HAIDA GWAII TIMBER SUPPLY REVIEW

TIMBER SUPPLY ANALYIS REPORT

April 4th, 2012

Submitted by: Joint Technical Working Group

Submitted to: Haida Gwaii Management Council

Contents

1 Executive Summary

This report presents results of a timber supply analysis done to support allowable annual cut (AAC) determinations by the Haida Gwaii Management Council and the provincial Chief Forester. The analysis used information on land and forests under current land use designations and management requirements, while accounting for other aspects of forest management such as harvesting and reforestation practices, tree growth and yield, and economic operability. Those inputs are described in detail in the Haida Gwaii Timber Supply Review Data package from November 8th, 2011.

As part of the analysis, harvest forecasts were generated that showed the available timber supply over 400 years to ensure that allowable harvest levels over the short and medium term are consistent with long-term sustainability, as well as the management requirements of the SLUA and LUOO.

First, a base case harvest forecast was generated using the best currently available information. As knowledge is evolving, and in consideration of future uncertainty, a series of sensitivity analyses were done to assess the timber supply effects of changes and uncertainties in the information used in the base case analysis.

The base case harvest forecast is approximately 895,000 m^3/yr for the first 80 years then about 925,000 m^3/yr after that. TSA 25's initial harvest level of about 490,000 m^3/yr is the about 55% of the base case initial harvest level. TFL 60's harvest level of nearly 330,000 m^3/yr is about 37% of the total. And, TFL 58's harvest level near 73,000 m^3/yr is about 8% of the base case total.

Some of the sensitivities acted to reduce the amount of timber available for harvest. Using 20% older minimum harvest ages lowered the forecast by 6.5%. Using inventory site index lowered the forecast by 6.2%. Increasing the hydrologic green-up requirement from 9 to 14 metres lowered the forecast by 1.7% for the first 20 years, and finally, excluding more area as economically inoperable will likely result in a 5 to 6% lower forecast.

Other sensitivities increased the amount timber available in the harvest forecast. An alternative base case forecast increased the first 10 years by 4.1%. Combining the management units raised the forecast for the first 40 years by 10.3%. Using 20% younger minimum harvest ages raised the first 20 years by 10.7%. Applying the results of a field based inventory volume correction study raised the first 20 years by 21.0%. Consistently risk managing several LUOO requirements increased the first 80 years by 8%.

The information in this report will be presented to the HGMC and the Chief Forester to support their AAC decisions. However, none of the forecasts in this report are meant as a recommendation for an AAC.

2 Introduction

This analysis results report is a companion to the Haida Gwaii Timber Supply Review Data package from November 8th, 2011 and the Public Discussion Paper of October 2011. The intent is to explore the base case using a range of output reports, and to discuss the impacts to projected timber availability of varying key land and management parameters in sensitivity tests.

Through reporting and discussing the results of the analysis it is expected that decision makers and others interested in the timber supply review will develop insight and understanding of the forecasts.

The base case forecast is described first and in the most detail. There are quite a few graphic indicator reports of species and age class distribution over the course of the forecast horizon.

Forecasts were run for 400 years. This long view is taken to ensure that the amount of wood on the land base is not diminishing within the model. It is recognized that the long term is particularly uncertain. Harvest forecast charts show the first 240 years. The other charts show the entire 400 years.

The forecasts are not predictions because many unforeseeable events will certainly occur. However, the forecasts are designed and constructed with sufficient rigour to support allowable annual cut decisions.

Effort was made to use the best available information, but there remain uncertainties and inaccuracies in the source data. The model was carefully prepared to reasonably represent forest management requirements, tree growth, and harvesting practices. However a modeling environment inevitably differs from reality. Sensitivity tests explore the implications of uncertainties and artificiality.

All the sensitivities that were conducted in comparison to the base case are also reported and discussed. The short, mid and long term effects of changing specific land and management parameters are described for each sensitivity test.

In order to keep this document compact and to avoid redundancy, materials that are explained in detail in the data package are not revisited in detail.

3 Base Case

The base case data inputs, modeling parameters, and harvest flow principles are described in the public discussion paper, and they are described in even greater detail in the data package. Essentially, the base case is designed to represent sustainable timber harvest levels according to current practice and management requirements

The timber volumes that are considered non-recoverable due to mortality from forest health agents such as wind, fire, insects and disease (44,913 cubic metres per year on average) are excluded from the harvest forecast levels shown in this report.

The three management units (MUs), TSA 25, TFL 60 and TFL 58 are flowed individually and their separate forecasts are summed for a combined total. A new separate tenure, a First Nations Woodland Licence, is being created from an existing Forestry Licence to Cut, (FLTC) (A87661). It is managed by Taan Forest Products, nested within the TSA, and its contribution to harvest is discussed on page 36 of this report.

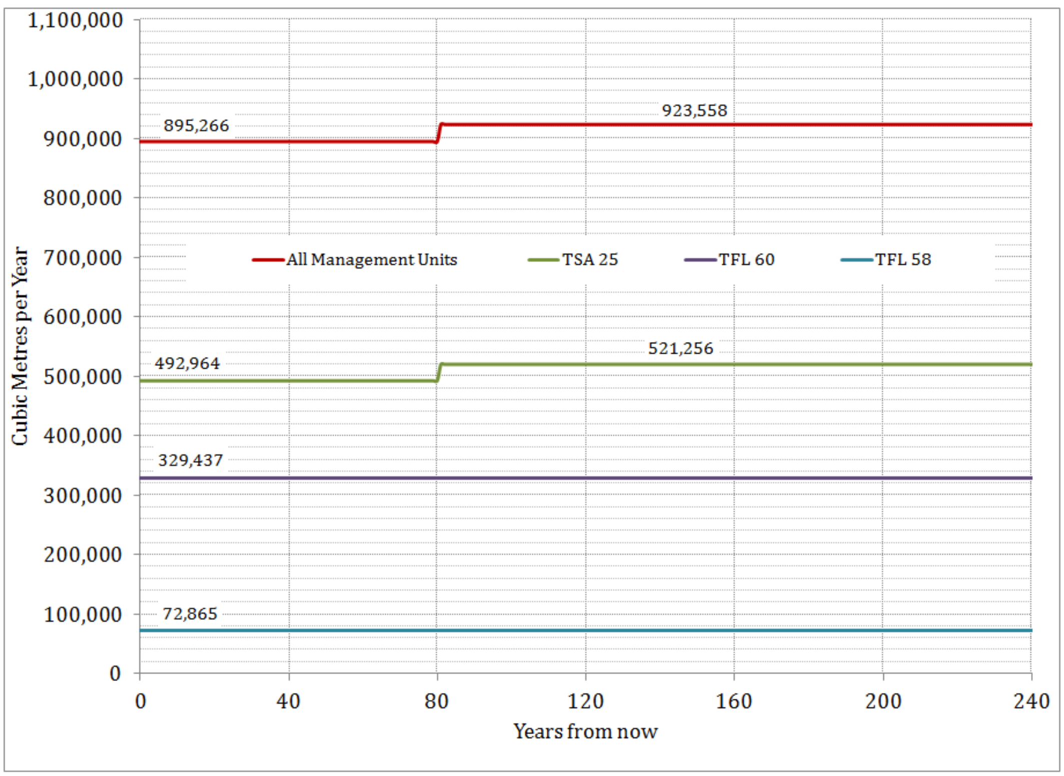

Figure 1: Base Case Harvest Forecast

TFL 58's initial harvest level, near 73,000 m^3/yr, is about 8% of the base case total (Figure 1). TFL 60's harvest level of nearly 330,000 m^3/yr is about 37% of the total, and TSA 25's initial harvest level of about 490,000 m^3/yr is the remaining 55% of the base case initial harvest level.

The crown land portions of the four woodlots on Haida Gwaii do contribute to the forecasts in this report. Annual allowable cuts within the four woodlots currently sum to 9,293 m^3/yr. A separate report will be provided to the HGMC with forecasts for crown land portions of the woodlots.

3.1 Base Case Indicators

3.1.1 Harvest by Stand Type

The harvest queue rule is to harvest the oldest stands first. Figure 2 shows that the model spends nearly 80 years harvesting existing natural stands almost exclusively and then makes a transition to managed stand harvests over about 20 to 30 years.

Figure 2 suggests that contrary to what might be expected, future managed stands appear to contribute to the harvest before existing managed stands. That is because when building the model data set, young stands for which there were no records in RESULTS (the provincial harvest and silviculture reporting system) were labelled as existing *natural* stands. Further assessment indicated that these stands were *managed* stands. Therefore they were assigned to yield tables for managed stands, and for the analysis were labelled as future managed stands.

It is these future managed stands that contribute to forecasted timber supply prior to stands labelled as existing managed stands between about 50 and 100 years from now, as shown in Figure 2.

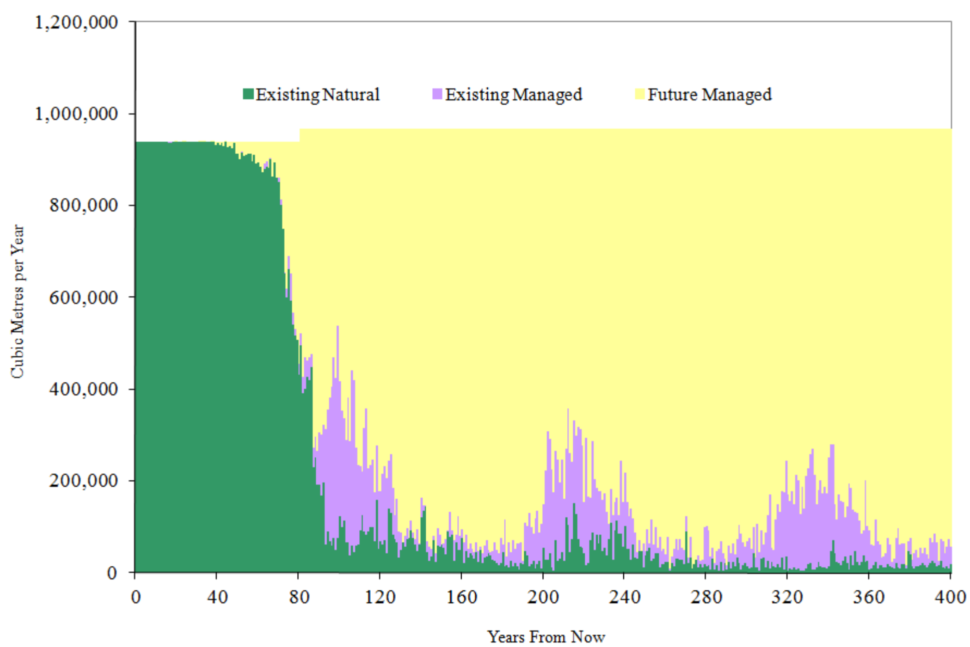

Figure 2: Base Case Harvest Transition to Managed Stands

3.1.2 Annual Average Area and Volume of Harvest

The area harvested each year is proportional to the annual volume harvested and the volume density of the stands harvested. Figure 3 shows that the area harvested each year averages near 1,800 hectares for about the first 40 years of the projection. Then it diminishes to near 1,300 or 1,400 hectares per year about 70 to 90 years from now, and stabilizes at approximately 1,500 hectares over the long term.

The higher average harvested stand volumes reported from about 70 to 90 years into the projection coincide with the transition from natural to managed stand harvest. Due to the oldest first queue rule, the harvests during that time are in the youngest of the existing natural inventory and then the oldest of the managed stands which would be around 110 years old by then. These stands have higher volumes than stands harvested later in the forecast.

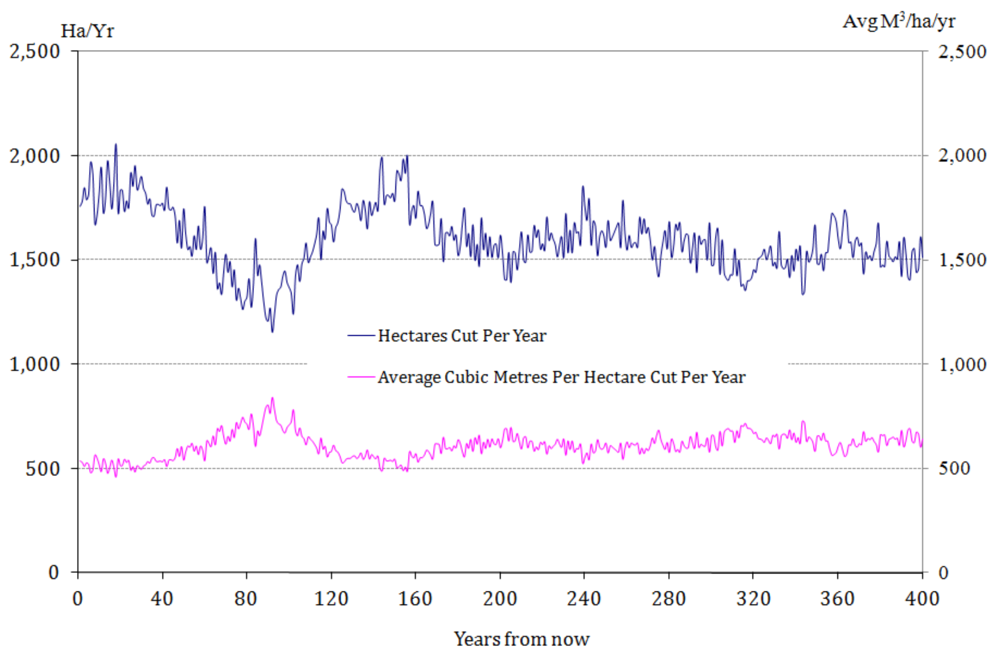

Figure 3: Annual Average Base Case Area and Volume Cut

3.1.3 Age Class Distribution of the Harvest

The following two figures provide other representations of the transition from natural to managed stand harvest and of the effect of the oldest first harvest queue. Figure 4 shows that the average harvest age for about the first ten or fifteen years is over 350 years old. Average harvest age then declines quite steadily until around 90 years into the projection after which it remains close to 115 years.

