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Xeni Gwet'in Community-based Climate Change Adaptation Plan

Prepared for:

The XENI GWET'IN FIRST NATION

by John Lerner and Tine Rossing

Deb Delong, Rick Holmes, Wayne McCrory, Theo Mylnowski and Nancy Oppermann

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John Lerner and Tine Rossing
Ecolibrio

<u>Please Note:</u> The Tsilhqot'in have met the test for aboriginal title in the lands described in Tsilhqot'in Nation v. British Columbia, 2007 BCSC 1700 ("Tsilhqot'in Nation"). These lands are within the Tsilhqot'in traditional territory and the Xeni Gwet'in First Nation's caretaking area. Nothing in this document shall abrogate or derogate from any aboriginal title or aboriginal rights of the Tsilhqot'in, the Xeni Gwet'in First Nation or any Tsilhqot'in or Xeni Gwet'in members.

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EXECUTIVE SUMMARY

Climate change may be the defining issue of our generation. Since the Industrial Revolution, the mean surface temperature of Earth has increased an average 0.6°C (Celsius) due to the accumulation of greenhouse gasses (GHGs) in the atmosphere.[1] Historically, the Earth is accustomed to experiencing wide-spread severe environmental change and has always been able to adapt to these changes accordingly. Yet, the difference now is the *speed* and *scale* of the warming that is currently occurring. Most of this change has occurred within the past 30 to 40 years, and the rate of increase is accelerating. These rising temperatures will have significant impacts at a global scale and at local and regional levels. As a result, climate change will increasingly impact natural and human systems to alter the productivity, diversity and functions of many ecosystems and livelihoods globally.

For resource-dependent communities, such as many First Nations in BC, climate change may increasingly compound existing vulnerabilities as the availability and quality of natural resources that they heavily depend upon decline. Limited resources and capacities for responding to stresses, such as wildfires, floods and droughts will increasingly constrain their ability to meet basic needs and become self-governing. There is, therefore, an urgent need to begin reducing current vulnerabilities and enhancing adaptive capacity of the communities so that people of these communities can face the longer-term impacts of climate change with resilience.

The Xeni Gwet'in First Nation is one of six Tsilhqot'in communities in the Cariboo-Chilcotin, occupying one of the last intact ecosystems on the east side of the Chilcotin range. While the community is relatively dynamic and healthy, it is still healing from the effects of colonization and the residential school system, it is increasingly experiencing stress over resource use conflicts in their traditional territory (Xeni Gwet'in Caretaker Area) and some of the early impacts of climate change (forest fire and fish stock declines). These impacts alone have left the Xeni Gwet'in somewhat anxious for their future but also determined to face it on their own terms. They envision a development and human activity in the Xeni Gwet'in Caretaker Area, which is grounded in an ecosystem-based approach to land use, minimizing human impact on the land and waters, leaving it as much as possible as a self-sustaining, wild environment with clean water, clean air and abundant fish and wildlife.

According to ClimateBC projections, the Xeni Gwet'in Caretaker Area (XGCA) can expect to see an average increase of 2.5 degrees Celsius and an increase of 104 mm of precipitation by 2050. This increase in temperature will be relatively uniform across the Chilko watershed, but precipitation will mostly increase in mountains at higher elevations. Most of this precipitation is snow, but will decrease by nearly 50 percent by 2050. Seasonally, most of the temperature increase will occur in the winter and spring and the precipitation increase during the fall and winter will become wetter. Summers will become drier. Finally, the higher locations will experience the colder and wetter climate and the lower locations will experience the warmer and dryer climate.

In the short-term, these changes in climate will likely increase the incidences of larger and hotter wild fires in the region, which may put the health, property, water, energy, cultural sites and livelihoods in the XGCA at risk. In the mid to long-term, the XGCA forests may shift to a preponderance of Interior Douglas-fir and Ponderosa Pine stands with some amounts of the Bunch Grass (BG), resulting in the extinction or migration of some culturally important plants. As well, in

[1] World Bank (2010).

the mid to long-term, warmer summers and winters could also threaten glacier stocks and consequently water flows and water quality, especially in the dryer areas of the XGCA like the Chilcotin Plateau. This in turn could have serious negative ramifications for cold water habitat upon which salmon and other cool water fish stocks in the XGCA depend for life. As well, a shift to a milder and drier environment will likely result in seasonal foraging challenges for moose, mule deer, california big horn sheep, mountain goats and grizzly bears, which in some cases may lead to seasonal migration and/or population declines.

These longer-term impacts could weaken wild food security and water security for the Xeni Gwet'in as well as jeopardize certain tourism and energy projects. At the same time, long-term climate changes may not be all bad. A warmer climate could present new opportunities for agricultural growth, a longer tourist season and new eco-forestry development in the XGCA.

These projected changes are by no means guaranteed but they are probable enough that the Xeni Gwet'in would do well to prepare rather than do nothing. The best form of preparation in this case is to strengthen the resilience of the Xeni Gwet'in community, which entails strengthening key support systems (see table below). Key measures include strengthening emergency procedures associated with fire and flooding, protecting and conserving potable water supplies, protecting shelter and infrastructure; protecting, conserving and diversifying energy supplies and food supplies, diversifying livelihoods, and preserving traditional culture. **However, perhaps the most effective way of building the resilience of the Xeni Gwet'in community is to protect and conserve the biodiversity of the XGCA.** The land is integral to the Xeni Gwet'in culture and way of life and the healthier the land is, the healthier and more resilient the Xeni Gwet'in will be. Moreover, a healthy ecosystem will benefit not just the Xeni Gwet'in but all residents of the XGCA and other adjacent and downstream ecosystems and communities.

Climate Adaptation Goals	**Objectives**
Biodiversity Protection and Conservation	• Maintain the XGCA as an intact ecosystem • Conserve Wildlife and Wild Horses in the XGCA • Conserve Fish Stocks • Preserve Wild Plants & the Habitats in the XGCA
Health and Safety Enhancements	• Protect Residents and Key Cultural Sites from Wild Fires in the XGCA • Protect Residents and Key Cultural Sites from Floods in the XGCA
Water Supply Protection and Conservation	• Protect Key Potable Water Sources • Conserve Potable Water
Food Supply Protection and Diversification	• Conserve and Use Wild Food Sources • Increase Development and Diet Cultivated Food Sources • Increase Preservation of Wild and Cultivated Foods
Shelter and Infrastructure Protection	• Protect Shelter and Infrastructure • Reduce risk of Mould, Mildew and Rot
Energy Supply Protection, Conservation and Diversification	• Protect Existing Energy Sources • Strengthen Energy Conservation • Continue Energy Diversification
Livelihood Diversification	• Develop Nature-based Aboriginal Tourism • Develop Eco-forestry and Wood Products • Develop Natural/Organic Agriculture • Develop Other Adaptive Enterprise

	Opportunities
Good Governance	• Incorporate Climate Adaptation Strategies into Local Governance Objectives
Cultural Preservation	• Protect the Xeni Gwet'in Culture • Celebrate the Xeni Gwet'in Culture

1. INTRODUCTION

1.1. Why Climate Change is Important for the Xeni Gwet'in First Nation

Climate change may be the defining issue of our generation, since the challenge that it presents the world is so pervasive and complex. The mean surface temperature of Earth has increased an average 0.6˚C (Celsius) since the Industrial Revolution, and increasing scientific evidence suggests that this is due to the accumulation of greenhouse gasses (GHGs) in the atmosphere.[2] Historically, the Earth has been accustomed to experiencing wide-spread severe environmental change and has always been able to adapt to these changes accordingly. Yet, the difference now is the *speed* and *scale* of the warming that is currently occurring. Most of this change has occurred within the past 30 to 40 years, and the rate of increase is accelerating. These rising temperatures will have significant impacts at a global scale and at local and regional levels. As a result, climate change will increasingly impact natural and human systems to alter the productivity, diversity and functions of many ecosystems and livelihoods globally.

For resource-dependent communities, such as most First Nations in Canada, climate change may increasingly compound existing vulnerabilities. Many First Nations communities are remote and/or tied closely to the land. Many are also weak economically and are still healing from colonization and the residential school system. As climate change accelerates and stresses the availability and quality of natural resources that these communities depend upon, it may affect their food and water security, their culture and their livelihoods. Limited resources and capacities to respond to stresses like floods, droughts and sea level rise, will increasingly constrain the ability of First Nations to meet basic needs, emerge from poverty and realize self-government. There is, therefore, a need to reduce current vulnerabilities and enhance adaptive capacity of these communities so that they can face the longer-term impacts of climate change with some confidence and on their own terms.

The Xeni Gwet'in First Nations Government, which is one of six Tsilhqot'in communities, occupies one of the last intact ecosystems on the east side of the Chilcotin range. Despite this relatively healthy ecosystem, the community is already facing changes in climate changes and impacts thereof including forest fires, drought, and fish stock decline. Forest fires, were particularly widespread in 2003 and 2009, putting at risk personal property and livelihoods associated with tourism and ranching (key engines in the area).

1.2. Why adaptation to climate change is necessary

While reducing global greenhouse gas emissions and reversing climate change are important long-term goals, many of the climate change impacts are already in evidence and will accelerate. The Xeni Gwet'in people, who are already vulnerable, will, therefore, need to prepare for the consequences of increasing global warming over the next 20-50 years. The Xeni Gwet'in already have few resources to reduce the risk posed by climate change, such as drought and wild fires and long-term changes to wildlife and fish stocks. Hence, adaptation preparations to cope with the existing and forthcoming risks are critical now.

[2] World Bank (2010).

Adaptation to climate change is typically aimed at reducing vulnerability to its adverse effects through efforts to enhance adaptive capacity and resilience of a given ecosystem and/or community. Hence, in order for the Xeni Gwet'in to reduce their vulnerability to climate change, they must focus on building their adaptive capacity, while reducing their exposure and sensitivity to climate impacts.

Box 1: Key definitions associated with adaptation

Impact:	The way a human or natural system is affected by environmental change, including climate effects.[1]
Risk:	In the context of environmental change, risk refers to the threat posed by a change, i.e. the probability of an adverse impact. Climate change risk is a function of the magnitude of an individual hazard and/or change and the degree of vulnerability of a system (or a community) to that hazard and/or change. Unless a system (or community) is vulnerable to the hazard, there is no risk.[1]
Coping:	Short-term actions to ward off immediate risk, rather than to adjust to continuous or permanent threats or changes – strategies usually rely on selling or using up assets or resources. Coping strategies are often the same set of measures that have been used before. When using coping strategies as the response to stress, it is possible that vulnerability will increase in the long term.[1]
Adaptation:	Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.[1]
Adaptive capacity:	The ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.[2]
Vulnerability:	The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity.[2]
Resilience:	The ability of a community to resist, absorb, and recover from the effects of hazards in a timely and efficient manner, preserving or restoring its essential basic structures, functions and identity.[2]

It should be noted that the terms "adaptation" and "coping" are often used interchangeably. However, these two terms are distinctly different, as demonstrated by the characteristics below.[3]

Coping	Adaptation
• Short-term and immediate • Oriented towards survival • Not continuous • Motivated by crisis, reactive • Often degrades resource base • Prompted by a lack of alternatives	• Oriented towards longer term livelihoods security • A continuous process • Results are sustained • Uses resource efficiently and sustainably • Involves planning • Combines old and new strategies and knowledge • Focused on finding alternatives

Sources: 1: ICIMOD, 2009. Local Responses to Too Much and Too Little Water in the Greater Himalayan Region; 2: IPPC, 2007 3: CARE 2009, Climate Vulnerability & Capacity Analysis Handbook.

1.3. Overview of the Study

Following brief introductory and methodology sections, the geographic and biogeoclimatic context to the XGCA are described in section 3. Section 4 follows with a detailed overview of historical and projected climate changes. Section 5 outlines the biophysical impacts of projected climate changes in the XGCA. Section 6 provides a description of key vulnerabilities in the Xeni Gwet'in community. Section 7 provides a detailed adaptation strategy to address key vulnerabilities and section 8 follows with an Adaptation and Monitoring Action Plan.

2. METHODOLOGY

2.1. Rationale of the Report

This report is the result of Phase I of a Community-Based Adaptation Project designed to help the Xeni Gwet'in First Nations Government understand and incorporate the potential risks of climate change into current and future land use and livelihood planning efforts. The Xeni Gwet'in live in the Xeni Gwet'in Caretaker Area (XGCA), which is located within the southwest region of Cariboo-Chilcotin Region of British Columbia. The project is envisioned as a two-phase initiative: Phase I occurring between fall 2009 and spring 2010, and Phase II occurring between spring 2010 and spring 2011, pending INAC approval.

The broad goals of the project were to:

- Provide a preliminary assessment of historical and possible future climate change in the XGCA.
- Assess the biophysical impacts of these projected climate changes on the XGCA;
- Assess the subsequent socio-economic and cultural impacts on the livelihoods of Xeni Gwet'in First Nation; and
- Identify adaptation measures for improving their livelihoods, while reducing their vulnerability to climate change.

2.2. Objectives of the Study

Specific project objectives were to:

1. Raise awareness of climate change and its potential impacts in the Xeni Gwet'in community and region
2. Estimate changes in climate in the XGCA in the medium term (to 2020) and longer term (to 2050) (with a focus on changes in temperature and rainfall)
3. Determine the environmental (biophysical) impacts of projected climate changes in the XGCA
4. Carry out a Vulnerability Assessment to help determine necessary adaptation measures to increase resilience of the communities.
5. Develop a realistic and practical Action Plan for adaptation strategies that can be implemented by the community over the next 20 years to improve the resilience of both the XGCA ecosystem and the Xeni Gwet'in community
6. As part of this Action Plan, determine resources for adaptation measures

7. Develop monitoring protocols to measure climate change impacts over the decades to come
8. Develop partnerships with other communities and agencies in the region

2.3. Approach

The project involved 9 tasks:

1. Project Initiation
2. Climate Change Awareness Raising
3. Assessment of Climate Change Impacts
4. Vulnerability Assessment
5. Definition of Community Vision
6. Identification of Adaptation Solutions
7. Preparation of a Community-based Climate Change Adaptation Strategy & Action Plan
8. Preparation of a Monitoring Plan
9. Presentation of Draft Adaptation Strategy & Action Plan Strategy

2.4. Framework for Assessment

The study drew on several different conceptual frameworks. The main framework was provided by Centre for Indigenous Environmental Resources' (CIER) *Community Adaptation Framework* (manuals), which was complemented by the *Climate Vulnerability and Capacity Analysis Methodology* used by CARE International[3] and the Tyndall Group's vulnerability assessment framework (WEHAB+)[4]. Together, these chosen methodologies provided the background for a framework to analyze vulnerability and capacity to adapt to climate change at the community level. They provided guidance and tools for participatory research, analysis and learning.

2.5. Tools and Methods

The tools and methods employed in this project were multifold, using a combination of community knowledge and scientific data and techniques to yield a better understanding about local climate changes and impacts (Table 1). Key informant interviews were used to collect information on historical climate trends, biophysical impacts, climate change vulnerabilities and adaptation solutions. Key informant interviews were conducted primarily with community elders but also with other members, including Chief and Council. The key informant interviews and associated discussions provided opportunities to link community knowledge with available scientific information on climate change. This served to honour local knowledge of the land and the climate, it helped local stakeholders understand the implications of climate change and it also served to check the validity of scientific conclusions.

[3] CARE 2009, Climate Vulnerability & Capacity Analysis Handbook.
[4] Surviving Climate Change in Small Islands, Tyndall Group for Climate Change Research

Table 1: List of Study Parameters and Tools

Assessment Parameters	Tools
1. Historical trend analysis of climate changes and variability	Key informants interviews, data
2. Future climate change and variability projection	Computer modeling
3. Climate Impact analysis	Professional estimations, Literature review, BEC modeling
4. Vulnerability Assessment	Literature review, Key informant interviews
5. Adaptation strategies	Key informant interviews, Literature review

Secondary information in the form of historical climate data was also used to develop a climate baseline for the study. Literature surveys and professional opinions were used to inform estimates regarding projected biophysical impacts, climate vulnerabilities and adaptation strategies. And computer modeling was used to develop climate projections. Except for the climate modeling, much of the analysis in the report was qualitative. This was due to the short time frame and modest budget of the project as well as the rather limited state of climate impact modeling at the regional and local level.

Climate Projections

Climatic data have been produced by the computer program ClimateBC[5], which offers high resolution spatial climate data for current and future climate change scenarios. This is particularly useful for remote regions like the XGCA. Recent climatic variables have been averaged spatially (i.e. with a resolution of roughly 6 km^2) throughout the XGCA and temporally for the periods 1961 – 1990 (which we consider as representative of present climate). Future climate projections are based on the Canadian Global Circulation Model version 2 (CGCM2) for two future emission scenarios as defined by the Intergovernmental Panel on Climate Change (IPCC). The A1F1 emission (or "worst case") scenario describes a future world of very rapid economic growth, global population that peaks in the mid-century and declines thereafter, and rapid introduction of new and more efficient technologies with an emphasis on fossil fuel energy sources. The B2 emission (or "best case") scenario describes a world in which the emphasis is on local solutions to economic, social, and environmental sustainability. Both emission scenarios are projected for the 2020's (i.e., 2020 – 2029) and 2050's (i.e., 2050 – 2059). In addition, both emission scenarios depict the same general trend; however, the intensity or scale of the trend is different.

Wildlife & Wild Horse Impacts

Conclusions concerning the impact of climate change on XGCA wildlife and wild horses were based on the best information available, including a partial search of the scientific literature, extensive grizzly bear, wildlife and wild horse habitat surveys in the XGCA, discussions with elders, local ranchers and others as well as field observations dating back to the first intensive wildlife surveys in 2001.

[5] See: http://www.genetics.forestry.ubc.ca/cfcg/climate-models.html

Due to the short time frame of this project and the large number of plant and animal species in the XGCA ecosystem, the approach in this section was to select a small number of tree and habitat types that are known to be important to a range of species and use these as well as a small number of animal species as "climate change indicators". For plants and habitats, a fair amount of literature was available to draw upon. For wildlife species, resiliency assessments were based on the types of overall North American distribution and range of habitats that some of the animals occupy today, and whether the wildlife are specialists or generalists in terms of habitat ranges.

Forest and Vegetation Impacts

Conclusions regarding the impacts of climate change on the XGCA forests and vegetation were based on the specific climate projections for each of the key Biogeoclimatic Ecological Classification (BEC) zones of the XGCA (discussed in section 4.2). The BEC system uses vegetation, soils, and topography to infer the regional climate of a geographic area. Areas of relatively uniform climate are called biogeoclimatic units, where climate refers to the regional climate that influences ecosystems over an extended period of time. The BEC unit can be expressed as statistics derived from normals of precipitation and temperature[6] The ClimateBC model was used to forecast potential changes to climatic variables in the medium term (2020 and 2050). The climate projections based on the worst case emissions (A1F1) scenario were used to describe possible effects on the forests of the Xeni Gwet'in Territory. The projected climate variable changes by 2020 and 2050 are presented along with climate normals (1960-1999) by BEC subzone. Although the model predicts changes to climate envelopes as classified by the BEC system, the changes do not represent changes to the forest ecosystem itself. Potential changes to the forest are inferred with the help of expert opinion and literature reviews[7].

Water Resource Impacts

Conclusions regarding the impacts of climate change on XGCA water resources have been developed after extensive literature reviews, particularly recent hydrological research conducting by the Pacific Climate Impact Consortium. In addition to the literature reviews, field observations and water sampling data since 2006 are consulted to establish a baseline.

Fishery Resource Impacts

Conclusions regarding the impacts of climate change on XGCA fishery resources have been developed through extensive literature research. Additionally, the author's observations are based on a number of fishery research projects undertaken in the XGCA on behalf of the Xeni Gwet'in First Nations Government and the Chilko Resorts and Community Association. All field sampling and observations for these projects were completed based on Resource Inventories Standards Committee (RISC) protocols. This research provided reliable baseline information for fishery resources in the XGCA.

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[6] Downloaded from http://www.for.gov.bc.ca/HRE/becweb/system/how/index.html. See Appendix 2 for a more detailed description of the BEC system.

[7] This simplistic approach was taken due to the budget constraints of this project. Models are now being developed that will project effects of climate change on vegetation (Campbell et al. 2009).

2.6. Data Analysis

The climate projection data were generated by using the *ClimateBC* model, which offers high resolution spatial climate data for current and future climate change scenarios.[8] This program and its approach is particularly useful for generating climatic data for remote regions like the XGCA.

One challenge the team faced in generating climate projection data is that currently it is only possible to get climate information within the Chilko Watershed and not for the whole XGCA. To overcome this obstacle, points were selected at set intervals on four transects (along a north to south direction) in the Chilko Watershed. Based on this data, a summary was prepared on how the climate in the larger area is projected to change. More specifically, recent climatic variables were averaged spatially (i.e. with a resolution of roughly 6 km^2) throughout the Chilko River watershed and temporally for the periods 1961 – 1990 (which is generally considered as a valid proxy representative of present climate).

2.7. Community Engagement

The Xeni Gwet'in community was involved in every stage of the project:

Project supervision: A local **Steering Committee** was established to guide the planning process and community extension. Nine members of the community were selected, including the Chief, four staff members, one elder and three members of the community known for their experience of the land. The committee met five times over the course of the project duration and acted as spokespersons in the community and at planned events. Another community member was hired to assist in coordinating project activities.

Community consultation process: General community feedback was collected through four public community meetings, with a special emphasis on collecting elder feedback. Three school events were hosted during which the project team engaged the youth in the local school to raise the awareness of climate change and present their ideas for adaptation solutions to the community. Twenty-eight key informant interviews were conducted to learn about the Xeni Gwet'in knowledge of the land and weather. Four members of the community were employed to carry out these interviews. All interviews and community meetings were held in the Nemiah Valley within the XGCA.

Progress reporting: Regular progress reports, final findings and results of the study were communicated at the Steering Committee meetings and at a community luncheon at the end of the project.

Awareness raising and capacity building: Capacity was built and awareness increased of climate change risks and vulnerabilities by involving community members in the supervision of the project (through the steering committee), engaging the school and hiring of several community members to lead part of the research and consultation.

[8] For details, please see: http://www.genetics.forestry.ubc.ca/cfcg/climate-models.html) and Wang and others (2006).

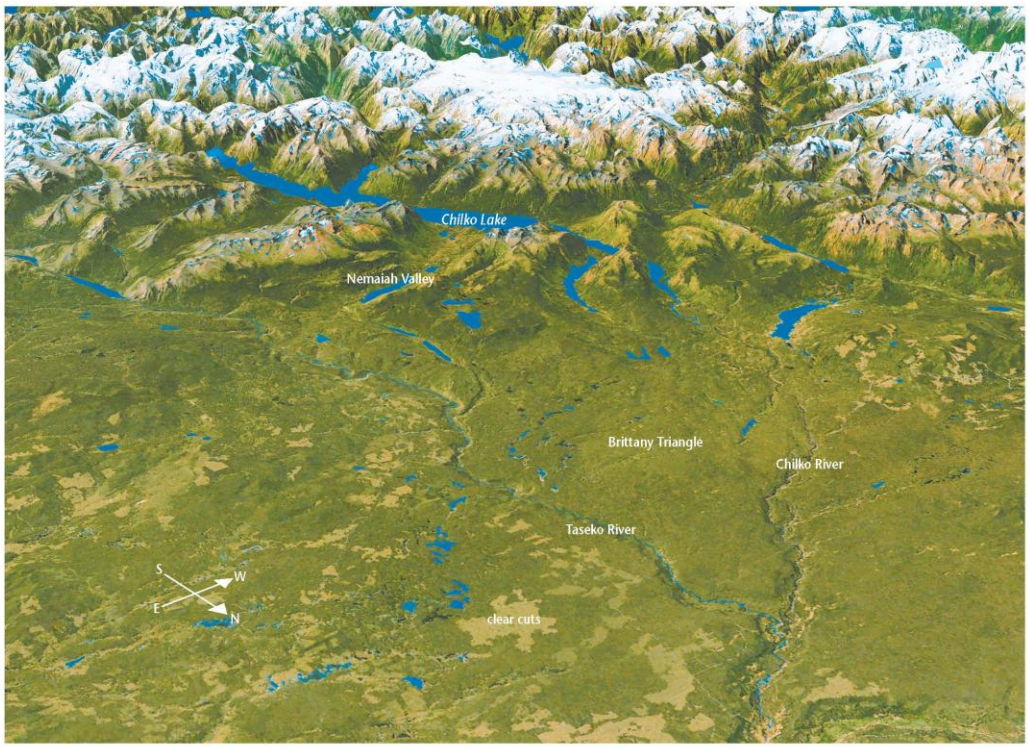
Workshops: A workshop was undertaken with the consultant team and the community members to present all of the draft findings to the community and to receive input. This included interviews with the Xeni Gwet'in elders, climate and biogeoclimatic zone projections and vegetation, fisheries, water and wildlife/wild horses projections.

3. BACKGROUND

3.1. Description of the Xeni Gwet'in Caretaker Area[9]

The Xeni Gwet'in Caretaker Area (XGCA) - also referred to as the Chilko River Watershed Area by some[10] - is the traditional Tsilhqot'in territory of the Xeni Gwet'in First Nation (hereafter referred to as XGCA). It encompasses a relatively isolated and underdeveloped part of the Chilko Forest Region in British Columbia, and is located 160 km by air or 250 km by road southwest of Williams Lake. The area can be described as the drainage of Chilko Lake, Chilko River, and includes the Taseko Lake and Taseko river system, along with the Tsuniah, Nemiah, and Elkin Valleys (Figure 1).

