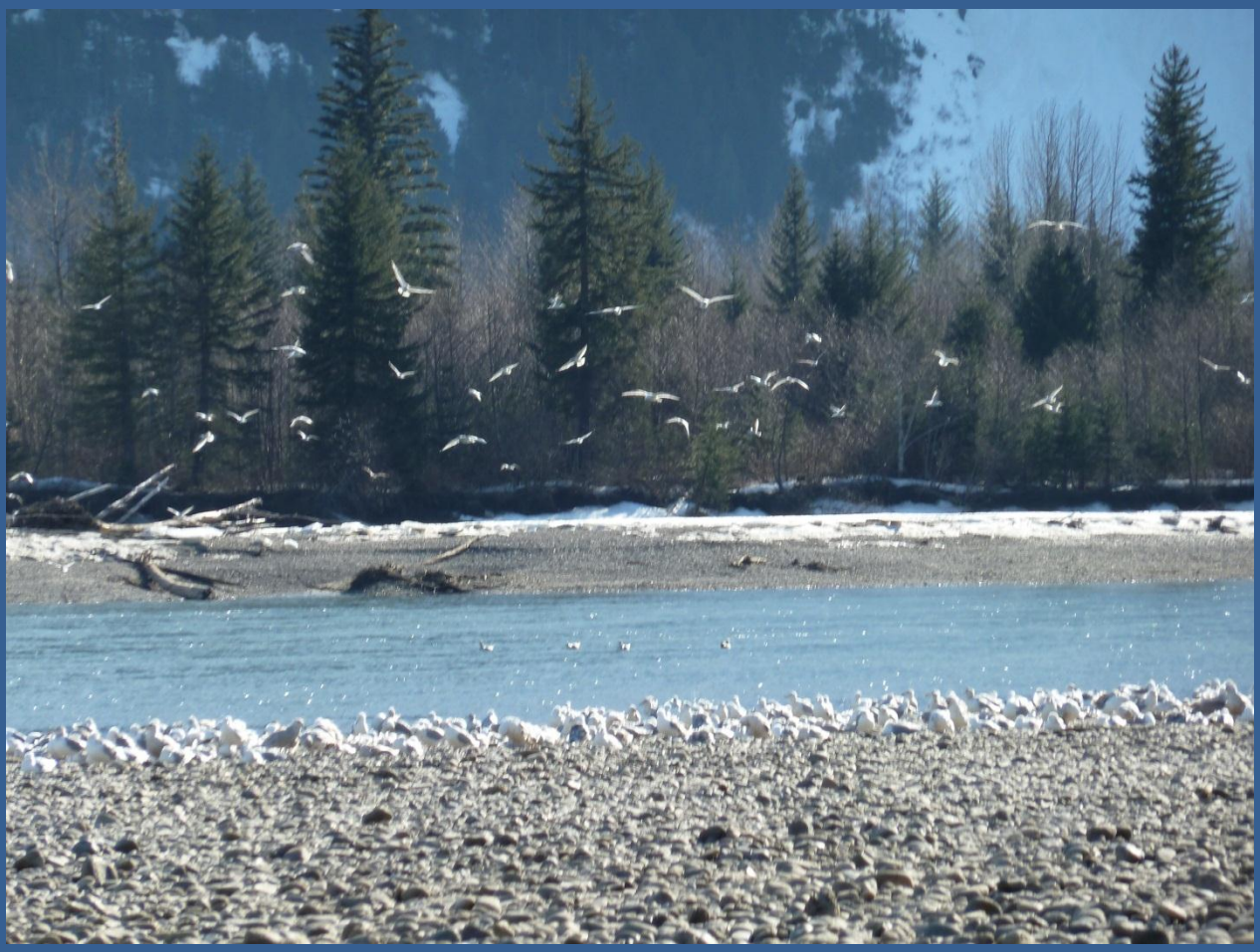

Climate Change Adaptation Planning for Northwest Skeena Communities

A Report for Communities on opportunities, tools, and challenges for adaptive and integrated management of forests, fish, and local values in a changing climate.

Research Team

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This report is the result of interdisciplinary collaboration between practitioners, experts, academics, and communities. This project would not have been possible without the knowledge and contributions of community leaders and stakeholders in Lax Kw ‘alaam, Terrace, and Prince Rupert. We are grateful also to the Board of Directors of Coast Tsimshian Resources for giving our team the opportunity to work together on this unique initiative.

Coast Tsimshian Resources LP

BRINKMAN FOREST LTD.

UBC

WWF

BRITISH COLUMBIA
Ministry of Forests, Lands and Natural Resource Operations

Environment Canada
Environnement Canada

ESSA

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Forward

Thank you to the research team, the community leaders and leaders in Lax Kw 'alaams and Coast Tsimshian Resources for joining us in this step in the journey to sustainability.

The place: Every year since 1975 I've worked in awe of the powerful Pacific storms and moisture so obviously shaping the great coastal forests. These forests feed the mist and rain back to the ocean through the spectacular Skeena River watershed. The Skeena's annual protein pulse of magnificent salmon is the primary diet of the hardy First and Second Nations' people. In fact, the people of the NW Skeena region may depend on salmon to a greater degree than any other people on earth.

In 2003, after planting over a hundred million trees in the Skeena region, Brinkman Forest was asked by the Lax Kw 'alaams Tsimshian community to help manage some new timber harvest volumes returned by the BC government's aboriginal reconciliation.

The mission: In 2004, finding little value in the Forest Service 'take-back' trees, Lax Kw 'alaams took a leap of faith and bought the half million hectares remaining of BC's Tree Farm License #1, plus a similar AAC quota volume (Forest License #16835) in the Kalum Timber Supply Area, from New Skeena's old receiver[1].

One thing we quietly did before the TFL#1 and FL#16835 purchase closed was run a fairly crude ClimateBC model to examine future climate impacts on the Skeena region's forests. This early model suggested the Biogeoclimatic zone species Hw/Ba might handle the predicted warming and subsequent wetter conditions (which may offset the risk of increased drought stress), for several decades at least.

Coast Tsimshian Resources and Brinkman Forest's first mandate was to survive the worst forest products market in BC history with the timber remaining after decades of over-harvesting the best of TFL#1. So, Lax Kw 'alaams Chief Counselor Garry Reese and counsel, and band administrator Wayne Drury, CEO of CTR, continued trading in the tradition of the Tsimshian people and CTR became the first First Nation business in Canada to open an agency office in China. In 2006 it began selling logs into South East Asia as well as throughout BC and in 2009 built a log debarker and merchandizing yard in Prince Rupert. CTR's initiatives reanimated the NW Skeena region forest sector, which just 5 years earlier was in a stunned, post receivership, standstill. Today in 2012, this study is of a region where aboriginal communities are emerging as the dominant timber license holders and play an increasing role in rural investment in energy, mining and transportation.

[1] Larry Prentice, well-known director of the Insolvency Institute of Canada, handled this assembly of pulpmills, saw mills and half dozen forest licenses through a five full cycle through the Companies' Creditors Arrangement Act. To flavor his experience in his keynote talk to the 2006 Canadian Insolvency Foundation's conference, he titled it *Forest Stump: Issues in Selling New Skeena's Box of Chocolates.*

Adaptation: In December 2006, in Nairobi, Kenya, I woke up to the need to engage local community action, rather than working for a global climate agreement, at a UN climate delegation debate. Developing nations faced adaptation challenges from climate change which they did not cause. We also work with aboriginal communities who face climate change they did not cause, and who now face the challenge of managing the forest without the benefits that existed beforethe forest license was exploited.???

