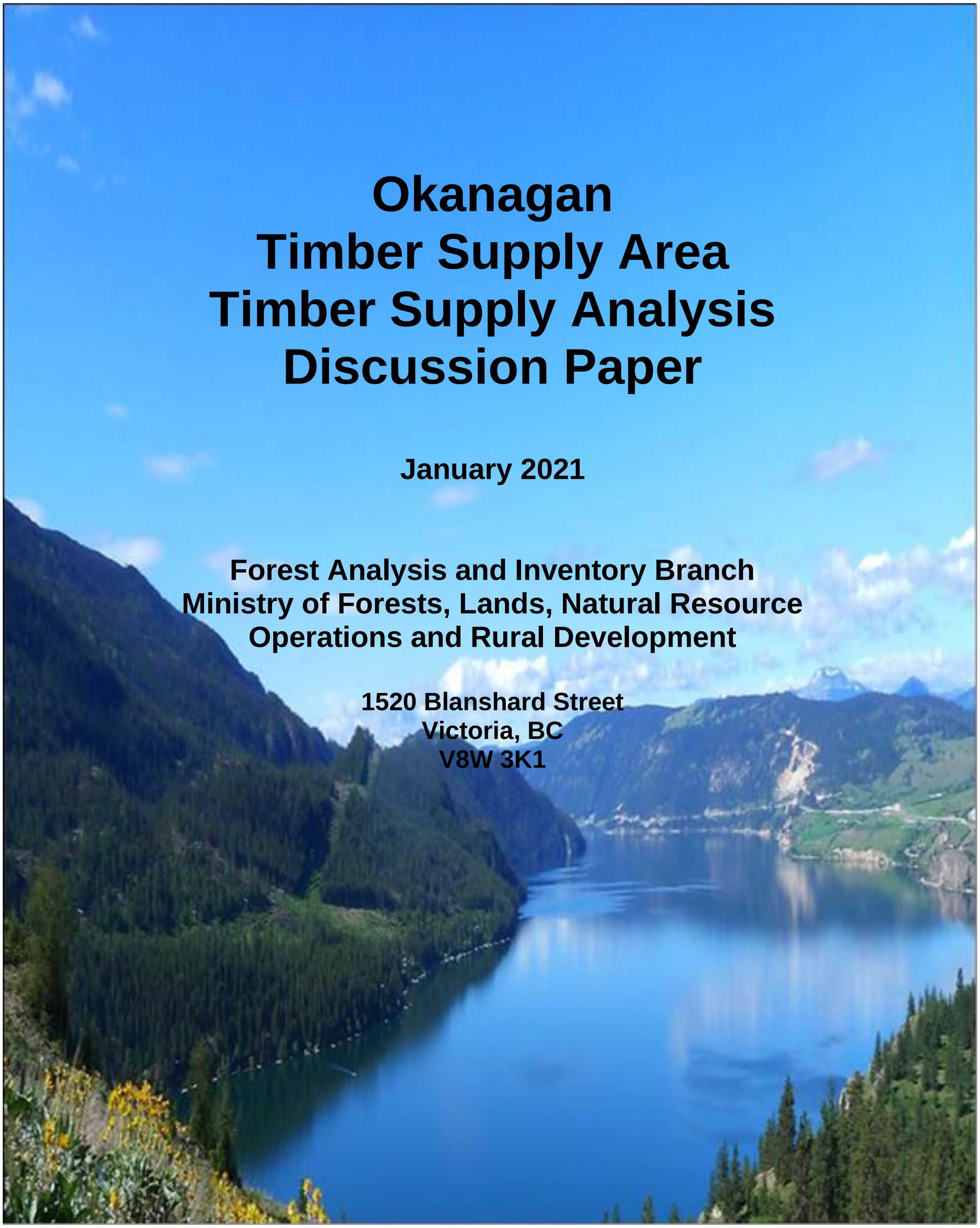

Okanagan Timber Supply Area Timber Supply Analysis Discussion Paper

January 2021

Forest Analysis and Inventory Branch
Ministry of Forests, Lands, Natural Resource Operations and Rural Development

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BRITISH COLUMBIA
Ministry of Forests, Lands, Natural Resource Operations and Rural Development

Cover photograph: Kalamalka Lake, Okanagan TSA
contributed by Jody Bradwell, Okanagan Shuswap Natural Resource District

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Introduction

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

According to Section 8 of the *Forest Act* the chief forester must regularly review and set new AACs for all 37 TSAs and 34 TFLs in the Province of British Columbia (BC).

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 Okanagan TSA. Details about the data and assumptions used in the analysis were provided in a data package (January 2018). Updates to the information used and technical details regarding the analysis are available on request from the Forest Analysis and Inventory Branch. 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 may need to be completed and existing analysis reassessed as a result of input received on this discussion paper.

The ministry response related to the provincial timber supply review program include the following actions:

- review marginally economic forest types within each TSA and quantify the types and areas of forest that might justifiably be included in a partition, while respecting resource objectives for other values, such as wildlife and water;
- where feasible and appropriate, provide information from the timber supply review to enhance public discussion of resource management objectives.

Timber supply reviews undertaken in support of AAC determinations are based on the current resource management objectives established by government in legislation and by legal orders. For the purposes of the Okanagan TSA timber supply review, forest management objectives are provided by the *Forest and Range Practices Act* (FRPA), the Okanagan Shuswap Land and Resource Management Plan (OSLMRP), which was approved by Cabinet as directed by policy in 2001, 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 future timber supply reviews.

[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.

Timber supply review in the Okanagan TSA

The current AAC for the Okanagan TSA, effective February 29, 2012, is 3.1 million cubic metres per year.

In January 2018, a *Data Package* documenting the data and forest management assumptions to be used in this timber supply analysis was released for public review and to assist with First Nations consultation. This *Discussion Paper* was released in order to provide an overview of the timber supply review and to highlight the key findings of the timber supply analysis for the Okanagan TSA. Before setting a new AAC, the chief forester will review all relevant information, including the results of the timber supply analysis and input from government agencies, First Nations, 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 that is determined by the chief forester during this timber supply review may differ from the harvest projections, including the base case, presented in this discussion paper as the chief forester must consider a wide range of information, some of which is not quantifiable. Ultimately, the chief forester's AAC determination is an independent, professional judgment based on the legal requirements set out in Section 8(8) of the *Forest Act.*

Once the chief forester has determined a new AAC, the Minister of Forests, Lands, Natural Resource Operations and Rural Development will apportion the AAC to the various licence types and programs as per Section 10 of the *Forest Act*. 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 Okanagan TSA

The Okanagan TSA is located along the southern boundary of the Province with the Columbia Mountains to the east and the Coast Mountains to the west. The TSA lies within the Interior Plateau and is intersected north south by the Okanagan Valley which contains many large lakes such as Okanagan, Kalamalka, Skaha and Osoyoos Lakes.

The climate, terrain and forests of the Okanagan TSA are varied. The area north of Vernon and Okanagan Lake is a relatively moist climate that supports forests predominated by Douglas-fir, balsam, spruce and pine. The area south of Vernon consists of a drier climate that supports predominantly pine, Douglas-fir, spruce and balsam forests. Overall, the TSA is covered by stands of Douglas-fir (39 percent by area), lodgepole pine (23 percent), balsam (18 percent), and spruce (15 percent) with other pine, hemlock, cedar, larch and deciduous forming minor components.

The Biogeoclimatic Ecosystem Classification (BEC) is a system developed by V.J. Krajina to classify and manage sites based on their ecosystems. There are 14 BEC zones identified in British Columbia. Within the Okanagan TSA there are seven BEC zones represented (in descending order by total area in the TSA): Engelmann spruce subalpine fir, Interior Douglas-fir, Interior cedar hemlock, montane spruce, ponderosa pine, bunchgrass and Interior mountain-heather alpine.

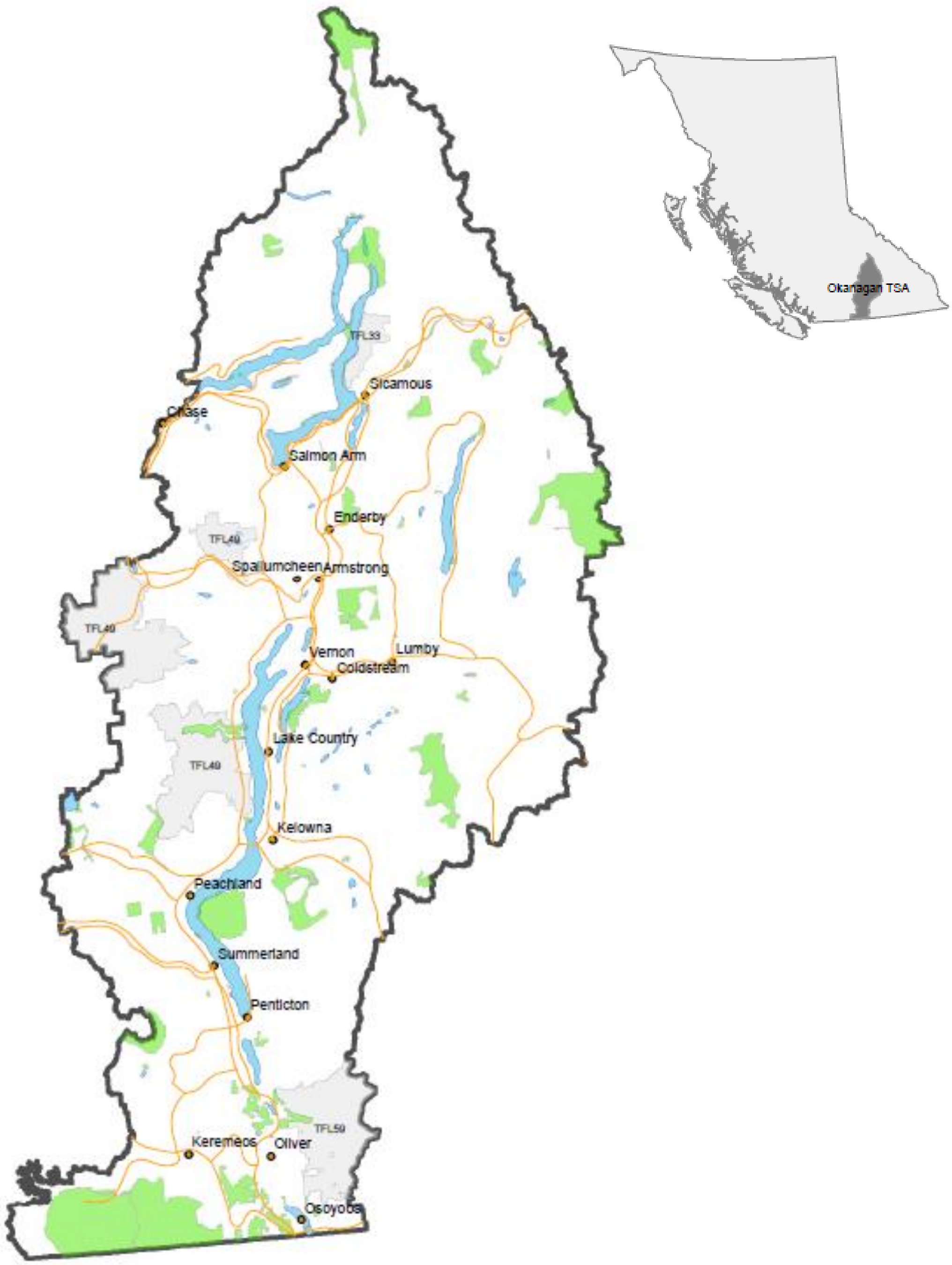

Figure 1. Map of major water features, major roads and parks - Okanagan TSA.

The TSA is administered by the FLNRORD Okanagan Shuswap Natural Resource District (OSNRD) office in Vernon. The Okanagan Shuswap Natural Resource District includes 72 woodlot licence areas, three tree farm licence areas, one established First Nation woodland licence (FNWL), two FNWLs assigned to the district and four community forest agreements, in addition to the TSA. The information provided in this *Discussion Paper* pertains to the TSA only, unless otherwise specified.

Environmental values

The distinct ecological features of the seven BEC zones in the Okanagan TSA contribute to high biodiversity values. The central portion of the TSA is characterized by low elevation stands, below 1000 metres, consisting of Douglas-fir, pine and cedar. The majority of low elevation stands are within natural disturbance type (NDT) four which have frequent low intensity stand initiating events such as fires, wind and insects that result in a natural mosaic of primarily uneven-aged stands.

The moderate elevation stands, between 1200 and 2000 metres, extend from the central valleys to the boundaries of the TSA and consist primarily of lodgepole pine, balsam, Douglas-fir and spruce. The majority of moderate elevation stands are within the NDT3, which has frequent stand events. There is a small amount of high elevation area above 2200 metres in the Okanagan TSA; about one-third of the area is forested. These stands consist of balsam, spruce, pine and larch within NDT5 which has infrequent disturbance events.

The diverse forests host a range of wildlife species, some are considered to be endangered or threatened. Examples in the Okanagan TSA include mountain caribou and American badger. Species considered to be potentially threatened by human activities or natural events include Northern goshawk, western rattlesnake and Williamson's sapsucker.

Protection and management of environmental values are addressed under provincial and federal legislation. The *FRPA* is the primary provincial legislation regulating forestry practices. Under *FRPA*, the Forest Planning and Practices Regulation identifies objectives set by government for environmental values including fish, wildlife, biodiversity, soils and water that are to be addressed within forest stewardship plans. Orders may be established under the Government Actions Regulation (GAR) or the Land Use Objectives Regulation for specific land uses such as ungulate winter ranges, wildlife habitat areas, critical habitat for fish, and old growth management areas (OGMA). Approximately nine percent of the Okanagan TSA is provincially designated for the protection of its natural environment and an additional 33 percent is constrained to provide for wildlife habitat.

Natural resources

Numerous natural resources are associated with the forest land base. Forest products, recreation and tourism, ranching, and wildlife highlight the wide range of resources and values found in the Okanagan TSA.