Figure 1: Map of Chilcotin

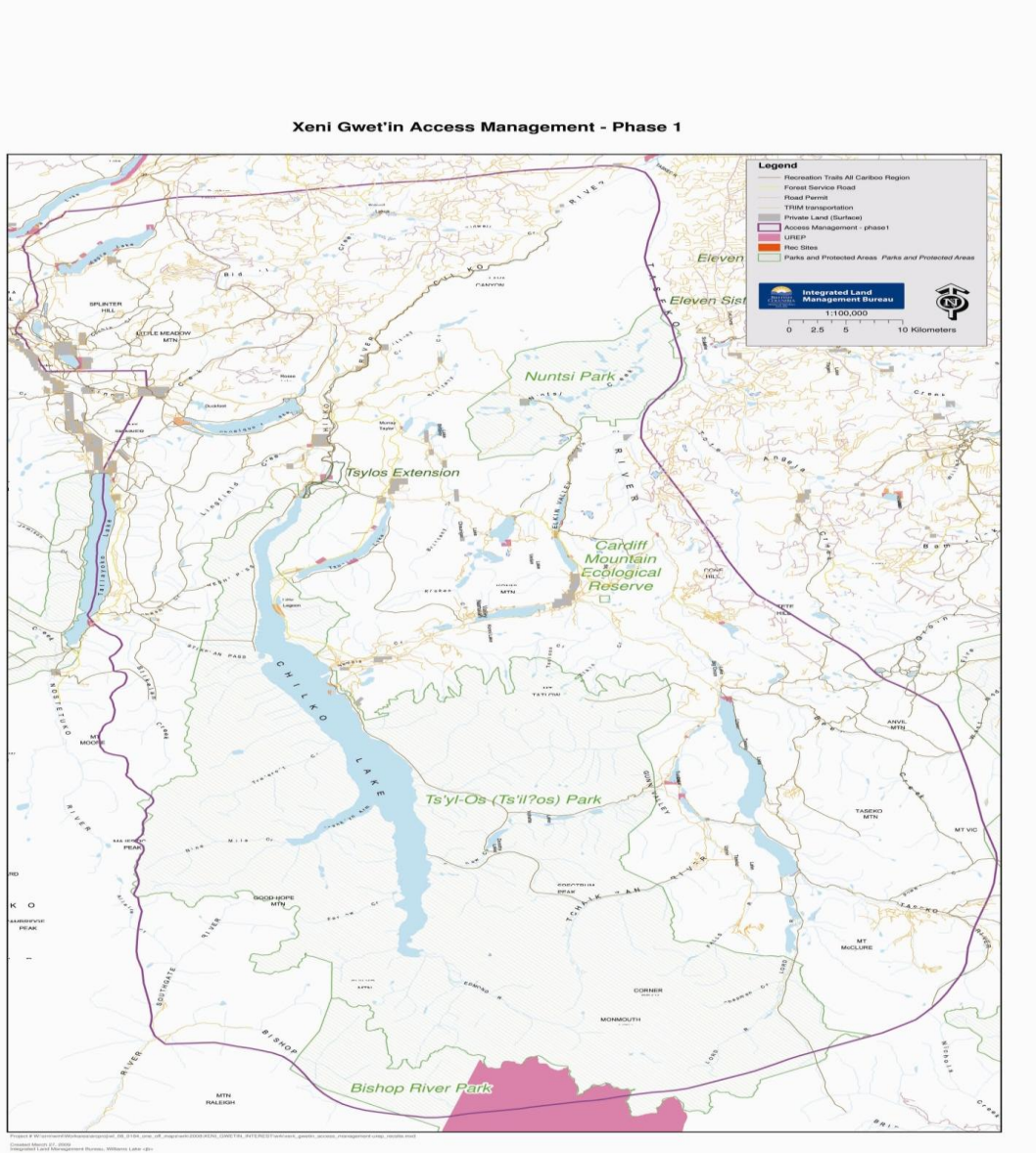


Source: Canadian Geographic

[9] Ecolibrio (2009); The Xeni Gwet'in Comprehensive Development Plan (2009).
[10] See Hammond and others (2004).

The study area includes the Potato Range, Choelquoit Lake Basin, the upper Chilko River, the Tsuniah Range, and portions of the Brittany Triangle and all of the lands in and adjacent to Ts'yl-os Provincial Park and to the east of Taseko Lake (Figure 2). It also encompasses portions of three of British Columbia's major landscapes, namely the Chilcotin Plateau, the Chilcotin Ranges, and the Pacific Coast Range. Much of the study area is undisturbed by industrial development and remains in a natural state. This "natural state" has been modified carefully by Xeni Gwet'in management systems for thousands of years.[11]

Figure 2: Map of XGCA



[11] Hammond and others (2004).

3.2. Geography

The study area is located within two of the five major physiographic regions[12] of British Columbia: The Coast Mountains and The Interior Plateau. The Coast Mountains and Interior Plateau are further subdivided into smaller more uniform physiographic regions. The southerly two-thirds of the study area is within the subdivision of the Coast Mountains unit known as the Chilcotin Ranges. The northerly one-third of the study area is found within a part of the Interior Plateau known as the Chilcotin Plateau.[13]

The Chilcotin Ranges Region

The Chilcotin Ranges include the Taseko Lakes, Nemiah Valley, Tsuniah Lake, and the Potato Range. The Chilcotin Ranges consist of gently sloping uplands, rounded mountain summits, and broad, flat-bottom valleys among the mountain ranges. The mountains are less rugged than those of the Pacific Ranges to the southwest and are generally no higher than 2700 metres in elevation. They show the effects of recent alpine glaciation as well as the effects of continental glaciation by the Cordilleran Ice Sheet during the last ice age. No major glaciers exist in the Chilcotin Ranges at this time, but numerous small isolated icefields are found in cirques in the higher alpine areas. The remnant icefields are associated with steep cirque headwalls, small glacial lakes, and terminal and lateral moraines formed of locally derived material.

The Chilcotin Plateau Region

The Chilcotin Plateau landscape includes the areas north of Choelquoit Lake, and north of a line extending from the north end of Chilko Lake to the north end of Taseko Lake.

The Chilcotin Plateau portion of the study area features level to gently rolling terrain, with an elevation between 1000 and 1500 metres. The upland portion of the Plateau is underlain by flat-lying bedrock and covered by glacial deposits. Subtle depressions and meandering streams on the undulating terrain have created many lakes and wetland complexes. Isolated low, rounded mountains and ridges of erosion-resistant rock rise above the general level of the Plateau to over 2000 metres elevation.

The Brittany Triangle is bounded by deeply incised, steep-sided valleys that developed as the Chilko River and the Taseko River down cut through the Plateau during the post-glacial melt period. The rivers currently occupy channels that are 100-200 metres lower than the Plateau surface. The Elkin Creek-Elkin Lake-Vedan Lake system occupies another deeply incised valley, which was likely down cut during the post-glacial melt but which no longer contains a major river system. Steep scarp slopes along the deeply incised rivers and creek valleys are unstable and susceptible to mass wasting and slope failures[14]

[12] Physiography refers to the physical geography of the land, including the terrain type, elevation, slope position, slope length, slope gradient (steepness), and orientation with respect to solar radiation (aspect). Slope length, slope gradient, and position along the slope also influence soil stability and ecological sensitivity to disturbance (*source:* Hammond and others (2009), p.13).

[13] Hammond and others (2004).

[14] Hammond and others (2004).

3.3. Socio-economic Context[15]

The total population of the XGCA is approximately 500 people; 375 are Xeni Gwet'in and 125 are non-indigenous. The area does not contain any formally incorporated communities but does contain a number of informal hamlets, such as north Chilko, Tsuniah, Taseko and Nemiah Valley. The people who comprise these communities are to a large extent self-reliant and have a long history of cooperation with each other to sustain their way of life.

The XGCA is a remote, wilderness area, where the rural inhabitants live very disbursed. The highest concentration of the people in the XGCA is in the Nemiah Valley, which is located 196.8 kilometres from the nearest city, Williams Lake, BC about a 3 hour drive southwest. The Xeni Gwet'in First Nation Government office is located there and maintains isolation status, which means they provide their own public works services such as electricity, heating, community water supply and communication systems. There is a post office, a gas bar/convenience store, visitor information services centre, a laundromat/internet facility, Charlene William's Daycare and immersion program, Naghtaneqed Elementary/Junior Secondary School, a health clinic and rodeo grounds.

The Xeni Gwet'in culture remains closely linked to the land. During the summer months the Xeni Gwet'in use the lakes and rivers throughout the XGCA to catch and dry fish. In addition, many still rely upon wild meat, including moose and deer. Moreover, according to two separate Tourism Strategies developed for the community, the primary economic activities for the Xeni Gwet'in today are ranching and involvement in tourism through local non-native wilderness tourism operators.

4. Climate Change in the Xeni Caretaker Area: Past Trends and Future Projections

This section provides an overview of the climate in the Cariboo-Chilcotin region, and wherever possible the specific climate for the XGCA. The section first outlines the general climate in the study area, as determined by physiographic features (4.1). Sub-section 4.2 then examines historical climate trends, which combines an assessment of scientific baseline data for the 1961-1990 period (4.2.1), which are complemented by community anecdotes gathered through a key informant survey (4.2.2) follows with a projection of possible future climates.

4.1. General Climate

As described by Sten and Coupe (1997) and Hammond and others (2004), the climate of the study area is largely determined by the physiographic[16] features of the region. Physiography refers to the physical geography of the land, including the terrain type, elevation, slope position, slope length, slope gradient (steepness), and orientation with

[15] This section is based on Ecolibrio (2009, 7-10) and Hammond and others, (2004, pp.44-46).
[16] Slope length, slope gradient, and position along the slope also influence soil stability and ecological sensitivity to disturbance (*source:* Hammond and others (2009), p.13).

respect to solar radiation (aspect).[17] One key relationship is the effect of these factors on principle air flow patterns. The latter include warm moist Pacific air from the west, and cold dry Arctic air from the north. Because the study area is located on the leeward side of the Coast Mountain Range, the climate is more strongly influenced by Arctic air. The moist Pacific air has a limited effect on the area. The following climate summary is from Hammond and others (2004):[18]

- *The **Chilcotin Plateau portion** of the study area has a typical continental climate characterized by cold winters and cool summers. The relatively high elevation of the Plateau (between 1000 and 1500 metres) contributes to the cold climate. As a result, the growing season is short, and frost can occur at any time of the year at all elevations. The Plateau is also strongly affected by the Coast Mountains rainshadow, which results in very dry conditions, including summer moisture deficits – a significant factor effecting soil and plant productivity. The season of moisture deficit can be from May to September, which includes most of the growing season. The dry conditions also result in frequent wildfires across the landscape of the Plateau.*
- *The **Chilcotin Ranges** part of the study area also has a dry, continental climate in the rainshadow of the Coast Mountains, but receives more precipitation than the Chilcotin Plateau landscape due to moist, coastal air pushing through the lower mountain passes. Summer moisture deficits are lower and the season of deficit is shorter than in the Chilcotin Plateau. However, the colder temperatures in this area significantly limit plant growth, with similar overall effects as the moisture deficits on the Plateau.*

The strong climatic gradient that occurs from the moist coastal mountains to the dry Chilcotin Plateau results in a diversity of ecosystems, and plant and animal life. The study area includes some of the coldest and driest forested landscapes in the province.

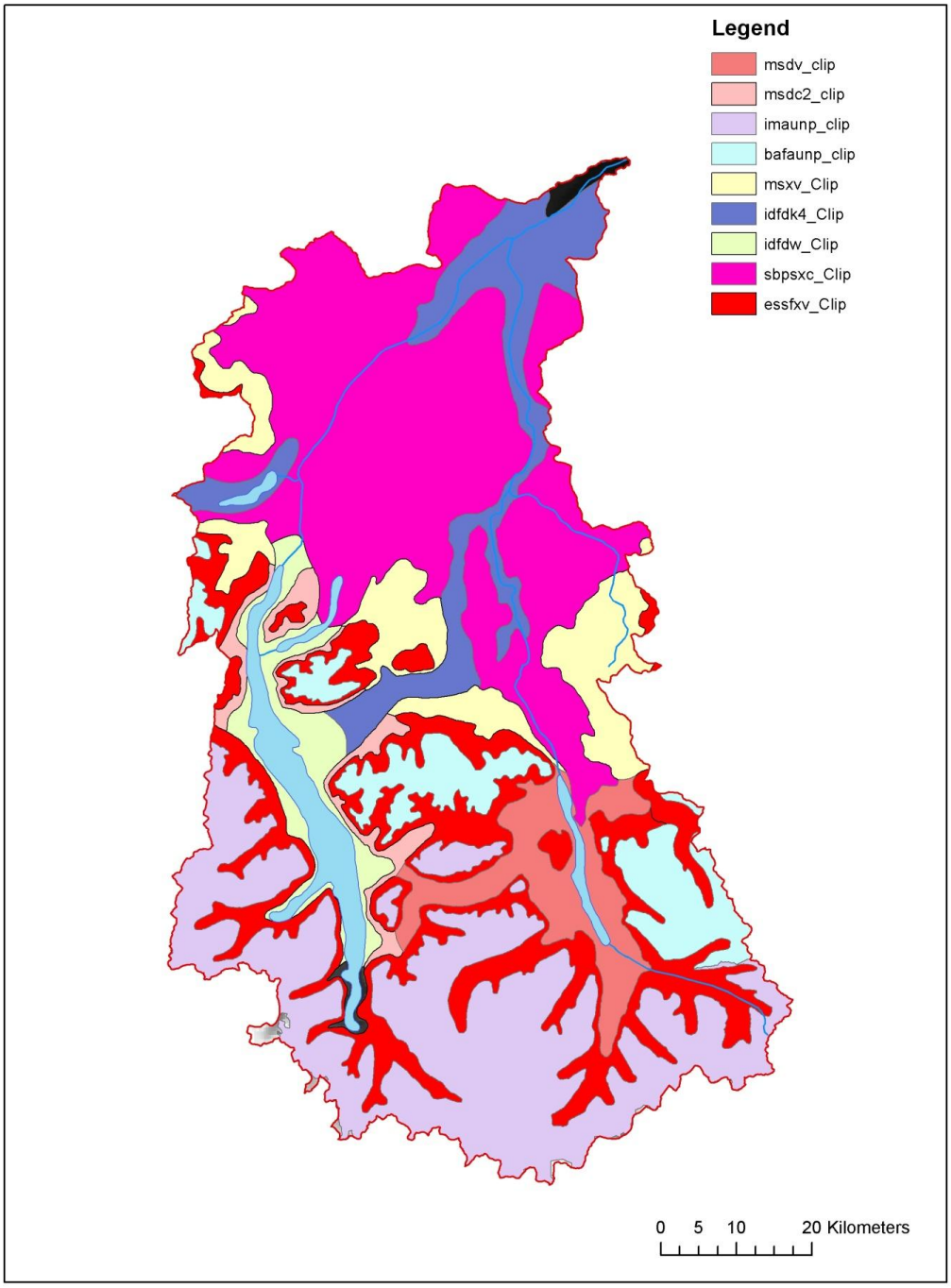
4.2. Biogeoclimatic (BEC) Zones

Steen and Coupe (1997) describe the cold, dry climate of the XGCA in their discussion of ***biogeoclimatic subzones*** in the Cariboo Forest Region. The biogeoclimatic classification system groups forests in British Columbia into areas of broadly uniform climate, geology, and biology. The following comments are drawn from the work of Steen and Coupe, as extracted by Hammond and others (2004), and highlight the exceptionally harsh climate of the study area (Figure 3):

- The ***Very Dry Very Cold Engelmann Spruce Subalpine Fir subzone*** (ESSFxv) has a very cold, very dry climate. Although no climatic data is available, the vegetation indicates that the ESSFxv is probably the driest area of the ESSF zone in British Columbia. Due to relatively low humidity and clear skies, overnight radiation cooling is intense, and frosts occur very frequently during the growing season.
- The ***Very Dry Very Cold Montane Spruce subzone*** (MSxv) is the coldest and driest Montane Spruce subzone in British Columbia, and is one of the least productive biogeoclimatic units for tree growth. Winters are cold and summers are cool with frequent growing-season frost.

[17] Sten and Coupe (1997).
[18] See Hammond and others (2004), p. 19.

Figure 3: XGCA BEC Zones



- In general, the ***Sub-Boreal Pine-Spruce zone*** (SBPS) has cold, dry winters and cool, dry summers. Substantial moisture deficits are normal during the middle and latter parts of the growing season. The low precipitation, dry air, and clear skies in the Coast Mountains rainshadow result in significant night-time radiation cooling and low overnight temperatures. Frost can occur at any time of the year, especially in low-lying areas. The SBPS zone is one of the least productive areas for tree growth in the region, outside of the Bunch Grass and Arctic Tundra zones which are generally considered "non-forested."
- The ***Very Dry Cold Sub-Boreal Pine-Spruce subzone*** (SBPSxc) occurs in the southern and western parts of the SBPS zone in the study area. This subzone is strongly affected by the Coast Mountains rainshadow, and the SBPSxc has the lowest annual precipitation of the SBPS subzones. Vegetation production and soil development are severely limited by the cold, very dry climate.
- The ***Dry Cool Interior Douglas-fir subzone – Chilcotin variant*** (IDFdk4) is the coldest biogeoclimatic unit of the IDF zone in British Columbia and is climatically transitional from the generally warmer portions of the IDF zone to the cold, dry SBPS zone.

Areas that are colder or drier than the pine and spruce forests of the Chilcotin Plateau are generally not forested. Steen and Coupe (1997) comment that the total annual precipitation near Tatla Lake at the western part of the Plateau is only 338 mm. For comparison, any region that receives less than 250 mm of precipitation annually is generally defined as a desert. Moist forested areas in the Cariboo region, such as the Interior Cedar-Hemlock Zone to the east, receive 700 to 800 mm of precipitation annually while some of the wetter areas of the Coast Mountains to the west receive in excess of 2500 mm of precipitation per year

4.3. Historical Climate Trends

Definition of scientific baseline based on 1961-1990 Station Climatology Data[19]

Long-term climate trends show that considerable warming has taken place in the Cariboo-Chilcotin and surrounding areas over the last century. A recent report from the Pacific Climate Impacts Consortium[20] shows that during this time period, the mean annual temperature has increased about 1°Celsius in the region. Even though data show a clear warming trend, there are large year-to-year variations in temperature, with ENSO climatic cycles having had a strong impact on temperature. Historical changes in precipitation are less clear and consistent than for temperature. What is certain, however, is that historical changes in temperature have already had real implications for important hydrological variables, including snow accumulation and timing of snow melt. In addition, divergences in temperature and precipitation from average conditions due to natural cycles and climate change have affected ecosystems and resource management over the past century in this region.

The following provides a baseline for climate information by using data for the 1961-1990 period. Note that the 1961-1990 climate period is used as a baseline against which the climate change projections shown in section 4.4 are compared. Tables 2 and 3 show baseline temperature and precipitation data for the Tatlayoko Lake, which is the weather station closest to the Study Area with longer-term historical climate data. While this station alone cannot adequately represent the diversity of the varied climate conditions found within the Study Area, it does provide a reference point to examine the mean and variability of seasonal climate during the baseline period. This is

[19] The information in this section is extracted from Pacific Climate Impacts Consortium (PCIC) 2008.
[20] Pacific Climate Impacts Consortium (PCIC), 2008, p.30.

important as both the mean and variability of seasonal temperatures affect many ecological and hydrological processes.

Table 2 shows that the mean annual and maximum winter temperatures are less than 0°C for Tatlayoko Lake. The figures also reveal that the variability (standard deviation) of minimum, maximum and mean temperatures is much higher in winter than in summer. Finally, the table highlights that minimum temperatures in winter are more variable than maximum temperatures while the opposite is true in summer.

Table 2: 1961-1990 Baseline temperature data for Tatlayoko Lake Weather Station

		Annual			Winter			Summer		
		Min Temp (°C)	Mean Temp (°C)	Max Temp (°C)	Min Temp (°C)	Mean Temp (°C)	Max Temp (°C)	Min Temp (°C)	Mean Temp (°C)	Max Temp (°C)
Tatlayoko Lake 1088010	Mean	-3.0	3.9	10.8	-11.1	-5.8	-0.4	0.6	0.8	1.4
	St dev	0.7	0.6	0.7	1.9	1.7	1.5	7.9	14.6	21.2

Source: PCIC 2008
Note – The station elevation is 870m

While temperature is a vital climate determinant, so is precipitation. In addition to the total precipitation, the proportion that falls as snow, the timing of snow melt and the variation in snow depth between years all have important ecological and hydrological implications and are likely to be affected by climate change. During the 1961-1990 baseline period, the proportion of total precipitation from snowfall was 27% at Tatlayoko Lake. As indicated by the coefficients of variation (Cf var), snowfall varies more from year to year relative to the mean than annual precipitation. Overall, precipitation is relatively low compared to other areas in BC.

Table 3: 1961-1990 baseline precipitation and snow depth for Tatlayoko Lake Weather Station

		Annual		
		Precipitation (mm)	**Rainfall (mm)**	**Snowfall (mm)**
Tatlayoko Lake	**Mean**	438.9	317.0	121.9
	St Dev	97.6	99.3	49.1
	Cf var	0.2	0.3	0.4

Source: PCIC 2008
Note: St. Dev = standard deviation; Cf Var = coefficient of variation

Xeni Gwet'in anecdotal information about past and present seasonal climate

To complement the scientific climate data, primary data and qualitative information was acquired through key informant surveys, which sought to capture community observations on past and

current climatic changes. Twenty-seven individuals were interviewed by four community members. The individuals surveyed included an equal amount of men and women but a high proportion of elders in order to gain a better historical perspective.

Table 4 sums up the main responses from the Xeni community members, in response to a question on how the seasons have changed climate-wise between now and their childhood. Since the majority of the interviewees have lived between 40-60 years in the study area, their responses provided a rich amount of information.

Table 4: Seasonal climate observations – past and present

Summer Weather
About temperature: • Summers used to be hot – but now they are even hotter, often 100 degrees and above. • Summers are longer now than they used to be. • Summers also used to have a mix of hot and cooler weather, but now they are mostly hot days. **About precipitation:** • Now the summers are drier, as there is much less rain than in the past. • As a result, there are more droughts in the area now than before. • Hail and lightning storms are not as common as they were. **Noticeable signs of weather changes:** • In the past it would be green everywhere and there would be lots of water in the lakes during the summers. • Now nothing seems to grow and there is a lot less hay than there used to be.
Observations – Fall Weather
About temperature: • The fall weather is warmer than it used to be. **About precipitation:** • There used to be a lot of rain and thunder during the fall, especially during the hay season, but now there is less. • The fall season has gotten shorter, as snow arrives earlier than it used to. • Falls used to be very windy, but now there is less wind – only rain and warm air. **Noticeable signs of weather changes:** • Before deer were fat in the fall after summer grazing, but now the deer are skinny, as there is not enough grass for their summer grazing.
Winter Weather
About temperature: • Winters used to be a lot colder than they are now, as it was normal to have temperatures of -40 degrees for long periods of time. **About precipitation:** • **Overall:** Winter weather has gotten very unpredictable – it now seems that it can rain or snow any time. • There used to be a lot more snow during winters than there is now. • The winter season has gotten shorter. • There used to be a lot more wind chills than there are now. **Noticeable signs of weather changes:**

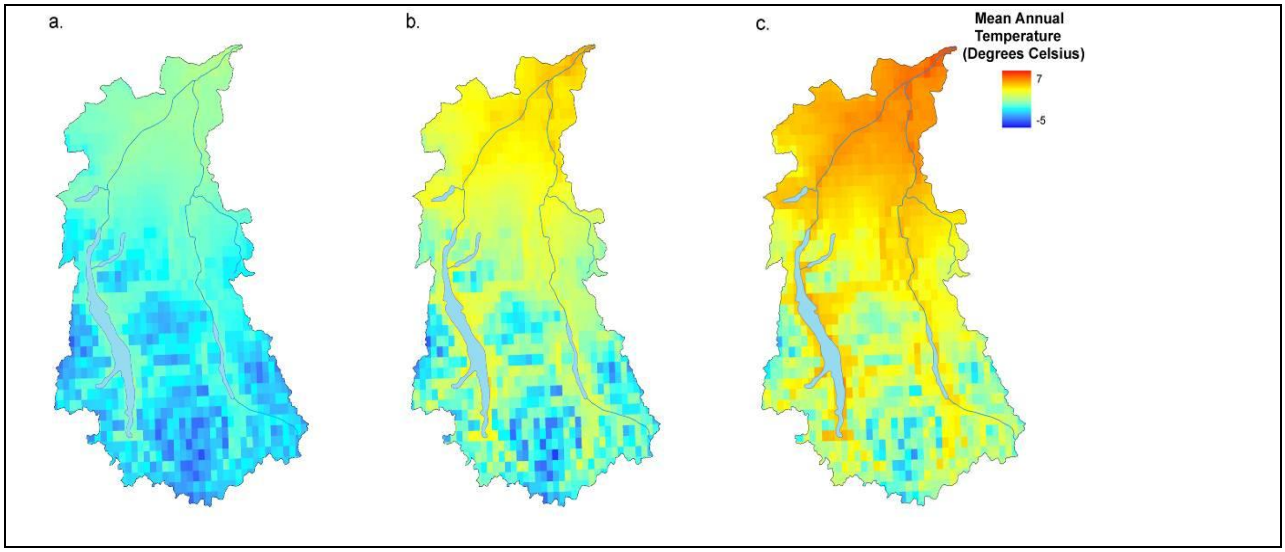
• While there used to be thick ice on most water bodies, now there is a lot less ice. For example, Chilko Lake no longer freezes over during the winters
Spring Weather
About temperature: • Spring used to arrive earlier, but now the season has gotten shorter, but colder **About precipitation:** • While it used to still snow in the Spring, now snow does not melt until June or July and it is cold until July • Now Springs have gotten more windy and there are lots of rain

4.4. Climate Projections

Temperature

Figure 4 shows a general warming trend for mean annual temperature (MAT) throughout the following periods: (a) 1961 – 1990, (b) A1F1 2020's, and (c) A1F1 2050's. By mean annual temperature we refer to the average of hot and cold extremes of temperature taken every day throughout the course of a year. In recent history (1961 – 1990), if we were to average out the temperatures for the whole area, MAT would have been 0.07 °C. The A1F1 scenario predicts a warming of 1.11 °C and 2.61°C for the 2020's and 2050's, respectively. That means that in only ten years (between now and 2020), the average temperature will

Figure 4: Mean annual temperature for the Chilko River watershed throughout following periods: a) 1961-1990, b) 2020's A1F1 scenario, and c) 2050's A1F1 scenario.



