conditions • Increase authority to implement water restrictions and other emergency measures as needed
	Reduce winter flood impacts	Strengthen dikes and levees where appropriate • Restore hydrologic function in floodplains • Improve flood forecasting and emergency management systems • Alter land use policies and flood insurance programs to incorporate the changing risks of extreme events • Preserve forest cover in source water areas and the riparian zones of headwater streams
	Increase public awareness about climate change impacts on water supplies	Include information on climate change impacts to water supplies and how residents can reduce water use in utility inserts, newsletters, websites, and local newspapers
	Enhance the type of information used for managing water supply	Expand the use of climate information (e.g. seasonal forecasts) in water resources planning and management • Actively monitor trends in snowpack, streamflow and other conditions affecting hydrology and water resources to anticipate problems • Conduct additional ongoing research on how climate change may impact water supply
	Increase capacity to manage stormwater	Increase capacity of stormwater collection systems to accommodate changes in precipitation • Modify urban landscaping requirements to reduce stormwater and runoff • Preserve ecological buffers (e.g. wetlands and riparian zones)
	Reduce property damage from stormwater and flooding	Move or abandon infrastructure in hazardous areas • Change zoning to discourage development in flood hazard areas • Update building codes to require more flood resistant structures in floodplains
	Improve information used to manage stormwater and flood events	Increase the use of climate and weather information in managing stormwater/ flood risk and individual events • Update flood maps to reflect changing risk associated with climate change • Conduct additional research on how climate change may impact storm water and flooding in your community
	Reduce flooding and erosion on infrastructure	Increase capacity of stormwater collection and treatment systems to accommodate projected changes in precipitation • Increase green infrastructure practices to treat stormwater on-site and reduce downstream peak flows
	Reduce damage to asphalt from warmer summer temperatures	Increase maintenance frequency of asphalt roads • Investigate potential of using other road surfaces on most heavily used roads • Promote tree canopy cover for asphalt shading • Promote shading of parking lots with solar panel cover

Urban Stormwater Infrastructure	Increase resiliency of stormwater management strategies	Promote the use of stormwater-management strategies that emphasize the management of stormwater volumes (e.g., Low Impact Development (LID) strategies), rather than strategies that depend on precise determination of rainfall depths and durations (e.g., engineered stormwater detention ponds)

Coasts	Accommodate coastal impacts	Incorporate climate change impacts into design requirements for coastal structures • Modify flood zone designations to incorporate projected sea level rise • Increase (or initiate) use of setbacks and rolling easements to allow for inland migration of wetlands, salt marshes, and other critical habitat systems, including shallow tidelands used in shellfish production. • Reduce sources of nutrients that contribute to harmful algal blooms (HABs) and increase HAB monitoring to help ensure continued viability of recreational and commercial shellfish harvests
	Protect high value coastal uses	Construct new dikes/raise existing dikes to protect high-value areas • Increase partnerships across government levels to manage impacts to ports and supporting transportation systems
	Retreat from high-risk coastal areas	Reduce development on beaches and bluffs likely to be threatened by sea level rise • Where protection of property is not feasible, abandon coastal sites and move to higher ground
	Improve information used in managing coastal systems	Increase monitoring and control of invasive species including the Chinese mitten crab, European green crab, and the zebra mussel • Incorporate information on sea level rise into the Whatcom County Shoreline Management Plan and WRIA 1 Watershed Management Plan

Forests	Maintain mixed landscape structure	Expand or adjust protected areas to incorporate greater diversity of topographic and climatic conditions to allow for shifts in species distributions in response to climate change • Tailor timber harvest or prescribed burning to create a mosaic of patch sizes and age classes • Avoid creating monoculture forests or forests lacking structural diversity (e.g., homogeneous stands or large clearcuts)
	Maintain species diversity and within-species diversity	Expand or adjust protected areas to incorporate greater diversity of topographic and climatic conditions to allow for shifts in species distributions in response to climate change • Plant tree species or varieties known to have a broad range of environmental tolerances • Reduce potential for invasive species such as Japanese knot weed, reed canary grass, and pine beetle
	Reduce the impact of climatic and non-climatic stressors	Manage forest density to reduce susceptibility to severe fire, insects outbreaks (whether native or invasive), and drought, by establishing or enhancing structural prescriptions • Manage forests for changing fire regimes so that the risk of extreme fire events is minimized • Thin stands from below to increase fire resilience • Create uneven-aged structures or reduce density • Use large disturbances as opportunities to establish new genotypes and forest heterogeneity and diversity
	Improve information used in forest management	Incorporate understanding of elevation-specific climate sensitivities into management strategies • Actively monitor trends in forest conditions, including drought stress, insects, and invasive species