The Okanagan has 110 605 hectares of lakes and wetlands and 38 159 kilometres of streams. These water features are partially protected by riparian reserve zones, enhanced riparian reserves, wildlife tree retention areas (WTRA), community watersheds, lakeshore management zones, parks, ungulate winter ranges, wildlife habitat areas and scenic areas.

There are 33 874 hectares of wildlife habitat area (WHAs) and 806 350 hectares of ungulate winter range (UWR) designed to protect mammals, birds, reptiles, amphibians and plant communities. The UWRs protect habitat for mountain caribou, mule deer, mountain goat and moose while the largest WHAs protect habitat for grizzly bear and mountain caribou. Wildlife and their habitat are partially protected by old growth management areas, recreations sites and reserves and the retention of deciduous stands as well as those measures protecting riparian features.

There are 189 782 hectares of provincial parks, protected areas and ecological reserves within the TSA with the six largest being Snowy Protected Area, Cathedral, Monashee, Graystokes, Okanagan Mountain and Upper Seymour River parks. There are also 23 307 hectares of active and pending recreation sites, reserves and crown use, recreation and enjoyment of the public (UREP) along with 3157 kilometres of recreation trails. These areas along with water features and wildlife provide for a range of recreational activities such as hiking, canoeing, camping, horse tours, fishing, hunting, snowmobiling, and downhill and cross-country skiing.

Crown range provides forage for both livestock and wildlife. In the Okanagan grazing occurs under the forest canopy as well as in early seral stage openings where forage is temporarily available a few years following harvesting or fire. Districts staff have worked with licensees to conduct a limited amount of selective strip harvest and grass seed throughout a range of BEC zones.

First Nations

The traditional territories of 26 First Nations are overlapped in whole or in part by the Okanagan TSA. These 26 First Nations are associated with three broader nation groups: the Okanagan, Secwepemc, and Nlaka'pamux. Many of the First Nations are also affiliated with political and tribal associations. Ministry staff work with non-treaty First Nations through engagement and economic agreements, working groups, and other non-treaty processes.

Half of the First Nation communities in the TSA have current Forest Consultation and Revenue Sharing Agreements (FCRSAs) with FLNRORD. Six First Nations of the Okanagan Nation Alliance are negotiating with the Province to build relationship and address concerns associated with land and resource use. Seven First Nations of the Secwepemc Nation are signatories to a letter of commitment with the Province to negotiate a new agreement to replace the expired Reconciliation Framework Agreement. Six First Nations of the Nlaka'pamux Nation Tribal Council are signatories to the Political Accord on Advancing Recognition, Reconciliation, and Implementation of Title and Rights.

First Nations are actively involved in the forest industry with Skul'qalt Forestry Limited Partnership owned by Lower Similkameen Indian Band, OKIB Forestry Limited Partnership owned by Okanagan Indian Band, Westbank First Nation, Upper Nicola and Penticton having replaceable forest licenses. OKIB and Yucwmenlucwu ("Caretakers of the Land") 2007 LLP owned by Splats'in have non-replaceable forest licences.

Analysis was conducted on the following key values due to concerns communicated by First Nations: water, moose, and identified sacred or traditional areas. Further information on the results of analysis are described in the sensitivity analyses section of this document.

Regional economy

The major population centre in the TSA is the city of Kelowna with a population of 136,230 in 2018. The total population of the TSA is about 385,725 including the populations of Armstrong, Chase, Coldstream, Enderby, Kelowna, Keremeos, Lake Country, Lumby, Oliver, Osoyoos, Peachland, Penticton, Salmon Arm, Sicamous, Spallumcheen, Summerland, Vernon, West Kelowna and the unincorporated areas of central and north Okanagan. The economies of the communities in the TSA are based in agriculture, construction, education, forestry, manufacturing, retail trade and tourism.

The OSNRD has a large processing sector with lumber mills, pulp mills, panel board plants and pellet mills. There are also 12 smaller facilities producing log homes, shakes & shingles, lumber and fence posts. The district has seen a contraction in the number of small and large timber processing facilities over the past several years. Table 1 provides a list of processing facilities.

Table 1. Major primary timber processing facilities (FLNRORD Competitive and Innovation Branch, July 2020) – Okanagan TSA

Mill number	Mill type	Company	Capacity assumptions	Location of mill
12	Panel	Canoe Forest Products Ltd.	146 Million square feet 3/8"	Canoe
12	Panel	Canoe Forest Products Ltd.	157 Million square feet 3/8"	Canoe
14	Lumber	Gorman Brothers Lumber Ltd.	132 Million board feet	Westbank
20	Lumber	Tolko Industries Ltd.	250 Million board feet	Lavington
35	Panel	Tolko Industries Ltd.	192 Million square feet 3/8"	Lumby
68	Lumber	Tolko Industries Ltd.	211 Million board feet	Armstrong
68	Panel	Tolko Industries Ltd.	262 Million square feet 3/8"	Armstrong
68	Panel	Tolko Industries Ltd.	192 Million square feet 3/8"	Armstrong
68	Chip	Tolko Industries Ltd.	38 Thousand BDUs	Armstrong
255	Lumber	Buff Lumber Ltd.	12 Million board feet	Westwold
271	Lumber	Rouck Brothers Sawmill Ltd.	3.36 Million board feet	Lumby
480	Lumber	Schapol Logging Ltd.	16.8 Million board feet	Enderby
597	Lumber	Lakeside Timber (2007) Ltd.	16.8 Million board feet	Tappen
618	Lumber	North Enderby Timber Ltd.	64 Million board feet	Enderby
929	Pellet	Pinnacle Renewable Energy	68 Thousand tonnes	Armstrong
988	Lumber	Northern Log & Timber	0.96 Million board feet	Winfield
989	Lumber	Deacoff Bros. Enterprises Ltd.	0.77 Million board feet	Kelowna
990	Lumber	Alan Hyde Sawmill	7.2 Million board feet	Sicamous
991	Lumber	T & N Custom Sawmill	1.44 Million board feet	Enderby
1002	Chip	BC Ecochips Ltd.	144 Thousand BDUs	Okanagan Falls
1049	Pellet	Lavington Pellet Limited Partnership	284 Thousand tonnes	Lavington

Land use planning

The Okanagan Shuswap Land and Resource Management Plan (OSLRMP) was approved by Cabinet in 2001. In 2007 the Province legally established 10 objectives related to the OSLRMP through an Order of the Minister of Agriculture and Lands. Forest development in the TSA is required to be consistent with those legally established objectives of this higher level plan. The timber supply analysis assumed that forest management and timber harvesting will be consistent with the OSLRMP.

Forest management

Timber harvesting land base

As part of the process used to define the modelled timber harvesting land base[e] (THLB) in the timber supply analysis, a series of deductions were made from the TSA land base. Table 2 shows categories of land that were considered not to contribute to the THLB. The table presents the area of the categories within the gross TSA boundary and the area for each factor that was uniquely (i.e., no overlaps with other factors) considered excluded from timber harvesting.

The total area within the TSA boundary covers 2 449 135 hectares, of which 61 percent, or 1 505 437 hectares, was Crown forest management land base[f] (CFMLB). Parks, unstable terrain, old growth management areas, wildlife habitat, ungulate winter range and retention areas for riparian management and wildlife trees made up 389 241 hectares of the CMFLB. Those areas were intended to protect wildlife habitat and water and to provide recreation opportunities. About 50 percent of the CFMLB, or 31 percent of the total TSA area, was included in the current THLB of 760 781 hectares.

Table 2. Land base classification – Okanagan TSA

Land classification	Gross area	Net area	% of total area
TSA boundary	**2,449,135**	**2,449,135**	
Non-provincial Crown lands	350,347	350,347	14
Not managed within TSA AAC	322,006	320,159	13
Non-forest and non-productive forest	464,471	255,821	10
Existing roads	41,405	17,371	1
Crown forest management land base		**1,505,437**	**61**
Parks	188,759	144,811	6
Inoperable	303,038	175,724	7
Terrain stability mapping - unstable	65,558	28,569	1
Terrain stability mapping - potentially unstable	178,300	19,828	1
Sites with low timber growing potential	159,030	36,099	1
Problem forest types	358,248	96,909	4
Deciduous stands	42,493	13,914	1
Old growth management areas	125,722	55,379	2
Wildlife habitat areas (no harvest)	13,517	3,908	0
Very dry sites	406,755	32,769	1
Ungulate winter range (no harvest)	14,295	6,724	0
Environmentally sensitive areas	230,084	20,135	1
Retention		109,887	4
Timber harvesting land base		**760,781**	**31**

[e]**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.

[f]**Crown forest management land base (CFMLB)**
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. Parks and other non-THLB forested areas contribute to the accounting for biodiversity targets and are therefore included in the CFMLB. For the purpose of an AAC determination under Section 8 of the Forest Act, *the CFMLB also excludes area-based tenures such as woodlots, community forests, tree farm and First Nations woodland licences.*

Figure 2 shows the current age class distribution for forests in the CFMLB separated by THLB and non-THLB. The large amount of young forest in the THLB reflected the increase in harvesting to salvage MPB-impacted pine and the large amount of non-THLB in the older forest classes reflected the non-timber management objectives.

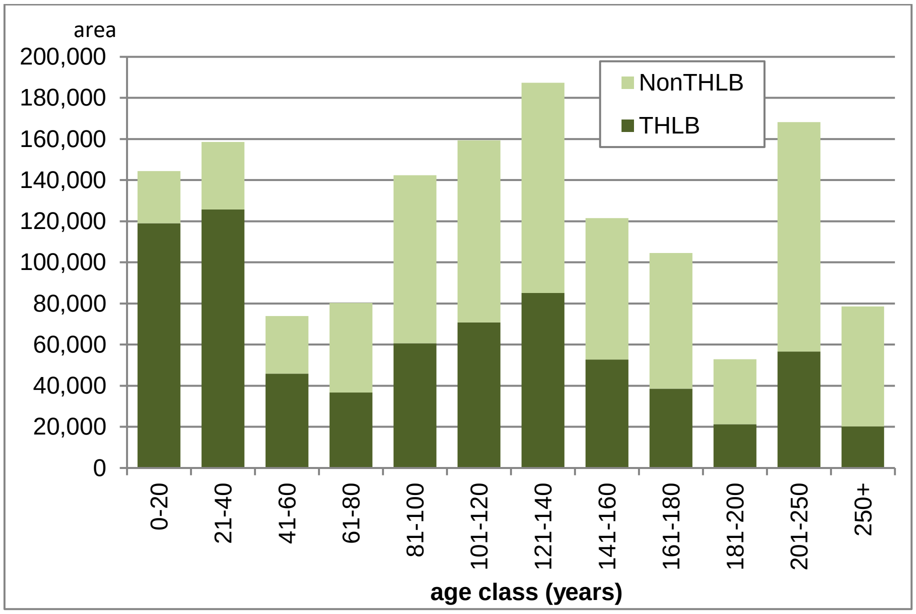

Figure 2. Age class distribution for the Crown forest management land base - Okanagan TSA.

Figure 3 summarizes the area and current volume by leading species on the THLB and illustrates the loss of pine volume due to the MPB epidemic. The THLB area with no species represents the recently harvested area that is typed as non-forest in the inventory.

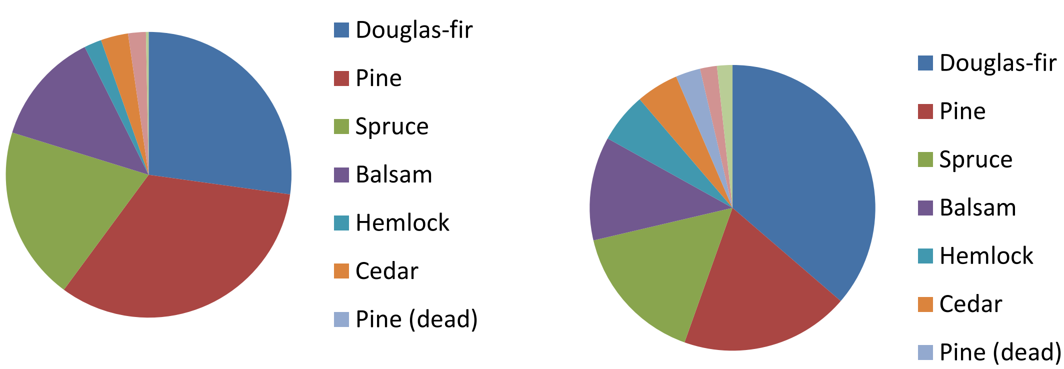

Figure 3. Leading species by area and by volume within the timber harvesting land base – Okanagan TSA.

Land base and forest management changes since 2011

The last AAC determination for the Okanagan TSA in February 2012 was necessitated as part of an ongoing assessment of the MPB epidemic in the central Interior. Since then, several changes have occurred to the land base and forest management data and practices, including:

- the end of the MPB epidemic;
- a new provincial site productivity (PSPL) map based on predictive ecosystem mapping;
- the addition to the TSA of a portion of Tree Farm Licence 49;
- a standardized approach to yield projections; and,
- differences in the modelling of constraints.

Mountain pine beetle

Mountain pine beetle (MPB) is native to BC where it occurs at endemic levels. Epidemic outbreaks have occurred periodically throughout the Interior of BC and have played a vital role in the natural disturbance of pine forests, contributing to biodiversity and variation across the landscape. The Canadian Forest Service began tracking forest health, including MPB, through aerial overview surveys to locate and record incidences in 1965. In 1995, the Province assumed responsibility for surveys; an amalgamated spatial layer with survey results from 1965 to present is available on the BC Geographic Warehouse. Figure 4 provides an overview of the survey data for MPB within the THLB.