Source: Theo Mlynowski, UNBC

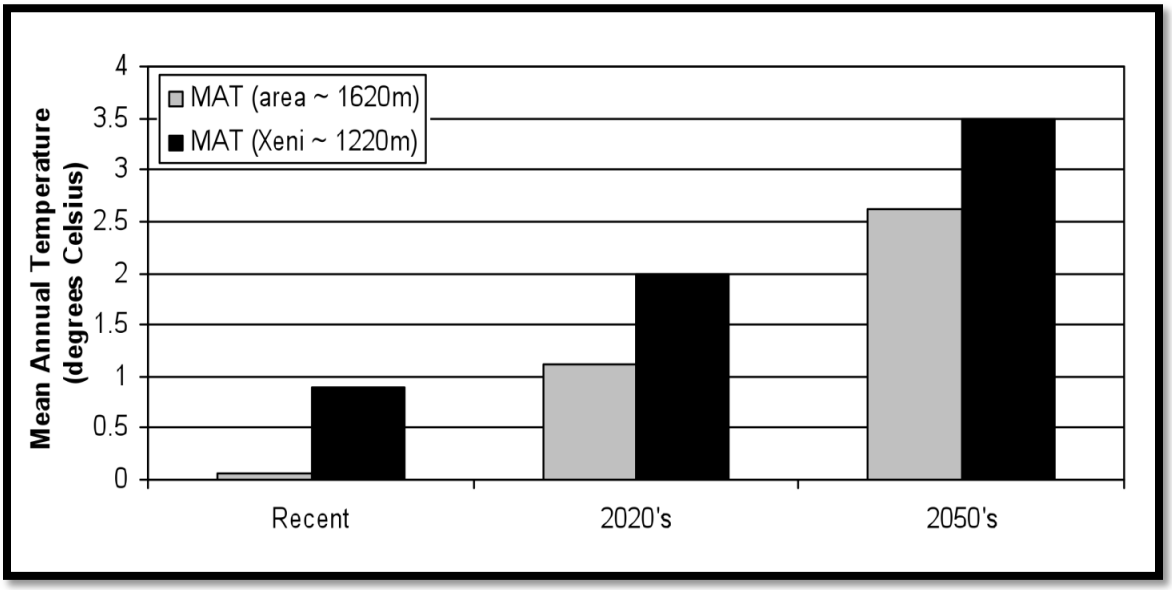
increase by 0.4 degrees Celsius and with yet another 2.54 degrees Celsius in another 40 years. Figure 4b and 1c illustrates that the colder temperatures will be experienced in the mountains, whereas warmer temperatures will occur in the lower areas.

To put this figure in perspective, worldwide, a 2 degree increase is expected to increase sea level rise 0.5 to 2 metres by the year 2100 from the melting of ice caps in west Antarctica and Greenland.

As a result, coastal areas where hundreds of millions of people currently live will get flooded. The B2 scenario predicts a more moderate warming of 1.02 °C and 1.72 °C for the 2020's and 2050's, respectively.

It is difficult to relate to the average weather that takes place across the whole XGCA. To provide a perspective of how varied the MAT will be even in a relatively small area like the XGCA when compared to the whole Cariboo-Chilcotin Area, the study prepared a graph that compares the temperature of the XGCA to the temperatures expected at the Xeni Gwet'in Government office in the Nemiah Valley. Figure 5 shows that for each of the time frames, the Xeni Gwet'in Government office is about 1 degree warmer than the average throughout the XGCA. This is a result stemming from the fact that the office is in the valley. For both A1F1 and B2 scenarios, temperatures increases will be relatively consistent over the landscape.

Figure 5: Comparison of Mean Annual Temperature (MAT).



Source: Theo Mlynowski, UNBC

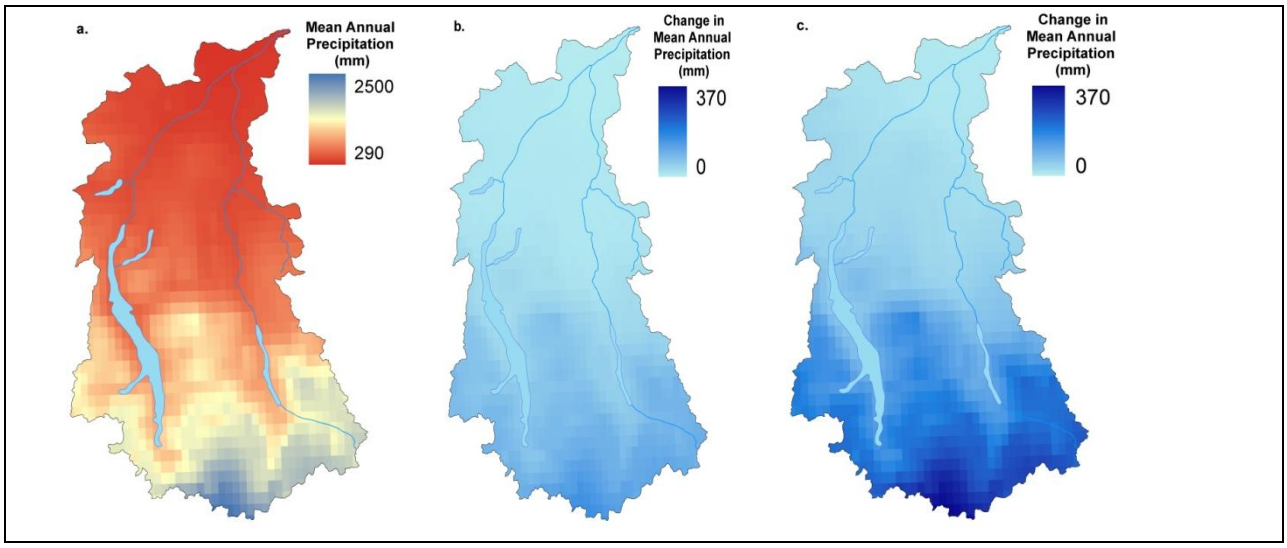
Precipitation

Similar to temperature, Mean Annual Precipitation (MAP) – which concerns both rain and snow – is the average of wet and dry extremes measured every day throughout the course of a year. Figure 6 shows a general increase of MAP throughout the following periods: (a) 1961 – 1990, (b) A1F1 2020's, and (c) A1F1 2050's.

At present, the MAP for the period 1961-1990 for the XGCA is 901-mm. Figure 5 illustrates that the bulk of the precipitation happens in the mountains, whereas the low lying areas of the territory are a bit dryer. Map 6b and 6c show that the future A1F1 scenario predicts an increase in annual precipitation of 44-mm and 104-mm for the 2020's and 2050's, respectively. In comparison, the B2 scenario (not shown in the Figure) predicts a slightly drier future with an increase in precipitation of 21-mm and 36-mm for the 2020's and 2050's, respectively. A large portion of the increase in precipitation will take place in the mountains, as illustrated by the dark blue patterns.

From the effects of a warmer climate, the percent of precipitation in the form of snow is expected to decrease. Throughout the period 1961 – 1990, roughly 60 % of precipitation was snow. The A1F1 scenario predicts a decrease to 57% by the 2020's, and 52% by the 2050's. Likewise, the B2 scenario predicts a decrease to 58% by the 2020's and 56% by the 2050's.

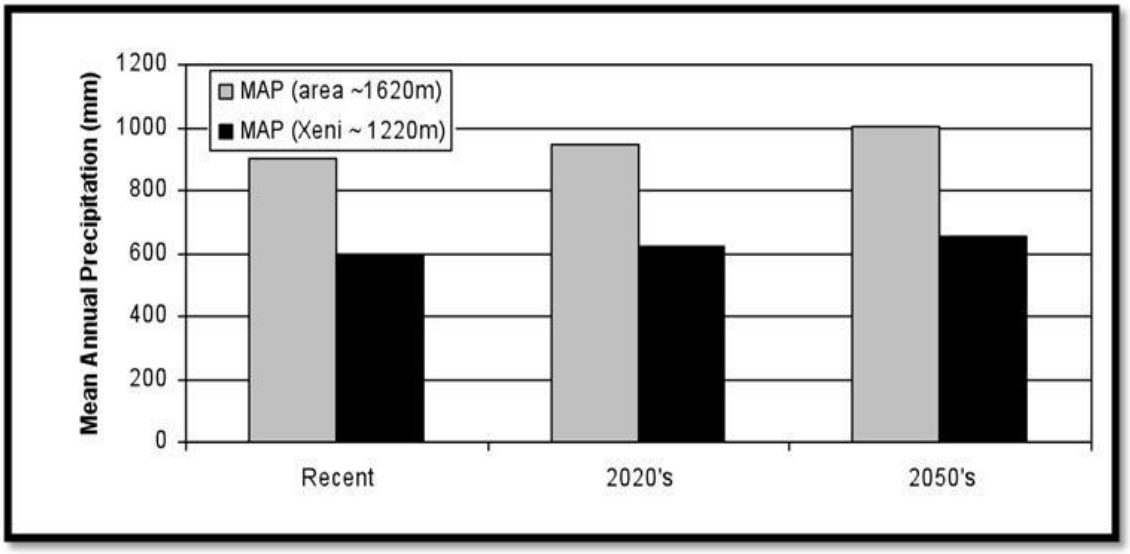
Figure 6: Mean annual precipitation for the Chilko River watershed throughout the following 1961-1990. Change in mean annual precipitation (in reference to the 1961 – 1990 values) is shown for b) 2020's A1F1 scenario, and c) 2050's A1F1 scenario.



Source: Theo Mlynowski, UNBC

As with temperature above, the study prepared a graph that compares the precipitation level of the Chilko Watershed to the one expected at the Xeni Gwet'in Government office. Figure 7 shows that for each of the time frames, the Xeni Gwet'in Government office gets about 350 m less rain than the average across the Chilko Watershed.

Figure 7: Comparison of Mean Annual Precipitation (MAT).



Impact on seasons from changes in temperature and precipitation

A fundamental question to ask is how the above changes in temperature and precipitation will change throughout the seasons. According to the projections, over the next 40 years, the largest temperature increase will be in the spring, followed by winter. Summer and fall will experience a slightly lesser temperature increase. In Table 5, the change in temperature between the normal period (the current situation) and the IPCC scenarios is shown by the trend which is marked by W or C (Warmer or Colder), and + or – (more than average or less-than-average).

Table 5: The mean temperature for each IPCC Scenario shown by season.

	Mean Temperature							
	Winter		**Spring**		**Summer**		**Autumn**	
Scenario	**◦C**	**Trend**	**◦C**	**Trend**	**◦C**	**Trend**	**◦C**	**Trend**
Normal 1961 - 1990	-9.12	-	-0.37	-	9.07	-	0.72	-
A1F1 2020's	-8.01	W+	0.99	W+	10.09	W-	1.64	W-
A1F1 2050's	-6.51	W-	2.86	W+	11.46	W-	2.92	W-
B2 2020's	-8.08	W+	0.86	W+	10.08	W-	1.53	W-
B2 2050's	-7.39	W+	1.70	W+	10.77	W-	2.10	W-

Source: Theo Mlynowski, UNBC

The pattern of future precipitation will be fairly different. Most precipitation will occur in the winter and fall, whereas the spring will undergo very little change and summers will become even drier than at present for both the 2020's and 2050's. Table 6 shows the change in precipitation

between the normal period (current situation) and the future IPCC scenarios. The change marked by W or D (Wetter or Drier), and + or – (more than average or less-than-average).

Table 6: The mean precipitation for each IPCC Scenario shown by season.

	Mean Precipitation							
	Winter		Spring		Summer		Autumn	
Scenario	**◦C**	**Trend**	**◦C**	**Trend**	**◦C**	**Trend**	**◦C**	**Trend**
Normal 1961 - 1990	313.58	-	153.76	-	151.29	-	282.37	-
A1F1 2020's	343.43	W+	153.98	W-	146.46	D-	300.91	W+
A1F1 2050's	384.57	W+	154.07	W-	139.75	D-	326.53	W+
B2 2020's	336.57	W+	154.95	W-	145.35	D-	285.07	W-
B2 2050's	352.85	W+	155.25	W-	141.24	D-	287.98	W-

Source: Theo Mlynowski, UNBC

It should be noted that the amount of snow the XGCA will receive will also very likely change. Currently about 60 percent of the precipitation is in the form of snow. By 2020, this amount will decrease to about 57 percent, and further decrease to only 52 percent by 2050.

In summary, over the course of the next 40 years, the XGCA can expect to see an average increase of 2.5 degrees Celsius and an increase of 104 mm of precipitation. This increase in temperature will be relatively uniform across the XGCA, but precipitation will mostly increase at higher elevations. Most of this precipitation is snow, but will decrease to nearly 50 percent by 2050. Seasonally, most of the temperature increase will occur in the winter and spring, whereas the fall and winter will become wetter and the summer will become drier. Finally, due to the general effect of mountains on climate, the findings confirm that the higher the location, the colder and wetter the future climate will be. Likewise, the lower the location, the warmer and dryer it will become.

5. Current and Projected Biophysical Impacts

5.1. Water Resources

This section provides a summary of the larger background report on *Climate Impacts on XGCA Water Resources* prepared by Ecolibrio (see Annex 1). This section provides an assessment of the impacts of climate change and variability on water resources in the Xeni Gwet'in Territory. It should be noted that this section is based on a literature review that summarizes previous studies from knowledgeable individuals and institutions familiar with the climate change impacts on water resources and/or the XGCA. More specifically, this section is built on previous work carried out and reflected in the following four reports/articles: (i) A recent report by the Pacific Climate Impacts Consortium (PCIC) (revised 2009); (ii) an older report by Rood and Hamilton (1995); (iii) a report

by Hammond and others (2004); and (vi) groundwater research carried out by Diana M. Allen and others, as documented in D. Allen (2009).[21] Other sources are listed, whenever they have been used to complement the main findings of these four reports.

Projected Climate Changes and Their Impacts on Water Resources [22]

Projections of future climate change are still an uncertain science, due to limitations in existing models and insufficient, longer-term data set. There is no doubt, however, that continuous climate change will impact the water resources within the XGCA, as it already is and will continue to impact the entire hydrological system in the Study Area. In particular, climate change will influence temperature as well as the timing, amount and form of precipitation. As a result, there will be shifts in streamflows and seasonal transitions, earlier spring runoffs, and increasing river temperatures.[23] Evaporation and soil moisture will be affected as well (see box 1). During the cold months of the year, temperature influences the balance between cryospheric[24] regimes (which are long-term storage) and rainfall (which results in a short-term response in streamflow) even *before* considering climate change. When adding climate change, projected changes in temperature will be especially critical for the water resources in the XGCA, given that temperature controls the storage of snowfall in the wet/cold season for subsequent use in the dry/warm season.

Box 1: Climate Change's Impact on Soil Moisture and Surface Evaporation

Soil moisture acts as a water reserve for vegetation and agriculture. It integrates inputs from rain, snowmelt, and losses due to evaporation, interception, surface runoff, and drainage (base flow**). Surface evaporation** is a critical hydrological feedback from the earth's surface into the atmosphere that has, itself, been modified by global climate change. Evaporation depends in part on conditions of soil moisture, solar radiation, and ground cover. Each process influences soil moisture with a different temporal signature and affects the timing of streamflow parameters. Finally, changes in soil moisture determine the fraction of precipitation and snowmelt that is released to streams as runoff. Some measurements have been made in BC, but projections for the 2050s require a comprehensive hydrologic model that would determine impacts on agriculture and forestry, and feedbacks within the hydrologic system. Current projections of changes in soil moisture have been made only for the Columbia Basin.

Source: PCIC (2007/revised 2009, p.68)

Projected changes in annual precipitation are small and somewhat uncertain. However, these projected changes become fractionally large, when they concern climatologically dry regions, such as a significant part of the Chilcotin Plateau, which make up a large part of the XGCA. The importance of this change does not so much refer to changes in the amount of rainfall, but more to a change in the ratio between rainfall and snow. In other words, the transition from snow to rain during the colder months (as they will become warmer) may cause complex changes in cryospheric regimes (glaciers, snowpack, lake ice) that may lead to subsequent changes in operation of reservoirs and in the seasonal shifts in timing of streamflow.

The rest of this section provides a summary of the results of current research to date concerning how climate impacts on snowpack, glaciers, streamflows and groundwater will increasingly affect

[21] Pacific Climate Impacts Consortium (PCIC) (2007/revised 2009).
[22] This section primarily draws from PCIC (2007/revised 2009).
[23] Walker, I.J. and Sydneysmith, R. (2008).
[24] The cryosphere describes the portions of the Earth where water is in solid form, such as sea ice, lake ice, river ice, snow cover, glaciers, ice caps and ice sheets, and frozen ground (which includes permafrost) (Source: Wikipedia).

the pristine water resources of the XGCA. This section highlights how the hydrology, and hence the water resources in the XGCA, are strongly influenced by precipitation and temperature. For instance, the amount of precipitation falling as snow versus rain, the amount of evapo-transpiration, the sustainability of glacial inputs to rivers and the timing of runoff are all potential impacts of climate change.[25]

Snowpack[26]

Snowpack is a critical seasonal water resource that is renewed each year at high elevations. It retains freshwater during the cold winter months, after which it supplies streamflow to soils, lakes and reservoirs during the warmer summer low-flow periods. Snowpack is, however, utilized during most of the year after transformation in reservoirs, streamflow and groundwater.

Snowpack projections in BC are still in their infancy, as snowpack is a difficult variable to measure. Given that the projected changes to snowpack rely on both temperature and precipitation, a great deal of uncertainty is associated with estimates. At present, a single estimate has been produced by one RCM model. The results, however, are not sufficient to produce a confident statement about future changes to snowpack in BC. The results do, however, demonstrate that a combination of scientific approaches is needed to provide reliable future estimates of changes to snowpack in BC.

While the findings are still tentative, the projections of spring snowpack for BC show a decline by 2050s of -200kg/m^2. Significantly, the projected snowpack decline is more pronounced in the Coastal Mountain ranges with -500kg/m^2. This is important as while this area is more water-rich than the Chilcotin Plateau as mentioned above, the decrease will impact the water resources in the vicinity of where the Xeni Gwet'in reside. In other words, the decrease in snowpack will impact the water resources that supply the daily water use of the Xeni people.

The projected decreases were primarily caused by the change in snow-to-rain ratios occurring through December, which delayed snowfall into the later winter months and reduced annual snow water equivalent.[27]

[25] Dawson, R., A.T. Werner, and T.Q. Murdock, (2008).
[26] This section is primarily prepared from information provided in PCIC (2007/revised 2009).
[27] Sushama et al (2006).

Glaciers[28]

Like snowmelt, glaciers are also an important contributor to water resources. Yet, contrary to snowmelt, their influence extends from seasons to decades. During the late summer, when rivers typically experience low flows and ecological requirements are high, glacier runoff may constitute a large portion of the streamflow.

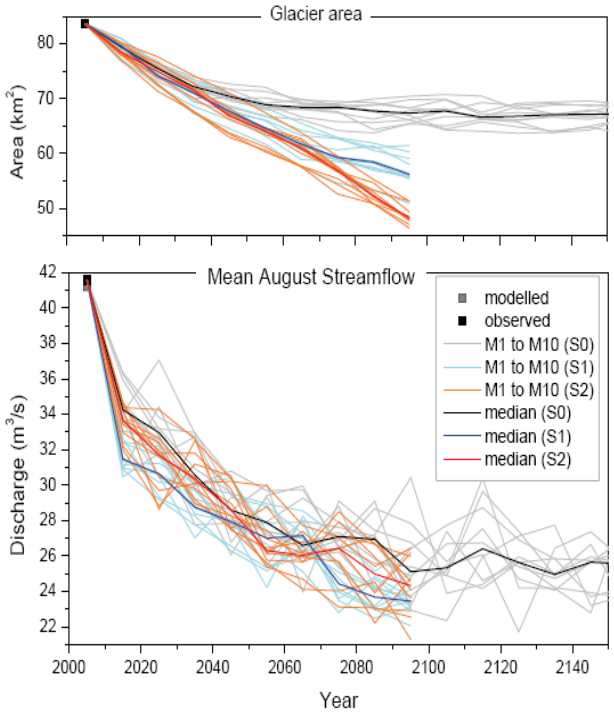
According to the IPCC, global glacier loss will continue throughout the 21st century because increased melt rates will exceed supplements from increased snowfall.[29] More specifically, based on the IPCC IS92a (or "business-as-usual") scenario, glacier surface area globally is expected to decrease by 38 % and 34 % by 2025 and 2050, respectively.[30] **Given the data limitations, the behavior of glaciers in the XGCA watersheds is hard to predict with any certainty**. Adding to the lack of data explained above, another key challenge is that due to the presence of more than 10,000 glaciers in Western Canada, projected changes cannot be made with fully dynamic glaciological models for all glaciers, although these models may serve well for projecting changes at individual glaciers. **What is clear, though, most of BC's glaciers are losing mass and many may disappear in the next century.[31] This will undoubtedly influence river discharges and temperature in a negative way in the XGCA.**

A strong example is provided in Figure 8, where projections for Bridge glacier highlight substantial reductions of its mass area by up to 20 percent by the 2050s even without further warming of the current climate. The figure also shows a subsequent marked reduction (37%) in the mean August (summer) stream flow from approximately 2005 to 2145, even when based on a continuation of the present climate. When the present climate was substituted with projected warmer temperatures in the applied models, the glacial trends got even stronger. These projected changes will be the result of the projected increases in air temperature and prevalence of precipitation falling as rain rather than snow.[32]

It should be noted that the Bridge glacier is located in the southern BC, so it is not of direct relevance to the water bodies of the XGCA. This projection is still alarming, though, as the Bridge glacier covers the largest fraction of watershed area in BC. In addition, these results suggest that for most of BC the phase of increased streamflow that generally follows climate warming has passed and continued reduction in glacier area will lead to decreased streamflow. In other words, the future will see less water in the water bodies.

[28] This section is based solely on PCIC (2007revised 2009), unless other source is stated.
[29] IPCC Technical Summary for the Fourth Assessment Report
[30] Bush, A., and Pollock, T. (2009); Personal Communication (Nov. 2009).
[31] Walker, I.J. and Sydneysmith, R. (2008).
[32] Stahl, K., Moore, R.D., Shea, J.M., Hutchinson, D. and Cannon, A., (2007 in press).

Figure 8: The Bridge glacier Projected changes in glacier area and mean August streamflow for the Bridge glacier in southern BC (2000-2150).



Source: Modified from Stahl et al., in review – as seen in PCIC 2009

Streamflow

At present, a comprehensive study of projected BC streamflow is not available, in spite of its importance for water resources. However, several independent studies have been made for major basins and individual watersheds, including two for the Fraser River (Table 7). These **studies confirm concerns that the influence of future regional projections of warmer temperatures, uncertain precipitation and a reduction in snowpack and glaciers will adversely affect both the timing and the volume of projected stream flow.**[33]

[33] Whitfield et al.(2002b).; Merritt, W.S. et al., (2006); and Loukas, A., et al. (2004)

Table 7: Research studies ongoing in BC on streamflow.

Region	Source	Study Site	Hydrologic Model	GCM Scenario	Downscaling Technique	Hydrology Scenarios	Changes to streamflow
Fraser River	Morrison et al. 2002[34]	Fraser River Basin (217,000 km^2)	UBC Watershed Model	CGCMA Hadley Climate Model (HadCM2)	Statistical climate inversion	Present climate: (1961-1990) Future climate: 2020 (2010-2039); 2050s (2040-2069); 2080s (2070-2099)	Modest average flow increase in the 2080s with a decrease in the average peak flow. General shift to earlier peak in the hydrograph (approx. 24 days)
Fraser River	Sushama et al. 2006[35]	Fraser River basin above Port Mann (232,000 km^2)	Canadian Regional Climate Model (CRCM)	CGCM2-A2 standard, CGCM2 – A2 updated, and CGCM2-IS92 standard	CRCM (dynamical downscaling)	Present climate: (1961-1990) Future climate: (2041-2070)	A significant decrease in SWE as less precipitation falls as snow. Runoff is higher during late-fall and early-winter. Spring peaks are attenuated and occur earlier. Increased variability in the number of days with low-flows. Increased low flows in fall.

Source: Adapted from Merritt et al. (2006)

The recent PCIC hydrology report from 2009 outlines a host of challenges and complexities related to modeling different runoff regimes, one being the multiple sources of streamflow that have to be accounted for (i.e. glacier-melt and groundwater). Yet, the studies highlight that projected changes to annual and seasonal streamflow volumes and timing are similar across models and approaches.[36] The following summary is provided by the PCIC report (p.106-108):

- *"All models and approaches that deal with nival (i.e. snow-fed) systems predict an earlier onset of the spring freshet or peak flows compared to the base case.*
- *Projected changes to the magnitude of flow include increased winter and decreased summer and fall streamflow, along with a diminished spring freshet volume.[37]*
- *Warmer winter temperatures will cause more precipitation to fall as rain rather than snow, resulting in increased winter runoff and decreased snowpack accumulation and a tendency towards more pluvial(i.e. rain-fed) streamflow regimes.[38]*

[34] Morrison, J., Quick, M.C. and Foreman, M.G.G., (2002).
[35] Sushama, L., Laprise, R., Caya, D., Frigon, A. and Slivitzky, M.,(2006).
[36] Merritt, W.S. et al., (2006).
[37] Hamlet, A.F. and Lettenmaier, D.P., (1999b).

- *Reductions to spring peaks will occur primarily from reductions in snowpack and from warmer temperatures causing an earlier spring melt."*

The changes to the flood and low-flow volume producing mechanisms are different for *pluvial (rain-fed)* and *nival (snow-fed)* systems.[39] *W*atersheds fed by rain are expected to have increased flood magnitude and frequency.[40] This response is primarily driven by warmer, wetter winters, where instead of snow, precipitation falls as rain.[41]

A decrease in the number and magnitude of flood events is predicted for many snow-fed watersheds, particularly those in the semi-arid interior regions.[42] This decrease is driven by the spring melt taking place earlier. Drier summers in combination with year-round warming are projected to increase water shortages in both *pluvial* and *nival* rivers because of changes in rainfall timing and amounts, projected smaller snowpack and increased evaporation.[43] Also an increase in the time elapsed between snowmelt and fall rain is projected, which will extend the dry-season low-flow period. Interestingly, rain-fed regimes have been shown to have noticeably longer dry seasons as a result of changes in temperature and precipitation inputs. Because of this rain-fed systems are considered sensitive to climate change.[44]

In terms of projected impacts in the XGCA, **based on the above trends, from the projected warmer temperatures and increase in precipitation for the Study Area, the XGCA rivers will probably see an increase in winter flows and decreased later summer flows.**[45] Glaciers play a major role in determining low-flows for 48 percent of the monitored rivers in BC (see section above). The influence of groundwater and glacier melt on low-flows requires further study.[46]

Groundwater[47]

Groundwater plays a critical role in maintaining streamflows during summer months, which sustain fish habitat, aquatic ecosystems, not to mention the animals and humans that depend on them. Yet, despite these important qualities of groundwater, very little research have been done to date on how climate change might affect groundwater resources in the future. Concerning BC, for the past decade a research program spearheaded by Simon Fraser University has focused on modeling recharge and groundwater-streamflow interation under different scenarios of climate change and the overall understanding of climate-groundwater-surface water interactions in BC.[48] To date, four case studies in BC have been completed to quantify potential impacts of future climate changes on groundwater recharge and groundwater levels.

