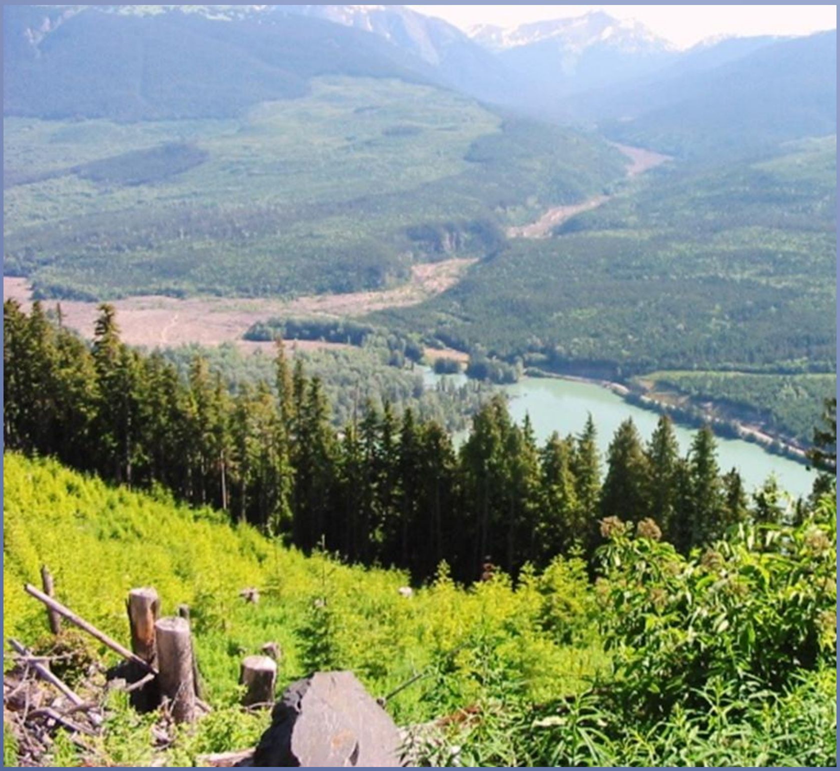

Chapter 7: Forest Management, Community Values, and Climate Adaptation

Compiled by Katie McPherson with support from Brinkman Forest Staff

Chapter 7: Forest Management, Community Values, and Climate Adaptation

7.1 Adapting Forest Management to Support Community Wellbeing

A key driver behind Coast Tsimshian Resources leadership in this project has been the opportunity to better understand community concerns related to potential change in the region, the perceived conditions of key resource values, and how forests can be managed for the benefit of communities according to local values and visions of the future. As a company wholly owned by Lax Kw'alaams, sustaining the values that contribute to the wellbeing of this community is especially important. The graph below, also included in Chapter 3, shows the comparative ranking of importance of environmental values across the three communities. As described in Chapter 3, salmon was ranked the number one most important resource value in all three communities, and is also perceived to be in critical condition. It is also significant to note that 85 per cent of respondents cited "economic issues" as the number one most important issue facing their communities. Employment, small business development, and creating opportunities for youth were common themes throughout many interviews.

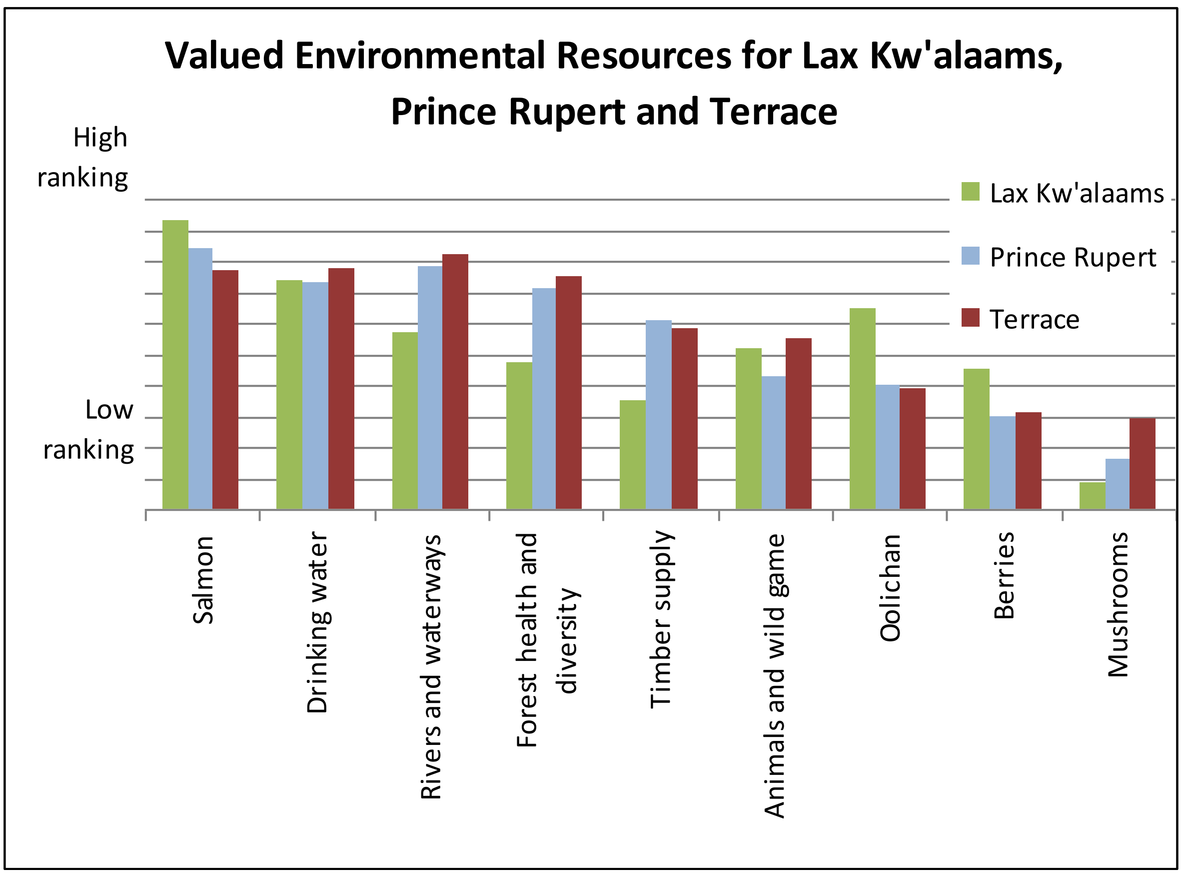

Figure 7.1: Sustainable forest management must occur in support of a broad range of values important for the well being of the community.

