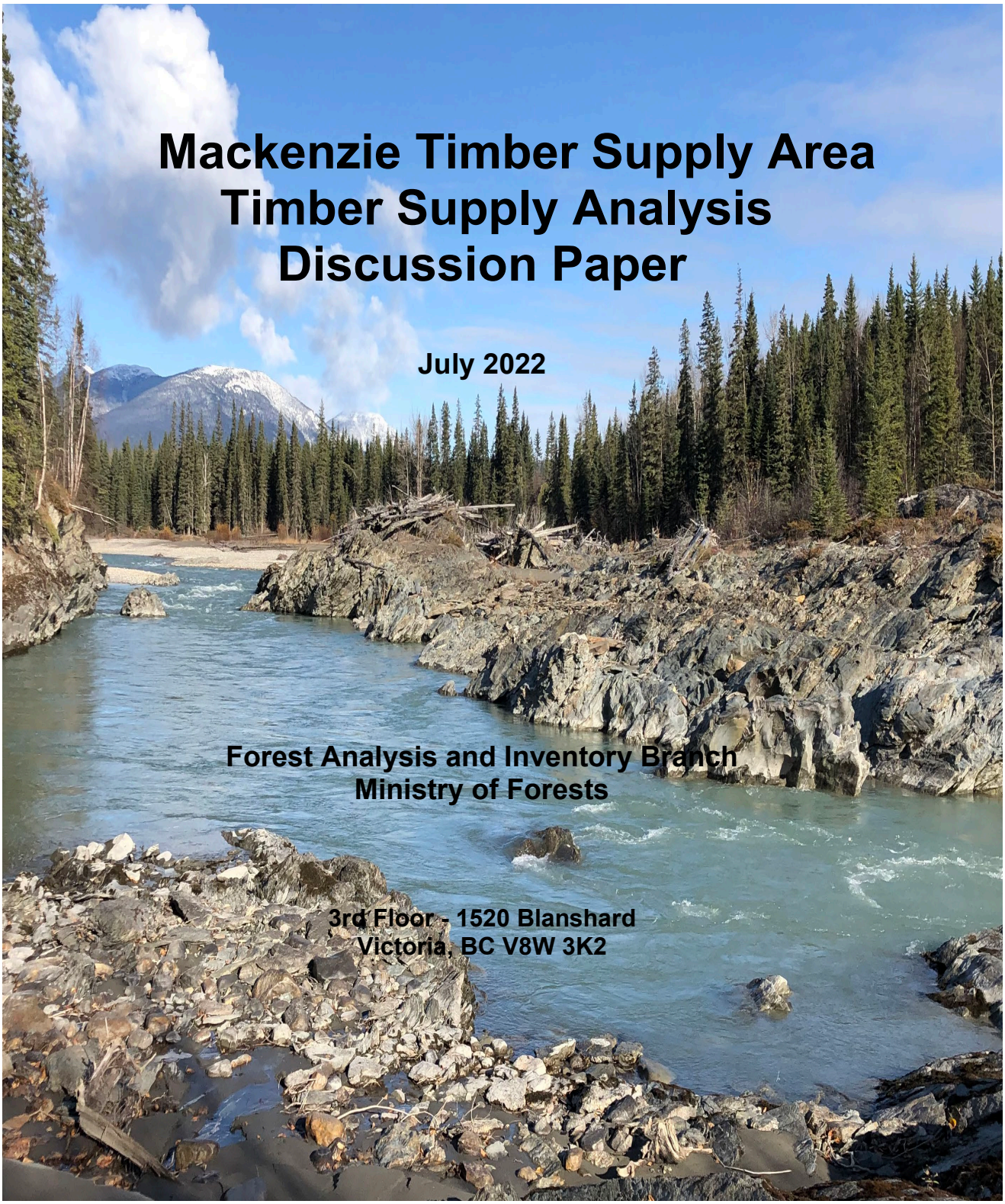

Mackenzie Timber Supply Area
Timber Supply Analysis
Discussion Paper

July 2022

Forest Analysis and Inventory Branch
Ministry of Forests

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BRITISH COLUMBIA | Ministry of Forests

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Introduction

The British Columbia Ministry of Forests (the "Ministry") regularly reviews the timber supply[a] for all timber supply areas[b] (TSA) and tree farm licences[c] (TFL) in the province. This review for the Mackenzie TSA examines the impacts of current forest management practices on the timber supply, economy, environment and social conditions of the local area and the province. Based on this review, the chief forester will determine a new allowable annual cut[d] (AAC) for the Mackenzie TSA.

According to Section 8 of the *Forest Act* the chief forester must regularly review and set new AACs for all TSAs and TFLs in the Province of British Columbia.

The objectives of the timber supply review (TSR) are to:

- examine relevant forest management practices, environmental and social factors, and input from First Nations, forest licensees and the public;
- set a new AAC; and,
- identify information to be improved for future timber supply reviews.

This discussion paper provides a summary of the results of the timber supply analysis for the timber supply review of the Mackenzie TSA. Details about the information used in the analysis are provided in a November 2020 data package. Additional technical detail is available upon request from the Ministry of Forests, Forest Analysis and Inventory Branch. Contact information is provided at the end of this document.

The timber supply analysis should be viewed as a "work in progress". Prior to the chief forester's AAC determination for the TSA, further analysis will be completed, and existing analysis reassessed as a result of input received during this review process.

Timber supply review undertaken in support of an AAC determination is based on the current resource management objectives established by government in legislation and by legal orders. For the purposes of the Mackenzie TSA timber supply review, forest management objectives are provided by the *Forest and Range Practices Act* (FRPA), Mackenzie Land and Resource Management Plan (LRMP), Mackenzie Sustainable Resource Management Plan (SRMP), and subsequent Higher Level Plan Orders under the *Forest and Range Practices Act* for specific objectives. The information compiled to support this timber supply review can be made available to support land use planning as required. However, land use planning and land use decisions are outside the scope of the chief forester's AAC determination. In the event that resource management objectives and practices change, these changes can be reflected in subsequent timber supply reviews.

There is inherent uncertainty associated with all the information supporting this analysis that can often lead to requests to delay the AAC determination or to generally reduce the AAC in the interest of caution. However, due to the significant impacts that AAC determinations can have on communities, the chief forester can not make an AAC determination solely on the basis of a precautionary response to uncertainty. Allowances may need to be made to address risks that arise because of uncertainty by applying judgment as to how the available information is used. The requirement for regular AAC reviews provides the opportunity for uncertainty to be reduced through the collection of new and improved information.

[a] **Timber supply**
Timber supply is the amount of timber available for harvesting over a specified period of time.

[b] **Timber supply areas (TSAs)**
Timber supply areas are integrated resource management unit established in accordance with Section 7 of the Forest Act.

[c] **Tree farm licences (TFLs)**
Tree farm licences are tenures that grant exclusive rights to harvest timber and manage forests in a specific area; may include private land.

[d] **Allowable annual cut (AAC)**
Allowable annual cut is the maximum volume of timber available for harvesting each year from a specified area of land, usually expressed as cubic metres of wood.

It is expected that this discussion paper will stimulate discussion of resource management objectives and practices within the Mackenzie TSA. All relevant information will be provided to the chief forester for consideration in determining a new AAC. Public comments are encouraged and will be accepted until the end of the 60-day review period.

Timber supply review the Mackenzie TSA

The current TSR process was initiated in the spring of 2019. A data package documenting the information requirements and assumptions for the timber supply analysis supporting the AAC decision was released in November 2020 for public review and to assist with First Nations consultation. The data package was developed through collaborative engagement with First Nations.

This discussion paper provides an overview of the timber supply review process and highlights the results of the timber supply analysis, including harvest projections for the Mackenzie TSA.

Before determining a new AAC, the chief forester will review all relevant information, including the results of the timber supply analysis, socio-economic information, First Nations input and input from government agencies, the public, and licensees. Following this review, the chief forester's determination will be outlined in a rationale statement that will be publicly available.

The actual AAC determined by the chief forester during this timber supply review may differ from the harvest projections presented in this analysis, as the chief forester must consider a wide range of information including the social, economic and environmental implications associated with a given harvest level. Ultimately, the chief forester makes a professional judgment based on the legal requirements set out in Section 8(8) of the *Forest Act*.

Once the chief forester has determined the new AAC, the Minister of Forests will apportion the AAC to the various licence types and programs. Based on the minister's apportionment, the regional executive director will establish a disposition plan that identifies how the available timber volume is assigned to the existing forest licences and, where possible, to new opportunities.

Description of the Mackenzie TSA

The Mackenzie TSA is located in the north-east interior of the province, is the fourth largest TSA in the province and covers approximately 6.41 million hectares. The Rocky Mountain Trench, with flat to gentle terrain, runs north-south through the center of the TSA, with the rugged Rocky Mountains on the east side and the more rounded Omineca Mountains to the west. The Williston Reservoir is within the central portion of the TSA and within the Rocky Mountain Trench. The Williston Reservoir is the largest reservoir in BC.

In the TSA the largest community is Mackenzie (3700 residents). Mackenzie was built in the 1960's during the construction of the W.A.C. Bennet Dam. Other smaller communities within the TSA include Kwadacha, Tsay Keh, Germansen Landing and Manson Creek.

In addition, there are two Indigenous communities and several First Nation territories that overlap the TSA. Since time immemorial, First Nations have resided on the lands of the Mackenzie TSA. The established communities that exist today were formed as a result of the historically acknowledged forced relocation of the First Nations following the flooding of a large part of their lands and resources that once flourished along the historic sections of the Finlay and Peace Rivers, now known as the Williston Reservoir. The community of Kwadacha is located north of Mackenzie at the confluence of the Fox, Kwadacha, and Finlay rivers in the Rocky Mountain Trench. The community of Tsay Keh is located near the northern terminus of the Williston Reservoir and just outside the TSA, the McLeod Lake community is located at the northern tip of McLeod Lake. Outside these communities, members extensively utilize the lands and resources within the TSA for sustenance and maintenance of cultural well-being through cultural practices including hunting, trapping, fishing, gathering and spiritual uses.

The TSA is one of three in the Omineca Region and is administered by the Ministry of Forests district office located in Mackenzie (District) as shown Figure 1.

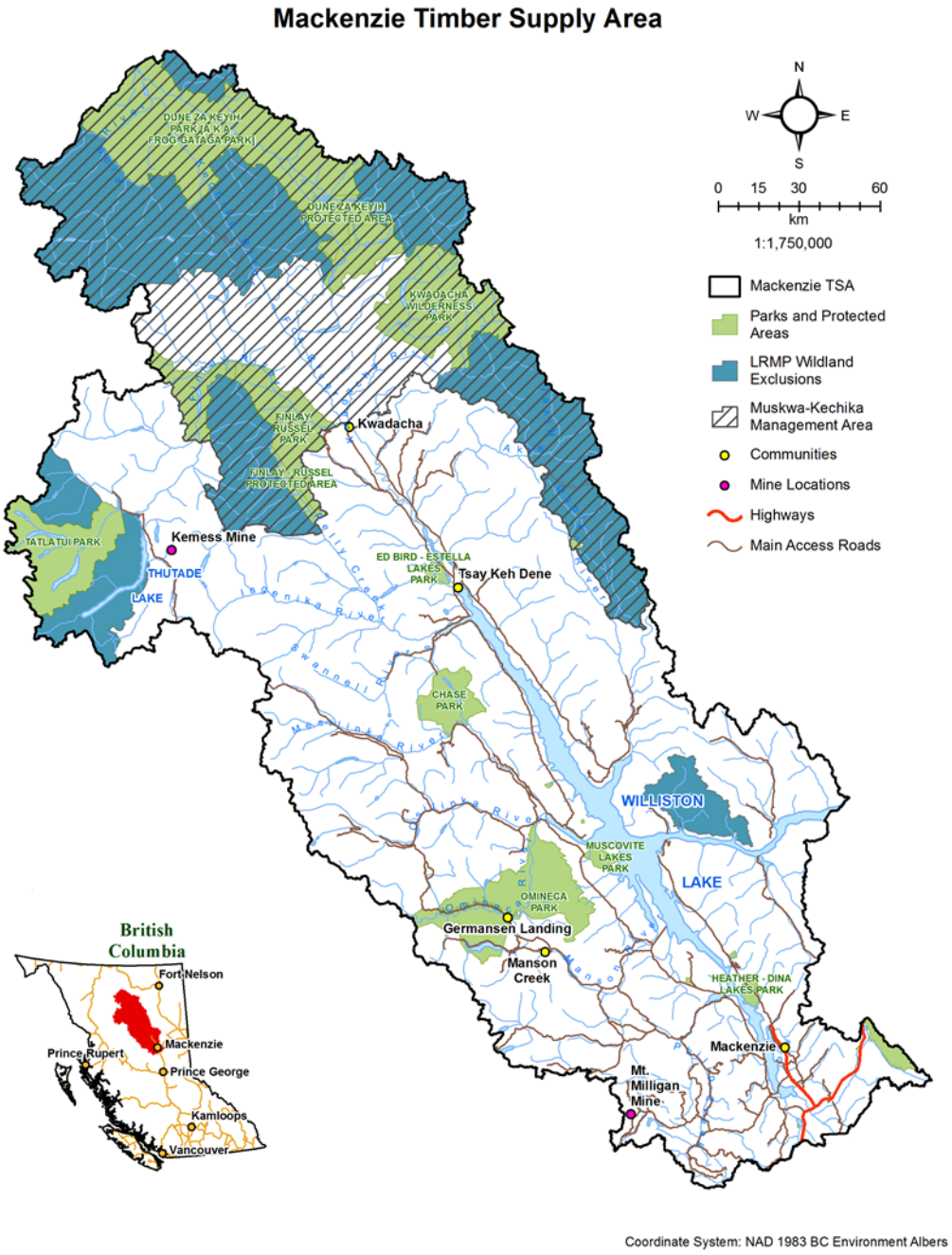

Figure 1. Location of Mackenzie TSA.

The diverse terrain of mountains and river valleys contribute to the distinct ecological features and high biodiversity values within the Mackenzie TSA. The forests are in the transition zone between the sub-boreal regions of BC's central interior and the boreal forests in the north-east portion of the province.

Forestry is the most extensive industrial activity but there is also mining and mineral development.

First Nations

The traditional territories of 15 First Nations are overlapped in whole or in part of the Mackenzie TSA. First Nations communities within the Mackenzie TSA include: Binche Whut'en, Blueberry River First Nation, Doig River First Nation, Fort Nelson First Nation, Gitxsan, Halfway River First Nation, Horse Lake First Nation, Kwadacha, Nak'azdli Whut'en, McLeod Lake Indian Band, Prophet River First Nation, Saulteau First Nations, Tahltan First Nation, Takla t Nation, Tsay Keh Dene Nation, and West Moberly First Nations.

Five of the First Nations communities in the TSA have a current Forest Consultation and Revenue Sharing Agreement with the Ministry. A number of Nations are working with the Province to build relationships and address concerns associated with land and resource use.

The Ministry and First Nations are collaborating on this timber supply review to mitigate and accommodate potential impacts to First Nations interests. The Province of British Columbia and Tsay Keh Dene Nation, Kwadacha and Gitxsan First Nations have signed collaboration agreements. The agreements provide a framework for the Province and the First Nations to increase and deepen collaboration on TSR.

This discussion paper was developed collaboratively and is intended to present the different views that have been expressed so far in the process for the purpose of public engagement. Contributions provided directly by the First Nations contributors have been included and are clearly identified in the sections titled Indigenous Perspectives and are shown in *italics*.

Indigenous Peoples of the Mackenzie TSA

This section provides a brief description of the 15 First Nations within the Mackenzie TSA that have cultural, social and economic interests in the area.

Binche Whut'en

Binche Whut'en First Nation recently obtained its independence from the Tl'azt'en Nation. The primary community is Pinchi, located 35 km north-east of Fort St. James. The Binche Whut'en forms one of several Indigenous communities that make up the Carrier or Dakelh ("on water travel people") who are members of the Athapaskan language group.

Blueberry River First Nations

Blueberry River First Nations territory overlaps the south-eastern portion of the Mackenzie TSA. The Blueberry River Indian Reserve #205 is located approximately 80 km northwest of Fort St. John. Blueberry River First Nations is an Athapaskan-speaking nation, belonging to the Beaver culture. Their linguistic groups are Dane-zaa (Beaver) and Nehiyawewin (Cree). The Blueberry River First Nations first adhered to Treaty No. 8 as part of the Beaver of Fort St. John. The community was later recognized as Beaver St. John in 1950 and as Fort St. John in 1962. In 1977, the group split to form Blueberry River and Doig River. Blueberry River First Nations held a past affiliation with the Treaty 8 Tribal Association. In August 2005, the Blueberry River First Nations removed themselves from the Treaty 8 Tribal Association (Treaty 8 Council of Chiefs) and are no longer affiliated with this or any other tribal council or organization.

Doig River First Nation

The Doig River First Nation territory overlaps the eastern portion of the Mackenzie TSA. Their reserve area was established in 1952 and is located 70 km northeast of Fort St. John. Doig River First Nation is an Athapaskan-speaking nation, belonging to the Dane-zaa (Beaver) culture. The Doig River First Nation is a member of the Treaty 8 Tribal Association which also includes Halfway River First Nations, Prophet River First Nation, Saulteau First Nations, and West Moberly First Nations.

Fort Nelson First Nation

The Fort Nelson First Nation territory overlaps the north-eastern portion of the Mackenzie TSA. Fort Nelson First Nation is an Athapaskan-speaking people belonging to the Slavey culture group. The Fort Nelson First Nation linguistic group includes Slavey (Dene) and Cree. This group signed Treaty No. 8 in August 1910 as part of (Siccannie: Siccanni: Sekani: Slave Band of Fort Nelson: Slavey/Cree), and in 1974 split into Fort

Nelson and Prophet River. The Fort Nelson First Nation held past affiliation with the Treaty 8 Tribal Association but are no longer affiliated with this or any other tribal council or organization.

Gitxsan

Gitxsan territories overlap the north-western corner of the Mackenzie TSA. Most Gitxsan live in five Gitxsan villages (Gitwangak, Gitsegukla, Gitanmaax, Glen Vowell, Kispiox) and two municipalities (Hazelton, New Hazelton). The Gitxsan language or Gitxsanimaax is from the Tsimshianic linguistic group of north-western BC.

The diverse Gitxsan Nation, in Northern BC, upholds a traditional society that is governed by a system of laws (Ayook) and oral histories (Adaakw).

Halfway River First Nation

The Halfway River First Nation territory overlaps the Peace and Mackenzie TSA. The Halfway River First Nation community is located about 75 km northwest of Fort St. John. The Halfway River First Nation is an Athapaskan speaking people belonging to the Beaver/Cree culture groups and is a member of the Treaty 8 Tribal Association.

Horse Lake First Nation

Horse Lake First Nation territory overlaps the south-eastern portion of the Mackenzie TSA. The Horse Lake First Nation community is located west of Hythe in north-western Alberta. The Horse Lake First Nation is linguistically and culturally part of the Dane-zaa (Beaver). The Horse Lake First Nation is a member of the Western Cree Tribal Council.

Kwadacha Nation

The Kwadacha Nation (formerly Fort Ware Band) territory overlaps the northern part of the Mackenzie TSA. The Kwadacha Nation is part of the Kaska Dena Council and live in the Finlay River watershed, at the confluence of the Fox, Kwadacha, and Finlay Rivers within the Mackenzie TSA. The Kwadacha Nation are an Athapaskan-speaking people and belong to the Kaska and Sekani culture groups. The Nation is affiliated with the Kaska Dena Council, the Kaska Forest Resource and Stewardship Council, and the Tsay Keh Nay (a partnership between Tsay Keh Dene, Kwadacha and Takla). Kwadacha means "white water " in Tsek'ene language.

McLeod Lake Indian Band

The McLeod Lake Indian Band territory overlaps the southern portion of the Mackenzie TSA extending into the Prince George and Dawson Creek TSAs. The main community of the McLeod Lake Band is located on McLeod Lake Indian Band Indian Reserves #1 and #5 near the unincorporated village of McLeod Lake, approximately 150 km north of Prince George on Highway 97. McLeod Lake Indian Band members are an Athapaskan-speaking people within the Sekani group of Indigenous peoples that include bands at Kwadacha and Ingenika (Tsay Keh Dene). The English translation of Tse'Khene is "people of the rock". McLeod Lake Indian Band is an adherent to Treaty 8 and a member of the Treaty 8 Tribal Association.

Nak'azdli Whut'en

The Nak'azdli Whut'en territory overlaps the south-western portion of the Mackenzie TSA. The Nak'azdli Whut'en are a Dakelh-speaking people. Nak'azdli Whut'en refers to a wartime between the little people and Nak'azdli Whut'en and translates as "when arrows were flying". Nak'azdli traditions of land management operate through a system of heredity stewardship that is operational at a localized family-level of protection. Many of these areas were codified and/or arbitrarily circumscribed in the early 1900s through the provincial trapline registry, and the commodification of territory and coerced settlement in urban areas now means that traditional intra-territorial boundaries are incompletely known.

Today, the Nak'azdli Whut'en territory is collectively defined by 24 Keyohs that have existed in harmony with the land since time immemorial. Each family has generational rights to their Keyoh with its laws enforced and maintained through a complex witnessing system of governance known as the clan system. As part of a larger

effort to maintain a relationship with the land through enhanced decision-making power, Nak'azdli Whut'en signed the Pathways Forward 2.0 Agreement in 2017. As part of this agreement, Nak'azdli Whut'en is in the process of developing and releasing a Land Stewardship Plan that manages the land according the principles and values of its Keyoh people.

Prophet River First Nation

The Prophet River First Nation territory overlaps the north-eastern portion of the Mackenzie TSA. Prophet River First Nation is located at Mile 227 (Kilometre 365) on the Alaska Highway. Prophet River First Nation is an Athapaskan-speaking people belonging to the Sekani/Beaver culture group and the Beaver (Dunne-zaa) linguistic group. Prophet River (also referred to prior to 2004 as Prophet River Band: Dene Tsaa Tse K'Nai First Nation) signed Treaty No. 8 in 1910 as part of Sicanees of Fort Nelson, which split into Fort Nelson and Prophet River in 1974. The Prophet River First Nation is a member of the Treaty 8 Tribal Association.

Saulteau First Nations

The Saulteau First Nations territory overlaps the eastern portion of the Mackenzie TSA. Their community is located approximately 100 km southwest of Fort St. John. The Saulteau First Nations are one of the Treaty 8 bands and are an Athapaskan-speaking people, belonging to the Cree culture group. The Saulteau First Nations linguistic groups include Saulteau, Beaver and Cree. Formerly named East Moberly Lake (or Moberly), the Saulteau First Nations signed onto Treaty 8 in 1914. Saulteau First Nations originally travelled to the Moberly Lake area from Manitoba.

Tahltan First Nation

Tahltan First Nation territory overlaps the north-western portion of the Mackenzie TSA. Tahltan live primarily in three main communities: Telegraph Creek, Dease Lake and Iskut. The Tahltan language is Na-Dene (or Athapaskan) and is typically grouped with Tagish and Kaska as distinct dialects within a single language family.

Takla Nation

The Takla Nation territory overlaps the mid-western portion of the Mackenzie TSA. Takla Nation's main community is at Takla Landing in the Stuart Nechako Resource District and is home to approximately 250 residents. The Noostel Keyoh community is the most active within the Mackenzie TSA, with several Takla members residing year-round in the Germansen Landing area. The Takla Nation is an amalgamation of the North Takla Band and the Fort Connelly Band, a union which occurred in 1959. The Takla Nation territory was traditionally the lands of the Athapaskan-speaking Sekani and is now a product of the 20th century amalgamations and intermarriages. In the North, the Sekani were known as the Fort Connolly Band, the Bear Lake Tribe, the Sustut'enne, and the Sasuchan. To the South they were the Yutuwichan or Takla Sekani.

Takla Nation is part of Tsay Key Nay, an alliance between Tsay Keh Dene, Kwadacha, and is a member of the Carrier Sekani Tribal Council.

Tsay Keh Dene Nation

The Tsay Keh Dene territory overlaps the central portion of the Mackenzie TSA and encompasses the largest territory with resource activity within the TSA. The Tsay Keh Dene people are culturally and linguistically Sekani. Sekani refers to an Athabaskan-speaking ethnolinguistic group and is often translated as "people of the rocks" or people of the mountains. The Sekani people were the original occupants of the Rocky Mountain trench in north-central BC.

The Tsay Keh Dene people are highly disadvantaged socio-economically. This disadvantage is the result of colonization, flooding of a large part their territory in the 1960s to build the W.A.C. Bennett Dam and Williston Reservoir and their forcible relocation to reserves outside of their traditional territory, Canada's residential schools policy and the resulting erosion of their language, culture and way of life. Despite the challenges, Tsay Keh Dene is resilient and forward-looking. Forestry continues to be the main economic driver in Tsay Keh Dene territory and a sustainable forest industry in which Tsay Keh Dene is a major participant is key to Tsay Keh Dene's long-term vision for economic prosperity and self-reliance.

West Moberly First Nations

The West Moberly First Nations territory overlaps the mid-eastern portion of the Mackenzie TSA. The main community is situated on Moberly Lake north-west of Chetwynd. West Moberly First Nations are an Athapaskan-speaking people, belonging to the Beaver and Cree culture/linguistic group. Formerly part of the Hudson Hope Band, West Moberly First Nations signed onto Treaty No. 8 in 1914, and in 1977 split into West Moberly Lake and Halfway River. West Moberly is affiliated with the Treaty 8 Tribal Association.

Collaborative Technical Working Group (CTWG)

To support the AAC determination, the Ministry is endeavoring to work collaboratively with Indigenous peoples throughout the TSR process for the Mackenzie TSA. The collaboration is unique as it supports moving towards the Province's broader commitment to implement the *United Nations Declaration on the Rights of Indigenous Peoples* (UN Declaration).

The Ministry is working with Indigenous peoples across the province in various ways to support strategic and collaborative management of the land base, in recognition of the Province's and Indigenous peoples' shared responsibility for stewardship of lands and resources within their respective jurisdictions. These processes include but are not limited to:

- Modernized land-use planning;
- Environmental Stewardship Initiative;
- Collaborative Stewardship Framework; and,
- Engagement on TSRs.

This approach emphasizes collaboration at the strategic level and reduces the focus on individual operational-level applications and projects.

The Province's *Declaration on the Rights of Indigenous Peoples Act* (the *Declaration Act*) establishes new shared decision-making tools. These agreement mechanisms are the objective of many Indigenous peoples and will take time to negotiate. These decision-making tools also must be enabled through changes in legislation including the *Forest Act.*

To support collaboration, representatives from Kwadacha Nation, Tsay Keh Dene Nation, Takla Nation, Gitxsan, Nak'azdli Whut'en and McLeod Lake Indian Band are working with the Ministry's staff as a Collaborative Technical Working Group (CTWG).

Additional information received during public engagement and First Nations consultation will be incorporated in the analysis that will be used to help inform the chief forester for consideration in the AAC determination. The chief forester's AAC determination will be documented through the public release of an AAC determination rationale.

CTWG Indigenous Perspectives: CTWG

As a measure to influence and change the current TSR process, the Nations most impacted by this decision are participating in the CTWG "CTWG Nations". To guide the CTWG process, Kwadacha, Tsay Keh and Gitxsan have signed a collaboration plan with BC and all other member Nations of the CTWG respect the spirit and intent of this plan. Even though the collaboration plan did not meet all the expectations of some of the CTWG Nations, it established a clear and robust framework for collaboration on the TSR. To date the CTWG has led a collaborative review and analysis of some of the data and information that will ultimately inform recommendations to the chief forester on an AAC determination.
Outlined in this Discussion Paper, under "Indigenous Perspectives" sub-headings, the CTWG Nations summarize various limitations within the TSR process, and the implications to impacts on Aboriginal rights (including treaty rights), title and interests, which are referred to by CTWG Nations as "First Nations' Rights".