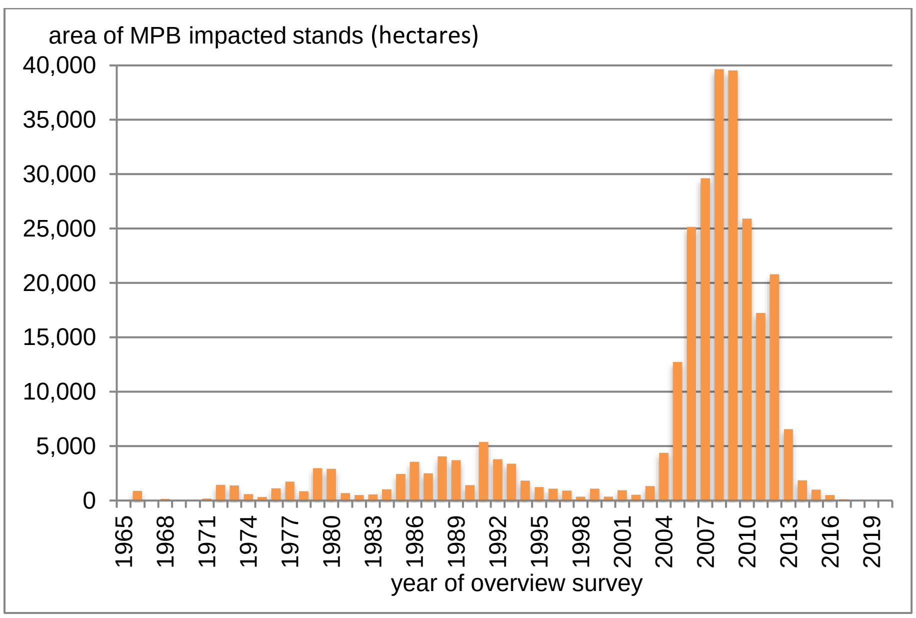

Figure 4. Aerial overview survey results for MPB-impacted pine-leading stands within the THLB - Okanagan TSA.

Between 1987 and 1993 there were a series of AAC decisions with MPB uplifts designed to address MPB mortality and limit non-recoverable losses. At the start of the MPB outbreak, the pre-uplift AAC was 2.7 million cubic metres per year set in 1980. The series of AACs to address the MPB went from a high of 3.2 million cubic metres including a 0.2 MPB partition[g] in 1998 to a low of 2.8 with a 0.189 million MPB partition in 1993. After the outbreak, the post-uplift AAC was set at 2.615 million cubic metres per year in 1994. The outbreak affected 24 263 hectares of THLB.

[g]**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.*

Table 3 summarizes the recent AAC decisions with MPB uplifts.

Table 3. Recent MPB uplifts – Okanagan TSA

Year	Total AAC (m^3)	MPB uplift	Cedar Hemlock partition	Deciduous partition	Small scale salvage partition
2001	2,655,000				80,000
2006	3,375,000	700,000		20,000	80,000
2012	3,100,000				

The magnitude of the most recent outbreak was attributed to two factors. First, due to the success of fire suppression over the past century, there was more area of mature lodgepole pine, which was the beetle's preferred host. Second, beetle populations were historically limited by cold winters; however, the absence of sufficiently-cold temperatures in the Interior allowed large populations of beetles to survive the winters.

Figure 5 shows the BC mountain pine beetle model (BCMPB) recorded annual MPB red-attack pine from 1999 to 2015 and projected red attack from 2016 to 2020. From 1999 to 2015 there were 10.00 million cubic metres of recorded red-attack pine while from 2016 to 2020 the model projected 0.15 million cubic metres of red attack. As of 2020, the combined actual and projected volume affected by MPB was 10.15 million cubic metres based on the BCMPB.

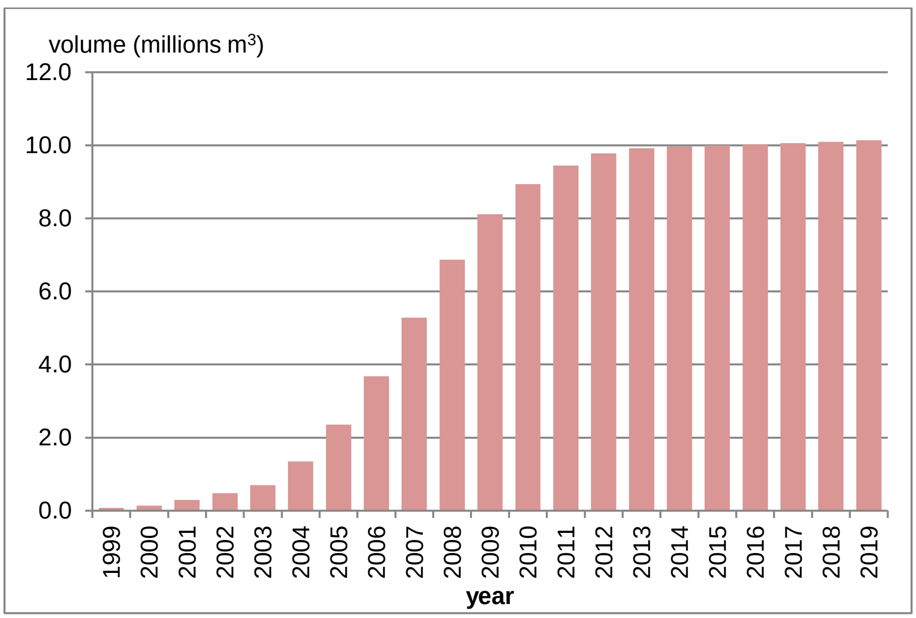

Figure 5. BC Mountain Pine Beetle Model (cumulative observed 1999–2015 and projected 2016-2019) – Okanagan TSA.

The Electronic Commerce Appraisal System (ECAS) was assessed to determine the amount of net coniferous volume, lodgepole pine volume and MPB-impacted pine volume that was permitted for harvesting in the TSA. From the last AAC decision in 2012 to 2019, approximately 25.82 million cubic metres of coniferous volume was permitted. Of that volume, 6.11 million cubic metres, or 24 percent, was lodgepole pine and 2.02 million cubic metres, or eight percent, were MPB-impacted pine. The permitted percent of MPB impacted pine declined steadily from 16 percent in 2012 to five percent in 2019. In the last three years green (undamaged) pine contributed an average of 15 percent of the permitted volume while MPB-impacted pine contributed an average of four percent of the permitted volume.

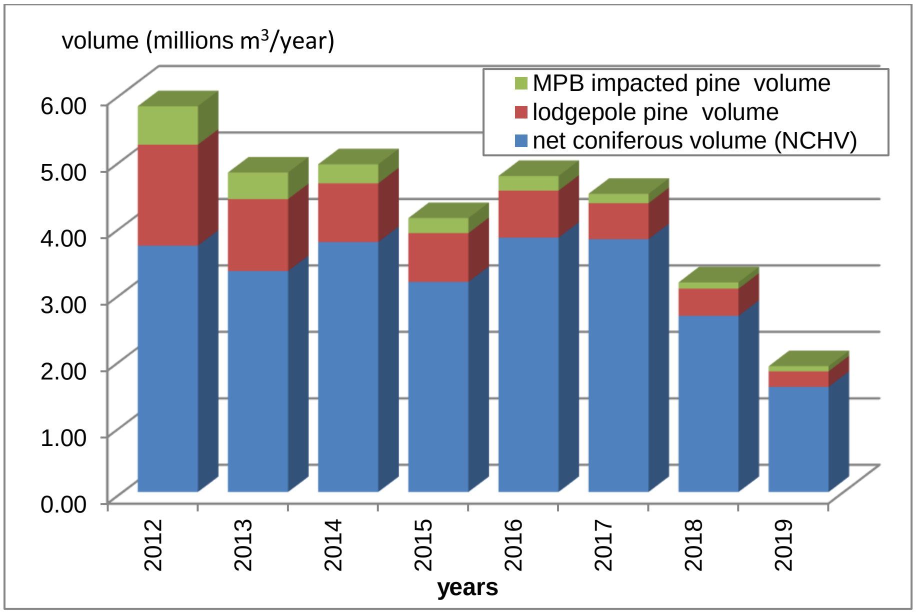

Figure 6. Comparison of ECAS permitted volume – Okanagan TSA.

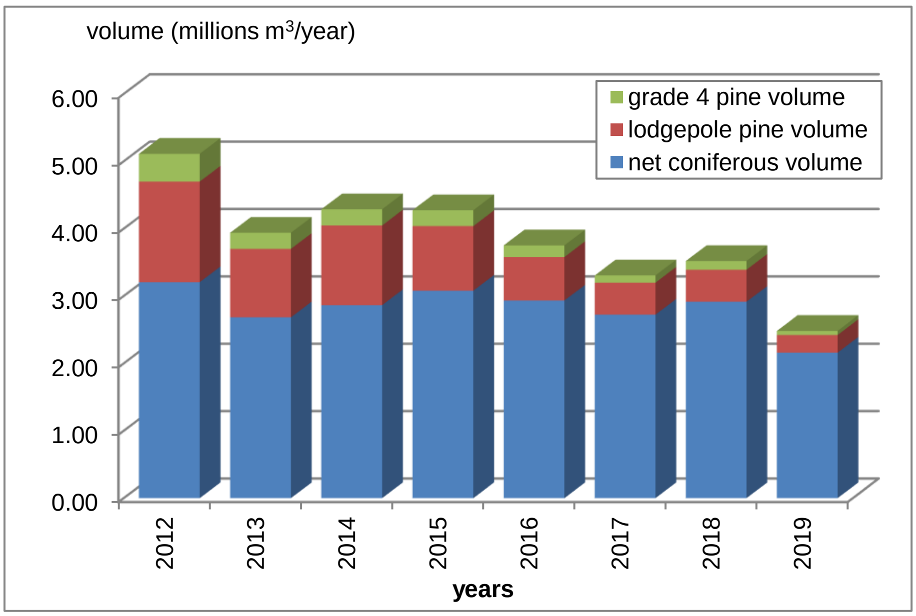

Figure 7. Comparison of Harvest Billing System (HBS) scaled volume – Okanagan TSA.

History of the allowable annual cut

Table 4. History of the AAC – Okanagan TSA

Year	Total AAC (m^3)	MPB uplift	Cedar Hemlock partition	Deciduous partition	Small scale salvage partition
1980	2,700,000				
1987	2,900,000	200,000			
1988	3,200,000	500,000			
1989	2,820,000	120,000			
1990	2,900,000	200,000			
1992	2,815,000	200,000	50,000		
1993	2,804,000	189,000	50,000		
1994	2,615,000		50,000		
1996	2,615,000		50,000		
2001	2,655,000				80,000
2006	3,375,000	700,000		20,000	80,000
2012	3,100,000				

The allowable annual cut (AAC) for the Okanagan TSA was first established in 1980, at 2.70 million cubic metres per year. In response to the late 1980's MPB outbreak, the AAC for the Okanagan TSA was increased by 0.20 million cubic metres per year. The uplift for MPB remained in place until 1994 although it fluctuated from 0.12 to 0.50 million cubic metres. A partition of 0.05 million cubic metres per year was in place from 1992 to 1996 to harvest decadent (old) cedar-hemlock stands. In 1994, the AAC decreased to 2.615 million cubic metres where it remained until 2001.

In 2001, the AAC determination increased to 2.66 million cubic metres per year with a 0.08 small scale salvage partition. The next AAC decision in 2006 included a MPB uplift of 0.70 with an additional deciduous partition of 0.20. The 2012 AAC determination was set at 3.1 million cubic metres per year. The chief forester's *Rationale* directed licensees to continue to focus harvesting on MPB-impacted pine-leading stands. Subsequent to that determination, the AAC was reduced to 3 078 405 cubic metres following the establishment of a Community Forest Agreement in January 1, 2013.

Timber supply forecast

For most AAC determinations, a timber supply analysis was carried out using three categories of information: land base inventory, timber growth and yield, and management practices. Using this information and a computer model, a series of timber supply forecasts were produced to reflect different starting harvest levels, rates of decrease or increase, and potential trade-offs between short- and long-term harvest levels.

From a range of possible forecasts, one was chosen which attempts to avoid both excessive changes from decade to decade and significant timber shortages in the future, while ensuring the long-term productivity of forest lands. This was known as the 'base case' forecast and formed the basis for comparison when assessing the effects of uncertainty of the information modelled on timber supply. The base case was designed to reflect current management practices.

Because it represented only one in a number of possible forecasts, and because it incorporated information and modelling assumptions about which there may be some uncertainty, the base case was not an AAC recommendation. Rather, it is one possible timber supply forecast, whose validity - as with all the other forecasts provided - depends on the validity of the data and assumptions incorporated into the computer model used to generate it.

Due to the existence of uncertainty in the timber supply analysis, additional forecasts are usually prepared to test the effect of changing some of the assumptions or data used in the base case. These additional forecasts are either 'alternative forecasts' or 'sensitivity analyses'. Alternative forecasts test the feasible alternatives to the base such as continuing the salvage of MPB-impacted stands while the sensitivity analyses test the uncertainties that affect timber supply to varying degrees. The base case, alternative forecasts and sensitivity analyses are prepared using a computer model that projects the future availability of timber for harvesting based on the growth of the forest and the level of harvesting, while staying within the legal land use objectives established by the provincial government.

The computer model used for the Okanagan TSA was the SELES Spatial Timber Supply Model (STSM1), analysis was conducted using spatial data at a one hectare grid level.

The base case forecast

In this analysis, the base case was constructed as a step down flow, as shown in Figure 8. The first decade (short term) harvest flow is 2.65 million cubic metres per year, which is similar to the pre-MPB uplift AAC from 2001. The second decade (short term) is 2.46 and the remaining 23 decades are 2.29 (long term). The three harvest levels were established with the objective of balancing constraints, available timber supply and sustainability of the long term. The transition between the short- and long-term occurs at the end of the second decade when a long-term sustainable harvest flow is achieved. The long-term harvest level ensured the growing stock is steady after an initial decline due to the step down. Scenarios showing other possible short- and long-term harvest levels are provided as alternate harvest flows.