Each of these communities have a different orientation for CTR, with Terrace being most local to the licence areas; Lax Kw 'alaams community being the home of people, each of whom own one Limited Partnership unit of Coast Tsimshian Resources LP and whose traditional territory includes some of the license area; and Prince Rupert, being an important service centre for Lax Kw 'alaams, home to many of their people, and the Port of Prince Rupert which functions as a primary route to market for license timber.

Forestry in the region has implications for the economy, just as it does for the future of fish and other environmental values. In British Columbia, and in Canada, forest policy is meant to support the goal of achieving Sustainable Forest Management (SFM). The Canadian Council of Forest Ministers (CCFM) defines SFM as:

> "Management that maintains and enhances long-term health of forest ecosystems for the benefit of all living things while providing environmental, economic, social, and cultural opportunities for present and future generations" (CCFM, 2008, taken from the 2003-2008 NFS Vision statement, taken from the 1991-1993 Roundtable on the Forests and the Environment. The development of this statement was led by one of the authors and has remained relevant for 20 years).

Thus, CTR, and indeed the Crown, are now faced with meeting this challenge based on the knowledge gained through this study. Achieving SFM for the future is made more complicated by the potential impacts and high levels of uncertainty associated with climate change (Chapters 5 and 6). CTR must continue to add benefit to the economy of the region, while incorporating adaptive measures to protect those values critical for the well-being of communities. In addition, the government must take responsibility for supporting policy that enables CTR to engage in ecosystem based adaptive management, without risking the jobs and economic benefits the company brings to all three communities.

This challenge entails 3 major elements:

1) Ensuring that policy is in place to support and compensate forest managers for actions taken to protect fish values and the economic risks associated with investing in adaptive strategies.
2) Managing forests to the benefit of fisheries and watershed values.
3) Adapting forest sector management to climate impacts on forests and timber supply to ensure the long-term viability of the license.

Cumulative impacts of climate change and land use of fisheries values are discussed in the next section, followed by a review of challenges and adaptive strategies for forest management specific to issues of climate change. After a brief discussion of the unique characteristics of the forest license areas, the chapter concludes with a response from CTR and Brinkman Forest professional foresters to the LPJ-GUESS vegetation model projections, some specific examples of adaptation that could be pursued by CTR on the license and a number of recommendations to overcome barriers and develop an adaptation agenda.

7.2 Climate change impacts, cumulative effects, and integrated adaptation strategies for fisheries and watershed values

The goal of this section is to introduce for community members, resource managers and stakeholders some of the potential impacts to hydrogeomorphic processes resulting from climate change and land-use activities, and to discuss some of the indicators of stream health that are impacted by forestry and road-building. It is acknowledged that there are a number of other important land-use activities not considered in this discussion including: urban and rural development, mining, run-of-river hydro projects, pipelines, agriculture and recreational activities. All of these are worthy of consideration, however they are beyond the scope and resources of the immediate project. This section concludes with a number of adaptive actions and strategies that are presented as options that could be implemented or tested in the Skeena region.

Information for this section comes from work done through the fisheries sensitive watershed monitoring component of the research, and input from local experts who participated in a hydrological indicators workshop in Terrace as part of the SRWCP (See summary report Appendix 9.2). Tools developed as a part of the FSW and SRWCP work are described in more detail in Chapters 8 and 9 respectively.

7.2.1 Climate Impacts and Cumulative Effects

Streams and rivers have often been considered a resource that can be captured, allocated, and managed. This approach has recognized shortcomings among which is a failure to manage water for the "many different functions [water] plays and multiple roles in the dynamics of ecosystems." (Falkenmark, 2003). As discussed briefly in the introductory chapter of this report, Ecosystem Based Management (EBM) is recognized by experts in BC and around the world, as a viable alternative to the common approach of managing water and other natural resources in isolation from each other. In 2004 the Coast Information Team (2004) defined 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."

This definition was used in establishing an EBM framework for the Central Coast of British Columbia, including Haida Gwaii. (See http://www.citbc.org/c-ebmf-fin-03May04.pdf for the full document.)

EBM on a watershed scale requires identifying the ecological processes that are essential for maintaining stream productivity. In BC, the Forests and Range Practices Act (FRPA) defines 'properly functioning stream' as:

> *The ability of a stream, river, wetland, or lake and its riparian area to: 1) withstand normal peak flood events without experiencing accelerated soil loss, channel movement or bank movement, 2) filter runoff, and 3) store and safely release water.*

Presumably, a properly function stream is capable of supporting healthy fish populations. Fish, particularly salmon, are vulnerable to changes in stream temperature, flow, and sediment delivery, all of which can impact the capacity of the stream to sustain fish species (Porter et al. 2000). As part of the FSW monitoring pilot, remotely sensed (Tier 1) indicators associated with peak flow, surface erosion, riparian buffer, mass wasting, low flow regime, and cumulative impacts were analyzed and used to assess risks and vulnerabilities in the Lakelse Lake watershed (Reese-Hansen, et al. 2010). There are number of ways in which climate change and land-use can affect these indicators and the health of streams, and subsequently salmon values.

Results from current studies have highlight ongoing shifts in hydrological regimes which align with the modeled impacts associated with climate change (Monk et al., and Fritze et al, 2011). For Northwestern North America some of the changes that have been documented include; "declining spring snowpacks, greater fractions of precipitation coming as rain, and a spring snowmelt runoff that has come increasingly earlier over the past several decades" (Fritze et al, 2011). In addition, new research is emerging that anticipates significant changes in the return periods for both high flow and low flow events (Poitras et al 2011). Historical climate records (see Chapter 1), show a trend of increasing temperature and precipitation levels in the study area. In the Terrace region, more winter precipitation is falling as rain than snow then in the past (Environment Canada, 2010). As shown in Chapter 5 and 6, outputs from the LPJ-GUESS model project potential increases in runoff and flood risk in the autumn, with potential decreases in precipitation and runoff in the summer months. This equates to potential changes in the timing and level of peak and low flows; a projection supported by other research studies (Poitras et al, 2011). Continued monitoring needs to be done to test the validity these projections, but given the sensitivity of salmon to changing habitat conditions and the value of salmon to Skeena communities, further investigation is warranted.