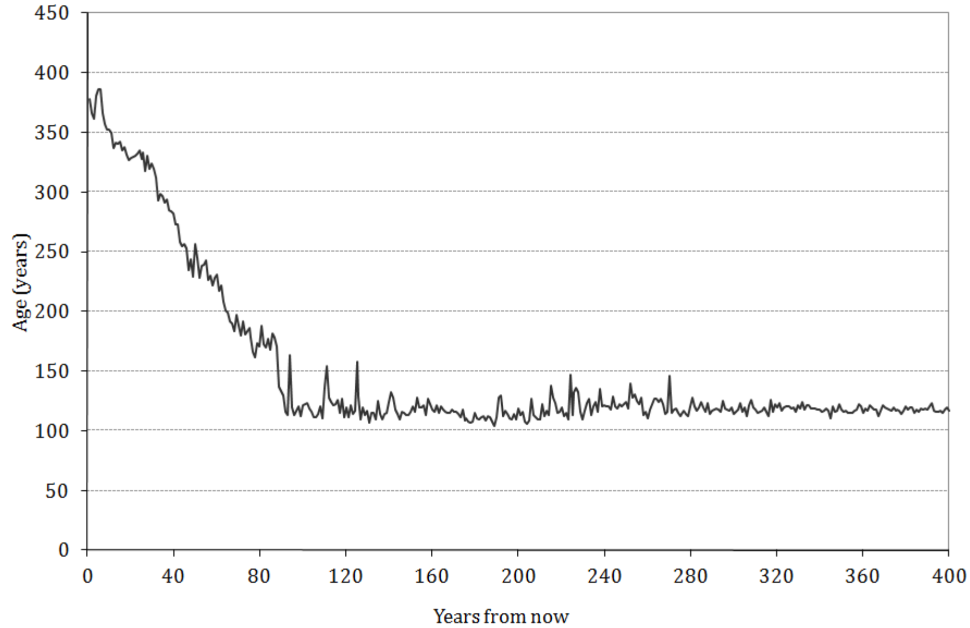

Figure 4: Annual Average Base Case Harvest Age

Figure 5 shows the age class distribution of the harvest using standard age classes. This shows the distribution of harvested ages around the average shown in Figure 4. Even with the oldest first rule, in the first 80 years or so the model is required to harvest younger natural stands. You can also see the dominance of age class 6 (101 to 120 years old) when the transition to harvesting predominantly managed stands occurs. Those are generally the oldest available managed stands at that time.

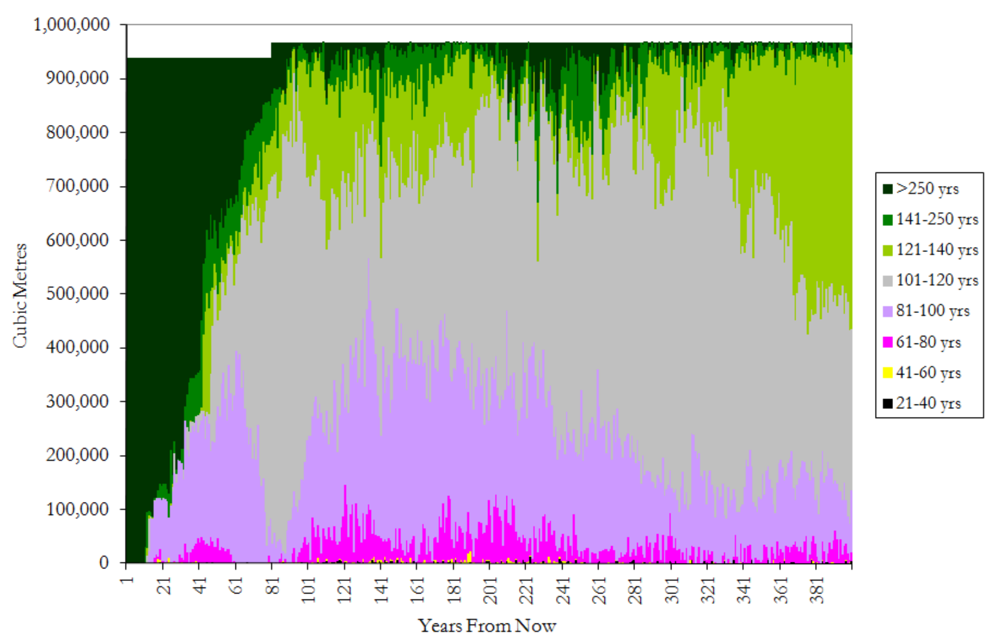

Figure 5: Age Class Distribution of Base Case Harvest Volume

3.1.4 Age Class Distribution of Growing Stock

Figure 6 shows the age class distribution of the timber harvesting land base (THLB) area. The area of age class 9 (forest over 250 years old) on the THLB diminishes due to harvest but doesn't disappear. The persistence of older age classes on the THLB is due mainly to management constraints for hydrology, visuals and landscape level biodiversity. Recall also that significant amounts of old forest are retained due to requirements of the SLUA and LUOO, and have been excluded from the THLB.

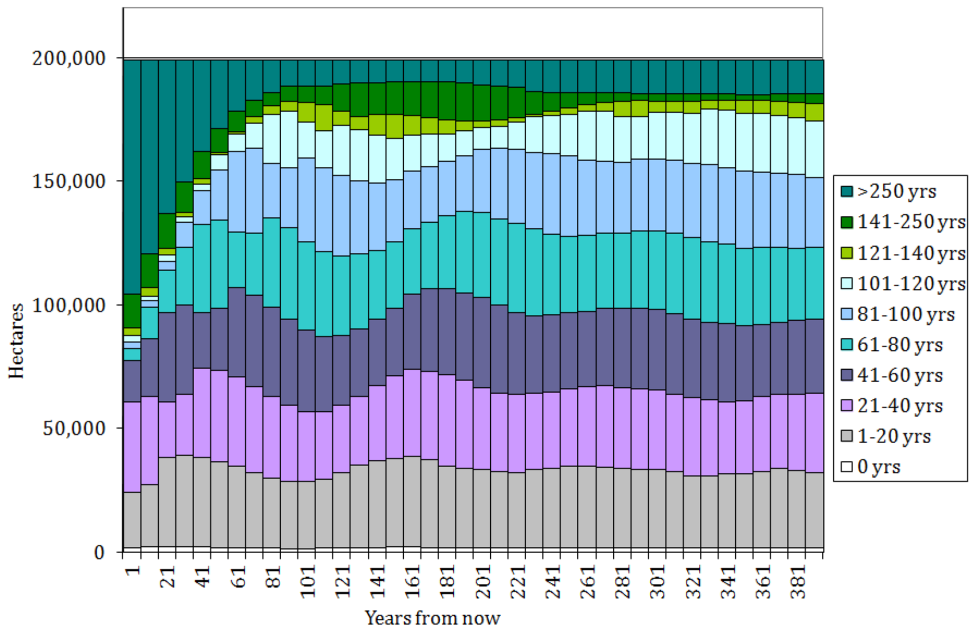

Figure 6: Base Case THLB Age Class Area Distribution

Figure 7 shows the age class distribution of the total forest management land base (FMLB). Parks and conservancies are not included in this amount. All non-forested areas are also excluded. The FLMB includes areas of unstable terrain, economically inoperable area, all the area reserved under the Land Use Objective Order (LUOO) and the THLB. The FMLB is very close to twice the size of the THLB. The projection is for more than half of that area to be older than two hundred fifty years for the long term. Over the long term, the area in each of the younger age classes is fairly constant since area cycles through each class due to harvest and aging. Age class zero represents the amount of harvest in each year.

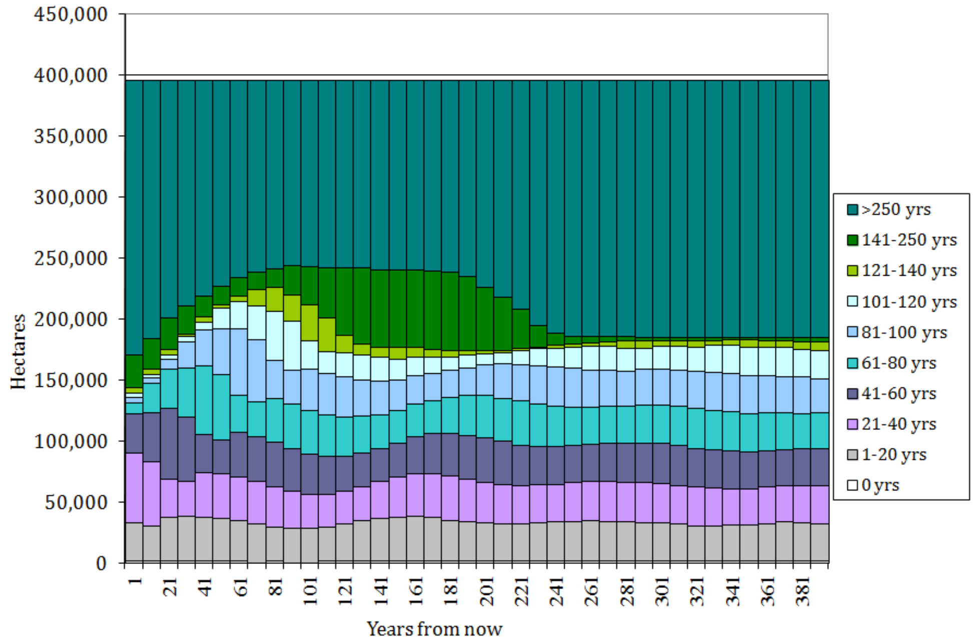

Figure 7: Base Case FMLB Age Class Area Distribution

Figures 8 and 9 are similar to Figures 6 and 7 except they describe the volume of wood rather than area. Figure 8 shows THLB volumes declining for the first 80 years and then gradually recovering over the projection period. The top line of this chart is monitored during forecasting as an indication of harvest level sustainability to ensure it doesn't decline over the long term.

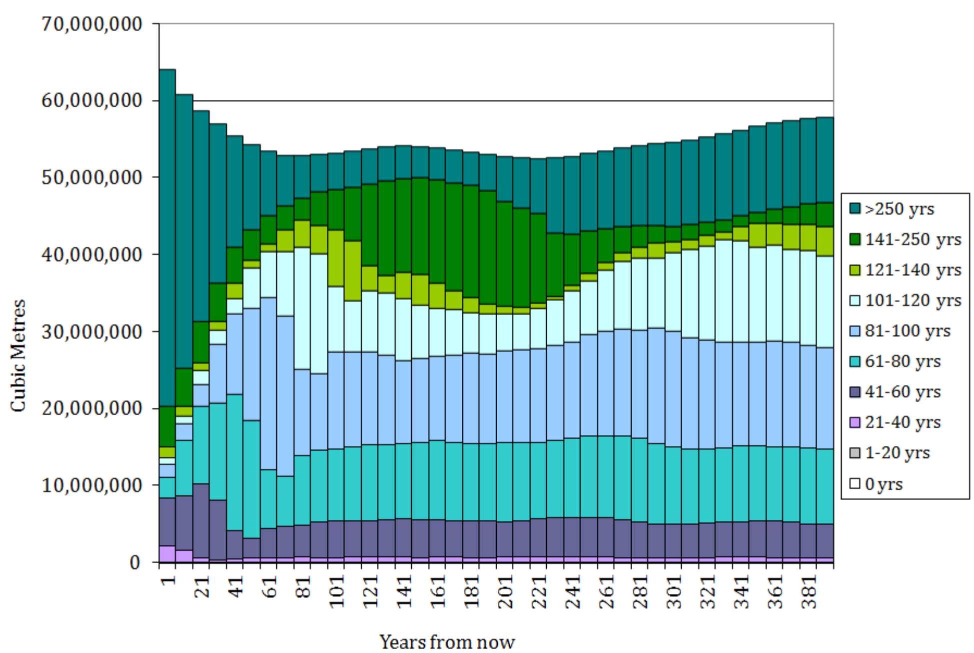

Figure 8: Base Case THLB Age Class Volume Distribution

Figure 9 shows the age class distribution of the FMLB growing stock volume. There are approximately 30,000 hectares of non-THLB FMLB 60 years and younger. Much of these previously harvested areas are now in conservancies and reserves for EBM requirements. It is the projected regeneration of those stands that explains most of the increase in FMLB wood volume or growing stock for the first 140 years of the base case.