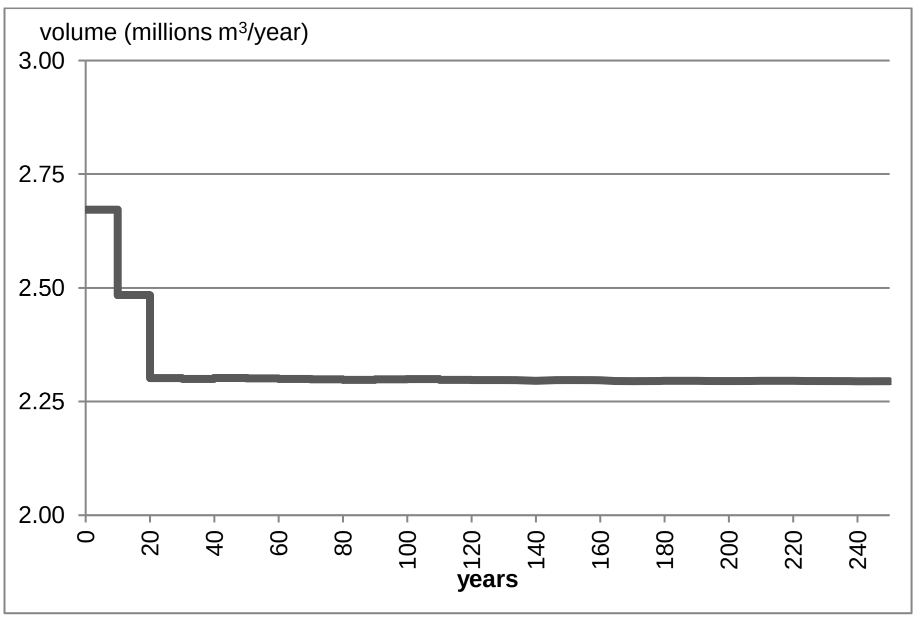

Figure 8. Base case harvest flow – Okanagan TSA.

The 2011 timber supply review base case proposed a harvest of 3.36 million cubic metres per year for one decade (short term), followed by a mid-term of 2.35 cubic metres for five decades then a long term of 2.47 cubic metres for four decades. The determination in 2012 set the AAC at 3.1 million cubic metres after considerations outlined in the *Rationale for AAC Determination* document.

In the base case, the oldest stands are prioritized for harvest. While there is recognition that substitution of stands with different characteristics is often operationally feasible without affecting the harvest flow, it is important to reflect on the timing of the contribution of different stand types to the harvest flow in the base case *versus* current operational expectations. Figure 9, Figure 10 and Figure 11 present the characteristics of the stands harvested in the base case and the trends observed are discussed below.

Figure 9 presents the flow of stand types over time. Managed stands are those equal to or less than three decades in age, thrifty stands are greater than three decades and less than 14 decades while old stands are greater than or equal to 14 decades. The harvest flow begins with predominantly old stands that transitions at decade three to predominantly thrifty stands. Managed stands begin contributing at decade six and then become the predominant contributor to harvest at decade seven. By decade 11, the old- and thrifty-stands make negligible contributions to harvest.

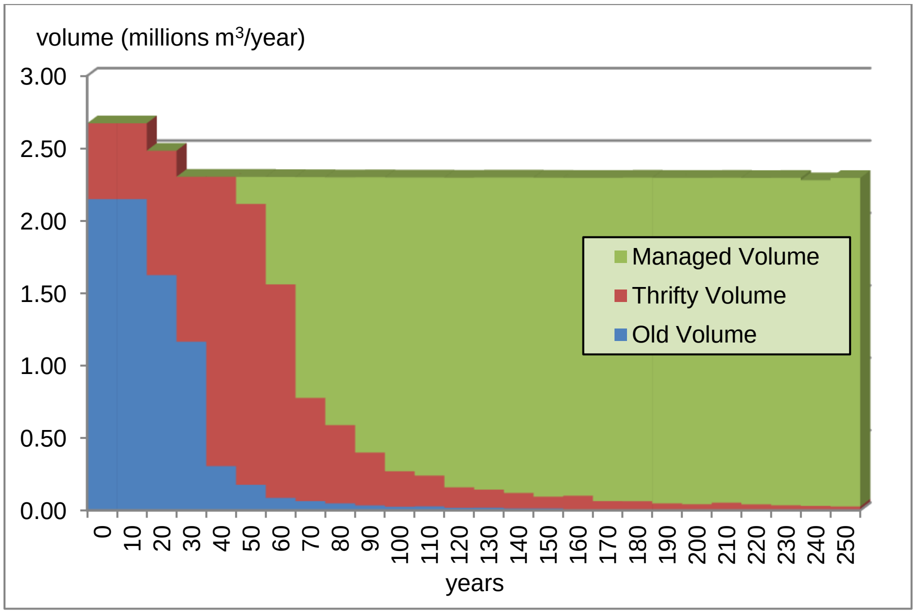

Figure 9. Volume by old, thrifty and managed stand types for base case – Okanagan TSA.

Figure 10 presents the timing of the transition from old to thrifty stands at decade three and from thrifty to managed stands at decade six.

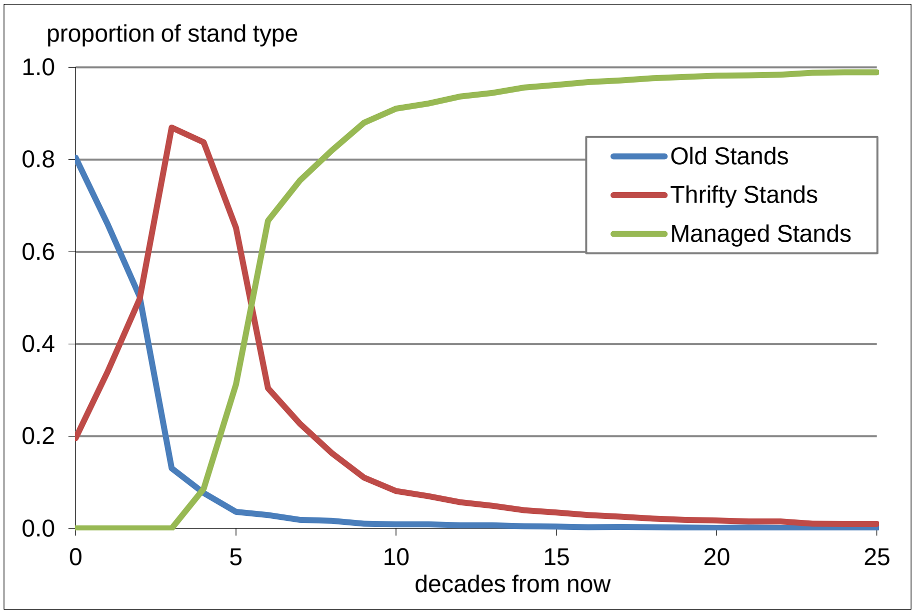

Figure 10. Contribution from stand types – Okanagan TSA.

Figure 11 presents the changes in mean volume per hectare and the mean harvest age over time. The mean harvest volume remains around 325 cubic metres per hectare from time 0 to decade four then declines to around 275 cubic metres per hectare at decade 70. For the remainder of the time period the volume fluctuates between 275 to 295 cubic metres per hectare with an average of 278 cubic metres per year. These changes are consistent with the timing of the transition between old, thrifty and managed stands.

The mean harvest age begins at 198 years and sharply declines until decade six when the mean age is 95. The age declines to 86 years at decade 12; then the age averages 83 years to the end of time period. Managed stand have younger ages and lower volumes than thrifty and old stands however managed stands will have more consistent quality.

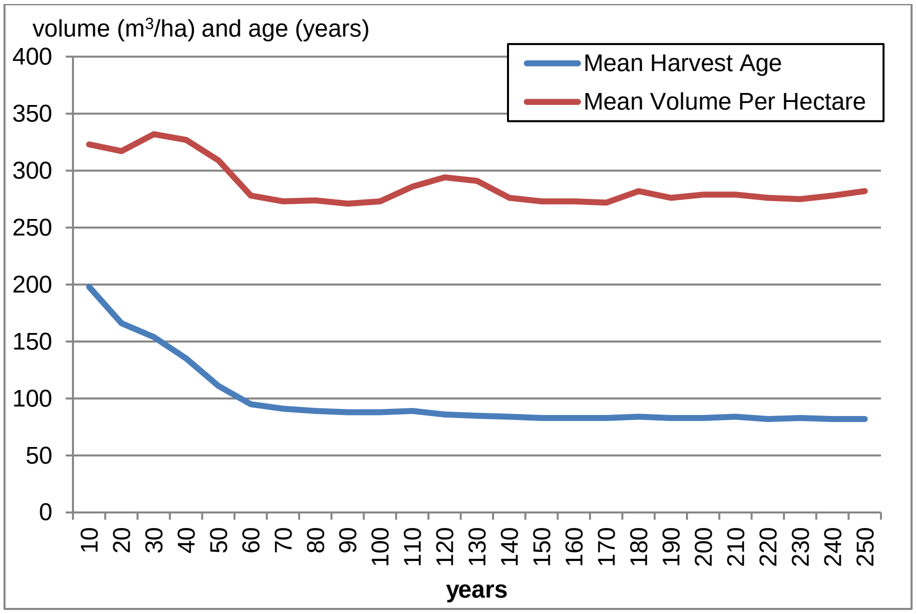

Figure 11. Mean volume per hectare and mean harvest age for base case – Okanagan TSA.

Alternative harvest flows

The base case is one of many alternative harvest flows possible. Presented below are four alternatives that demonstrate how changing the initial harvest level or changing the assumptions regarding potential salvage can affect the forecast harvest levels in the following decades. Four alternative harvest flows explore the implications of 1) maximum even--flow harvest level, 2) current AAC harvest level, 3) average pre-uplift harvest level, and 4) current AAC for salvage of MPB-impacted stands.

The first alternative flow, as shown in Figure 12, was to achieve the maximum even-flow harvest level for 25 decades with all base case constraints applied. The harvest level was 2.33 million cubic metres per year. The maximum even-flow resulted in an increase of two percent to stand age and volume per hectare at time of harvest. This alternative flow is less than one percent higher than the base case. The maximum even-flow would require an immediate 25 percent decrease in harvest flow compared to the current AAC.

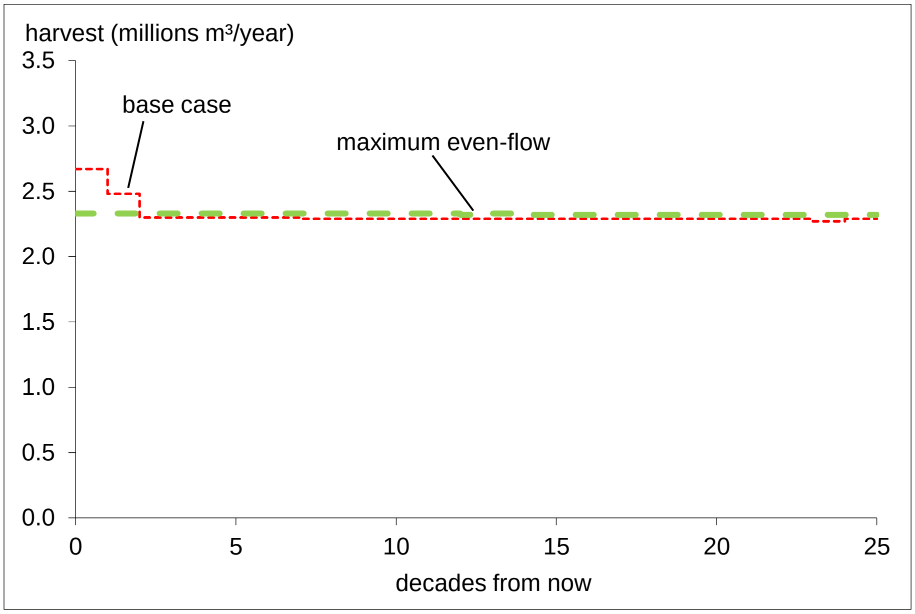

Figure 12. Base case and maximum even-flow harvest forecasts – Okanagan TSA.

The second alternative flow, as shown in Figure 13, was to maintain the current AAC of 3.1 million cubic metres per year for as long as possible. The initial harvest level was 3.1 million cubic metres per year for three decades before declining to 1.78 million cubic metres per year for seven decades. The harvest level then increased to 2.44 million cubic metres per year for the remaining 15 decades.

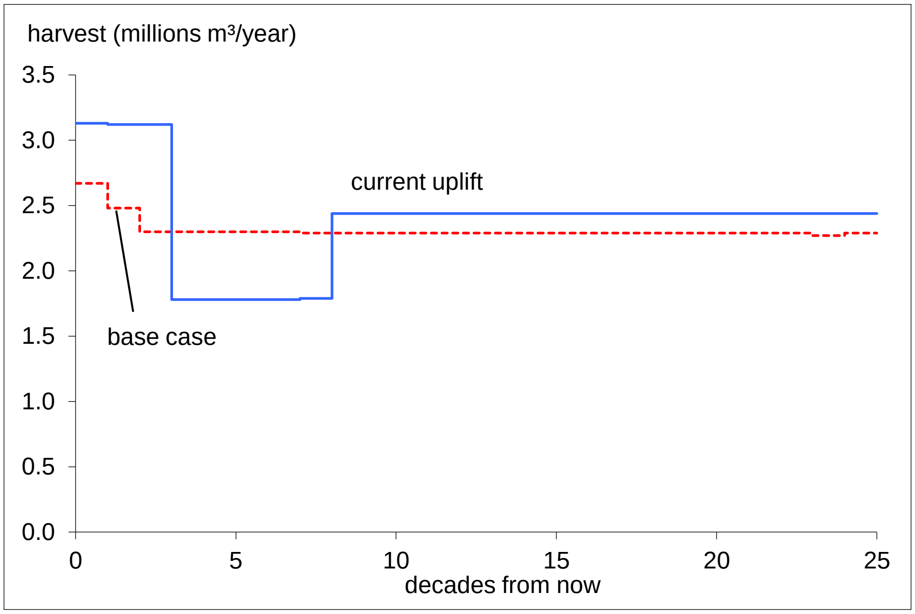

Figure 13. Base case and current uplift harvest forecasts – Okanagan TSA.