For a more in-depth review and rationale, the CTWG Nations have developed the "First Nation DMKTSR Technical Report" that is available at https://portal.taklafn.ca/document_downloads/MackenzieTSR_2022.pdf, or by contacting:

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CTWG Indigenous Perspectives: Timber Supply Review

The structure of the TSR and AAC determination processes limits the ability of First Nations to practice their inherent way of life which is based on stewardship of their own lands. The TSR and AAC approach to forest management is an abstract and complex process that is far removed from an "Indigenous Perspective" on land management. Indigenous land management is grounded in intergenerational knowledge that families apply in the stewardship of specific areas within their territories with a focus on preserving First Nations' values for future generations.

This approach to land management by First Nations, is best described in western concepts as ecosystem- based sustainable land management that employs a "Precautionary Principle". The application of precaution is a legitimate and distinctive decision-making approach within risk management, is distinctive within science-based management, and is characterized by three basic tenets: the need for a decision, a risk of serious or irreversible harm, and a lack of full scientific certainty.

Scientific uncertainty in the TSR and AAC determination processes is associated with not one, but numerous variables, such as current and future yields, managed stand site productivity, forest health losses, future fire losses, and the compounding effect of climate change on all these variables. While the risk to sustainable AAC levels can be adjusted/amended in the next AAC determination, the risk to the livelihood and continuing cultural practices of First Nations are values that, if lost, cannot be replaced during the next AAC determination.

When the TSR process cannot adequately demonstrate the impacts to First Nations' Rights, the CTWG Nations have identified the need for a precautionary approach when setting the AAC.

CTWG Indigenous Perspectives: Apportionment

Regarding the minister's apportionment decision following the AAC determination, most of the First Nations affected by the TSR have unextinguished Aboriginal rights including title. At common law Aboriginal title confers beneficial ownership of the lands and resources including timber resources and the right to make decisions regarding how the land and resources are used. In the words of the Supreme Court of Canada, Aboriginal title has an "inescapable economic component". Despite developments in the law of Aboriginal rights, a common perception among Indigenous groups is that BC has been unduly slow and cautious in implementing rights and title or exploring ways by which to reconcile and harmonize its underlying Crown title and Aboriginal rights and title.

To advance reconciliation and fulfil the Province's promise of recognition of Aboriginal rights including title, it is vital that during the apportionment, First Nations receive an equitable share of forestry tenures in their territories and the economic and other benefits that forestry activity produces. This is not only about social justice and empowering First Nations to develop their own economies and improve the lives of their members. Greater access to tenure by First Nations is critical to the long-term stability and prosperity of the forest sector. Opportunity to achieve more equitable access to forestry tenures for First Nations exists following the AAC determination in the Mackenzie TSA. The Nations most affected by this TSR will pursue this opportunity to ensure the forest sector and the Indigenous and non-Indigenous communities that depend on forestry can continue to prosper.

Environmental values

Current forest management must be consistent with the requirements of the *Forest and Range Practices Act* and associated regulations, which are designed to maintain a range of biodiversity and wildlife values. All forest lands, whether they contribute to timber supply or not, help to maintain critical habitats for many species. The timber supply analysis accounts for forest resource values such as old growth forests, visual quality, wildlife habitat, recreation features, riparian management and protection of environmentally sensitive areas. In the Mackenzie TSA, approximately 60 percent of the forested area is neither suitable nor available for timber harvesting given the various forest resource values or management requirements.

The diverse forests and landscapes of the Mackenzie TSA are home to a wide variety of wildlife species. Although best known for its caribou population, the TSA also supports moose, mule deer, elk, grizzly and black bear, mountain goat, stone sheep, wolves and coyotes. Significant populations of small mammals also exist, with fisher, pine marten, beaver and lynx being the most common. Thirty-eight percent of the bird species known to occur in British Columbia and 53 percent of all species known to breed in the province are found in the TSA. The rivers and lakes of the TSA support many fish species including Lake Whitefish, Bull Trout, Rainbow Trout, Kokanee, Arctic Grayling, Lake Trout, Burbot, Mountain Whitefish, Longnose Sucker, Largescale Sucker, White Sucker, Peamouth Chub, Northern Pikeminnow and Redside Shiner. Numerous lakes in the TSA also provide a range of fishing opportunities.

The First Nations represented at the CTWG have identified caribou, grizzly bears, aquatic ecosystem health and forest biodiversity as important values to maintain in the Mackenzie timber supply area. Appendix 2 describes indicator assessments associated with these values.

CTWG Indigenous Perspectives: Environmental Values

Environmental values, such as caribou, grizzly bear, moose, fisher and marten contain cultural values important to the Nation's section 35 Rights. The Nations way of life is dependent on the existence of healthy mature forests, wildlife habitats, fresh clean water, and access to these places. There must be healthy populations of caribou and other wildlife for Nations to meaningfully exercise their rights to hunt, fish, and trap. Current provincial forest policies, such as the TSR, puts these rights (associated with Environmental Values) at moderate to high risk over time. Current population declines of caribou and fisher, to the status of red- or blue-listed species under the Species at Risk Act, provides evidence of how provincial forest policy has been unable to protect First Nation Rights. Furthermore, current forest management practices result in highly concentrated harvesting of remaining productive old-growth forests which in turn impacts hunting, trapping, and gathering places and displaces First Nations from traditional areas of use and occupation.

Land use planning in the Mackenzie TSA

The Mackenzie Land and Resource Management Plan (LRMP) began in August 1996, involving 40 community and industry interests, First Nation(s), and local government. The government of British Columbia subsequently approved the LRMP in November 2000. While the LRMP itself is not a legally-established higher level plan, it contributed to the creation of two legal orders to establish the Muskwa-Kechika Management Area and the Mugaha Marsh Sensitive Area. New parks and protected areas were created as a result of the Mackenzie LRMP. Direction in the LRMP has also supported the establishment of several wildlife habitat designations in the TSA.

Timber supply reviews undertaken in support of AAC determinations are based on the land use objectives established by provincial government and current forest management. In the Mackenzie TSA these include:

- The Orders Establishing Ungulate Winter Ranges and Wildlife Habitat Areas throughout the TSA;
- Order Establishing Non-Spatial Old Growth Objectives – 2004;
- Non-Spatial Landscape Biodiversity Objectives in the Mackenzie Forest District – 2008;
- Amendment to the Non-Spatial Landscape Biodiversity Objectives – 2010;
- Spatial Land Use Objectives in the Mackenzie Forest District Area Including OGMAs – 2010;
- Order to Establish the Obo River and Fox Landscape Units and Objectives – 2002;
- Order Establishing a Sensitive Area and Objectives Mugaha Marsh Order – 2001;
- Order Establishing Agriculture Development Areas and Settlement Reserve Areas – 2006.

CTWG Indigenous Perspectives: Land Use Plans

The perception of the CTWG Nations is that land use planning for the District of Mackenzie or DMK in the past has not been balanced in its approach to development, inclusive or respectful of Indigenous rights and Interests. These LUP processes were dominated by provincial and private interests (including, in some respects, accelerated and unsustainable development) and did not reflect Indigenous values or priorities and strategies for development and conservation. The LUP process was premised on Provincial ownership of and primary stewardship over the lands and resources in the DMK. This may be slowly changing. The commitments by the Province to implement United Nation Declaration on Right of Indigenous Peoples (UN Declaration) and collaboratively implement Aboriginal rights and title has the potential to transform how land use planning processes are conducted in the province including the role of Indigenous groups in those processes.

The Environmental Stewardship Initiatives

The Environmental Stewardship Initiative (ESI) is a form of collaboration and partnership between the Province and First Nations. ESI projects are designed to focus on: ecosystem assessment and monitoring; ecosystem restoration and enhancement; ecosystem research and knowledge exchange; and stewardship education and training. Five ESI projects span the north-central portion of the BC. Three ESI projects overlap portions of the Mackenzie TSA: the Omineca ESI Demonstration Project (Omineca ESI), the Tsay Keh Dene ESI Project and the Northeast Regional Strategic Environmental Assessment (RSEA).

CTWG Indigenous Perspectives: The Environmental Stewardship Initiatives (ESI)

Even though ESI tables have been very successful in compiling, analyzing, and reaching a consensus on the current condition of and risks to Valued Ecosystem Components or VECs, ESI has not always met the expectations of some Indigenous groups. A major challenge for ESI from the perspective of some of the CTWG Nations has been to translate trusted information into concrete actions and measures to meaningfully address risks to VECs including immediate measures that are acceptable to both the Province, Indigenous groups and industry. However, despite the challenges some progress has been made. An obvious benefit of ESI has been that it has increased confidence among Indigenous groups that collaboration by the Province and Indigenous groups on stewardship of land and resources is not only possible, but it is an integral part of and necessary to reconciliation of Crown/Indigenous rights, title, and interests.

Indigenous land use plans and conservancies

Many of the Indigenous people with territory overlapping the Mackenzie TSA have developed Indigenous land use plans and conservancy initiatives. These plans are established by the communities to communicate stewardship and development priorities of the communities. Kwadacha Nation, Tsay Keh Dene, Nak'azdli Whut'en and Takla Nation are at various stages of development and establishment of their Indigenous land use

plans. Conservancy initiatives include the Kaska Indigenous Protected and Conservation Areas and the Ingenika (Tsay Keh Dene) Indigenous Protected and Conservation Areas.

The information compiled during this TSR can be made available to support a variety of other processes, including land use planning. In the event that new legal objectives are established following completion of the analysis and prior to the chief forester's AAC determination, sensitivity analyses will be used to assess the effect on timber supply relative to the current analysis.

Any changes in legal objectives that occur following the determination can be addressed in a subsequent TSR, or earlier if the chief forester believes the changes could significantly affect timber supply.

CTWG Indigenous Perspectives: Land Use Planning Processes

A key concern of the CTWG Nations is that efforts by them to develop their own land use plans and priorities and strategies for development (rights recognized in the UN Declaration) have been frustrated by the Province's outdated laws and policies. With the adoption of the Declaration on the Rights of Indigenous People, the Declaration Act and the commitment by the Province to greater collaboration with Indigenous groups in all forms of land use planning and decision making, Indigenous groups can be optimistic their efforts to develop their own land use plans will receive greater recognition and acceptance from the Province.

Climate change

The forest and range resources in the Mackenzie TSA are being impacted by a changing climate (the November 2020 *Data Package* provides a full climate change synopsis and discussion). The evidence of global climate change is very clear in north-central BC. The 10 hottest years on global record have all occurred since 2005. The climate trend at Fort St. James, which has the longest instrumental record in northern BC, is warming three times the global average. It is very likely temperatures will continue to increase in the Mackenzie TSA, whereas precipitation trends are less confident. The projections of large increases in temperature and minor increases in precipitation, coupled with a decreasing snowpack may lead to moisture stress for the land base in the non-winter months. Extreme events, which are already increasing in the Mackenzie TSA, are also more likely to occur with further warming (e.g., storms, extreme heat and cold, extreme precipitation excess and deficits) and lead to an increase in natural disturbances (e.g., floods, landslides, droughts, wildfire, pest outbreaks).

Given both the uncertainty of the rate and specific characteristics of climate change, and the uncertainty around the impact to the forest and how management will respond, it is not possible to quantify climate change impacts on timber supply with confidence.

For this review, sensitivity analysis is used to assess a range of climate change-related natural disturbance impacts and subsequent impacts to timber supply assumptions and harvest projections. In addition, information on climate trends, potential impacts to forest ecosystems and communities that depend on forests and related values, and potential management responses, will be presented to the chief forester for consideration during the AAC determination.

CTWG Indigenous Perspectives: Climate Change

Climate change can have a significant impact on biodiversity and as such, First Nations' Rights. The CTWG-Nations have concerns with the methodology of using sensitivity analysis to assess the possible impacts of climate change on timber supply assumptions and harvest projections.

Given the potential for climate change to directly impact the ability for First Nations to meaningfully exercise their rights, the CTWG Nations seek a precautionary approach in the AAC determination.

Current Allowable Annual Cut

The AAC has been set six times since 1981 and prior to the mountain pine beetle outbreak in 2010 the AAC was approximately 3 000 000 cubic metres as shown in Table 1.

Table 1. AAC history for Mackenzie TSA

Determination date	AAC (m^3)	Partition (m^3)[e]
1981	2 900 000	
1989	2 951 121	
1996	2 997 363	50 000 Deciduous
2001	3 050 000	100 000 Deciduous
2004 - Postponement Order June 16, 2004	3 050 000	100 000 Deciduous
2014	4 500 000	950 000 non-pine (300 000 from the south-west partition area)
2019 - Amended 2014 Decision	4 500 000	2 000 000 live uninfested (500 000 from the south-west partition area)

On November 14, 2014, the chief forester set the AAC for the Mackenzie TSA at 4.5 million cubic metres with 950 000 cubic metres of the AAC attributed to a non-pine partition[e] of which 300 000 could originate from the southwest (SW) partition area – the area that is west of Williston Reservoir and south of Omineca Provincial Park and Omineca Arm as shown in Figure 2.

In February 2019 the AAC partition was amended to be no more than two million cubic metres of live, uninfested coniferous timber of which 500 000 cubic metres per year was attributable to the SW partition area (Figure 2).

In the 2019 AAC partition amendment (*Rationale for Allowable Annual Cut (AAC) Partition Amendment*), the expectation was stated that harvest would focus on dead, dying and damaged timber throughout the TSA. The limit on live uninfested timber in the SW portion of the TSA was set to encourage harvesting of spruce beetle affected stands and salvage of dead volume. The Province, First Nations, and licensees continue to monitor harvest performance within the partitions.

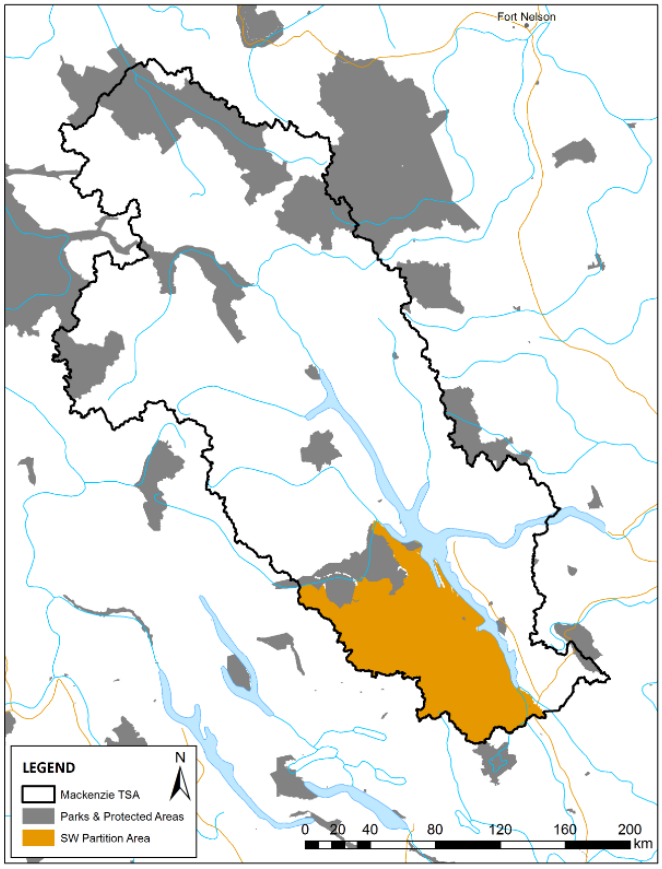


Figure 2. South west (SW) partition area within the Mackenzie TSA.

[e]**Partition**
Under Section 8(5) of the Forest Act *the chief forester in determining an AAC can specify a portion of the AAC that is attributable to certain types of timber, terrain or areas of the TSA.*

CTWG Indigenous Perspectives: AAC

Monitoring of the current AAC indicates an over realization of live uninfested volume in the south-west partition zone. The CTWG Nations identify that the lack of legal enforcement of partitions, combined with the lack of adherence to the chief forester's guidance on retention strategies in Mountain Pine Beetle and Spruce Beetle impacted stands, has resulted in significant impacts to First Nations' Rights in the south-west partition zone.

Major Issues and Significant Changes since the Previous TSR

The timber supply analysis presented in this *Discussion Paper* differs in many ways from the analysis used for the previous (2014) AAC determination. Some of the significant changes and issues are described below.

Inventory Audit / Monitoring - In 2019, Forest Analysis and Inventory Branch established 134 plots in mature forest on a systematic grid spanning the southern two-thirds of the TSA, plus 51 young stand monitoring plots in young stands. That information was supplemented by 59 additional mature audit plots that were established in 2011 making Mackenzie TSA one of the most intensely sampled units in the province. Statistical analysis of the sampling results indicates the inventory reasonably approximates the live volume on the ground, and that the managed stand yield curves used in the timber supply model represent the condition in young forests (as indicated by the initial measurements of the long-term monitoring plots). Of the ground measured mortality, only the half that is pine is captured in the inventory, with the remaining balsam and spruce mortality is not captured in the inventory.

CTWG Indigenous Perspectives: Inventory Audit / Monitoring

The CTWG-Nations have not accepted the statistical analyses of the mature inventory audit (MIA) data and Young Stand Monitoring (YSM) data as provided by FAIB. The CTWG-Nations have numerous concerns about the assumptions, accuracy and, application of models used in the TSR process to develop natural and managed stand yield projections.

Damaged Stands - Bark beetles (mountain pine beetle, spruce bark beetle and balsam bark beetle) have caused significant coniferous tree mortality in the forests within the Mackenzie TSA. It is understood that the economic value of beetle-damaged timber is determined by, and fluctuates with, changes in log costs, sawlog quality (and the consequential impact log quality has on lumber grade outturns), and sawmill performance. The economic viability of beetle-damaged timber deteriorates over time as decay progresses. The recovery of value from the dead pine profile has decreased markedly over the past decade. Licensees have reported that returns from low-grade lumber originating in the northern part of the TSA have become too low to cover extraction costs, let alone contribute to the recovery of manufacturing costs, and state there is very little, if any, commercial value remaining in beetle-killed stands in the Mackenzie TSA.

The spruce beetle epidemic continues in the south-eastern portion of the TSA though estimated emergent volume losses remain moderate to date. Significant losses of balsam have been recorded from balsam-leading stands identified in the inventory audit. These losses have not been previously captured in the inventory suggesting an overestimation of available merchantable volume from this profile.

Under current estimates there is approximately 16.4 million cubic metres of dead merchantable volume available for harvest (approximately 65 percent pine, 35 percent spruce/balsam), of which approximately 8.1 million cubic metres (50 percent pine, 50 percent spruce/balsam) occurs in the southern portion of the TSA.

CTWG Indigenous Perspectives: Damaged Stands

Damaged stands, that include dead and dying stands, are vital components of a functioning forested ecosystem that contribute to a variety of wildlife habitat niches which in turn support First Nations' Rights. However, the economic trade-off of salvaging damaged stands to reduce impact to the mid-term timber supply have resulted in compounding negative impacts to First Nations' Rights.

Harvest performance - Since the previous TSR there has been an ongoing decline in the proportion of dead volume reported from cutting permits issued in the TSA. The following charts depict the volume harvested since 2000 reported by the geographic partition zone established in the current AAC (PZ) and the rest of the TSA (ROT).

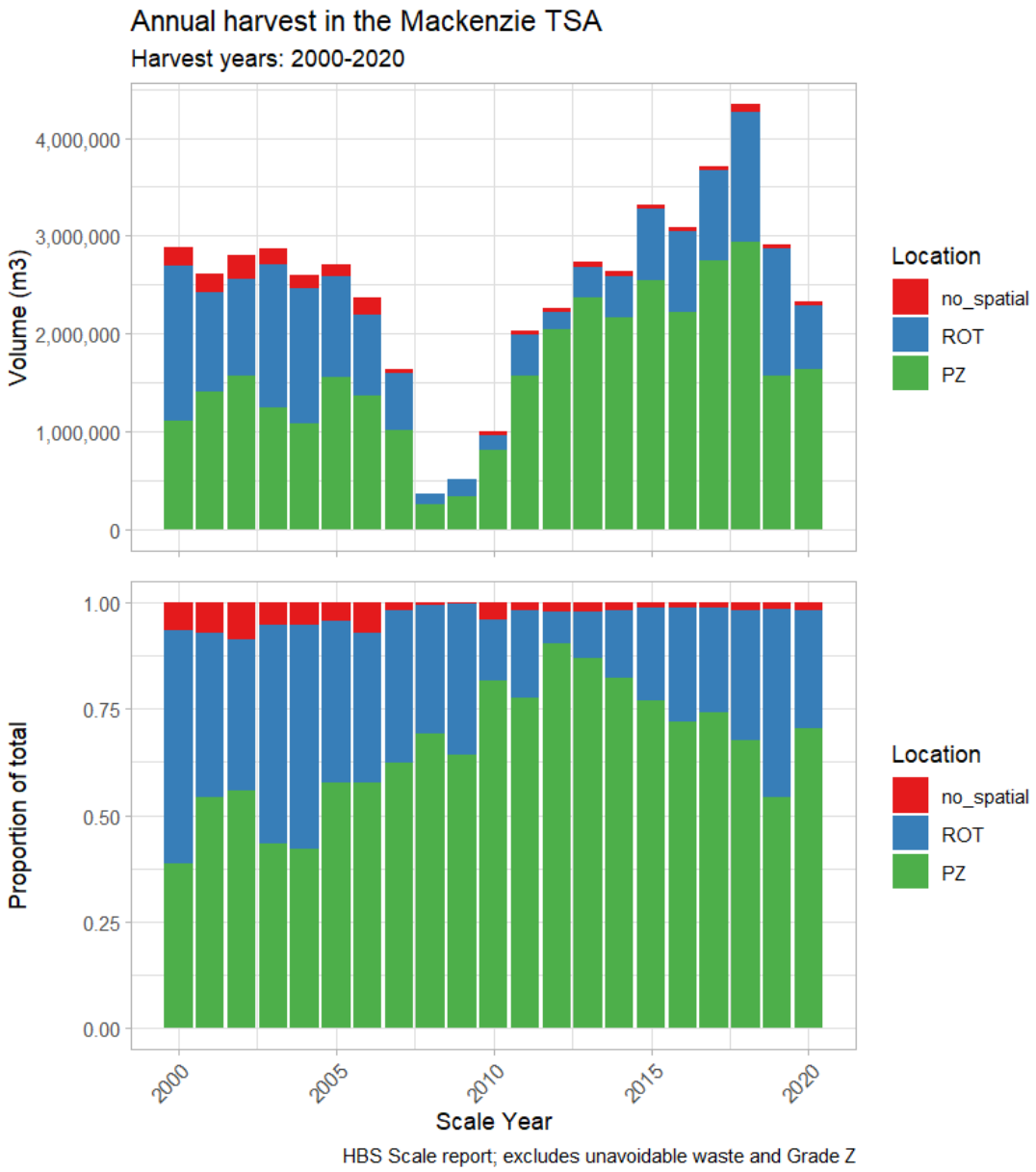


Figure 3. Scaled volume between 2000 and 2020 by geographic partition zone in the Mackenzie TSA.

The average annual harvest since 2014 is 3.28 million cubic metres per year, 72 percent of which (2.28 million cubic metres per year) was harvested from the partition zone. The proportion of dead volume reported from cutting permits has declined annually from a high of 57 percent in 2014 to a low of 27 percent in 2021.

CTWG Indigenous Perspectives: Harvest Performance

Harvest Performance during both the 2014 and 2019 partitions identified over-realization of live volumes in the south-west partition area that continue to this day.

The scale and rate of disturbance associated with the concentration of harvest in the partition zone can also contribute to negative outcomes for both wildlife and forest hydrology.

Figure 4 depicts a trend surface based on the year of initial disturbance for all harvest records in the TSA. The colours represent the localized period of harvest with orange and red representing harvest since 2005, highlighting the concentration of harvest in the south-west portion of the TSA over the past 15 years.

Road density in the partition zone has increased significantly as a function of concentrated, large scale mountain pine beetle mortality salvage harvesting over the past 10 years. Road densities greater than 0.6 kilometres per square kilometre are considered detrimental to the well-being of some wildlife species, while densities greater than 2.4 kilometres per square kilometre can create hazardous interactions between roads and riparian areas. The median road density in the forested area of the partition zone is 0.7 kilometres per square kilometre. The mean road density of the partition zone is 0.995 kilometres per square kilometre which is 2.5 times greater than the mean density for the rest of the TSA.

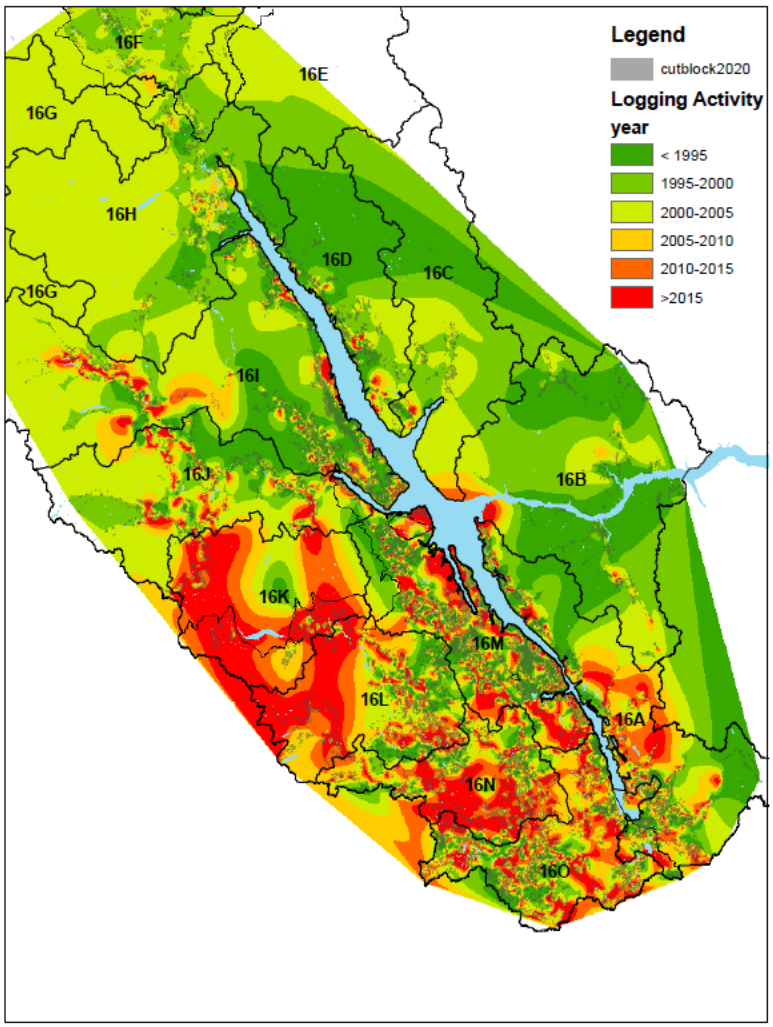


Figure 4. Historic harvest spatial trend in the Mackenzie TSA.