When the Future Forest Ecosystem Science Council (FFESC) formed to 'promote research that supports adaptation of BC's forest management framework to anticipated effects from climate change in 2008, and then held a workshop to guide researchers into regional community adaptation processes in 2009, the question was: Who would make the best team?

The team: Also at the FFESC workshop was Dave Marmorek of ESSA Technologies, who had been analyzing questions associated with climate impacts on forests and fish values for a generation. Dave was accompanied by his client, Lars Reese-Hansen, a Terrace local and Ministry of Environment Stewardship Program coordinator for Fisheries Sensitive Watersheds and Temperature Sensitive Streams. Lars needed a study area to develop stream function monitoring methods—what better area than his childhood backyard, the Lakelse drainage. The work was done through ESSA's stream team, Mark Porter, Darcy Pickard and Katherine Wiekowski working closely with MOE consulting fisheries biologist Derek Tripp. On the climate side, ESSA's Don Robinson, Systems Ecologist brought a strong climate impact and modeling background through which to coordinate with University of Victoria adjunct professor Jed Kaplan, who was working with another Canadian researcher Joe Melton, on the EU's study on forest and agriculture vegetation adaptation to climate, using a new modeling tool running out of the University of Lausanne, Switzerland.

Recommended by Wayne Drury, CEO of CTR was Ralph Mathews, UBC Sociology professor emeritus whose career in the human dimension of environmental change involved climate adaptation studies on BC's coastal communities, including Lax Kw 'alaams, and on other northern aboriginal communities in addition to coastal civic communities. Ralph's assistant instructor Robin Sydney-Smith and two incredibly competent PhD students, Georgia Piggot and Jordon Tesluk, whose statistical analysis and people skills guided the 150 community leaders' interview process, were also involved. Ralph connected the project to UBC Forestry Department's Steward Cohen, who was seconded to UBC by Environment Canada and is a rare national expert on the fine adaptation art of integrating socio-metric and bio-metric climate research to create community engagement.

James Casey, a local Terrace conservation analyst at the World Wildlife Fund led the partnership with Coast Tsimshian Resources to develop a regional water and forest impacts modeling study, for which he engaged Cortex Consultants. WWF funded the development of the climate sensitive regional cumulative impact framework for Management Options Analysis and scenario- based planning and embedded the FSW monitoring indicators. WWF also contributed the NW Skeena Community Adaptation 'toolkit', designed and developed by James, which gives interested stakeholders an interactive, accessible summary of the report and helps to foster continued dialogue on multi-level adaptation. . James coordinated closely with the adaptation research work throughout and his passion for the region and commitment to the project was a strong driver for much of the work.

Coordinating the diverse teams to integrate this material and bring together coherent results required a strong personality with unique skills. Richard Chavez, a Yale graduate forester who became CTR's second forest planner, supported the coordination in 2010 as the project started, but CTRs market challenges eventually took priority. In late 2010, Katie McPherson emerged from assistant supervision of field planting operations,a position which funded her Masters in Emergency Response, and took over project coordination responsibilities; climate change is a slow moving disaster and integrating independent researchers' work was as complex as the human/environment dynamic. Without Katie's strong coordinating skills, which t redirected the project back on course time and time again, along with her strong writing skills and focus, we would not have this report to present.

Results: The sociology team's interviews confirmed the region's fish-centric values. Emerging from the public workshops in the civic communities of Prince Rupert and Terrace was a strong determination to develop an independent Skeena Basin decision-making network. In Lax Kw 'alaams, the elders emphasized educating youth is the next step towards integrated regional stewardship between these communities. Both community leaders are determined to make sure development is done right to protect the regions' incredible natural wealth, especially its vulnerable fish values which are at the center of every community's value set. The civic and First Nation communities must coordinate for coherent local stewardship, to guide the $30 billion in regional capital investment coming into the region. The research team recognizes the value of continuing dialogue between the strong leadership in each of these communities.

The climate modeling found that the region will warm 5-8^{o}C in spring/summer, making dry periods several weeks longer. Though this will be offset by 30% higher precipitation in the fall/winter, it is the dry period and peak storms which will cause problems. How many problems? It is difficult to predict, as the magnitude of temperature and precipitation pattern changes depend on future global emissions. However, extreme precipitation events are likely to increase, primarily in the cold season months, and extreme minimum and maximum temperatures are also likely to increase. Increasing variability of shifts from climate 'normal' patterns within which current tree species evolved, will severely stress many of these species, certainly before their life-cycle/rotation is complete. Climate change puts timber, fish, fresh water and biodiversity values in the Skeena basin at risk, and compels ongoing monitoring and further careful research.

The fisheries biologists trained a local team in the Fisheries Sensitive Watershed protocol and began data collection for long term cooperative management in the Lakelse pilot. Substantive progress was made in defining practical indicators for stream function monitoring. The work continues and the team is proud of this collaborative first step toward setting practical guidelines for local stream keepers.

The absolutely rich and thoughtful results and challenges you will find in this report compel Coast Tsimshian Resources and Brinkman Forest to continue leading emerging climate and sustainable development initiatives in the region.

Thank you: We are grateful for the thoughtful engagement and support from today's leaders in all of the communities. You permitted us to make a small step toward meeting the challenge of 'timeless

sustainability'-- safeguarding today's incredible natural wealth for future generations. Safeguarding the livability of the Skeena region for 'time immemorial', that is, for longer than Lax Kw 'alaams five hundred generation memory, will be the ongoing mandate of each generation's leaders. We have all been privileged to have shared in this journey.

Dirk Brinkman, Project Leader

Chapter 1: Introduction

1.1: The challenge of climate change and adaptation for resource dependent communities

British Columbians are well aware of the devastation that a changing climate can have on forest-ecosystems and on the culture, ecology, economy, and social well-being of the communities that depend on them. Over the past decade, communities throughout the interior of BC watched as the mountain pine beetle affected 17.5 million ha of timber and killed 831 million cubic metres of pine (ABCFP, 2011). Worrying that a similar fate befalls the resource values in the Skeena River watershed, the Chief of the Lax Kw 'alaams First Nation community, formerly known as Port Simpson, strongly supported this proposed climate adaptation project (see Appendix 1.1 for letter of support).

The 2007 Intergovernmental Panel on Climate Change (IPCC) confirmed in the Fourth Assessment Report (FAR) that "Warming of the climate system is unequivocal…" and that "Most of the observed increases in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas (GHG) concentrations" (IPCC, 2007). The vulnerability of BC's forests to climate change extends well beyond insect infestations; Yellow Cedar, one of BC's most valuable species, has also been dying for the past three decades. It was recently confirmed that the central cause is the lack of snow cover in the winter, resulting in deep frost killing its shallow root system, which has relied on snow cover to survive cold winters (Klinkenberg, 2010). Similarly, the Project 9 Report of the Cohen Commission suggests that the vulnerability of salmon in the Fraser River may be increasing as a result of climatic shifts affecting both ocean and fresh water conditions (Hinch & Martins, 2011). These and other threats highlight the need to better understand and plan for the economic, environmental and social impacts of climate change in BC. Resource managers in BC and across North America widely acknowledge that climate change is happening and are now asking scientists and policy makers to work together to respond and adapt to novel and uncertain conditions (Millar, et al. 2008).

Climate change mitigation is critical; however, the reality that the local climate is changing everywhere has prompted nations, communities, organizations, and corporations to move beyond climate change mitigation and make plans to adapt to new, and highly uncertain future scenarios. While there are a number of global climate models with general projections for large regions of the earth, it can be difficult for local communities and individual stakeholders to translate this information into local impacts in order to develop effective plans. With respect to natural ecosystems, policy makers and managers tasked with the sustainable management of natural resources, such as timber supply, fisheries & water, face the challenge of planning resource use with insufficient data to project future trends.