During low flow conditions, salmon are vulnerable to competition, predation, elevated stream temperatures and decreases in available habitat (Reese-Hansen, 2011). Climate change has the potential to exacerbate low flow conditions and impacts on salmonids. We can anticipate that climate change in the study area will have the potential to adversely influence stream temperature, sedimentation rates, channel forming hydrological processes (especially in the winter and spring), and the frequency and severity of landslides and mass wasting. Ongoing work is required to better understand how climate change could impact hydrological factors like snow pack levels, freeze-thaw cycles, and to identify subsequent consequences for stream conditions and fish habitat in this region.

All climate impacts will interact with the effects of land-use and resource operations. Growing knowledge about the intersection of forestry and fisheries values has, in recent decades, led to significant changes in policy and procedures in efforts to decrease the impact of forestry operations on fish (MOFR, 2009). Forests play a critical role in maintaining the natural functioning of streams, lakes, and wetlands. Healthy riparian areas filter runoff, are a source of large woody debris, and contribute to the stability of banks through mature root networks. Forests shade streams and maintain sensitive bank microclimates. With respect to assessing a watershed's stream condition, important attributes and management activities used to maintain healthy watersheds include: the land-area harvested, the width of riparian buffers, steepness of the watershed's topography, and the standard used to construct, maintain, and deactivate (forest service) roads. These factors are considered when assessing watershed conditions using the FSW monitoring protocol as part of this study (See Chapter 9.)

The Lakelse Lake watershed was the location for a pilot project testing a new watershed based fish habitat monitoring protocol. The monitoring pilot has shown that historical logging practices have had negative long-term impacts on the function and condition of streams. The Lakelse watershed was first harvested at a time when no legislation was in place to protect stream-side riparian areas, and trees were often cut right up to the stream banks. Today, although new regulations are in place to protect fisheries values, historically logged sites are still in a state of recovery and remain sensitive to adjacent and upstream land-use. The aggraded stream and degraded riparian zone in Figure 8.1 are examples of long-term instability caused by historic harvest practices. With a better understanding of the watershed hydrology and fish habitat values, resource managers today have an opportunity to manage forests to contribute to the recovery of these important areas. Provided sufficient policy and tools are in place, forest management can be implemented as a tool to help increase the resilience and buffering capacity of streams to climate change.

Understanding the long-term and cumulative effects of land-use will help resource managers protect aquatic ecosystems and the species that depend on them. In the Skeena region, agriculture, forestry, mining, pipelines, and associated road building, all contribute to changes in hydrology and water quality (SRWCP Expert Workshop on Hydrological Indicators, 2010). Despite this, provincial legislation to protect fisheries sensitive watersheds is only applicable to forestry through the FRPA and oil and gas through the Oil and Gas Activities Act. Where industries and activities lack regulation, or where non-compliance is common place, they often intersect without consideration of fisheries values, and the cumulative effects of operations negatively impact watershed health. Addressing this problem requires integrated management of natural resources and the enforcement of regulations to protect fish and water values (BC Pacific Salmon Forum, 2009). The non-functioning culverts pictured in Figure 7.2 are a local example of the negative impact of that a lack of maintenance in non-forestry sectors can have on streams.

Figure 7.2: Aggraded channel and degraded riparian in the Lakelse Drainage, a result of historic harvest practices that did not retain any riparian buffer zone. (Photo: Lars Reese-Hansen, September 2011)

Figure 7.3: Fish and water can no longer pass properly through theses streams. (Photo: Marc Porter)

7.2.2 Adaptive Actions and Recommendations

The preliminary outputs from the FSW pilot allow us to make a number of recommendations to improve the health of streams and decrease the vulnerability of fisheries values. These recommendations are also applicable to resource and land managers and policy-makers beyond the study area, and are listed in Table 7.1. The following chapters introduce two new tools developed as part of the CCAP and SRWCP project to help facilitate adaptive and integrated management of resources.

Table 7.1

Fisheries Values and Stream Health	
Policy	1. Provide incentives for protecting and buffering critical ecosystem services from climate impacts beyond levels currently legislated. 2. Assess road building, road maintenance, and deactivation engineering standards in light of increased peak-flows, annual runoff, and warmer winter temperatures to further minimize the potential for elevated fine and course sediment transport and mass wasting. 3. Assess the effectiveness of riparian buffer regulations through monitoring and enforce wider buffers where necessary to protect fish habitat. 4. Training and support for community-level monitoring of watersheds, including strengthening collaboration with First Nations communities. 5. Pursue integrated land management, including cumulative effects analysis, across resource sectors and landscape units. 6. Inclusion of other sectors in efforts to protect watershed values (i.e. other resource exploitation sectors should adhere to the same practices that the forestry and oil & gas industries do in watersheds that are legally recognized for their fish values and inherent sensitivity [i.e. FSW]). 7. Restructure land tenure systems to provide incentives for protecting fish and water values.
Resource Managers and Land-users	1. Increased stream crossing structure sizes to accommodate increased flows associated with climate change and to facilitate fish passage. 2. Collaborate with local experts to determine the location of critical fish habitat (e.g. spawning, rearing, etc.) as they fluctuate over space and time, to develop site specific plans and limit cumulative effects. 3. Closer examination and avoidance of cumulative effects (often this is limited to spatial analysis but temporal analysis is also very important) (Pike et al. 2010) 4. Collaborate with experts to identify options for hillslope restoration to limit mass wasting and control sediment. 5. Invest in low impact technology and use low impact techniques to decrease soil disturbance during forestry, mining, road building, and other resource exploitation operations.
Monitoring and Assessment	1. Track precipitation and runoff (strategically install more hydrometric stations). 2. Adopt and implement watershed-based fish values monitoring protocol (Chapter 8). 3. Enable communities to engage in monitoring through training, funding and programming development. 4. Mandate monitoring protocol for land-users in and around FSWs. 5. Implement climate change monitoring (using indicators such as: snow pack & glacial melting, stream temperature, stream flow gauging, etc to better understand changes and impacts).

7.3 Climate change impacts and adaptive strategies for forest sector management

In BC the Forest and Range Practices Act (FRPA) defines the core resources and values that forest managers must include in management plans. Under FRPA, the government commitment is to manage the forest in relation to eleven values:

> soils, visual quality, timber, forage and associated plant communities, water, fish, wildlife, biodiversity, recreation resources, resources features, and cultural heritage resources (FRPA, Sec 149,1).