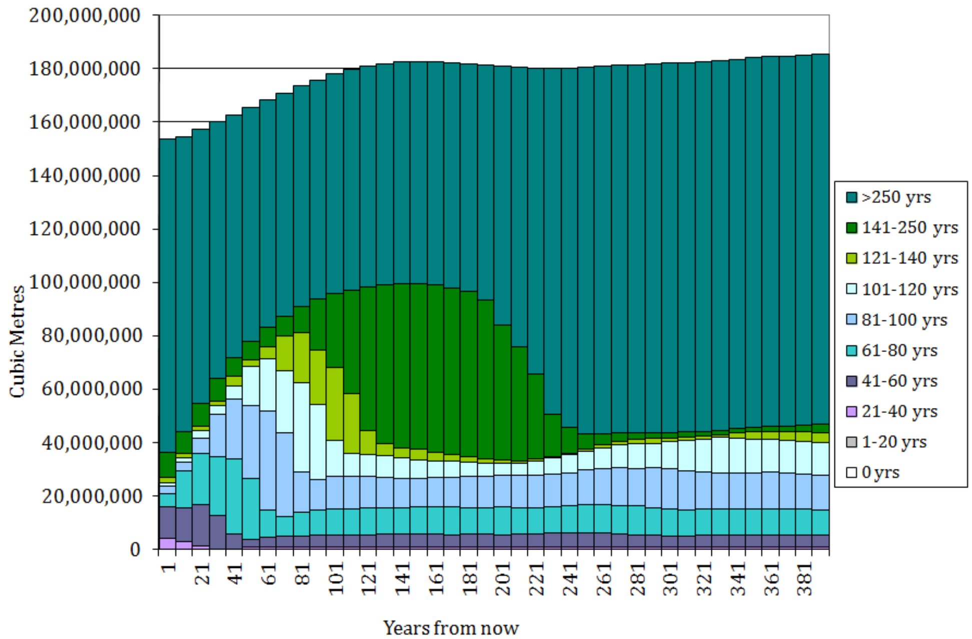

Figure 9: Base Case FMLB Age Class Volume Distribution

3.1.5 Species Distribution

Figure 10 shows the species distribution of the base case harvest forecast. The proportion of the harvest from yellow and red cedar is projected to diminish steadily for the next 80 years from a little over 40% to about 10%. This is because harvestable old growth is diminishing and there is a lag before second growth cedar contributes to the harvest profile.

The regeneration assumptions anticipate the same species composition for regenerating stands as in the preceding harvested stands. So the cedar proportion of harvest is forecast to recover to initial levels in about 110 years. An area chart for species composition is not provided because it is unchanging, again, since regenerated stands are modeled as having the same composition as the previous, harvested stand.

As the cedar component of harvest declines, the spruce and hemlock components generally increase for the first 80 years of the forecast.

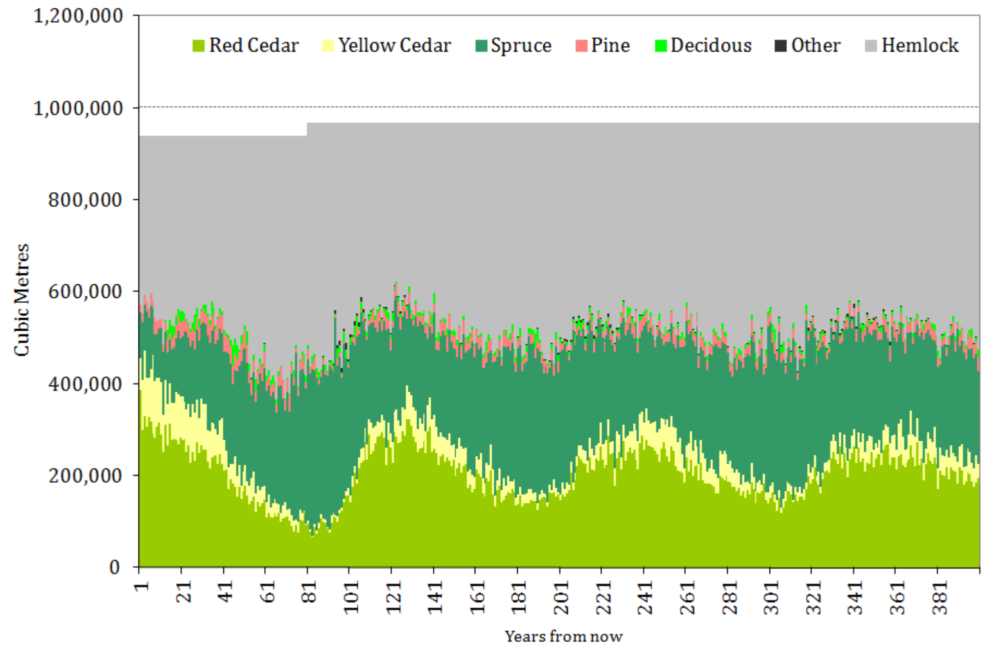

Figure 10: Base Case Species Composition of Harvest

Figure 11 presents the species composition of the THLB growing stock which is the standing volume of timber. The combined proportion of the red and yellow cedar is initially about one third of the total. That declines to less than 20% in 60 years. The proportion of cedar in the harvest is initially higher than the cedar representation in the growing stock because an oldest first harvest queue rule is used, and many of the oldest stands in the forest inventory files have a significant amount of cedar in them.

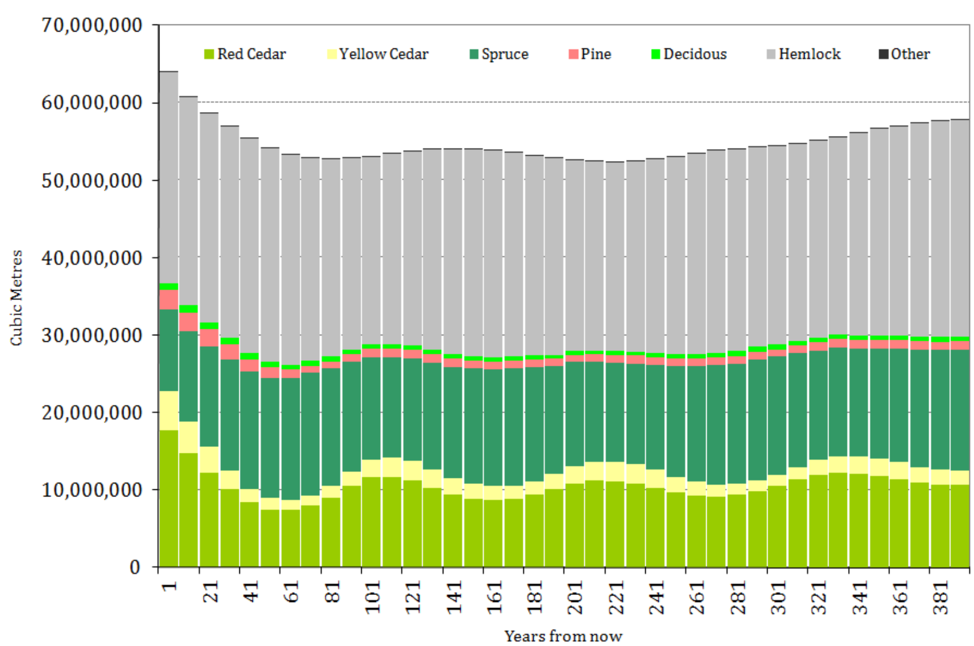

Figure 11: Species Composition of Base Case THLB Growing Stock

Figure 12 shows the FMLB growing stock species composition. The projected fluctuation of cedar volume shown in Figure 11 is much less pronounced when including the non-THLB portion of FMLB. It can also be seen that most of the increase in FMLB wood volume is projected to occur in hemlock and spruce stands.

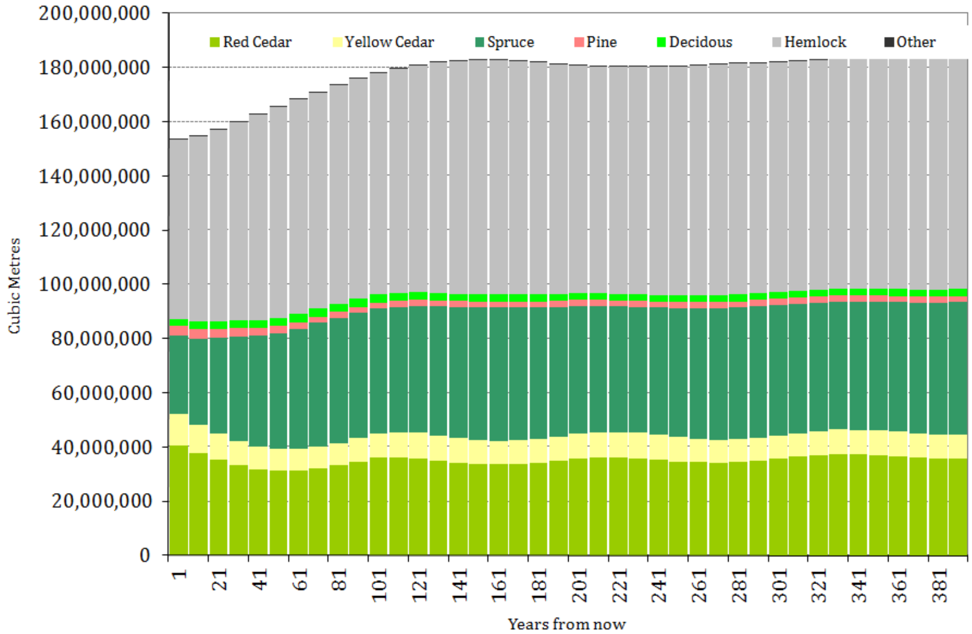

Figure 12: Species Composition of Base Case FMLB Growing Stock

3.1.6 Cedar Age Class Distribution

For charts 13, 14 and 15 yellow and red cedar are combined. Figure 13 shows the age class distribution of THLB cedar area. There appear to be about 4,000 hectares or 7% that are never harvested. Some of this area is permanently reserved and other parts are aging into that class from younger age classes. But in a now familiar pattern, (see Figures 10 and 11), the old cedar is mostly harvested in about 80 years.

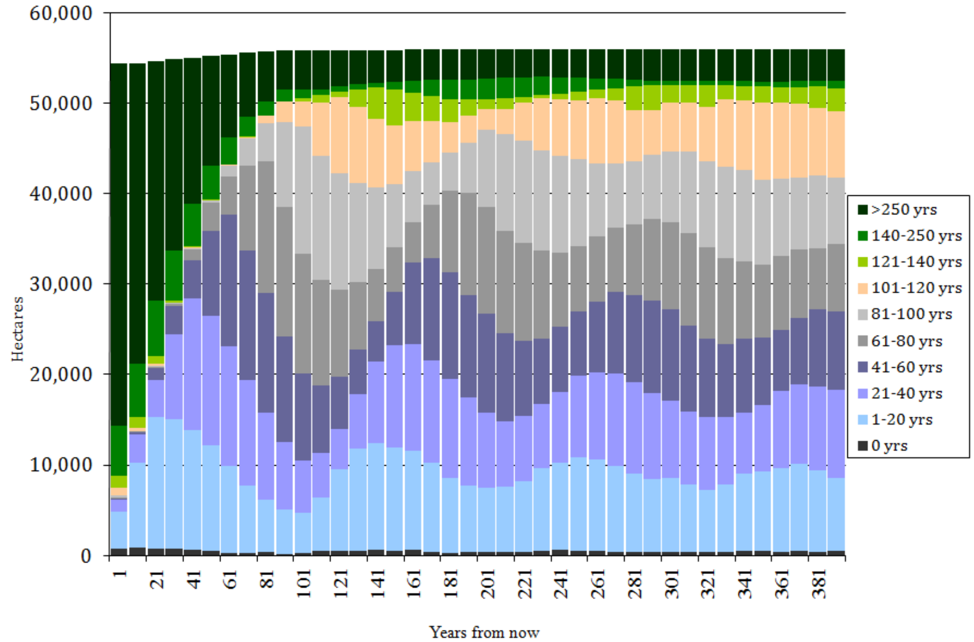

Figure 13: Base Case THLB Cedar Age Class Area Distribution

Now looking at the cedar volume on the THLB in Figure 14, the fluctuation in available cedar becomes more obvious.

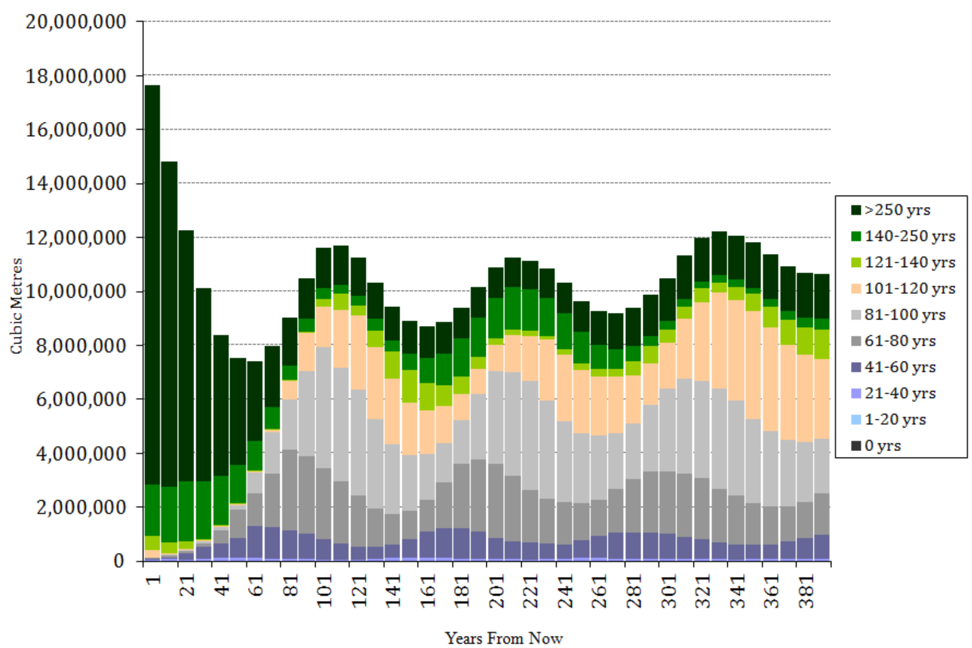

Figure 14: Base Case THLB Cedar Growing Stock Volume by Age Class

Figure 15 shows cedar less than 80 years old contributing a tiny component of the harvest in any given year. It also shows that during the transition from natural to managed stand harvest (60 to about 100 years from now) there is projected to be a limited amount of cedar available for harvest. As shown in figures 10 and 11, cedar harvesting in the base case is approximately proportional to the cedar proportion of the THLB growing stock and after about 80 years from now, most of the cedar harvest is projected to come from stands between 80 and 120 years old. As discussed in the next section, cedar is actually harvested on Haida Gwaii at a disproportionate rate.