All communities depend on the availability of natural resources, but for those where direct natural resource management and operations make up a significant part of the economy, and where the natural environment is of major social and cultural significance, there is an imminent need to address tough questions about what a community, or region, wants from its natural environment in the future, and how that future can be achieved in light of the influence of climate change and increased demand for ecosystem services.

1.1.1 Climate change adaptation planning for northwest Skeena communities

The Skeena River Watershed is an area of British Columbia highly valued for its vast expanses of pristine wilderness, wealth of natural resources, and incredible cultural history. The region is also poised for growth as global demand for natural resources increases, plans move forward to construct a major transmission line, and First Nations communities become more involved in resource management. Despite increasing pressure on ecosystem services, very little was known about the potential impacts of climate change on communities and resources in the Skeena, prior to this project

People here recognize that change is happening on many fronts, and that more information is needed in order to ensure that resources and development are managed sustainably. The complex and interdependent relationship between humans and nature means that community participation and local knowledge must be integrated with scientific research and sociological analysis in order to effectively identify potential climate change impacts, and the best approach for adaptation. Inevitably there will be costs associated with climate change; but the price of inaction is the highest. Indeed, if we work proactively toward adaptation, we can significantly reduce the economic, social, cultural, and environmental costs of a changing climate in the future, and take advantage of better opportunities.

Recognizing that climate change and adaptation will play a role in the future of forestry and development in the Skeena region, Coast Tsimshian Resources, LP, in partnership with academics, experts, and government advisors, applied for funding from the Future Forest Ecosystem Scientific Council (FFESC) to launch the '*Climate Change Adaptation Planning for Northwest Skeena Communities*' (CCAP) project. The goal of this interdisciplinary project is to build adaptive capacity and facilitate climate change adaptation planning for the resource-dependent communities of the Lower Skeena River Watershed. The project combines science, biophysical modelling, social science, and community engagement to better understand impacts and adaptation options, and to lay the foundation for future collaboration and planning on a regional scale.

The various activities carried out by the study team have been structured to address a wide range of stakeholders: policy-makers at various levels of government, decision-makers and managers involved in natural resource management and operations, First Nations communities, municipal leaders, environmental organizations, business owners, recreationalists, and residents of the Lower Skeena. As illustrated in this report, the positive outcomes and large number of recommendations resulting from workshops with community leaders demonstrates that the process also helped promote creative and collaborative thinking about climate change, its impacts, and the future of the community, and thus strengthened adaptive capacity.

In December 2011, the CCAP research team hosted community workshops in Prince Rupert, Lax Kw 'alaams, and Terrace. During these workshops the research team shared results and findings from the various components of the study, and asked community members to respond to this new information with their knowledge, insights and recommendations for adaptation both in their communities, and with respect to natural resources in the region. This report documents the outcomes of the community workshops, along with responses from expert stakeholders, and serves as a public document in which to share results and findings from each component of the project.

The project was funded in part by the provincial Future Forest Ecosystem Scientific Council and the federal Mitacs accelerate program, with significant in-kind contributions from each of the partners and their respective organizations. Certain initiatives within the project received funding from other sources, including Natural Resources Canada through the Regional Adaptation Collaborative (RAC), Tides Canada, and the Skeena-Stikine Regional District. The closely linked Skeena River Water Conservation Project (SRWCP) led by WWF Canada was supported by funds from Coca Cola and Natural Resource Canada.

1.1.2 Purpose of the Report for Communities

The *Report for Communities* is a deliverable of the project, intended to share the outcomes of community workshops and to make the findings and outputs of the research accessible to local stakeholders. The report is a 'living document', structured to grow with new research initiatives and to include additional research documents that emerge from ongoing analysis and work by members of the research team. The first part of the report describes the response and recommendations of community members, CTR foresters, and local experts. This is followed by detailed sections on each component of the project, including:

1. Sociological research including reports on valued community and environmental resources, and drivers of change;
2. The development and piloting of a Monitoring Protocol for Fisheries Sensitive Watersheds (FSW) in the Lakelse Lake watershed;
3. Regional vegetation modelling using different climate scenarios and timber harvest schedules to inform and support long-term adaptation planning and adaptive management;
4. The development and piloting of a climate-sensitive cumulative effects analysis tool, aimed at facilitating integrated forest and water resource management (Note: This 4th component was led by World Wildlife Fund in partnership with Coast Tsimshian Resources as part of the Skeena River Watershed Conservation Project (SRWCP)).

The report also acknowledges the limitations of the study and identifies knowledge gaps and required next steps to advance our knowledge of climate change impacts and adaptation processes in the region. The main body of the report is dedicated to results and outputs, while technical reports, data sets and longer methodological descriptions can be found in the appendices of their respective chapters. This report will also be publically available online at http://brinkmanforest.com/ffesc/, along with other project deliverables and outputs. To provide users with an accessible summary of this report, an interactive three part 'toolkit' was created which presents information about the general nature of climate change and adaptation, a summary of results of this project and a more in-depth look at the data which inform the results, illustrated with narrated slides and interactive visuals. The toolkit is hosted on the project website (http://brinkmanforest.com/ffesc/lower-skeena-adaptation-toolkit/) and contains links to relevant components of this written report as well as additional resources. Details about the research team, project structure, integration challenges, and other deliverables can be found in Appendix 1.2.