Climate change is expected to impact all of these resource values in different ways, and there is an urgent need to understand *how* it will impact these values, if we are going to ensure their long-term sustainability (Eddington, et al, 2009; Steensburg, et al. 2011).

We do know that despite significant uncertainty in climate change projections, implementation of sustainable forest management practices is an important strategy for maintaining the adaptive capacity of forests and mitigating the impacts of climate change (Buck et al, 2009). Sustainable forest management in the future must explicitly incorporate climate change adaptation strategies, and Canada, as a leader in SFM, is well positioned to lead advancements in this sector provided that the appropriate frameworks for adaptation are in place at the policy, management, and operational levels.

Forest management is influenced by ecological conditions, policy and legislation, global and local markets, local values, technology, and transportation, among other things (Lucier, et al, 2009). As much, operational practices are an amalgam of equipment innovation, historic practice, involving a slow careful evolution of change, as the trees of coastal British Columbia are among the largest and heaviest in the world, and grow on some of the steepest mountain slopes. Logging them is a difficult and dangerous business in which safety, and practical logistics predominates.

The capacity to meet the demand for forest products is completely dependent in the short term on the capacity of the forest management team to operate within the constraints of the Forest Practices code, and in the long term on the forests to renew and grow. Climate change brings new demands both to operational and social factors, and to ecological dynamics, both of which must be considered in future management strategies. The interaction between climate change, forests, and human well-being is such that forest managers and policy-makers will have to address challenges that reach far beyond traditional management practices and objectives and include:

- Adapting forestry operations to changing climate conditions.
- Selecting for harvest species or age classes that are vulnerable to climate change
- Considering modest adjustments or innovations in operating practices and techniques
- Conserving and managing forests specifically for climate change mitigation.
- Promoting ecological adaptation through management strategies.
- Reducing the vulnerability of key forest values like fish or stream health

- Protecting forest ecosystems and non-timber forest products from climate change.
- Engaging in integrated land and resource management with other industrial sectors and communities to optimize regional value.
- Managing forests for additional ecosystem services such as carbon and water as markets for these values emerge (Spittlehouse & Stewart, 2003)

A number of research reports document potential methods of adaptation in other settings as it relates to these and other forestry-related challenges (see for example: Bernier & Scheone, 2008; Keskitalo, 2011; Eddington, et al, 2009; Innes,et al. 2009; Peterson, et al. 2011; Spittlehouse & Stewart, 2003). Choosing adaptation strategies is highly dependent on the understanding of specific impacts and local practices, the level of confidence behind impact projections, the scale and implementation level of the proposed actions, and the goals and priorities of managers and stakeholders and markets. The results from the vegetation modelling component of the CCAP, along with findings from other reports, tell us that over time shifting temperatures and changing precipitation patterns associated with climate change will impact:

- Phenology (the timing of ecological processes)
- Biodiversity
- Hydrologic cycles
- Carbon flux and storage
- Frequency and severity of extreme events and disturbances (wind storms, fires, drought, flooding, etc)

For the forest sector, this translates, generally, into changes that include impacts to:

- Timber supply (changing growing conditions for market species)
- Accessibility of timber
- Condition of forest values and resources (wildlife, fish, water, cultural heritage values, etc)
- Forest health and diversity
- Risk of insects and invasive species
- Overall vulnerability of forests and the forest sector to climate change

Responding to these changes requires conducting vulnerability assessments that span a range of spatial, temporal, and governance scales, and subsequently, the identification of adaptation options appropriate to different levels of implementation and management (Peterson, et al, 2011; Keskitalo, 2011). There is a growing collection of literature recommending an array of possible adaptive actions for the forest sector based on the responsibilities of different actors. Tables 7. 2 and 7.3 provide some common examples from the literature of potential adaptive actions and strategies that could be applied during different phases of adaptive management to address the objectives of promoting forest health and diversity (Table 7.1), and maintaining a sustainable timber supply (Table7. 2). The adaptation options have not been tested through this project, but are listed to provide practitioners and stakeholders with a foundation for investigating their future application in the Skeena region.

Table 7.2

Forest Health and Biodiversity	
Policy	1. Legislate percentage of land to be managed specifically for climate change (Steenburg, et al, 2011) 2. Legislate carbon sequestration as a goal of forest management 3. Provide incentives for protecting critical ecosystem services from climate impacts 4. Revise sustainable forest management criteria and indicators to account for climate change impacts (Eddington, 2009; Steenberg, et al. 2011) 5. Add forest values that can be integrated into watershed management practices and share or pay for benefits created by changes in practice.
Management and operations	1. Conduct Integrated Land Management planning with other resource users to optimize shared costs, access, road maintenance and outcomes 2. Include prospective analysis for planning and decision-making (Steenburg, et al, 2011) 3. Improve connectivity of protected areas (Spittlehouse & Stewart, 2003) 4. Harvest at optimal rotation to limit pathogens and disease 5. Stand management to decrease competition from invasive species (Walker et al, 2007) 6. Sanitation thinning (Spittlehouse & Stewart, 2003) 7. Plant resistant or resilient species and genotypes over vulnerable ones 8. Invest in low impact technology to decrease soil disturbance during harvest and silviculture 9. Engage in crisis planning to determine how to respond to extreme events and unforeseen threats. 10. Investigate options for salvage and extraction for use of invasive species.
Monitoring and assessment	1. Monitor and track areas of forest by specific disturbance, including native and invasive species (Steenburg, et al, 2011) 2. Include temperature measures in inventory studies to track impact of temperature shifts on phenology and associated functions and production (Steenburg, et al. 2011) 3. Monitor conditions of current connective corridors 4. Monitor to detect state of forest and identify when critical thresholds are reached (Spittlehouse & Stewart, 2003) 5. Track growth and productivity to and revise composition targets as necessary to maximize production (Spittlehouse and Stewart, 2003)