However, none of the assessments carried out pertained to the XGCA or the Chilcotin Habitat Management Area. Given the scarcity of information related to the groundwater situation in the XGCA, the following are therefore general observations from these other assessments. While some

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[38] Hamlet, A.F. and Lettenmaier, D.P., (1999b) and Whitfield, P.H., Reynolds, C.J. and Cannon, A.J., (2002b).
[39] Loukas, A., Lampros, V. and Dalezios, N.R., (2002a).
[40] Loukas, A., Vasiliades, L. and Dalezios, N.R., (2004) and Whitfield, P.H., Reynolds, C.J. and Cannon, A.J., (2002b).
[41] Parson, E.A. et al., (2001b).
[42] Cohen, S. and Kulkarni, T., (20010. And Loukas, A., Vasiliades, L. and Dalezios, N.R., (2002b).
[43] Parson, E.A. et al., (2001a).
[44] Whitfield, P.H. and Taylor, E., (1998).
[45] Walker, I.J. and Sydneysmith, R. (2008).
[46] Stahl, K. (2007).
[47] Given the scarcity of available information and data, this section is primarily based on information in the recent article by Diana Allen in Innovation May/June 2009, Impacts of Climate Change on Groundwater in BC.
[48] Allen, Diana M. (2009)

of these findings may be very relevant for how climate change will impact the groundwater resources in the XGCA, they should still be considered with a high degree of uncertainty, as any given groundwater aquifer has unique physical properties (i.e. the geology), geometry (i.e. the control of broad flow patterns), and the nature of connection with surface water (i.e., can be a highly dynamic water source and sink for groundwater). The following are some of the main findings of these assessments:

- Of importance to the Xeni Gwet'in, **groundwater systems in the interior regions of BC will be particularly sensitive to climate change** owing to shifts in the timing and amount of precipitation, and the strong dependence of rates of evapotranspiration, snow accumulation and snowmelt on temperature.
- In the spring, an increase in temperatures will kick off the growing season earlier, and lead to increased rates of evapotranspiration.
- **In the summer and early fall, higher temperatures will limit groundwater recharge** even more than presently observed.
- In the winter, **loss of snowpack and timing of snowmelt in the spring can potentially have significant impacts on the amount and timing of spring runoff. As a result, these shifts will influence groundwater recharge both in the valley bottom and in the upland areas.**

If groundwater levels are reduced - brought about either by increased extraction (i.e. for agricultural or human consumption) or lower recharge - the consequence could be a reduction in summer baseflow to stream corridors. Even if changes in recharge amounted to only a few millimeters per year, when summed across an entire aquifer, a significant about of stored groundwater could be lost, which, subsequently, would lead to a significant reduction in the contribution of groundwater to baseflow. Furthermore, a shift in peak stream flow will occur due to earlier snowmelt. The consequent longer baseflow period will demand a higher groundwater contribution to sustain the flow.

In glacierized catchments – such as some of the catchments within the XGCA -, it is likely that glacier-fed rivers will experience a shift from a glacial regime with high flows in mid and late summer to a regime that responds to the summer dry period with streamflow recession, low flows and increased temperatures. In such areas, groundwater will become an increasingly important source of water for sustaining baseflow during the summer months. As a result, according to Allen (2009, "***summer low flows in the streams may be exacerbated by the decreasing groundwater levels and diminished glacier cover, and streamflow may become inadequate to meet economic needs such as domestic consumption, irrigation, as well as ecological functions such as in-stream habitat for fish and other aquatic species [emphasis added].***"

If the timing of river discharge shifts, it may lead to a strong impact on groundwater levels. This is especially the case in valleys that have major rivers flowing through them. For the Xeni Gwet'in, the rivers of such importance would include the Chilcotin, Chilko and Taseko Rivers. In addition, peak flow in many BC rivers is predicted to shift to an earlier date, combined with a prolonged and lower baseflow period. Such a shift in peak flow would force groundwater levels to shift by the same interval.

Another important factor is the projected higher incidence of extreme events. Generally, heavy rain events result in less groundwater recharge, because the ground is not able to absorb the increased precipitation fast enough. The result will be greater runoff, more flooding, etc., which it is difficult to quantify with accuracy in hydrologic models. Similarly, extended periods of drought would lead

to dry soil conditions, which in some cases can result in less groundwater infiltration. So despite the fact that BC, as a whole, is projected to become wetter, some of this additional precipitation may fall as heavy rainfall and, consequently, the amount of groundwater recharge could decrease.

5.2. Forest and Vegetation

This section provides a summary of the larger Study Background Report on Climate Impacts on forest and vegetation prepared by Orman Consulting. For the full report, please see Annex 2. The methodology for the assessment carried out is provided in section 2.3 above. In brief, climate projections based on the worst case emissions (A1F1) scenario were used to describe possible effects on the forests of the Xeni Gwet'in Territory by 2050. The projected climate variable changes by 2020 and 2050 are presented along with climate normals (1960-1999) by Biogeoclimatic (BEC) subzone. Although the model predicts changes to climate envelopes as classified by the BEC system, the changes do not represent changes to the forest ecosystem itself. Potential changes to the forest are inferred with the help of expert opinion and literature reviews[49].

Forests of the Xeni Gwet'in Territory

The XGCA ecosystem, including its wildlife, is somewhat adapted to periods of climate extremes, whether very severe winters or summer drought periods. In the winter, strong winds called "Chinooks" (warm drying winds) periodically blows from the west, causing rapid warming and snow melting, as they also do in the foothills of the Rocky Mountains. Many plant and animal species have evolved and survived in areas like the XGCA because of their resiliency to extreme climate variations. Other species have not done so well, largely in part due to man-induced habitat alternations or destruction, rather than climate extremes and so have either been extirpated or put on the threatened or endangered list, provincially and/or federally.[50]

The forests of British Columbia are classified using the Biogeoclimatic Ecological Classification (BEC) System mentioned earlier. These components include climate, site factors, and associated vegetation. The BEC system uses vegetation, soils, and topography to infer the regional climate of a geographic area. Areas of relatively uniform climate are called biogeoclimatic units, where climate refers to the regional climate that influences ecosystems over an extended period of time. The BEC unit can be expressed as statistics derived from normals of precipitation and temperature.[51] It was a lack of climate stations capable of documenting the complexity of British Columbia's climate, as well as a need to have biologically relevant climate zonation for understanding climatic affects on vegetation and associated sites that drove the creation of the climate component of BEC. See Appendix 1 for a more detailed description of the BEC system.

General Projected Climate Changes

The climate of the Xeni Gwet'in Territory is projected to get warmer and drier and this is reflected in the changes to the BEC subzones. Note the shift zones from Figure 9 to Figure 10. To generate Figure 10, best matches (drier, warmer BEC subzones) were determined for each original BEC subzone based on the climate variables projected to 2050. Although the BEC subzones can closely represent the changes in the climate variables, precipitation and temperature, they do not

[49] This simplistic approach was taken due to the budget constraints of this project. Models are now being developed that will project effects of climate change on vegetation (Campbell et al. 2009).

[50] See Hammond and others (2004)

[51] **Downloaded from http://www.for.gov.bc.ca/HRE/becweb/system/how/index.html).**

represent how the forests might change by 2050. However, the changes to the BEC subzones described below can give some insight into what species and/or ecosystems may be vulnerable as the climate changes.

Eventually the climate of the majority of the area will be similar to what is now the Interior Douglas-fir (IDF) zone, with some amounts of the Bunch Grass (BG) zone and Ponderosa Pine (PP) zone in the warmest areas. This generally agrees with a recent modeling project completed on the entire province by UBC (Figure 11). By 2050 the IDF (yellow), BG (red), and PP (orange) visibly expand in the Chilcotin area (middle of the bottom third of the map).

Figure 9. BEC zones in the study area [52]

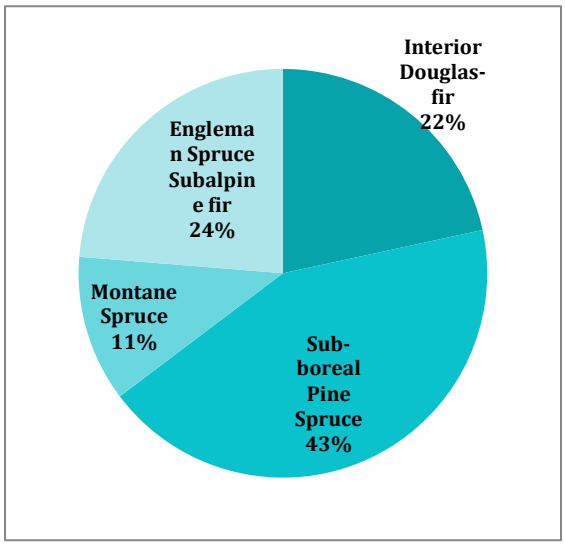
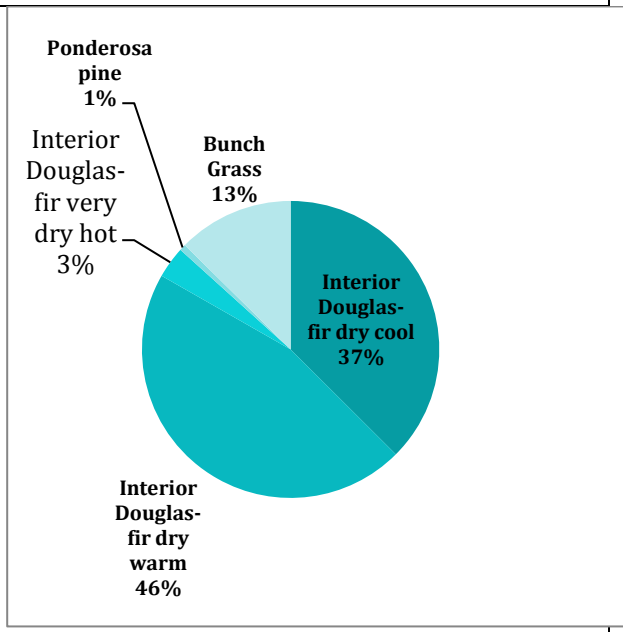


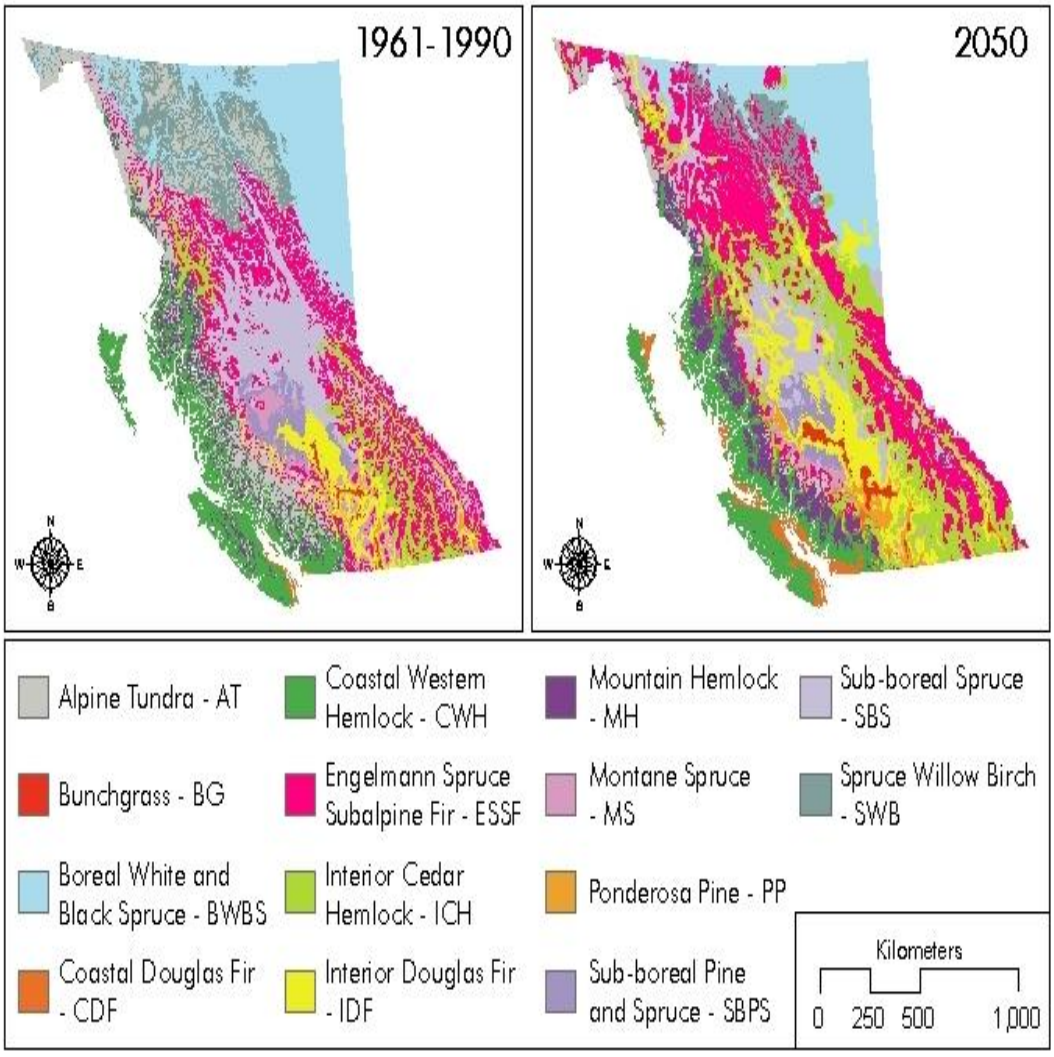
Figure 10. Projected BEC subzones by 2050



Source: Delong 2010

[52] % of hectares excluding Alpine Tundra zone

Figure 11. Biogeoclimatic changes by 2050[53]



Source: UBC Faculty of Geography website. www.geog.ubc.ca/courses/geog376/students/class07/bec_pred/

Projected Climate Changes and Impacts by BEC Zone

A description of each ecosystem is summarized from Steen and Coupe (1997) and Silva Forest Foundation (2004) by BEC zone. Much of the potential effect on the forest vegetation is summarized from the 'Ecological Summary and Narratives' appendix of the Kamloops Future Forest Strategy (2009). The Narrative was generated by local specialists and practitioners with experience in forestry, habitat and biodiversity, First Nations, watershed management, visual landscape management and fire interface management at a workshop. It should be read with following caveat in mind:

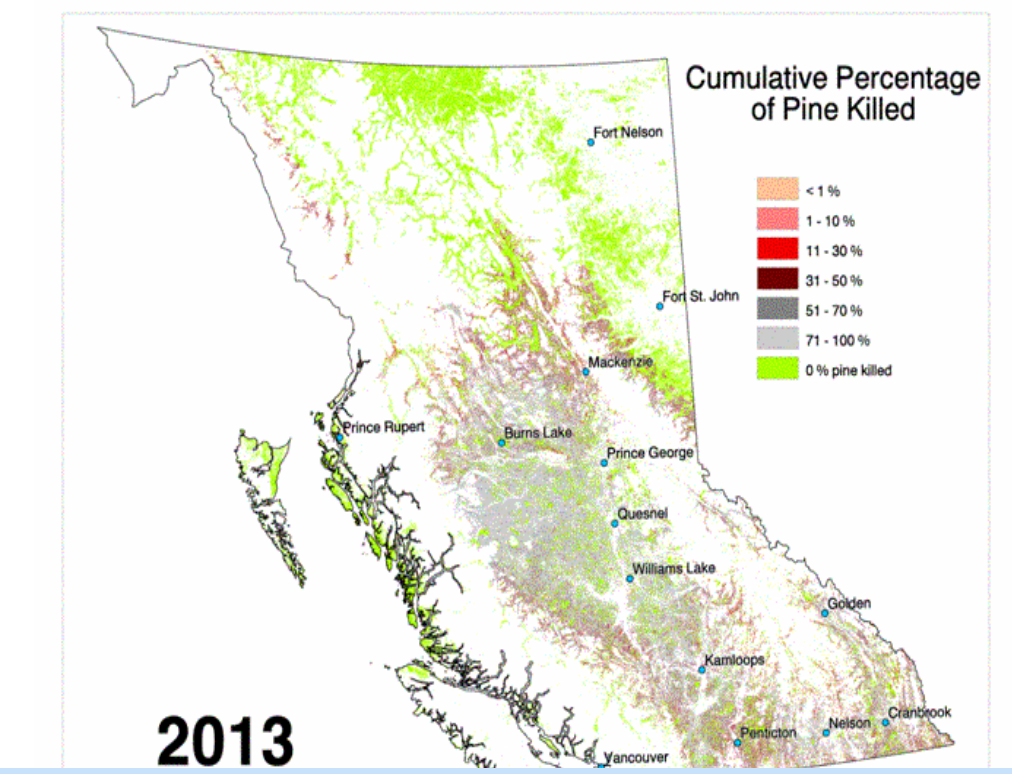
[53] As predicted by the CGCM2 A2x model, which represents minimalistic emission reductions resulting in rapid global warming. http://www.geog.ubc.ca/courses/geog376/students/class07/bec_pred/

"We think that these narratives are entirely plausible given the information available today. We do expect them to be correct. However, we think they are less unbelievable than assuming that nothing will change. The key thing we are trying to achieve is to not blindly paint ourselves into a corner as our climate changes, with only a few difficult options. This strategy will not be the final word. These narratives and associated management direction should be updated as new information emerges."[54]

Box 2: The importance of current and future pine beetle kill

The forest cover of the Xeni Gwet'in Territory is currently dominated by lodgepole pine, regardless of BEC unit. From a climatic point of view, the dynamics of lodgepole pine are intimately related to fire and mountain pine beetle.[1] Recent warm, dry summers, and mild winters have elevated the pine beetle populations to epidemic levels all throughout British Columbia. The Ministry of Forests and Range estimate that 80 percent of the pine in the province's central and southern Interior could be killed by 2013, which does not bode well for the pine in the XGCA (Figure 12). As trees are killed by mountain pine beetle, mortality can be extensive enough to become a very large contiguous fuel base.[1] The large 2009 fires on the west side of Chilko Lake and in the Brittany Triangle are good examples.

Figure 12. Predicted cumulative percent of lodgepole pine killed by 2013.[1]



Source: BC Ministry of Forests and Range website. www.for.gov.bc.ca/hre/bcmpb/cumulative/2013.htm

[54] Ecological Narratives - Backgrounder, Kamloops Future Forest Strategy (2009) Page 1.

In summary, the combination of beetle kill and forest fires will be the most significant impact of climate change to be addressed in the XGCA. The BC Ministry of Forests and Range predicts that 80 percent of the pine will be infected with mountain pine beetle by 2012 (see Box 2). As a result, not only will the forest fire hazard increase in terms of frequency, but more intense fires are projected as well (see Box 3). Secific impacts on the forest and vegetation will likely be:

- By 2050 and beyond pine, subalpine fir will no longer be well suited to the XGCA environment
- Aspen presence will likely decline, but will remain on moister slopes and draws
- Douglas-fir and Ponderosa Pine on the driest of sites, may be more successful
- Grasslands expand into more marginal sites
- Invasive species, such as knapweed, will increase
- While some culturally important plants will decrease, others might become more abundant within the XGCA, such as the Soopolallie and Choke Cherry.

Interior Douglas-fir (IDF) zone

The IDF zone is characterized by warm dry summers and cool dry winters. It comprises about 22% of the forested areas of the study area (Figure 2). Two IDF subzones occur in the study area - the IDFdk4 (dry cool) and IDFdw (dry warm). The IDFdk4 occurs in the Nemiah, Elkin, Taseko River and Lower Chilko River Valleys. It also occurs as a wide crescent shape band from Cheolquoit Lake to Tatla Hill within the North Trapline area. The elevation range is from about 950 to 1200m. Climax stands on zonal (mesic) sites typically have multi-aged Douglas-fir canopy with abundant regeneration. Dominant seral species include lodgepole pine, trembling aspen willow ad rose. Cold air accumulation areas have lodgepole pine forests similar to those on zonal sites in the Sub Boreal Pine Spruce xc (very dry cold). Drier sites are dominated by Douglas-fir, common and Rocky Mountain juniper, bluebunch wheatgrass, Rocky Mountain fescue and lichens, while moister sites have hybrid white spruce, black twinberry, palmate colt's foot and common horsetail.

The IDFdw subzone occurs at low elevations along the Chilko and Tatlayoko Lakes. Due to the influence of coastal air masses, the IDFdw has a warmer moister climate relative to most other parts of the IDF zone in the Cariboo Chilcotin. Climax stands are dominated by multi-aged Douglas-fir and pine grass, with some lodgepole pine and the occasional subalpine fir, while moist areas have hybrid spruce.

Climate impacts: Climate change will result in hotter and drier summers, warmer winters with less snow and more rain in the fall and winter in both the IDFdw and IDFdk4. Lower elevations and southern exposures will experience greater drought stress with associated reductions in tree vigor and increases in mortality. On northern and moister sites, there will be stands of Douglas-fir with scattered openings from pine and possibly spruce mortality. Fire is a concern in the remaining lodgepole pine stands in the near term.

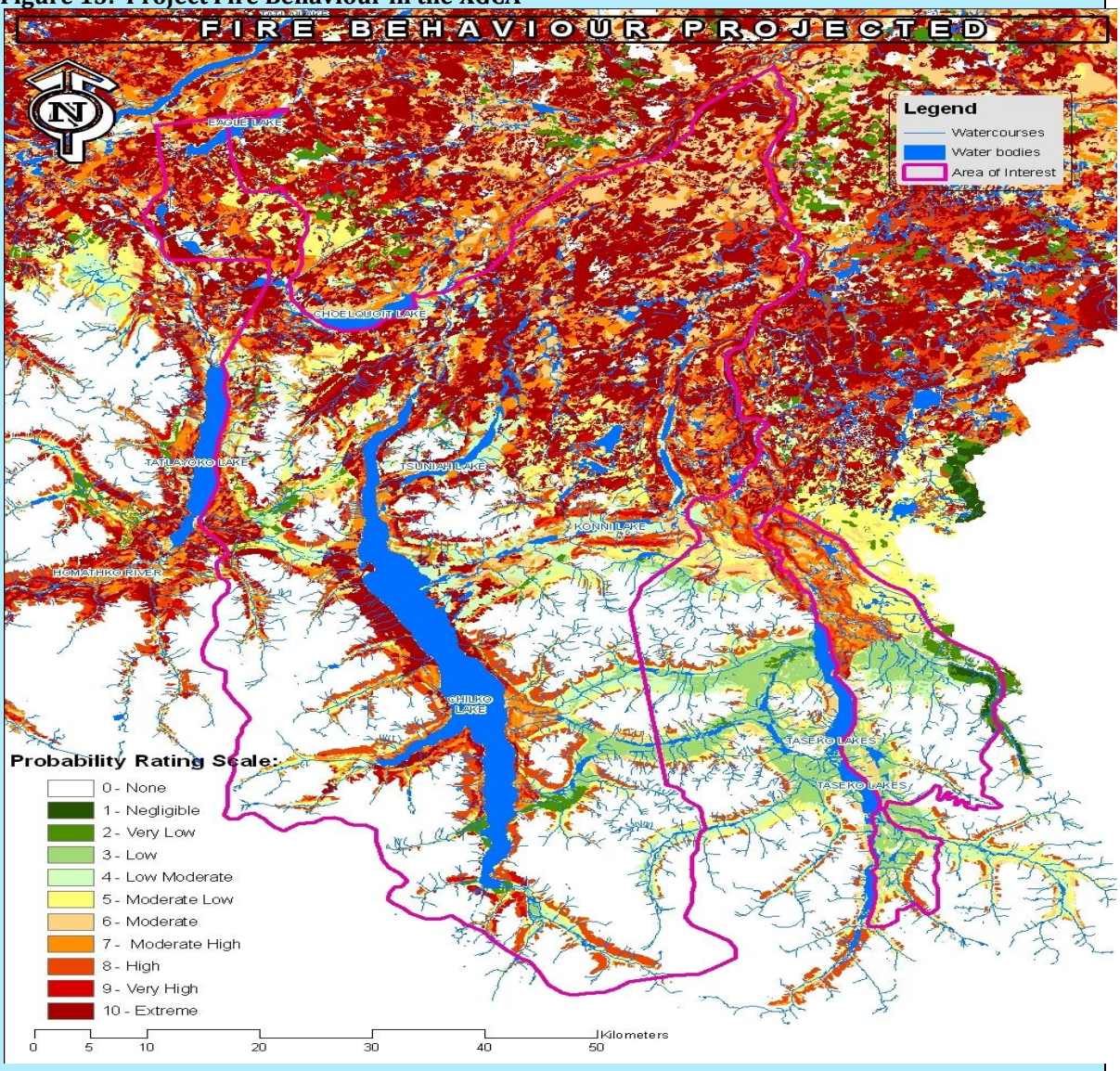
These subzones will become much less suited to growing lodgepole pine. Increased drought stress will lower vigour and increase susceptibility to western gall rust, terminal weevil, dwarf mistletoe and possibly bark beetles. This increased mortality along with warmer summers will create a high risk of large intense fires.[55] Lodgepole pine established on cooler aspects will have a better chance of survival. Douglas-fir, Ponderosa pine and spruce should be well adapted up to 2050; however the KFFS (2009) indicates that by 2080, most of the lodgepole pine regenerated in the early century

[55] KFFS 2009.

Box 3: Forest Fire Hazard in the XGCA

Fire hazard is already a concern in the XGCA due to high proportions of beetle kill and high fuel loads in the XGCA forests. Climate change will only worsen this hazard. Forests in these areas will experience greater drought stress with associated reductions in tree vigor and increases in disease and mortality. This increase in mortality along with warmer summers will create a high risk of large intense fires. Figure 13 shows the projected fire behaviour in the XGCA forest. The dark red markings indicate areas of extreme fire hazard and a high probability of fire. Large tracts of forests in the Brittany and on the west side of Chilko Lake are identified as extreme fire hazard burned in 2009. More dry summers will likely see the remaining High to Extreme hazard areas burn in the near term.

Figure 13: Project Fire Behaviour in the XGCA



Source: BA Blackwell and Associates 2009

will be either dead or will struggle under hotter drier conditions. This mortality and past wildfires may contribute to expanded grasslands. Ponderosa Pine could eventually be the only conifer adapted to drier sites and Douglas-fir will be limited to moister areas and require shade for establishment.