CTWG Indigenous Perspectives: Harvest Concentration

The concentrated harvest of the AAC, and the accelerated depletion of mature supply in the south-west partition zone of the TSA, has led to a highly constrained ability of First Nations to meaningfully exercise their rights in this region. Continued geographic concentration or aggregation of primary forestry activities will have a tremendous impact on current and traditional land uses and the overall homogenization of previously peaceful landscapes.

Dense concentrations of forest cover openings and permanent access drastically modify landscapes and diminish the ability to practice cultural, recreational, and life-sustaining activities. Aggregations of primary forest activities introduce long-term disturbances that impact a broad spectrum of ecosystem services and wildlife habitat functions. Additionally, these areas present unnecessary (and often poorly maintained) recreational and industrial access opportunities in precarious landscapes.

These artifacts of forest management represent the sustained erasure of cultural capacity through the industrial homogenization of wilderness landscapes. Where clearcuts, forest roads, and artificial stands are the predominant land cover, there is also a deeply constrained ability to enjoy and connect with the land.

Declaration on the Rights of Indigenous Peoples Act - The provincial government passed the *Declaration on the Rights of Indigenous Peoples Act* in November 2019 to implement the *United Nations Declaration on the Rights of Indigenous Peoples*, which the Truth and Reconciliation Commission confirms as the framework for reconciliation. The *UN Declaration* emphasizes Indigenous peoples' rights to land, territories and resources (including timber resources), free, prior and informed consent and to live in dignity, to maintain and strengthen Indigenous institutions, cultures and traditions, and to pursue self-determined development, in keeping with Indigenous needs, aspirations and laws.

New ungulate winter ranges and wildlife habitat areas established - Since the previous review approximately 285 000 hectares of new ungulate winter range (UWR) and wildlife habitat areas (WHA) have been established in the Mackenzie TSA, and an additional 215 646 hectares has been set aside through Part 13 Designated Area legislation to provide habitat protection for caribou while engagement and discussions with First Nations on long-term caribou management continues.

Kwadacha First Nations Woodland Licence - The Kwadacha First Nations Woodland Licence (FNWL N2T) occupies approximately 239 000 hectares of the TSA and was approved on September 1, 2019. The FNWL is an area-based tenure and is excluded from the timber supply analysis and TSA AAC decision since the AAC for the FNWL is established through a separate process.

Forest management

Area available for timber harvesting

As part of the process used to define the timber harvesting land base (THLB)[f] in the timber supply analysis, a series of deductions are made from the TSA land base (see Table 2). The total area of the TSA is approximately 6.4 million hectares. After removing lands that are under area-based tenures, are not Crown land or are non-forested, the analysis forest land base (AFLB)[g] is approximately 2.99 million hectares.

After further reductions for areas not suitable or available for timber harvesting because of ecological, economic, or social factors, the THLB is approximately 1.23 million hectares. This is 18.6 percent smaller than in the 2014 timber supply analysis with the difference largely attributable to the establishment of the Kwadacha First Nation Woodland Licence and the establishment of new fisher and caribou ungulate winter ranges and wildlife habitat areas. Area reductions are partially offset by the revised merchantability and isolated area estimates. About 80 percent of the total TSA area and 59 percent of the AFLB is not available for timber harvesting. Areas excluded from harvest include land base designated for protection of wildlife, riparian reserves, old growth, archaeological sites, potentially or unstable terrain, inoperable conditions, and uneconomic stands.

As well, there are several timber profiles within the THLB that have seen limited or no harvesting historically. The timber supply analysis included an assessment of the harvesting activity in these timber profiles and used this information to regulate the projected contribution of these areas to the timber supply. Sensitivity analysis explored the implications of excluding some of these timber profiles from the THLB.

Current forest management must be consistent with the requirements of the FRPA and associated regulations that are designed to maintain a range of biodiversity and wildlife values. All forested lands, whether they contribute to timber supply or not, help to maintain critical habitat for many species. Therefore, the timber

[f]**Timber harvesting land base (THLB)**
The THLB is an estimate of the land where timber harvesting is considered both acceptable and economically feasible, given the objectives for all relevant forest values, existing timber quality, market values and applicable technology. The THLB is derived from the data, forest management practices and assumptions described in the data package. It is a theoretical, strategic-level estimate used for timber supply analysis and could include areas that may never be harvested or may exclude areas that will be harvested.

[g]**Analysis forest land base (AFLB)**
The forested area of the TSA that the provincial government manages for a variety of natural resource values. This excludes non forested areas (e.g., water, rock and ice), non-productive forest (e.g., alpine areas, areas with very low productivity), and non-commercial forest (e.g., brush areas). The analysis forest does include federally-protected areas because of their contribution to biodiversity.

supply analysis includes constraints or forest cover requirements for biodiversity, visual quality, wildlife habitat, community watersheds, recreation features, riparian management and protection of environmentally sensitive areas. These requirements are applied to the AFLB in the timber supply analysis.

The timber harvesting land base is not a legal entity, rather it is a modelling construct. The THLB is a strategic-level estimate used for the purposes of timber supply analysis and consequently inclusion or exclusion of any particular area has no bearing on how an area will actually be managed. At an operational level, there will always be areas that are excluded from the THLB that can be harvested and areas within the THLB that may never be harvested.

The various land base classes deductions used to derive the timber harvesting land base assumed in the timber supply analysis are listed in Table 2.

Table 2 Land base netdown

Land class	Gross area	Net area	Category total	Percent excluded from total gross area	Percent of total gross area
Gross Timber Supply Area	6,410,643			0.00	100
Kwadacha First Nation Woodland Licence	238,918				
Community Forest Agreement Schedule B	24,096				
Private	7,397				
Woodlot Licence Schedule B	4,732				
First Nation Reserve	921				
Municipal Parcels	754				
Miscellaneous	59				
Federal Parcels	32				
Excluded Crown and Private Lands	276,909	276,909	6,133,734	4.32	
Alpine	1,427,133				
Non-productive Forest	1,398,596				
Riparian (Lake, Wetland, Reservoir)	322,248				
Non-forest and Non-productive Forest	3,147,977	3,103,594	3,030,140	48.41	
Lineal Features	42,219	33,892		0.53	
Analysis Forest Land Base	2,996,248		2,996,248	53.26	46.74
Provincial Parks and Miscellaneous Reserves	932,081	364,047		5.68	
Ungulate Winter Range	1,197,551	292,434		4.55	
Wildlife Habitat Areas	67,281	34,423		0.54	
Old Growth Management Areas	62,192	46,294		0.72	
Mugaha Marsh Sensitive Area Plan	610	0		0.00	
Gross Timber Harvesting Land Base	2,259,050		2,259,050	64.76	35.24
Inoperable Forest	4,237,899	774,647		12.08	
Non-Merchantable Forest	3,806,050	129,868		2.03	
Inaccessible Forest	2,285,009	8,557		0.13	
Retention	557,726	117,100		1.83	
Timber Harvesting Land Base			1,228,877	80.83	19.17

Figure 5 contrasts the 2014 and 2021 spatial distribution of the THLB and AFLB within the TSA. The 2021 land base overlays the 2014 land base so only the areas that exceed the spatial extent of the current land base are shown. The area in red is classified as the 2021 THLB, while the area in blue is classified as 2021 AFLB that is outside of the THLB. The green areas represent the 2014 THLB, while the gold areas represent the 2014 AFLB.

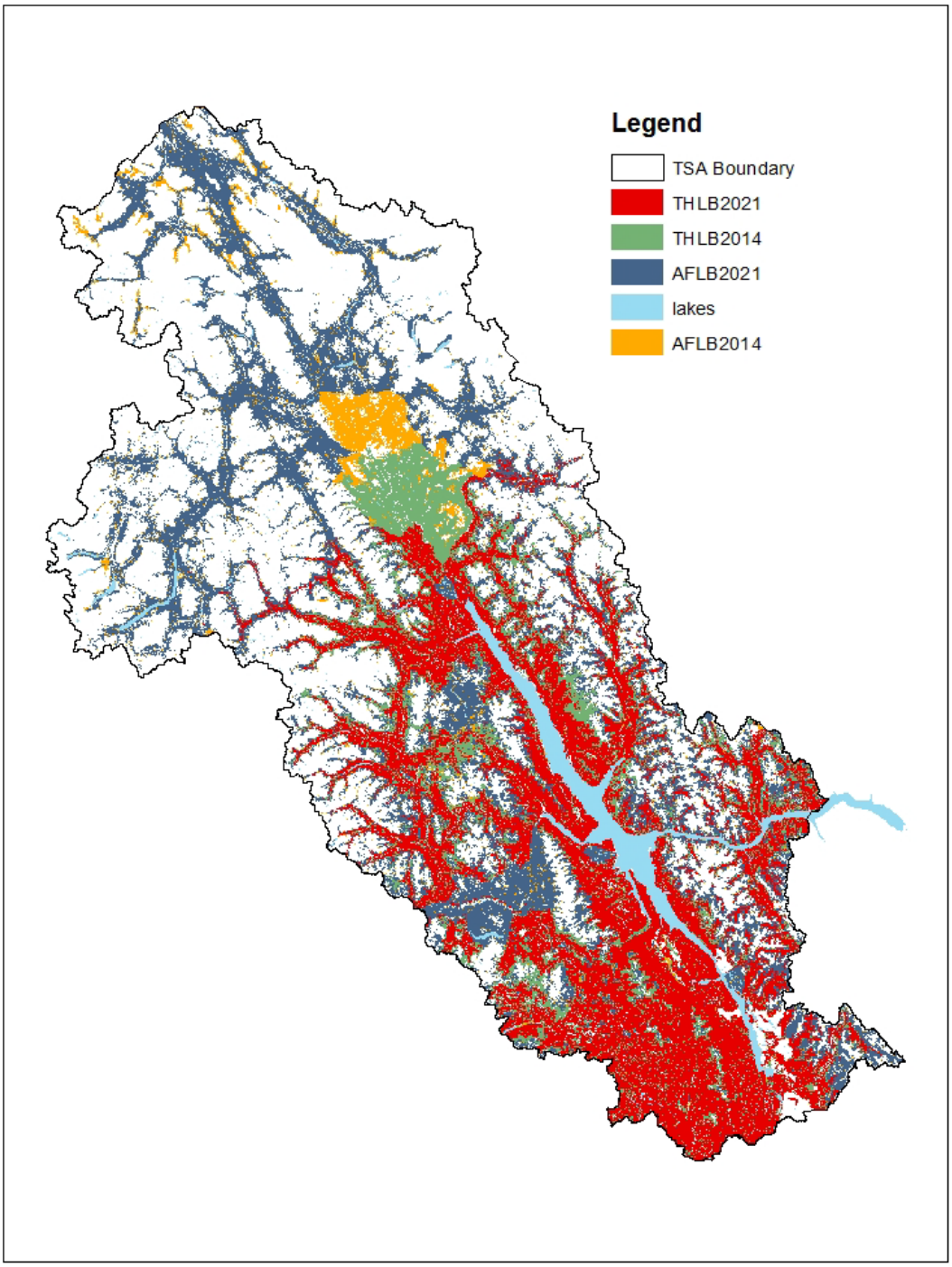


Figure 5. The THLB and AFLB in the Mackenzie TSA.

Not identified in the netdown table are 33 645 hectares of THLB (2.7 percent of the total) within the caribou moratorium recovery zones in the south-east portion of the TSA which are subject to a Part 13 designation under the *Forest Act*. These areas are currently modelled in the timber supply analysis as a permanent deferral area that is reserved from harvesting, but further land use designation is expected prior to the AAC determination, potentially requiring revision to the THLB.

On March 30, 2022, an order establishing moose ungulate winter range (u-027) was established in the Mackenzie TSA and is reflected in both the current THLB definition (536 hectares excluded) and in the timber supply analysis.

CTWG Indigenous Perspectives: Forest Management

CTWG Nation's identify the following challenges to the current provincial approach to area available for timber harvesting:

- *Historically, the Province has managed unceded First Nations' lands, that includes setting a rate of cut and determining which forest operators will be granted access to First Nations' forest resources.*
- *The CTWG Nation's requested the AAC be a joint decision between the Nations and the province. Currently, although the province's Declaration Act establishes new shared decision-making tools for "consent" and "joint" decisions with First Nations, implementation of these mechanisms are currently not in place for this TSR.*
- *Provincial forest management policy and socio-economic objectives most often place First Nations' Section 35 Rights and ecosystems at high risk.*

Forest structure and composition

Figure 6 illustrates the distribution of forest ages, categorized in 10-year increments, between the THLB and the remaining AFLB outside of the THLB (non-THLB).

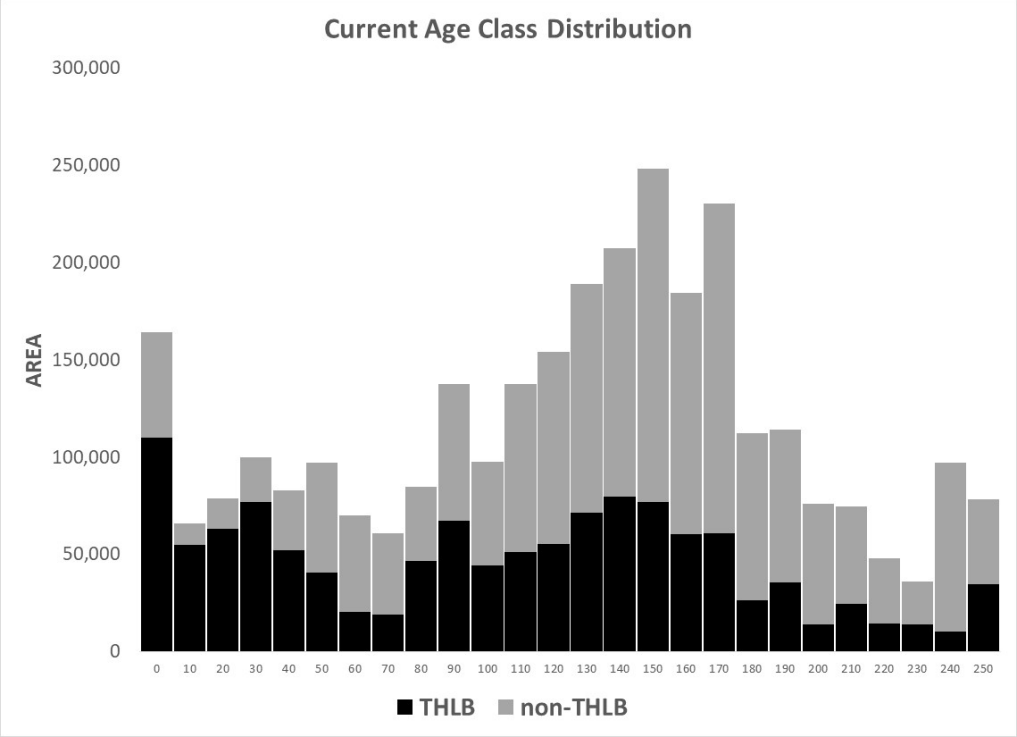


Figure 6. Current age class distribution of THLB and non THLB in the Mackenzie TSA.

Figure 7 depicts the spatial distribution of stands by age class at two time periods: 2002 and 2021. The map on the left represents the spatial distribution in 2002 just prior to the onset of the mountain pine beetle epidemic and large-scale salvage operations in the TSA. The effects of recent and past wildfires are evident in large contiguous areas in younger age classes. Stands older than 140 years are shown in green, stands between the ages of 41 years and 140 are shown in orange and yellow while stands younger than 40 years are shown in red.

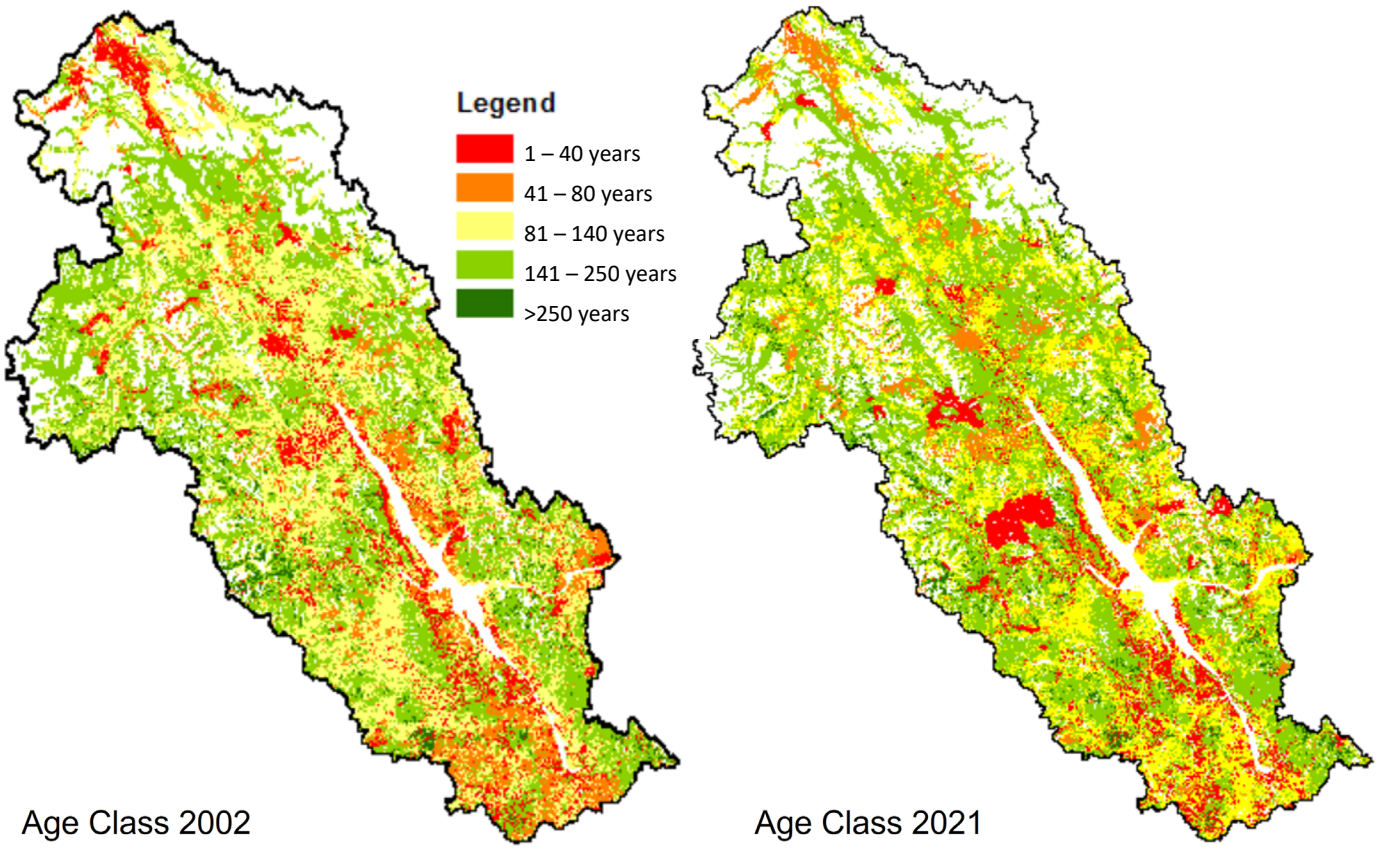


Figure 7. Age class distribution in the Mackenzie TSA in 2002 and 2021.

Figure 8 (next page) illustrates the distribution of timber volume of stands within the AFLB and the THLB grouped by dominant tree species: spruce, pine, balsam and deciduous. The THLB is further stratified into those areas considered merchantable and mature (stands that meet the live [green] volume merchantability thresholds of greater than 125 cubic metres volume per hectare and greater than 80 years of age). Each chart details the total volume by leading species and the percentage the dominant tree species class represents. Salvage volume is dead volume decremented for shelf-life losses (based on exponential decay curves). The inclusion of merchantable dead volume also increases the available live volume in the TSA as many stands that were previously considered non-merchantable based on the live volume alone now surpass the minimum merchantability threshold when the live and dead volumes were combined.

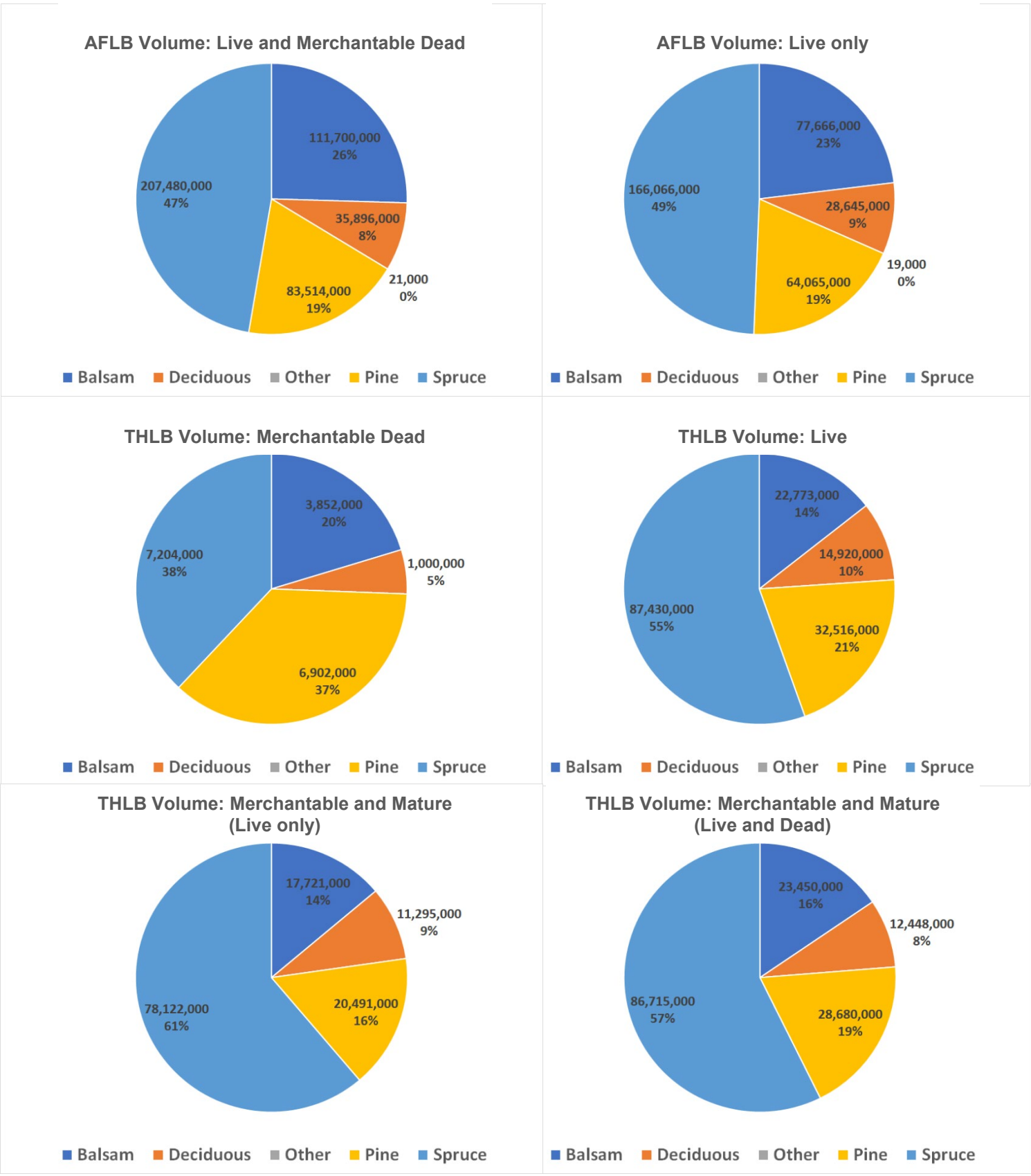


Figure 8. Species volume distribution in the Mackenzie TSA.

There is approximately 157 million cubic metres of live growing stock within the THLB, of which approximately 128 million cubic metres (81.5 percent) meets the coarse merchantability and mature definition. If merchantability thresholds based on harvest system are applied the estimate falls to 116 million cubic metres. Of the 128 million cubic metres of merchantable and mature volume, approximately 108 million cubic metres (85 percent) is considered initially available for harvest in the timber supply analysis (e.g., not reserved to meet forest management objectives).

Current to the summer of 2020, there is approximately 16.4 million cubic metres of dead merchantable volume available for harvest in the THLB (approximately 65 percent pine, 35 percent spruce/balsam), of which approximately 8.1 million cubic metres (50 percent pine, 50 percent spruce/balsam) occurs in the southern portion of the TSA.

CTWG Indigenous Perspectives: Forest Composition

There is disproportionate amount of high-productivity old forest in the THLB compared to the non-THLB forest. The high-productivity old forest in the THLB has been or will be replaced by managed stands and will have negative impacts to biodiversity, which in turn will negatively impact First Nations' Rights over the short-, medium- and long-terms.

Timber supply analysis

In order to determine an AAC, the chief forester reviews many sources of information including a timber supply analysis that models the development of the forest through time and its response to harvesting while respecting the provincial government's many timber and non-timber objectives. This section highlights some of the important findings from the timber supply analysis.

The base case

For a timber supply review, a number of projections are prepared that are an outcome of the best available data and assumptions intended to reflect current management practices. However, more than one projection can be prepared using the same data, information and timber supply model depending on the harvest flow objectives applied in the analysis. From these projections, the chief forester selects one to use as a reference for the purposes of assessing the uncertainty associated with the information and assumptions used in the analysis. This projection is referred to as the "base case". The remaining projections that were not selected as the base case are still considered in the AAC determination and are referred to as "alternative harvest projections".

The base case and alternative harvest projections are not AAC recommendations, but rather some of many sources of information the chief forester will consider when setting the AAC. Furthermore, based on the input received from the public and First Nations or new information that becomes available following the review and consultation period for this discussion paper, the base case may be revised prior to the AAC determination meeting. The AAC determined by the chief forester may be different than the initial harvest level presented in the base case or the alternative harvest projections or any of the projections presented in this paper. All harvest flow objectives and assumptions are detailed in Appendix 1.

The base case was defined using the following criteria:

- The starting harvest level is the maximum achievable for a live harvest projection for the Mackenzie TSA and is therefore a least-risk scenario with respect to the current state and utilization of dead volume in the unit.
- The base case assumes no geographic partition but includes a preference to harvest in the winter-roaded (year-round access) southern portion of the TSA. Partition options have been considered separately through alternative harvest projections and sensitivities.

In addition:

- Regenerating stands were restricted from harvest until at least 80 years of age, regardless of volume or piece size, allowing stands to approach their potential maximum growth rate. This requirement prevents regenerating stands from being harvested before they achieve full growth potential.
- All stands were restricted from harvest until a minimum live volume per hectare threshold that varies by harvest system (75 percent conventional, 15 percent mixed, 10 percent cable). Regardless of harvest system, the coarse definition of a merchantable stand was a minimum total volume greater than 125 cubic metres per hectare.
- Stands were prioritized for harvest based on the combination of the highest volume per hectare relative to their volume at culmination age, proximity to the milling complex, and proximity to the existing or future road network.
- Harvest was modelled to preferentially progress from south to north (as demonstrated by current and historic practice). Harvest also preferentially progressed from the existing and future road network outward. All harvesting was restricted to occur within two kilometres of the road network and the model projected the expansion of the road network over time to access the undeveloped portions of the THLB.
- Periodic losses due to natural disturbances were modelled explicitly through simulation in the timber supply model and natural disturbance losses were not prioritized for salvage harvesting.

Figure 9 depicts the current base case projection. The black-solid line represents the base case while the green-solid and red-dashed line represent the base case and salvage alternative from the previous (2014) TSR. The blue-dashed line represents the maximum non-declining even-flow for the current TSR.