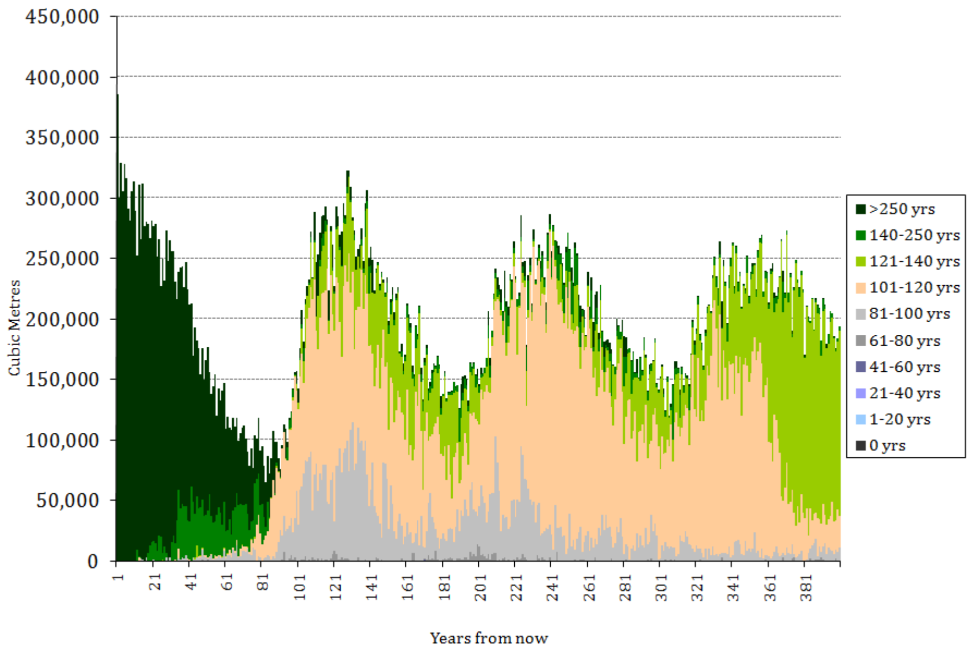

Figure 15: Base Case Harvested Cedar Volume by Age Class

3.1.7 Cedar Harvesting Emphasis

All the forecasts in this analysis were run using an oldest first harvest queue rule. Operationally, there are a range of factors taken into account that are not handled in the model. Species composition, proximity to roads, timber values, development costs, and market prices are some of the other factors besides age that bear on the order of harvest. This is to say that the model does not always prioritize stands the same way the timber industry does.

The proportion of cedar in the harvest is an important case in point. Cedar has had a high market value for close to a decade. Consequently there has been a focus on harvesting cedar on Haida Gwaii, as there has been on other parts of the BC coast. Some have expressed concern that for some time, cedar has been disproportionately harvested in relation to its natural occurrence (harvest rate of 49%, natural occurrence of 34%).

Despite the difference between operational reality and model workings, the base case can tell us about the ability to continue harvesting with a cedar emphasis. The recent emphasis on mature cedar harvests is evident in a review of harvest billing. Between 1995 and 2010, 49% of the billed volume was cedar (41% western red cedar and 8% yellow cedar).

The base case results show that a fall-down in cedar harvesting is approaching. Figures 13 and 14 indicate that there is very little cedar area younger than 120 years and an even smaller proportion by volume. Figure 15 shows the forecast for cedar harvest diminishing over the next 80 to 90 years.

Figure 15 shows that the contribution of old cedar to harvests diminishes to a very low level after about 80 years. However there is a very different answer if we ask the question, "How long can cedar remain in the harvest profile at the current proportion it is being logged?" In the base case forecast about 19 million m^3 are harvested from cedar leading stands over the first 90 years. The old cedar inventory on the THLB is essentially exhausted at that time. Assuming that, consistent with recent levels, 49% of the harvest would be dedicated to cedar; then it would take only 41 years to harvest 19 million m^3 at that rate. This assessment points out that if the current cedar harvesting emphasis were to continue, there may be negligible opportunity to commercially harvest old cedar within 40 years. Given this potential outcome, and based on the projected availability of cedar for harvest (Figure 15), then in 40 years there may be a 60 year period during which cedar barely contributes to the harvest profile. It is inevitable (unless harvest rotations were extended very substantially) that primary old growth cedar will, at some point, no longer be a part of the harvest profile as forest licensees make a transition to managing a THLB landscape that contains very little primary forest.

Another concern is that low and medium productivity growing sites are being avoided while high quality, economically profitable stands growing sites are selected for harvest. This ongoing forest management practice is applied to other tree species as wellThe current AAC has approximately 91 000m^3/yr partitioned for 'low volume cedar' sites. The history of this partition will be explored in a history of AAC on Haida Gwaii within the Haida Gwaii Management Council's 'decision binder.'

3.1.8 Base Case Hydrologic Recovery

Hydrologic recovery is modeled in the base case by ensuring that no more than 20 percent of each sensitive watershed, and 30 percent for each upland stream area, is below nine metres in height. At the same time, the intent for on the ground evaluations of hydrologic status is to recognize proportionate contributions from stands of various heights according to hydrologic recovery curves.

The forest estate planning model FSSAM is not currently programmed to evaluate constraints using variable contributions such as this. However, the status of each hydrology assessment unit was calculated based on the base case results (using FSSAM outputs) creating a fairly accurate hydrologic recovery indicator. This indicator compares modeled outcomes with intended performance. Figures 16 through 19 indicate that the base case hydrology constraints do a reasonable job of modeling hydrological recovery requirements from the LUOO.

Figure 16 shows results for an example sensitive watershed that was selected because more than half the forested area is THLB. The figure shows the compares outcomes of applying 3 recovery curves to the Forest Management Land Base against the minimum requirement of 80% hydrologic recovery. It is projected that for most of the forecast this sensitive watershed would be considered to be in compliance with the LUOO requirement if evaluated either according to recovery assumptions from the Coastal Watershed Assessment Procedure (CWAP), or using a rain-on-snow recovery curve. See Data Package page 84 and 85 for a description of recovery heights.

There is a new stand height-based hydrologic recovery curve based on research being undertaken by hydrologists in the Ministry of Forests, Lands, and Natural Resource Operations. It is identified as appropriate for evaluating hydrologic recovery on Haida Gwaii and similar land bases along the coast of British Columbia. See pages 84 through 88 of the data package for a detailed discussion of hydrological inputs used in the analysis. According to the new recovery curve, in the base case this sensitive watershed is also forecast to meet the LUOO maximum equivalent clear-cut area of 20% in most periods.

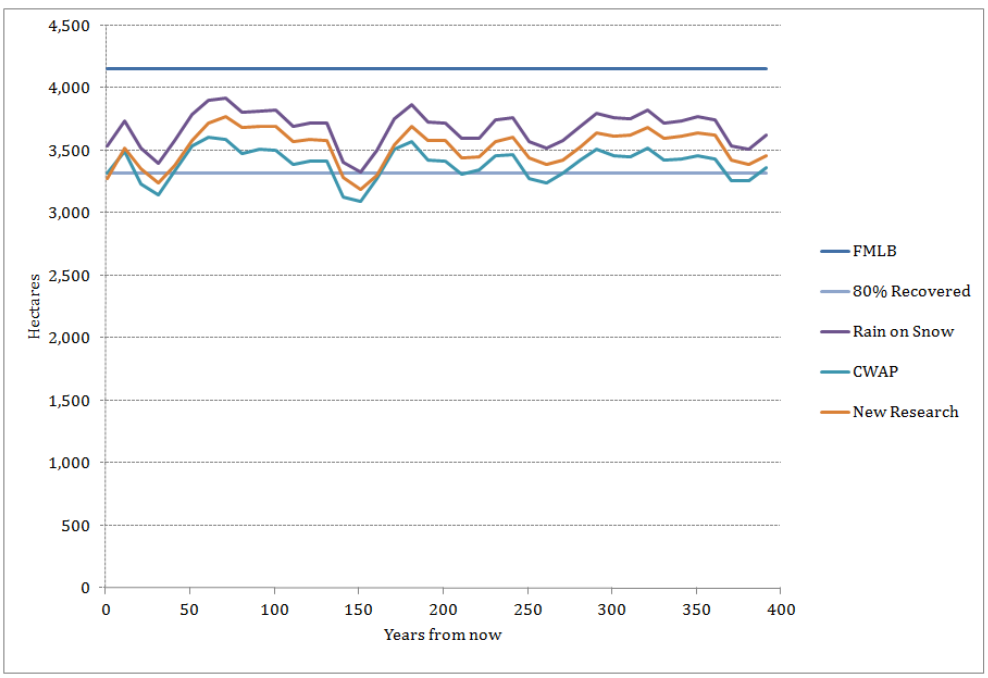

Figure 16: Example Sensitive Watershed Hydrology Performance

The same general trend applies to Figure 17 which is an aggregation of all sensitive watersheds in landscape units with at least some THLB, which are the only areas where harvesting may occur and hence where hydrological recovery may be an issue. Taken in aggregate, the sensitive watersheds are hydrologically greened up according to CWAP, the rain-on-snow curve and the new research curve.

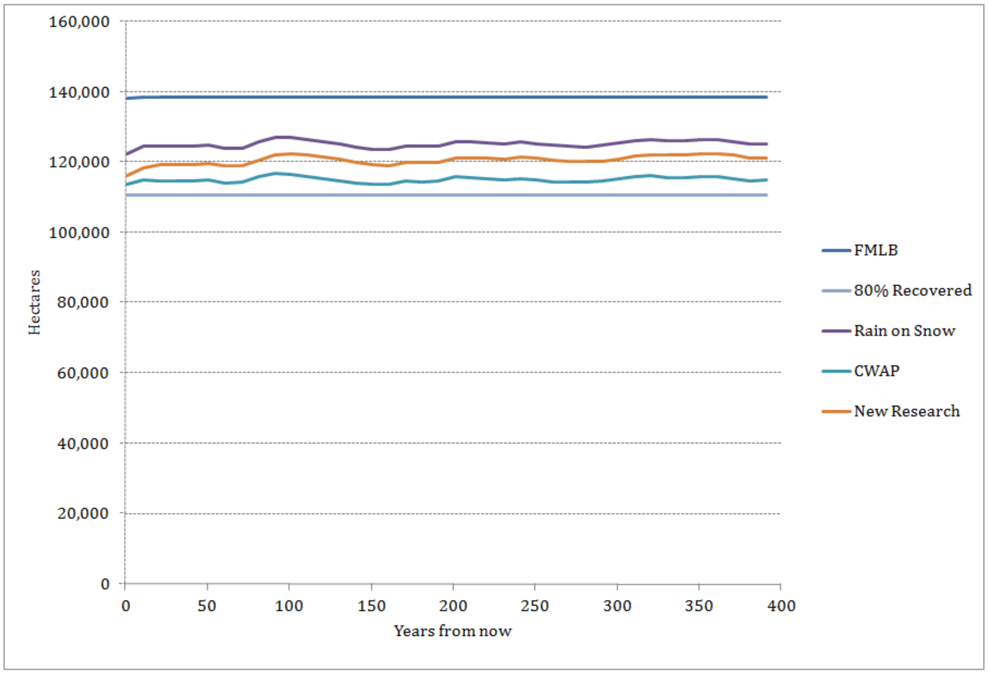

Figure 17: Base Case FMLB Hydrologic Recovery Status of Sensitive Watersheds Aggregated

Figures 18 and 19 deal with the hydrologic recovery status of upland stream areas. Figure 18 is an example of a particular upland stream area sub basin. It was chosen for being large in size and mostly THLB. In the base case forecast, this example area complies with the LUOO requirement using each of the relevant measures including the new research curve.