Sub-Boreal Pine- Spruce (SBPS) zone

The SBPS zone has cold dry winters and cool dry summers due to its location at moderately high elevations in the rain shadow of the Coast Mountains. The SBPSxc (very dry cold) subzone is the only subzone of the SBPS in the study area and it comprises also most half of the area (Figure 2). It occurs on the Chilcotin Plateau between about 1100 and 1500 m. The SBPSxc has the least annual precipitation of the SBPS subzones and vegetation and soil development has been severely limited by the cold very dry climate. The landscape is dominated by extensive lodgepole pine forests and abundant wetlands. On zonal (medium moisture) sites, the forest canopy is often a patchwork of even-aged lodgepole pine stands which originated from various fires over time. Scattered aspen occur on zonal sites and hybrid white spruce occurs on moister sites. Wet meadows are common in poorly drained depressions. Mountain pine beetle has caused extensive mortality in the pine across this subzone.

Climate impacts: By 2050 the climate of the SBPSxc will likely be approaching the current climate of the IDFdw. The risk of wildfires will increase in the short term as more pine is killed by mountain pine beetle. As the climate warms, lodgepole pine will not be suited to this environment. As pine declines, it is likely that grassland will expand. Aspen will likely remain in moister areas and Douglas-fir may expand into the area. Since there is more precipitation over all - but warmer, drier summers, the wet meadows may contract and expand on a seasonal basis.

Montane Spruce (MS) zone

The MS zone occurs in the transition between the SBPS or the IDF and the Engelmann Spruce Subalpine fire (ESSF) zone. Lodgepole pine also dominates the MS landscape. There are two MS subzones in the study area- MSxv (very dry very cold) and the MSdc2 (dry cold). The MSxv occurs in the plateau portion of the study area between 1400 and 1700m. The MSxv is one of the least productive BEC units in the province for tree growth. Vegetation succession is very slow and pine stands greater than 200 years old with only a few spruce or subalpine fir trees in the canopy are common.

The MSdc2 occurs in the Chilko and Tatlayoko valleys and Stikelan and Cheshi Passes and also between the IDFdk4 and ESSF in the lower Nemiah Valley. It ranges from 1150- 1650m. The climate is moderated by the costal influences. Zonal stands are dominated by lodgepole pine with moderate amounts of subalpine fir, aspen, scattered spruce and occasionally Douglas-fir. Drier sites have significant amounts of Douglas-fir and moist sites have hybrid spruce.

Climate impacts: The ClimateBC model projected hotter and drier summers and warmer winters with slightly less snow in the MSxv subzone. The risk of large wildfires will likely increase due to warmer temperatures and the increased fuel load from dead lodgepole pine stands. Where it is found, Douglas-fir and spruce released by pine mortality will increase in size and vigour over the near term, but will show signs of moisture stress on all but the wettest of sites. Subalpine fir may survive in the short term but will have a limited role as a future overstory species. By 2050 there will likely be scattered Douglas-fir with small patches of aspen scattered over a landscape mostly covered by pine in decline. Lodgepole pine established on the wetter, cooler aspects will have a

higher chance of survival, but the climate will not be favourable to pine in the long run. There will be a trend to more open forests and more grasslands.

Engelmann Spruce- Subalpine Fir (ESSF) Zone

The ESSF zone lies below the Alpine Tundra zone and above the MS or IDF zones. There are two ESSF subzones in the study area- ESSFxv1 (very dry very cold) and the ESSFxvp (very dry very cold parkland). The ESSFxv1 lies between 1650 and 2100m. It is dominated by lodgepole pine forests which regenerate following relatively frequent fires. Subalpine fir and Engelmann spruce are present in the understory however; few seral pine forests have been replaced by these long lived species. Whitebark pine is common at elevations above 1850m on drier, warm aspects.

The ESSFxvp is a parkland subzone characterized by patches of stunted trees. It is dominated by subalpine fir with spruce on cool exposures and Whitebark pine and lodgepole pine on warmer aspects.

Climate impacts: By 2050 the climate of this area will also be warmer and wetter overall, but summers will be drier. It is colder and wetter than the IDF, but warmer than the MS zones. It is likely that fire frequency will go up and all species may move up in elevation. Douglas-fir may also move up slope from lower habitats as climate warms. The parkland areas will become more treed, however the speed at which this happens will be limited by soil development (Campbell et al. 2009). The slow maturing Whitebark pine will be threatened as it cannot adapt rapidly to changing conditions and will probably be out-competed.[56]

Culturally Important Plants [57] [58]

As the authors of the Kamloops Future Forest Strategy (2009) describe, the dynamic nature of ecosystems makes predictions about future conditions challenging at best. However, some generalities were surmised:

- Long lived species may be able to survive changes.
- Wet to moist site plants will see suitable habitat shrink, while some dryland species may be threatened by competition by invasive species.
- However, species that are adapted to wet or dry conditions will likely survive where biophysical factors influence the amount of moisture available.
- Drought adapted species may also have a wide range of adaptation.

Vulnerability of culturally important plants of the Xeni Gwet'in will vary by species. There have been upwards of 50 species identified as important to most First Nations in the Cariboo-Chilcotin.[59] What follows is a small selection of those plants that were specifically identified as important by the survey of the Xeni Gwet'in elders.

*Claytonia lanceolata (*Indian potato) (Western Spring Beauty*)*

- ***Ecology:*** Indian potato is widely scattered at mid to high elevations in open, moist, grassy slopes. It is often found in areas of late snow beds. Other than the Potato Range it is not

[56] Cox 2000.
[57] Ecology summarized from Parish et al. 1996.
[58] Information also provided by Ray Coupe, Ecologist, Ministry of Forests and Range, Williams Lake.
[59] Powell 2005.

common in Chilcotin. It is more common the Quesnel Highland and the Cariboo Mountains east of the Fraser River. It is also common in some Interior Douglas-fir grassland areas near Kamloops (Lac du Bois and Niskonlith).

- ***Effects of climate change:*** Indian potato seems capable of enduring some drought but also requires early spring moisture for early season growth and flowering. As snow pack declines and temperatures warm, growth may start earlier and it may migrate upward in elevation where there is suitable habitat.

Erythronium grandiflorum (beartooth) (yellow glacier lily)

- ***Ecology:*** Beartooth is not common west of the Fraser River. It is more common and widespread in the Quesnel Highland and Cariboo Mountains in the ESSFwcw and WSSFwcp. It occurs in subalpine and alpine meadows and wet, open high sub-alpine forests. It blooms soon after snow melt, on the edges of retreating snow.
- ***Effects of climate change:*** As snow pack declines and temperatures warm, growth may start earlier and it may migrate upward in elevation where there is suitable habitat.

*Amelanchier alnifolia (*Saskatoon)

- ***Ecology:*** Saskatoon is widespread and common dry to moist forests at low to mid elevations. It also occurs occasionally at high elevations on warm aspects.
- ***Effects of climate change:*** Saskatoon may disappear from the very driest of sites but overall habitat will likely expand into the MS and SBPS.

P*runus virginiana (*Chokecherry*)*

- ***Ecology:*** Chokecherry is not common in the Chilcotin. It is found on dry exposed warm aspects and rocky outcrops in low to mid elevation open forests. Most common on steeper warm aspects, roadsides and some low elevation talus slopes.
- ***Effects of climate change:*** As the climate warms and becomes drier, chokecherry will likely spread and be more common.

Rubus idaeus (raspberry)

- ***Ecology:*** Raspberry is relatively common on moist disturbed sites in the Chilcotin, especially in Coast/Interior transition. It is scattered and often abundant from low to subalpine areas in clearings and disturbed areas.
- ***Effects of climate change:*** May be vulnerable to warmer, drier climate, but easily cultivated.

Fragaria virginiana (strawberry)

- ***Ecology:*** Strawberry is widespread and common at low to subalpine elevations in dry and moist forests, openings and disturbed areas.
- ***Effects of climate change:*** Strawberry exists across a wide range of sites and is therefore less susceptible to climate change. It will likely expand and become more common at higher elevations.

Arctostaphylos uva-uri (kinnikinnick)

- ***Ecology***: Kinnikinnick is widespread and common at low to alpine elevations on sandy and well drained exposed sites.
- ***Effects of climate change***: Kinnikinnick is likely at low risk to climate change as it is adapted to droughty sites across BECs. However, it is sensitive to moderate and severe fires.

Sheperdia Canadensis (soapberry)

- ***Ecology***: Sheperdia is widespread in dry to moist openings and clearings
- ***Effects of climate change***: Sheperdia will likely expand into areas as they get drier.

Veratrum viride (Indian Hellebore)

- ***Ecology***: Hellebore is wide spread and most abundant subalpine elevations on wet seepage sites.
- ***Effects of climate change***: Hellebore is at risk as it has a preference for wet seepage sites with cold air drainage.

*Ledum groenlandicum (*Labrador tea*) and Ledum glandulosum (Trapper tea)*

- ***Ecology***: Most common in colder mid to high elevations in the Chilcotin. Often dominating bogs and cold wetland fringes. Absent in hot arid climates.
- ***Effects of climate change***: At risk as climate becomes warmer and drier. Persistence may depends on what BEC it is in, i.e. the colder (higher) and wetter the ecosystem is now the longer it will persist.

5.3. Wildlife & Wild Horses

This section provides a summary of the larger Study Background Report on wildlife and wild horses prepared by Wayne McCrory, RPBio. For the full report, please see Annex 3.

Past and present exogenous and climate-related impacts on wildlife and wild horse habitats

Impact of climate change on wildlife is not a new phenomenon. Indeed, the effects of long-term climate variations can be observed dating back to the last Ice Age on three of the indicator species that are currently found in the XGCA: (i) the mountain goat; (ii) the wild horse; and (iii) moose.

- *Mountain Goat* - Until about 8,000 years ago, there were mountain goats on Vancouver Island. Yet, they went extinct at that time, apparently because of global warming (temperatures higher than today), which caused fragmentation and loss of the goats' alpine habitat, which, in turn, was a result of the treeline expanding upward in elevation.

- *Wild Horses* - The horse species, which evolved in North America (and even existed on Vancouver Island) also went extinct about 8,000 years ago, but for unknown reasons. It was later re-introduced by the Spaniards to the Americas in the 1500s, and was brought northward by First Nations. As a result, it arrived in the XGCA before the Europeans did, about 200+ years ago.

- *Moose* - The moose did not arrive in the Chilcotins until about 90 years ago as a result of a gradual, southward range expansion from refugia in the Yukon during the last Ice Age.

In more recent time (the past couple of decades), the wildlife and wild horse habitats within the XGCA have been negatively impacted by a range of factors, including both exogenous and climate-related ones. The most significant climate-related factors have been massive pine beetle infestations and two very large wildfires (2003 and 2009), whose enabling conditions were created by global warming. As mentioned earlier in section 5.2, even larger, hotter wildfires are projected for the future. Another threat is posed by uncontrolled wildfires that burn up the peat that

underlies the hundreds of small and large meadows, which store considerable carbon that is released in large amounts when burned.

It is important to acknowledge, however, that there are very important exogenous factors, which have nothing to do with climate change, but which have also negatively impacted the wildlife and wild horse habitats to date. Government policies of wildfire suppression, for example, allowed excessive fuel loading, which contributed to the past wildfire situations. Other exogenous factors include tree encroachment, over-grazing by livestock and lack of natural grassland wildfires, which have already caused some native grassland deterioration. In addition, roading and clearcutting in some outlying areas have increased drying conditions that would be expected to accelerate further drying conditions, changes in micro-climate and drying of lakes and ponds that are fed by run-off.

Projected climate-related impacts on wildlife and wild horse habitats

Climate change factors will have an increasing effect not only on the biogeoclimatic zones of the XGCA but also subsequently on wildlife habitats and wildlife survival. According to climate projections in section 4.4, the XGCA may expect (i) Increased mean temperatures; (ii) increased drought conditions in the summer; and (iii) increased rainfall (instead of snow) in winter. These climatic changes are projected to cause (i) larger and hotter wildfires (which is also a result of fire suppression); (ii) increase the extent of grasslands in several low elevation bioclimatic subzones in XGCA; (iii) increase drought; and (iv) possibly cause the treeline to increase in elevation.

To assess how these projected climate changes will impact the wildlife and wild horses in the XGCA, three sets of biological indicator species were used:

1. A small number of plant species and their habitat associations were chosen for their relative importance to wildlife. These indicator species included
    a. Whitebark Pine *(Pinus albicaulis)*,
    b. Trembling Aspen *(Populus tremuloides)*,
    c. Soopolallie/Soapberry *(Shepherdia canadensis)*, and
    d. Western Spring Beauty "wild potato" (*Claytonia lanceolata)*.

2. Another set of indicator species included sensitive habitat ecotones (treeline and grasslands).

3. The final set of indicator species concerned wildlife, and besides the wild horse, included the grizzly bear *(Ursus arctos)*, California bighorn sheep *(Ovis canadensis)*, mountain goat *(Oreamnos americanus)*, moose *(Alces Alces americana)*, and mule deer *(Odocoileus hemionus).* These mammal indicator species were chosen either because of their apparent vulnerability to global warming and or their importance to the Xeni Gwet'in First Nation. Finally, comments were also made on birdlife

The following is a summary of the assessment, of which further details can be found in Appendix X. This is a subjective assessment by the project team, hence these projections should be treated with care.

Assessment of future climate impact on plant indicators

- Whitebark Pine: Of the two tree indicator species of high value to wildlife and biodiversity, Whitebark Pine will likely suffer similar extensive die-offs due to diseases caused by global warming as has been reported in many areas of the continental United States with

concomitant negative impacts on the grizzly bear and the pine crow (*Nucifraga Columbiana*) that seasonally depend on pine nuts. However, wildfire could be a balancing factor in restoring/maintaining ecosystem health of this fire-suppressed habitat.

- Trembling Aspen: Barring unforeseen factors, this species will most likely continue to thrive in XGCA, even with a predicted increase in drought and wildfires. If this holds true, it would continue to provide vital nesting and feeding habitat to a great variety of bird species. Moose would also benefit from an increased winter food supply. Large wildfires may temporarily decrease the amount of older trees as cavity-nesting habitat for a host of birds, but may increase the forest health over time of this fast-growing hardwood.

Assessment of future impact on wildlife indicators

- Moose: This is an important food for the Xeni Gwet'in. Due to lack of sweat glands moose may suffer during hotter periods of summer droughts when there are few ponds available to use for cooling off. Moose is primarily a browser of shrubs and may suffer some habitat loss as grasslands increase. Yet, it will also benefit from regeneration of vital shrub foods at higher elevations from an increase in wildfires. Rain on snow in the winter may create crusting conditions, reducing some winter survival.

- Mule deer: This is another important year-round food for the Xeni Gwet'in. The mule deer is a very resilient species, which has adapted to many different biogeoclimatic zones in BC and North America, including near-desert and grassland-shrubland conditions. The project team does not expect it to suffer from global warming in XGCA over the next 50 years. More rainfall during winters may lead to crusting and icing, that combined with deep snow, may cause some localized declines of resident deer that over-winter in XGCA instead of migrating to easier conditions.

- California Bighorn Sheep: The XGCA is well known for its bighorns and here this famous desert "thinhorn" subspecies reaches the northern limits of its distribution in North America, perhaps making it more vulnerable to climate changes. Total population estimates in XGCA vary between 130–450 sheep. It is uncertain at this point as to how much sheep are still used as a traditional meat source by the Xeni. The males are mainly hunted for trophies, even though this bighorn is blue-listed provincially. Some of the herds have suffered declines, including disappearing from over-hunting on Potato Mountain on the west side of Chilko Lake. There have been several successful re-introductions in XGCA. This species would appear to have some vulnerability to global warming, especially as the herds in the XGCA appear to be of the ecotype that winters and summers in the mountains on high-elevation, windswept, alpine ridges rather than at a variety of habitats at different elevations. Possible threats from global warming include increased icing-over in winter of alpine meadows used for foraging and tree encroachment. Several controlled burns of high elevation habitats have already been done to improve winter ranges and this offers some hope to help this species adapt and survive global warming.

- Mountain goat: The XGCA has a population of about 400 goats and there have been several small re-introductions. They have some food value for the Xeni but are also managed for some limited entry hunting. As noted for the bighorns, the project team expect some limited effects from global warming, although icing of winter ranges from more rainfall in wintertime could cause increased hardships.

- Grizzly bears: These are provincially listed as threatened in the West Chilcotin Ranges, with perhaps 100 left, and extirpated on the plateau to the north. There has been no trophy hunting for years. Recent DNA studies detected 119 grizzlies in the combined Tatlayoko/the upper Chilko River sections of XGCA, so the population in Xeni may be in better shape than expected. Nonetheless overall numbers are considered to be approximately one-half of capacity and former numbers. An independent conservation study shows, however, that a non-climate related concern is that the XGCA is too small to support a viable grizzly population that could survive over the long-term. If combined with large intact mountain and foothills areas to the north and south, the total area would have enough quality grizzly habitat and salmon to provide a viable population core larger that the Greater Yellowstone Grizzly Bear Yellowstone Ecosystem. **Although the grizzly population is overall threatened and well below capacity, being part of a much larger, intact ecosystem will help XGCA grizzly numbers to survive threats from global warming**. Since grizzly bears have a cosmopolitan diet, this may also help them survive global warming. Given that Grizzlies use salmon in a number of areas of XGCA, they will experience changes in food supply as salmon runs decline (see section 5.4). It is expected that other important habitats and food sources will also decrease in abundance and productivity including wild potatoes (western spring beauty), whitebark pine nuts, and wetlands/riparian areas. Increased berry production from wildfires will help offset some of the fall habitat and food source losses for grizzly bears such as whitebark pine nuts and salmon. Losses of other seasonal food sources such as wild potato and green plants in wetlands are a major concern as these represent specialized habitats that grizzly bears would use disproportionately to their low occurrence in the ecosystem and represent a net loss of food resources**. It is expected that this will cause seasonal hardships for the food supply for some grizzly bears.**

- Wild horse: An estimated 200 – 400 horses range free in the XGCA, some in the Nemiah Valley where they intermingle with a small number of domestic horses and cattle, and the Brittany Triangle, which have the remotest surviving wild horses left on the Canadian mainland. So far, horses have managed to adapt to a wide range of grassland habitats and desert-like conditions, so they will likely be quite resilient to further climate changes. Notably, two large wildfires in the Brittany, partly attributed to global warming, has overall improved wild horse habitat by bringing back large areas of grasslands that were overgrown with pine forests. Horses will continue to benefit from increased grasslands, but icing of grazing areas from increased rainfall combined with alternating freezing conditions in winter may cause some hardships. A loss of wetlands, critical grazing areas, will also have a negative impact on food supply. Also, overgrazing by domestic livestock in the Nemiah Valley and near Henry's Crossing has resulted in range deterioration and this is of concern. Spread of alien plants by wild horses, pack animals and livestock is another concern. However, overall the project team expects wild horses to adapt well to conditions brought on by climate change.

- Wetlands & migratory waterfowl: As mentioned earlier (section 5.1), increased summer droughts will affect many of the large and small wetlands, such as reduced water levels, limiting the amount of marsh habitat for nesting ducks around a pond. Migratory birds, such as waterfowl, will not only be affected by global warming in XGCA, they are also susceptible to all kinds of changes to their continental habitat that makes them more vulnerable.

5.4. Fisheries

This section provides a summary of the larger Study Background Report on Climate Impacts on fisheries in the XGCA prepared by Cariboo Envirotech Ltd. 2006. For the full report, please see Annex 4.

The Xeni Gwet'in First Nation have long been reliant on their own resources for food and to this day actively harvest what the local landscape and rivers have to offer from their Caretaker Area including fish for their consumption. Since time immemorial, the Xeni Gwet'in have relied on the large sockeye, Chinook, Steelhead and Coho salmon runs as a source of protein in their diets. This is still the case, as a community survey conducted in 2006 as part of a fish and fish habitat study in the Nemiah Valley showed that community members depend on fish in their diet at a minimum of twice per week.[60]

Baseline – fisheries in the Xeni Gwet'in Territory

The following Table 8 provides some of the preferred fishing sites and the species found at these locations within the XGCA.

Table 8: Preferred fishing locations and species in the XGCA

Location	Known Species Present
Chilko River	Bull Trout, Chinook Salmon, Coho Salmon, Dolly Varden, Longnose Dace, Mountain Whitefish, Pacific Lamprey, Rainbow Trout, Sockeye Salmon, Steelhead, Whitefish (General)
Chilko Lake	Bull Trout, Chinook Salmon, Dolly Varden, Minnow (general), Mountain Whitefish, Rainbow Trout, Sockeye Salmon, Steelhead, Sucker (General), Whitefish (General)
Taseko River	Bull Trout, Chinook Salmon, Dolly Varden, Longnose Sucker, Mountain Whitefish, Rainbow Trout, Sockeye Salmon, Steelhead, Whitefish (General)
Taseko Lakes	Bull Trout, Dolly Varden, Longnose Sucker, Mountain Whitefish, Rainbow Trout, Sockeye Salmon
Elkin Creek	Bull Trout, Chinook Salmon, Dolly Varden, Kokanee, Largescale Sucker, Longnose Dace, Longnose Sucker, Mountain Whitefish, Northern Pikeminnow (formerly N. Squawfish), Rainbow Trout, Redside Shiner, Steelhead, Whitefish (General)
Big Lake	Rainbow Trout
Konni Lake	Bull Trout, Dolly Varden, Mountain Whitefish, Kokanee, Largescale Sucker, Longnose Dace, Longnose Sucker, Rainbow Trout, Redside Shiner
Fish Lake	Rainbow Trout
Big Onion Lake	Dolly Varden, Rainbow Trout
Nemiah Creek	Bull Trout, Dolly Varden, Kokanee, Largescale Sucker, Longnose Dace, Longnose Sucker, Mountain Whitefish, Rainbow Trout, Redside Shiner
Tsuniah Lake	Longnose Sucker, Northern Redbelly Dace, Rainbow Trout, Redside Shiner
Chaunigan Lake	Rainbow Trout, Redside Shiner
Brittany Lake	Longnose Sucker, Rainbow Trout, Redside Shiner, Sucker (General). Whitefish (General)
Twin Lakes	Bull Trout, Dolly Varden, Longnose Sucker, Mountain Whitefish, Nothern Pikeminnow, Whitefish (General)

[60] Cariboo Envirotech Ltd. 2006.

Sockeye salmon is the most important fish species for consumption by the Xeni Gwet'in community. *Fisheries and Oceans Canada* determined decades ago that the salmon stocks utilizing the Chilko and Taseko River drainages were extremely important and as such have invested a great deal of time and funding in the monitoring and assessment of these runs. The following Table 9 shows sockeye and Chinook escapement data for the Chilko River.[61] The trend is further evidence that these stocks are in decline. It should be noted that the 2009 Chinook escapement is from the 2004 brood year that saw 16,287 adult Chinook return to spawn.

Table 9: Salmon (Sockeye and Chinook) escapement to the Chilko River 1993-2009.

Year	Sockeye	Chinook		Year	Sockeye	Chinook
1993	555226	6343		**2001**	668783	10891
1994	450745	5665		**2002**	382814	11027
1995	534559	10461		**2003**	608321	21625
1996	974349	17000		**2004**	91909	16287
1997	985827	16272		**2005**	535967	7668
1998	879017	14549		**2006**	468947	5201
1999	891922	8920		**2007**	305853	4366
2000	758941	9171		**2008**	249863	5186
				2009	217572 (preliminary)	8548 (preliminary)

Source: Data provided by Fisheries and Oceans biologist Linda Stevens of Williams Lake.

How climate change impacts fish

While there are many negative influences on both anadromous and non-anadromous fish stocks, including over-fishing, climate change is now considered to be one of the greatest threats to fish stocks throughout the world, including British Columbia and the Pacific Ocean. In its comprehensive Fourth Assessment Report in 2007, the Intergovernmental Panel on Climate Change (IPPC) states:

> *"There is high confidence, based on substantial new evidence, that observed changes in marine and freshwater biological systems are associated with rising water temperatures, as well as related changes in ice cover, salinity, oxygen levels and circulation. These include:* ***shifts in ranges and changes in algal, plankton and fish abundance in high-latitude oceans; increases in algal and zooplankton abundance in high-latitude and high-altitude lakes; and range changes and earlier fish migrations in rivers [emphasis added].*** *While there is increasing evidence of climate change impacts on coral reefs, separating the impacts of climate-related stresses from other stresses (e.g. overfishing and pollution) is difficult. {WGII 1.3, SPM}"* (IPCC[2]).

The Panel's statement reflects the impact climate change will very likely have on both freshwater and marine aquatic environments. Additionally, climate change is projected to not only affect anadromous species such as salmon, but also non anadromous species, such as rainbow trout, Dolly

[61] Data provided by Fisheries and Oceans biologist Linda Stevens of Williams Lake.

Varden, Bull Trout, and Kokanee, all of which currently provide food for the Xeni Gwet'in community from lakes and streams in their Caretaker Area.

Past climate changes and their impacts on fish to date

Globally, trends provided by scientists show fish stocks in dramatic decline. According to the IPCC, evidence for impacts of recent climate change being a serious factor in this decline is rapidly accumulating. In their 2007 4th Assessment, the Panel summarizes the state of salmonids on the west coast. The report stated that: *"Cold- and cool-water fisheries, especially salmonids, have been declining as warmer/drier conditions reduce their habitat. The sea-run salmon stocks are in steep decline throughout much of North America. Pacific salmon have been appearing in Arctic rivers. Salmonid species have been affected by warming in U.S. streams."*[62]

Closer to home, climate change is believed to have been affecting the fishery resource in the XGCA for some time. While the Fraser River remains one of the most productive Pacific salmon rivers in the world, overall trends are not positive, and climate change is likely to make things worse. A recent University of British Columbia (UBC) study analyzed the relationship between stream temperature and salmon survival. Their findings show that temperature challenges aerobic activity in salmon and that each stock of salmon may have different thresholds of survival.[63] According to UBC scientist Tony Farrell, *"This study shows that an increase over the past 50 years of 1.8 degrees Celsius in the Fraser River's peak summer temperatures is too much too fast for some salmon stocks". He goes on to say "It also shows that climate change affects even the same species differently because individual populations may have adapted to their respective environments.*[64]

The following three Fgures (13, 14 and 16) from their 2009 report highlight the declines in sockeye, Coho and Chinook salmon for the Fraser River, into which the Taseko and Chilko Rivers flow. Aside from the Upper Fraser summer Chinook run, all other species and runs are in jeopardy, which will only be further compounded by climate change and its effects on fish and fish habitat located within the XGCA.