Table 7.3

Timber Supply	
Policy	1. Improve current AAC system 2. Reassess road building standards to maintain or improve access to timber supply. 3. Support development of technology to diversify options for timber harvest and use of wood products. 4. Provide special funding for the restoration of emerging disturbances 5. Provide silviculture value improvement payments for the benefits of commercial thinning to encourage improvement of second growth stand value and health
Management and operations	1. Include prospective analysis for planning and decision-making. 2. Harvest at optimal rotation to limit pathogens and disease. 3. Sanitation thinning (Spittlehouse & Stewart, 2003). 4. Plant resistant or resilient species and genotypes over vulnerable ones 5. Fertilization of nutrient deficient soil 6. Increase amount of salvage logging (Spittlehouse & Stewart, 2003; Walker, et al, 2007) 7. Develop technology to use altered wood quality and size (Spittlehouse & Stewart, 2003) 8. Plan for timber supply decreases by identifying uses for other species, and diversified use of wood products.
Monitoring and assessment	1. Monitor and track areas of forest by specific disturbance, including native and invasive species 2. Include temperature measures in inventory studies to track impact of temperature shifts on phenology and associated functions and production. 3. Track growth and productivity to and revise composition targets as necessary to maximize production (Spittlehouse and Stewart, 2003)

7.4 Tree Farm License 1 and the Kalum Timber Supply Area

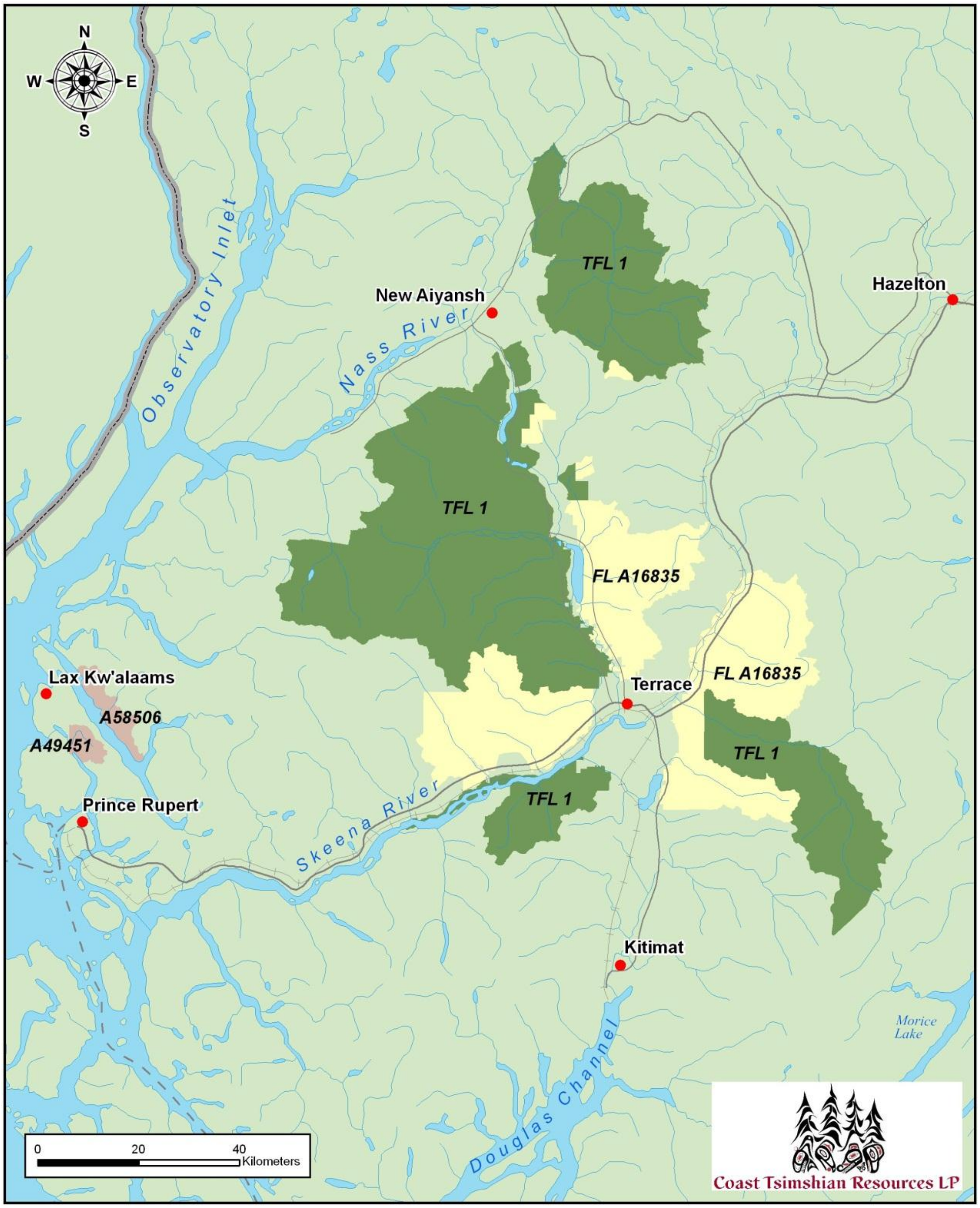

Figure 7.4: Map of CTR's Tree Farm License 1 (dark green) and the chart areas for Forest License 16835 (yellow) in the Kalum Timber Supply Area.

The adaptive strategies discussed above do not represent a one-size-fits-all solution for forest managers. The unique ecosystem characteristics of forested areas, socio-economic values, and historical harvesting and management patterns all combine to influence the appropriateness of different strategies. This section provides a description of TFL 1 and the Kalum TSA in which Forest Licence 16835's quota is allocated.

In 1948, the Columbia Cellulose Company Ltd. was granted tenure rights to what is now TFL 1. Since then the license has passed through a series of ownership and boundary changes. In 1951, the Port Edward Pulp Mill began operating. Harvesting operations, the pulp mill, and multiple saw mills in the area provided a significant source of employment until the 1990s when the industry began a long decline. The Smithers, Carnaby, and Terrace mills ceased operation in 2001. In 2003, then licence holder New Skeena Forest Products went into receivership and the Terrace sawmill was detached from TFL 1(TFL 1 MP 10, 2006).

In 2005, Lax Kw 'alaams owned company, Coast Tsimshian Resources LP (CTR), purchased TFL-1 and Forest License 16835 (See Figure 7.4) and engaged Brinkman Forest Ltd. to manage forestry operations on these licenses. Together CTR and Brinkman pursued new markets in Asia and made use of shipping facilities in Prince Rupert to transport timber overseas. In the coastal trading tradition of the Tsimshian people, CTR set up Canada's first Aboriginal business trade office in Beijing, China in 2007. This is an important development as the closure of the Port Edward pulp mill left the remaining demand for pulp-grade logs from mills further down the coast. This led to significant reduction of the allowable annual cut (AAC) from 2001 to 2006 (MOFR, 2010).