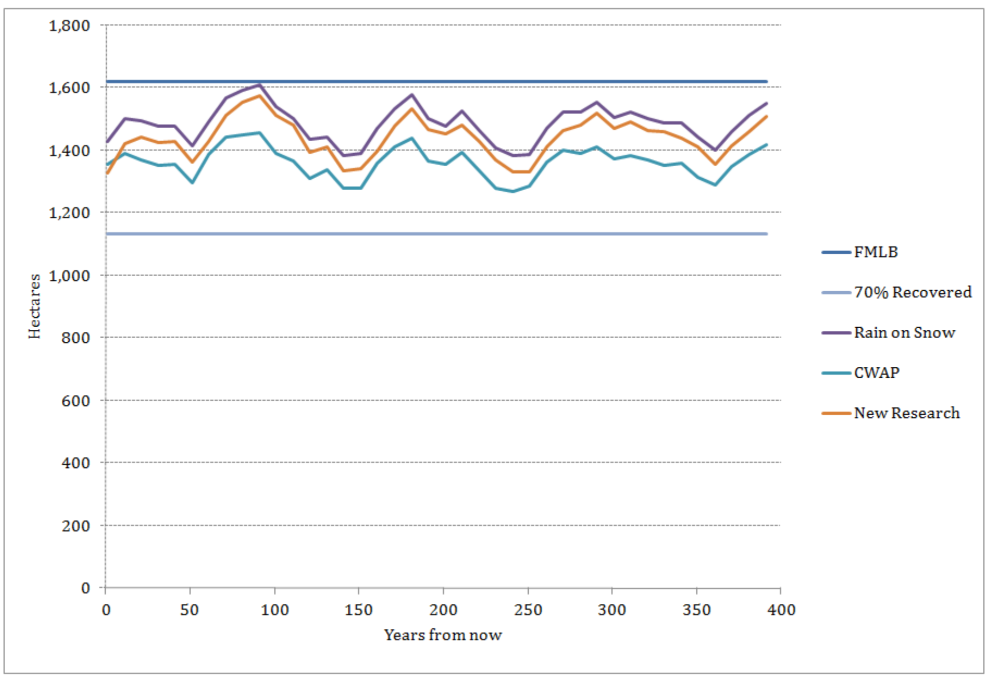

Figure 18: Example Upland Stream Area (18_526) Hydrology Performance

Figure 19 is an aggregation of all upland stream areas in landscape units with some THLB. On average, the land-base as a whole meets the LUOO requirement for hydrologic green-up according to the CWAP, rain-on-snow and new research curves.

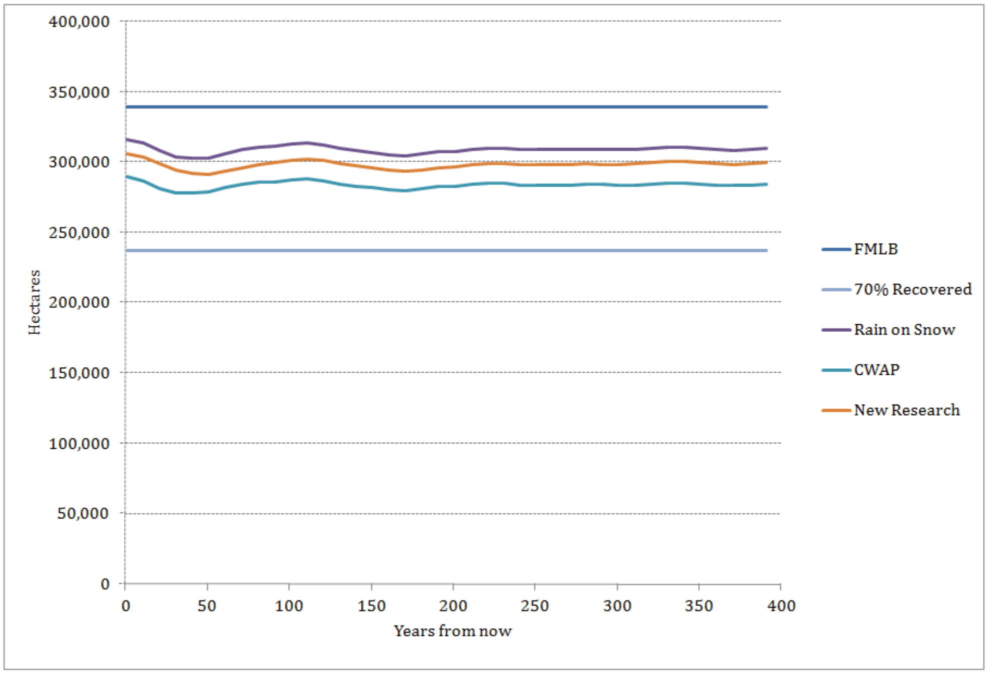

Figure 19: Base Case FMLB Hydrologic Recovery Status of Upland Stream Areas

The distance between the constraint and the hydrology condition is larger for upland stream areas on Figure 19 than it is for sensitive watersheds on Figure 17. This indicates that upland stream requirements tend not to be a driving constraint. The sensitive watershed requirements are generally not limiting either. However their status runs closer to the constraint, so tightening the requirement could constrain timber supply.

3.1.9 Long Run Sustained Yield

Long run sustained yield (LRSY) is the theoretical maximum sustained yield from the THLB. It could only occur on an un-constrained land base where there is a continuous supply of stands being harvested at their biological culmination (maximum average timber production). The calculation is for THLB only and is the sum of managed stand maximum mean annual increments multiplied by areas.

UNIT_TB	LRSY	LTHL (without removing non-recovered losses)	LTHL Pct of LRSY
TFL58	82,359	76,009	92.3%
TFL60	388,617	342,462	88.1%
TSA25	654,324	550,000	84.1%
TOTAL	1,125,300	968,471	86.1%

Table 1: LRSY Vs LTHL

Overall, the long term harvest level (LTHL) is approximately 14 percent below the 'optimal' yet un-attainable LRSY (Table 1). Several observations help to explain. Forest cover requirements are applied to achieve non-timber objectives within the model. These management constraints in many cases ensure that some stands are not harvested until much later than culmination age. Also, some stands are not even harvested once in the 400 year planning horizon which can be due to those management constraints. And, as shown in Figures 6 and 8, the age class distribution is uneven at first. Most of the THLB area is over 250 years old, and only about 20% is between 40 and 250 years old. It takes about 200 years to create a fairly even age class distribution.

4 Base Case Alternative Forecast

There is not much flexibility to raise the initial harvest level in the three management units while adhering to the harvest flow principles described in the data package (pp. 64-65). It was possible to raise the initial level by 7.4% on the TSA, and only for 10 years. Any increase beyond that created harvest failures in the mid-term. No increases in the initial level were possible for the TFLs without causing disruptions in the future. These results, which are shown in Figure 20, indicate that the base case is a very tight forecast which ensures it will be responsive in sensitivity tests. It is possible to raise initial harvest levels further, but only by accepting a fall-down in the mid-term, and that was not desired in this analysis.

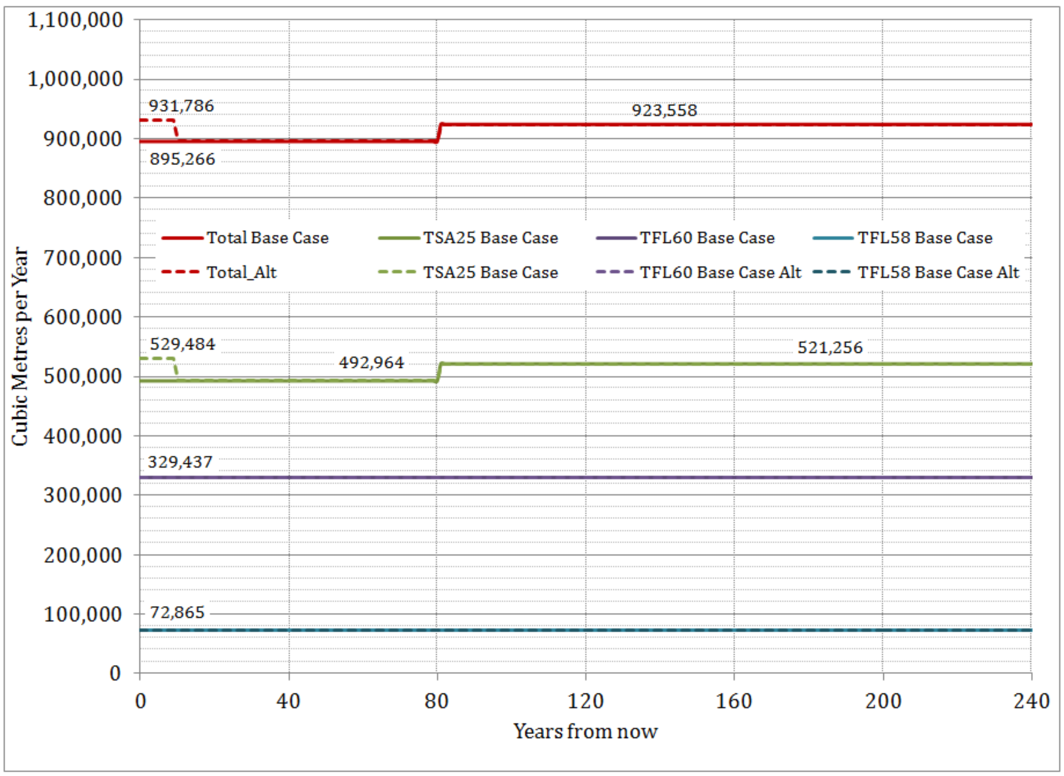

Figure 20: Base Case Alternative Forecast

5 Sensitivity Analyses

Once the base case data set is fully assembled and base case harvest forecasts are accepted, it is possible to use the model to ask a range of questions about what would happen to timber supply if things were different than in the base case. For this TSR, the sensitivity analyses asked about

- Combining the management units
- Allowing for the potential of shorter rotation ages
- Ensuring longer rotation ages for greater timber value
- Basing yield predictions on lower than expected site level timber growing potential
- The possibility that volumes in the natural forest inventory are higher
- Uncertainty regarding hydrologic recovery of watersheds
- Consistently risk managing several LUOO provisions at once

The answers to these questions come in the form of the magnitude, if any, of changes to timber availability. Those answers and their interpretation are intended as decision support in the allowable annual cut determination.

5.1 Single Management Unit Sensitivity

The Haida Gwaii Management Council is required to make an allowable annual cut (AAC) determination for Haida Gwaii as a whole. The Chief Forester is required to make AAC determinations for the management units on Haida Gwaii such that their sum does not exceed the HGMC determination.

Can the entire THLB taken as a whole sustain any more harvest than the sum of the three management unit forecasts in the base case? This sensitivity considers the impact on timber availability of assuming that all the THLB lies within one management unit. Combining the management units allows the timber supply model additional flexibility. For instance, it has the potential to fill a gap in available timber within one management unit (MU) with volume from another MU.

As shown in Figure 21, this increases timber availability by 10.3% for the first forty years and by 5.1% for the following forty years. Long term timber availability is projected not to change. Haida Gwaii is currently divided into three management units, and there is no plan at this time to combine them into one. In fact, currently there is a plan to establish another management unit on land that is now part of the TSA, which will have its own AAC. So, the likelihood is higher that the number of management units will increase rather than decrease. This sensitivity was done simply to see the potential influence of including all the THLB in one MU.

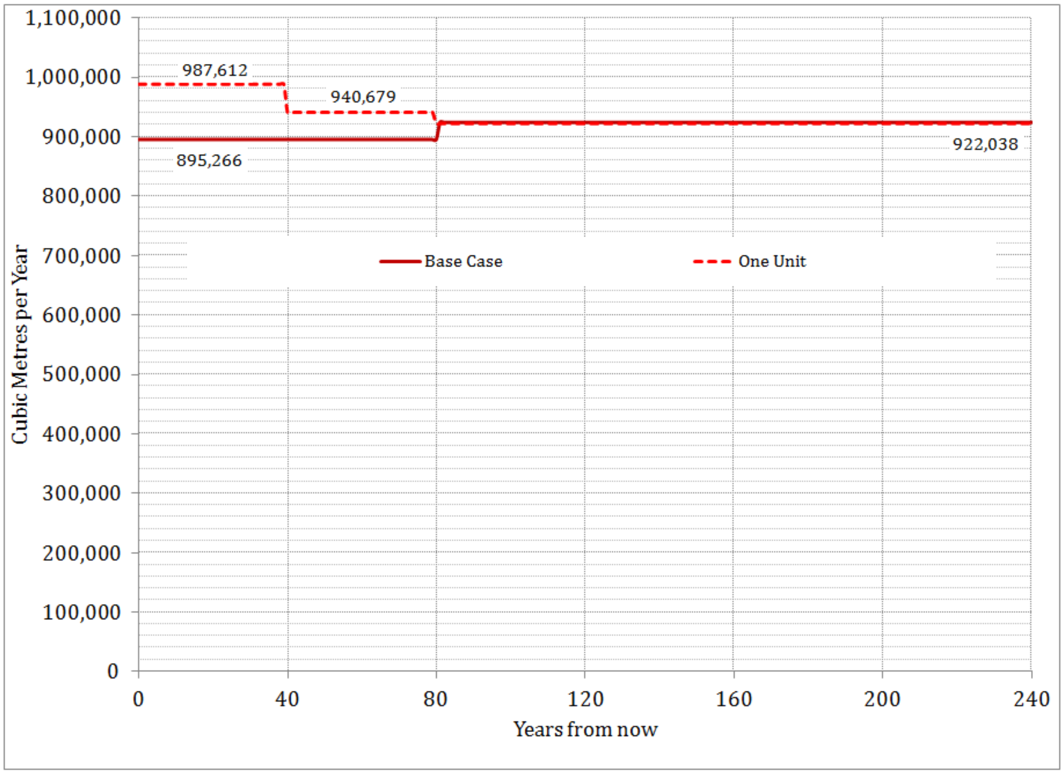

Figure 21: One Management Unit Sensitivity

5.2 Minimum Harvest Age Sensitivities

The minimum harvestable age (MHA) is an approximation of how long a stand takes to reach a harvestable condition. In the base case, MHAs were based on the biological optimum age, or maximum productivity: the age at which a stand reaches 95% of culmination mean annual increment (CMAI). Two sensitivity analyses were run to address the question, "What happens if stands are harvested much later, or much earlier than what was modeled in the base case?"