The above development is very alarming to the Xeni Gwet'in community, given that Sockeye salmon are their most important fish food species.. The 2009 sockeye escapement into many tributaries of the Fraser River including the Chilko was far below expectations. The preliminary indications suggest that the sockeye fry from the Chilko River brood year left the Chilko system in record numbers and size and expectations ran high in 2009 as a result of this, but the return rate was considered a collapse.

The situation remains of great concern nationally and a judicial inquiry has been scheduled by the Canadian government to determine the cause of the sockeye collapse in the Fraser River. Early indications suggest climate change may be to blame. Scientists are now suggesting that ocean conditions in 2007 played a large role in this issue with warmer water temperatures and a lack of food that the young sockeye are reliant on during their first months at sea.

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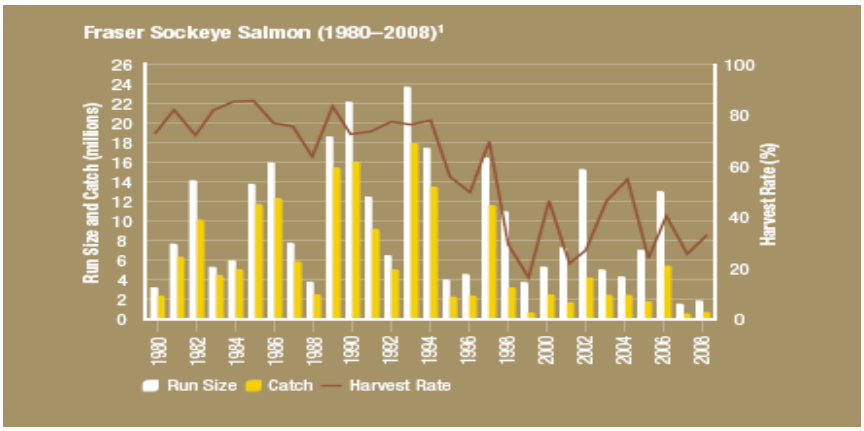
[62] IPCC, 2007 (In the North America Chapter of the IPCC's WGII Technical Report: "Climate Change 2007: Impacts, Adaptation and Vulnerability" issued April.)

[63] University of British Columbia (2008, November 21). Formula For Predicting Climate Change Impact On Salmon Stocks Established.

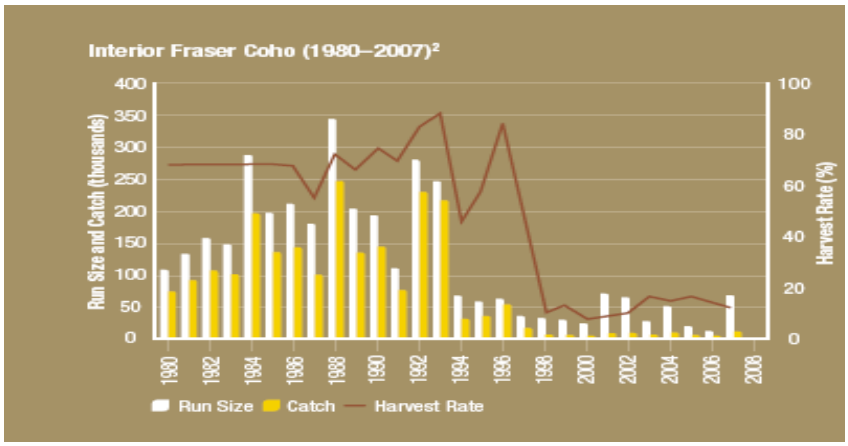
[64] University of British Columbia (2008, November 21). Formula For Predicting Climate Change Impact On Salmon Stocks Established.

Figure 14: Fraser Sockeye Salmon (1980-2008)



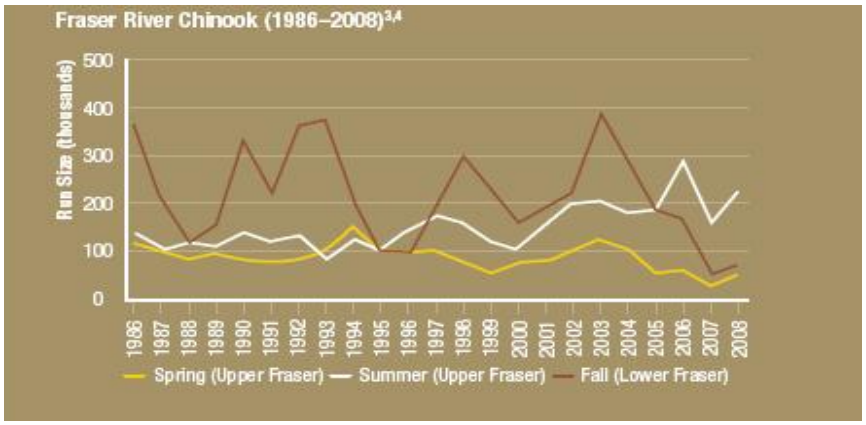
Source: Fraser Basin Council

Figure 15: Interior Fraser Coho (1980-2007)



Source: Fraser Basin Council

Figure 16: Fraser River Chinook (1986-2008)



Source: Fraser Basin Council

Projected Climate Changes and Impacts

On December 9, 2009 the Pacific Fisheries Resource Conservation Council (PFRCC) co-hosted with Simon Fraser University a think tank of scientists concerned about the failing sockeye salmon returns to the Fraser River. Their press release on that date stated "***Climate change poses a major threat to the future of Fraser River salmon, not only through direct effects of temperature on the fish, but also through impacts on food webs and habitats*** *[emphasis added]. Management agencies must take this information into account in order to meet the objectives of Canada's Wild Salmon Policy, which include maintaining biodiversity as well as monitoring and protecting habitat. These are clearly challenging times for Fraser River sockeye salmon."* (PFRCC).

Few scientists from Fisheries and Oceans Canada will discuss the issue due to the scheduled judicial inquiry; however, other respected scientists are stepping forward with comments and opinions. Simon Fraser University's Dr. John Reynolds who holds the Tom Buell chair in salmon conservation recently stated "This is now the way that things may well be for the future, especially under the predictions we have for climate change" (CBC).

Climate change will have varying effects on fish species that the Xeni Gwet'in rely on as a food source. In 2009 Nelitz and Porter from ESSA Technologies Ltd. prepared a report on the effects of climate change on Chinook habitat in the Cariboo-Chilcotin.[65] According to this report, the findings suggest that regional climate change impacts on Chinook salmon may be mixed. Interestingly, in some locations there may be benefits of habitat changes, while in other locations there may be constraints on production. For instance, **stream habitats with temperatures optimal for Chinook rearing are predicted to decrease in northern areas on the study area and increase in southern areas.** Late summer / early flows necessary to maintain rearing juveniles and allow return of spawning spring and summer Chinook are also predicted to decrease more markedly in the north than in the south**. In some of the more northern streams summer / fall flows are predicted to decline to such an extent that minimum flows to support successful spawning and rearing may not be reached consistently in the future.** The report stressed that further exploration of these data and field validation of the modeled interpretations would be fruitful.

Nelitz and Porter also prepared a report in 2009 on the effects that climate change may have on Coho salmon habitat. This report stated *"From a thermal perspective, there appears to be a current abundance of suitable coolwater and coolwarm transition habitats within the downstream reaches of the Chilcotin, Quesnel, and West Road watersheds. Under a "best" case scenario of climate change,* ***changes are predicted to be most significant in the Horsefly and Chilcotin drainages, with temperatures shifting towards those preferred by warmwater fish communities****. Under a "worst" case scenario thermal shifts are even more significant and extensive in the Chilcotin and Quesnel. On average, the linear extent of coolwater habitats is predicted to decline in the Chilcotin by the 2080s, while cool-warm transition habitats are expected to increase. The pattern is the opposite in the Quesnel where coolwater habitats are expected to increase while cool-warm transition habitats are expected to decrease. These changes are accompanied by potentially large increase in the extent of warmwater habitats which could adversely affect Coho."*[66] The authors notes in their report that although informative, it will be important to examine where these changes occur specifically to determine whether they might be a benefit (increasing extent of suitable thermal habitats, as in the Quesnel) or constraint (decreasing extent of preferable thermal habitats, as in the Chilcotin) on the productive capacity of Coho habitats.

[65] Nellitz and Porter (2009a).
[66] Nellitz and Porter (2009b).

Concern for future climate change and its effects on fish are not restricted to anadromous species such as salmon, but also to non-migratory species such as bull trout which form part of the Xeni Gwet'in diet. Bull trout are blue listed as a species of special concern in British Columbia. Nelitz and Porter prepared a third report –in 2009 - on the effects climate change may have on bull trout in the Cariboo Chilcotin. Their analyses suggest that for **all regional watersheds with resident bull trout the extent of preferred coldwater habitats will decrease considerably** under the varied climate change scenarios and that the extent of habitats considered thermally sub-optimal or potentially unusable by bull trout will increase.[67] The report stated that: *"The general patterns of this analysis do not, however, seem promising for bull trout. Bull trout are already considered a sensitive species within BC with very specific cold water habitat requirements, so further impacts to their remaining core habitats is likely a cause for concern.* ***The long term patterns suggest both an expected decrease in the total amount of cold water stream habitat and fragmentation of these colder areas into disconnected "patches" of suitable habitat.*** *Maintaining viable sized patches of cold water habitats for bull trout and ensuring unimpeded connectivity between them may become an important future issue for maintaining genetic exchange between increasingly isolated regional bull trout populations.* [68]

6. Xeni Gwet'in Climate Change Vulnerability Assessment

Climate change vulnerability is defined as the ability or inability of individuals or a group to cope with or adapt to climate impacts on their livelihood and well-being[69]. The following section is an assessment of the vulnerability of Xeni Gwet'in First Nation to potential climate changes and their impacts.

The Xeni Gwet'in, like many First Nations, have seen their fair share of changes to their way of life over the last few centuries. They have experienced colonization, the spread of new diseases, the imposition of the reserve system and the residential school system, continued encroachment by outside interests intent on carving up the territory for industrial forestry and mining, resort and real estate development. And the community increasingly faces the influences of western consumer culture through the TV, the internet and the education system.

Despite these changes or influences, the Xeni Gwet'in have maintained a relatively healthy community as compared to many First Nation communities in the Cariboo-Chilcotin. Many of the population continue to speak their mother tongue and pass on traditional ways, the people continue to hunt fish and collect, they have an excellent K-9 school system that teaches the Chilcotin language and culture and the community is actively engaged in political and cultural affairs. The community has also managed to protect a large part of its traditional territory and therefore have a relatively intact ecosystem, abundant with clean water supplies, wildlife, fish and wild horses. They have a moderately diversified energy system, a reliable water system and road maintenance system. They are relatively healthy and have managed not be overcome by substance abuse like other reserves.

[67] Nellitz and Porter (2009c).
[68] Nellitz and Porter (2009c).
[69] Tyndall Group for Climate Change Research, 2005

Nevertheless the community might be characterized as relatively vulnerable to potential climate changes, since they remain very dependent on one source of income (Federal government transfers) for their livelihood and maintenance and they have very little control over the land they actually inhabit and depend upon for sustenance.As well, they are increasingly dependent on food and technology imports, they have few people and resources to plan, monitor and enforce the management of their land or to invest in new enterprise. They also are increasingly subject to conflicts over land use in their territory, the results of which could jeopardize the health and biodiversity of their land and thereby their ability to cope with climate change.

Below is an assessment of Xeni Gwet'in First Nation based on the WEHAB+ framework developed by the Tyndall Group for Climate Change Research[70]. The WEHAB+ methodology is simply an acronym that stands for the six or more important supports for society:

W - Water
E - Energy
H - Health
A - Agriculture and Food Supply
B - Biodiversity
+ additional supports like human settlements and infrastructure

We use this framework but also add governance, livelihoods and culture as other important supports.

6.1. Biodiversity

The XGCA is one of the last intact dryland ecosystems on the east side of the Chilcotin range. In both the mountain areas, foothills and plateau there are large riparian areas ranging from open wetlands and closed canopy moist forest. These moist habitats provide habitat diversity in a mosaic of dry forests and grasslands. The XGCA has high alpine features mixed with barren mountain-sides and alpine meadows that experience cold temperatures most of the year. These rich habitats support an abundance of moose, mule deer, black bears and grizzly bears, mountain goats, California Big Horn Sheep, wolves and coyotes, beavers, marmots, tree nesting birds,waterfowl and many other species. The XGCA still supports almost all of the native flora that were present during the Pleistocene era and includes a population of wild horses whose ancestry may date back to the Spanish horses that migrated north from Central America. Its proximity to the coastal ranges and an abundance of glaciers has also blessed it with an abundance of clean freshwater in its many lakes, rivers and streams. These water bodies are home to one of the largest interior salmon runs in BC, providing spawning grounds for sockeye, Chinook, Steelhead, Coho, Chum and Kokanee as well as home to an abundance other endogenous cool water fish. This rich biodiversity is a result of a complex of diverse soils, water and topographic conditions but it is also a result of limited human use in the area.

This is not to say that there are no stresses on the XGCA ecosystem. There is increasing recreational tourism pressure on the land and water bodies, leading to more hunting, fishing, and camping, boating, off-road motorized and non-motorized access. There is also increased subsistence and recreational hunting and fishing by non-Xeni Gwet'in First Nations and and recreational hunters. Salmon stocks, as indicated in section 5.4, have recently experienced a significant decline for unknown reasons. There have been two significant fires in the last decade

[70] Tyndall Group for Climate Change Research (2005, p 42).

resulting in large burns, fireguards and new roads.[71] There is increasing mineral exploration activity in the area, not least of which includes the Prosperity Mine Project, which has led to tree clearing, drilling and more on- and off-road traffic.

As indicated in the climate projections and biophysical impacts in earlier sections, accelerated climate warming, will place more stress on the ecosystem than it has recently experienced. There will be impacts throughout the XGCA on vegetation, wildlife, fish and water resources. However, despite some of the human induced stresses on the ecosystem, the XGCA is still a fairly healthy and intact ecosystem, making it fairly resilient to potential climate changes. Conservation biologists agree that *"maintaining connectivity between natural habitats, and along altitudinal gradients, is a key strategy to allowing plant and animal species to adapt to climate change."*[72] And if the XGCA ecosystem is healthy and "resilient", the Xeni Gwet'in community, who depend significantly upon the land for their sustenance, their health and their culture, stand a better chance of coping with climate change. The World Bank states as much when commenting on the relationship between biodiversity and climate adaptation:

> *"Within any given ecosystem, functionally diverse communities are more likely to be resilient to climate change and climate variability than biologically impoverished communities."*[73]

The same holds true for communities and ecosystems outside the XGCA. The benefits of a healthy ecosystem accrue to ecosystems and communities downstream as well, since the ecosystem services produced in the XGCA flow out of the area benefitting all life.

> "*Mountain habitats...bestow multiple ecosystem, soil conservation, and watershed benefits. They are often centers of endemism, Pleistocene refuges, and source populations for restocking of more low-lying habitats. Mountain ecosystems influence rainfall regimes and climate at local and regional levels, helping to contain global warming through carbon sequestration and storage in soils and plant biomass. Wetlands are nature's kidneys, providing indispensable ecosystem services that regulate nutrient loading and water quality."*[74]

Where the Xeni Gwet'in may be vulnerable is if they cannot manage to maintain a healthy ecosystem due to increasing pressures from the outside world. There are significant logging and mining plans for the XGCA, which threaten to seriously disturb the existing balance. If this is the case and the land increasingly becomes fragmented by roads and development and the air, waters and soils become stressed by increased pollution, the ecosystem will be much less resilient to the stresses of climate change, which will undoubtedly affect the Xeni Gwet'in's ability to cope with climate change as well.

[71] The 2003 Chilko Fire and the 2009 Lava Canyon Fire were the largest in BC in both years.

[72] World Bank (2009).
[73] World Bank (2009).
[74] World Bank (2009).

6.2. Health and Safety

At present, there is one full-time nurse position in the community (Nemiah Valley) and a full-time nurse in Tatla Lake (two hours from Nemiah) but no doctor. The nearest ambulatory services are at Alexis Creek Reserve or Tatla Lake (over 1.5 hours away by road). Air ambulance is available from Williams Lake (0.5 hours away) for life threatening conditions pending weather conditions.

Despite having rather limited health services, the Xeni Gwet'in community is relatively healthy, although there is a moderate rate of substance abuse and addiction and the community is experiencing some increases in diabetes, asthma, heart disease and obesity likely due to changing diet.

Safety services and infrastructure are also very limited in the XGCA, there is no community fire service or fire crew or firefighting equipment in Nemiah or Chilko, or Tatla Lake, the airstrips in Nemiah and north Chilko Lake are too short to legally handle anything bigger than a Cessna 172 or Cessna 206 (4-6 seaters) and there is only one good road in and out of Nemiah and north Chilko. However, the Xeni Gwet'in community has very good road maintenance equipment and skills to develop fireguards and flood guards, it has recently developed an emergency preparedness plan and a wildfire protection plan for the reserve and certain high value sites in the great XGCA and the community is also served by the BC Wildfire Management Branch in case of emergencies.

The most immediate risk of climate change is the damage due wild fires, which could result in the loss of life (Xeni Gwet'in, non-Xeni Gwet'in residents, and visitors), the loss of property (homes, businesses, infrastructure and livestock), increased mental stress associated with these losses or potential losses and respiratory ailments due to smoke and ash. More long-term risks are associated with flooding in the spring[75]. Flooding has occurred regularly in Elkin Creek, Nemiah Creek and Konni Lake drainages and even in the Klokon Creek aquifer. Chilko Lake and Chilko River also regularly experience high levels that put property owners at risk. These and other residential areas of the XGCA as well as major roadways could experience more serious or frequent flooding in the future with milder winters. Because the Xeni Gwet'in have very limited health and safety services and they are remote and have limited access in and out of the area, they are fairly vulnerable to wild fires and flooding.

6.3. Water Supply

There is abundant, high quality water throughout the XGCA, with numerous glacier fed lakes and rivers. Access of potable water for household purposes by the Xeni Gwet'in is primarily through the community water system, based on a community well near the Band office, which draws on the Klokon aquifer. Approximately 9% of the Xeni Gwet'in residents are not on this system but use shallow Wells or an infiltration gallery. The community water system and other household systems are tested weekly and monitored closely. By and large the community wells and Klokon aquifer are quite healthy, with a sustainable yields of between 2.90 L/s and 5.0 L/s [76] during the summer

[75] Flooding does occur occasionally at certain points in the XGCA, which has impeded daily life for Xeni Gwet'in and non-Xeni Gwet'in residents. Klokon Creek and Elkins Creek are particularly vulnerable in Nemiah Valley as are the shorelines of Chilko Lake and the Chilko River, where a number of resorts are located. The Cariboo Regional District has kept some records of flooding in the area and now has a shoreline policy in place for property development but no comprehensive flood protection plan is in place for the Nemiah Valley or the XGCA.

[76] Sustainable yield of 2.96 L/s for WIN20361, 2.90 L/s for WIN20362. 5.0 L/s for WIN24154 – Kala Groundwater 2008.

season and below detection coliform counts. The Klokon aquifer on which the community depends is estimated to be quite large, stretching from the bifurcation of Klokon creek down to the valley bottom, which is expected to serve the community quite easily for years to come.

The Xeni Gwet'in rely on water sources other than their water systems. Because they are somewhat nomadic within the XGCA for traditional activities such hunting, fishing, collecting and back country riding, they often acquire drinking water from local streams, rivers, and lakes.

Water for non-potable uses such as gardening depends on these same systems, except in the case of large scale irrigation for hay farming. To irrigate fields in the Nemiah Valley, the Xeni Gwet'in use flood irrigation. This involves allowing natural flooding or diversions from nearby streams during the spring or early summer. Elkin's Creek Ranch however diverts water regularly from Elkin's Creek via a pump and sprinkler irrigation system. Other pasture lands in the XGCA are largely rain fed and wild, which the cattle, wildlife and wild horses graze on the fall, spring and summer. Watering of livestock is also dependent on water directly from streams or ponds and is largely unmanaged, leading to frequent and unmonitored contamination with fecal matter.

Climate change will bring a variety of risks to water supply but most of these are likely to occur in the medium to long-term, barring any damage to water systems or water courses due to fire or flood. Milder and wetter winters will cause peak flows to occur earlier in the spring or summer, which could lead to increased flooding but also less water stored as snow for flows in the late summer. Drier and hotter summers could lead to increased evapo-transpiration from XGCA lakes, streams and accelerated melting of glaciers, which in the short-term may not affect water flows but in the medium and long-term may result in reduced water flows in the summer. Both increased flooding in the spring and reduced flows in the summer could jeopardize property or potable water supplies.[77]. These events may also affect water supplies for livestock, wild life and vegetation.

The one weakness of the current water system is that it is fed by the Klokon glacier, which may be in jeopardy in the long-term with milder weather. However, should this system fail due to low glacial flows, Konni Lake has been designated the back-up water source for the community, which is quite large, deep and easily accessible by the community. The community is also near to Chilko Lake, which could also be a long-term source of freshwater. Hence, the Xeni Gwet'in might be considered fairly resilient as far as water supply goes due to the abundance of fresh water sources in the Nemiah Valley. This could change rapidly if outside interests begin contaminating these water sources as a result of industrial logging or mining in the area or if they attempt large scale water diversions.[78] None of these risks are improbable. Indeed, the Prosperity Mine project is at its final stage of review and it is only one mountain range away from the Nemiah Valley. Moreover, as the southern US becomes more arid due to climate changes, XGCA water may become a hot commodity and may either attract more development or attract increasing pressure to export.

[77] Flooding could cause contamination of wells and surface water as well as creating stagnant water in poorly drained areas. Increased evapotranspiration could result in lower flows, lesser recharging of water supplies and therefore result lower dilution ratios to particulates or contaminants.

[78] The Taseko Lakes were proposed to be part of a massive hydroelectric development which would have seen the flow of the Taseko River dammed and diverted westward via a tunnel to Chilko Lake, which would have been also dammed and diverted through further tunnels to Tatlayoko Lake on the Homathko River, which unlike the Taseko and Chilko Rivers drains directly to the ocean at Bute Inlet rather than via the Chilcotin and Fraser Rivers. Fisheries and aboriginal land claims concerns have derailed the Taseko diversion, although the Chilko diversion remains as a possibility.

6.4. Food Supply

The Xeni Gwet'in depend on a variety of food sources for their diet, including wild plants and animals, store bought food and some cultivated vegetables. Wild animals important to the Xeni Gwet'in for food include: mule deer and moose, salmon, trout and whitefish for protein. These meats and fish foods are typically caught in large batches in the spring and fall and canned or dried for winter food supplies and sharing. Wild plants important to the Xeni Gwet'in for food and medicines include but are not limited to wild potato, beartooth, Trapper Tea, Indian Hellebore, raspberry, saskatoon berry, chokecherry, soapberry, Kinnikinnik and strawberry. Some of these plants are dried or canned if sufficient quantities warrant and the products lend themselves to preservation. Some of the community also cultivate vegetables in the summer and can or preserve the surpluses where available. Ironically, many of the Xeni Gwet'in raise or have raised cattle but seldom slaughter them for eating, instead preferring to sell them for cash. Whatever is not obtained from wild sources or local gardens is supplemented by store bought food, often purchased in Williams Lake. Based on recent surveys roughly 70% of food supplies are purchased from commercial sources with a predominance of these purchases occurring in the winter months. Although this balance of wild, cultivated and store bought food sources is undoubtedly higher than most non-First Nations and urban dwellers it is gradually shifting to more store bought food as a result of easier access to commercial food sources and as a result of less hunting, fishing, collecting and gardening by younger generations.

Climate change may affect Xeni Gwet'in food supply in both negative and positive ways. In the immediate future the occurrence of wild fires may temporarily threaten the food security of the community because it may cause wild game to flee from traditional hunting areas, it may destroy summer gardens and/or it may hinder access to food imports (from town).

In the medium and long-term, however, as the climate increasingly warms some wild food sources may shift to new areas of the XGCA or disappear altogether which may lead to lower consumption of these wild foods. As mention in section 5.3, dry summers may cause moose to migrate to wetter and cooler environments. Drier summers may also cause wild potato, bear tooth, trapper tea, Indian hellebore and raspberry to die off at current elevations (section 5.2). Warmer rivers, lakes and oceans, caused by hot summers and mild winters, may also reduce salmon and trout populations significantly in the XGCA (section 5.4).

At the same time, the milder winters and warmer summers in the medium and long term may expand the growing season for new and existing crops. If the water is available and the Xeni Gwet'in are inclined towards agricultural development, there may be opportunities to expand their cultivated food supply. Moreover, with the help of more frequent wild fires, the availability of rangeland for cattle and mule deer may be expanded, making beef and deer meat more available. Drier summers may also invigorate the growth of saskatoon berry, chokecherry, soapberry, Kinnikinnik and strawberry, which are commonly harvested by the Xeni Gwet'in.

Hence, while climate change may reduce the availability of some wild foods, it may allow others to thrive and it may allow for greater agricultural production in the region, with the potential for making the Xeni Gwet'in's food supply more diverse.

6.5. Shelter and Infrastructure

Housing among most of the Xeni Gwet'in community might best be described as rustic. Much of the housing stock in the Nemiah Valley consists of small single family log homes that are relatively old (between 30 and 50 years). Some new stick frame and mobile homes exist as well but they do not appear to be aging very well.[79] These houses in the community are spread out sparsely in small clusters from Konni Lake to Chilko Lake. Despite the age of much of the log housing it is still relatively functional and comfortable. There are issues with rot and mold due to leaky roofs and leaky pipes, and ventilation as well as with draftiness and poor accessibility for seniors but recent renovations by the community have rectified some of these concerns. There continues to be a demand for new modern housing but INAC housing stipends are not sufficient to build new single family housing and few in the community can afford to finance a home themselves.

Infrastructure in the XGCA is relatively sparse and largely locally maintained. Water, energy, and health infrastructures have already been discussed in earlier sections, so these need no further discussion here. Sanitation, telecommunication and public buildings used by the Xeni Gwet'in are largely in the Nemiah Valley and are very small in scale. The road network in and out of the XGCA is comprised of tertiary gravel and bush roads and are partially maintained by the Xeni Gwet'in up to the Stone Reserve and thereafter maintained by the Interior Roads Ltd. There is only one four season gravel road accessing the Nemiah Valley from Highway 20. There is also one four season gravel road maintained by Interior Roads Ltd. into north Chilko Lake.