After several years of industry decline, CTR contributed to the revival of forestry in the region, and provided important economic benefits to the people of Lax Kw 'alaams, forest technicians and staff, local contractors and regional service providers. TFL 1 has a controversial history of over-harvesting and exploiting the highest value timber in the valley bottoms, making the remaining forest a challenging wood profile in which to profitably operate. Given its difficult history, Coast Tsimshian Resources recognizes that the sustainability of forestry operations is closely linked to restoring and sustaining the long-term health and diversity of the regions forest ecosystems, in order to support the sustainable economic wellbeing of the region.

Coast Tsimshian Resources is a unique forest licensee, owned by individuals who comprise a community which has existed in the region for 500 generations. While CTR is acutely aware that the first order of the day is economic survival, despite the low quality of wood on the license today, they have a vested interest in growing the long term value of the standing inventory and other resource values, not least among them are the salmon and other fish populations in the watershed.

Investment in the CCAP research project has been undertaken as a first step in identifying alternate long term management strategies and making the necessary preparation for a changing climate and potential new management objectives. The modelled study area encompasses the majority of the land base of TFL 1 and the chart areas of Forest License 16835 within the Kalum TSA that fall within the drainage of the lower Skeena watershed. The Kalum TSA does extend south beyond the CCAP and SRWCP study area boundary and this external area was not included in project modelling and analysis. The study area includes four biogeoclimatic zones: Coastal Western Hemlock, Interior Cedar Hemlock, Mountain Hemlock, and Alpine Tundra. In addition, a very small portion of the area is Engelmann Spruce – Subalpine Fir biogeoclimatic zone (Sutherland, 2008).

In total, the Kalum TSA covers 522 700 ha of land and the area of TFL 1 is 483 014 ha. In February 2011, the Chief Forester decreased the annual allowable cut (AAC) for the TSA by 2.9 % to 424,000 m^3 (Snetsinger, 2011) and the AAC for TFL 1 was also reduced from 500 000 m^3 to 378 059 m^3 as of July 6, 2011 (MFLNRO, 2012).

From 2002 – 2009 there was significant undercut of the AAC in both the TFL and TSA. This has been attributed to the "low quality of the existing mature volume on the TSA, high operating costs, the closure of local processing facilities and current economic conditions" (Snetsinger, 2011). In recent years, demand for local wood products increased as CTR developed new markets in Asia. A significant amount of local timber is debarked at CTR's log merchandizing yard and debarking facility in Prince Rupert and shipped to Asia through the Port of Prince Rupert. The shipment of raw logs is a controversial issue in other parts of the province, but is permitted where there are no local processors or buyers.

Coast Tsimshian Resources has been selling to over forty buyers within British Columbia who process the logs, and is currently engaged in feasibility studies to assess the potential for expanding local processing capacity to more forest products. Because a considerable portion of the forest profile does not have a market and debarking produces a continuous supply of hog fuel, Coast Tsimshian Resources has been working with its manager, Brinkman Forest, to develop a viable bioenergy operation that can process this surplus profile and processing waste.

Additional local influences on the regional forest sector in the study area include:

- First Nations Treaty Settlements, which may lead to a decrease in the area and AAC of the Kalum TSA and TFL 1 (Snetsinger, 2011).
- Availability and demand for second growth timber and associated local concern over long-term sustainable supply of second growth (Snetsinger, 2011).
- Potential for diversification of economic activities including the production of bio-energy.
- Unique planning environment in the TFL that functions more like a TSA than other Tree Farm Licences (this is because the Forest Service on behalf of other local First Nations routinely authorises the harvesting of stands within the Tree Farm License)

More detailed information on the history of TFL 1, the Kalum TSA, and management decisions are included in Appendix 7.1-7.3.

7.5 Adaptation options, barriers, and recommendations for TFL 1 and the Kalum TSA: Response from Coast Tsimshian Resources and Brinkman Forest to LPJ-Guess model outputs

Chapter 6 details the potential impacts of climate change on factors that will affect forest health and forestry management and operations, including species composition, timber supply, runoff, carbon storage, and fire risk. These results were reviewed by foresters at Coast Tsimshian Resources to determine potential risks and opportunities for adaptation within the forest sector, as well as recommendations to support additional research and adaptive management. Staff commented on a number of outputs, and posed questions geared toward improving the reliability of the model as a tool for strategic planning. The following section discusses adaptation options, challenges, and recommendations related to species shifts, colonization of alpine areas, planning and management for TFL-1, policy, and questions pertaining to modelling results.

A key warning from professional foresters is that while it is important to attempt to understand the potential implications of climate change on forest ecosystems, there are many variables of forest ecology that are not well understood even before adding climate change to the equation. Human adaptations for forest ecosystems are risky, both economically and ecologically, and few managers and licensees can absorb the risk of making major changes to operations based on highly uncertain models. Proposed adaptation options need to be carefully considered and the risk of failure or maladaptation fully understood by all stakeholders. Scientific research and monitoring must accompany adaptation efforts and while this is a good start, further work is required.

7.5.1 Species Shifts – Dominance of Hw and Ba

Modelling results show a general trend toward the dominance of *T. heterophylla* (Hw) and *A. amabilis* (Ba) in the study area with moderate confidence. According to the professional opinion of CTR foresters, this is a reasonable prediction. These tree species are not the most lucrative species to harvest (relatively low $/m^3 when compared *to T. plicata* or *P. sitchensis*), but they represent the majority of the standing volume within the tenure and of CTR's currently marketed volume. Despite the fact that the margin (disregarding development costs) is relatively low, these species account for the majority of CTR's profit due to the volume logged. These two species are the climax species and also perform well as seral species (especially Ba) across the majority of ecosystems within the Timber Harvesting Land Base (THLB) of CTR's combined tenure. Licensees within that tenure generally rely significantly on natural regeneration, either as the only means of re-establishing a stand or to supplement planted stock. Hw and Ba's ecological suitability to the majority of the sites logged within the THLB results in increased representation of these species in managed stands. In general, the trend toward the dominance of Hw and Ba is not a departure from the current stand composition within the study area.