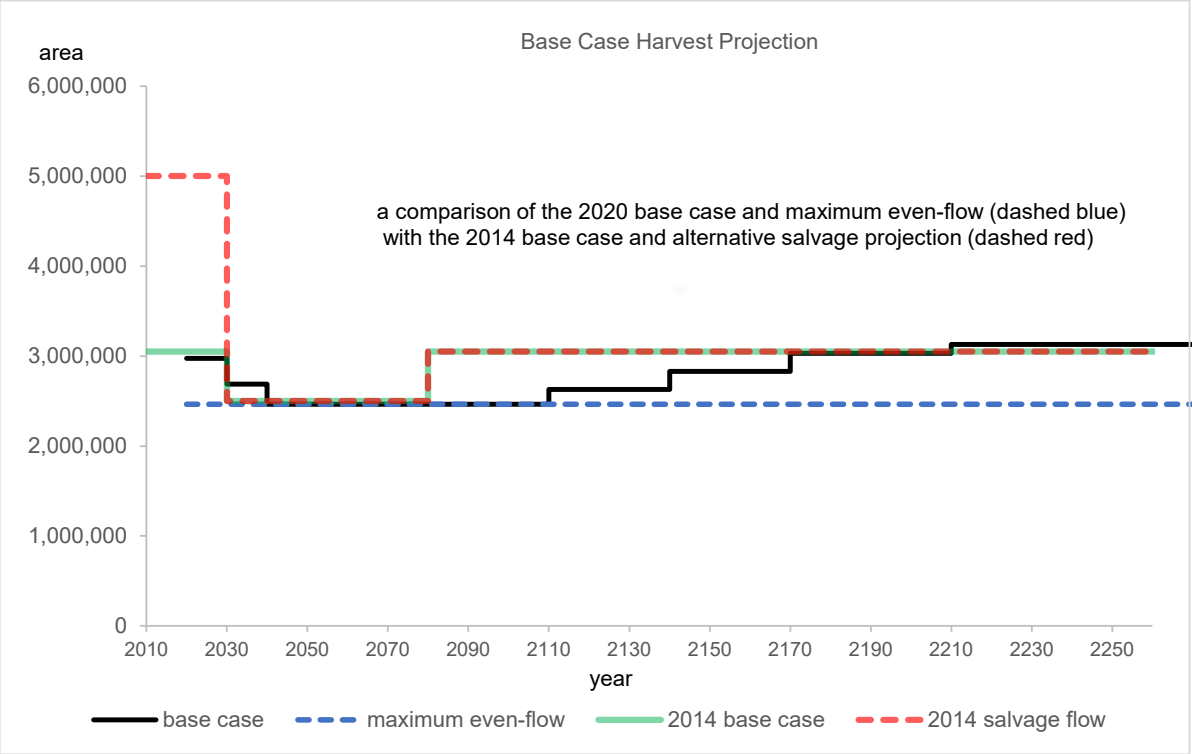


Figure 9. Base case for the Mackenzie TSA.

The initial harvest level of 2.97 million cubic metres per year is maintained for 10 years before stepping down to 2.47 million cubic metres per year by the end of the third decade. The mid-term harvest level is sustained for 60 years before climbing to the long-term harvest level of 3.13 million cubic metres per year in the 20th decade. The transition to harvesting existing managed stands begins in the fourth decade and continues for 40 years with 75 percent of the harvest coming from existing or projected future managed stands. Existing natural stand harvest persist throughout the planning horizon as stands damaged by mountain pine beetle recover through growth of secondary stand structure and become merchantable over time.

Non-pine leading stands contribute over 80 percent of the mature harvest over the first four decades while the average deciduous-leading contribution is 11 percent. The harvest profile shifts during the transition to managed stands with more than 70 percent of the harvest contributed from pine-leading stands by the tenth decade.

Figure 10 depicts the base case contributions of harvest from the current southwest partition zone and the rest of the TSA. The columns in black represent the percentage of the total harvest originating in the southwest partition zone, the columns in light grey represent the percentage of the total harvest originating in the south-eastern portion of the TSA (south of the Peace Arm) while the columns in dark grey represent the percentage of the total harvest originating in the northern portion of the TSA (North of Omineca park and Peace Arm).

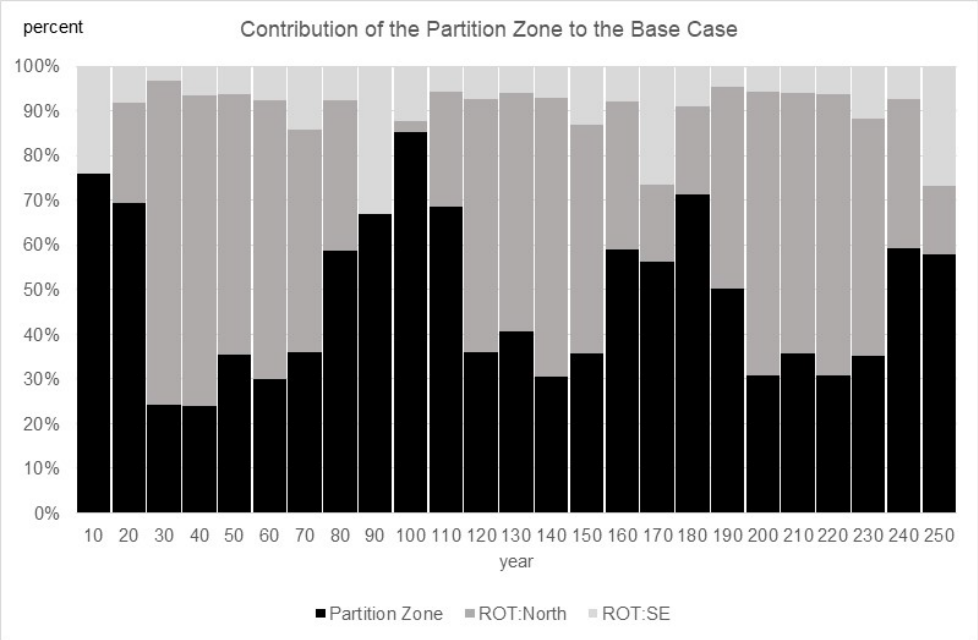


Figure 10. Contribution of the southwest partition zone to the base case.

In the absence of a geographic regulation of harvest, approximately 78 percent (2.3 million cubic metres per year) originates from the current partition zone, continuing the trend of harvest performance that has occurred since the last determination in 2014. Harvest continues to be concentrated in the southwest portion of the TSA for another decade (69 percent) until available growing stock is depleted forcing harvest into the rest of the TSA for five decades.

The dependence on the rest of the TSA for the mid-term timber harvest projection runs counter to both the historic trend of less than 50 percent of the harvest originating outside the southern partition and the need to balance operations between the two log delivery systems to offset the elevated costs associated with operations in the rest of the TSA.

CTWG Indigenous Perspectives: Base Case

Historically, most of the harvest in the Mackenzie TSA has come from the south region, with the majority coming for the southwest portion. In the first 10 years of the base case projection this trend continues with 99.9% of the harvest coming from the south region, of which over 75% of the harvest comes from the southwest portion.

This will have irreparable impacts to First Nations' Rights in the southern region of the TSA as many of the environmental values linked to First Nations' ability to meaningfully exercise their rights are already at unacceptable levels of risk.

While the base case analysis does not simulate the actual operational activities on the ground, it does indicate that as the current practice trends continue, so will the significant impacts to First Nations Rights that are already highly constrained in most cases.

Adjusting the AAC in 10 years may be a quick enough response to adequately maintain a harvest flow into the future, it will not be an adequate response to prevent or mitigate significant impacts to values on the land base that support the continued cultural vitality of First Nations' Rights.

Alternative harvest projections

Utilization of dead volume

Figure 11 depicts alternative harvest projections where existing dead merchantable volume contributes to the timber supply (note: the y axis starts at two million cubic metres to help contrast harvest levels visually). The base case is included for comparison. The salvage harvest of dead volume is not prioritized in the model and only occurs where dead volume exists as a component of selected live stands.

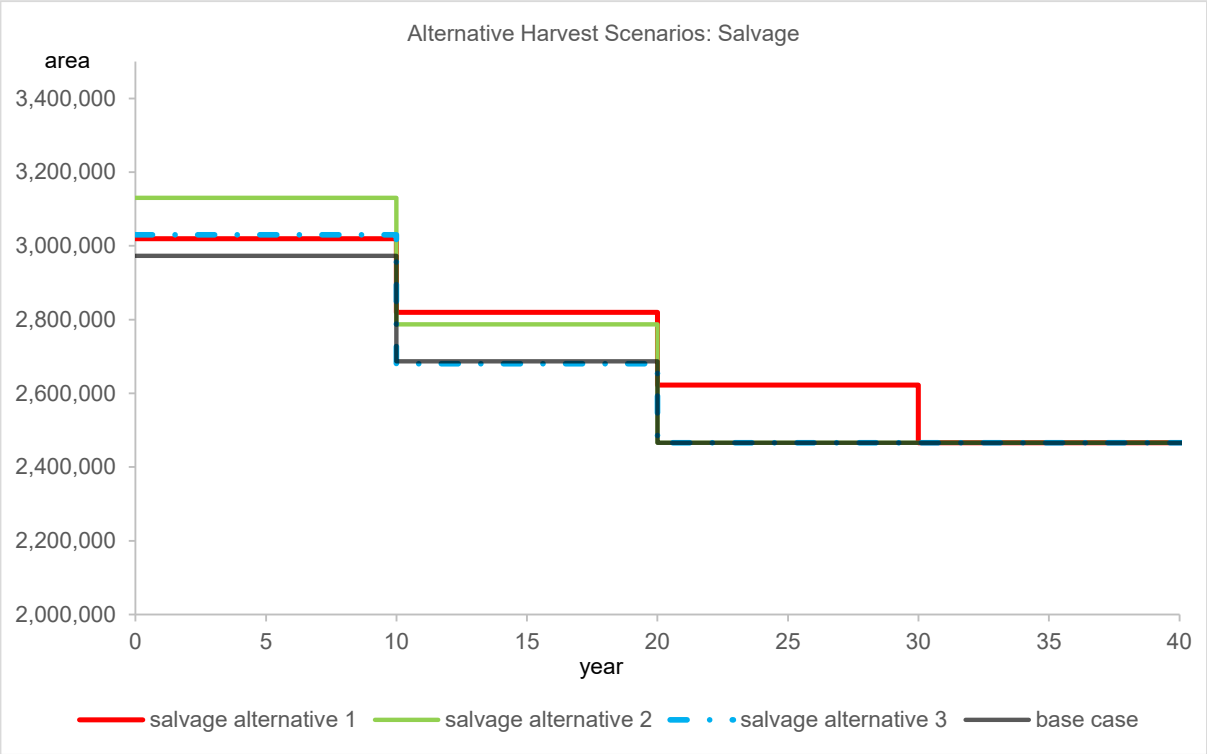


Figure 11. Alternative harvest scenarios: salvage.

Salvage Alternative 1 (red-solid line) assumes that the harvest of merchantable dead volume can occur anywhere in the TSA for the next 10 years. A starting harvest level of 3.02 million cubic metres per year is maintained for 10 years before stepping down to the mid-term harvest level in the fourth decade. Alternative 1 is the only scenario that allows for an additional harvest level step which prolongs the transition to the mid-term harvest level. During the first decade an average of approximately 370 000 cubic metres per year of dead volume (12.6 percent) is harvested.

Salvage Alternative 2 (green-solid line) assumes that the harvest of merchantable dead volume can occur only in the southern portion of the TSA (the area bounded by the Peace Arm in the east and Omineca park in the west) for the next 10 years. A starting harvest level of 3.13 million cubic metres per year is maintained for 10 years before stepping down to the mid-term harvest level in the third decade. Alternative 2 most closely approximates the actual average harvest level in the unit (3.28 million cubic metres per year) since the last determination. During the first decade an average of approximately 320 000 cubic metres per year of dead volume (10.1 percent) is harvested.

Salvage Alternative 3 (blue-dashed line) assumes that the harvest of merchantable dead volume can occur only in the southern portion of the TSA for the next five years. A starting harvest level of 3.03 million cubic metres per year (equivalent to the base case) is maintained for 10 years before stepping down to the mid-term harvest level in the third decade. During the first five years an average of approximately 320 000 cubic metres per year of dead volume (10.1 percent) is harvested.

CTWG Indigenous Perspectives: Utilization of Dead Volume

The CTWG Nations does not support the province's approach or assumptions in the base case or sensitivities associated with the utilization of dead volume as this approach to forest management will lead to short-, mid-, and long-term impacts to First Nations' Rights.

Maintenance of current geographic partition

Figure 12 depicts the first geographic partition alternative harvest projection (Partition Alternative 1 - Southwest Partition) where the partition set with the current AAC is applied to the base case. Each geographic zone is modelled as a discrete management unit with a sustainable harvest projection. The total level is the sum of the contribution from the two zones. Only live volume was modelled in this projection.

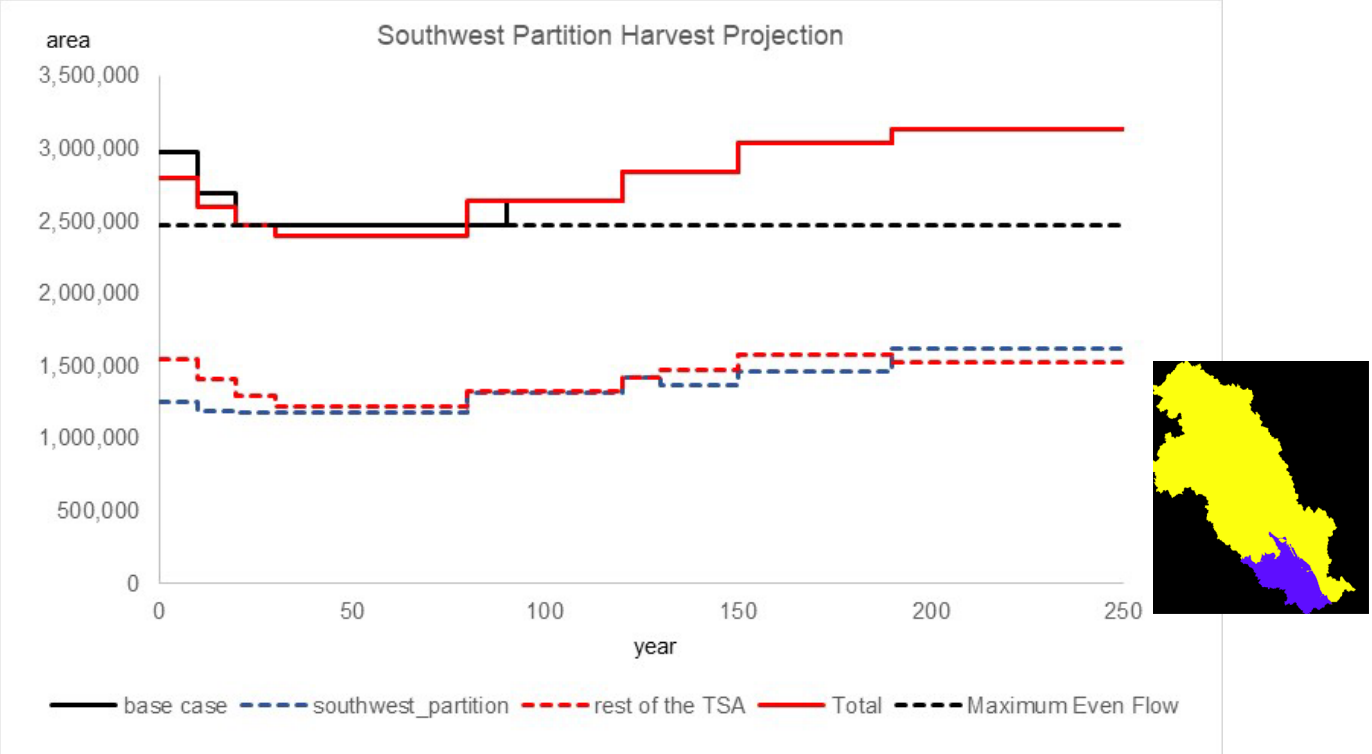


Figure 12. Southwest partition harvest projection.

The total harvest is represented by the red-solid line (with the black-solid and black-dashed lines representing the base case and maximum even-flow projection). A starting harvest level of 2.8 million cubic metres per year (six percent less than the base case) is maintained for 10 years before stepping down to the mid-term harvest level of 2.4 million cubic metres per year (four percent less than the base case) in the fourth decade. This transition required an additional step compared to the base case.

The harvest projection from the southwest partition zone is represented by the blue-dashed line. A starting harvest level of 1.27 million cubic metres per year (45 percent of the total) is maintained for 10 years before stepping down to the mid-term harvest level of 1.17 million cubic metres per year in the third decade. The harvest projection from the rest of the TSA is represented by the red-dashed line. A starting harvest level of 1.53 million cubic metres per year (55 percent of the total) is maintained for 10 years before stepping down to the mid-term harvest level of 1.22 million cubic metres per year in the fourth decade.

The harvest contribution from the rest of the TSA to the short- and mid-term timber harvest levels runs counter to the historic trend of less than 50 percent of the harvest originating outside the current partition zone.

CTWG Indigenous Perspectives: Maintenance of Current Geographic Partition

Preliminary CTWG results specific to this region indicate significant impacts to First Nations Rights, in which further harvesting in the geographic south-west partition zone would worsen an already significantly reduced ability for First Nations to meaningfully exercise their Rights. First Nations cannot support the proposed south-west partition as explored by the province (and independent of the CTWG).

Establishing a south/north partition

The second geographic partition alternative harvest projection (Partition Alternative 2 – Southern Partition) applies a partition that encompasses the entire "winter-roaded" portion of the TSA (here bounded by the Peace Arm in the east and Omineca park in the west). Only live volume was modelled in this projection. The chart below depicts the results.

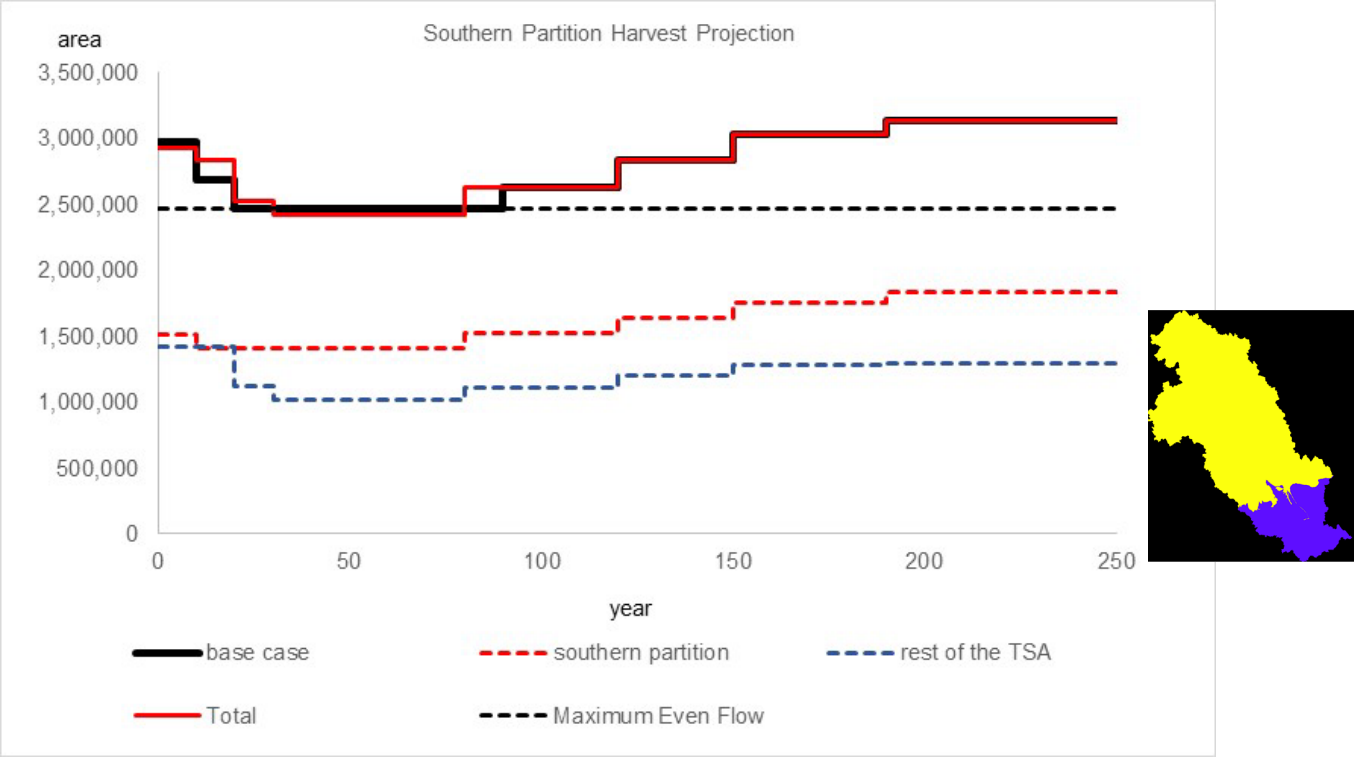


Figure 13. Southern partition harvest projection.

The total harvest is represented by the red-solid line. The starting level is 2.93 million cubic metres per year which is slightly below the base case but the starting level can be sustained for two decades (with a minor step down). The harvest then decreases to 2.42 million cubic metres per year which is again slightly below the base case.

The harvest projection from the southern partition zone is represented by the red-dashed line. A starting harvest level of 1.51 million cubic metres per year (52 percent of the total) is maintained for 20 years (with a minor step down) before transitioning to a mid-term harvest level of 1.4 million cubic metres per year in the third decade.

The harvest projection from the rest of the TSA is represented by the blue-dashed line. A starting harvest level of 1.41 million cubic metres per year (48 percent of the total) is maintained for 20 years before transitioning to the long-term harvest level of 1.01 million cubic metres per year in the third decade.

In this alternative harvest projection, the harvest contribution from the rest of the TSA is consistently at or below the contribution from the southern partition zone which more closely resembles historic harvest performance in the TSA.

CTWG Indigenous Perspectives: Establishing a South/North Partition

The proposed South/North partition was independently explored by the Province outside of the collaborative CTWG process and is not supported by the CTWG Nations, as per Indigenous Perspective "Maintenance of Current Geographic Partition". Forest harvesting in the southern regions of the DMK TSA will result in a worsening state to First Nations currently highly constrained ability to meaningfully exercise their rights.

Southern partition - 75 percent yield

The alternative harvest projection described in this section reflects the perspective of the representatives of the First Nations participating in collaborative engagement on the Mackenzie TSA TSR through the CTWG.

Representatives of the First Nations on the CTWG were interested in understanding the implications of reducing all yields by 25 percent and applying the southern geographic partition zone (south is defined as all areas south of the Peace Arm in the east and Omineca Park in the west). The stated objective of this alternative harvest projection is to evaluate a timber supply projection that exercises caution by lowering the short-term harvest level and yield estimates to reduce the risk of overharvest and potential adverse impacts to other resource values. The underlying assumption is that it is impossible to prove unequivocally that the volume estimates are correct and that the harvest volume exists currently or into the future, so the appropriate stewardship response is to exercise caution. This assumption is not supported by detailed statistical analysis of the recent change monitoring inventory or young stand monitoring audits conducted in 2019 (as discussed in under *Major Issues - Inventory Audit / Monitoring*) nor is supported by the Province. The southern partition was included to represent the concerns shared by all participants of the CTWG over the historic disproportionate harvest in the south of the TSA.

Figure 14 depicts the southern partition - 75 percent yield alternative scenario (red-solid line) together with the base case scenario (black-dashed line). The southern partition contribution to the harvest level is depicted as a green-solid line and the harvest contribution from the rest of the TSA (ROT) is depicted as a blue-solid line. The southern partition contribution is further stratified into the south-east contribution (green-dotted line) and the south-west contribution (green-dashed line).

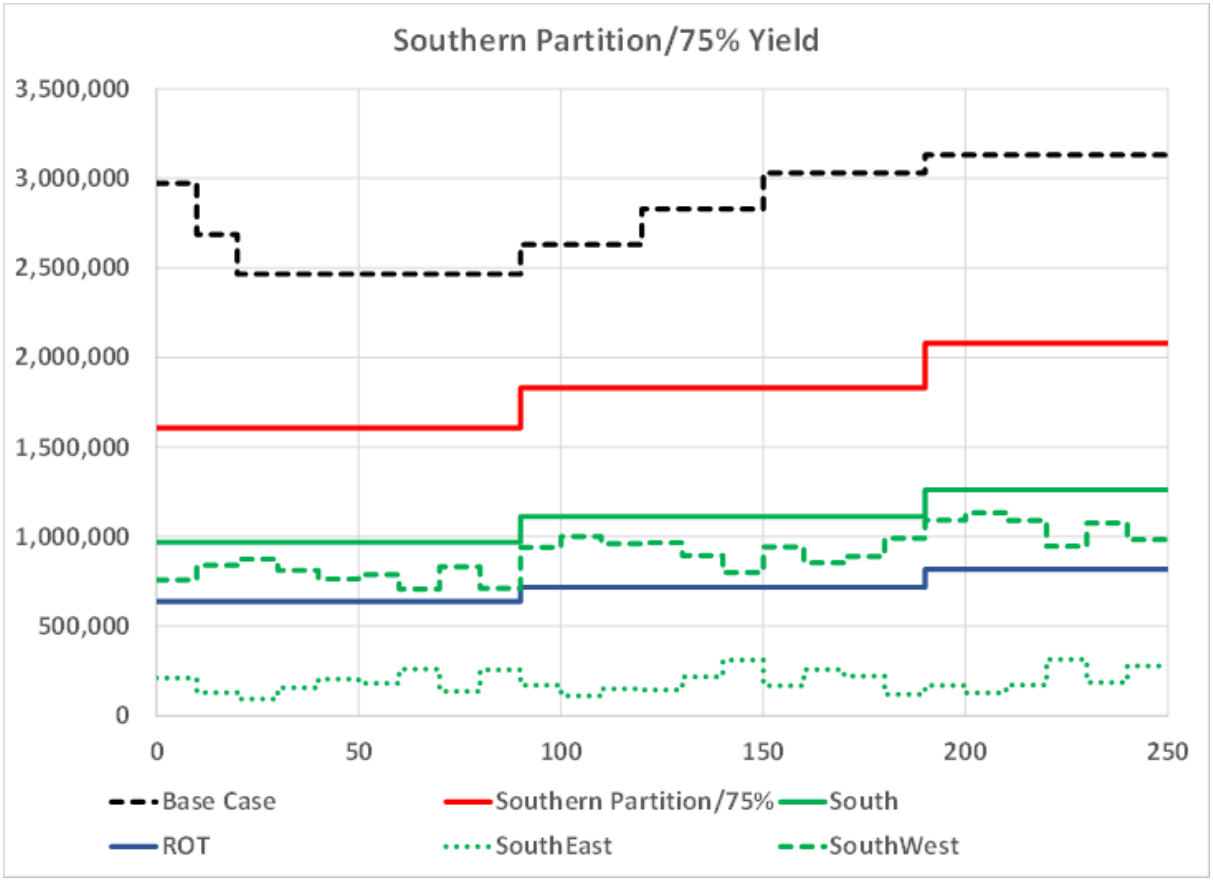


Figure 14. Southern partition 75 percent yield scenario.