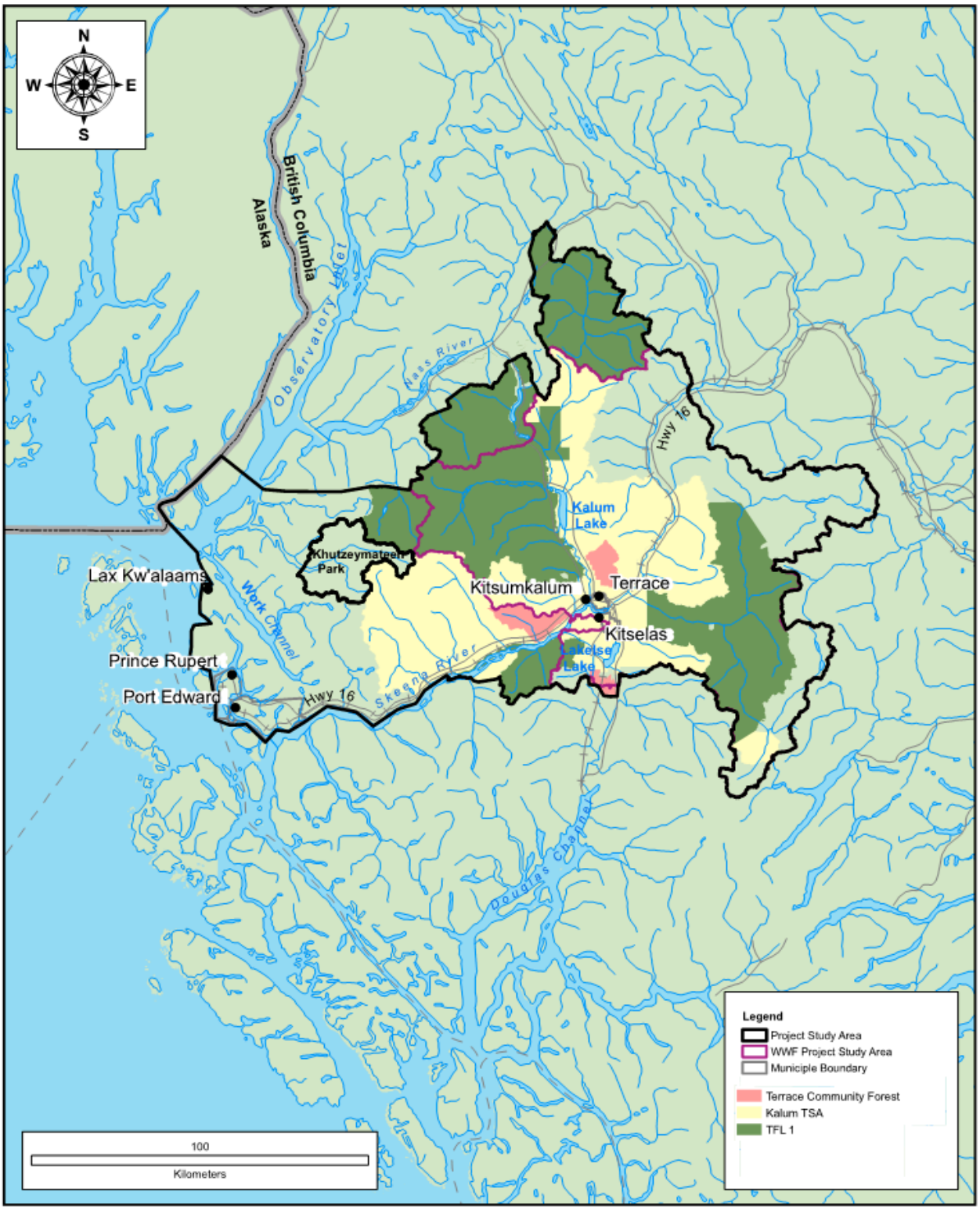

Figure 1.1: The CCAP study area, outlined in black, extends from the ocean on the West to the height of land on the Eastern boundary, encompassing the entire land base of TFL 1, and parts of the Kalum TSA. The smaller SRWCP study area is outlined in purple.

1.2 Study Area

Coast Tsimshian Resources operates in areas of the Kalum Timber Supply Area (TSA) including Tree Farm Licence 1 and Forest License 16835 (Figure 1.1). Understanding that the impacts of climate change and forestry will be felt beyond the borders of the TSA, and given the importance of the lower Skeena watershed as the traditional territory of the Tsimshian people, the study boundaries were established to include the Skeena River watershed, from the eastern border of the Kalum TSA to the Western side of the Skeena drainage on the coast.

This area is unique in that it includes a large transitional region between the coastal and interior forests, which supports a number of diverse ecosystems. The dominant species in the TSA is western hemlock, and other major species include: amabilis fir, mountain hemlock, sitka spruce, western red cedar, lodgepole pine, cottonwood, aspen, and birch (MOFR, 2010). The moderating effect of the ocean and high precipitation means that the study area tends toward forests and ecosystems with coastal characteristics.

The study area for the CCAP project encompasses the First Nations communities and traditional territory of Kitsumkalum, Kitselas, and Lax Kw ‘alaams, as well as the municipal communities of Terrace and Prince Rupert (Figure 1.1). Sociological research and community workshops were carried out in Terrace, Prince Rupert, and Lax Kw alaams, with the support of local leadership. Although each of the three communities interviewed for this project have unique characteristics, histories and priorities, they are connected by their relationship with the Skeena River and Watershed, their dependence on and use of natural resources, and their desire for positive and sustainable development in the region. It is beyond the scope of this project to provide a full historical account of the communities and their people; the following descriptions are provided for context. More information is available on the respective community websites.

1.2.1 The Skeena River

The River of Mists, as the Skeena is known, starts its impressive 570 km journey to the coast high on the Spatsizi Plateau. The second longest river in British Columbia and among the longest undammed rivers in the world, the Skeena is renowned for its mythical beauty, epic salmon runs, and productive ecosystems. In his book, ‘River of Mists, Journey of Dreams,’ Thom Henley (2010) describes the evolution of the Skeena River, carved over millennia by glacial flows, and alternately host to humid rainforests, dinosaurs, ice, and snow. Today the Skeena River passes from its alpine sources south through forests of pine, sitka spruce, mountain hemlock, western hemlock, cottonwood, and western red cedar, known by First Nations people as the tree of life. Since time immemorial the Babine, Gitskan and Tsimshian people have lived with and depended on the rich resources of the Skeena watershed. The place where the village of Kitkatla now exists is considered the longest continually inhabited site in BC. The Tsimshian have traditionally controlled trade routes up and down the Skeena, acting as ‘middle men’ first between the Haida and communities further inland, and later controlling trade between Europeans and inland trading partners. Today roads and highways follow the same paths as the Grease

Trails carved over thousands of years by First Nations people trading valued oolichan grease for goods and commodities from the interior (Henley, 2010).

1.3 Participating Communities

1.3.1 Lax Kw ‘alaams

Lax Kw ‘alaams, formerly Port Simpson, is located north of the City of Prince Rupert. The Tsimshian people of Lax Kw ‘alaams have traditionally based their economy on fishing, trapping and hunting (www.laxkwalaams.ca). In particular, salmon, oolichan and red cedar were and remain critical resources for the community. When the Hudson Bay Company erected a trading post at Lax Kw ‘alaams (and changed the name to Fort Simpson), the Tsimshian people continued to control trade up and down the Skeena between Europeans and other First Nations even after the advent of paddle-wheelers on the Skeena. Today the community is invested in the fishing and forestry industries, and demand for ecosystem services on the traditional territory of the Lax Kw ‘alaams is growing. Given the cultural and economic significance of the natural environment to the community, they have a vested interest in better understanding the potential local impacts of climate change and the CCAP project has received the support of the Chief and Band Council, and Elders of the community. For more information about the history of Lax Kw alaams and current initiatives, please visit www.laxkwalaams.ca.

In 2005, Lax Kw ‘alaams owned company, Coast Tsimshian Resources LP (CTR), purchased the licence for TFL-1 and Forest License 16835 (See Figure 1.1) and engaged Brinkman Forest Ltd. to manage forestry operations. Together CTR and Brinkman pursued new markets in Asia and made use of shipping facilities in Prince Rupert to transport timber overseas. This is an important development as the closure of the Port Edward pulp mill greatly diminished the demand for pulp-grade logs and led to significant undercut of the allowable annual cut (AAC) from 2001 to 2006 (Snetsinger, 2011). Following several years of industry decline, CTR has contributed to the revival of forestry in the region, and provided important economic benefits to the people of Lax Kw ‘alaams, and local contractors. That said, forestry in the region has been controversial in the past, and the Kalum TSA is known as an area subject to historical over-harvesting and as a challenging place to profitably operate given the low quality of timber and historical harvest record. Coast Tsimshian Resources recognizes that the sustainability of forestry operations is closely linked to the long-term health and diversity of forest ecosystems, and the economic wellbeing of the region. Investment in the CCAP project has been undertaken as a first step in identifying alternate management strategies in preparation for a different future as a result of a changing climate and potential new management objectives.