In one sensitivity test, base case MHAs were raised by 20% to simulate a desire to allow stands to develop higher quality logs. In the other, base case MHAs were reduced by 20% to shorten the time between investment in silviculture and receiving revenue from harvesting. These sensitivities provide a reasonable idea of the general magnitude of change that could stem from a focus on either higher quality logs or economic rotations. The details of the economic rotation age approach and the product based approach to higher value logs are provided in the data package.

5.2.1 Older Minimum Harvest Age

The older MHA sensitivity looked at the effect of assigning stands MHAs 20% older than the base case. This is driven by the idea of a product-based MHA. The data package includes a description of an analysis that explored the grade distribution of harvests over the last 10 years. Extending MHAs by 20% does not result in the same proportion of higher grade logs as in historic harvests. Harvest Billings Systems (HBS) data shows that older stands are typically harvested with over 40% H grade and I grade logs. Although this ratio of log grades does not occur until stands are as much as 43% older than the base case MHAs. , the 20% older MHA sensitivity still provides insight into the implication of waiting longer for stands to grow more of the higher grade logs.

Increasing MHAs by 20% forces the model to wait longer for some stands to become available prior to harvesting them. Like the base case, the majority of stands in the existing natural inventory remain available for harvest from the start. They are well above MHA in either case. However, higher MHAs do decrease timber availability over the long term and extend the time until reforested stands become available for harvest. Specifically, extended MHSs also affect the availability about 80 years into the forecast during the transition to harvesting managed stands. With the application of the non-declining flow rule, this leads to lower initial harvest levels as well.

As shown in Figure 22 the harvest level is about 6.5% lower for the entire forecast. The impact varies somewhat depending on management unit. For TSA 25 the forecast is about 8.5% lower than base case. TFL 60 and TFL58 are both about 4.2% lower with the higher MHAs.

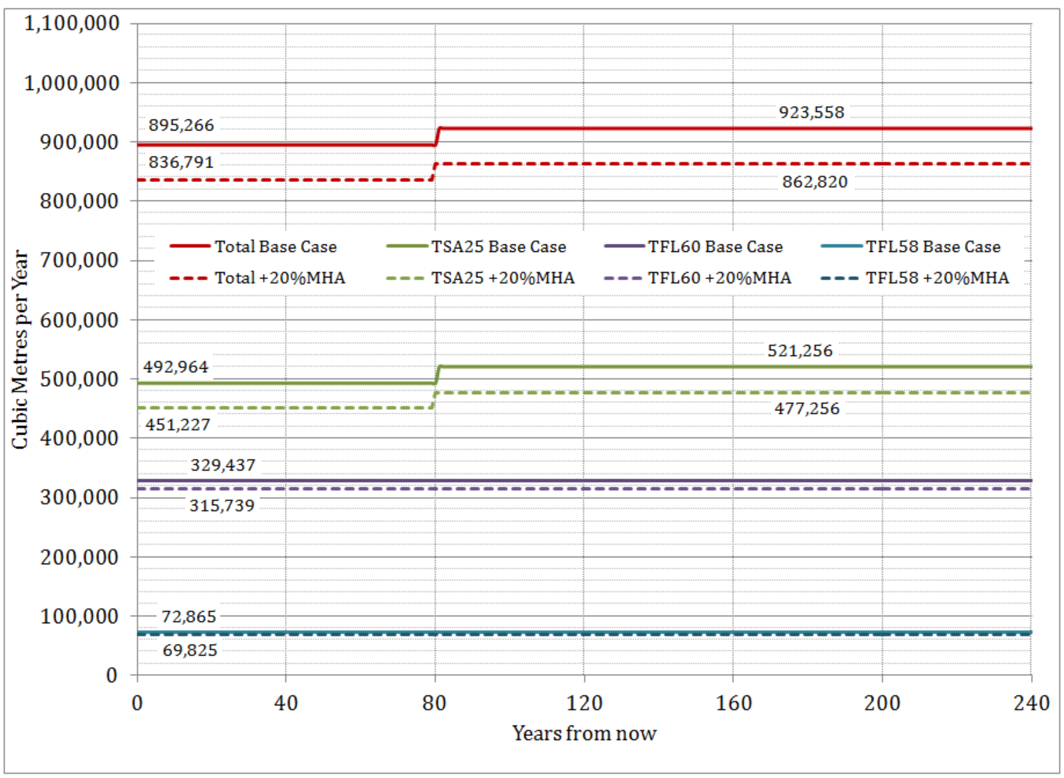

Figure 22: 20% Older Minimum Harvest Age Sensitivity

5.2.2 Younger Minimum Harvest Age

The younger MHA sensitivity used MHAs 20% younger than those used in the base case. This explores economic rotation ages whereby stands are typically harvested at younger ages, because an assumed interest rate (or discount rate) is used which assigns greater value to a dollar today than a dollar decades into the future. Therefore the monetary values of stands (future values minus future costs) tends to be highest before biological culmination.

So, decreasing MHA is like assuming stands will be available for harvest at an economic rotation age that occurs well ahead of their projected biological culmination age. This adjustment increased short term timber availability which is expressed with three orderly steps down to a level very close to the base case mid and long term levels. The additional depletion of the growing stock allowed by the lower MHAs did force the LTHL down slightly.

As shown in Figure 23, for the first 20 years the harvest level is 10.7% higher than base case. The next 20 years the harvest level is 7.1% higher than base case. From 40 to 60 years from now the level is projected to be 3.2% higher. For the remainder of the forecast the harvest level is projected at 1% below base case.

Harvesting stands at younger ages may be driven by broad economic considerations such as proximity to log dumps and good market prices. Faster growing sites may also be favored. The 10 year volume billings data analysis shows that stands with lower grades (J grade and better) represent around 65% of stands harvested on Haida Gwaii. Further, the analysis indicated that on average stands would reach that J grade composition at ages 44% younger than the base case MHAs.

This sensitivity indicates significantly greater short term timber availability when MHAs are reduced. The higher short-term harvest is mainly due to improved timber availability when the dominance of natural stand harvest ends. The lower long term level results from harvesting prior to stands reaching the maximum MAI.

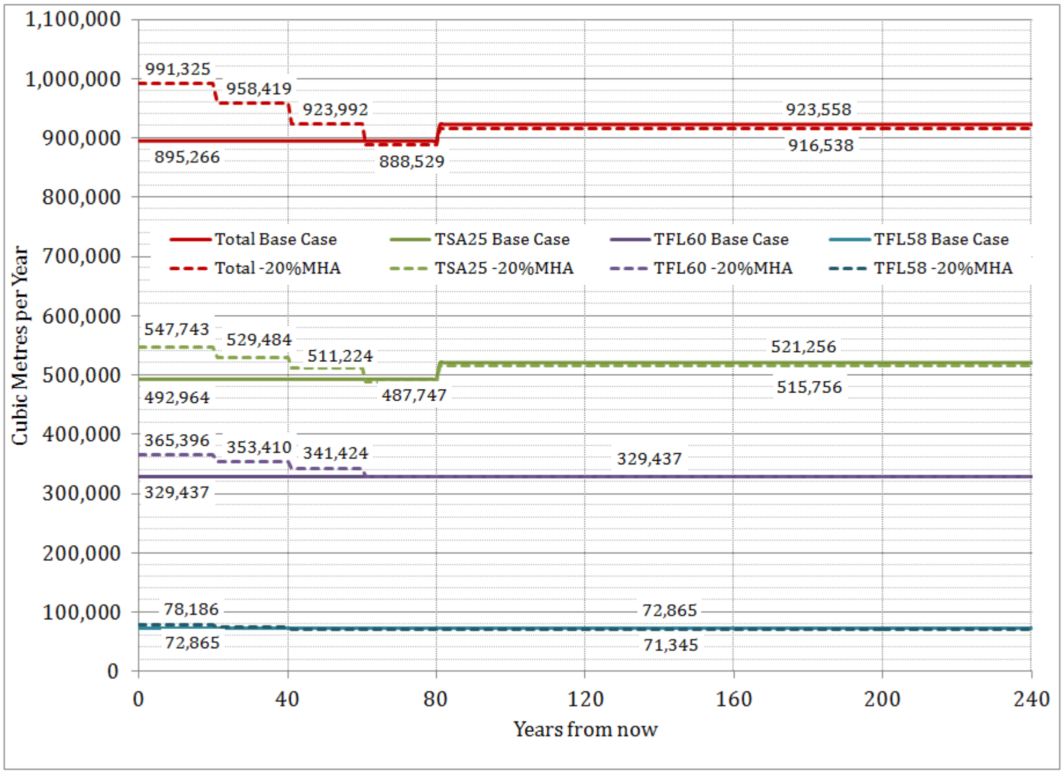

Figure 23: 20% Younger Minimum Harvest Age Sensitivity

5.3 Inventory Site Productivity Sensitivity

Site index (SI) in BC is defined as the height a stand's dominant trees reach at breast height (1.3m) age of 50 years. It is a measure of site productivity and an input for generating stand yield tables. Inventory attributes and Site Tools are used for defining SI for modeling existing natural stands with the Variable Density Yield Predictor (VDYP). Site Tools is a site index and growth model that utilizes attributes such as species, age, and height within the inventory to derive a site index. Site Tools and inventory data were typically used to define site productivity in previous TSR's for the Timber Supply Area on Haida Gwaii. However other approaches, such as assigning SI based on ecosystem, have been used in previous TSRs for TFLs.

Other sources of SI are often used for generating managed stand yield tables using TIPSY since inventory attributes of old existing stands are usually not good indicators of productivity. Several methods of better estimating site productivity are available on Haida Gwaii. These vary in where they may be applied and in level of confidence. The stump SI study (also known as logged and regenerated or LAR), the site index adjustment study (SIA), and site index by ecosystem classification (SIBEC) are described in detail in the data package.

In the Site Tools sensitivity analysis, areas that were assigned SI using SIBEC in the base case were assigned SI based on the inventory attributes using Site Tools. However, RESULTS and stump SIs were used in both model runs where either RESULTS information was available or where the stump SI study applied (i.e., spruce and hemlock leading stands over 140 years old) since there is good confidence for using LAR and RESULTS in the applicable areas. In the base case, SIBEC was used everywhere else as the next best estimate of SI. Figure 24 shows THLB area in hectares where the different SI estimates are used. Grey represents base case and red is the Site Tools sensitivity.

This sensitivity addressed the question, "What if site productivity estimates derived from forest inventory data more accurately reflect site productivity than TEM/SIBEC?"

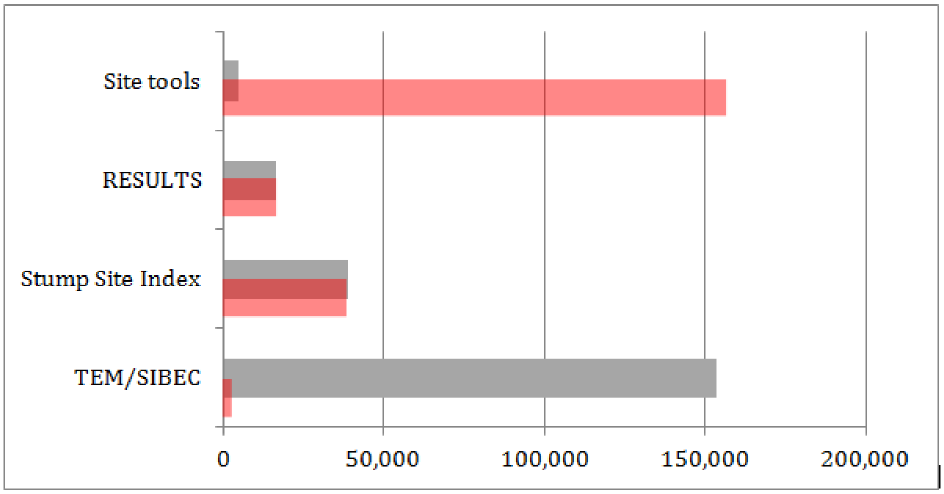

Figure 24: SI Estimate Method Areas - Base Case Vs Site Tools Sensitivity

Before the results of the sensitivity test are given, here is a discussion of the magnitude of the change in site productivity estimates. Table 2 shows area-weighted average (AWA) SI for the base case, and for the Site Tools sensitivity analysis. The base case has higher site indices for most species except alder which doesn't change, and hemlock.