The initial harvest level is immediately reduced to a mid-term harvest level of 1.6 million cubic metres per year which is 46 percent (1.365 million cubic metres per year) below the base case. The harvest level begins to increase in year 90 culminating in a long-term harvest level of 2.08 million cubic metres per year by year 190.

CTWG Indigenous Perspectives: Southern Partition - 75 Percent Yield

The base case, south-west partition, and south partition was developed outside of the collaborative process. The CTWG-Nations raised concerns with the assumptions embedded in growth and yield predictions for existing and managed stands in the base case, existing south-west partition, and the south-partition. In this context, the CTWG Nations were interested in exploring impacts to First Nations Rights:

1. *If the growth and yield estimates were correct; and,*
2. *If the growth and yield estimates were overestimated by 25%.*

The analysis was designed to assess the implications to First Nations' Rights if the growth and yield estimates applied in the base case are overestimated and such overestimations are not considered in the AAC determination. The province has not provided the detailed indicator assessments required for the CTWG-Nations to assess the implications to First Nations Rights.

Additional sensitivity analysis

The base case uses a specific set of available data and forest management assumptions that attempt to capture current forest composition and management. Sensitivity analysis is used to examine the effect on timber supply of uncertain information or known differences in the assumptions used in the base case. A selection of sensitivities is described below. A full list of sensitivity analyses completed is provided in the Tables 3, 4 and 5 (pages 36 through 38).

CTWG Indigenous Perspectives: Additional Sensitivity Analysis

The TSR uses sensitivity analysis as a method of exploring the impact of uncertainty with timber supply assumptions and harvest projections on the base case. The sensitivity analyses do not provide an assessment of the indicators of First Nations' values to help facilitate the CTWG-Nations in understanding the impact of uncertainty in the TSR process on First Nations' Rights.

Minimum harvestable assumption sensitivity analyses

Sensitivity analyses completed indicate that timber supply is highly influenced by changes in both the minimum harvestable age and minimum harvestable volume thresholds used to define merchantable stands. An analysis that reduced the minimum harvestable age to 60 years resulted in an increase in the available growing stock on the THLB; that is, on average, nine percent greater than the base case growing stock over the first seven decades of the harvest projection. Consequently, the transition from the harvest of natural stands to managed stands occurs earlier leading to a four percent increase in the both the short- and mid-term harvest level.

Higher short-term and mid-term harvest levels can be achieved through reducing the minimum harvestable age, however, the long-term harvest level is reduced as a consequence of stands being harvested before achieving full growth potential. In the analysis above, reducing the minimum harvestable age to 60 years resulted in a 13 percent reduction in the long-term harvest level compared to the base case. The average volume of stands harvested in the long term is 206 cubic metres per hectare which is 33.5 percent less than the base case average of 311 cubic metres per hectare.

In the base case, both the minimum harvestable age and minimum harvestable volume thresholds must be met for a stand to be considered merchantable. An additional sensitivity analysis was completed that considered stands to be merchantable when only one of the two criteria was met (minimum harvestable age **or** minimum harvest volume). This change significantly affects the available growing stock and, consequently, the harvest levels across the planning horizon. Using only one merchantability criteria increases the short-term harvest level by 11 percent (3.3 million cubic metres per year) which can be sustained for three decades before declining to the base case mid-term harvest level. Similar to the previous sensitivity analysis, the long-term harvest level is reduced by 13 percent (2.7 million cubic metres per year) as younger managed stands are harvested much earlier compared to the base case. The average stand volume per hectare harvested in the long term is 28 percent less than the base case.

CTWG Indigenous Perspectives: Minimum Harvest Assumption Sensitivities

The CTWG Nations do not support the province's approach or assumptions used for the base case. They do not reflect the CTWG Nations interpretation of current practice that indicates a post-salvage estimate of minimum harvestable volume to be approximately 200 cubic metres per hectare.

Deciduous sensitivity analysis

Stands dominated by deciduous species were considered to be merchantable in the base case, but historically, very limited harvesting has occurred in these stand types. In the previous AAC determination the chief forester did not provide any specific consideration regarding the contribution of deciduous volume to the AAC. This varied from earlier AAC determinations which included partitions attributed to deciduous volume in order to

promote the utilization of deciduous species. Based on the very limited historic harvesting the deciduous portion of the harvest profile should be considered an uncertainty within the base case.

Sensitivity analyses were conducted to explore the effect on timber supply of restricting the contribution of deciduous species. Four analyses were run:

1. Exclude all deciduous-leading stands: The initial harvest level is 2.63 million cubic metres per year (12 percent lower than the base case) decreasing to a mid-term harvest level of 2.23 million cubic metres per year in the third decade.
2. Establish a deciduous-leading stand partition and regulate an even-flow harvest level from the partition: the initial harvest level is 2.78 million cubic metres per year decreasing to a mid-term harvest level of 2.48 million cubic metres per year in the fourth decade. A deciduous leading even-flow harvest of 200 000 cubic metres per year can be maintained throughout the planning horizon.
3. Exclude all deciduous-leading stands where deciduous species are greater than 75 percent of the stand composition: The initial harvest level is 2.93 million cubic metres per year (1.5 percent lower than the base case) decreasing to a mid-term harvest level of 2.33 million cubic metres per year (six percent lower than the base case) in the third decade.
4. Establish a partition for deciduous-leading stands with greater than 75 percent deciduous and regulate an even-flow harvest level from the partition. The initial harvest level is 2.93 million cubic metres per year (1.5 percent lower than the base case) decreasing to a mid-term harvest level of 2.35 million cubic metres per year (four percent lower than the base case). An even-flow harvest of 60 000 cubic metres per year can be maintained from the partition throughout the planning horizon.

CTWG Indigenous Perspectives: Deciduous Sensitivity Scenarios

Eliminating deciduous from early successional forests, in preference of coniferous plantations, is contributing to cumulative impacts on ecosystem resilience (i.e., fire, drought, forest health), biodiversity, and wildlife (i.e., forage for species such as moose) that will negatively impact First Nations' Rights in the short-, mid- and long-term.

Harvest system sensitivity analyses

The harvest contribution from stands only accessible through cable harvest systems was also explored through sensitivity analysis. Cable harvest systems are used in the TSA but the historic use is not proportional to harvest contribution attributed to stands expected to require a cable harvest system in the base case. Based on an assessment of past practice, about 25 percent of the THLB in the TSA is designated as accessible through cable or mixed systems, with about 35 percent of the THLB in the more northern portion of the TSA designated cable or mixed.

The higher harvest costs associated with cable systems, along with the existing high cost associated with water-borne delivery systems, suggests this portion of the profile should be considered an uncertainty in the base case. Sensitivity analyses explored the effect on timber supply of excluding or limiting the harvest contribution from stands requiring cable or mixed harvest systems.

Four scenarios were run:

1. Exclude all cable designated areas (retain mixed harvest system areas): The initial harvest level is 2.88 million cubic metres per year (three percent lower than the base case) decreasing to a mid-term harvest level of 2.31 million cubic metres per year in the third decade. The THLB is reduced by 10 percent.
2. Exclude all cable and mixed designated areas in the northern part of the TSA (water-borne delivery partition): The initial harvest level is 2.43 million cubic metres per year decreasing to a mid-term

harvest level of 2.2 million cubic metres per year in the third decade. The THLB is reduced by 17 percent.

3. Exclude all cable designated areas (retain mixed harvest system areas) in the north and establish southern partition: The initial total harvest level is 2.78 million cubic metres per year, decreasing to a mid-term harvest level of 2.33 million cubic metres per year in the third decade. The THLB is reduced by 7.5 percent. The southern partition initial harvest level is 1.51 million cubic metres per year, decreasing to a mid-term harvest level of 1.41 million cubic metres per year in the second decade. The northern initial total harvest level is 1.27 million cubic metres per year, decreasing to a mid-term harvest level of 0.92 million cubic metres per year in the second decade.
4. Exclude all cable and mixed designated areas in the north and establish southern partition: The initial total harvest level is 2.63 million cubic metres per year decreasing to a mid-term harvest level of 2.15 million cubic metres per year in the third decade. The THLB is reduced by 17 percent. The southern partition initial harvest level is 1.51 million cubic metres per year decreasing to a mid-term harvest level of 1.4 million cubic metres per year in the third decade. The northern initial harvest level is 1.11 million cubic metres per year decreasing to a mid-term harvest level of 0.75 million cubic metres per year in the third decade.

Spruce Beetle sensitivity analyses

Sensitivity analyses were conducted to assess the resilience of the timber supply to disturbances resulting from the ongoing spruce beetle epidemic in the TSA. The sensitivity analyses tested additional natural disturbance losses while maintaining the model component that projected disturbances from wildfires already incorporated in the base case.

The spruce beetle epidemic expansion has developed geographically in three phases over a 40-year period:

1. Current epicentre within the TSA bounded by the Peace Arm and Williston;
2. Southern portion of the TSA bounded by Omineca Park and Williston;
3. Rest of the TSA.

These steps of the spruce beetle epidemic initiation and expansion were modelled in the sensitivity analysis in succession at 10-year intervals from the start the planning horizon. Spruce beetle damage was assumed to be concentrated in all spruce stands with greater than 50 percent spruce. The infestation moved northward as follows:

1. all stands were killed (modelled as stand replacement events with 30 percent reserved) in the south-east (SE) in the first two decades;
2. the mortality initiates in the south-west (SW) in the second decade and persists for 20 years; and,
3. the mortality initiates in the north in the third decade and persists for another 20 years before ending.

Two harvest projections were developed to explore worst-case scenarios as described below.

1. Complete loss (100 percent) in the north with no partition: The initial harvest level is 2.4 million cubic metres per year (18 percent less than the base case) and is maintained for 10 years then decreasing immediately to the mid-term harvest level of 2.2 million cubic metres (11 percent less than the base case) in the second decade.
2. Complete loss (100 percent) in the north and establish a southern partition: The initial harvest level is 2.55 million cubic metres per year (14 percent less than the base case) and is maintained for 10 years then decreases to the mid-term harvest level of 2.26 million cubic metres (10 percent less than the base case) in the third decade.

Spruce beetle losses are partially mitigated in the partitioned scenario as harvest in the south is maintained at a constant level which increases salvage recovery of damaged stands and reduces emergent additional losses from the expansion of the epidemic.

CTWG Indigenous Perspectives: Spruce Beetle Sensitivity

The CTWG Nations do not support the Province's approach or assumptions in the base case or sensitivities associated with spruce beetle as this approach will lead to short-, mid-, and long-term impacts in regions in which the First Nations' ability to meaningfully exercise their rights is already highly constrained.

Sensitivity Analyses

Table 3. Sensitivity Analyses: merchantability, stand yield and problem timber types

Key issue	Change	Initial harvest level	Short-term impact	Mid-term impact	Long-term impact
Merchantability Parameters					
Minimum harvest age (MHA)	MHA = 60 years	3.1 million cubic metres per year	+ 4 percent	+ 4 percent	-13 percent
Minimum harvest age (MHA)	MHA = 100 years	2.3 million cubic metres per year	- 21 percent	- 8 percent	+5 percent
Merchantability definition	MHA > 80 years **OR** MHV > 125 cubic metres per year	3.3 million cubic metres per year (held for first 3 decades)	+ 11/22/33 percent over first 3 decades	0 percent	+6 percent
Stand Yield					
MSYT (Managed Stand Yield Tables)	Increase MYST yield by 5/15/25 percent	2.97 million cubic metres per year	0 percent	+2.5/5/8 percent respectively	+3/7/14 percent respectively
MSYT	Decrease MYST yield by 5/15/25 percent	2.90, 2.73, 2.68 million cubic metres per year respectively	- 2/8/10 percent respectively	- 1/3/7 percent respectively	-10/16/20 percent respectively
NSYT (Natural Stand Yield Table) + MSYT	Increase NYST+MYST yield by 25 percent	3.33 million cubic metres per year	+18 percent	+35 percent	+35 percent
NSYT + MSYT	Decrease NYST+MYST yield by 25 percent	1.73 million cubic metres per year	-42 percent	-34 percent	-38 percent
Problem Timber Types					
Deciduous 1	Remove All Deciduous leading stands	2.63 million cubic metres per year	- 12 percent	- 9.6 percent	- 8 percent
Deciduous 2	Partition All Deciduous leading stands	2.78 million cubic metres per year/Deciduous partition = 210 000 cubic metres per year	- 6.5 percent	- 1.1 percent	- 2 percent
Deciduous 3	Remove all Deciduous leading stands > 75 percent	2.93 million cubic metres per year	- 1.5 percent	- 6.5 percent	- 2 percent
Deciduous 4	Partition Deciduous leading stand > 75 percent	2.93 million cubic metres per year / Deciduous partition = 63 000 cubic metres per year	- 1.5 percent	- 4.5 percent	- 4 percent
Balsam	Remove Balsam stands > 75 percent Balsam	2.83M cubic metres per year	- 4.9 percent	0 percent	-2 percent

* Note: the base case initial harvest is 2.97 million cubic metres/year. The mid-term decreases to 2.47 million followed by an increase to 3.13 million cubic metres/year in the long term.

Table 4 Sensitivity Analyses: harvest systems and forest practices

Key issue	Change	Initial harvest level	Short-term impact	Mid-term impact	Long-term impact
Harvest Systems					
Harvest system 1	Remove cable ground from THLB throughout TSA	2.88 million cubic metres per year	- 3.1 percent	- 6 percent	-17.3 percent
Harvest system 2	Remove mixed and cable ground from THLB in the North (Rest of the TSA – ROT)	2.43 million cubic metres per year	-18.3 percent	- 10.7 percent	-9.7 percent
Harvest system 3	Partition TSA (south and ROT) and remove cable ground from THLB in the ROT	2.78 million cubic metres per year / South partition starts at 1.52 million cubic metres/ROT starts at 1.27 million cubic metres	- 6.5 percent	-5.4 percent	-4.2 percent
Harvest system 4	Partition TSA (south and ROT) and remove mixed and cable ground from THLB in the ROT	2.63 million cubic metres per year. /South partition starts at 1.52 million cubic metres/ROT starts at 1.11 million cubic metres	- 11.6 percent	-12.6 percent	-10 percent
Forest Practices					
Adjacency	Forest Cover Constraint: No more than 25 percent less than 3M	2.97 million cubic metres per year.	0 percent	0 percent	0 percent
Adjacency	Forest Cover Constraint: No more than 33 percent less than 3M	2.97 million cubic metres per year	- 8.1 percent	0 percent	0 percent
Adjacency soft: (probability of harvest within buffer 1 percent)	spatial buffer cut blocks 100m with green-up height of 3M	2.73 million cubic metres per year	- 8.1 percent	0 percent	0 percent
Adjacency hard: (no harvest within buffer)	spatial buffer cut blocks 100m with green-up height of 3M	2.42 million cubic metres per year	-19 percent	-1.9 percent	-6.2 percent

* Note: the base case initial harvest is 2.97 million cubic metres/year. The mid-term decreases to 2.47 million followed by an increase to 3.13 million cubic metres/year in the long term.

TWG Indigenous Perspectives: Adjacency

The CTWG Nations do not support the Province's approach or assumptions in the base case. They do not reflect the CTWG Nation's interpretation of the intent of current legislation.

Table 5. Sensitivity Analyses: natural disturbance

Key issue	Change	Initial harvest level	Short-term impact	Mid-term impact	Long-term impact
Natural Disturbance					
Spruce Beetle (IBS)	Expand current IBS epidemic to rest of TSA over first 3 decades of projection-Assume no salvage in north	2.44 million cubic metres per year	- 17.7 percent	- 10.8 percent	0 percent
Spruce Beetle	Expand current IBS epidemic to rest of TSA over first 3 decades of projection/North-South Partition in place/Assume no salvage in north	2.55 million cubic metres per year / South partition starts at 1.45 million cubic metres/ROT starts at 1.1 million cubic metres	- 14 percent	- 8.2 percent	-5 percent
Mountain Pine Beetle (IBM)	Initiate decade-long IBM epidemic in 8th decade targeting managed pine stands/persist for 20 years	2.95 million cubic metres per year	-0.8	-6.8 percent	-1.2 percent
Balsam decline	Yield curves from mature Balsam leading stands (> 50 percent Balsam) decremented 1 percent per year	2.8 million cubic metres per year	-3.2 percent	0 percent	0 percent
NRL	Apply OAF2 to capture NRL losses in NSYT dynamically over time (incrementally increasing to 6 percent at 130 years)	2.44 million cubic metres per year	-18 percent	-5 percent	-1 percent
Fire	Climate Change Tranche Analysis: Increase Fire frequency based on RCP4.5 and 8.5 scenarios: see Appendix 3 for results				

* Note: the base case initial harvest is 2.97 million cubic metres/year. The mid-term decreases to 2.47 million followed by an increase to 3.13 million cubic metres/year in the long term.

CTWG Indigenous Perspectives: Natural Disturbance Sensitivity Scenarios

The CTWG does not support the Province's approach or assumptions in the base case or sensitivities associated with natural disturbance. The base case and sensitivities do not adequately capture the extent of potential natural disturbance dynamics for both biotic and abiotic events in the context of climate change over the short-, mid-, and long-terms.

Regional Economy and Socio-Economic Analysis

The implication of changes in the timber supply for local communities is an important consideration in the timber supply review. It is recognized that the forestry sector plays a significant role in local economies and employment and supports additional employment through businesses purchasing goods and services (indirect impact) and through employees spending their income on local goods and services (induced impact).

Information on the local economy was provided by the District of Mackenzie. Results presented in the 2021 report, *Mackenzie Community Economic Development Strategy: Community Profile*, indicate that in 2021 agriculture, forestry, fishing, hunting and manufacturing (milling) account for approximately 44 percent of the total basic employment in the community of Mackenzie. Using this information, along with other sources, including the *Canadian 2016 Census of Population*, a socio-economic analysis was completed by Economics and Trade Branch of the Ministry. This analysis considered harvest volume, stumpage value, and direct impacts to gross revenue, gross domestic product (GDP), employment and government revenue, and used the *Census* to estimate that 38 percent of the TSA's employment in 2016 was in the forest sector.

Based on the average harvest level for the past seven years and aligned with the results presented in the base case, three different scenarios were generated to examine the effect of a decline in timber supply on employment: the base case, the maximum even-flow, and an alternative harvest projection developed by representatives of First Nation engaged in the CTWG (Southern Partition - 75 Percent Yield [SPY75]). These scenarios project sustainable harvest over a long planning horizon, but the socio-economic impacts calculated in this section will only utilize the initial harvest level between years 0-10.

The Statistics Canada Input-Output Model (IOM) was used to generate the estimates. Economic multipliers were applied to potential harvest scenarios to estimate the impact to employment, provincial government revenue, output (gross sales), and GDP. Table 6 summarizes the results of an input-output analysis that assessed the economic impacts of the three scenarios. These should be considered longer-term impacts after adjustment – in the short term, impacts could be higher or lower depending on business decisions of the forest industry.

The impacts presented for each scenario represent the upper bound of impacts since it is assumed that the entire projection volume is harvested. Additionally, these impacts are not limited to the management unit under review and instead may be occurring anywhere in the province. Estimated impacts are presented in Table 6.

Dollar Values in Millions	Indicator	Base Case Year 10	Even Flow Year 10	SPY75 Year 10	Current AAC	Average Harvest - 2019-2020
Harvest Related	Annual Harvest Volume (m³)	2,972,807	2,465,000	1,607,784	4,500,000	2,736,643
	Gov. Stumpage Revenue*	$38	$31	$20	$57	$35
	Employment	513	426	278	777	473
Forestry and Logging Outcomes**	Output (Gross Sales)	$205	$170	$111	$311	$189
	GDP	$94	$78	$51	$143	$87
	Additional Gov Revenue*	$8	$6	$4	$12	$7
Manufacturing Outcomes	Output (Gross Sales)	$473	$392	$256	$716	$436
	GDP	$139	$115	$75	$211	$128
	Additional Gov Revenue*	$13	$11	$7	$19	$12
	Employment	903	748	488	1,366	831
Total Outcomes	**Output (Gross Sales)**	**$679**	**$563**	**$367**	**$1,027**	**$625**
	GDP	**$234**	**$194**	**$126**	**$354**	**$215**
	Additional Gov Revenue*	**$20**	**$17**	**$11**	**$31**	**$19**
	Employment	**1,416**	**1,174**	**766**	**2,143**	**1,303**

**Based on 2-year average from 2019-2020. Additional Gov. Revenue covers sales tax, commodity taxes, plus corporate and individual tax.*

***Includes support activities for forestry and logging.*

Table 6. Direct economic impact Mackenzie TSA harvest

Scenario 1 (base case) shows that a harvest level of 2.97 million cubic metres a year could potentially sustain 1,416 direct jobs provincially.

Scenario 2 (maximum even-flow) includes a short-term decrease of approximately 500 000 cubic metres per year of volume harvested (2.47 million cubic metres per year), which reduces the total potential employment to 1,174 direct jobs (17 percent lower than the base case).

In scenario 3 (Southern Partition - 75 Percent Yield) the short-term harvest level is reduced by approximately 1.36 million cubic metres per year (to 1.6 million cubic metres per year) which reduces the total potential employment to 766 direct jobs (46 percent lower than the base case).

The chief forester will consider the results of this analysis in the AAC determination. It should be noted that the chief forester does not speculate on business decisions of the forest industry. The utilization of the AAC, including employment levels and types of forestry products, depends on business and operational plans.

CTWG Indigenous Perspectives: Regional Economy and SEA

Regional Economy

The Province has stated it is committed to reconciliation, inclusion, equity and empowering Indigenous peoples to become full participants in the economic life of BC. To date the Province has been slow in implementing this promise. In the Mackenzie TSA forestry is the main economic driver and forestry is key to meaningful participation in the regional economy by some Indigenous groups. It is also key to closing the glaring socio-economic gaps that exist in many First Nations communities including poverty, unemployment, substandard or inadequate housing and poor health outcomes (all legacies of colonialism and outdated laws and polices). Yet, despite the dire socio-economic conditions in many First Nation communities in the Mackenzie region, efforts to empower Indigenous groups to fully participate in the forest sector and larger regional economy are gaining momentum.

Historically, forestry has served BC and private interests at the expense of Indigenous rights and Interests and Indigenous peoples and their rights have been disproportionately impacted by forestry activity in the TSA. This

is slowly changing. Access to forestry tenures and capital are major obstacles to participation by Indigenous groups in the forest sector. However, these obstacles to participation in the forest sector by Indigenous groups can be overcome. The key to this is collaboration and "partnerships" by the Province, Indigenous groups and industry.

Ultimately, First Nations' communities would like a regional economy that is built upon a truly sustainable forest industry that creates more jobs with less timber.

Socio-Economic Analysis

The provincial Socio-Economic Analysis "SEA" described above, has a significant influence on the chief forester's determination (legally, the SEA must be considered). The socio-economics are described in monetary value and jobs based on the amount of forest removed in a 10-year period. It is concerning how extremely limited the scope of the provincial SEA is.

In short, the provincial SEA does not address the considerable socio-economic impacts that will occur in the near term (over the next 10 and 30 years from present) when the forest industry eventually runs out of existing mature and old-growth forests to cut and becomes more dependent on coniferous plantations.

Some of the CTWG Nations expressed that their communities are interested in pursuing alternative economic opportunities, other than the current forest management paradigm, via Atmospheric Benefit Agreements. Many First Nations land management directives and objectives, such as increased riparian buffers, increased stand retention and conservation to protect First Nations' Rights, that are currently not classified as "current practice" (business as usual) could be eligible for carbon offset projects. First Nations intend to offset the cost, including lost revenue, of such directives and objectives through the sale of carbon credits. The TSR process (including SEAs) should document any changes to current practice, due to First Nations initiatives, that are eligible for carbon credits.

Summary

Prior to the onset of the mountain pine beetle epidemic the AAC in the unit was approximately three million cubic metres. The mountain pine beetle epidemic peaked in 2009/10 and damaged over 1.3 million hectares. The previous TSR was initiated in 2011 to facilitate the salvage of mountain pine beetle-killed pine while the dead still trees retained economic value. In November 2014, the AAC was set a 4.5 million cubic metres resulting from an uplift of 1.5 million cubic metres. The 2014 AAC determination also included a non-pine partition of 950 000 cubic metres, of which a maximum of 300 000 cubic metres was attributed to the south-west portion of the TSA. The objective for the geographic partition was to reduce harvest concentration and facilitate a geographic transition of harvest activities northward. In 2014 a spruce beetle outbreak began to grow in the south-eastern portion of the TSA and by 2019 it had expanded to such a concerning extent that the chief forester issued an amendment to the partition to facilitate salvage of spruce beetle-killed stands. At that time, the chief forester also concluded that there is a need to re-examine the Mackenzie timber supply and to determine a new AAC.

The base case has an initial harvest level of 2.97 million cubic metres per year which is maintained for 10 years before declining to 2.47 million cubic metres per year in the third decade of the harvest projection. The mid-term harvest level is also the maximum even-flow harvest level for the unit. The base case assumes no harvest of dead volume and, as such, is the least risk scenario with respect to the current state and utilization of dead volume in the TSA. The base case also assumes that the timber supply can be maintained by increasing levels of harvest outside the southern ("winter-roaded") portion of the TSA. Historic harvest performance suggests this assumption is unrealistic given the cost structure of the unit and the need to balance operational costs between log transportation zones. Therefore, the base case contains risk associated with geography, along with assumptions regarding non-conventional harvest systems and the species profile (deciduous utilization).

Including dead volume harvest in the southern part of the TSA for 10 years increases the harvest level in the first decade to 3.1 million cubic metres per year. Implementing the existing geographic south-west partition lowers the harvest level in the first decade to 2.8 million cubic metres per year. The contribution of the northern 'water-borne delivery' portion of the TSA to this alternative harvest projection exceeds levels that have occurred historically. Implementing a "winter-roaded" based southern geographic partition lowers the harvest level in the first decade to 2.93 million cubic metres per year. The contribution of the 'water-borne delivery' portion of the TSA to this alternative harvest projection matches levels that have occurred historically.

The harvest level projected in the base case is sensitive to changes in the assumed minimum harvestable volume and minimum harvestable age. Lowering merchantability assumptions increases available growing stock and allows for significantly higher harvest levels. Although these stands represent an opportunity to mitigate timber supply shortfalls, they are not representative of the current or historic harvest profile. Stands dominated by deciduous species contribute to the base case but, historically, very limited harvesting has occurred in this profile. Limiting the contribution of deciduous volume decreases short-term timber supply ranging between 1.5 and 12 percent. Cable-based harvest systems are used in the TSA but the historic use is not proportional to the harvest contribution attributed to cable harvest systems in the base case. Limiting the contribution of cable and mixed harvest systems creates short-term downward pressures ranging between 3 and 18 percent.

The provincial chief forester's AAC determination is a judgment based on professional experience and consideration of a wide range of information as required under Section 8 of the *Forest Act*. An AAC is neither the result of a calculation nor limited to the results of timber supply analysis; therefore, the new AAC may not be the same as any of the initial harvest levels depicted in any of the projections included in this document.

CTWG Indigenous Perspectives: Summary

The TSR process, is a strategic-level decision that has negative cumulative impacts to First Nations' Rights. TSR re-enforces "Current Forest Management Practices" and provincial socio-economic objectives that undermine First Nations' Rights and render functioning forested ecosystems ineffective. Furthermore, modelling has inherent error and interpreting results must be weighed against accuracy of model inputs and reliability of model outputs. First Nation technical representatives at the CTWG have discussed several model inputs that influence the base case that are highly variable. Most notable are growth and yield projections, forest health predictions, and the influence of climate change.