1.3.2 Terrace

Situated along the Skeena between the Copper and Kitsumkalum Rivers, Terrace was officially named in 1912, and was soon recognized for its booming forest industry. Known as the ‘pole capital of the world,’ for its production of cedar telegraph and transmission line poles, the community opened its first sawmill in 1908. Terrace is located in the centre of what was to become the first Tree Farm License

in 1948, first controlled by the Celanese Corporation of America. Since its designation TFL 1 has undergone numerous boundary transformations and shifts in management. Since 2005 the tenure has been owned by Coast Tsimshian Resources. From the 1950s to the late 1980s, a number of saw mills were constructed in the region, and a pulp mill in Prince Rupert processed lesser quality timber. When the forest industry began to decline in the 1990s, so too did the population of Terrace and surrounding communities. Today, there are renewed efforts from local organizations and stakeholders to diversify the economy through investments in tourism, recreation, and education and skills training. Protection and sustainable management of natural resources is promoted by a number of active organizations, and like many communities in the area, the protection of salmon and watershed ecosystems is a high priority. As the largest City in the region, Terrace is a hub for services and activity. With the construction of the Northwest Transmission Line underway, the building of liquid natural gas plants, the upgrade of the Alcan aluminum plant in Kitimat, and serious debate occurring over the installation of pipelines, mines and run-of-river hydro projects from a number of large corporations, Terrace is in a position to once again exploit their position as a resource rich area. However, leaders and concerned citizens are wary of the potential negative impacts of poor planning and management. This project received significant support from the people of Terrace, concerned not only about the impact of climate change on their future, but also in retaining the health and surrounding beauty of natural ecosystems in balance with economic growth and development. For more information about the City of Terrace, see www.terrace.ca.

1.3.3. Prince Rupert

The City of Prince Rupert was founded in the early 1900s with a vision of one day shipping goods and resources from across Canada to the Orient. The Port of Prince Rupert is one of the deepest natural harbours in the world, with close proximity to Asian trading partners. Similar to Terrace, Prince Rupert was also subject to the boom and bust of resource-based economies. Once known as the 'Halibut Capital of the World', the decline of the fisheries industry dramatically impacted the community. The closure of the pulp mill in 2001, further decreased employment opportunities; the local population has declined from a peak of 20 000 in the 1980s, to half of that today. Despite challenges of recent years, the community is once again beginning to grow, due in part to increased activity and planned expansion of the Port, combined with a growing tourist economy. Like Terrace, there is concern over the way in which this growth will impact natural resources, and in particular, how to protect and manage salmon stocks, which remain integral to the culture and economy of the community. At the same time, creating jobs and attracting skilled people to the region is important and the community is striving to balance economic diversification and growth with long-term sustainability. Support for this project has been conveyed by the Mayor and Council of Prince Rupert. For more information on Prince Rupert, please visit www.princerupert.ca.

1.4 Community Engagement

Community engagement with the CCAP project was facilitated in a number of ways and through different means of interaction with various research teams. The sociological research team conducted interviews between November 2010 and August 2011. After initial participation through the interview

process, a number of people made themselves available as local experts to provide feedback and advise on project methods and outcomes.

The SRWCP included an advisory group with representatives from a number of communities and First Nations within the study area, including from Lax Kw ‘alaams, Prince Rupert, Gitanyow, Terrace, and Kitsumkalum. This advisory group was also introduced to the wider CCAP study and provided informal insight and inputs around community values and the utility of research outcomes for their specific interests. Expert workshops provided another opportunity to share the progress of both projects and discuss potential future collaboration between research partners and local stakeholders (See Appendix 9.2 for a summary of the SRWCP expert workshop on hydrological indicators).

Coast Tsimshian Resources LP supported community engagement by organizing meetings and presentations between project coordinators and the Board of Directors, who are all from Lax Kw ‘alaams, and staff in the Brinkman Forest Terrace office.

The Fisheries Sensitive Watershed component of the project included training for local volunteers and stakeholders in the monitoring protocol and participation in field data collection. Many of these participants were also interviewed for the sociological component and all were invited to attend the final community workshops. The FSW training builds local capacity by empowering stakeholders to be a part of future monitoring endeavours, a key recommendation of this project.

Community workshops were held in Prince Rupert, Lax Kw ‘alaams, and Terrace in December 2011. Chapter 2 summarizes the major findings from the study and the outcomes of the workshops. Subsequent chapters detail the research findings from all components of the study, with links to additional technical reports and other deliverables and resources.

1.5 Climate History in the Lower Skeena

In order to think about how a changing climate could impact the Skeena watershed in the future, it is important to understand historical climate trends and the ways in which climate has influenced the communities of the area. The project area encompasses a region that exhibits a range of climatic conditions that lend to the unique biogeoclimatic zones (See Appendix 1.3) and range of species and ecosystem zones inhabiting the watershed. Over time, both society and nature have adapted to these climate conditions. The following figures show the changes over time for seasonal temperature and precipitation as measured by weather stations in Terrace and Prince Rupert. Climate projections for the region are discussed in Chapter 5.

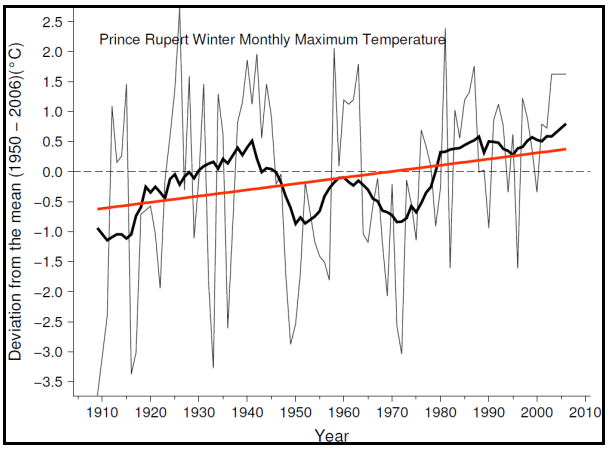

Figure 1.2
Trend in max. winter temperature in Prince Rupert over 100 yrs

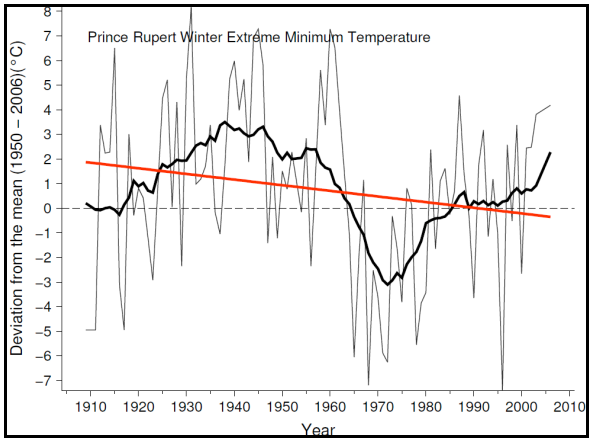

Figure 1.3:
Trend in min. winter temperature in Prince Rupert over 100 yrs

The data in the figures show the trend in the maximum warm temperature in winter months increasing and the extreme minimum temperature decreasing over time, suggesting higher *variation* in extreme high and low temperatures.

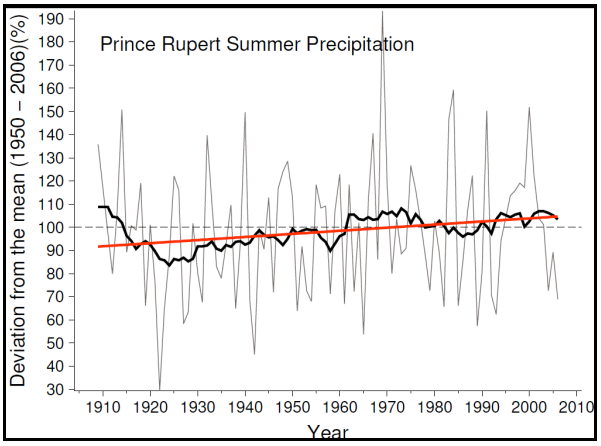

Figure 1.4:
Trend in summer precipitation levels in Prince Rupert over 100 yrs

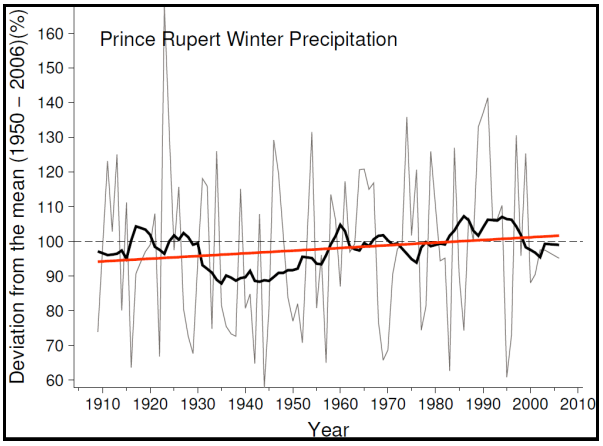

Figure 1.5:
Trend in winter precipitation levels in Prince Rupert over 100 yrs

The data in the above figures show increasing precipitation trends in both summer and winter months from 1910-2010.