Leading species	AWA SI Base case (m@50 years)	AWA SI Site Tools sensitivity analysis (m@50 years)	Differenc
Cedar	17.0	11.5	-5.5
Alder	23.6	23.6	0.0
Hemlock	23.6	25.3	+1.7
Pine	15.4	14.0	-1.4
Spruce	27.7	26.4	-1.3
Yellow cedar	15.5	13.6	-1.9

Table 2: Base Case Vs Site Tools Sensitivity SI by Species

Table 3 shows THLB areas and SIs for only those areas where the SI changed between the base case and the Site Tools sensitivity analysis. Since LAR applied to spruce and hemlock over 140 years old, and since RESULTS applied to most managed stands, the hemlock and spruce areas in the following table are mostly natural stands less than 140 years old. Stands older than 140 years are included for the other leading species. Here again hemlock leading stands have lower site productivity in the base case than in the sensitivity.

Leading species (Sp1)	Mgmt unit	THLB (ha)	AWA SI Base case (m@50 years)	AWA SI Site Tools sensitivity analysis (m@50 years)	Difference
Western Red Cedar	TFL58	2,589	16.5	13.8	-2.6
	TFL60	9,477	19.2	12.4	-6.8
	TSA25	64,875	16.7	11.3	-5.4
Alder	TFL58	70	22.8	22.8	0.0
	TFL60	293	22.9	22.9	0.0
	TSA25	1,725	23.7	23.7	0.0
Western Hemlock	TFL58	6,500	21.2	22.2	0.9
	TFL60	36,871	23.8	26.2	2.3
	TSA25	38,233	23.7	24.9	1.2
Lodgepole Pine	TFL58	29	13.8	13.8	0.0
	TFL60	219	16.5	15.4	-1.1
	TSA25	3,184	15.3	13.9	-1.4
Sitka Spruce	TFL58	3,638	28.5	25.6	-2.9
	TFL60	7,849	26.9	25.9	-1.0
	TSA25	14,620	27.9	26.9	-1.0
Yellow Cedar	TFL58	395	13.0	12.3	-0.7
	TFL60	3,100	16.0	14.5	-1.5
	TSA25	3,673	15.3	12.9	-2.4

Table 3: Base Case Vs Site Tools Sensitivity SI by Species and by MU

Tables 2 and 3 show that the area weighted average SI is higher for hemlock-leading stands in the Site Tools/inventory attribute sensitivity analysis than for the base case. This discovery was unexpected. Potential causes for this anomaly are (1) SIBEC SIs for hemlock in the site series on Haida Gwaii are simply lower than expected, and (2) uncertainty about hemlock inventory attributes or the SI relationship for hemlock in Site Tools.

The 2010 Site Index Adjustment (SIA) study for the TSA can give some insight on this issue. In the TSA where the SIA study is applicable, SIA average for hemlock was 25 m. The base case SIBEC values for hemlock leading stands on the TSA is 24.9 metres (Table 3). This similarity gives some corroboration for SIBEC values used in the base case. So, the issue with hemlock SI is more likely due to uncertainty about hemlock inventory attributes.

As shown in Figure 25, the forecast is lower with the lower site productivity estimates provided by inventory attributes and Site Tools. The harvest level is 6.2% lower than the base case in the short term and 9.0% lower in the long term. The impacts differ by management unit. On TSA 25 the short term harvest level is 13.5% lower and the long term is 18.1% lower. TFL 58 is 8.3% lower throughout the forecast. In contrast, the harvest level on TFL 60 is 4.9% higher than the base case.

Without Tables 2 and 3 and the discussion about hemlock SIs above, the TFL 60 result would come as a surprise. However knowing that the majority of TFL 60 is hemlock leading and that Site Tools estimates are on average 2.3 metres taller there than in the base case explains the higher forecast for TFL 60 in this sensitivity

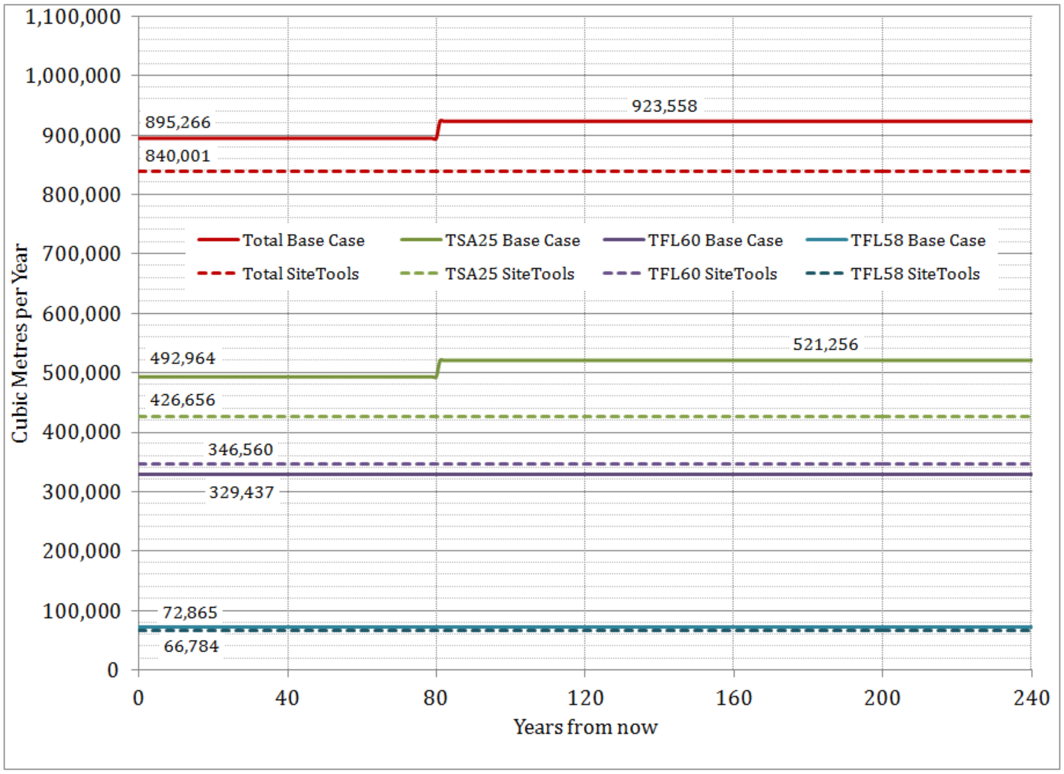

Figure 25: Inventory Site Productivity / Site Tools Sensitivity

5.4 Taper and Loss Volume Adjustment Sensitivity

A study of tree shape (taper) and decay was done on Haida Gwaii during the 1990s, and results were reported in 1999. It is described starting on page 35 of the data package, and it showed that, in general, existing older trees contain more sound wood volume than indicated in the current Variable Density Yield Predictor, VDYP7.

In this sensitivity analysis, the tree-level taper and loss factors developed in that study were applied to timber yield tables for existing older stands, addressing the question, "What if we apply new loss factor and taper equations to the growing stock?" They were applied according to species and age category using the volume adjustments shown in Table 4.

Age Group	Cedar	Hemlock	Spruce	Cypress
Immature (>60 and <140yrs)	+10%	+2%	+1%	N/A
Mature (>=140yrs)	+41%	+19%	+3%	+17%

Table 4: Volume Adjustment Factors from Taper and Loss Study

The overall effect on growing stock of applying those adjustment factors are shown by management unit in Table 5. Growing stock increased by about 19% across the FMLB, but that varies by MU. The magnitude of the differences is very similar if the focus is the THLB, but that is not shown.

	Current Growing Stock (m^3)		
FMLB	Base Case	VDYP Adjusted	% difference
TFL 58	16,324,022	18,803,214	15.2%
TFL 60	118,572,899	140,530,110	18.5%
TSA 25	313,562,310	374,725,196	19.5%
Haida Gwaii	448,459,231	534,058,520	19.1%

Table 5: Taper and Loss Adjustment Volume Comparison

With the volume adjustments completed, a forecast was produced which shows the influence of that additional volume on timber availability (Figure 26). The initial harvest level is 21.0% higher than base case for 20 years. From 20 to 40 years into the forecast, the harvest level is 13.7% higher than base case. And from 40 to 80 years the harvest level is 6.7% higher than base case. Long term harvest levels are equivalent to those of the base case.

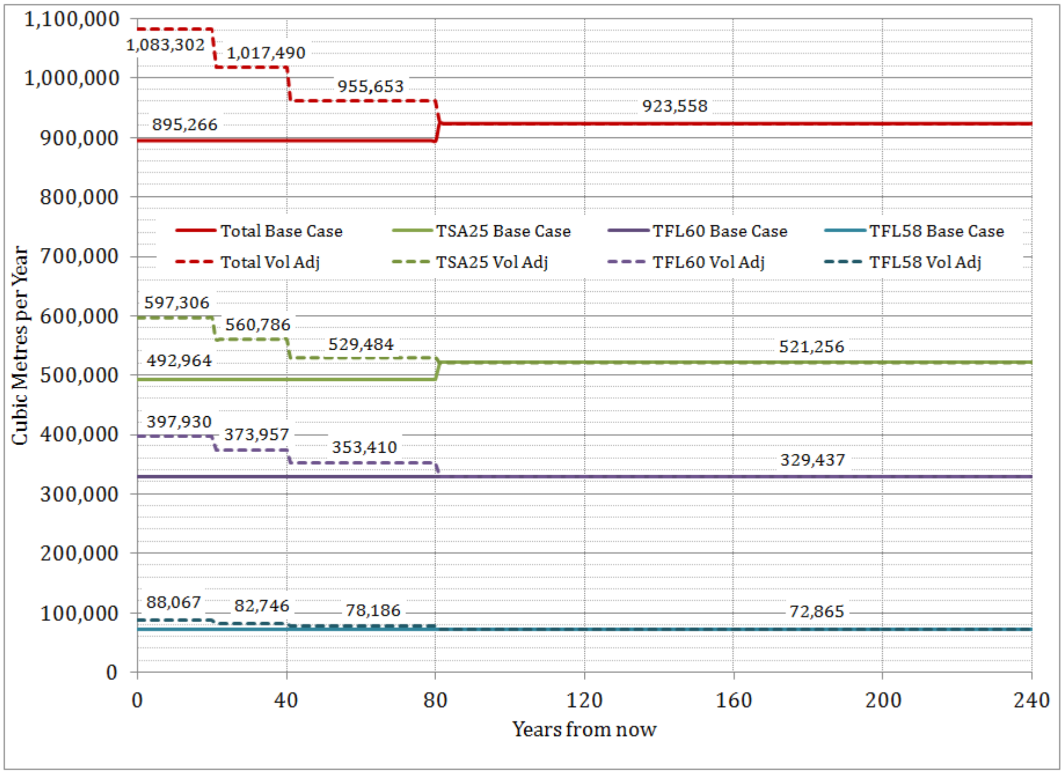

Figure 26: Taper and Loss Volume Adjustment Sensitivity

The application of the ratios provides a general idea of the potential volume underestimate. However, as described on page 36 of the data package, there are caveats attached to this study:

- It is about 20 years old, so could be considered somewhat dated;
- The factors apply at the individual tree level and aren't strictly applicable to stand-level yield curves. The sensitivity therefore only provides a general idea of how inventory volume estimates would change given integration of the taper and loss factors into VDYP7, and;
- The application of the new taper equations and loss factors would affect volumes differently at different ages and in different types of forests, therefore can only provide a general idea of potential volume underestimate.

5.5 Hydrologic Green-up Sensitivities

Section 2.1.7 of this report describes the LUOO requirements for sensitive watersheds and upland stream areas. This section describes 2 sensitivity analyses conducted for hydrologic green up.

For the base case, hydrologic recovery was modeled using an area-weighted average stand age as a surrogate for tree heights for each type of assessment area (either sensitive watershed or upland stream). The best information and knowledge available when preparing inputs for the base case indicated that hydrological recovery for both sensitive watersheds and upland stream areas should be based on a rain-on-snow recovery curve which indicates 90% recovery at 14m.

The forest estate model used for the analysis cannot account for the partial contribution to hydrological recovery from the younger, shorter stands in a watershed. It can recognize a stand as either recovered or not based on a given threshold age.

To address this issue an assessment was done to determine how the binary threshold could be adjusted to account for partial contributions of shorter stands. It was determined that for the base case, lowering the threshold height for hydrological recovery to 9m from 14m reasonably accounts for these partial contributions. The discussion in section 2.1.7 deals with the evaluation of base case outcomes.

Nevertheless, research on hydrological recovery is ongoing, and there is still uncertainty about what stand and watershed conditions will be adequate to achieve hydrological objectives. Two sensitivity tests were conducted to evaluate the sensitivity of the base case to changes in hydrologic green-up constraints. Decreasing the green-up height from the base case level of 9 metres to 7 metres represents a relaxation of these constraints. Increasing the green-up height to 14 metres tightens the constraint.

5.5.1 7 Metre Hydrologic Green-up

A sensitivity test using a 7 metre recovery was run to account for continuous variable contributions from shorter stands and represents less restriction on timber availability and addresses the question, "What if shorter stands contribute even more to hydrologic recovery?" The 7 metre threshold was also used during past timber supply analyses (2009, 2007) and therefore acts as a useful comparative benchmark.

There was only limited potential for increasing initial harvest levels after easing the hydrologic green-up constraint. This suggests that either the base case is not especially limited by the LUOO hydrology requirements as modeled, or that shifting the constraint from a 9 metre to 7 metre requirement isn't significant. Nine metre stand heights are achieved about 4 years later than 7 metre stand heights.