Ultimately, when combining the inventory uncertainty with the uncertainty of natural disturbance events in both primary and managed stands, it would stand to reason that the "base case" AAC would be more appropriate if it reflected these risks. Unfortunately, the TSR process isolates "uncertainty risks" in a single variable "sensitivity" format that neglects a "worst case scenario" in which multiple downward pressures could apply to the base case. Therefore, the CTWG Nation's identify that an approach to model uncertainty, by applying a 25% reduction to stand yields, could be argued to be a more accurate scenario that reflects uncertainty of factor(s) other than the estimation of yields.

Importantly, preliminary results from the CTWG process have identified concerning current and predicted future trends of environmental values linked to First Nations' Rights such as caribou, grizzly bear, and aquatic ecosystem health under current provincial forest management regimes. In particular, the southern regions of the DMKTSA (and mostly in the current southwest partition zone) have been significantly impacted by the sustained and concentrated harvest of the AAC in this region in which most environmental values linked to First Nations' Rights are at "moderate" or "high risk".

Of most concern is that impacts to environmental values have been shown to continue to occur in the southern regions of the DMKTSA in the short-, mid-, and long-terms - even if the base case AAC is reduced by almost half (as a precautionary approach to growth and yield estimates) and a south partition is applied (as per SPY75 Alternative Projection). Given these results, the contemplated provincial harvest flows in this TSR will undoubtably result in significant and potentially irreparable impacts to First Nations already highly constrained ability to meaningfully exercise their rights in the southern regions of the DMKTSA. This is notwithstanding

further consideration of the impacts to First Nations Rights in this region by the interacting cumulative effects from other industrial activities such as mining, mineral exploration, and energy projects.

In this context, it is the responsibility of the Province to ensure the AAC determination, in conjunction with all other cumulative effects, will not unduly impact First Nations' Rights. When uncertainty exists around the impacts to First Nations' Rights, then a precautionary approach to the AAC determination must be considered.

Your input is needed

Public input is a vital part of establishing the allowable annual cut. Feedback is welcomed on any aspect of this discussion paper or any other issues related to the timber supply review for the Mackenzie timber supply area. Ministry staff would be pleased to answer questions to help you prepare your response. Please send your comments to the District Manager at the address below (via email if possible).

Your comments will be accepted until September 14, 2022.

You are reminded that responses will be subject to the *Freedom of Information and Protection of Privacy Act* and may be made public. If the responses are made public, personal identifiers will be removed before the responses are released. For more information or to send your comments, contact:

Mackenzie Natural Resource District
Ministry of Forests
Box 2260
Mackenzie, BC
V0J 2C0
Telephone: 250-997-2200
Fax: 250-997-2236
Email: Forests.MackenzieDistrictOffice@gov.bc.ca

If you have any comments or questions, contact:

Ryan Bichon
District Manager
Mackenzie Natural Resource District
Electronic mail: Ryan.Bichon@gov.bc.ca

Further information regarding the technical details of the timber supply analysis is available on request by contacting Forests.AnalysisBranchOffice@gov.bc.ca

Visit the Forest Analysis and Inventory Branch web site
https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/timber-supply-review-and-allowable-annual-cut

To complete a public opinion survey on this report and the allowable annual cut please scan the following QR code from your cell phone or visit the following website.

https://arcg.is/1jq9T

Appendix 1: Harvest Flow

Flow objectives

- Do not exacerbate the most constraining period: the harvest level should be maintained at or above the maximum even-flow harvest level for the unit.
- Maximized harvest levels should be feasible and sustainable in practice.
- Maintain existing harvest levels to the degree possible.
- Modelled harvest outcomes (profiles) should reasonably approximate historic conditions and practice recognizing the effect of transitioning from natural to managed stands.
- Limit supply decline discontinuity to steps of no more than 10 percent per decade where feasible.
- Increased long-term harvest levels should be enduring beyond the planning horizon.

Initial base case assumptions

- Salvage (defined as the unit-wide focused harvest of dead volume) is no longer a management objective.
- No existing dead volume is contributing to the initial base case.
- The THLB is stratified by harvest system (75 percent conventional, 15 percent mixed, 10 percent cable).
- Available stands must be greater than or equal to 80 years of age and greater than minimum harvest volume per hectare for the harvest system.
- Harvest preferentially progresses from south to north.
- Harvest preferentially progresses from existing road network outward.
- Emergent NRLs are produced via fire simulation, salvage of NRLs is not prioritized.
- Harvest must initiate within a maximum of 2 km of the road network.
- Target block sizes can range between 5 to 100 hectares in size (as demonstrated by current practice).
- Adjacency is not applied (as demonstrated by current practice).
- Deciduous-leading stands contribute to the initial harvest projection.

Supplemental (alternative) assumptions

- A south-west partition remains in place and each geographic area is treated as a discrete management unit.
- Residual existing dead volume is available for harvest for one time-step (5 and 10 years respectively).
- Residual existing dead volume is available everywhere in the TSA and alternatively, only in the southern part of the TSA (south of Omineca Park and south of the Peace Arm).

Harvest queue

- The probability of harvest initiation is based on maximum volume per hectare relative to volume at culmination age weighted by distance to mill and distance to road.

Appendix 2: Indicator Analysis

The First Nations represented at the CTWG have identified caribou, grizzly bears, aquatic ecosystem health, moose, marten, marmot, fisher, rocky mountain elk, bull trout, arctic greyling, and forest biodiversity as important values to maintain in the Mackenzie timber supply area. This appendix describes indicator assessments associated with caribou, grizzly bears, and aquatic ecosystem health values.

Indicator values are assessed for two harvest flows: the base case and the south partition with 75 % of yields (SPY75).

CTWG Indigenous Perspectives: Indicator Analysis

The CTWG-Nations have found that the framework of the TSR process is not an effective or efficient way to evaluate the impact of industrial scale harvesting on First Nations' Rights:

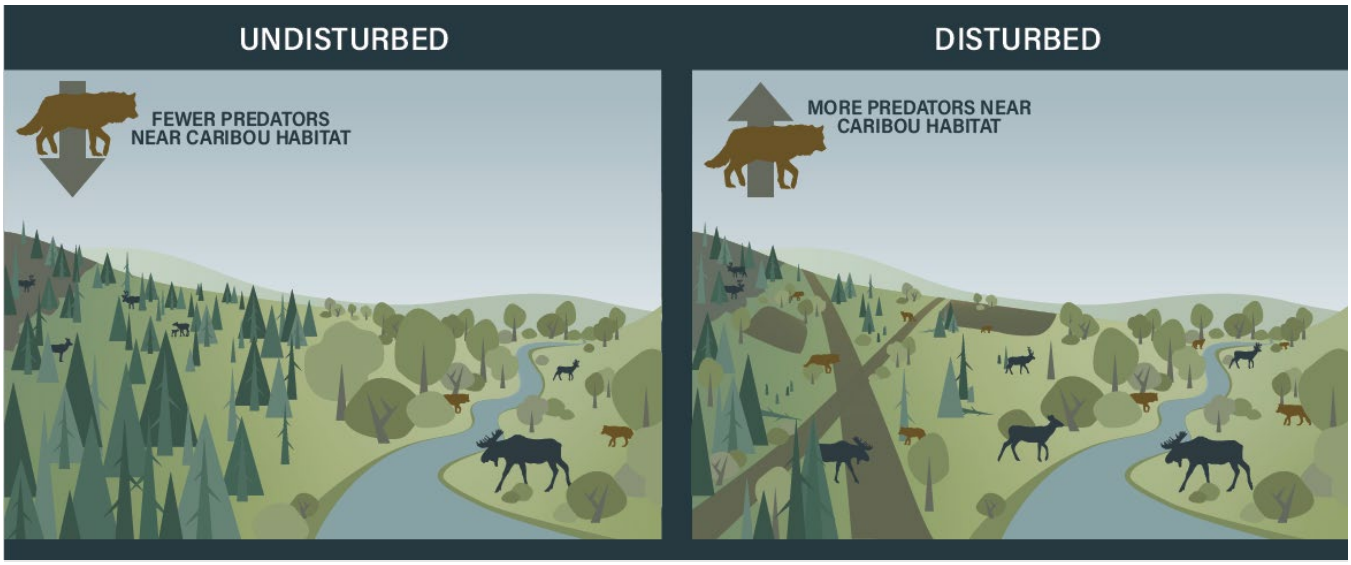
- *Projections prepared depend on the harvest flow objectives and the CF selects one to assess the uncertainties.*
- *Harvest flow objects maintain and maximize the harvest levels that are sustainable in practice without consideration of cultural values that are inherent to First Nations' Rights.*
- *The assessment of indicators of First Nations' values is done on the output from a harvest flow or sensitivity analysis simulation. As such, First Nations' Rights are a by-product of the harvest maximization process.*
- *The assessment of uncertainty and risk to First Nations' Rights is limited as most of the sensitivity analyses provide no assessment of indicators of First Nations' values*

Caribou

Caribou and Forest Harvest

Woodland caribou are a species of great ecological importance and have significant cultural and ecological value for people that call British Columbia (BC) home. Once abundant, many caribou herds have declined steeply over the past several decades. The overall population in BC has gone from approximately 40,000 animals to 15,500 currently. Caribou recovery is a key priority of the Government of BC, and a wide range of recovery actions have been implemented in caribou ranges.

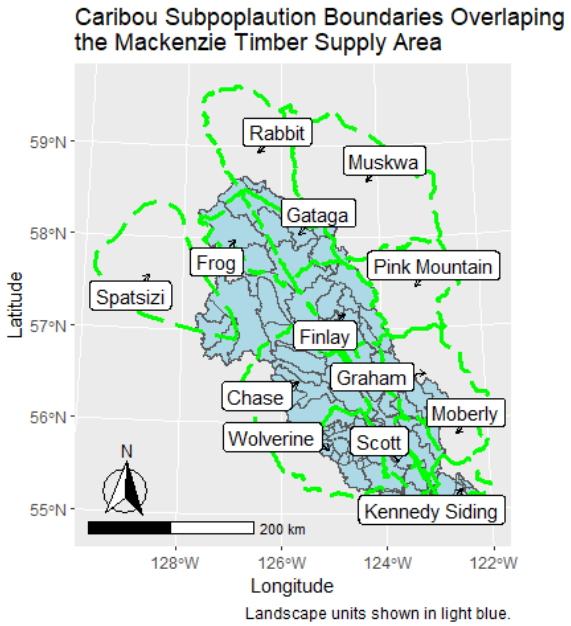
Caribou are adapted to live in mature coniferous forests, mountainous terrain, peatlands, and areas with deep persistent snowpack. However, scientific evidence indicates that industrial disturbance has negatively altered caribou habitat and is the main cause of population declines. Specifically, when forests are harvested, the regrowth is initially dominated by leafy shrubs, herbs, and grasses. This surplus of food leads to more moose, elk, and deer, and their main predator, wolves. In addition, industrial roads and other linear features facilitate the movement of wolves. Thus, these disturbances result in greater abundance and distribution of wolves within and near caribou habitat, which leads to unsustainable predation on caribou by wolves, and eventually caribou population declines.



Indicator Analysis

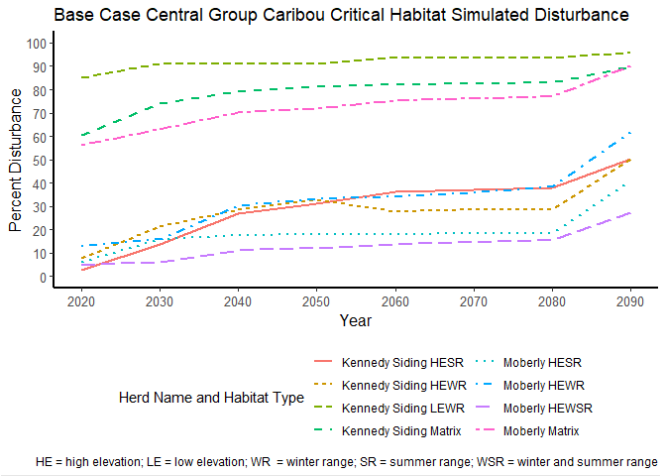
The following is a summary of the caribou indicator analysis undertaken for the Mackenzie TSR. The analysis approach is based on the scientific evidence that higher levels of disturbance in caribou habitat results in decreased probability of self-sustaining (e.g., non-declining) caribou subpopulations. Here 'disturbance' is defined as areas less than 500 m from roads or early seral (less than 40-year-old) forestry cutblocks, or areas burned in the last 40 years.

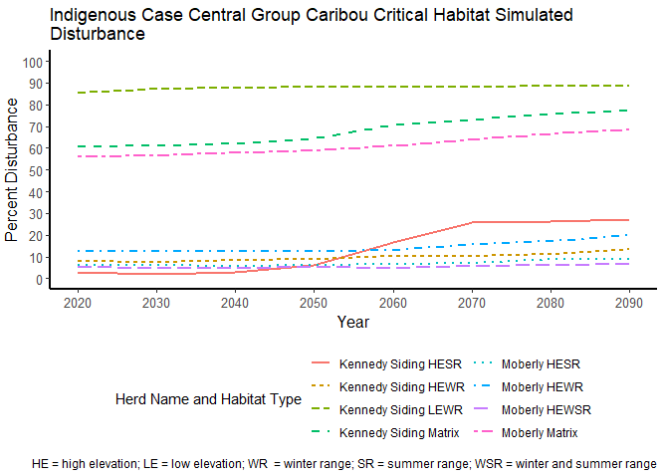
Disturbance estimates were calculated within caribou habitat using the current and simulated future cutblock, road and fire outputs from the timber supply model for the base case and the SPY75 Scenario. Caribou habitat of the Kennedy Siding, Moberly, Graham, Frog, Gataga, Muskwa, Pink Mountain, Rabbit, Spatsizi, Finlay, Thutade (not shown), Chase, Wolverine and Scott subpopulations overlapped the Mackenzie TSA. Note that here we refer to each of these as subpopulations, but others may refer to them as herds or populations.



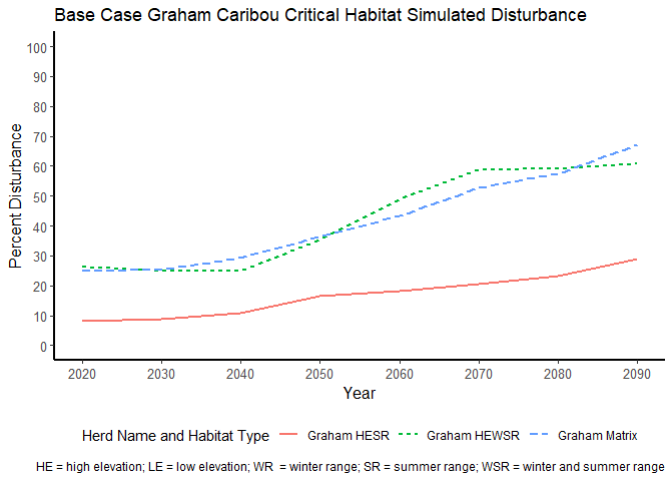
Below summarizes the amount of disturbance estimated within each caribou sub-populations habitat from 2020 to 2090, for each sensitivity analysis.

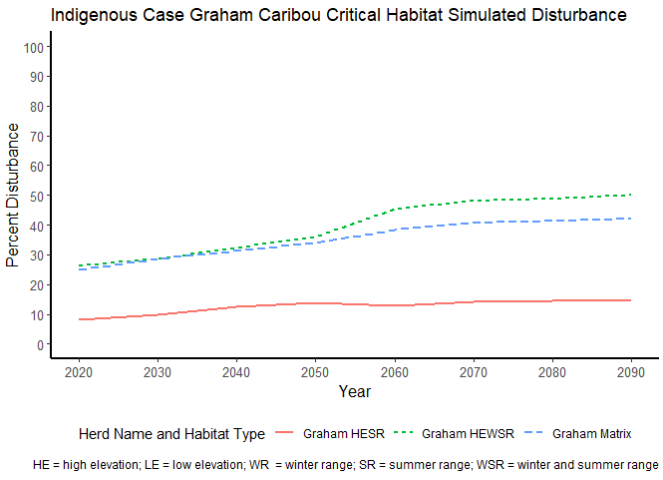
In the Kennedy Siding and Moberly sub--populations, simulated disturbance increased from 2020 to 2090 in all habitat types in the base case. However, in the SPY75 scenario, disturbance only notably increased in Kennedy Siding high elevation summer range (HESR) and matrix, and Moberly matrix habitat types.





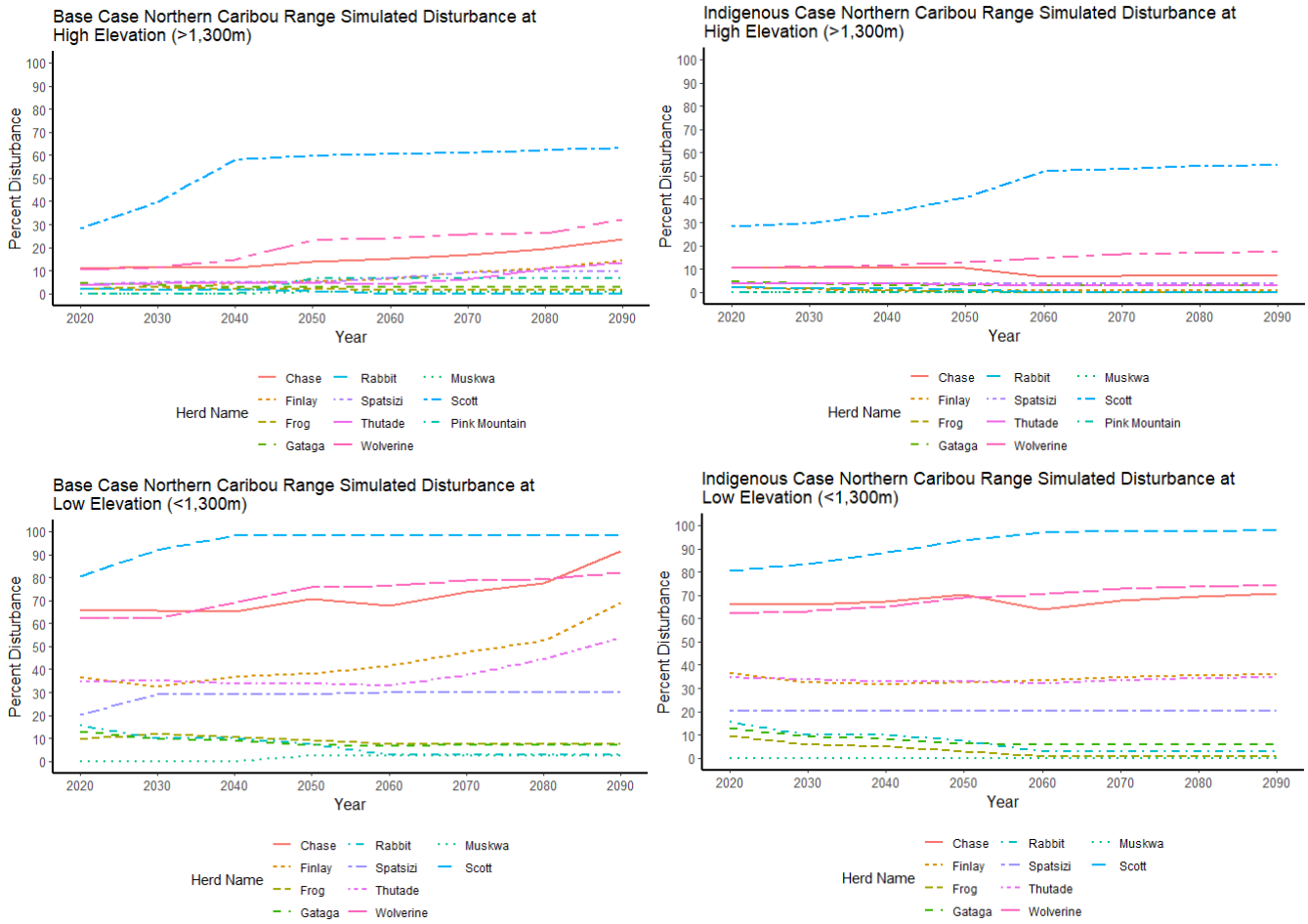
In the Graham caribou sub-populations habitat, simulated disturbance increased from 2020 to 2090 in the base case and SPY75 scenario but was notably less in the latter.





In the Chase, Finlay, Frog, Gataga, Muskwa, Pink Mountain, Rabbit, Scott, Spatsizi, Thutade and Wolverine subpopulations, disturbance was estimated within higher (greater than 1,300 m) and lower (less than or equal to 1,300 m) elevation habitat. In the base case and SPY75 scenario, disturbance remained relatively low (e.g., <10%) within the high elevation habitat of most of the sub-populations throughout the simulation period. The exceptions were the Scott, Wolverine and Chase sub-populations in the base case, and Scott sub-population in the SPY75 scenario.

In the base case and SPY75 scenario, disturbance decreased or was relatively stable in low elevation habitat of the Rabbit, Gataga, Muskwa and Frog sub-population ranges. In the base case, disturbance increased in low elevation habitat of the Chase, Finlay, Spatsizi and Thutade sub-populations, but was stable or declining in the SPY75 scenario. Disturbance increased in low elevations of the Scott and Wolverine sub-populations in both cases, but the SPY75 scenario case had lower overall disturbance levels.



In summary, in the base case, forestry and fire disturbance increased in caribou habitat between 2020 to 2090, suggesting increased loss of habitat and risk of caribou population decline. The Kennedy Siding, Graham, Chase, Moberly and Finlay sub-populations appeared to be at greatest risk to hypothetical future forestry development. The SPY75 scenario resulted in less disturbance in caribou habitat compared to the base case, suggesting this scenario would result in less risk of caribou population decline in the region.

CTWG Indigenous Perspectives: Caribou

First Nations have a long-shared history with caribou and the land. Caribou were one of the primary sources of food for many Nations in the early 1900's. It's only been over the last few decades that there have been sharp population declines, primarily in the federally designated southern mountain caribou (northern and central group) within the DMK. Most notable, is the recent extirpation of the Scott West herd and a 27% decline in the Wolverine herd since 2016. These declines are primarily attributed to increased predation that has been facilitated by habitat alterations associated with industrial operations. These negative impacts exasperate the already highly constrained ability of First Nations to meaningfully exercise their rights to hunt caribou during this TSR determination period. In fact, because of the current state most First Nations have voluntarily stopped the harvest of caribou for food.

In general, the First Nations support the habitat disturbance methodology applied for this analysis except for the following assumptions:

- *That caribou habitat recovers in 40 years after disturbance. However, most harvested areas overlap with the 500-meter road buffer area in the model that never recovers.*

- *In both harvest flows, future increases of area disturbed by fire, due to the predicted influence of climate change, are not considered.*
- *The focus of the TSR is forestry, so cumulative effects from other disturbances including mining, mineral exploration, energy, and agriculture are not included.*
- *The caribou analysis is constrained to the DMKTSA, yet caribou herd ranges extend beyond this boundary.*
- *That the near-term forest harvesting impacts (i.e., during this TSR determination period) to the Chase, Wolverine, Finlay, and Thudate caribou herds are not adequately captured in the caribou analysis using the base case model for years 0-10. This is not an issue with the analysis work, but rather the discrepancy in what the base case models as forest harvesting from years 0-10 versus what is currently being permitted to harvest. In this context, the CTWG Nations emphasize the potential to misinterpret the implications to First Nations' Rights during this determination period using the base case results for this analysis. It is notable, however, that the base case, does describe a general trend over time of worsening caribou habitat.*

Grizzly Bear

The following is a summary of the Grizzly Bear Indicator analysis undertaken for the Mackenzie TSR. The analysis is based on processes described in the Interim Assessment Protocol for Grizzly Bear in British Columbia (October 2020). The protocol enables a provincially consistent assessment approach for understanding the current state of, and risks to, grizzly bears and their habitats across BC.

The Grizzly Bear indicator analysis focused on two indicators of risk to Grizzly Bear habitat in the Mackenzie TSA: Core Security (core population risk indicator) and Road Density (supplementary population risk indicator). The analysis focuses on the impacts of the base case and SPY75 harvest projection scenarios for the Mackenzie timber supply review.

For core security the analysis found that under the base case projection approximately 60% of the assessment units fell below the 60% core habitat threshold recommended for recovery of grizzly bear populations by the year 2120. This is a 28.6% increase over the starting condition in 2020. In the SPY75 scenario 53% of the assessment units fell below the threshold by 2120.

The following table summarizes the outcomes from both the SPY75 scenario and the base case for core habitat retention in Grizzly Bear Assessment units across the TSA.

Base case				
Category	Current	Year10	Year50	Year100
Above 60% Core	48	47	36	28
Below 60 Core	22	23	34	42
% Below	31.4%	32.9%	48.6%	60.0%
SPY75				
Category	Current	Year10	Year50	Year100
Above 60% Core	48	47	37	33
Below 60 Core	22	23	33	37
% Below	31.4%	32.9%	47.1%	52.9%

Both scenarios contribute to significant core habitat loss in the southern part of the TSA with the base case projection reducing core habitat by 47% (~ 235 000 ha reduction) over the first 100 years with most of the

reduction occurring in the first 30 years of the projection (37% reduction), while under the SPY75 scenario there is a 35% reduction in the starting condition occurring in the first 50 years and a 42% reduction after 100 years. For road density the analysis found that under the base case projection approximately 21% of the assessment units rose above the 60% high-density (> 0.6km/km2) threshold recommended for recovery of grizzly bear populations by the year 2120.

Under the SPY75 scenario, 15.7% of grizzly bear assessment units rose above the 60% threshold for high road density at the end of 2120.

The following table summarizes the outcomes from both the SPY75 scenario and the base case for Road Density in Grizzly Bear assessment units.

Base case				
Category	Current	Year10	Year50	Year100
Above 60% High Density	7	7	12	15
Below 60 High Density	63	63	58	55
% Above	10.0%	10.0%	17.1%	21.4%
SPY75				
Category	Current	Year10	Year50	Year100
Above 60% High Density	7	7	10	11
Below 60 High Density	63	63	60	59
% Above	10.0%	10.0%	14.3%	15.7%

CTWG Indigenous Perspectives: Grizzly Bear

CTWG Nations generally support the methodology used to assess the two population risk indicators for grizzly bears applied in this analysis against the two harvest flows: base case and SPY75. The CTWG Nations identify that the results from this methodology differs from results found in the Cumulative Effects Framework (CEF) – Current Condition Report for Grizzly Bears in the Omineca Region.

Further, as noted above in "CTWG Indigenous Perspective: Caribou", the spatial distribution of the cutblocks and associated roads produced in the base case don't align with what is currently been observed in recently harvested, permitted, and planned forest harvesting activities, making it challenging to assess the potential impacts to First Nations' Rights over the next 10 years on changing grizzly bear core habitat and road density.

The results identify that the both the base case and SPY75 harvest flow show the future trend is a "worsening state" to Grizzly Bear Core Security and Road Density Indicators in the southern regions of the DMKTSA. This has significant implications to First Nations' Rights in this region.