In coastal communities like Lax Kw ‘alaams and Prince Rupert, people have grown accustomed to abundant precipitation and relatively moderate temperatures. Further inland, winter precipitation is more likely to fall as snow and colder winter temperatures mean that communities like Terrace and Kitsumkalum prepare for snowy, winter conditions. The winter temperatures patterns recorded in Prince Rupert (Figure 1.2 & 1.3) show higher variability in extreme temperatures but a slower rate of overall warming compared to the extreme winter temperatures in Terrace (Fig. 1.6 & 1.7), which illustrate a steady increase since 1955. Additional climate graphs are included in Appendices 1.4 and 1.5.

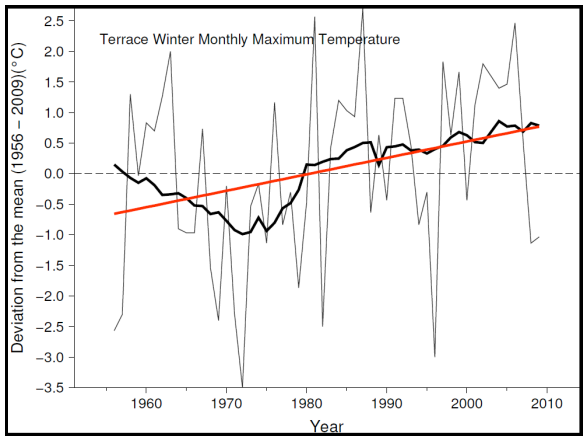

Figure 1.6:
Trend in max winter temperatures in Terrace over 55 yrs

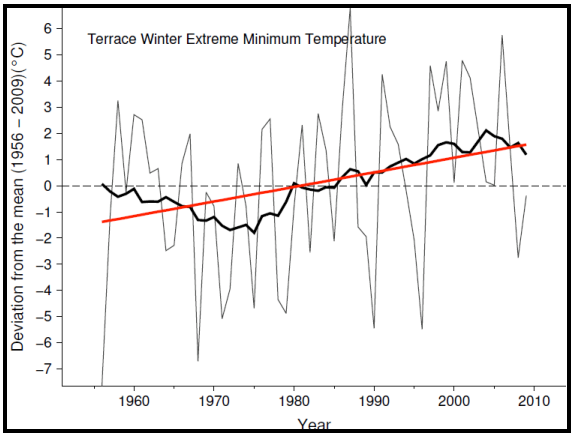

Figure 1.7:
Trend in min. winter temperatures in Terrace over 55 yrs

The data above show that both extreme maximum and minimum winter temperatures in Terrace show a steady increase since 1955.

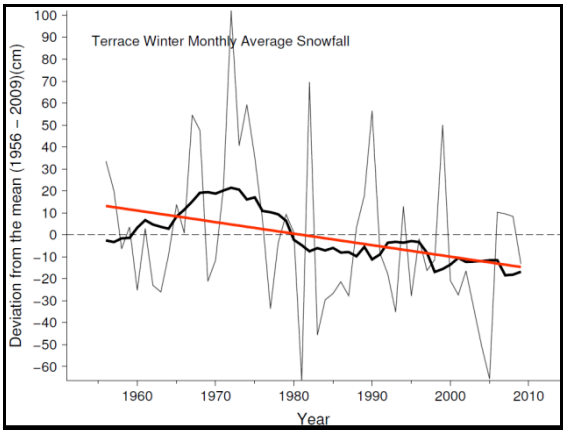

Figure 1.8:
Average monthly winter snowfall in Terrace over 55 yrs

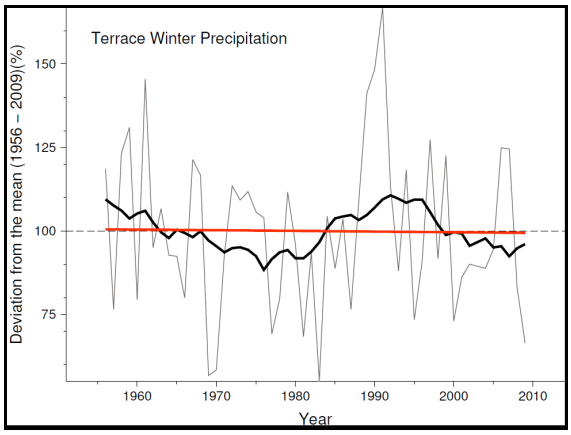

Figure 1.9 (a):
Winter precipitation in Terrace over 55 years

The above data show that although winter precipitation has remained stable, there has been a decline in the amount of winter snowfall in Terrace, indicating that more precipitation is falling as rain in the winter months.

There are many ways that these communities and individuals have adapted to different climates over the past 100 years. With respect to forestry, cold winter temperatures around Terrace facilitate access to timber via frozen roads which means the industry has been able to harvest in the winter months, but these cold periods are shortening. Reforestation planning is based on where tree species are expected to grow best and as the climate changes, new seed zone transfer guidelines have been put in place to match the trend of species and genotypes moving northward and higher in elevation (MoFLNRO, 2011). As temperature and precipitation shifts occur, the forest industry will have to take into consideration the way climate change will impact operations, timber supply, and forest health. Similarly, the fishing industry, a mainstay of the region, is scheduled around assumed conditions and seasonal events like snow melt and ice break-up on the Skeena and its tributaries. Salmon spawning requires specific conditions in terms of stream flow and water temperature. Anticipating how climate change will impact fish and determining what can be done to support resilient ecosystems is a key

challenge for Skeena communities. Chapter 5 describes potential future climate scenarios and, chapter 6 presents model outputs simulating the potential impact of climate change on vegetation and other ecosystem functions in the study area.

1.6 Climate Change Adaptation and Vulnerability Assessments

The CCAP study has been structured to address a number of elements with respect to climate change and the process of climate change adaptation. The Intergovernmental Panel on Climate Change (IPCC) defines adaptation as: "Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities" (IPCC, 2007, p. 869). Whereas ecological adaptation is reactive (in response to environmental change), humans have the capacity to proactively adapt to, or plan for, anticipated or potential changes (Louman, et al. 2009).

Forest and resource management interventions are designed to influence the flow of natural systems for the benefit of human values. Adaptation is the adjustment of management interventions to anticipate change in natural systems and human values, and requires an in-depth comprehension of both. Adaptation planning for communities and regions that are resource dependent requires significant analysis of socio-ecological impacts, vulnerabilities, and objectives, in order to plan for long-term sustainability of communities and resources.

In adaptive planning, understanding vulnerability within natural and human systems is an essential first step. In the context of bio-ecological and socio-ecological systems, vulnerability has been defined as "the susceptibility of a system to disturbances determined by exposure to perturbations, sensitivity to perturbations, and the capacity to adapt" (Nelson, et al. 2007). Increasingly, vulnerability assessment methodologies are being developed to incorporate a range of social, economic, political, cultural and environmental factors and determinants (Glick, et al, 2011; Smit & Wandell, 2006).