From a broad ecological perspective, an argument could be made that the trend toward increased representation of Hw/Ba might lead managers to artificially encourage the establishment of other species through aggressive planting, regeneration silviculture and incremental silviculture. From a production ecology standpoint, the counter argument can be made that the comparative advantage the combined tenure holds in terms of growing Hw/Ba leads managers to encourage the establishment of those species. The predicted increase in the climactic conditions that favour Hw/Ba supplements that argument.

Both arguments have some validity and forest management strategies can be developed to address them. The most productive (in terms of commercial timber) areas of the THLB are the low elevation, relatively flat areas with comparatively deep soils and significant fluvial influence. These include the West Kalum/Erlandsen and Whitebottom operating areas as well as the fronts of the Little Cedar River and Williams, Nelson and Star creek drainages. The model predicts that these areas "… will likely experience increased growth due to CO_2 fertilization and increased moisture and growing season temperatures." The opportunity exists to manage these sites relatively intensely for production of commercial timber. Options to accomplish this include:

- commercial thinning or selection logging to increase the retention stand diameter/value and health;
- focusing silviculture investments (both regeneration and incremental) on these areas;
- consideration of fertilization as a method for increasing timber production;
- reducing rotations from biological (roughly 75 years) to technical (any age as long as the logs meet minimum specification);
- changing the landscape level biodiversity objectives for these areas, either by changing the objectives for the Landscape Units (LUs) that include these areas, or by designation of new zones with separate objectives within those LUs.

There are also areas where previous stand replacing disturbances and/or the ecology has resulted in establishment of stands with a significant component of non- Hw/Ba species; primarily *Thuja plicata* (Cw) and *Pinus contorta* var. *latifolia* (Pl). These include areas within the Hoodoo, North Copper, South Douglas, Maroon/Goat Creek, Chimdemash, and Legate operating areas. Many of these areas contain mature second growth timber that is either perpetually profitable or profitable under relatively high market conditions. These are the areas that should be targeted for management of non- Hw/Ba species. When they are logged, they should be planted or brushed/spaced to ensure representation of the ecologically suitable (and potentially climatically compromised) species. From a production ecology standpoint, this management directive is supported by the ecology of those sites. Without intense management (e.g. fertilization, herbicide, multiple brushing/spacing), these sites will likely never produce pure Hw/Ba stands. They should be actively managed for production of non-Hw/Ba species because those species will maximize productivity and add diversity to the range of marketable timber species. From a broad ecology standpoint, those stands should be maintained as non-Hw/Ba stands to support both the plant and animal communities associated with the existing stands.

7.5.2 Colonization of Alpine Areas

From a timber supply analysis perspective, the productivity gains anticipated by colonization of alpine areas should be considered negligible, especially in the short term, unless an afforestation initiative is justified. The higher elevation forests within the tenure are typically economically marginal or not profitable for harvesting. Access is costly, standing timber volumes are low, infrequent stand replacing disturbance results in low lumber recovery and tree growth is generally slow. Until better data supports it, increased timber availability due to afforestation of alpine areas is not recommended to increase the volume of allowable annual cut determinations, especially as these areas include goat range.

These recommendations, combined with the species shift modelling, does warrant reconsideration of the seed transfer guidelines and potential alteration of the stocking standards applied to high elevation ecosystems (MHmm2). Under the current standards, Hw is absent from the list of preferred and acceptable species and Ba is considered preferred in only the 01, 03, 04, 05 and 07 variants. If the climatic suitability of Hw/Ba increases in elevation, these species may prove suitable for reforestation of, or greater representation as a component of reforestation of MHmm2 sites.

Further study is warranted here. An easy place to start is the existing inventory of logged MHmm2 sites. There are not many; logging progresses uphill and as stated before, these sites are typically the least profitable to log. The silviculture survey records for logged MHmm 2 sites should be reviewed to see if, or in what proportion, Hw/Ba or MH is regenerating. If it looks like Hw is regenerating naturally under current conditions, consideration might be given to establishment of Hw/Ba plantations at high elevation (outside of approved stocking standards) sites. If this is undertaken a careful plan and commitment for long term monitoring must be in place. These sites regenerate relatively slowly and any high elevation Hw/Ba trials will not yield answers to long term viability in the immediate term. Any initiative like this will have to be monitored beyond free- growing (at minimum) in order to support a formal amendment to the approved stocking standards. Locating and monitoring existing field trial of previously planted, high elevation Hw/Ba for survival and timber productivity would be the logical place to start to collect some useful data before undertaking long-term experiments without funding for monitoring.

7.5.3 Assisted Migration

Assisted migration is a commonly cited adaptation option for the forest sector, and some outputs suggest this could be an option for Douglas fir in the study area. It should be noted that attempts to establish southern species (*Pseudotsuga menziesii*) and southern provenances of Pl within the region have been unsuccessful. Outside of expanding the elevation range of existing species, introducing new species into the region based on model outputs is not recommended. There are too many other factors (e.g., susceptibility to local or locally adapted pathogens, allelopathy, and fungal symbiosis) that are too poorly understood to warrant assisted migration of commercial tree species on any significant scale. Despite the initial work done through this study, there remains too much uncertainty in forest modelling, climate projections and high risk survival factors to make assisted migration based on LPJ-GUESS outputs advisable at this time. Small scale test stands could be attempted, but would require investment in long-term monitoring and risk analysis.

7.6 Barriers and Recommendations for Adaptation in the Forest Sector

7.6.1. Planning Environment in TFL #1

The current planning environment is the most significant barrier to investment in immature timber. The situation is the same all over the province; wherever there is publicly owned forest land tenured to forest licensees, everyone (government, industry, academics and stakeholders) acknowledges that there is a high degree of uncertainty that any current licensee will ever benefit from investment in a regenerating stand of timber.

However, the above cautions notwithstanding, Tree Farm License #1 is one of the most gutted and overexploited licenses in British Columbia. It is also the oldest license. Now, after its long and sordid history, during which it provided very little benefit to local First Nations, it is owned by a local First Nation who have been in the region for hundreds of generations. Its history makes it a good candidate for some government funded long term restoration of the historic high timber values on the license. Within that framework, it may become a pilot for resolving some of these difficult climate adjusted provenance questions for the benefit of all licenses in these Biogeoclimatic zones. With the leadership of a strong silviculture forester within Coast Tsimshian, support from the Ministry of Forests, Lands, Natural Resource Operations, academia, and some research funding, restoration collaboration is recommended.