Maintaining the current AAC resulted in a three percent lower stand age and nine percent lower volume per hectare at harvest. This alternative flow has a 43 percent decline between decades 3 and 4 compared to the base case which has a seven percent decline at decade one and another seven percent at decade 2.

The third alternative flow, as shown in Figure 14, was to maintain the average pre-uplift harvest level for as long as possible before declining to the long-term harvest. The initial harvest level was 2.66 million cubic metres per year for four decades before declining to 2.03 for three decades. The harvest level then increased to 2.20 million cubic metres per year for seven decades then increased to 2.38 for 11 decades.

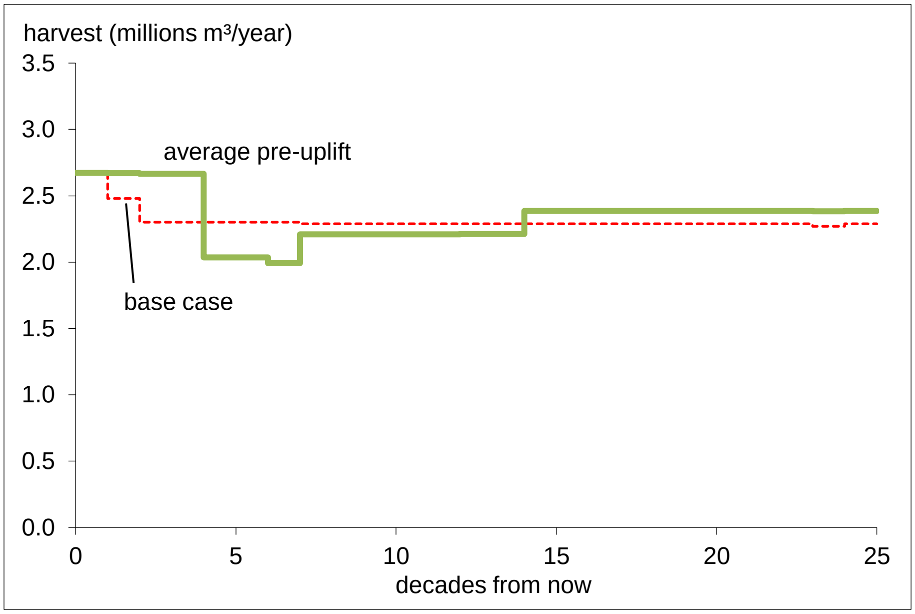

Figure 14. Base case and average pre-uplift harvest forecasts – Okanagan TSA.

Maintaining the average pre-uplift harvest level for four decades resulted in an increase of two percent of the volume per hectare at harvest. This alternative flow has a 30 percent decline between decades four and five compared to the base case which has a seven percent decline at decade one and another seven percent at decade 2.

The fourth alternative flow, as shown in Figure 15, was to maintain the current AAC for the salvage of mountain pine beetle. The initial harvest level for the MPB salvage alternative was 3.1 million cubic metres per year. Adjacency constraints were not applied in the model while salvage was the priority. The previous timber supply review used a 20-year shelf life assumption while this model used an exponential loss curve. No assumptions were made about the potential end use of the dead pine (e.g., whether or not the fibre was of sufficient quality for use as sawlog, pulp or for bioenergy). After four years, the dead trees are assumed to fall over and were no longer viable for harvest.

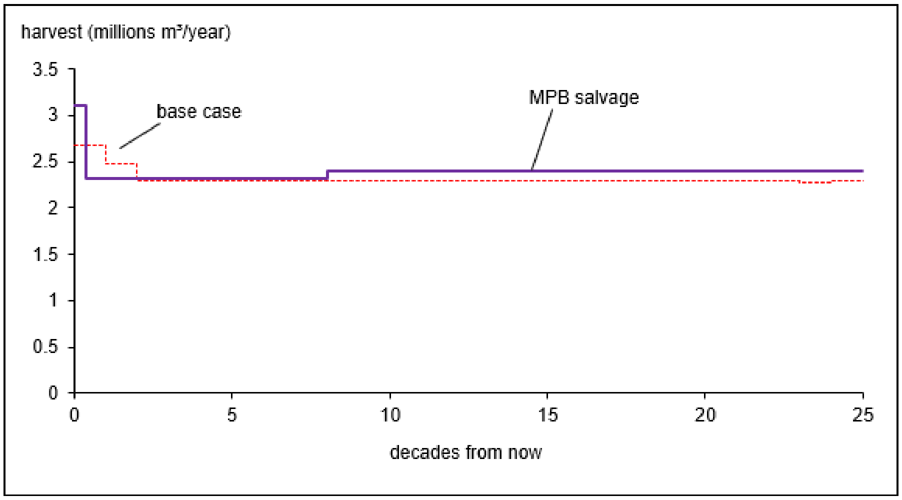

Figure 15. Base case and MPB alternative harvest forecasts – Okanagan TSA.

In this scenario, the growing stock within the THLB consisted of 125.0 million cubic metres with 2.5 million cubic metres of MPB-impacted pine, or two percent of the growing stock in 2019. The MPB-impacted pine-growing stock declined from 2.00 million cubic metres in 2020 to 0.70 million cubic metres in 2026. After 2026, there was no longer any MPB-impacted pine volume in the growing stock.

After four years the MPB salvage partition was concluded with 1.0 million cubic metres of MPB salvage volume having been harvested. After the four years the adjacency constraint was applied and the harvest level was reduced to 2.32 million cubic metres per year, which was slightly above the base case until decade nine when it increased to 2.41 for 16 years. This alternative resulted in harvesting older stands with higher stand volumes therefore less area was logged per year.

To achieve this alternative, the licensees would need to return their focus to MPB-impacted stands for four years then the harvest flow would abruptly need to drop from 3.1 to 2.32 million cubic metres per year. ECAS permitted volume indicated that green pine has contributed an average of 15 percent of the permitted volume in the last three years while MPB-impacted pine has contributed an average of four percent of the permitted volume.

Table 5 contrasts the three alternative harvest flows with the base case.

Table 5. Base case and alternative harvest flows – Okanagan TSA

Harvest flow	250 year average	% difference from base	Short-term average	% Difference from base	Long-term average	% Difference from base
Base case	2,319,680		2,577,471		2,297,263	
Maximum even-flow	2,330,909	0	2,337,362	-9	2,330,348	1
Current AAC uplift	2,364,234	2	3,122,873	21	2,298,265	0
Average pre-uplift	2,337,792	1	2,670,973	4	2,308,819	1
MPB salvage	2,457,816	6	3,106,944	21	2,371,266	3

Sensitivity analyses

The base case used a specific set of data and assumptions that were intended to reflect forest composition and growth, legally-established land use objectives and current forest management practices. However, while the base case was designed to reflect current management in the Okanagan TSA, there was uncertainty about some management information and the modelling framework. Therefore, sensitivity analyses are used to provide further understanding by examining the effect on timber supply of uncertainty in data and assumptions.

Timber harvesting land base sensitivities

Two sensitivities explored increasing the size of the THLB by first increasing the THLB numerical factor by 10 percent and the second by making every hectare of the THLB harvestable rather than reduced by aspatial reductions such as riparian retention and roads. If THLB was increased by 10 percent, mid-term and long-term timber supply would be 1.2 percent and 11.6 percent higher, respectively. If every hectare of THLB was harvestable, mid- and long-term timber supply would be 7.5 and 21.1 percent higher.

Two sensitivities tested a smaller land base, the first by decreasing the numerical THLB factor by 10 percent and the second by removing any groupings of THLB polygons less than five hectares if those groupings were isolated from larger polygons. If THLB was decreased by 10 percent, mid- and long-term timber supply were - 3 and -0.1 percent lower. If isolated polygons were removed, mid- and long-term timber supply would decrease by -0.3 and -0.1 percent, respectively.

Natural stand yield

Two sensitivities were run to test natural stand yield, the first to increase the yield by 10 percent by utilizing an existing stand volume multiplier in the STSM1 model, while the second was to decrease the yield by 10 percent. If yield was increased by 10 percent, mid- and long-term timber supply would be 7.5 percent and 4.6 percent higher, respectively. If yield was decreased by 10 percent, mid- and long-term timber supply would be -8.1 and -3.5 percent lower.

Future managed stand yield

Two sensitivities were run to test future managed stand yield, the first to increase the yield by 10 percent by utilizing an existing stand volume multiplier in the STSM1 model, while the second was to decrease the yield by 10 percent. If yield was increased by 10 percent, mid- and long-term timber supply would be 2.2 percent and 6.6 percent higher, respectively. If yield was decreased by 10 percent, mid- and long-term timber supply would be -10.3 and -4.3 percent lower.

Minimum harvestable age

Two sensitivities were run to test minimum harvestable age, the first to increase the age by 10 years by changing the minimum harvest age in the STSM1 model, while the second was to decrease by 10 years. If age was increased by 10 years, mid- and long-term timber supply would be -1.7 percent lower and 10.6 percent higher, respectively. If age was decreased by 10 years, mid- and long-term timber supply would be 0 and -1.1 percent lower.

Minimum harvest criteria

One sensitivity was run to change the minimum harvest criteria (MHC) from effective stand age, also known as oldest first, to cumulative mean annual increment (CMAI). The change forced the model to harvest in low volume stands resulting in a decrease in the timber supply of -3.2 percent in the short term and -8.8 percent in the long term.

Very dry sites

One sensitivity was run to return the very dry sites to the THLB, resulting in an increase of 81 900 hectares. The change to the THLB resulted in an increase of 1.7 in the long term.

Problem forest type

One sensitivity was run to return the problem forest type stands to the THLB, resulting in an increase of 26 605 hectares. The change to the THLB resulted in an increase to the timber supply of 8.5 percent in the short term and 5.8 percent in the long term.

Resource values assessment

Two sensitivities were run to address concerns expressed by First Nations. The first by increasing the aspatial retention within the THLB, the second to remove areas from the THLB that were known to be sensitive to First Nations. If the aspatial retention was increased by 10 percent, mid- and long-term timber supply decreased -8.9 in the short term and -11.9 in the long term. If known sensitive sites were removed from the THLB, the mid-term timber supply decreased by -2.3 percent and the long term by -2.0 percent.

Hydrological recovery

The base case analysis constraint for community watersheds was 30 percent of the THLB must be less than six metres in height. One sensitivity was run to return the community watersheds constraint to the level of the previous TSR, 30 percent of the THLB less than two metres in height. The change in the constraint resulted in an increase to the timber supply of 2.6 percent in the short term and -0.7 percent in the long term.

The results of the sensitivity analyses completed are summarized in Table 6 below. The short term is from 0 to 20 years while the long term is from 20 to 250 years.

Table 6. Adjusted harvest flow sensitivity analyses – Okanagan TSA

Issue tested	Sensitivity levels	Percent impact	
		Short term	Long term
Timber harvesting land base	+ 10%	+ 1.2	+ 11.6
	- 10%	- 8.9	- 10.1
	No aspatial netdown	+ 7.5	+ 21.1
	Remove isolated polygons	- 0.3	- 0.1
Natural stand yields	+ 10%	+ 7.5	+ 4.6
	- 10%	- 8.1	- 3.5
Future managed stand yields	+ 10%	+ 2.2	+ 6.6
	- 10%	- 10.3	- 4.3
Minimum harvestable age	+ 10 years	- 1.7	+ 10.6
	- 10 years	+ 0.0	- 1.1
Minimum harvest criteria	Cumulative mean annual increment	- 3.2	- 8.8
Very dry sites	Include very dry sites in THLB	- 0.3	+ 1.7
Problem forest type	Include PFTs in THLB	+ 8.5	+ 5.8
Resource values assessment	Increase riparian retention + 10%	- 8.9	- 11.9
	Remove identified sensitive sites	- 2.3	- 2.0
Hydrological recovery	30% less than 2m	2.6	- 0.7

Additional analysis was conducted on the influence of current and potential future forest harvest on moose due to the importance of moose to First Nations. Recent moose density estimates were modelled with road and cutblock spatial layers to assess status and trend of moose populations. In general, the coarse-scale moose population and habitat indicators used suggested that moose populations were at least stable across the majority of the TSA. There were no clear indications that previous forestry and other land use activities were negatively influencing the sustainability of moose populations in the region. Interestingly, road densities were high across much of the TSA, but they did not appear to be correlated with declining moose populations or high hunting pressure. In addition, there were high densities of cutblocks in the west-central portion of the TSA, but moose population indicators did not suggest a declining population there.

Simulated future forestry in the base case suggested that road density may have increased in portions of the TSA. However, increases were relatively small (10 percent), as road densities were already high, indicating that future roads may not have been a particularly large concern for moose management. Simulated future cutblock densities were on average lower across the TSA, and distribution was less dispersed. It is possible that future lower cutblock densities may have created a shortage of forage for moose in some areas. Overall, the indicators suggest that at a coarse-scale, previous and future forestry activity has not, and potentially will not, have a clear negative impact on moose. See ‘*Appendix 1 Moose Habitat Analysis*’.

Conclusion

The base case begins with an initial harvest level of 2.65 million cubic metres per year for 10 years, which reflects the average pre-uplift harvest levels. The base case then steps down to 2.465 for 10 years then maintains 2.288 for the remaining 230 years. Four alternative harvest flows explore the implications of 1) maximum even-flow harvest level, 2) current AAC harvest level, 3) average pre-uplift harvest level, and 4) current AAC for salvage of MPB-impacted stands.

Although the above timber supply analysis is a significant source of information provided to the chief forester for consideration, the chief forester’s AAC is not a calculation solely based on this strategic level analysis. The AAC determination of the chief forester is an independent judgment based on professional experience and consideration of the broad range of social, economic and environmental factors required under Section 8 of the *Forest Act* in addition to the timber supply analysis.