Other infrastructure like Xeni Gwet'in government buildings comprise of a Band Office, the Health and Social Services building, the daycare, the Tourism/Economic Development office, the Xeni Enterprise Trailer, the Public Works yard and the K-9 school, which are clustered together near the west end of Konni Lake. Telecommunication infrastructure is based on radio or satellite systems, with practically every household and office having access to one or the other. Sanitation is fairly decentralized with each household on septic fields and tanks, except for the public buildings and an adjacent sub-division which have a centralized septic system.

Climate change may affect Xeni Gwet'in housing and infrastructure in both immediate and longer term ways. In the immediate term the occurrence of wild fires may threaten the destruction or damage of housing and infrastructure. Houses, in particular, will be difficult to protect because they are so spread out throughout the Nemiah Valley. This is not the case for for community buildings, which are fairly centralized near the head of Konni Lake. Road access is the only mass evacuation route out of the XGCA at the moment and if it is blocked due to fire or damaged bridges, there are few alternatives for efficient evacuation. Telecommunication may be fairly resilient to wild fires because it is either based on radio or satellite systems, which are not dependent on a central hub in the region. Similarly, sanitation is fairly decentralized, except for the public buildings.

In the medium to long-term, wetter and milder winters and unpredictable storms may increase the incidence of flooding and wind damage in certain areas as well as the incidence of mold and mildew in the houses and public buildings if they are not well maintained. It may also wreak havoc on the roads networks due to more frequent icing and thawing or washouts.[80]

[79] Comments from Jon Tanis, Carpenter and resident of Nemiah Valley.

[80] Typically, winter is easier on the roads than the other seasons because the snow and ice act as a shield against wear and tear. With more frequent thawing, the roads could become quite slick and pot-holed. As well, floods have occurred east of Konni Lake and Elkins Creek and even at the Band office. These may become more common.

Firefighting capacity has been discussed above and needs no further elaboration. The Xeni Gwet'in have fairly strong capabilities to deal with road maintenance and repair but not bridge repair. They do not have much in the way of resources to monitor and deal for flood protection, sanitation repair and telecommunication equipment repair. They do have a number of good carpenters but few other trades people and few funds to undertake building repair, although INAC is theoretically obligated to finance these repairs in the event of an emergency or in the event of a health risk yet this does not always happen quickly.

6.6. Energy Supply

Comparatively speaking the people of the XGCA are relatively small energy consumers and are relatively diversified in their use of energy. All of the XGCA, except for Tatla Lake are off the BC Hydro electrical grid. The nearest BCHydro line is either Tatla Lake or Lee's Corner just passed the north east boundary of the XGCA. The entire area is also unserviced by natural gas but residents and operators can and do have propane and diesel delivered regularly. To provide power and heat for all those off the grid, a combination of diesel generator, propane, solar, wind and/or firewood are employed. Tsuniah Lodge also has access to hydro from its own micro-hydro system. The most common strategy for generating power in the XGCA is to use diesel, gas or propane generators. The most common strategy for generating heat is still wood fire stoves, furnaces or fireplaces. There are a number of solar/propane hybrid systems set up to serve a number of housing clusters in the Nemiah Valley. Some individual houses also have their own solar systems. There is also some exploration in the community concerning alternative energy sources including wind, mini-hydro, linking to the BCHydro grid, and bio-fuel. At the moment, the most feasible approach seems to entail a mini-hydro power station on Klokon Creek (above the Band office), which would have the capacity to power (not heat) the whole Nemiah Valley and more[81].

Climate change may affect Xeni Gwet'in energy systems in a number of ways. Firstly, wild fires induced by drier summers may put some of the existing power and heating systems at risk but because of the decentralized distribution of these systems it is unlikely that all systems would be affected. Secondly, drier summers may limit the capacity of the proposed new mini-hydro project if significant draw downs occur because of evapo-transpiration and low rates of replenishment. On the positive side, milder winters are likely to result in lower heating requirements for public buildings and households.

6.7. Livelihood

The Xeni Gwet'in sustains their livelihoods in a mix of ways. The most predominant means is through public sector transfers (mainly federal), in the form of Band government employment, BC Parks employment, social assistance, unemployment insurance, training subsidies or social security. The second most common means of support is by working outside of the XGCA, either in the service sector or in the resource sector (forestry and mining), on a seasonal basis. And the third means of support is by working in the XGCA tourism sector (B&B operation or guiding for wilderness resorts) or in the ranching sector (cow-calf operations). There is a significant tourism sector in the XGCA, including 11 resorts, 3 B&Bs, 3 guide-outfitters, and 4 boat/raft companies but few of the Xeni Gwet'in community are directly involved in it as yet. There are significant forest,

[81] Feasibility/predesign of the mini-hydro project is complete; now awaiting decision from Xeni Gwet'in Council as to whether or not they wish to pursue the project. Funding is somewhat dependent on INAC and BC Hydro. Chief Marilyn wants to have a referendum on whether Xeni Gwet'in should partner with BC Hydro.

wildlife, mineral and fishery resources in the region but the Xeni Gwet'in have yet to develop them except for subsistence purposes[82]. There may even by viable wind energy to exploit and sell into the grid at the north end of the territory. There are plans to do more with these resources and opportunities in the near future in a eco-friendly manner but the lack of capital and manpower make progress very slow.

The heavy dependence of the Xeni Gwet'in on the public sector is both an advantage and disadvantage in the face of climate change. Core public transfers to date have been relatively stable and are likely to stay that way as long as the Xeni Gwet'in are governed by the Indian Act. This means that the Xeni Gwet'in are somewhat insulated from the vagaries of the economy and the effects that climate change may have on the economy. However, the dependence on public transfers also limits the Xeni Gwet'in to a fairly low level of income, employment and investment. It also limits the level of community autonomy and the ability to pursue what it sees as its best interests in terms of a response to climate change.

There are three potential growth sectors that the Xeni Gwet'in are interested in pursuing in the future including: nature-based aboriginal tourism, eco-forestry & value-added wood products and natural/organic agriculture. Nature-based aboriginal tourism development is the key focus at the moment and involves plans for investments in guided tours, ceremonial meals and a destination resort.[83] Eco-forestry has also begun to be explored with the intention of focusing on small-scale ecosystem-based conservation forestry[84]. Agriculture has not been closely examined but the intention is to build on the Xeni Gwet'in ranching heritage and explore new opportunities for niche cultivation.

Climate change will have a mixed impact on all three of these economic sectors.

Nature-base Aboriginal Tourism

Wild fire poses a risk to business property and livestock, the temporary loss of wildlife for hunting and viewing, the loss of viewscapes, and the interruption of business operations. Warmer summers also may result in more frequent open camp fires bans for campers. And warmer waters pose a risk to fish stocks and therefore fishing tourism as well as the proposed cat-skiing operation proposed. On the other hand, wild fires could improve habitat for certain wildlife and thereby improve opportunities for hunting and wildlife viewing. And milder springs and falls could expand should seasons to make tourism more viable in the area.

Eco-Forestry & Value-added

The impacts of climate change on forests have been discussed in section 5.2. Suffice to say that climate change could result in the destruction of significant amounts of merchantable and non-merchantable timber through wild fires and new pests, which could greatly reduce the potential for forest harvests. However, climate change could also result in the new botanical opportunities (mushrooms, berries etc) and it could, in the long-run transform a large portion of the XGCA forest into Douglas-fir stands, which are typically more merchantable and of higher value than the current lodgepole pine dominated forests. The proposed Silva ecosystem-based forestry approach

[82] The Prosperity Mine at a copper/gold mine that is being proposed for the Fish Lake area in the XGCA. However, this project is opposed by the Xeni Gwet'in and most of the Tsilqot'in Nation.
[83] Ecolibrio (2009).
[84] Hammond and others (2004).

proposes an annual volume cut of 783m^3 distributed by selective and small batch cutting throughout the "eco-forestry zones of the region[85], which would leave the forest ecosystem essentially intact. As it is, the proposed approach does not account for the extensive fire risk occurring throughout the region as a result of the beetle kill infestation nor the potential transition the ecosystem may experience over the long-term. However, given the relatively small cut prescribed, it is likely that it will be easy to meet the annual cut with beetle kill wood alone and/or adjust to cutting to new areas if wildfires destroy proposed cutting areas. Moreover, since the forestry approach is ecosystem-based, any major changes to the ecosystem would hopefully be reflected in the approach to forestry.

Organic/Natural Agriculture

Ranching and haying are the main agricultural activities that the Xeni Gwet'in are engaged in the XGCA, although the level of activity has declined over the years due to poor returns on cattle sales. The community is looking to re-invigorate this commercial activity and perhaps partner with a meat processing facility in the region to market Xeni branded natural or organic beef products. They are also interested in investigating the potential of other commercially viable cultivated products in the region.

The most immediate risk to ranching and agricultural development in general in the XGCA is fire. Wildfires could kill, maim or scatter livestock, destroy hay fields and pastures, and damage fencing. At the same, time fire could also re-invigorate and expand grasslands for grazing in the medium to long-term, which would benefit ranching in the area. A milder fall and spring may also expand the growing season for new crops.

6.8. Governance

The Xeni Gwet'in First Nation government governs its community under the auspices of the Indian Act and the federal government of Canada. This means that most decision-making is carried out by the four members of the Xeni Gwet'in Band Council.[86] All of the community's planning, administration and social services, basic health care, housing administration, public works, economic development, external agency referrals and jurisdictional decision-making are carried out by the Band Government with some assistance of the Tsilqot'in National Government on regional planning issues. Most of the funding for these services comes from the federal government with small amounts also coming from the provincial government for designated projects. There are no other revenue sources for the Band government at this time. Although this funding covers most of the basic necessities of government, there is very little discretionary funding to deal with land use management issues in the XGCA.

Governing the community can not be easy. The community is fairly depressed economically, youth and young families regularly leave the area for work and education resulting in a capacity drain. The community is aging and the number of children is declining making it difficult to maintain the K-9 school. There are constant threats and pressures on the land from outside sources, including

[85] Hammond and others (2004).
[86] By-Elections for two council positions recently added a fourth member to Council, which will add capacity to the current Band Council affairs and decision-making.

most recently the push to establish the Prosperity Mine at Fish Lake and real estate development at the north end of Chilko Lake. There is also increasing unpermitted use by ATVs, mountain bikers, hunters and sports fishermen and boaters. On top of this, the community is fighting a rights and title case against the BC government in the BC Supreme Court.

Climate change will not directly affect community governance but the effects it will have on the land and on community assets could certainly add more stress to governing an already challenging situation. In the short-term, wild fires could destroy housing and public infrastructure, which could impede the regular activities of government. Long-term changes due to climate change will be more gradual but they will force more systematic changes to community development.

6.9. Culture

The Xeni Gwet'in are the original inhabitants of the XGCA, occupying and using the land for thousands of years. Culturally they regard themselves as people of the Tsilhqot'in Nation, which has a distinct language, a distinct system of meanings and values, a distinct kinship system and a distinct way of life marked by a blend of sub-arctic, plateau and coastal practices.[87] The Xeni Gwet'in are unusual among First Nation communities in the southern half of BC in retaining almost complete use of their own Chilcotin language and in continuing to hunt, fish and collect berries, roots and medicines from the land much the same way their ancestors did. It is not an accident that the Xeni Gwet'in culture is relatively strong. The community is remote and is not inundated by non-Xeni Gwet'in culture. It has its own K-9 school, wherein the language and the culture are taught. The community makes a real effort to gather together and celebrate its culture at regular times of the year. The children are taught and encouraged to ride and hunt, fish and collect. And the land has remained fairly healthy so hunting, fishing and collecting is relatively easy. Indeed, the strength of the Xeni Gwet'in culture is closely related to the health of the land, since their stories, their diet, their medicines, their seasonal movements and their social gatherings all revolve around a healthy land.

Although the Xeni Gwet'in culture is relatively strong, the culture is at risk of declining as the outside world increasingly influences the community through TV, radio, internet and consumer culture and as the youth travel or leave the community for work, education or marriage. Climate change will only stress the traditional culture further, since it will stress the land upon which the Xeni Gwet'in culture is inextricably linked. Salmon and trout fishing, to some extent hunting (moose) and collecting may become more difficult, which may negatively impact traditional food gathering and local self-sufficiency. Climate change could accelerate a shift that is already occurring away from traditional culture, perhaps to a more agrarian culture, if farming is taken up in a bigger way, or perhaps to a more western rural culture, if store bought foods become the sole food source. **There is no way of knowing how the Xeni Gwet'in culture will respond to the climate changes. However, what is guaranteed is that the adaptation choices available to the Xeni Gwet'in will become fewer if the biodiversity and resiliency of the land is compromised by unsustainable development. If the land remains healthy and resilient, it will more easily adapt to the coming climate changes and the same is true for the Xeni Gwet'in traditional culture.**

[87] Argument of Plaintiff, Volume 1. Roger Williams vs the Province of BC. P. 175

7. The Xeni Gwet'in Vision for Sustainable Development

The Xeni Gwet'in see themselves as stewards of the XGCA and envision sustainable development and human activity, grounded in an ecosystem-based approach to land use. The community intends to continue to be to hunt, trap, fish, and collect for sustenance. They intend to ranch and guide as they traditionally have as well as take a lead role in the administration of their local government and its services. They also intend to be engaged in new activities such as eco-forestry and value-added wood processing,cultural tourism, organic/naturalagriculture and alternative energy development. However, they intend to pursue these opportunities while minimizing impacts on the land and waters, leaving them as much as possible in a self-sustaining and wild state, so that there continues to be clean water, clean air and abundant fish and wildlife.

There may be other opportunities that the community may pursue but development in the XGCA must strengthen the community's well-being, its capacity for self-sufficiency as well as the Xeni Gwet'in people's capacity to realize their dreams and aspirations. Future development may utilize the best of mainstream technology and practices but it must also respect and conserve traditional values and practices of the Xeni Gwet'in culture.

The Xeni Gwet'in welcome the opportunity to work cooperatively with all their neighbours within the XGCA and outside to develop sustainable activities that are consistent with this vision.

8. Xeni Gwet'in Climate Change Adaptation Strategies

Adaptation to climate change can occur in many ways. Below are strategies that are based on the WEHAB+ framework used in the Vulnerability Assessment.

8.1. Biodiversity Protection and Conservation

The protection and conservation of biodiversity in the XGCA is the foundation for community resiliency in the XGCA. A healthy and resilient ecosystem allows for a healthy and resilient community and therefore a key strategy in the Xeni Gwet'in's adaptation plan must include the protection and conservation of biodiversity. The following are number of measures recommended by the community and the consultants to protect and conserve the biodiversity of the XGCA. They are divided into general, wildlife & wild horse and wild plant categories.

Objective #1. Maintain the XGCA ecosystem(s) intact

- Limit fragmentation of the XGCA area by roads, clearcuts, mines and real estate development (ongoing)
- Limit access to the XGCA wilderness, restricting road, water and air access to designated areas through implementation of the Xeni Gwet'in access management plan (ongoing)
- Continue with the Aboriginal/Wild horse Preserve for the XGCA, which maintains there be no industrial forestry, mining and hydro-electric development
- Adopt an ecosystem-based planning approach to all land use in the XGCA (short-term)
- Limit access to the XGCA wilderness, restricting road, water and air access to designated areas (ongoing access management)
- Establish baseline indicator data for biodiversity in the XGCA (short-term)

Objective #2. Conserve Wildlife and Wild Horses in the XGCA

- Establish clear protocols for sustainable range management with stakeholders (ongoing)
- Integrate natural and prescribed burns into the Wild Fire Protection Plan- to restore grassland and mixed forest/grassland ecosystems (short-term)
- Integrate peat preservation into Wild Fire Protection Plan (ensure peat meadow fires are extinguished after wildfires) (short-term)
- Monitor indicator wildlife and wild horse stocks and limit commercial, recreational and subsistence hunting as well as wild horse captures if stocks decline
- Investigate habitat modification to retain certain species (forest thinning to improve moose winter range) (Long-term)
- Restrict hunting during mating season (short-term)
- Continue to humanely catch a small number of wild horses, train them and use them as domestic stock (short-term)
- Ensure domestic horses and cattle are managed carefully to reduce the current levels of over-grazing from animals running free when they should be kept home and fed (e.g. Konni Lake range is severely over-grazed by domestic stock)(short-term)

Box 4: Community Ideas for Biodiversity Protection

Community Ideas – Biodiversity Protection

Wildlife

1. Reduce commercial/recreational hunting
2. Control subsistence hunting (take only what you need)
3. Xeni Gwet'in start monitoring for poaching and over-hunting (set up road check points)
4. No industrial logging or mining
5. Stop littering and polluting
6. Restrict hunting during mating season

Fish

1. Reduce commercial/recreational fish catches
2. Control subsistence fishing (take only what you need)
3. Work with lodges to monitor and control catches
4. No industrial logging or mining
5. Clear beaver dams from streams
6. Stop polluting the waters, esp. fire retardants and pesticides
7. Catch only big fish (leave small fish)
8. No net fishing

Wild Horses

1. No shooting of wild horses. If wish to cull the herd, catch them and sell them as stock.

Objective #3. Conserve Fish Stocks

- Monitor fish stocks and limit commercial, recreational and subsistence fishing if stocks continue to decline (short-term)
- Limit fish catches to large fish only (short-term)
- Transplant or re-introduce fish stocks to new or extirpated lakes or streams (mid to long-term)
- Preserve pristine watersheds from unsustainable development (e.g. Prosperity Mine) (short-term)
- Implement low impact irrigation practices (short-term)
- Dam and store water at Abelachez Lake to release water during the late summer months if necessary (mid to long-term)
- Improve fish passages by clearing culverts and streams of debris and beaver dams (ongoing)
- Encourage low impact forestry (if forestry is pursued) to protect riparian areas (short-term)
- Encourage low impact ranching (fence cattle, control runoff and designate watering areas) to protect riparian areas. Nemiah and Elkin creeks are a particular concern. (short-term)
- Clean or install new gravels at key cattle crossings on Nemiah Creek (short-term)
- Encourage riparian planting where needed (mid to long-term)
- See Water Protection and Conservation for more recommendations

Objective #4. Preserve Wild Plants in the XGCA

- Transplant traditional food/medicine plants that require moist to wet habitats (wild potato, glacier lily, bear tooth, trapper tea, Indian hellebore and raspberry). Assist migration as habitats shrink or move (mid to long-term)
- Protect wild plant gathering habitats from any ecosystem-based forestry, housing or tourism development (short-term).

8.2. Health and Safety Enhancements

Wild fire protection and prevention is perhaps the most urgent need in terms of adaptation for the Xeni Gwet'in community although flood protection may be an increasing threat as well. Large wild fires have already begun (summers of 2003 and 2009) and will likely continue. An emergency evacuation plan is in place, which will cover mass evacuation in the event of a wild fire and other events (floods). The recent wild fire protection plan developed by the community lays out a number of preventive strategies to address the risks in the short-term as follows:

Objective #1. Protect Residents and Key Cultural Sites from Wild Fires in the XGCA

<u>Short-term</u>

- Deliver FireSmart hand-outs to all households to encourage FireSmart landscaping for individual residences.
- Develop and pass a Band Council Resolution, with Band policy implemented, requiring that all future home construction, modifications, and renovations conform to FireSmart standards.
- Work closely with the appropriate agencies to carry out the necessary repairs to the mesh around the waste disposal pit and clear the forested area at least 30 metres around the entire perimeter.
- Acquire sufficient wildland firefighting equipment for 10 firefighters.
- Acquire sufficient equipment to manage and minimize wildfire threat i.e. mulcher, chipper.

- Appoint one individual with the responsibility to co-ordinate wildland firefighting activities through equipment acquisition and maintenance, and training coordination and supervision of firefighters.
- Obtain a Structural Protection Unit capable of deployment on up to three buildings at once.
- Work with the appropriate agencies to upgrade existing airstrips located in the XGCA that have been identified to date (Chilko and Nemiah) to provide a better alternative for emergency evacuation and address the population increases during the season where there is the most risk for wildfires in the area.
- Fuel modification and other works identified should be carried out on the areas listed in Appendix 1 to help minimize the potential impact of a forest fire on structures.
- Obtain appropriate insurance coverage for all Xeni Gwet'in homes and public assets
- Ensure that appropriate partner agencies have a copy of the Community Wildfire Protection Plan.

Mid to Long-term Measures

- Implement a science-based controlled burn program to reduce fuel loads around communities and to improve wildlife habitats in other areas where wildife suppression has led to unnatural conditions.
- Coordinate FireSmart practices with wilderness lodgesand residents in the area. Establish a fire safety committee for XGCA.
- Cut Fire Breaks or reduce fuel loads around the key cultural sites outside Nemiah Valley.
- Undertake road side thinning along the road from Nemiah through to the Stone reserve and from the north Chilko Lake through to the highway.
- Salvage dead pine in high lightening strike areas off reserve where feasible
- Re-introduce fire and identify areas where natural fires will be allowed to burn

These ideas are more comprehensive than those suggested by the community but they fairly consistent (see Box 5)

Box 5: Community Ideas for Wildfire Protection

Community Ideas – Wild Fire Protection

1. Fire safety education and education about emergency evacuation procedures for community members
2. More investment in silviculture in the area for spacing, thinning and controlled burning
3. Cut fireguards and cutting of beetle kill wood around the settlement areas in reserves
4. Establish a local fire crew, provide equipment and contact list and have fire kits (hoses, axes, etc.) at all fire hydrants in the community
5. Restrict forest fire suppression in select (high risk) areas that don't endanger life or property
6. Harvest beetle kill wood and remove it.
7. Remove fire hazards (dead trees, glass, oil etc.) from around houses

Objective #2. *Protect Residents and Key Cultural Sites from Floods in the XGCA*

Short-term

- Develop a Flood Protection Plan for high risk areas near homes, roads and cultural sites
- Contact Pacific Climate Impacts Consortium to undertake hydrological modeling in area to determine long-term flood risk in the area.
- Ensure that appropriate partner agencies have a copy of the Flood Protection Plan.

Mid to Long-term

- Monitor key lake, river and stream levels
- Acquire flood protection supplies and equipment from partnering agencies as needed.

8.3. Water Supply Protection and Conservation

Water is crucial to life and healthy potable water is crucial to good health. The Xeni Gwet'in and most other residents of the XGCA enjoy excellent water resources. To maintain secure sufficient volumes of quality water the follow recommendations are made:

Objective #1. Protect Key Potable Water Sources

Short-term[88]

- Educate the Xeni Gwet'in members about water protection (disposal of toxic chemicals, protection from livestock, water quality standards)
- Prohibit industrial logging, mining and hydro-electri developments in the XGCA
- Fence streams from cattle and designate cattle watering areas
- Establish a recycling depot in Nemiah for toxic chemicals
- Remove garbage that may leach toxic chemicals into water system (old cars, appliances, drums of chemicals, etc.)
- Clean up debris and garbage from streams
- Collect baseline data for key glaciers and rivers, lakes & aquifers (Klokon) in the XGCA
- Establish weather stations or rainfall monitoring equipment in several key locations in the XGCA
- Continue water quality monitoring on key lakes, rivers, streams and aquifers
- Begin water flow and temperature monitoring beyond the Chilko and Taseko rivers
- Begin glacier monitoring
- Monitor the water chemistry of Cheolquoit Lake (potential test case)

Mid to Long-term

- Coordinate water protection protocols with all wilderness lodges in the XGCA ensuring all parties meet the Canadian Water Quality Standards.

Objective #2. Conserve Potable Water

Short-term

- Educate the Xeni Gwet'in members about water conservation measures (reduced usage techniques)
- Repair pipe, faucet and toilet leaks
- Install low flow faucets and toilet tank boosters

[88] Many of these recommendations are courtesy of Cariboo Envirotech.

Mid to Long-term

- Install rainfall collectors and cisterns, at least for non-potable uses.
- Examine the need for water reservoirs to store peak flows for summer

These ideas are more comprehensive than those suggested by the community but they are fairly consistent (Box 6). A recurring action item put forward by the community was to restrict the industrial logging and mining in the XGCA. Prosperity Mine, in particular, was seen as a significant threat to the water quality of the area.

Box 6: Community Ideas for Water Conservation and Protection

Community Ideas – Water Conservation and Protection

1. Prohibit industrial mining (Prosperity Mine) and logging
2. More efficient water use.
3. Investigate alternate wells for community or sub-divisions
4. Clean up streams of debris and beaver dams. Trap beaver.
5. Protect water from litter and pollution. Recycle. Don't dump oil and anti-freeze on ground.

8.4. Food Supply Protection and Diversification

Wild foods are crucial to the health and the culture of the Xeni Gwet'in community but there is also realization that more cultivated foods (rather than store bought foods) could also enrich the community and make it more resilient to climate change.

Objective #2. Conserve and Use Wild Food Sources

- Preserve biodiversity (see biodiversity)
- Continue to subsistence hunt, fish and collect (but take only what you need) (ongoing)
- Continue to educate youth about hunting, fishing and collecting (ongoing)
- Transplant or cultivate traditional plant foods/medicines that are stressed to new more hospitable areas of the XGCA (long-term)

Objective #2. Increase Development and Diet Cultivated Food Sources

- Examine interest in raising cattle and poultry for sustenance (short-term)
- Investigate community/household slaughter options (short-term)
- Host workshop to educate Xeni Gwet'in members on how to start gardens and green houses (short-term)
- Establish clear protocols for sustainable range management with stakeholders (ongoing)
- Explore low impact irrigation system to produce more hay (mid-term)
- Explore opportunities for new crops that are suitable to warmer climate and wildlife (mid-term)

Objective #3. Increase Preservation of Wild and Cultivated Foods

- Host workshops to educate and encourage Xeni Gwet'in members to start canning, drying and using root cellars

Box 7: Community Ideas for Food Diversification

Community Ideas – Food Diversification

1. Hunt, fish, trap and collect wild roots and berries
2. Prohibit industrial mining and logging
3. Raise and butcher cows and chickens for meat
4. More gardening and greenhouses
5. Preserve/can more berries, fish, meat and vegetables
6. Bring back root cellars
7. Put in proper irrigation systems for hay production
8. More education for growing vegetables

8.5. Shelter and Infrastructure Protection

Shelter and infrastructure are most at risk from wildfires and floods and from mould and mildew issues. Section XX (Health and Safety) discusses wild fire and flood protection strategies at length so no further elaboration is required. Mould and mildew problems are addressed in Objective 2 below.