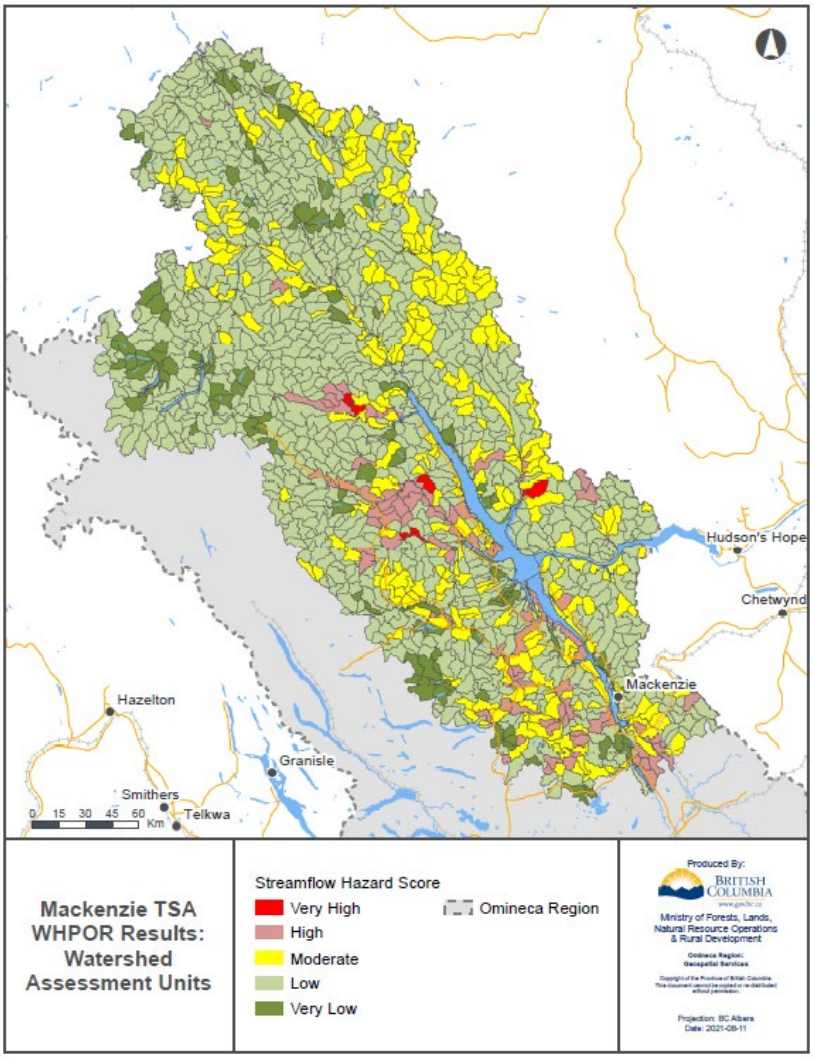
Aquatic ecosystem health

Aquatic ecosystem health was evaluated using the Watershed Health Project Omineca Region protocol (GIS-based watershed hazard assessment) and the provincial cumulative effects framework Interim Assessment Protocol for Aquatic Ecosystems. Supplemental analysis was completed to evaluate the effect of applying the H60 concept to six candidate watersheds.

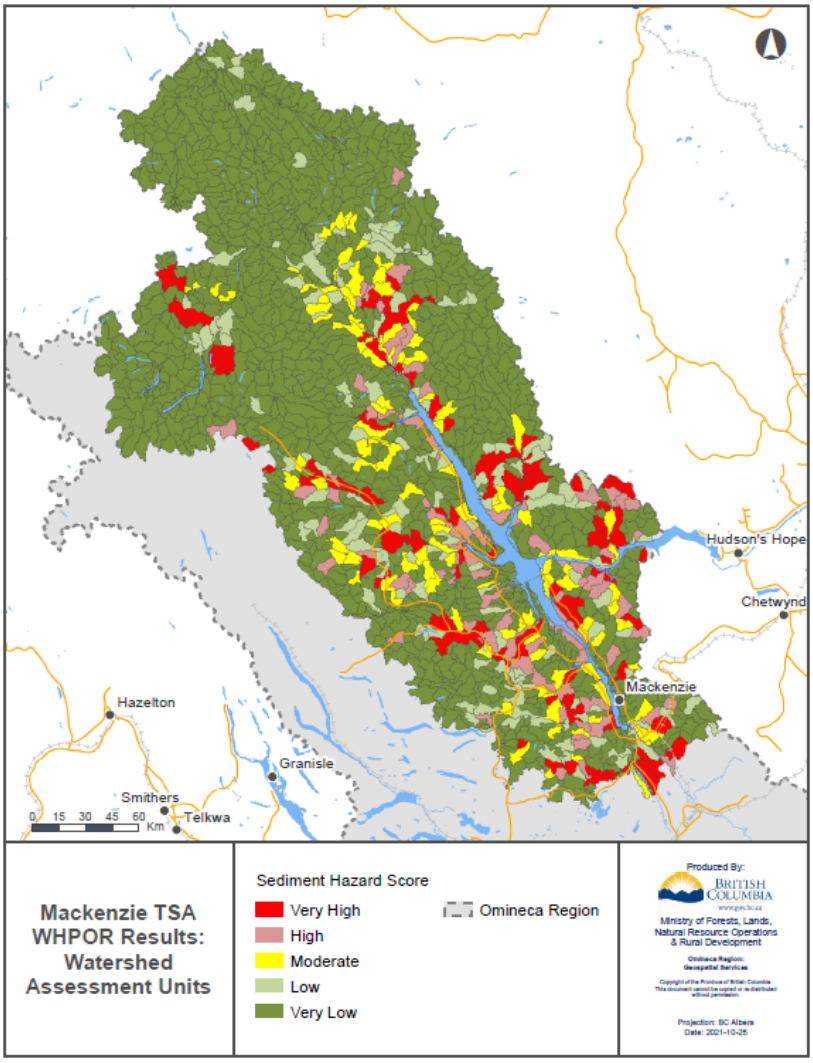
Current condition – GIS-based watershed hazard in the Mackenzie TSA

The purpose of this section is to provide a broad overview of how GIS-based watershed hazards were determined for the Mackenzie TSA. The approach used here is based on a regional assessment program that will be outlined more completely in a soon to be released current condition report. The assessment presented here is scaled to the assessment unit watershed (AUW) which are areas between 2,000 and 10,000 ha meant to emulate third order watersheds. AUW are advantageous because they cover the entire landscape but they are not always true watersheds. Future regional assessments will be completed for hydrologically correct watersheds.

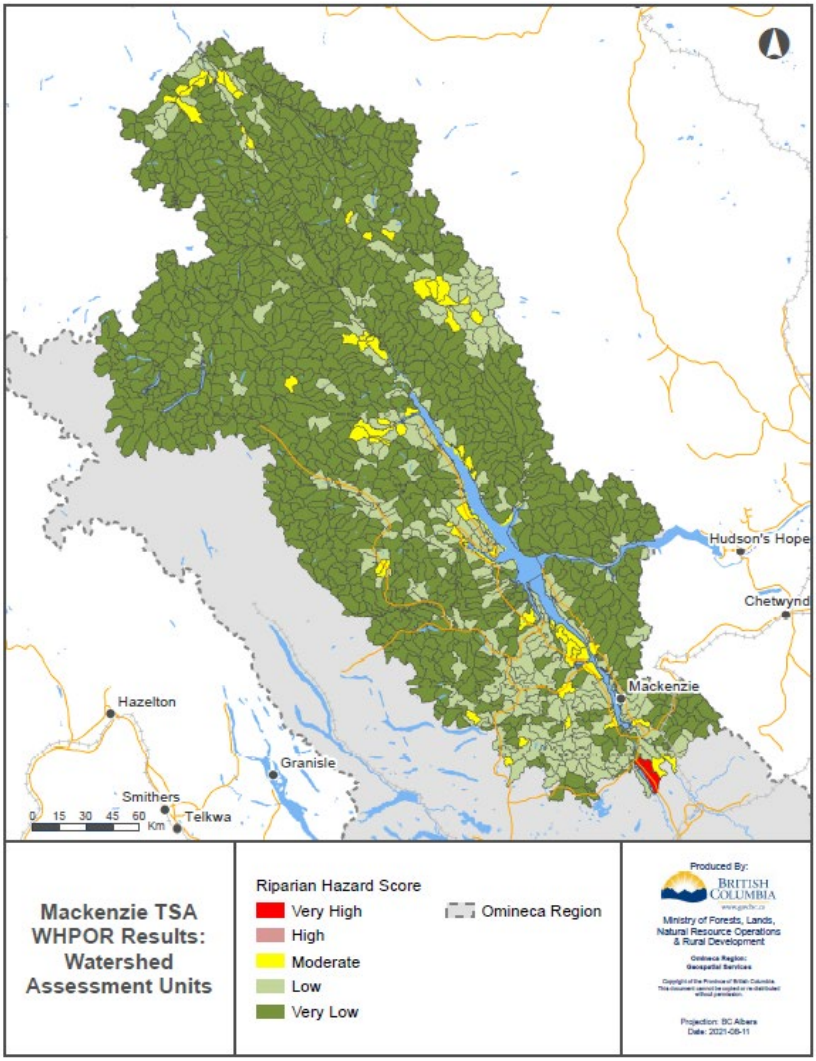
Streamflow hazard reflects the relative likelihood of increased peak flow at the outlet of a AUW by considering the snow conditions, forest cover and disturbance, slope and drainage density, as well as size and location of wetlands and lakes. Streamflow hazard as shown in the figure on the right show elevated hazard levels in watersheds that have past forest disturbance and/or in AUW with high snow load and steep slopes. High snow load systems with steep slopes and few wetlands or lakes have a higher inherent streamflow hazard compared to lower profile systems with less snow and wetlands and lakes in the lower portions of the AUW.



Sediment hazard reflects the relative likelihood of increased sediment generation and delivery of sediment to streams within the AUW. Sediment generation and transport potential was determined by considering sensitive soils and slopes next to streams as well as roads near streams and on steep slopes, stream crossings, forest development next to steep slopes as well as drainage density, watershed slope, and area and location of wetlands and lakes. Sediment hazard for the TSA shown in the right panel indicate a variable response with moderate and higher scores associated with areas that have either seen disturbance from past development activities such as harvesting, pine beetle and salvage, or that have sensitive soils, slopes connected to streams, and little buffering capacity for increases to sediment generation levels.



Riparian hazard reflects the likelihood that disturbance within the riparian zone will alter the freshwater and terrestrial attributes that make this area one that holds some of the highest biodiversity values across the landscape. This hazard identifies intrusion of forestry, private land, or range tenures within 20m of the stream bank. TSA hazards are identified in the figure on the right and show moderate and higher riparian disturbance in areas with either some past disturbance history such as fire, harvesting, or beetle affected areas as well as private and agricultural lands.



Summary

- Mackenzie TSA has more than 20% of AUW in moderate or higher stream flow hazard indicating that areas of the TSA have been influenced by forest disturbance or their watershed characteristics are such that the units may be quite responsive to increased peak flow with forest canopy disturbance.
- Mackenzie TSA has close to 20% or more AUW with a moderate or higher sediment hazard so sediment erosion and control planning is important with road development and other sediment generating activities.
- Hazard estimates reflect disturbance and watershed characteristics. Disturbance indicators such as ECA or stream crossing density can show a high or lower disturbance footprint relative to watershed hazard because watershed characteristics such as slope, presence of sensitive soils, and drainage density can buffer or exaggerate disturbance response.

Summary table of the three hazard types in the Mackenzie District.

District	Hazard	Very Low	Low	Moderate	High	Very High
Mackenzie	Streamflow	7	67.4	19.6	5.6	0.4
	Sediment	70.6	9.8	7.3	5.5	6.7
	Riparian	76.4	20	3.6		

The findings identified in this summary are from a desktop GIS-based exercise that has not been verified for the area. The hazard estimates provided here present a relative comparison of potential hazards across AUW with the expectation that other supporting activities such as air photo interpretation and field verification would occur during development and conservation planning and review.

Interim Assessment Protocol for Aquatic Ecosystems

The following is a summary of the Aquatic Ecosystem Health analysis undertaken for the Mackenzie TSR. The analysis is based on processes described in the Interim Assessment Protocol for Aquatic Ecosystems in British Columbia (December 2020) https://www2.gov.bc.ca/assets/gov/environment/natural-resource-stewardship/cumulative-effects/protocols/cef_aquatic_ecosystems_protocol_dec2020_final.pdf. The protocol enables a provincially-consistent assessment approach for understanding the current state of, and risks to aquatic ecosystem habitats across B.C. The protocol is based on the scientific understanding of watershed processes.

The analysis focused on trends in core indicator hazard ranking over time. Six Core indicators: Road Density, Stream Crossing Density, Peak Flow, Road Density < 100m from streams, Road Density on Unstable Slopes and Riparian Disturbance were assessed at three time-steps in the timber supply projection: 2030, 2070 and 2120.

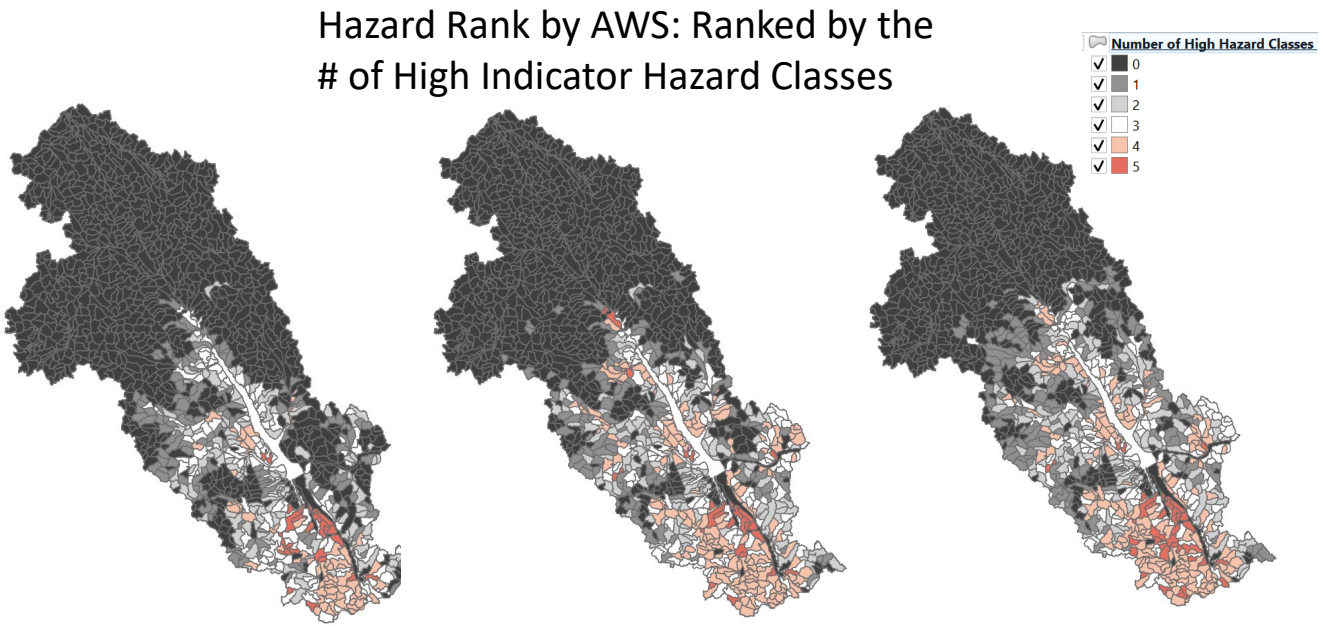
Base Case Summary

The following table details how the overall ranking of analysis watersheds (AWS) change with time with the base case harvest projection. The category specifies the number of indicators that are classified as high hazard. For each category and projection year, the number of AWS with high hazard scores are shown, as well as the percentage of all the AWS that overlap the THLB (753 units overlap).

Year	Category	pct of all AWS	AWS Count
Yr10	one or more high ranks	56.7%	427
Yr10	two or more high ranks	39.8%	300
Yr10	three or more high ranks	25.6%	193
Yr50	one or more high ranks	70.0%	527
Yr50	two or more high ranks	54.8%	413
Yr50	three or more high ranks	38.5%	290
Yr100	one or more high ranks	79.8%	601
Yr100	two or more high ranks	59.4%	447
Yr100	three or more high ranks	42.2%	318

There are trends of increasing hazard for all indicators across the first 50 years of the projection, with a minor reduction in hazard for peak flow occurring by the end of the second assessment period. After the first decade of the projection (year 10) 57% of the units had at least one 'High' rank for the 6 primary indicators of potential hazard while approximately 26% of the units overlapping the THLB had three or more 'High' hazard ranks. By the year 100 approximately 20% of the units had no 'High' rank while the % of units with 2 or more increased by 20%. Units with 3 or more 'High' ranks increased by approximately 16% (42% in year 100 vs 26% in year 10).

The following figure depicts the spatial distribution of the number of High Hazard Classes by AWS (the graduated color scheme is based on natural Jenks optimization).



SPY75 Summary

The following table details how the overall ranking of AWS change with time with the SPY75 harvest projection scenario.

In the SPY75 scenario there are trends of increasing hazard for all indicators across the first 50 years of the projection. After the first decade of the projection (year 10) 57% of the units had at least one 'High' rank for the 6 primary indicators of potential hazard while approximate 40% of the units overlapping the THLB had two or more 'High' hazard ranks. By the year 100 approximately 21% of the units had no 'High' rank while the % of units with 2 or more increased by 17%. Units with 3 or more 'High' ranks increased by approximately 13% or 4% less than the base case (33 fewer units).

Year	Category	pct of all AWS	AWS Count
Yr10	one or more high ranks	56.6%	426
Yr10	two or more high ranks	40.4%	304
Yr10	three or more high ranks	24.0%	181
Yr50	one or more high ranks	69.6%	524
Yr50	two or more high ranks	51.7%	389
Yr50	three or more high ranks	34.4%	259
Yr100	one or more high ranks	79.0%	595
Yr100	two or more high ranks	57.9%	436
Yr100	three or more high ranks	37.8%	285

In the SPY75 scenario, there is increased roading that is necessary to achieve the harvest targets – the scenario assumes 25% less available volume per hectare and therefore more road per m^3 developed. Most of the core indicator hazards are driven by roads and road density and the overall impacts of both scenarios are quite similar (with some small spatial variation).

Supplemental Analysis – H60 concept

Supplemental analysis was completed for the CTWG that included the application of the H60 concept to six candidate watersheds within the TSA. The H60 concept refers to the elevation of the snowline when the upper 60% of a watershed is covered in snow. Timber harvesting in this "snow zone" has the potential to have a greater influence on peak flows because of changes in snow accumulation and snowmelt when the forest canopy is removed. A correction factor of 1.5 was applied to area above the H60 line.

The results of the H60 analysis show higher ECA levels in all six candidate watersheds selected for analysis. Higher ECA score results in increased stream flow hazard in the Nation River watershed (streamflow hazard increased from low to moderate).

ECA scores within candidate watersheds with and without the application of the H60 correction factor.

Candidate watershed	Area (ha)	ECA score	ECA H60 score	Streamflow hazard	Streamflow hazard H60
Manson River	153,152.0	25.6	30.7	H	H
Mischinsinlika Creek	23,490.3	12.0	12.1	M	M
Nation River	692,116.9	23.1	28.3	L	M
Chichouyenily Creek	9,719.3	20.0	23.4	L	L
Mugaha Creek	20,630.1	11.3	11.9	L	L
Osilinka River	211,270.4	18.3	20.8	M	M

CTWG Indigenous Perspectives: Aquatic Ecosystem Health

The CTWG-Nations would like to highlight that there is no current state reported using the provincial Assessment Protocol for Aquatic Ecosystem in British Columbia methodology for years 10, 50 and 100.

However, it is extremely concerning that over half (57%) of all watersheds in the DMKTSR are at high risk at year 10, regardless of harvest flow applied (or further consideration of the H60 adjustment and/or the cumulative impacts of other non-forestry related industrial activities). It is further noted that essentially all watersheds in the current geographic southwest partition area, and in the proposed southern partition area, are at high risk at year 10 (and continue to worsen over time). This indicates a highly disturbed state of watersheds that will have significant negative impacts on First Nations' Rights.

Appendix 3: Tranche Analysis

Overview

Various spatial pattern and temporal process elements of a forested landscape contribute to timber supply over time, with differing levels of associated uncertainty or risk. For example, different geographic regions may be differentially affected by access and transport costs, and hence economic conditions. As another example, uncertainties associated with landscape-scale natural disturbance and potential effects from climate change, as well as management response (e.g., salvage), lead to uncertainty related to the degree of reliance on natural disturbance assumptions in timber supply projections. To address these uncertainties, timber supply analysis in support of the timber supply review process can be viewed as risk assessments. In this perspective, timber supply risk is defined as the likelihood that a given level of timber supply in one or more time periods will not be achieved in reality.

This appendix presents practical methods in which we use structured sensitivity analysis to explore timber supply risk that we call the "risk tranche" approach. This approach applies the perspective that information on timber supply risk may be useful to better understand timber supply projections and make decisions that anticipate and mitigate risk.

To provide a concrete illustration, we applied this method in the Mackenzie Timber Supply Area (TSA) using two different aspects of risk that are relevant in that TSA:

- Geographic access that recognizes the existence of areas with good and poor road access, and areas that rely on water transport across the large Williston Reservoir.
- Wildfire is a significant agent of natural disturbance in Mackenzie TSA, with relatively high uncertainty regarding potential changes due to climate change, and the economics of salvage (especially if there is increased disturbance and/or changes in the age-class structure of disturbance stands over time).

1 Risk Tranche Method to Assess Timber Supply Risk

One primary goal of timber supply analysis is to identify the most likely maximum timber harvest level that can be sustainably harvested over time, based on the best available data and knowledge of the forest system, and subject to meeting the biophysical, economic and social objectives and constraints defined for a given scenario. The main scenario of focus, often called the "base case", is a representation of current management (e.g., current land-use objectives, current inventory, etc.).

There are multiple sources of uncertainty inherent to timber supply analysis, including:

- Data uncertainty: accuracy and completeness of forest inventory and other required spatial and non-spatial inputs.
- Natural process uncertainty: understanding of variable stand and landscape scale natural processes, such as tree growth, natural disturbance, and climate change.
- Operational uncertainty: variability of economic drivers of timber harvesting (including external effects such as markets, as well as aspects of decisions for which data is unavailable such as information from pre-harvest timber cruising) and access costs (including complex factors applied to develop multi-year access plans).

Much of this uncertainty cannot be significantly reduced in the foreseeable future (if ever). Hence, uncertainty should be accepted and addressed explicitly as a significant aspect of timber supply analysis.

One way that uncertainty has been addressed in timber supply analyses is via use of "sensitivity analyses", in which experiments vary one or more key parameter (e.g., increase or decrease managed stand growth by 10 percent). These provide useful information to understand the stability (resilience) of the base case projection. However, sensitivity analyses are typically applied as independent scenarios, each with a separate timber supply outcome.

We developed a method of structured analysis based on the financial concept of risk tranches. In complex financial investments, such as mortgage-backed securities, large collections of investments are stratified by risk class (from lower risk to higher risk), called tranches ("slices" in French), each of which contributes differently to expected levels of return as well as expected loss of capital (e.g., the nominal interest on "junk" bonds is higher than class A bonds, offsetting the higher levels of uncertainty of default).

We adapted this concept to timber supply assessment, in which components of a timber supply landscape system can be partitioned according to expected levels of risk due to their respective uncertainty. These components may be defined as elements of the state of the forest (e.g., existing mature volume, future managed yields) and/or elements of forest processes (e.g., potential increases in landscape scale disturbance or decreases in stand growth due to climate change).

A low-risk tranche represents the portion of timber supply with high certainty of being achievable, while a high-risk tranche represents the portion of timber supply with lower certainty. For example, low-risk timber supply might consist of low susceptibility stands in the existing inventory, regeneration with no projected improved future yields, stands in lower disturbance areas (e.g., areas with lower expectations of impacts from climate change). High-risk timber supply might consist of stands with high susceptibility to bark beetles or fire, assumptions about future yield improvements (e.g., anticipated genetic future gains in growth rate), stands in high disturbance areas (especially where disturbance can affect pre-merchantable stands) and stands in areas with high expected impacts from climate change.

By defining a set of risk classes in which higher risk categories embed lower risk categories, the resulting nested timber supply assessments can be expressed in terms of the contribution of each risk class to timber supply (e.g., identifying the timber supply tranche associated with the risk class). This provides a tool to help interpret the degree of risk associated with timber supply, and in particular how risk changes over time.

1.1 Step 1: Define risk classes

The first step is to define aspects of a timber supply system that have different levels of uncertainty or risk. This is dependent on the management unit, and may include one or more of the following:

- Geographic areas (e.g., high productivity, low elevation forests with good road access vs. lower productivity, high elevation forests that requires heli-access or expensive road construction).
- Forest type (e.g., cedar vs. hemlock that have different market values; old growth vs. second growth).
- Regeneration assumptions (e.g., unmanaged natural regeneration vs. heavily managed regeneration with thinning, genetic improvements and fertilization).
- Natural disturbance (e.g., assumptions of low vs. high recovery of salvage).
- Climate change (e.g., historic wildfire levels vs. increased wildfire, climate refugia).

The approach can be applied using multiple factors, either by doing separate risk assessments for different sets of risk classes, or by combining factors into a single assessment.

At this stage, one needs to define the number of risk classes. A simple assessment may focus on just low vs. high risk, but a more detailed assessment may include a gradient of as many risk classes as desired.

1.2 Step 2: Structured sensitivity analysis

The basic method involves assessing a set of "nested" sensitivity analysis scenarios, in which risk monotonically increases as a gradient from more optimistic assumptions to more pessimistic assumptions. The first scenario to assess is the scenario with the most pessimistic assumptions (those of the lower risk class), which in general provides the lowest risk (most certain) timber supply projection.

Subsequent scenarios are then assessed, each incrementally adding the next lowest risk class. The timber supply outcome will normally be the same or higher than the previous outcome across all time periods. That is, because the included factors encompass those for a prior scenario, the resulting timber supply will generally be nested, with the subsequent scenario realizing an increased timber supply in one or more time periods (however, there can be complex interactions in which reductions in one time period can result in increases in another time period). The final scenario will include the timber supported by all risk classes.

Note that the "base case" scenario may be one of the scenarios included in the risk analysis, placing it in context with higher/lower risk assumptions.

1.3 Step 3: Overlay and assess results

Instead of simply showing a timber supply "flow" a single line (potential volume harvested over time), the structured analysis of scenarios using risk classes allows timber supply to be shown as a surface (volume contributed from each risk class over time).

The resulting timber supply surface can then be examined for the magnitude and timing to which each risk class contributes to timber supply. Since uncertainty tends to increase over projected time, the contribution of future timber supply may come from increasingly risky classes. However, mid- and long-term behaviour may have an effect on short-term timber supply. Hence, higher risk timber supply classes may also contribute significantly to short-term timber supply. That is because risk classes are assessed in terms of how they contribute to resulting timber supply, not to the exact stands harvested. For example, including a higher risk class may result in a significant increase in short-term harvest levels. The stands harvested in the short term may be considered lower risk individually, but the timber supply assessment may allow a higher level of such stands to be harvested in the short-term because of an assumption that higher risk stands will be available to support the mid- and/or long-term.

2 Application in Mackenzie TSA: Risk Classes

In the Mackenzie TSA case study, we assessed two different sets of risk classes. In both cases, the lowest risk class represents the most pessimistic assumptions, and higher risk classes encompass the lower classes plus include timber supply that represents increasingly optimistic assumptions.

2.1 Geographic area risk classes

Like many TSAs in BC, Mackenzie TSA includes areas with easier as well as more challenging access. This was in part recognized in the previous TSR for Mackenzie TSA that included a partition zone in the south-west of the TSR that includes gentler terrain and a more developed road network.