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*, the *Data Package* or any other issue related to the timber supply review and the allowable annual cut determination for the Okanagan TSA.

Ministry staff would be pleased to answer questions to help you prepare your response. Please send your comments to the address below.

Your comments will be accepted until March 18, 2021.

You may identify yourself on the response if you wish. If you do, 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.

Please send your comments to:

Ministry of Forests, Lands, Natural Resource Operations and Rural Development
Okanagan Shuswap Natural Resource District
2501 - 14th Avenue,
Vernon, BC V1T 8Z1

Email: Forests.OkanaganShuswapDistrictOffice@gov.bc.ca

Telephone: (250) 558-1700
Fax: (250) 549-5485

If you have any comments or questions, contact:

Karri Lee, Stewardship Officer
Okanagan Shuswap Natural Resource District
Ministry of Forests, Lands, Natural Resource Operations and Rural Development
Telephone: (778) 943-6879
Electronic mail: Karri.Lee@gov.bc.ca

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

Visit the Timber Supply Review & Allowable Annual Cut web site:
https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/timber-supply-review-and-allowable-annual-cut

Appendix 1: Okanagan Timber Supply Review 2020 - Moose Analysis

Tyler Muhly

25/05/2020

1. Importance of Moose in British Columbia and the Okanagan Timber Supply Area

Recent court decisions in British Columbia (BC) have stated that statutory decision makers must use credible information to consider the effects of land management decisions, including allowable annual cut (AAC) determinations, on Indigenous peoples rights to harvest wildlife (e.g., see William v. British Columbia 2012 and West Moberly First Nations v. British Columbia 2011). Accommodations to First Nations communities for impacts of forest harvest on wildlife may be necessary as part of some AAC decisions.

In general, moose are a highly valued wildlife species in North America for a variety of cultural and economic reasons (Timmermann and Rogers 2005). Prior to European colonization, moose were used extensively by Indigenous peoples for food, clothing and shelter (Moose In British Columbia). In the last 100 years, moose have become an important, nutritious, staple food of many interior and coastal First Nations communities in BC (First Nations Health Authority fact sheet).

Several meetings (Dec. 15, 2016, January 30, 2017 and April 12, 2017) were held with the Secwepemc Nations, including Adam's Lake Indian Band and Splatsin First Nations to discuss key wildlife values in the Okanagan timber supply area (TSA) that should be considered as part of the timber supply review (TSR). Sustainability of moose populations was identified as a priority value by the Secwepemc Nations. In addition, the Secwempemc Nations previously developed a collaborative Moose and Watershed stewardship pilot program with the Thompson Rivers Natural Resource District to improve moose sustainability in some portions of the Okanagan TSA.

2. Key Relationships Between Moose and Forestry

Research has shown that forestry activity influences moose density and distribution, both positively and negatively. Forestry cutblocks remove forest canopy, which generally increases the production of deciduous shrub browse on landscapes, which can positively influence moose. Shrub production in forestry cutblocks varies, but appears to peak anywhere from at 5 to 30 years after harvest, and moose appear to use these stand ages the most. Cutblocks less than 5 years old and older than 30 years old (i.e., mid-seral stands), appear to generally be of less forage value to moose and receive less use as foraging habitat. However, older stands, including mature cutblocks, can benefit moose by providing valuable cover habitat. Closed canopy conifer forest stands are important habitat for providing thermal cover in summer and to intercept snow in high snowfall years or areas.

Forest harvest, when done in moderation and in a way that creates a diversity of forest stand ages and types, can benefit moose. However, the creation of road infrastructure to extract timber may negatively affect moose density and distribution overall. Forestry roads can make areas more accessible to moose hunters, increasing hunting mortality, which can limit moose population size. The overall effects of forestry on moose may be negative when roads endure on the landscape and are not actively decommissioned or recovered.

Moose have an important and complex relationship with forestry development. Based on a review of previous research on the effects of forestry on moose, the relationship is most likely to be positive when: - At the scale of a moose home range (i.e., approximately 10 km^2), forest cutblocks are interspersed with large mature or old forest stands, and cut in a progressive way over a 5 to 10 year period so there is a distribution of cutblock ages - Silvicultural practices on harvested stands allow for growth of some shrubs, particularly along cutblock edges with mature stands - Roads are minimized, blocked, deactivated or restored.

3. Forestry-related Indicators of Moose Habitat and Population Condition

Based on previous research, and what can be simulated from TSR models, we used the following indicators to assess current and future conditions of moose habitat in the Okanagan TSA: - percentage of watershed area that is 5 to 30 years old, with an ideal percentage of 30% - percentage of watershed area that is conifer stands greater than 5 ha in size and 15m tall, with an ideal percentage of 40% - road density in a watershed area, with an ideal target of less than 1km/km^2.

4. Current State of Moose Habitat and Populations in the Timber Supply Area

Spatial data were downloaded from DataBC on April 7, 2020, and saved into a file geodatabase. Data that were downloaded included the digital road atlas (DRA), forest tenure (FTEN) roads, forest vegetation resources inventory (VRI), TSA boundaries, freshwater atlas assessment watershed areas (AWAs), landscape unit (LU) boundaries and wildlife management unit (WMU) boundaries.

The DRA, FTEN roads, freshwater atlas and VRI data were 'clipped' to the Okanagan TSA boundary. The linear DRA and FTEN roads data were merged together and then converted to a 20 m resolution raster to remove duplicate roads in both datasets (i.e., roads less than 20 m apart). I then converted data back to linear data using the ArcScan extension, with the following settings: - Geometrical intersection - Max line width = 20 - Noise level = 20 - Compression tolerance = 0.025 - Smoothing weight = 3 - Hole size = 0.

Roads data, and data on forest stand crown closure, species, projected age and projected height from VRI were Unioned to TSA, WMU, LU and AWA boundaries in ArcGIS 10.6.

Moose Population Status and Trends

Moose population data was obtained by searching the BC government's species inventory web explorer (SIWE) for 'moose' inventory data collected in the Okanagan or Thompson regions. I recorded data on moose density, populations, bull:cow ratios and calf:cow ratios.

Recent moose density estimates in the Okanagan TSA ranged from 0.85 moose/km^2 in WMU 8-11 to 0.22 moose/km^2 in WMU 8-21 (Fig. 1). Most of these estimates were obtained between 2011 to 2019, with the exception of WMU 3-12 (0.26 moose/km^2) and WMU 8.10 (0.27 moose/km^2), which were obtained in 1985 and 1999, respectively.

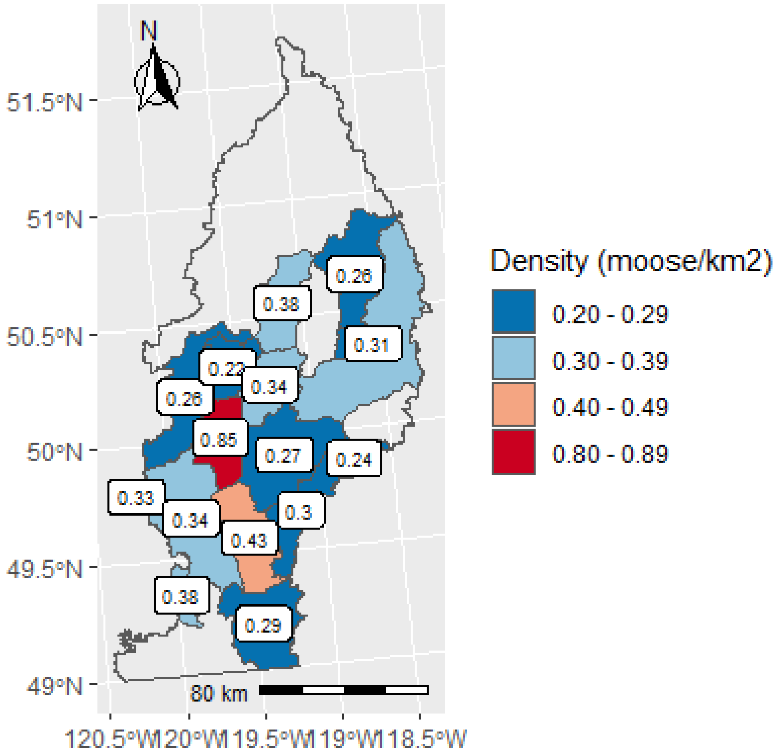

Figure 1. Most recent moose density estimates by wildlife management unit in the Okanagan Timber Supply Area.

The ratio of bull moose to cow moose is often used to indicate hunting pressure on moose populations, and a ratio of greater than 30 bulls to 100 cows is a typical management target, where populations below that indicate a heavily hunted, and potentially unstable population (Young and Boertje 2008; Walker et al. 2017).

Recent bull:cow ratios indicate that moose populations were under relatively high hunting pressure in the south and central portions of the TSA, ranging from 6 to 16 bulls:cows (Fig. 2). Ratios were highest in the eastern and west-central portions of the TSA, reaching up to 85 bulls:cows in WMU 8-14.

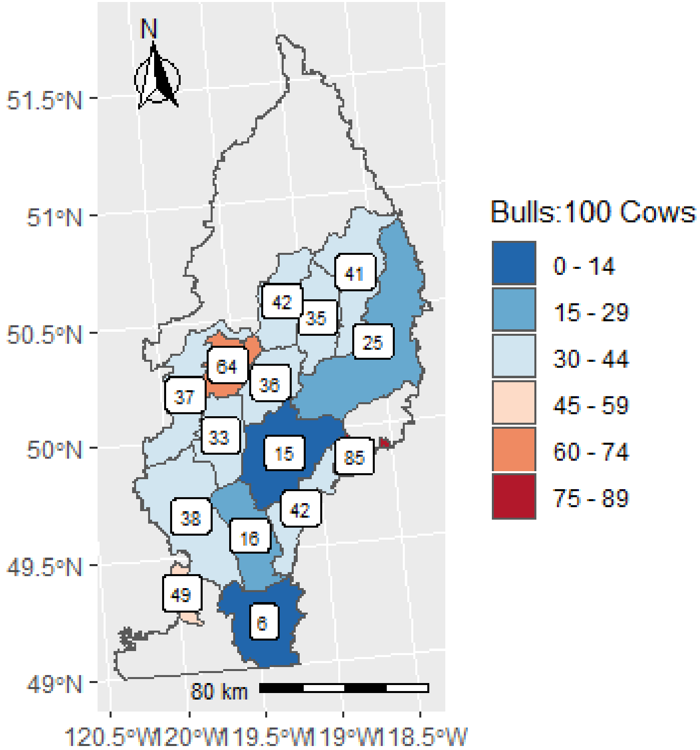

Figure 2. Most recent moose bull/cow ratios by wildlife management unit in the Okanagan Timber Supply Area.

The ratio of calves to cow moose is often used as an indicator of moose population trend, where ratios of 25 to 30 indicate a stable population, and ratios greater than 30 indicate an increasing population (FLNRORD 2019).

The most recent calf:cow ratios were lowest in the north-central and south-central portions of the TSA, and highest in the central and far southern portions of the TSA (Fig. 3). The lowest calf:cow ratios (19) were less than 25, indicating a potential decreasing population in those areas. However, the majority of WMUs were close to or above 30 calves:100 cows, indicating a high potential for stable to increasing population trends for much of the TSA.

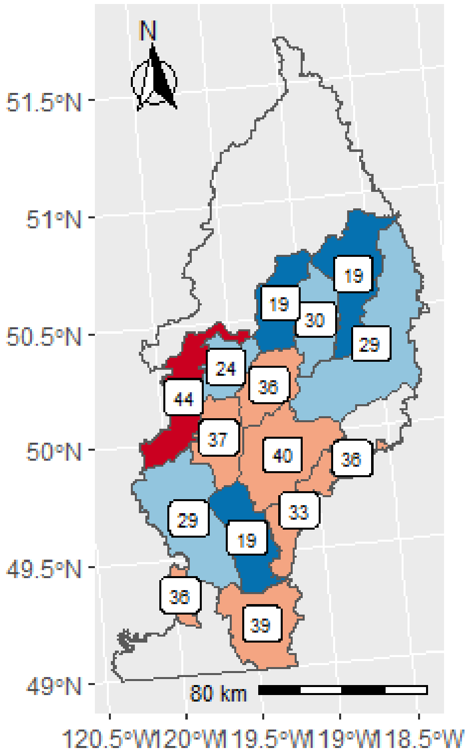

Figure 3. Most recent moose calf/cow ratios by wildlife management unit in the Okanagan Timber Supply Area.

Recently, the moose population appears to have been increasing across the Okanagan region. In 2007, the population was estimated at 2,200 animals (Gyug 2007), then it was estimated at 3,913 animals in 2013 and 4,352 in 2017 (Walker et al. 2017). However, within the Okanagan TSA there were some WMUs where moose populations appeared to be decreasing (Fig. 4). Moose densities decreased from 0.38 moose/km^2 to 0.31 moose/km^2 and 0.38 moose/km^2 to 0.26 moose/km^2 in WMUs 8-23 and 8-24, respectively, between 2003 and 2014.