Objective #1. Protect Shelter and Infrastructure

- See Health and Safety recommendations

Objective #2. Reduce risk of Mould, Mildew and Rot

Short-term

- Continue monitor for mould, mildew and rot on a regular basis and apply housing renovation funds where available (short-term)
- Educate householders about how to monitor for mould, mildew and rot, how to ventilate their homes properly and how fix minor leaks (short-term)

Mid to Long-term

- Examine the need to redesign new housing for wetter and milder winters (e.g. better ventilation systems, better exterior drainage and wider roof overhangs) (long-term)

8.6. Energy Supply Protection, Conservation and Diversification

Energy systems are most at risk from wildfires and floods. Section 8.2 (Health and Safety) discusses wild fire and flood protection strategies at some length so no further elaboration is required. Energy conservation and diversification are discussed in objectives 2 and 3.

Objective #1. Protect Existing Energy Sources

- See Health and Safety recommendations

Objective #2. Strengthen Energy Conservation

Short-term

- Inspect Xeni Gwet'in housing and public building for drafts and install weather stripping where necessary
- Inspect Xeni Gwet'in housing and public buildings for insulation quality and install new insulation where necessary
- Where relevant replace incandescent bulbs with compact fluorescent bulbs and conventional power bars with smart power bars
- Where feasible install root cellars or cold rooms to supplement refrigeration

Mid to Long-term

- Where feasible replace old fridges and stoves with energy smart ones

Objective #3 Continue Energy Diversification

Short-term

- Continue to expand the hybrid systems (particularly the solar aspect) where cost effective
- Explore mini-wind units for hybrid systems
- Continue to pursue mini-hydro development but test for sensitivity to increased summer drought conditions.

Mid to Long-term

- Explore other renewable energy supply options such as wind, solar, geothermal and linking into the BC hydro grid system.
- Explore a district biomass heating system or a geothermal system for Xeni Gwet'in public buildings and the school
- Explore the development of wind energy at the boundary of the XGCA for sale into the BChydro grid

Box 8: Community Ideas for Energy Diversification

Community Ideas – Energy Diversification

1. More solar panels for hybrid systems
2. Wind power on reserve
3. Wind power near boundary of XGCA to sell into BCHydro grid

8.7. Livelihood Diversification

Moving the Xeni Gwet'in toward greater economic diversification will increase the level of wealth in the community, reduce dependence on federal government transfers, and increase the level of autonomy of the community has to make its own decisions. Moreover, if this diversification is done in a sustainable manner and it is planned with future climate changes in mind, it will strengthen community resilience. The three sectors that show particular promise for sustainable development are nature-based aboriginal tourism, natural or organic based agriculture and eco-forestry. These sectors should be developed with potential climate change impacts in mind. There may also be other enterprise opportunities arising out of housing and infrastructure upgrades, fire and flood protection, water conservation and biodiversity protection (adaptive enterprise development).

Objective #1. Develop Nature-based Aboriginal Tourism

Short-term

- Continue access management planning and measures
- Integrate cultural conservation and tourism development plans into the wild fire protection plan and measures
- Integrate tourism development plans into the community emergency evacuation plans
- Pursuekey key key airstrip improvements
- Investigate business and property insurance for on and off-reserve tourism enterprises

Mid to Long-term

- Develop and market non-fishing based products if fish stocks continue to decline
- Expand spring and fall shoulder season products if climate permits
- See biodiversity section for more recommendations

Objective #2. Develop Eco-forestry and Wood Products

Short-term

- Integrate wild fire protection planning and measures into eco-forestry development planning
- Undertake eco-forestry plan with new climate projections in mind
- Explore viability of FSC certification for forest and wood products
- Re-introduce fire and allow natural fires in select areas
- Explore business opportunities identified in Xeni Gwet'in Fibre Needs Analysis

Mid to Long-term

- Plant species mixes (in particular more Douglas-fir) with shelter to protect from frost
- Preserve and encourage aspen and other deciduous species
- See biodiversity section for more recommendations

Objective #3. Develop Natural/Organic Agriculture

Short-term

- Assess feasibility of organic/natural beef business
- Undertake an ecosystem-based plan for agriculture and tie in with tourism plans
- Integrate agriculture development plans into the wild fire protection plan and flood protection plan
- Investigate low impact irrigations options for hay production and other crops
- Explore range land management solutions to over grazing
- Integrate agriculture development plans into the community emergency evacuation plan, particularly livestock evacuation contingencies

Mid to Long-term

- Investigate new cultivation opportunities, particularly drought resistant varieties and water conservation techniques to cope with warmer and drier summers
- Control Invasive (non-native) species as grasslands expand, especially near roadsides.
- Investigate business and property insurance for on and off-reserve agricultural enterprises

Objective #4. Develop Other Adaptive Enterprise Opportunities

- Explore enterprise opportunities arising out of other adaptation measures (water, energy, food, biodiversity, shelter and infrastructure etc.)

8.8. Good Governance

Good governance in the face of climate change is about building community resilience towards climate impacts. The Xeni Gwet'in government is the key mobilizer in this task and has a lead role in all of the recommendations of this report, whether it be protecting XGCA biodiversity, managing health and safety, protecting community infrastructure and housing, diversifying the local economy or controlling access management into the XGCA. These things will not happen without its direction. However, it cannot undertake all of these responsibilities alone, so it is important that it consult with the Xeni Gwet'in members and other residents of the region regarding its adaptation plans to get buy-in and partnerships wherever possible to see its plans realized.

Objective #1. Incorporate Climate Adaptation Strategies into Local Governance Objectives

Short-term

- Inform and consult with Xeni Gwet'in population re adaptation plans
- Review priorities and determine what measures it will implement first
- Apply for Phase II funding to begin implementing the Adaptation Strategy
- Contact key regional, provincial and federal government to inform about adaptation plans and solicit resources and expertise to implement

Mid to Long-term

- Integrate climate adaptation objectives into all local government planning
- Monitor climate changes and review priorities as necessary

8.9. Cultural Preservation

Protecting the culture of the Xeni Gwet'in people is key to protecting the land and visa versa. Through the wisdom and the knowledge of the elders, the Xeni Gwet'in know-how to live off and care for the land. This wisdom protects the land. At the same time, the health of the Xeni Gwet'in traditional culture is closely linked to the health of the land, since the Xeni Gwet'in culture is closely tied to their hunting, fishing and collecting. Protecting the Xeni Gwet'in culture therefore involves retaining use and knowledge of the Chilcotin language and customs but it also involves protecting the health of the XGCA ecosystem.

Objective #1. Protect the Xeni Gwet'in Culture

- Continue to identify and protect cultural assets in the XGCA
- Integrate the protection of cultural sites into wild fire protection plan and flood protection plan and access management plan
- See biodiversity section for more recommendations

Box 9: Community Ideas for Cultural Protection

Community Ideas – Cultural Protection

1. Protect the land and it will protect the people
2. More cultural education of youth by elders and parents at home
3. More speaking to youth in our language by parents and elders at home and at school
4. More living off the land (hunting, fishing and collecting) and learning traditional ways from elders
5. Acknowledge and celebrate the elders
6. More community gatherings, potlucks and sweat lodges

Objective #2. Celebrate the Xeni Gwet'in Culture

- Encourage elders and parents to speak Chilcotin to the children at home.
- Continue to teach children about hunting, fishing, collecting and living from the land
- Continue to support Chilcotin studies in school and Culture Day
- Continue to support the traditional gatherings, healing ceremonies and sweats

9. XENI GWET'IN CLIMATE ADAPTATION ACTION & MONITORING PLAN

Biodiversity Protection and Conservation

Adaptation Objective	Actions	Priority[89]	Responsibility	Timeframe[90]	Funding Required
Maintain the XGCA as an intact ecosystem	• Limit fragmentation of the XGCA area by roads, clearcuts, mines and real estate development	1	Council	Ongoing	
	• Deactivate/de-commission unnecessary roads	1	Council	Short-term	
	• Adopt an ecosystem-based planning approach to all land use in the XGCA	1	Council	Ongoing	
	• As per the Xeni Gwet'in 1989 aboriginal preserve declaration and the 2002 wild horse preserve declaration, prohibit industrial logging and forestry in the area (ongoing)	1	Council	Ongoing	
	• Adopt Xeni Gwet'in Proposed Access Management Plan	1	Access Mgt Committee & Council	Short-term	
	• Establish baseline indicator data for biodiversity in the XGCA (short-term)	1	Fish & Wildlife Committee	Short-term	
	• Identify species at risk and develop conservation programs (e.g. grizzly bear recovery, sharptailed grouse recovery)	1	Fish & Wildlife Committee	Mid-term	
	• Obtain recognition from local to international level (e.g. IUCN) of the unique biodiversity qualities of the XGCA and aboriginal/wild horse preserve	3	Fish & Wildlife Committee	Mid-term	
Conserve Wildlife and Wild Horses in the XGCA	• Undertake a range management plan and establish clear protocols for sustainable range management with stakeholders	1	Nemiah Stockman's Association	Short-term	
	• Integrate natural and prescribed burns into the Wild Fire Protection Plan- to restore	1	Fire Protection Committee	Short-term	

[89] Priorities range from 1 to 5 ratings, with 1 the highest and 5 the lowest
[90] Timeframes range from short-term (0-5 yrs), mid-term (6-10 yrs) and long-term (11 yrs +)

	grassland and mixed forest/grassland ecosystems				
	• Integrate peat preservation into Wild Fire Protection Plan (ensure peat meadow fires are extinguished after wildfires)	1	Fire Protection Committee	Short-term	
	• Monitor indicator wildlife and wild horse stocks and limit commercial, recreational and subsistence hunting for wildlife and round-ups for wild horses if stocks decline	2	Fish & Wildlife Committee	Short-term Ongoing	
	• Manage wildlife species that are traditional foods such as moose and deer with a priority for Xeni subsistence first	4	Fish & Wildlife Committee	Long-term	
	• Habitat enhancement for grizzly, moose, big horn sheep and Whitebark to retain certain	2	Fish & Wildlife Committee	Short-term	
	• Restrict hunting during mating season	1	Fish & Wildlife Committee	Short-term	
	• Keep domestic horses and cattle off ranges as specified by range management permits	2	Nemiah Stockman's Association	Short-term	
	• Continue wild horse counts & habitat mapping	1	Nemiah Stockman's Association	Short-term	
	• Capture small numbers of wild horses humanely and sell them to good homes for for stock (do not kill)	2	Fish & Wildlife Committee	Short-term	
	• Protect migratory and resident birds and species at risk	2	Fish & Wildlife Committee	Mid-term	
	• Ensure protection of special natural features and specialized wildlife and fish habitats that include rare and endangered species	2	Fish & Wildlife Committee	Mid-term	
	• Manage trails, campgrounds and residences to minimize conflicts with grizzly and black bears	1	Fish & Wildlife Committee	Short-term	
Conserve Fish Stocks	• Monitor fish stocks and limit commercial, recreational and subsistence fishing if stocks continue to decline	1	Fish & Wildlife Committee	Short-term	
	• Limit fish catches to large fish only	1	Fish & Wildlife Committee	Short-term	
	• Transplant or re-introduce fish stocks to new or extirpated lakes or streams	3	Fish & Wildlife Committee	Mid-term	
	• Preserve pristine watersheds from unsustainable development (e.g. Prosperity Mine)	1	Council	Short-term	
	• Implement low impact irrigation practices	3	Nemiah Stockman's	Short-term	

	(short-term) • Dam and store water at Abelachez Lake to release water during the late summer months if necessary • Improve fish passages by clearing culverts and streams of debris and beaver dams • Encourage low impact forestry (if forestry is pursued) to protect riparian areas • Encourage low impact ranching (fence cattle, control runoff and designate watering areas) to protect riparian areas. Nemiah and Elkin creeks are a particular concern. • Clean or install new gravels at key cattle crossings on Nemiah Creek • Encourage riparian planting where needed **NOTE - See Water Protection and Conservation for more recommendations**	4 1 1 1 4	Association Fish & Wildlife Committee Fish & Wildlife Committee Council Council Fish & Wildlife Committee Fish & Wildlife Committee	Mid to Long-term Short-term Short-term Short-term Short-term Mid to Long-term	
Preserve Wild Plants & the Habitats in the XGCA	• Transplant traditional food/medicine plants that require moist to wet habitats (wild potato, glacier lily, bear tooth, trapper tea, Indian hellebore and raspberry) (mid to long-term). Assist migration as habitats shrink or move.	1	Elders	Mid to Long-term	

Health and Safety Enhancements

Adaptation Objective	Actions	Priority	Responsibility	Timeframe	Funding Required
Protect Residents and Key Cultural Sites from Wild Fires in the XGCA	• Deliver FireSmart hand-outs to all households to encourage FireSmart landscaping for individual residences. • Develop and pass a Band Council Resolution, with Band policy implemented, requiring that all future home construction, modifications, and renovations conform to FireSmart standards.	1 1	Fire Protection Committee Council	Short-term Short-term	

	• Work closely with the appropriate agencies to carry out the necessary repairs to the mesh around the waste disposal pit and clear the forested area at least 30 metres around the entire perimeter.	1	Council	Short-term	
	• Acquire sufficient wildland firefighting equipment for 10 firefighters.	1	Fire Protection Committee	Short-term	
	• Acquire sufficient equipment to manage and minimize wildfire threat i.e. mulcher, chipper.	1	Fire Protection Committee	Short-term	
	• Appoint one individual with the responsibility to co-ordinate wildland firefighting activities through equipment acquisition and maintenance, and training coordination and supervision of firefighters.	1	Council	Short-term	
	• Obtain a Structural Protection Unit capable of deployment on up to three buildings at once.	1	Council	Short-term	
	• Work with the appropriate agencies to upgrade existing airstrips located in the XGCA that have been identified to date (Chilko and Nemiah).	1	Fire Protection Committee	Short-term	
	• Fuel modification and other works identified should be carried out on the areas listed in Appendix 1.	1	Fire Protection Committee	Short-term	
	• Obtain appropriate insurance coverage for all Xeni Gwet'in homes and public assets	1	Council	Short-term	
	• Ensure that appropriate partner agencies have a copy of the Community Wildfire Protection Plan.	1	Council	Short-term	
	• Coordinate FireSmart practices with resorts and residents in the area. Establish a fire safety committee for XGCA.	2	Fire Protection Committee	Mid to Long-term	
	• Cut Fire Breaks or reduce fuel loads around the key cultural sites outside Nemiah Valley.	2	Fire Protection Committee	Mid to Long-term	
	• Undertake road side thinning along the road from Nemiah through to the Stone reserve and from the north Chilko Lake through to the highway.	3	Fire Protection Committee	Mid to Long-term	
	• Salvage dead pine in high lightening strike areas off reserve where feasible				

	• Re-introduce fire and identify areas where natural fires will be allowed to burn	2	Fire Protection Committee	Mid to Long-term	
Protect Residents and Key Cultural Sites from Floods in the XGCA	• Develop a Flood Protection Plan for high risk areas near homes, roads and cultural sites • Contact Pacific Climate Impacts Consortium to undertake hydrological modeling in area to determine long-term flood risk in the area. • Ensure that appropriate partner agencies have a copy of the Flood Protection Plan. • Monitor key lake, river and stream levels • Acquire flood protection supplies and equipment from partnering agencies as needed.	2 4 3 2 3	? Council/Science Committee Council Fish & Wildlife Committee Health Dept	Short-term Mid-term Short-term Short-term Mid-term	

Water Supply Protection and Conservation

Adaptation Objective	Actions	Priority	Responsibility	Timeframe	Funding Required
Protect Key Potable Water Sources	• Educate the Xeni Gwet'in members about water protection (disposal of toxic chemicals, protection from livestock, water quality standards) • Prohibit industrial logging and mining in the XGCA (no Prosperity Mine) • Fence streams from cattle and designate cattle watering areas • Establish a recycling depot in Nemiah for toxic chemicals • Remove garbage that may leach toxic chemicals into water system (old cars, appliances, drums of chemicals, etc.) • Clean up debris and garbage from streams • Collect baseline data for key glaciers and rivers, lakes & aquifers (Klokon) in the XGCA • Establish weather stations or rainfall monitoring equipment in several key locations	1 1 2 2 1 1 1 3	Health Dept Council Nemiah Stockman's Association Recycling Committee Recycling Committee Fish & Wildlife/Recycling Watershed Committee Watershed	Short-term Short-term Short-term Short-term Short-term Short-term Short-term Short-term	

	in the XGCA • Continue water quality monitoring on key lakes, rivers, streams and aquifers • Begin water flow and temperature monitoring beyond the Chilko and Taseko rivers • Begin glacier monitoring • Monitor the water chemistry of Cheolquoit Lake (potential test case) • Coordinate water protection protocols with all wilderness lodges in the XGCA ensuring all parties meet the Canadian Water Quality Standards.	 1 2 3 3 2	Committee Watershed Committee Watershed Committee Watershed Committee Watershed Committee Watershed Committee	 Short-term Short-term Short-term Short-term Short-term	
Conserve Potable Water	• Educate the Xeni Gwet'in members about water conservation measures (reduced usage techniques) • Repair pipe, faucet and toilet leaks • Install low flow faucets and toilet tank boosters • Install rainfall collectors and cisterns, at least for non-potable uses. • Examine the need for water reservoirs to store peak flows for summer	1 3 3 3 5	Health Dept Housing Dept Housing Dept Housing Dept Watershed Committee	Short-term Short-term Short-term Mid-term Long-term	

Food Supply Protection and Diversification

Adaptation Objective	Actions	Priority	Responsibility	Timeframe	Funding Required
Conserve and Use Wild Food Sources	• Preserve biodiversity (see biodiversity) • Encourage subsistence hunt, fish and collect (but take only what you need) • Continue to educate youth about hunting, fishing and collecting (ongoing) • Transplant or cultivate traditional plant foods/medicines that are stressed to new more hospitable areas of the XGCA (long-term)	1 1 2	Fish & Wildlife Committee Fish & Wildlife Committee ?	Ongoing Ongoing Mid to Long-term	

	• Foster First Nations marketing of morel mushroom harvest linked to wildfires and controlled burn areas	1	?	Short-term	
Increase Development and Diet of Cultivated Food Sources	• Examine interest in raising cattle and poultry for sustenance • Investigate community/household slaughter options • Host workshop to educate Xeni Gwet'in members on how to start gardens and green houses • Establish clear protocols for sustainable range management with stakeholders • Explore low impact irrigation system to produce more hay • Explore opportunities for new crops that are suitable to warmer climate and wildlife • Enhance marketing of sustainably harvested wild foods such as morel and other mushrooms,	2 3 1 1 3 3 1	Nemiah Stockman's Assoc./ Health Dept Nemiah Stockman's Assoc./ Health Dept Health Dept Nemiah Stockman's Assoc Nemiah Stockman's Assoc Econ Dev Econ Dev	Short-term Short-term Short-term Short-term Mid-term Mid-term Short-term	
Increase Preservation of Wild and Cultivated Foods	• Host workshops to educate and encourage Xeni Gwet'in members to start canning, drying and using root cellars	1	Health Dept	Short-term	

Shelter and Infrastructure Protection

Adaptation Objective	Actions	Priority	Responsibility	Timeframe	Funding Required
Protect Shelter and Infrastructure	• See Health and Safety recommendations				

Reduce risk of Mould, Mildew and Rot	• Continue monitor for mould, mildew and rot on a regular basis and apply housing renovation funds where available • Educate householders about how to monitor for mould, mildew and rot, how to ventilate their homes properly and how fix minor leaks • Examine the need to redesign new housing for wetter and milder winters (e.g. better ventilation systems, better exterior drainage and wider roof overhangs) (long-term)	1 2 4	Housing Dept Housing Dept Housing Dept	Short-term Short-term Mid to Long-term	

Energy Supply Protection, Conservation and Diversification

Adaptation Objective	Actions	Priority	Responsibility	Timeframe	Funding Required
Protect Existing Energy Sources	• See Health and Safety recommendations				
Strengthen Energy Conservation	• Inspect Xeni Gwet'in housing and public buildings for drafts and install weather stripping where necessary • Inspect Xeni Gwet'in housing and public buildings for insulation quality and install new insulation where necessary • Where relevant replace incandescent bulbs with compact fluorescent bulbs and conventional power bars with smart power bars • Where feasible install root cellars or cold rooms to supplement refrigeration • Where feasible replace old fridges and stoves with energy smart ones • Explore a bus or car pool system for trips	1 2 1 3 4	Housing Dept Housing Dept Housing Dept Health Dept Housing Dept	Short-term Short-term Short-term Mid–term Mid-term	

	to Williams Lake to help reduce fossil fuel consumption	2	?	Mid-term	
Continue Energy Diversification	• Continue to expand the hybrid systems (particularly the solar aspect) where cost effective • Explore mini-wind units for hybrid systems • Continue to pursue mini-hydro development but test for sensitivity to increased summer drought conditions. • Explore other renewable energy supply options such as wind, solar, geothermal and linking into the BC hydro grid system. • Explore a district biomass heating system or a geothermal system for Xeni Gwet'in public buildings and the school • Explore the development of wind energy at the boundary of the XGCA for sale into the BChydro grid	1 2 1 1 1 2	Xeni Gwet'in XG XG XG/Econ Dev XG/Econ Dev XG/Econ Dev	Short-term Short-term Short-term Short-term Short-term Mid-term	
Livelihood Diversification					
Adaptation Objective	**Actions**	**Priority**	**Responsibility**	**Timeframe**	**Funding Required**
Develop Nature-based Aboriginal Tourism	• Continue access management planning and measures • Integrate cultural conservation and tourism development plans into the wild fire protection plan and measures • Integrate tourism development plans into the community emergency evacuation plans • Pursue airstrip improvements • Investigate business and property insurance for on and off-reserve tourism enterprises • Develop and market non-fishing based products if fish stocks continue to decline • Expand spring and fall shoulder season	1 1 1 1 2 2	Access Mgt Committee Fire Protection Committee Health Dept XG/Econ Dev Econ Dev Econ Dev	Short-term Short-term Short-term Short-term Short-term Mid-term	

	products if climate permits • See biodiversity section for more recommendations	3	Econ Dev	Mid-term	
Develop Eco-forestry and Wood Products	• Integrate wild fire protection planning and measures into eco-forestry development planning • Undertake eco-forestry plan with new climate projections in mind • Explore viability of FSC certification for forest and wood products • Re-introduce fire and allow natural fires in select areas • Explore business opportunities identified in Xeni Gwet'in Fibre Needs Analysis • Plant species mixes (in particular more Douglas-fir) with shelter to protect from frost • Preserve and encourage aspen and other deciduous species • See biodiversity section for more recommendations	1 1 2 1 2 4 4	Econ Dev Econ Dev Econ Dev Fire Protection Committee Econ Dev Econ Dev Econ Dev	Short-term Short-term Short-term Short-term Mid to Long-term Mid to Long-term Mid to Long-term	
Develop Natural/Organic Agriculture	• Assess feasibility of organic/natural beef business • Undertake an ecosystem-based plan for agriculture and tie in with tourism plans • Integrate agriculture development plans into the wild fire protection plan and flood protection plan • Investigate low impact irrigations options for hay production and other crops • Explore range land management solutions to over grazing • Integrate agriculture development plans into the community emergency evacuation plan, particularly livestock evacuation contingencies • Investigate new cultivation opportunities, particularly drought resistant varieties and water conservation techniques to cope with warmer and drier summers	1 1 2 3 1 2 2	Econ Dev Econ Dev Fire Protection Committee Nemiah Stockman's Committee Nemiah Stockman's Committee Health Dept/Nemiah Stockman's Assoc Econ Dev	Short-term Short-term Short-term Short-term Short-term Mid to Long-term	

	• Control Invasive (non-native) species as grasslands expand, especially near roadsides. • Investigate business and property insurance for on and off-reserve agricultural enterprises	2 2	Nemiah Stockman's Committee Econ Dev	Mid to Long-term Mid -term	
Develop Other Adaptive Enterprise Opportunities	• Explore enterprise opportunities arising out of other adaptation measures (water, energy, food, biodiversity, shelter and infrastructure etc.)	2	Econ Dev	Short-term	

Good Governance

Adaptation Objective	Actions	Priority	Responsibility	Timeframe	Funding Required
Incorporate Climate Adaptation Strategies into Local Governance Objectives	• Inform and consult with Xeni Gwet'in population re adaptation plans • Review priorities and determine what measures it will implement first • Apply for Phase II funding to begin implementing the Adaptation Strategy • Contact key regional, provincial and federal government to inform about adaptation plans and solicit resources and expertise to implement • Integrate climate adaptation objectives into all local government planning • Monitor climate changes and review priorities as necessary	1 1 1 2 2 2	Council Council Econ Dev Council Band Mgr Council & Committees	Short-term Short-term Short-term Short-term Short-term Mid to Long-term	

Cultural Preservation

Adaptation	Actions	Priority	Responsibility	Timeframe	Funding

Objective					Required
Protect the Xeni Gwet'in Culture	• Develop a program to identify from elders, map and protect burial/cremation sites and other cultural/heritage features before the specifics are lost in time • Continue to protect cultural assets in the XGCA • Integrate the protection of cultural sites into wild fire protection plan and flood protection plan and access management plan • See biodiversity section for more recommendations	1 1 1	? ? Fire Protection Committee	Short-term Short-term Short-term	
Celebrate the Xeni Gwet'in Culture	• Encourage elders and parents to speak Chilcotin to the children at home. • Continue to teach children about hunting, fishing, collecting and living from the land • Continue to support Chilcotin studies in school and Culture Day • Continue to support the traditional gatherings, healing ceremonies and sweats	1 1 1 1	? ? ?	Ongoing Ongoing Ongoing Ongoing	

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BACKGROUND PAPERS

(**NOTE** –The following papers were key supporting documents for this paper and have been submitted as separate files)

1. Tine Rossing (Ecolibrio): Water Resources and Climate Change in the Xeni Gwet'in Caretaker Area

2. Deb Delong (Orman Consulting): Climate Change Impacts on Forests and Vegetation in the Xeni Gwet'in Caretaker Area

3. Wayne McCrory (McCrory Wildlife Services): Climate Change and Wildlife and Wild Horse Impacts in the Xeni Gwet'in Caretaker Area

4. Richard Holmes (Cariboo Envirotech Ltd.): The Impacts of Climate Change on the Fishery Resource in the Xeni Gwet'in Caretaker Area