A unique aspect of Mackenzie TSA is the relatively large area served by water-based transport (barge and boom) of logs across Williston Reservoir. Some water transport areas consist of valleys in rugged terrain with disconnected road networks, completely accessed via the tow/barge landing sites (e.g., along the Peace Arm). Other areas use water transport due to the long distances required (e.g., north end of the reservoir), even though there are connecting roads (e.g., trucks may not have to be transported by barge, but log transport is more economic via tow/barge). Further, some water-transport areas also require long road transport to reach the landing.

Four risk classes were defined based on access and transport geography (Figure 1):

- Risk class 1: Areas accessible by "non-remote" roads in the south-west partition, which comprise 33 percent of the timber harvesting land base (THLB).
- Risk class 2: Areas accessible by roads outside the south-west partition or from areas with "remote" road access, which comprise 16 percent of the THLB.
- Risk class 3: Areas that involve water transport on Williston Reservoir and access via "non-remote" roads, which comprise 35 percent of the THLB.

- Risk class 4: Areas that involve water transport and access via "remote" road access areas, which comprise 16 percent of the THLB.

Areas that require towing/barging were identified using road landings on Williston Reservoir, and associated road sub-networks that were either (a) not connected to any other roads to the south end of the TSA; or (b) at the mid to northern end of the reservoir with the barge landing as the primary outlet for timber transport. "Remote" road access was defined using estimated distance to either a road exit point on the southern boundary of the TSA or to a barge landing site. Distances more than 50km were classified as remote.

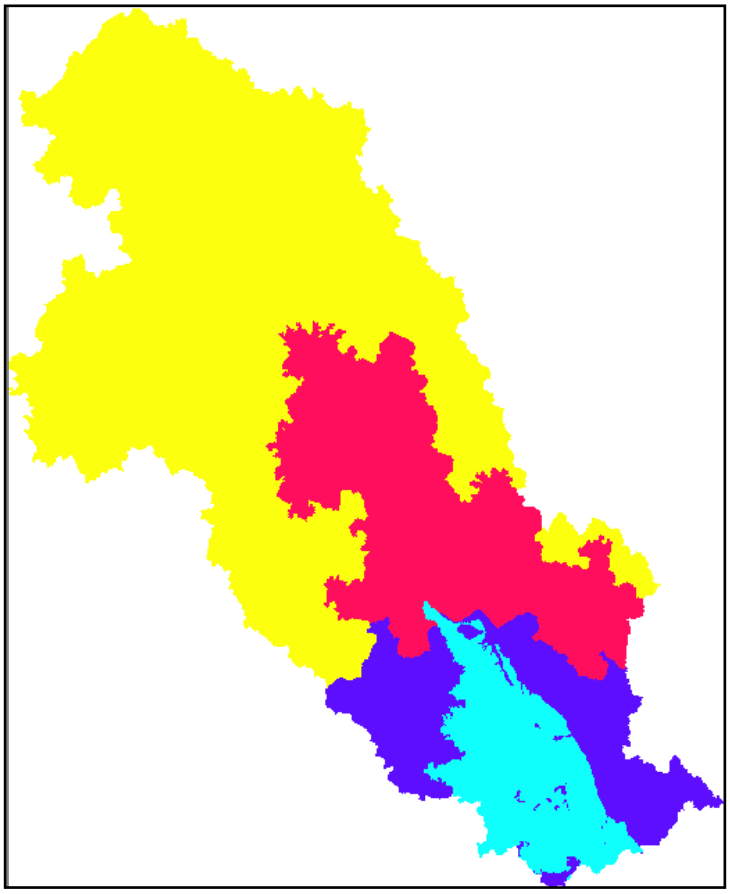
Figure 1A. Geographic area risk classes in Mackenzie TSA.

(1) light blue: non-remote road access areas in south-west partition that do not involve water transport;

(2) dark blue: areas outside south-west partition that do not involve water transport;

(3) red: non-remote road access areas that involve water transport; and

(4) yellow: remote road access areas that involve water transport.



2.2 Natural disturbance risk classes

Parameters for historic/current wildfire were derived using the Provincial historic wildfire database, in which parameters were fitted to the historic fire size distribution using a log-transformation:

- Rotation: 685 years.
- Fire initiation: random in forested cells.
- Fire patch size: log normal distribution with a mean of 4.755 and standard deviation of 2.471 for the underlying normal distribution. This resulted in a mean patch size of about 2,450 ha.
- Fire patch size: moderately complex (with shape complexity increasing with fire size, controlled by a maximum active front site of 30 grid cells).
- Salvage remaining post-fire: 80 percent (20 percent immediate loss due to fire).
- Salvage shelf life: 1 timestep (10 years).

Changes due to climate were modelled as dynamic adjustments to fire rotation. Wotton et al. (2017)[a] estimated expected change in key fire regime parameters for an area of boreal forest in central Alberta at 2030 and 2090 under moderate climate change (Representative Concentration Pathway, RCP 4.5) and more severe climate change (RCP 8.5) (Table 1). These factors effectively integrated changes in fire season length, individual fire behaviour and suppression potential. We multiplied these factors to estimate net fire regime effect.

Table 1A. Relative change in key fire parameters (averaged over three Global Circulation Models), and multiplied net effect on fire regime, based on Wotton et al. (2017)

Factor	RCP 4.5		RCP 8.5	
	2030	2090	2030	2090
Expected number of fire growth days (spread event day probability)	1.04	1.24	1.15	1.65
Expected number of days/seasons with crowning potential (crown fraction burned > 0.1)	1.08	1.30	1.25	1.63
Expected number of days/seasons that require air tanker support (head fire intensity > 2 MW/m)	1.13	1.37	1.28	1.68
Net fire regime effect (multiplication)	1.27	2.20	1.84	4.53

While the forest in Mackenzie TSA is different from the boreal forest of central Alberta, the expected changes seemed reasonable at least for illustrative purposes. Effects between 2030 and 2090, and at the start time-step, were scaled linearly. This resulted in dynamic changes in fire regime, implemented by dividing fire rotation by the dynamic change values (e.g., a 100 percent increase in fire regime would mean a fire rotation that was half as long). Effects after 2090 were held constant.

In all scenarios, we removed the non-recovered loss factors attributed to wildfire, leaving 30 000 cubic metres/year attributed to other natural disturbance agents (e.g., wind).

[a] Wotton, B M, M D Flannigan and G A Marshall. 2017. Potential climate change impacts on fire intensity and key wildfire suppression thresholds in Canada. *Environmental Research Letters* 12 095003 doi:10.1088/1748-9326/aa7e6e

We defined five risk classes based on a gradient from a more pessimistic outlook on climate change and management response to a more optimistic outlook:

- Risk class 1: Lowest risk (most pessimistic outlook): assume "worst case" fire under RCP 8.5 climate change (increasing fires), no salvage, and no fire suppression.
- Risk class 2: Assume timber recovery from potential salvage under RCP 8.5 (accounting for emergent loss of disturbed timber that is not merchantable or that is not salvaged before passing shelf life).
- Risk class 3: Assume a less severe fire regime under RCP 4.5 climate change (without salvage).
- Risk class 4: Assume a less severe fire regime under RCP 4.5 climate change (with salvage).
- Risk class 5: Assume no climate change (historic fire regime and fire suppression, with salvage).
- Risk class 6: Base case assumptions with no fire.

Risk class 5 is the TSR base case scenario, with fires modelled explicitly (rather than using non-recovered loss factors). Risk classes 2, 3 and 4 incrementally add increasing fires under moderate and more severe climate change, respectively. Risk class 1 separates the effect of salvage, resulting in a relatively low risk scenario that assumes increased fire under RCP 8.5 climate change and no salvage.

3 Application in Mackenzie TSA: Results

3.1 Geographic area classes

The results from the geographic area risk classes indicate (Figure 2A):

- About 40 percent of the total timber supply for the TSA over the mid- to long-term is supported by areas with good road access in the south-west partition (Tranche 1);
- An additional 12 percent is supported by other areas not involving water transport (Tranche 2);
- Approximately 33 percent is supported by areas that involve barge access, but with reasonably short road access (Tranche 3); and
- Approximately 15 percent is supported by areas that involve barge as well as relatively remote road access (Tranche 4).

These tranches represent the timber supply associated with increasing access and transport costs, and hence decreasing likelihood of harvest depending on economic market conditions.

In this analysis, the timber supply for each tranche is entirely embedded within the tranche of the next higher risk class (e.g., timber supply for tranche 2 is lower than that for tranche 3 over the entire time horizon). This indicates that there is relatively low feedback between time periods due to the inclusion/exclusion of these geographic areas.

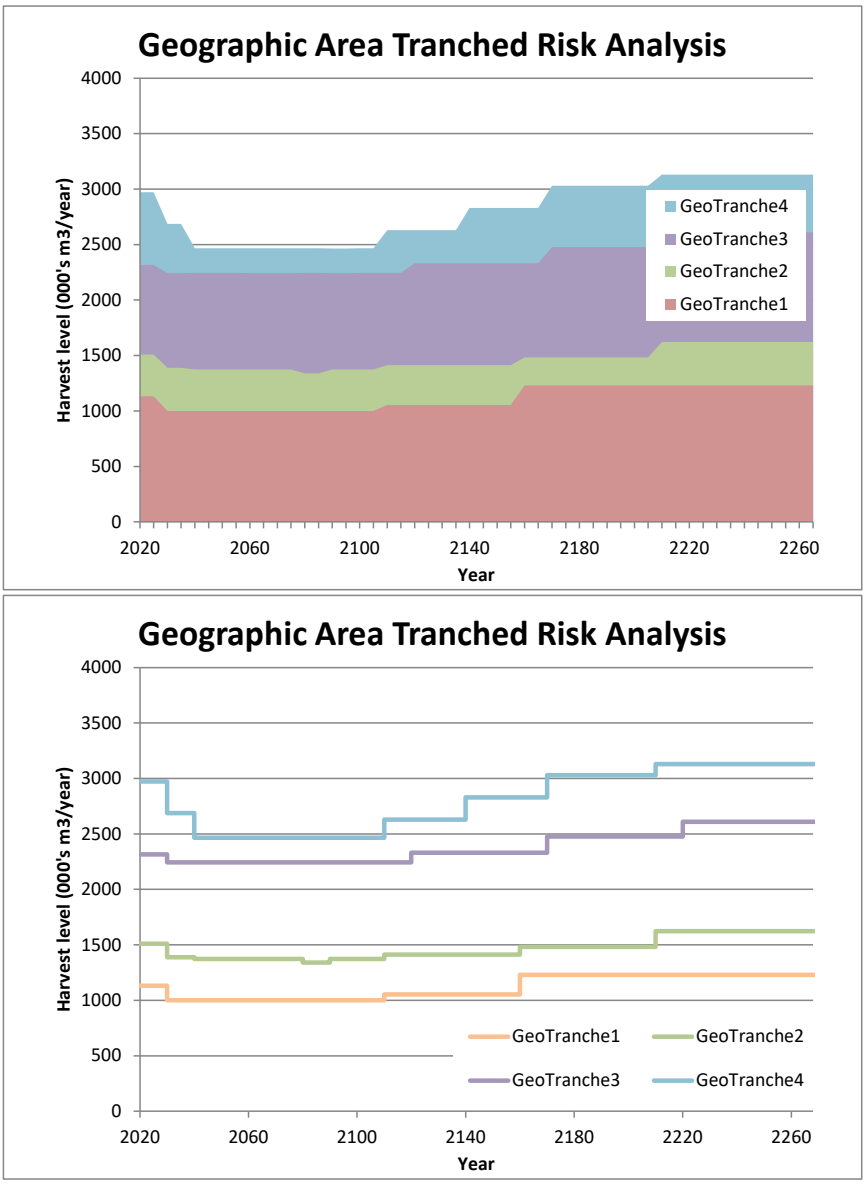
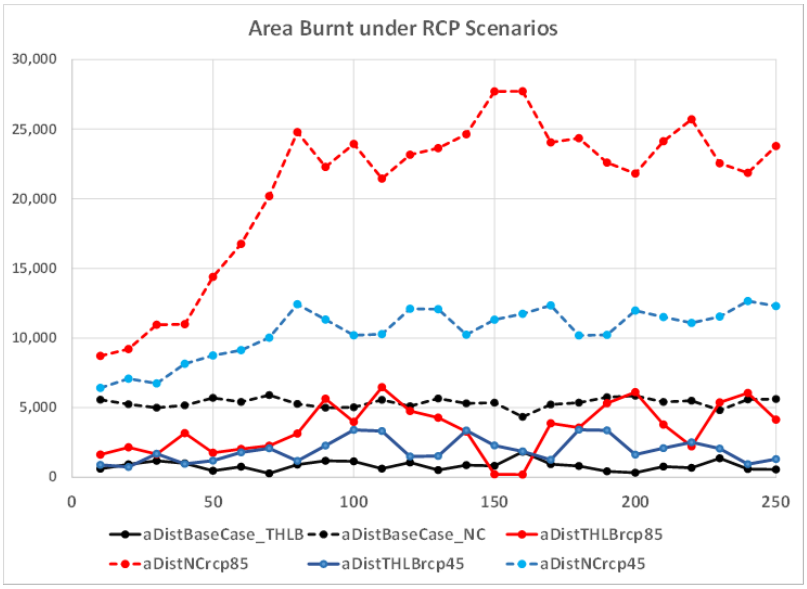


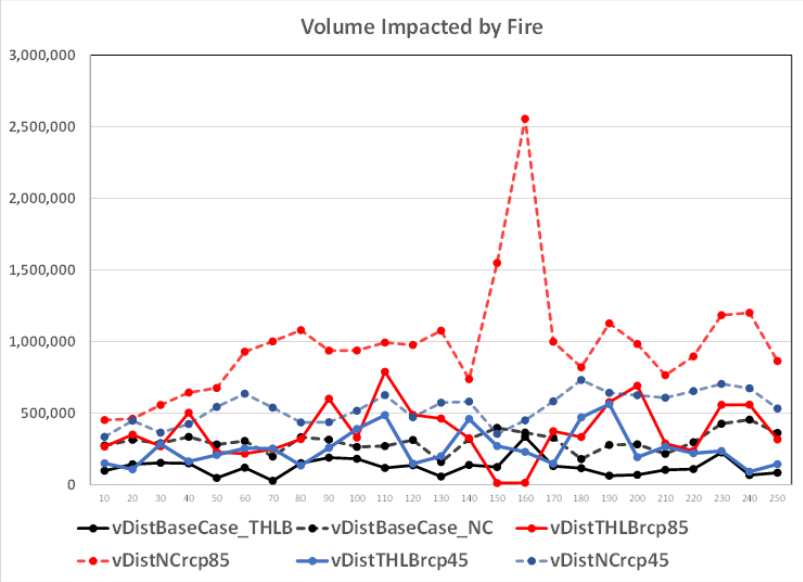
Figure 2A. Timber supply for the set of risk classes based on geographic areas.

Tranche 1 is supply for areas accessible by non-remote roads in the southwest partition.
Tranche 2 also includes supply from other areas that do not involve water transport.
Tranche 3 also includes supply from areas that involve water transport but via non-remote roads.
Tranche 4 additionally includes supply from areas that involve water transport and remote roads.

3.2 Natural disturbance risk classes

The following charts contrast the area burnt (left) in both the RCP8.5 (red) and RCP4.5 (blue) scenarios relative to the base case (black) and the volume impacted by each respective scenario. The source of the impacts is further differentiated between the THLB portion (solid line) of the forest and the non-contributing (*non-contributing to timber supply*: dashed) portion of the forest.



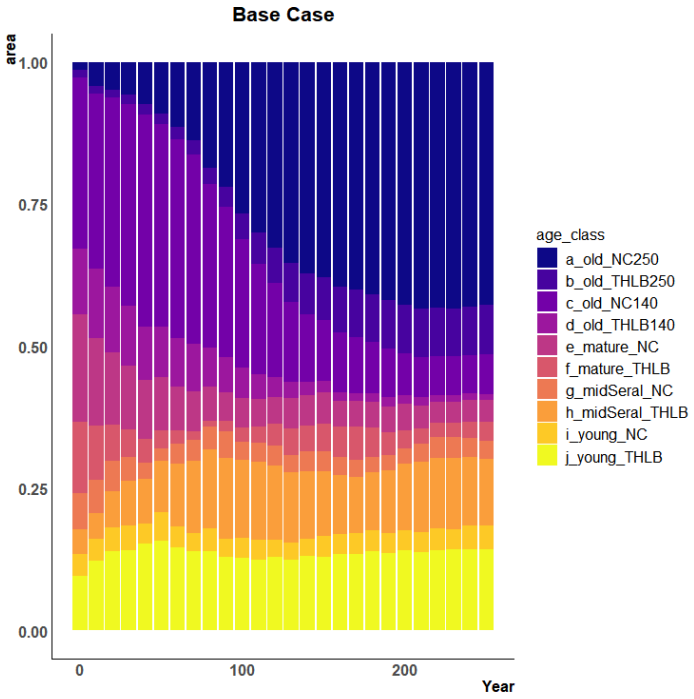


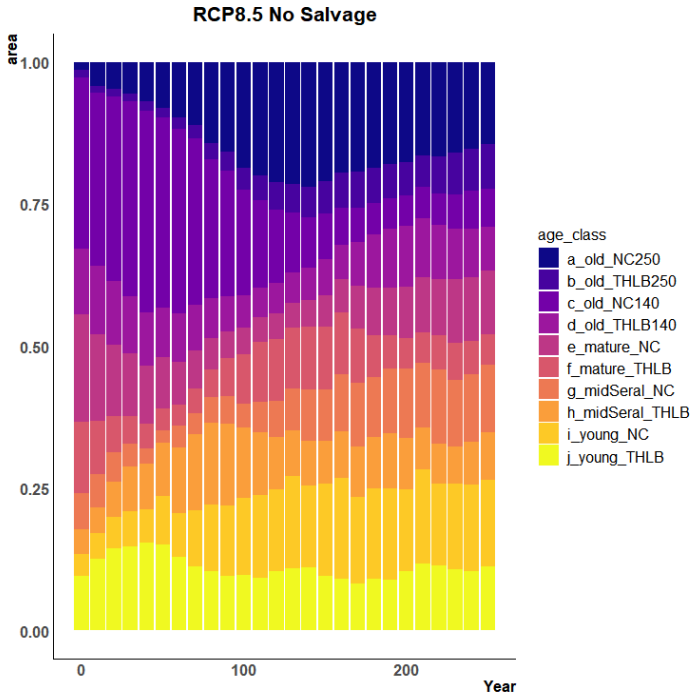
Under the RCP8.5 scenario the frequency of fire and area burnt increase approximately four-fold (450 percent increase) in the first 100 years relative to the base case, with on average 84 percent of the disturbance occurring in the non-contributing portion of the TSA (the THLB makes up approximately 28 percent of the forest estate). Area burnt in the THLB increases from an average 1000 ha/year to 2800 ha/years or approximately a three-fold increase. The average number of fires per year increases from 8 to 23.

Under the RCP4.5 scenario the frequency of fire and area burnt doubles over the first 100 years relative to the base case. The area burnt in the THLB increases 50 percent to 1500 ha/year while the average number of fires per year increases to 13 per year.

The following charts contrast the age class distributions between the base case and the RCP8.5 scenario.

The age of the forest land base is classified as young (less than 40 years), mid-seral (40-80 years), mature (80-140 years), old (140 – 250) and very old (> 250 years). Under the base case the proportion of forest classified as old increases over time and stabilizes at year 150 at approximately 60 percent of the productive forest. Alternatively, under the RCP8.5 scenario forests classified as old decline markedly stabilizing at year 150 at approximately 30 percent of the productive forest while the mid-seral or younger proportion grows to approximately 55 percent.





The chart on the right depicts the impacts of risk classes 1 and 3 on the base case. Implementing the risk class 1 scenario with no salvage (RCP8.5 – red-dashed line) causes a harvest flow rupture in the seventh decade lowering the harvest in that decade by 62 percent. Further significant disruptions occur from year 180 onward.

Implementing the risk class 3 scenario (RCP4.5 – blue-dotted line) cause mid-term decadal flow reductions ranging between 5 to 72 percent in the 7th and 8th decades.

The following charts detail the 6 risk classes as flowed projections:

About 59 percent of the long-term timber supply for the TSA (beyond 1st 100 years) term is supported in the presence of more severe RCP 8.5 climate change and no salvage (Tranche 1);

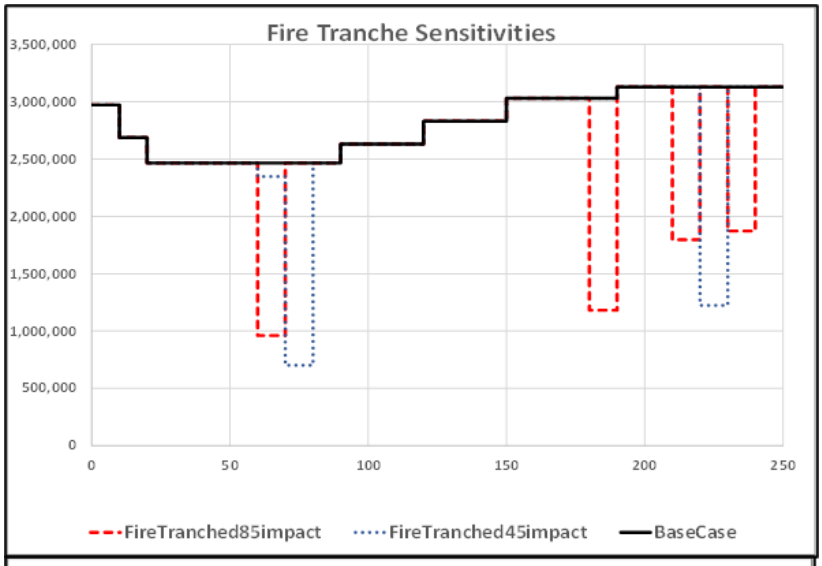
An additional 35 percent of the long-term timber supply is supported by potential salvage under RCP 8.5 climate change (Tranche 2);

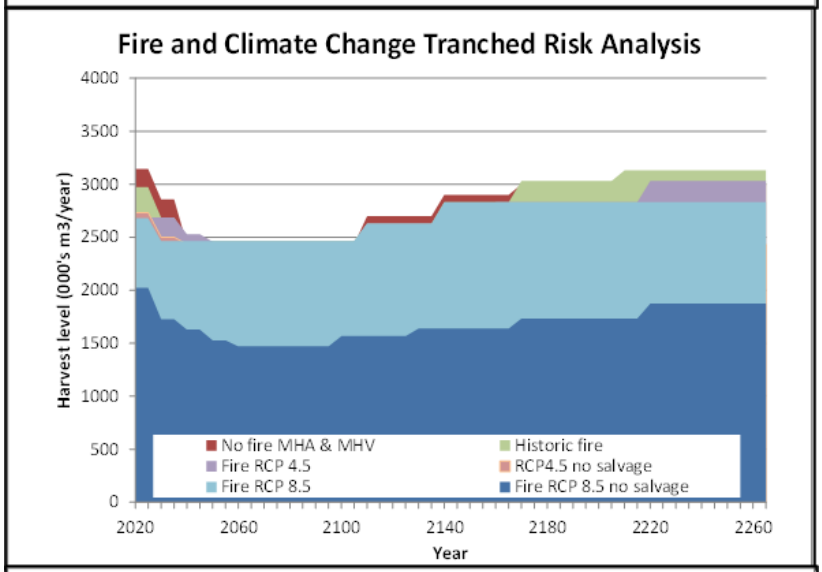
An additional 2 percent (total 96 percent) of the long-term timber supply is supported in the presence of moderate RCP 4.5 climate change with salvage (Tranche 4);

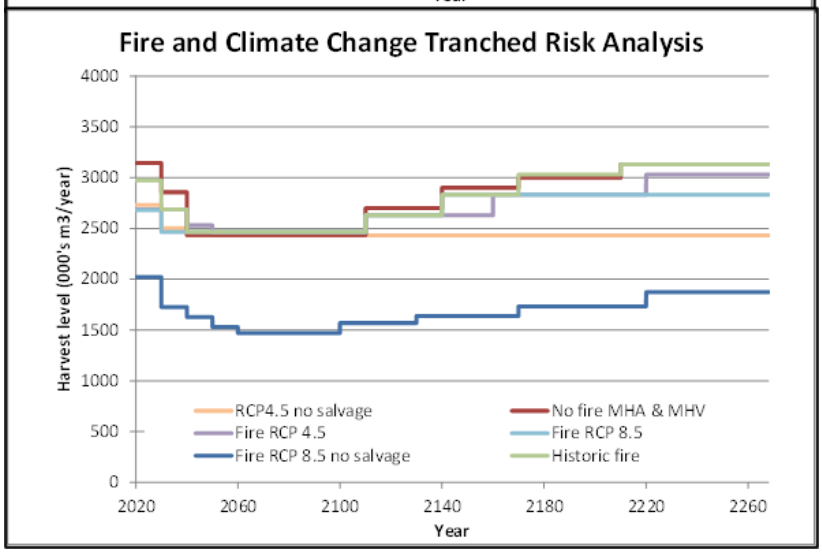
An additional 4 percent (100 percent) of the long-term timber supply is supported under historic fires with salvage (Tranche 5).

Mid-term timber supply is dramatically affected by the most severe climate scenario with Tranche 1 (no salvage) reducing the mid-term harvest level by 39 percent.

Conversely, when salvage occurs, the more severe impacts are partially mitigated with the mid-term harvest flows for Tranches 2 thru 4 stepping down to approximately the mid-term level of the base case (Tranche 5).







All climate change scenarios stabilize once the fire regime stabilizes after about 100 years. The increased loss from increased fire has the effect that short-term harvest can technically increase (subject to modest-size steps as harvest potential declines) without exacerbating the low point of the timber supply flow. This is in part because logging timber that has a high chance of burning in the future may have little impact on future timber supply.

However, this is somewhat a technical anomaly in the sense that this is due to how timber supply is assessed as a maximization process. The tranche approach helps contextualize potential short term "opportunity" to cut timber that may be at risk due to climate change in terms of expectations of worsening potential declines as the system adjusts to new natural disturbance regimes. In any case, the short-term differences among scenarios are relatively minor compared to the longer-term separation of the risk tranches.

Salvage harvest plays a significant role in mitigating the most severe impacts of increased frequency of fire in the TSA. Thirty-five percent of the long-term timber supply is supported by potential salvage under RCP 8.5 climate change (Tranche 2). The higher operating costs associated with the northern portion of the TSA significantly limit the ability to action low-quality (damaged) timber, and future fire damage in the northern portion of the TSA poses a significant risk to long-term timber supply.

Other drivers affecting fire frequency and timber supply impacts include the proportion of THLB to forested non-THLB, with the vast majority of modelled fires not directly impacting and reducing available growing stock in the THLB in a significant way. The impacts are also moderated by degree of roading within the THLB which serves to limit spread in the model and by extension the average size of fires that occur there.

A key message from this analysis is that even modest climate change (RCP 4.5) has the potential for significant disruption to timber supply based on more optimistic assumptions (e.g., projecting historic fire). While the parameters derived for this analysis could be refined and improved, it seems reasonable to expect increased fires due to a combination of increased fire season length, increased change of fires crowning and increased fire intensity (decreased suppression potential). Combined, this suggests that there can be an expectation of a protracted time period of adjustment, and increased timber production from salvage (which may interact with the economic aspects of the geographic risk analysis).

That said, the analysis also indicates that there is a window of a couple of decades over which the timber supply in the fire risk scenarios with salvage are similar. This represents a planning opportunity to refine understanding of how climate change may affect this landscape and improve anticipation of appropriate strategic forest management response.