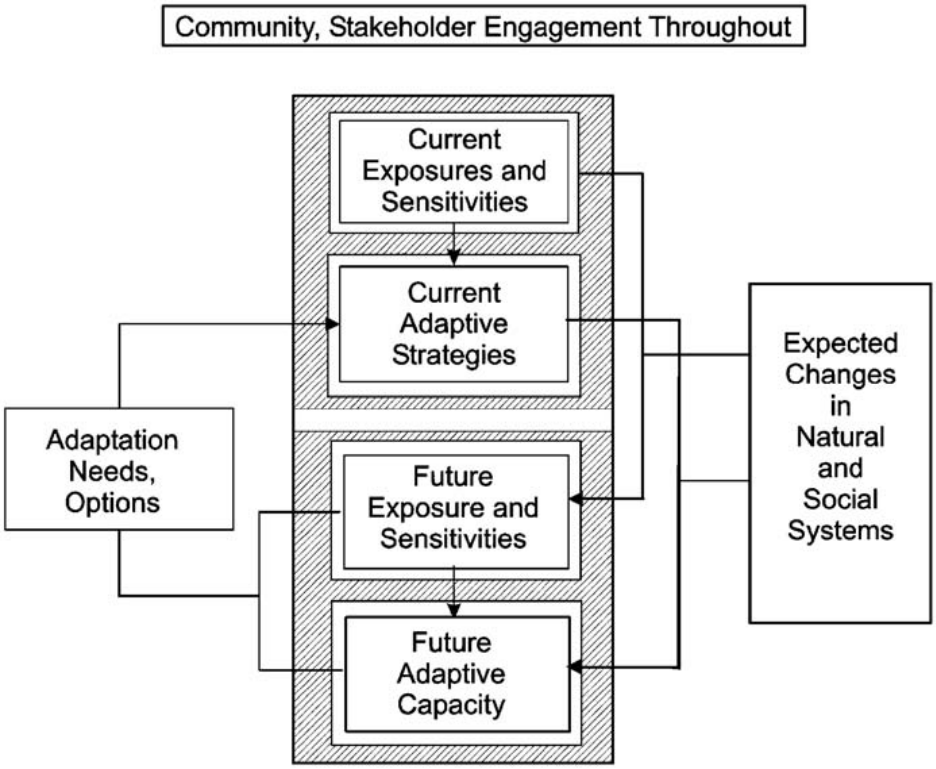

Figure 1.10: The CCAP approach used scientific and sociological methods to assess vulnerability to climate change, and determine adaptive capacity in order to support adaptive planning and management processes in the future. (Smit and Wandel, 2006)

The study employed a participatory approach similar to that described by Smit and Wandel (2006) and illustrated in Figure 1.9(b). This includes the use of both sociological and scientific modelling methodologies, as well as community feedback from informed experts and local stakeholders and leaders to assess both the vulnerability and capacity of ecosystems and communities. This interdisciplinary approach was used as a foundation for the community workshops, and to inform the development of tools to support adaptive management and adaptation planning.

The flip-side to vulnerability assessments includes identifying opportunities that may emerge as a result of climate change, or as a result of effective climate change adaptation. While our study identifies a number of ecological vulnerabilities pertaining to both forest and aquatic ecosystems, findings also suggest that the overall impacts of climate change are likely to be less severe in the Skeena region than in other areas of the province. This implies that, if effectively managed, long-term opportunities may exist to preserve ecosystems, and species, and to take advantage of the ecosystem functions and services that may not exist in other regions of the province in the future.

Once vulnerabilities have been established, it is possible to consider several different options for adaptation. Nature is very good at adapting to changing environmental conditions; however, the pace of climate change is very likely to outpace the adaptive capacity of forest and aquatic ecosystems (Buck, et al, 2009). Humans are now faced with the dilemma of adapting our own management of resources to enable the continued sustainable use of resources, and the long-term health of ecosystems.

Increasingly, resource managers and experts are debating the value of mimicking nature to facilitate faster adaptation to climate change. Planning for adaptation requires an understanding of different adaptive processes, and approaches vary depending on the ultimate objective that adaptation efforts are aiming to achieve. In both natural and human systems, adaptation can usually be described as a spatial and temporal process involving transition or transformation, resilience, resistance, or some combination of the three, (Glick, et al. 2011). The following definitions provided by the US Forest Service Climate Change Resource Centre website are used with modifications for the context of this study. (http://www.fs.fed.us/climatechange/advisor/scorecard/adaptation-actions.html)

Resilience is defined as the degree to which systems can recover from one or more disturbances without a major shift in composition or function. Nature has built-in resilience 'strategies'. For example, pine forests are resilient to fire due to the fact that pine cones require heat to germinate. From a resource management perspective, examples of resilience strategies include the reduction of tree density to reduce fire intensity which supports natural recovery after fire events.

Transition, or transformation, refers to strategic actions that work directly with the changes that climate is provoking, and ease transitions to future states by mitigating and minimizing undesired and disruptive outcomes while maintaining essential functions. Assisted migration is an example of transition and is the deliberate planting of non-native tree species in areas where they are expected to flourish under future climate conditions.

Resistance is defined as the ability of an organism, population, community, or ecosystem to withstand perturbations without significant loss of structure or function. Activities to enhance resistance include boosting the inherent ability of species to resist change. An example of this could include conserving and managing salmon stocks to maintain genetic diversity and resist change, thereby improving the capacity of salmon to adapt.

All three of these approaches require careful consideration, and none of the examples given are meant to inform specific adaptive actions in the Skeena region. Any adaptive actions will have long-term consequences and must be carefully analyzed and monitored to ensure that the action is having the desired effects.

1.6.1 Adaptation Planning, and Adaptive Ecosystem Based Management

Experts agree that effective vulnerability assessments and adaptation planning at the community level requires buy-in and participation from a wide range of stakeholders (Smit & Wandel, 2006). Given the uncertainty associated with climate change projections, adaptation plans must also be rooted in consciously designed adaptive management structures. Management frameworks must be flexible enough to integrate new information and make changes as necessary to achieve goals and objectives. Adaptive management strategies are increasingly employed in many natural resource management plans, but climate change provides significant impetus to carry out *all* resource

management operations and decisions within an adaptive management framework. Glick, et al. (2011) describe adaptive management as a

> "…cyclical process in which: management goals are defined based on current understanding and predictive models, but with key uncertainties explicitly highlighted; management actions are carried out and monitored, and outcomes are compared to predictions; and refinements are made to goals and actions based on real-time learning and knowledge generation."

From this definition it is possible to identify several elements necessary for effective adaptation planning and subsequent adaptive management.

1. Management goals are determined through a combination of socio-economic objectives; goals are value-based products of the individual or group setting them.
2. Predictive models require significant data about past and present conditions, as well as the capacity to project different climate futures and identify areas of uncertainty.
3. Monitoring to test the results of management decisions requires that baseline data exists, and also that expert knowledge is employed to analyze the effectiveness of adaptive strategies in order to make necessary changes.
4. Goals and management objectives may change depending on changing values, new information, and improved knowledge about systems or climate change impacts. The capacity to continuously obtain, analyze and integrate new knowledge and adjust accordingly is an important feature of adaptive management and depends largely on the adaptive capacity of resource managers, communities and their institutions.