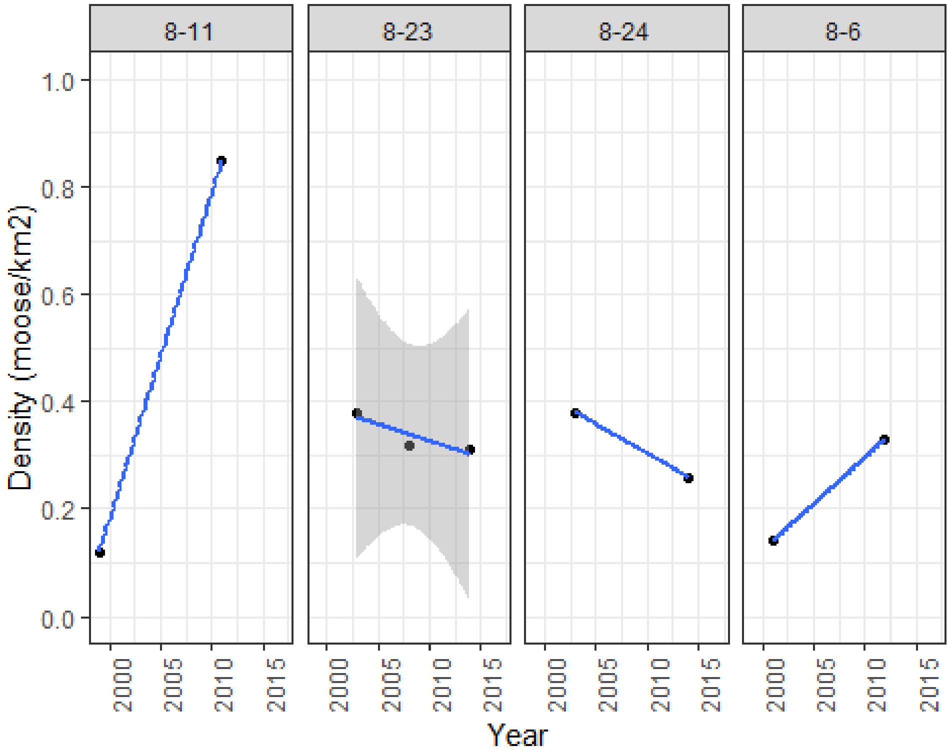

Figure 4. Trends in moose density in wildlife management units with more than one recent density estimate within the Okanagan Timber Supply Area.

Road Density

Current road density (km/km^2) estimates were relatively high (greater than 2 km/km^2) across much of the Okanagan TSA (Fig. 5). Lower road densities, less than 1 km/km^2, typically occurred in the northeast (Monashee mountains and towards Revelstoke), and southwest (EC Manning and Cathedral provincial parks) portions of the TSA.

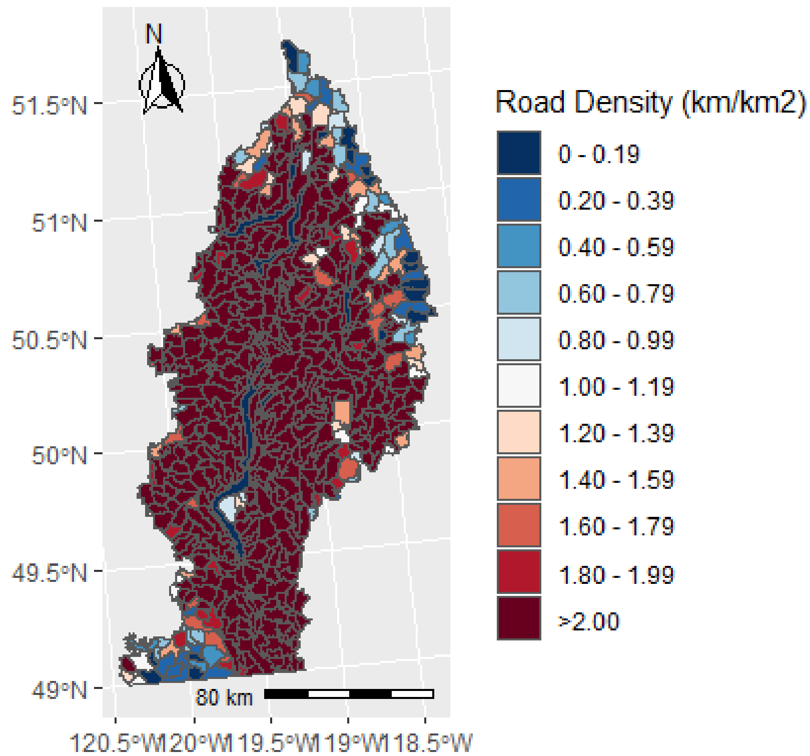

Figure 5. Map of current road density by freshwater assessment watershed area in the Okanagan Timber Supply Area.

Forest Cover for Moose

The AWA's with the highest proportion of conifer forest cover for moose (i.e., stands at least 5 ha in size and 15 m tall) occurred in the west-central portion of the TSA, west of Okanagan Lake, north of Shuswap Lake and north of Osoyoos (Fig. 6). There were a limited number of AWA's with little amounts of conifer forest cover along the western edge of the TSA. AWA's with an approximately 40% proportion of conifer forest cover occurred in the east-central and north-west portions of the TSA.

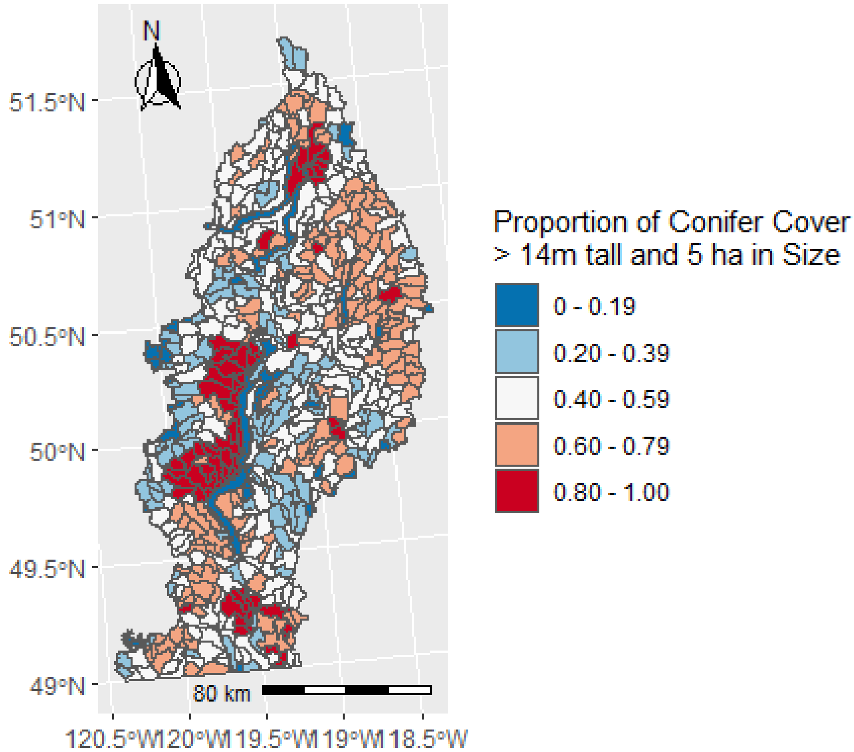

Figure 6. Map of current percentage of conifer forest cover greater than 14 m tall and 5 ha patch size by freshwater assessment watershed area in the Okanagan Timber Supply Area.

Early Seral Forest for Moose

The amount of early seral forest (5 to 30 years old) from cutblocks was highest in the west central and southeast parts of the TSA (Fig. 7). Some AWA's in these areas exceeded a proportion of 0.40 early seral cutblocks. The majority of AWA's were less than 0.20 early seral cutblocks.

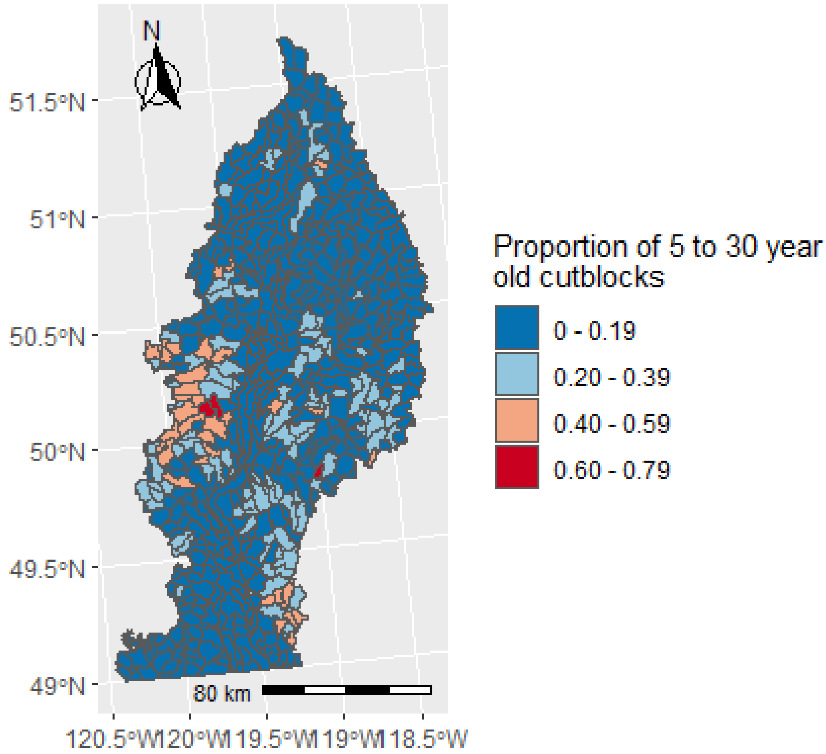

Figure 7. Map of proportion of area of cutblocks 5 to 30 years old by freshwater assessment watershed area in the Okanagan Timber Supply Area.

5. Moose Habitat and Population Management Tools

Previous research suggests that moose require a diversity of forest stand types to meet their forage and cover needs, for example, a mix of older and younger, open and more dense and conifer and deciduous stands. This can make habitat management for moose challenging, as it is difficult to develop and apply a simple forest management regime to meet all of these needs and maximize moose habitat.

Roads are typically found to have a negative effect on moose, by increasing human accessibility into moose habitat, and thus hunting pressure and disturbance that can negatively affect moose survival. Therefore, a management regime to minimize road density may be useful for minimizing forestry impacts on moose. However, moose populations across the Okanagan TSA seem to overall be stable or increasing, despite relatively high (greater than 2 km/km^2) road densities.

Currently, there are no alternative proposed large-scale forest management regimes designed to maximize moose habitat quality in the Okanagan TSA, and no simulated alternative regimes were applied within the TSR model.

6. Simulated Future States of Moose Habitat and Populations Under Different Management Scenarios in the Timber Supply Area

Base Case Scenario

Simulated Road Density

Future forestry road density in the TSA was simulated as a function of simulated future cutblock density as outputted from the TSR model, based on a modeled statistical relationship between cutblock density and road density in AWA's (Muhly 2016).

Under the base case scenario, simulated road density increased steadily but at small increments from 2018 to 2078 across the TSA (Fig. 8). The median road density in AWA's in 2018 was 2.45 km/km^2, which increased to

2.66 km/km^2 by 2078. The increase in road density primarily occurred in a limited number of AWA's mostly along the edges of low road density areas in the northeast and southwest potions of the TSA (Fig. 9, Fig. 10).

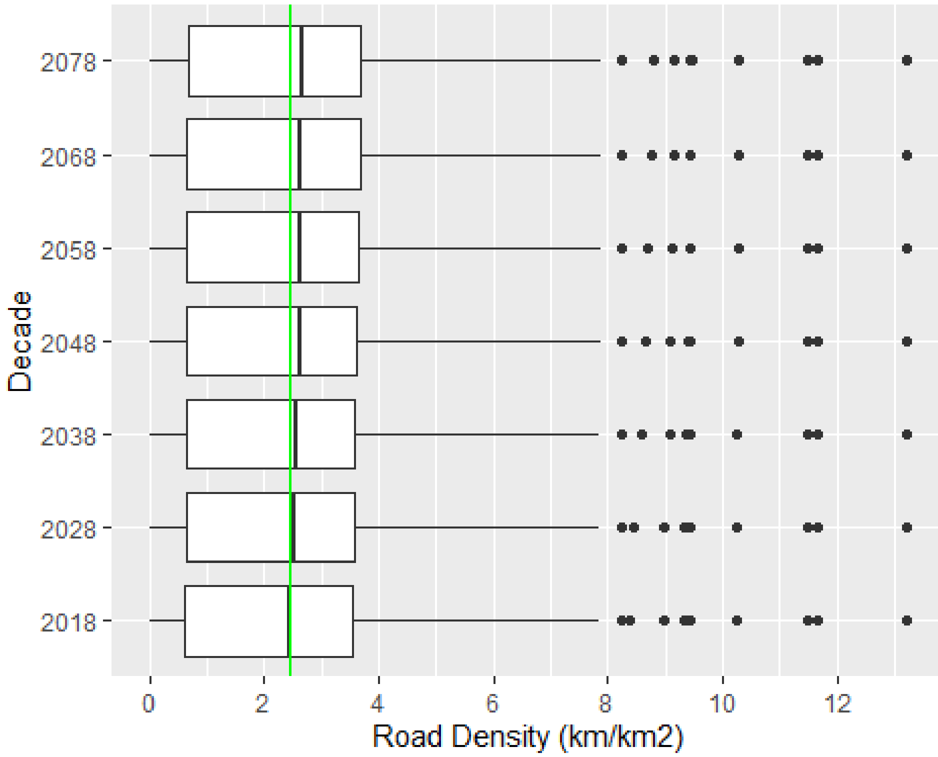

Figure 8. Current and simulated future road density by decade in freshwater assessment watershed area in the Okanagan Timber Supply Area.