The current planning environment can best be described as a single, area based tenure conjoined operationally with CTR's quota license, with multiple other licensees operating on volume based licences with minimal limitations on where they log within the overall area. TFL #1is unique in that it lacks the proprietary cutting rights that enable the planning stability characteristic of other TFLs; all licensees operate in what is essentially a large Timber Supply Area. As such, the current planning and management environment creates disincentives for making silviculture investments.

Recommendation: It is critical that the current planning environment on TFL #1 be restructured to involve collaboration and joint planning with a focus on the shared outcomes of management strategies. The shared outcomes must recognize the pro rata share of the licensees within the area, as well as the capacity of the forest resource across the land base.

7.6.2 First Nations Treaty Settlement and Conflicting Policy Initiatives

The uncertainty associated with the current planning environment is superseded by the uncertainty associated with unresolved First Nations land claims. Every hectare of land within CTR`s combined tenure is currently claimed by at least one of seven separate First Nations (Gitxsan and Gitanyow are considered single First Nations, the individual Wilps have not been accounted for). Every one of these First Nations is pursuing treaties, including land claims settlements, to varying degrees. It is probable that the combined tenure available for timber production will get smaller with the potential for replacement lands to be less productive and more costly to develop than the lands removed. With the likelihood of a decreasing harvestable land base, silviculture investment for long- term timber supply is not economically rational until treaties are settled and stability supports strategic planning. Unfortunately, forestry companies province wide are faced with the very real challenge of meeting economic demands in a highly competitive market, without certainty that investments in land will be returned in the long- term. Essentially, the current management structure combined with the instability of the pre-treaty settlement process, undermines the capacity for comprehensive, long term forest planning, and decreases the likelihood of investing in adaptive actions or pursuing recommendations such as those outlined in the Species Shifts section.

In addition to Treaty settlement, government is currently pursuing other policy initiatives that are in conflict with what the land base can support. These include:

- First Nation Woodland Licenses – these licenses are area based and government is having a hard time identifying where to put them for the respective first nations in the Northwest, given the limits of the land base for economically viable forest resource opportunities.

- BCTS pricing areas – this occupies a significant portion of the land base and removes it from availability for priorities of FN Woodland Licences, and Treaty settlement.

Recommendation: Given the implications for management control of the land base as the Treaty process moves forward, government needs to define a process that will provide certainty of planning for forest/land managers. Furthermore, it is recommended that government make some hard choices in terms of the various overlapping policy initiatives it is currently pursuing on the land base (First Nation Woodland Licenses, Treaty, and BCTS pricing areas), so that forest and land managers can engage in longer-term planning.

7.6.3 Complexity of Amending the Existing LRMP and SRMPs

The LRMP plans form the basis for many of the Results and Strategies mandated via CTR`s Forest Stewardship Plan. The planning process began in 1991 and concluded in 2002, with significant portions of the enacted plans left unfinished. The multi-stakeholder consensus-based process used to develop the plan is intended to be used to amend it but requires enormous amounts of time to implement, especially since First Nations consider that they were not appropriately represented in the process. These difficulties discourage active refinement or improvement of the plan.

Recommendations: It is the nature of climate change planning to consider 100 year horizons, something that most LRMPs had difficulty doing. Adding issues of climate change and integrating additional ecosystem services to the current LRMP and SRMP process might be seen as further complicating the planning, but it also provides a long term modelling framework. There is a need for new processes and tools to support the integration of these factors. Scenario based planning tools that include cumulative effects analysis would also improve the efficiency and clarity of the process. In addition, there is a need to streamline the multiple and overlapping policies and regulations that govern forestry operations, to provide clarity for practitioners and stakeholders. Objectives identified through consultation processes should also apply more widely to other land-users, including infrastructure building and mining operations.

7.6.4 Lack of Research Capacity

Among the licensees operating in the Kalum Forest District there are none with established Research and Development departments. The investment required for long-term monitoring is substantial and beyond the capacity of individual licensees to accommodate, especially considering the nature of risk associated with establishing trial stands. Partnerships between stakeholders and universities are beneficial, but there needs to be very long- term funding available and either, clear long term benefits or limited risk or both, to licensees who invest in research and development.

Recommendation: Continued investment from provincial government in support of practitioner-academic research endeavours to pursue next steps identified through this and other FFESC research projects. Internship grants from the government to support hiring of recent graduates for research purposes.

7.7 Recommendations for Future Research

In addition to recommendations made in specific relation to the above mentioned issues, future work could be done to test and improve the reliability of the model, and to test the feasibility of adaptation recommendations.

1) Validation of model outputs through long-term monitoring and calibration to justify field trials based on projections. If the model proves valid over the next time increment, field trials could be established and results could be used to support calibration and further implementation of the model's predictions.

2) Include in runoff scenarios the effect of varying levels of retention on snowpack accumulation and depletion in high-elevation stands of timber. This may require the establishment of logged sites with varying levels of in-block retention in order to observe the impact of different variations on snowpack.

3) Re-assess the validity of current road building standards given projections for increased precipitation, warmer winters, and runoff. The consequences of which could negatively impact access to timber, fisheries and water resource values, and increase risk to recreational users of activated and deactivated roads.

4) Additional refinement of the LPJ-GUESS model to assess the potential for invasive species and insects to impact the study area and timber supply.

5) Refinement of the LPJ-GUESS and other models to assess opportunities for carbon sequestration in the region, this would entail the collecting and analyzing of soil data.

6) Develop a hydrological model for the Skeena Watershed that included the glaciers, snow pack and total watershed hydrology and as this model is gradually corrected to the dynamics of the real world of the region, use the model to better manage and protect the fish resources that are valued most highly the region.

7) Enter into a regeneration partnership with the province to double the standing timber value of the license areas over the next one hundred years through climate adjusted species afforestation and stand tending.

8) Consider entering into a long term agreement with an academic institution (e.g. UNBC) with the goal of developing a long term research partnership. This could include co-maintaining a research library and data base of all past activities, co-developing trials or studies so that monitoring can be continuous and designating TFL #1's as a host for an educational institution's research as a living laboratory for regional and First Nation forest studies and learning, for conducting current research, provenance trials and providing innovative management. Through this arrangement, the institution can also be a co-host for the corporate history as the oldest TFL has some unique value for looking at tenure rights.

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