Salmon	Improve freshwater survival rates and carrying capacities	Carefully limit harvests for selective fisheries • Protect and restore natural functions in watersheds (e.g. floodplains, woody debris, riparian vegetation) • Protect and restore instream flows • Control water pollution
	Improve estuarine survival rates and carrying capacities	Carefully limit harvests for selective fisheries • Improve hatchery practices • Reduce the spread of invasive species such as the Chinese mitten crab and spartina grass • Protect and restore nearshore habitat
	Improve marine survival and carrying capacities	Carefully limit harvests for selective fisheries • Improve hatchery practices
	Improve information used in salmon ecosystem management	Integrate climate change information into the WRIA 1 Salmon Recovery Plan
	Maintain species diversity and within-species diversity	Expand or adjust protected areas to incorporate greater diversity of topographic and climatic conditions to allow for shifts in species distributions in response to climate change • Plant tree species or varieties known to have a broad range of environmental tolerances • Reduce potential for invasive species such as the Chinese mitten crab and carp

Agriculture	Adjust production to reflect changing conditions	Change planting dates • Change planting varieties to include crops that are better suited for warmer and drier conditions • Continue to promote Integrated Pest Management (IPM) practices and improve approaches to weed and insect management
	Improve agricultural water supply and use	Promote new irrigation technologies to improve water use efficiency • Promote water conservation • Use market forces to distribute water • Diversify and expand water supplies and infrastructure
	Improve information and technology used in managing agriculture	Maintain well-funded monitoring network and information center for data collection on impacts to agriculture • Support research on biotechnology-based breeding to increase the number of crop varieties that are suitable for projected climate conditions • Increase research on automation, sensors, and overall improvement of agricultural management practices to reduce costs and compensate for yield losses

Table 3. Adaptation strategies and examples of actions by sector - adapted from the Climate Impacts Group.[31]

Although there is uncertainty as to the exact timing and magnitude of climate change impacts, early actions are needed as the cost of preparation and adaptation will dwarf the costs of inaction. Protecting forests, wetlands, coastal habitats, and other natural ecosystems will provide social, economic, and environmental benefits, both directly and indirectly. Protected areas, and the natural habitats within them, can ensure watershed health and regulate water flow and water quality; prevent soil erosion; conserve renewable harvestable resources and maintain genetic reservoirs; and protect breeding stocks, natural pollinators, and seed dispersers, which maintain ecosystem health. Riparian buffers provide storm protection and act as safety barriers against natural hazards such as floods, while natural wetlands filter pollutants and serve as nurseries for fish and other wildlife. Better protection and management of key habitats and natural resources also benefit indigenous communities by maintaining ecosystem services and maintaining access to resources. (The World Bank 2009) Implementing on-the-ground actions, however, requires long-term commitment and greater awareness and engagement of the public.

Action Plan

Although Whatcom County has already committed to significantly reducing its contributions for climate change by creating a Climate Protection and Energy Conservation Action Plan, many changes will not be preventable. This is why it is important for specific action to be taken to respond to the climate change challenge. The goals and objectives of this effort (known as the Nooksack River Climate Solutions Project or NRSCP) are outlined below and describe the efforts NSEA staff will undertake to initiate discussions among stakeholders in Whatcom County as to the importance of raising awareness of the need for climate change education, including climate adaptation strategies in natural resource management planning processes, and educating the community about local climate change impacts.

Goals and Objectives

GOAL A. Raise awareness of the need for climate change education for local and regional natural resource managers, city and county planners, and city and county council members.

Objectives:

1. Provide PowerPoint presentations on the NRCSP to the Bellingham City Council, Bertrand Creek Watershed Improvement District (Bertrand WID), Birch Bay Watershed and Aquatic Resources Management (BBWARM) Advisory Committee, Blaine City Council, Drayton Harbor Shellfish Protection Advisory Committee, Ferndale City Council, Lake Whatcom Watershed Advisory Board, North Lynden Watershed Improvement District (North Lynden WID), Whatcom County Agricultural Preservation Committee, Whatcom County Council, Whatcom County Flood Control Zone Advisory Board, Whatcom County Marine Resources Committee (MRC), and the WRIA 1 Management Team.