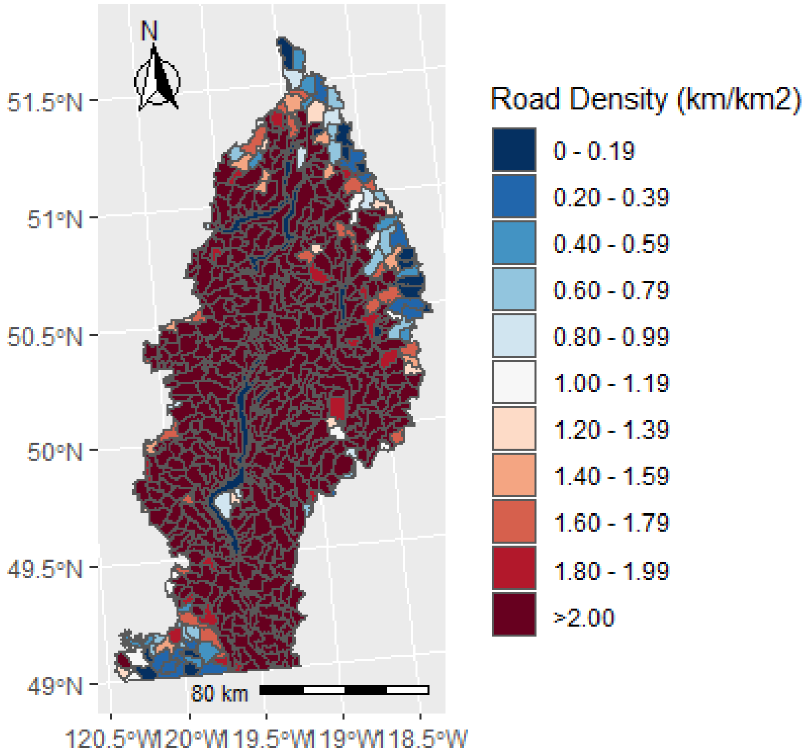

Figure 9. Map of simulated road density in 2048 by freshwater assessment watershed area in the Okanagan Timber Supply Area.

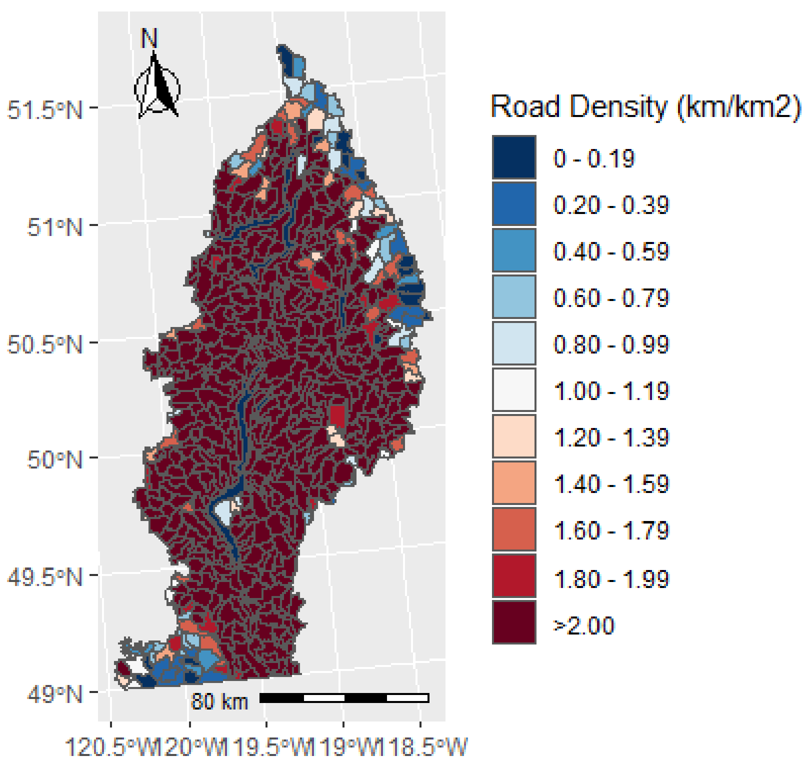

Figure 10. Map of simulated road density in 2078 by freshwater assessment watershed area in the Okanagan Timber Supply Area.

Simulated Early Seral Forest

The median density of 0 to 30 year old cutblocks in AWA's was 0.09 km^2/km^2 in 2018. This increased slightly to 0.10 km^2/km^2 in 2028 and then declined to approximately 0.06 km^2/km^2 in subsequent decades (Fig. 11). Cutblock density became more disbursed from 2018 to 2078 (i.e., there were more lower density cutblock AWA's and fewer high density AWA's). The location of cutblocks shifted from the west central portion of the TSA (Fig. 11), to east central portions in 2014 (Fig. 12) and northern portions (Fig. 13) of the TSA in 2078.

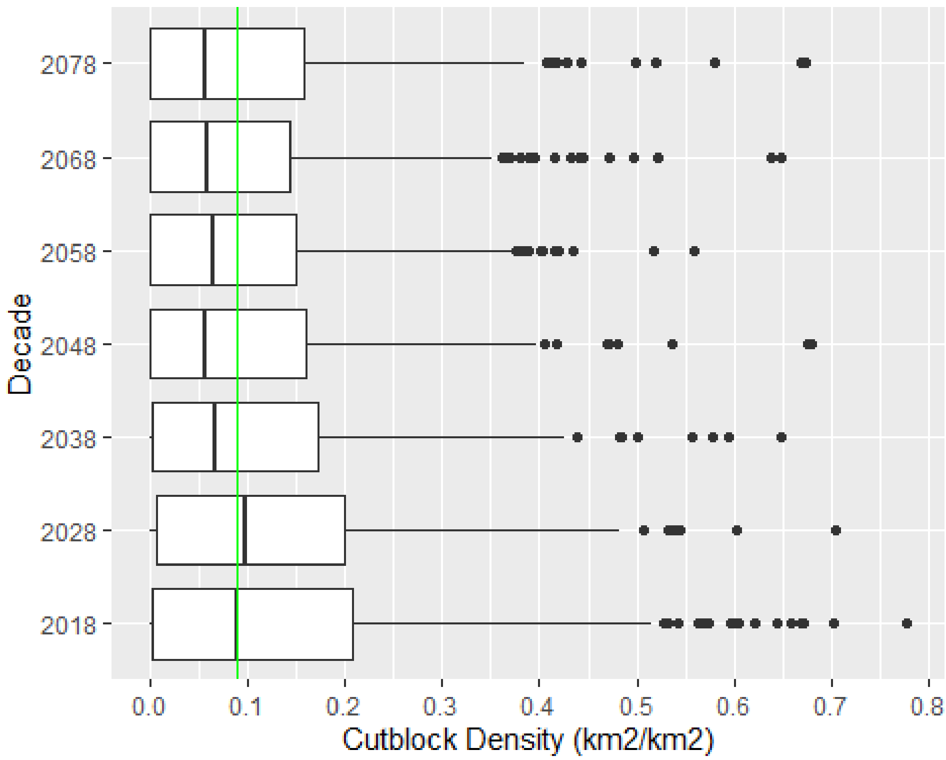

Figure 11. Distribution of current cutblock density by freshwater assessment watershed area in the Okanagan Timber Supply Area.

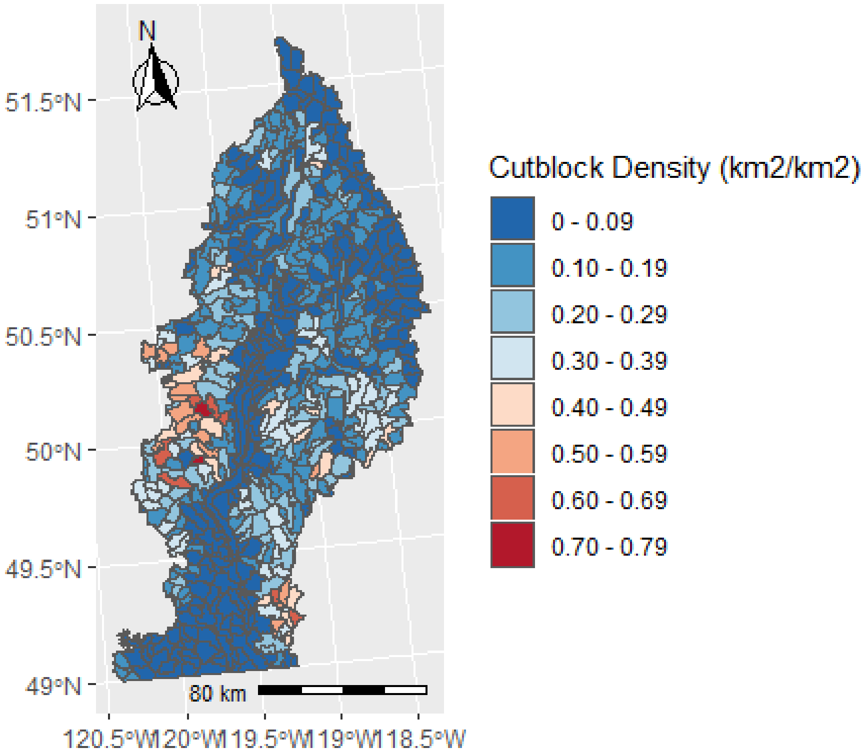

Figure 12. Map of simulated cutblock density in 2018 by freshwater assessment watershed area in the Okanagan Timber Supply Area.

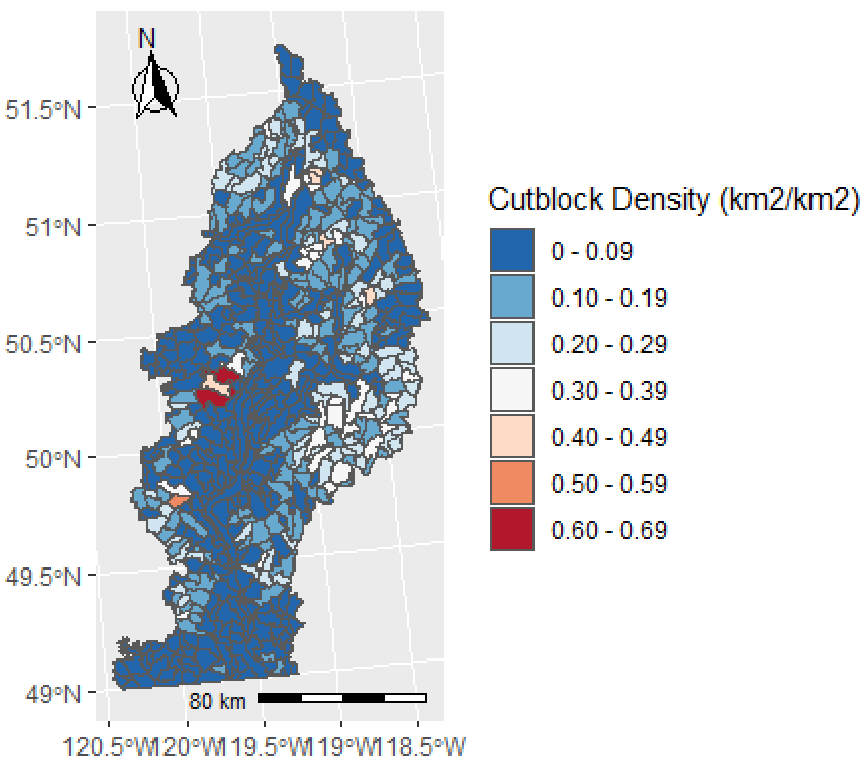

Figure 13. Map of simulated cutblock density in 2048 by freshwater assessment watershed area in the Okanagan Timber Supply Area.

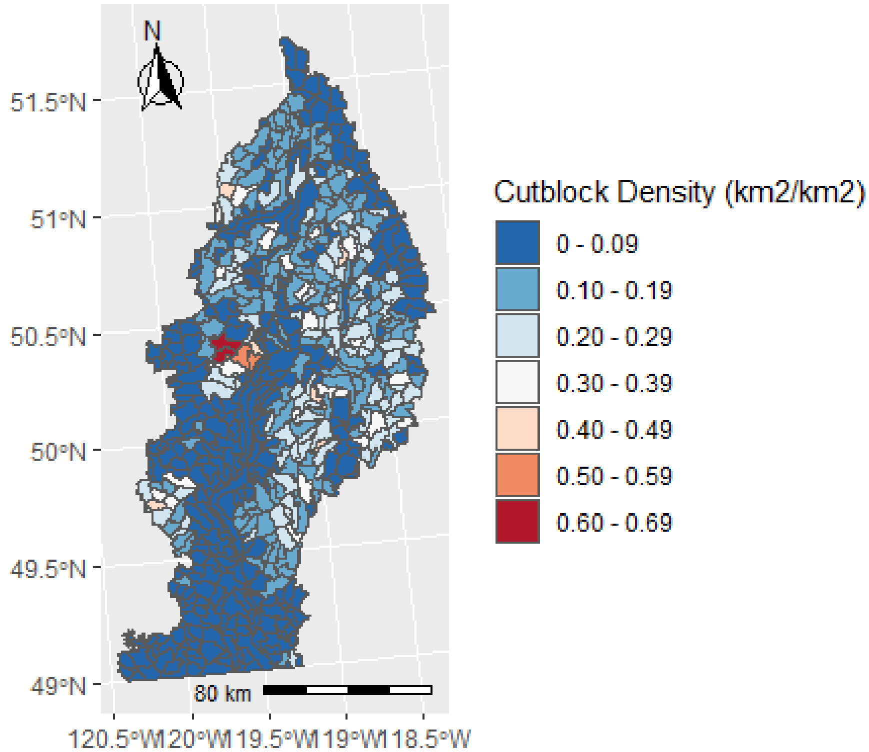

Figure 14. Map of simulated cutblock density in 2078 by freshwater assessment watershed area in the Okanagan Timber Supply Area.

7. Conclusions

In general, the coarse-scale moose population and habitat indicators used here suggest that moose populations are at least stable across the majority of the TSA. There are no clear indications that previous forestry and other land use activities are negatively impacting the sustainability of moose populations in the region. Interestingly, road densities are high across much of the TSA, but they do not appear to be correlated with declining moose populations or high hunting pressure. In addition, there are high densities of cutblocks in the west-central portion of the TSA, but moose population indicators do not suggest a declining population there.

Simulated future forestry in the base case suggests that road density may increase in portions of the TSA. However, increases were relatively small (10%), as road densities were already high, indicating that future roads may not be a particularly large concern for moose management. Simulated future cutblock densities were on average lower across the TSA, and distribution was less dispersed, it is possible that future lower cutblock densities may create a shortage of forage for moose in some areas.

Overall, the indicators suggest that at a coarse-scale, previous and future forestry activity has not, and potentially will not, have a clear negative impact on moose.