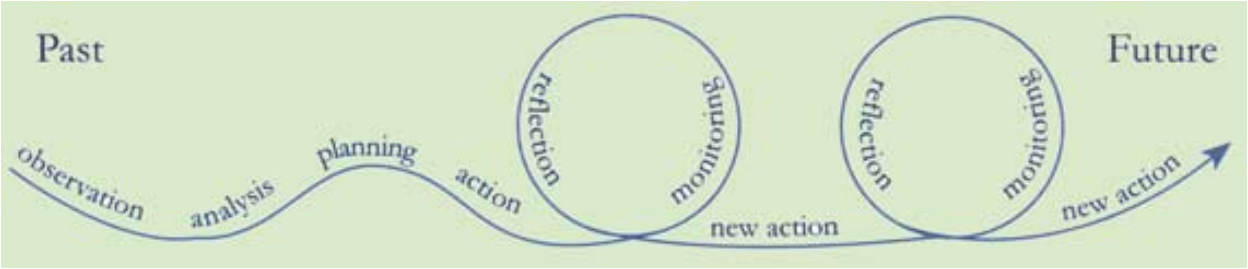

Figure 1.11: This simple depiction of adaptive management illustrates the monitoring and learning process as it occurs over time. In an integrated land management scenario, stakeholder consultation, information sharing, and the integration of new knowledge would be key elements of planning (Colfer, 2005 in Innes et al, 2009).

Adaptive actions and strategies can be implemented at many levels; i.e., community, organizational, provincial, federal and for different temporal and spatial scales (Peterson, 2011). Whether considering adaptation strategies at the site level for forestry operations, or implementing

adaptation policy across a watershed, it is important to understand the breadth of knowledge and information that is available to inform these decisions. As Spittlehouse and Stewart (2009) point out "Effective adaptation policy must be responsive to a wide variety of economic, social, political, and environmental circumstances." Although they are referring specifically to forest sector policy, this statement is broadly applicable to adaptation strategies concerning communities and natural resources in the Skeena region. With respect to natural resource management and climate change, there is a need for adaptive management at the ecosystem and landscape scales that extend well beyond the objectives of a single sector (Peterson, et al. 2011). In other words, while adaptive management for forestry is important, it must also support socio-ecological adaptation at a broader scale. This is why it was important for Coast Tsimshian Resources to undertake this study.

Ecosystem-based management (EBM) is a related approach increasingly recognized for its relevance to managing and mitigating the impacts of climate change. The independent expert advisory group for the Central Coast Land and Coastal Resource Management Planning framework defines EBM as:

> " …an adaptive approach to managing human activities that seeks to ensure the coexistence of healthy, fully functioning ecosystems and human communities. The intent is to maintain those spatial and temporal characteristics of ecosystems such that component species and ecological processes can be sustained, and human wellbeing supported and improved" (Coast Information Team, 2004)

In her excellent book on the topic, Judith Layzer (2008) has defined three main attributes of EBM listed below:

1. **A Landscape Scale Focus**

   Promotes "an integrative scientific assessment that captures the interrelationships among an ecosystem's main elements and functions, [therefore raising] policymakers' and stakeholders' awareness and knowledge of critical ecological processes."

2. **Stakeholder Collaboration**

   Allows participants on all sides to access and understand the scientific evidence, ecosystem functions and social values which must combine to create sustainable and acceptable results through innovative and participatory problem solving.

3. **Flexible and Adaptive Implementation**

   The uncertainty inherent in predicting the future of ecosystems, particularly in light of climate change and population growth, means that all plans must be flexible enough to meet changing social and environmental conditions while adaptable enough to ensure that goals remain strong and achievable.

The 2008 National Forest Strategy Working Group on Intensive Forest Management (IFM) "…recognizes that one of the foundations of ecosystem-based management is Integrated Landscape Management (ILM) Planning or explicit area-based management planning which integrates multiple stakeholders' interests." The IFM Working Group recommended that a consultative planning process supporting ILM be incorporated in all forestry interventions. A key recommendation of this report is that ILM include analysis of the cumulative effects of all land-users, not just the forest industry, over space and time. Integrated Land Management in the context of adaptation in the Skeena then, would include the setting of watershed-scale objectives, collaboration between multiple stakeholders. The British Columbian government is on the right track by bringing natural resource management under a restructured government ministry - The Ministry of Forests, Lands, and Natural Resource Operations (MoFLNRO). However, Given the current planning environment of TFL 1 (described in Chapter 7), this is an ambitious goal and one that will require significant changes to policy and regulatory systems and strong local governance at the watershed scale.

As pointed out in a 2005 report on integrated land management models, " The use of scientifically based analytical modelling tools is required to address the highly complex suite of interactions that exist between global warming, ecosystem functions and health, human well-being, and land and water degradation" (PRI, 2005). The research team and Coast Tsimshian Resources believe that this type of management - adaptive, ecosystem based, and integrated, is achievable with the right tools. The CCAP project has contributed to the tools available to support EBM in the Skeena through the development of a monitoring framework for fisheries sensitive watersheds, and through the development of a cumulative effects analysis framework to support integrated resource management and scenario-based planning.

1.6.2 Empowering adaptive capacity through community engagement and interdisciplinary research

Adaptation and adaptive management will not occur if communities and stakeholders do not have sufficient adaptive capacity to facilitate these processes. The concept of adaptive capacity is closely linked to vulnerability, and is used in reference to both social and ecological systems. The IPCC Fourth Assessment Report (2007) defines Adaptive Capacity as "the ability of a system to adjust to climate change, moderate potential damages, to take advantage of opportunities, or to cope with the consequences." The interconnection between ecological and social systems is well recognized, as is the reality that the adaptive capacity of managed resources is as dependent on ecological processes, as on the institutions and policies that govern their management. As pointed out in the Brundtland Report *Our Common Future* (1987) "The real word of interlocked economic and ecological systems will not change: the policies and institutions concerned must."

From a community perspective, adaptive capacity is largely dependent on organizational flexibility and institutional culture; it is closely tied to the quality of leadership, the depth of knowledge, social capital, political will, economic conditions, and the availability of resources (Matthews & Sydneysmith, 2010). In addition, adaptive capacity is influenced by the dynamics of local and external drivers (Smit & Wandel, 2006). Adaptive capacity is not static, nor are the various determinants of adaptive capacity the same across different communities (Smit & Wandel, 2006). A discussion of the

micro and macro-level influences of adaptive capacity is included in Chapter 4, Drivers of Change and Visions for the Future.

The CCAP Project was structured so that it would contribute to the adaptive capacity of the Skeena region, through the creation and sharing of knowledge, and the development of tools critical for adaptation planning and adaptive management. The blend of social science, biophysical science, predictive modelling, and local knowledge combines to improve the understanding of local values, socio-ecological vulnerabilities, and potential climate futures.

Community engagement activities have helped to build social capital by bringing together multiple stakeholders in a shared-learning experience. Through the research interviews, expert advisors, and community workshops, the study has identified both barriers and enablers to adaptation that provide an excellent outline for necessary next steps as the region moves toward effective adaptive management for communities and resources.

The FSW monitoring component fulfills a critical element of adaptive management and establishes a tool to assess the impact of adaptation strategies on watershed values over time.

The cumulative effects analysis framework is an important tool to support future integrated land management, and expert input has identified a number of risks and regulatory conditions that must be overcome to achieve comprehensive adaptive and integrated management.

Climate and vegetation modelling with multiple scenarios has led to an improved understanding of the potential future impacts of both climate change and harvesting with relevance to community stakeholders and regional resource managers.

Next steps and recommendations around building local adaptive capacity, and facilitating adaptation for the communities and ecosystems of the study area included in subsequent chapters and summarized in the conclusion. Specific outcomes from the community workshops are included in Chapter 2.

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