Strategy:
1. Research, review, and compile existing information on climate change trends, climate change projections, and climate impacts and risks for Whatcom County and the Puget Sound region. (2011)

2. Create PowerPoint presentations highlighting and the results of the NRCSP Whatcom County Forest, Water, Climate, and Economic assessments and Whatcom County's risks and opportunities in terms of climate change impacts and adaptation. (completed)

Measure:
1. Number of presentations given.
2. Number of attendees at each presentation.

2. Create an email listserv for the NRCSP in order to distribute information regarding events, webinars, and podcasts and links to scholarly papers, journal articles, and news features relating to local, regional, and national climate change impacts and adaptation.

Strategy:
1. Solicit email addresses from individuals attending all NRCSP presentations and combine into the NRCSP Listserv. (2011 - ongoing)

2. Send bi-weekly emails to NRCSP Listserv members. (2011 - ongoing)

Measure:
1. Number of individuals on listserv.
2. Percentage of clicked-through links from listserv emails.

GOAL B. Include climate adaptation strategies in WRIA 1 salmonid recovery planning, WRIA 1 watershed planning, and other state, regional, and local forest and water resource management planning processes.

Objectives:

1. Incorporate climate change adaptation language into WRIA 1 Salmonid Recovery Plan Three-Year Work Plan.

Strategy:

1. Meet monthly with the WRIA 1 Salmon Recovery Staff Team to discuss climate impacts and critical risks for wild salmonid populations associated with climate change in the Nooksack River basin. (2011 - ongoing)

2. Meet quarterly with the Puget Sound Partnership and Regional Implementation Technical Team to receive feedback on Three-Year Work Plan goals and objectives. (2011 - ongoing)

Measure:

1. Number of meetings held.
2. Climate adaptation language in WRIA 1 Salmonid Recovery Plan Three-Year Work Plan.

2. Incorporate climate change adaptation language into WRIA 1 Watershed Management Project Plan Three-Year Work Plan.

Strategy:

1. Meet monthly with the WRIA 1 Watershed Management Staff Team to discuss climate impacts and critical risks associated with climate change in the Nooksack River basin and Lake Whatcom watershed. (2011 - ongoing)

Measure:

1. Number of meetings held.
2. Climate adaptation language in WRIA 1 Watershed Management Project Plan Three-Year Work Plan.

Goal C. Educate the community about climate change impacts on Whatcom County's forest and water resources and climate adaptation strategies.

Objectives:

1. Devise a public outreach campaign and host a series of workshops and presentations, including the Salmon Summit.

Strategy:

1. Research and review existing information on climate change trends, climate change projections, and climate impacts and risks for Whatcom County and the Puget Sound region. (2011 - ongoing)

2. Work as a member of the Climate Adaptation Outreach Committee with the Staff Team, the Whatcom County Marine Resources Committee (MRC), and the Whatcom Watershed Information Network (WWIN) to research and coordinate speakers and develop presentations. (2011)

3. Focus the theme of the 2011 Salmon Summit on Climate Change and Adaptation in WRIA-1. (November 2011)

4. Utilize traditional (newspapers, etc.) and social media outlets to promote awareness and events. (2011)

Measure:
1. Number of workshops/presentations hosted.
2. Number of attendees at workshops/presentations.
3. Number of attendees at the Salmon Summit.
4. Number of articles published in local newspapers.
5. Number of posts to NRCSP and partner organization's Facebook pages, Twitter pages, blogs, and websites.

2. Develop an online guide for homeowners and developers, etc. to educate them about the significance of riparian areas and wetlands and their role in adapting to climate change.

Strategy:
1. Research and review existing information on riparian areas and wetlands. (2011 - ongoing)

2. Work with advisors from the Staff Teams and the Whatcom Watershed Information Network (WWIN) and students from Western Washington University to create a website for the NRCSP. (2011)

3. Partner with county and city planning departments and the Whatcom County Association of Realtors to funnel traffic to and promote use of website. (2011)

Measure:
1. NRCSP website.
2. Number of visits to website.

3. Incorporate the NRSCP and climate change into established community environmental events.

Strategy:
1. Partner with the Northwest Straits Chapter of the Surfrider Foundation (Surfrider) to focus World Water Day events on the topic of climate change. (February - March 22, 2011)

2. Host an Earth Day streamside habitat restoration Work Party to plant native trees and shrubs along a streambank. (April 2011)

3. Host a WWIN Water Week event featuring movie on climate impacts in our region. (May - October 2011)

Measure:
1. Number of attendees at World Water Day.
2. Number of attendees at Earth Day Work Party.
3. Number of attendees at Water Week event.

NSEA will work as a member of the Salmon Staff Team, the Watershed Staff Team, and WWIN to implement the outreach and education actions identified in this climate adaptation plan. The support of these cooperative groups of stakeholders is critical to the success of the Nooksack River Climate Solutions project. NSEA staff will be responsible for tracking the progress made towards the realization of the goals outlined in this plan and will revisit and review the plan in December of 2011. The ultimate success of the NRCSP will result in the WRIA 1 Management Teams (both Watershed and Salmon) and other affected local governments and stakeholders recognizing the critical need for climate adaptation as a core management responsibility. The expectation is that all will then work to integrate a climate change response strategies and actions into natural resource planning and management.

References

[1]Casola, J.H., J.E. Kay, A.K. Snover, R.A. Norheim, L. C. Whitely Binder and the Climate Impacts Group. 2005. *Climate Impacts on Washington's Hydropower, Water Supply, Forests, Fish, and Agriculture*. A report prepared for King County (Washington) by the Climate Impacts Group (Center for Science in the Earth System, Joint Institute for the Study of the Atmosphere and Ocean, University of Washington, Seattle). Available for download at http://www.cses.washington.edu/db/pdf/kc05whitepaper459.pdf

[2]City of Bellingham Water Use Efficiency Program. 2008. http://www.cob.org/services/environment/conservation/index.aspx, accessed 9.30.10

[3]Daniels, J.M. 2004. *Assessing Socioeconomic Resiliency in Washington Counties*. USDA Forest Service.

[4]FAO (Food and Agriculture Organization). 2008a. *Climate Change and Food Security: A Framework Document*. Rome: FAO.

[5]FAO (Food and Agriculture Organization). 2008b. *Climate Change and Mitigation in the Food and Agriculture Sector: Technical Background Document* (HLC/08/BAK/1). Rome: FAO.

[6]Federal Emergency Management Agency. 2010. http://msc.fema.gov/webapp/wcs/stores/servlet/MapSearchResult?storeId=10001&catalogId=10001&langId=-1&userType=G&panelIDs=53073C1214D&Type=pbp&nonprinted=&unmapped=, accessed 11.16.10

[7]Hamlet, A.F., S.Y. Lee, K.E.B Mickleson, and M.M. Elsner. 2009. Effects of projected climate change on energy supply and demand in the Pacific Northwest. *Washington climate change impacts assessment: evaluating Washington's future in a changing climate*. Available for download at http://cses.washington.edu/db/pdf/wacciach4energy647.pdf

[8]Huppert, D.D., A. Moore, and K. Dyson. 2009. Impacts of climate change on the coasts of Washington State. Washington climate change impacts assessment: evaluating Washington's future in a changing climate. Available for download at http://cses.washington.edu/db/pdf/wacciach8coasts651.pdf

[9](IPCC) Intergovernmental Panel on Climate Change. 2001a. *Climate Change 2001: The Scientific Basis, Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC)*, [J.T. Houghton, Y. Ding, D.J. Griggs, M. Noguer, P.J. van der Linden and D. Xiaosu (Eds.)], Cambridge University Press, Cambridge, England. Available for download at http://www.grida.no/publications/other/ipcc_tar/

[10](IPCC) Intergovernmental Panel on Climate Change. 2001b. *Climate Change 2001: Impacts, Adaptation, and Vulnerability, Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC)*, [J.J. McCarthy, O.F. Canziani, N.A. Leary, D.J. Dokken, and Kasey S. White (Eds.)], Cambridge University Press, Cambridge, England. Available for download at http://www.grida.no/publications/other/ipcc_tar/

[11]Kaluarachchi JJ, Kra E, Twarakavi N, and Almasri M. 2002. *Nitrogen and pesticide contamination of groundwater in water resources*, Version 1.3. Utah Water Research Laboratory. Utah State University. Logan, Utah.

[12]Lake Whatcom Management Program. 2007. http://www.lakewhatcom.whatcomcounty.org, accessed 9.30.10

[13]Littell, J.S., E.E. Oneil, D. McKenzie, J.A. Hicke, J. Lutz, R.A. Norheim, and M.M Elsner. 2009. Forest ecosystems, disturbance, and climate change in Washington State, USA. *Washington climate change impacts assessment: evaluating Washington's future in a changing climate*. Available for download at http://cses.washington.edu/db/pdf/wacciach7forests650.pdf

[14]Lummi Nation Natural Resources Department. 2007. http://www.lummi-nsn.org/NR/Water/FloodPlain/floodplain.htm, accessed on 12.4.10

[15]Mantua, N.J., I.M Tohver, and A.F. Hamlet. 2009. Impacts of climate change on key aspects of freshwater salmon habitat in Washington State. Washington climate change impacts assessment: evaluating Washington's future in a changing climate. Available for download at http://cses.washington.edu/db/pdf/wacciach6salmon649.pdf

[16]McKenzie, D., A.E. Hessl, and D.L. Peterson. 2001. Recent growth in conifer species of western North America: assessing the spatial patterns of radial growth trends. Canadian Journal of Forest Research 31:526-538.

[17]National Parks Traveler. 2010. www.nationalparkstraveler.com, accessed 10.23.10

[18]Reeves, Christina. 2007. *Climate Protection and Energy Conservation Action Plan - Whatcom County*. Available for download at http://www.co.whatcom.wa.us/executive/conservation/ClimateProtectionandEnergyConservationActionPlan.pdf

[19]Rehfeldt, G.E., N.L. Crookston, M.V. Warwell and J.S. Evans. 2006. Empirical analysis of plant-climate relationships for the western United States. *International Journal of Plant Sciences* 167(6): 1123-1150.

[20]Rhodes, Elizabeth. 2004. Lynden celebrates the ripe, red raspberry. Travel/ Outdoors in The Seattle Times.

[21]Snover, A. K., L. Whitley Binder, J. Lopez, E. Willmott, J. Kay, D. Howell, and J. Simmonds. 2007. *Preparing for Climate Change: A Guidebook for Local, Regional, and State Governments*. In association with and published by ICLEI – Local Governments for Sustainability, Oakland, CA.

[22]Snover, A. K., P. W. Mote, L. Whitley Binder, A.F. Hamlet, and N.J. Mantua. 2005. *Uncertain Future: Climate Change and its Effects on Puget Sound*. A report for the Puget Sound Action Team by the Climate Impacts Group (Center for Science in the Earth System, Joint Institute for the Study of the Atmosphere and Oceans, University of Washington, Seattle.

[23]Thomson, A.M., R.A. Brown, N.J. Rosenberg, R. C. Izaurralde, and V. Benson (2005), Climate Change Impacts for the Conterminous USA: An Integrated Assessment, Part 3, Dryland Production of Grain and Forage Crops, Climatic Change, 69: 43-65; also, Gitay, H., S. Brown, W. Easterling, and B. Jallow (2001), Ecosystems and Their Goods and Services, pp.235-342 in McCarthy et al. (eds.), *Climate Change 2001: Impacts Adaptation and Vulnerability, Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC)*. Cambridge University Press, Cambridge.

[24]Washington State Employment Security Department. 2009. http://www.workforceexplorer.com/, accessed 10.6.10

[25]Washington State Department of Ecology. 2010. http://www.ecy.wa.gov/programs/wq/303d/2010/index.html, accessed 8.4.10

[26]Washington State Department of Natural Resources. 2004. *Forest Land Conversion in Washington State*. http://www.dnr.wa.gov/Publications/em_fwflanduse.pdf, accessed 10.1.10

[27]Washington State Office of Financial Management. 2010. http://www.ofm.wa.gov/, accessed 9.20.10

[28]Whatcom County Hazards Mitigation Plan. 2004. http://www.whatcomcounty.us/dem/pdf/hm_plan4_maps.pdf, accessed 9.20.10

[29]Whatcom County Ordinances. 2005. “Critical Areas Ordinance: WCC 16.16”, http://www.codepublishing.com/wa/whatcomcounty/html/whatco16/whatco1616.html accessed 6.27.10

[30]*Whatcom County Critical Areas Ordinance – Best Available Science Review and Recommendations for Code Update*. 2005. Prepared for Whatcom County Planning and Development Services in Bellingham, WA. Available for download at: http://www.co.whatcom.wa.us/pds/naturalresources/criticalareas/pdf/bas_final_20050520.pdf, accessed 6.27.10

[31]Whitely Binder, Lara C., et al. 2009. Preparing for Climate Change in Washington State. W*ashington climate change impacts assessment: evaluating Washington’s future in a changing climate*. Available for download at http://www.cses.washington.edu/db/pdf/wacciach11adapt654.pdf

[32]*WRIA 1 Watershed Management Plan*. 2007. http://wria1project.whatcomcounty.org/admin/64.aspx#wmp, accessed 7.1.10