There is no harvest response on the TFLs (Figure 27), and only a minor response on the TSA; 5.3% for 20 yrs. On the aggregated forecast, that is 2.9% for 20 years. Most of this response is timber that is available in the base case anyway. Referring to the base case alternative forecast we see a very similar response of 7% for 10 years that was only on the TSA. So tightening the hydrology constraints a little bit has almost no effect on the forecast. The forecast is insensitive to that change.

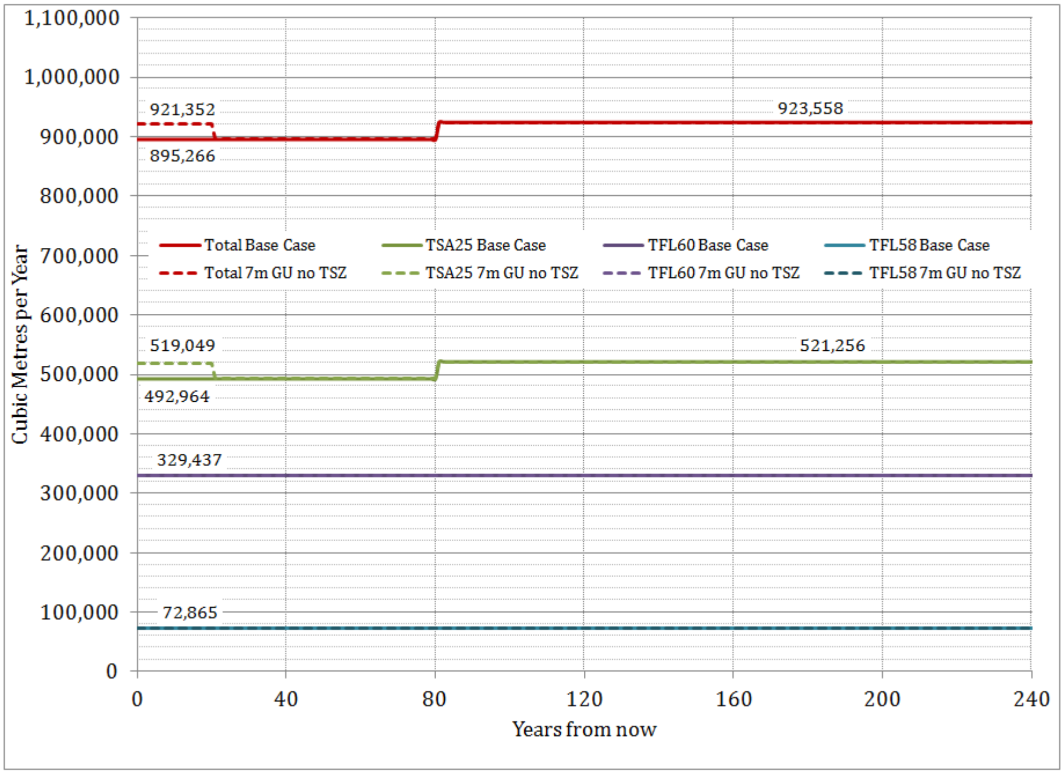

Figure 27: 7 Metre Hydrologic Green-up Sensitivity

5.5.2 14 Metre Hydrologic Green-up

A sensitivity test was run in which only stands taller than 14 metres contributed to hydrologic recovery. This run offers a bookend that may represent a maximum constraint. This sensitivity addresses the question "What if younger, shorter stands do not contribute to hydrologic recovery?"

The results of the 14 metre hydrologic green-up sensitivity (Figure 28) indicate that TFL 58 is constrained in the short-term but that TFL 60 and TSA 25 are not. TFL 58's initial harvest level is 31.3% below base case for the first 20 years. This is a 1.7% impact for 20 years on the overall forecast.

There is a mid-term impact from tightening this constraint on TSA 25. Delaying the step-up in the forecast by 60 years avoids harvest request failures. That is 5.4% lower for between 80 and 140 years into the forecast.

There is also an 8.3% impact for 120 years in the mid-to long term for TFL 60. Alternatively, this could have been represented as a non-declining flow at 302,040 m^3/yr for the first 200 years. However the harvest flow pattern illustrates that a reduction in timber in the short term would not be required to meet hydrological requirements.

Mid to long-term impacts include a 6.4% lower overall forecast from 80 to 120 years and 3.4% lower from 120 to 200 years.

Despite the significant short term impact to TFL 58, the overall forecast is not very sensitive to quite a significant tightening of the hydrologic green-up requirements. Fourteen metre stand heights are achieved about 10 or 11 years later than base case 9 metre stand heights. A more dramatic impact to timber availability may have been expected. Referring to section 2.1.8 and figures 16 through 19 of this report it seems the model has some flexibility to work within the constraint assessment areas.

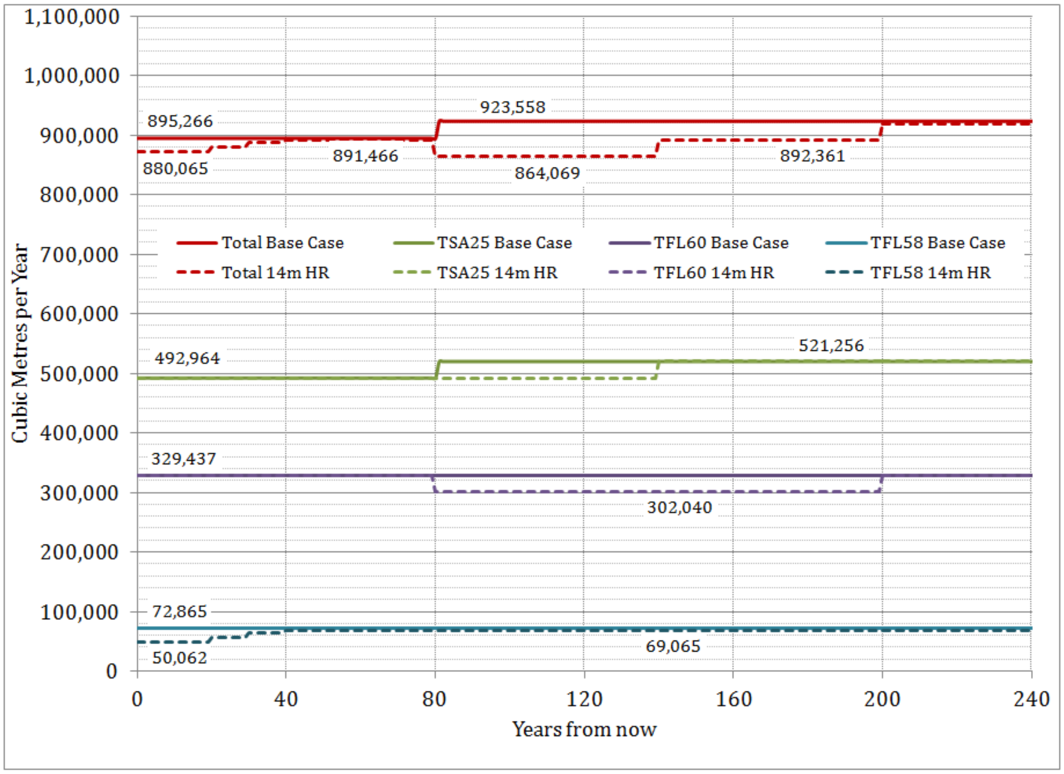

Figure 28: 14 Metre Hydrologic Green-up Sensitivity

5.6 Risk Managed Land Use Objective Order Sensitivity

The LUOO allows for variances to the default objectives in order to risk-manage a given feature or value for operational flexibility. These risk variances are not intended to be frequently used. The Strategic Land Use Agreement stipulates that the resource value being risk managed must be protected or sustained; that adaptive management principles be applied; and that the purpose for taking the risk managed approach warrants consideration.

A sensitivity analysis was run to identify the maximum upward pressure to timber supply if the potential variances in the list were consistently applied in all areas. Table 6 shows the variances modeled in this sensitivity, which are consistent with allowances in the LUOO.

Type 1 fish habitat	5% area reduction to reserve zones on Type I fish habitat.
Type 2 fish habitat	20% area reduction to Type II fish habitat (aggregate of management and reserve zones)
Active Fluvial Units	20% reduction to buffer on active fluvial unit (management and reserve zones together).
Forested swamps	40% reduction to management zone buffers
Sensitive watersheds	Increase Equivalent Clear-cut Area to 30%
Upland streams	Increase Equivalent Clear-cut Area to 40%
Cultural heritage	Lower the per hectare impacts in natural stands for Monumental cedar to 7%

Table 6: Risk Managed LUOO Sensitivity Variances

Figure 29 shows the results. Overall there is 8.0% more volume available for the first 80 years and 3.1% more available for the long term.

The results vary somewhat by management unit. On TFL 58 there is 7.3% more timber available for the first 100 years but no LTHL difference. On TFL 60, the projected harvest level is 7.3% higher than base case for 60 years and 3.1% higher for the long term. On TSA 25 the harvest is 9.3% higher for the first 100 years and the LTHL is 3.2% higher.

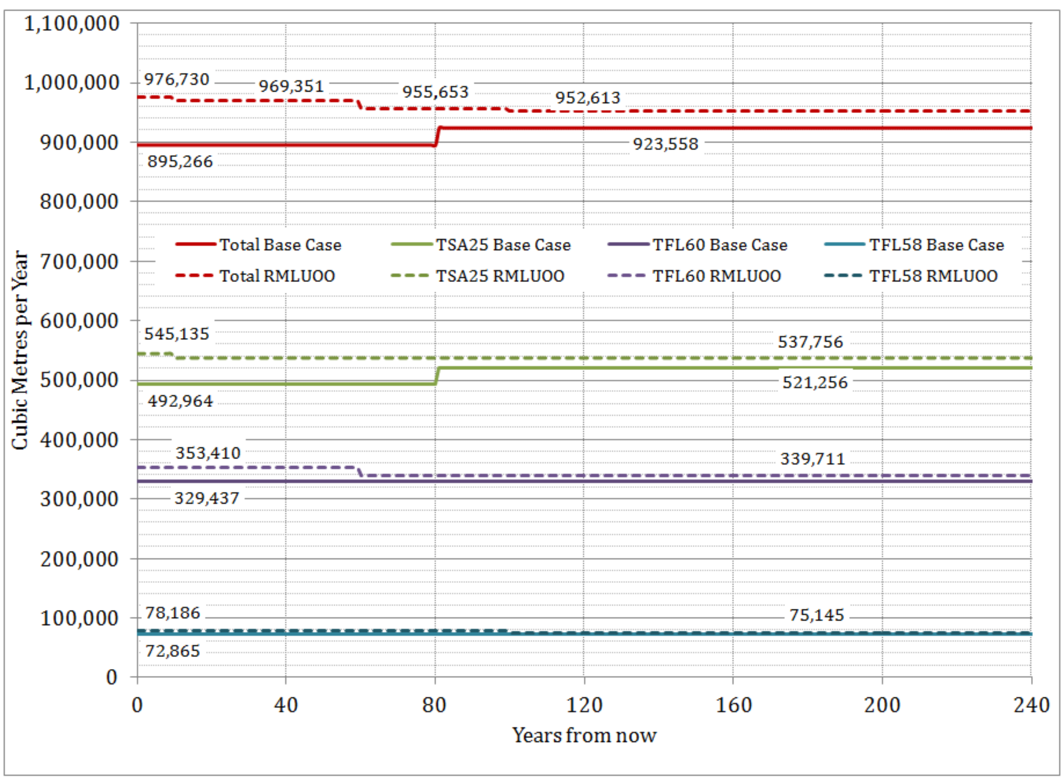

Figure 29: Risk Managed LUOO Sensitivity

5.7 Goshawk Foraging Habitat Sensitivities

A suite of sensitivity analyses were completed that explore the potential timber supply impacts of a draft federal goshawk recovery strategy on Haida Gwaii. The draft federal strategy discusses objectives for medium and high quality foraging habitat. To explore the implications of the draft recovery strategy, in these sensitivities, forest stands at least 80 years and 18 metres tall were used to represent moderate to highly suitable foraging habitat. The draft federal strategy indicates that successful nests require from 40 to 60% medium to high quality foraging per territory. It is not known whether future provincial policy to protect goshawk foraging areas will apply only around known goshawk nests or around both known and potential nesting sites.

There are 17 known and 30 potential nest sites identified on Haida Gwaii for this analysis (see TSR data package appendix 2). Eighty years was the limiting factor in all but one foraging area where stands were projected to reach 18 metres tall in 90 years on average.

Six sensitivity analyses were completed that looked at foraging habitat available per territory over time across the entire FMLB for either known and potential territories, or only for known territories. These sensitivity analyses determined the effects relative to the base case of applying requirements for protecting a minimum of 40, 50, and 60% of moderate to highly suitable foraging area.

In the most constrained case harvest is prevented until at least 60% of the foraging area is moderate to highly suitable within each known and potential goshawk territory. The timber supply reduction relative to the base case, averaged over the first 80 years, is approximately 24%. If the timber supply is flowed so that there is a gradual rise rather than one large increase, the initial impact is significantly larger, at 37% (figure 30). Major timber supply impacts were observed on the TFLs. The projected average harvest level over the first 80 years was 64% lower than base case for TFL 58 and 52% lower for TFL 60. There were no impacts relative to the base case for the TSA.

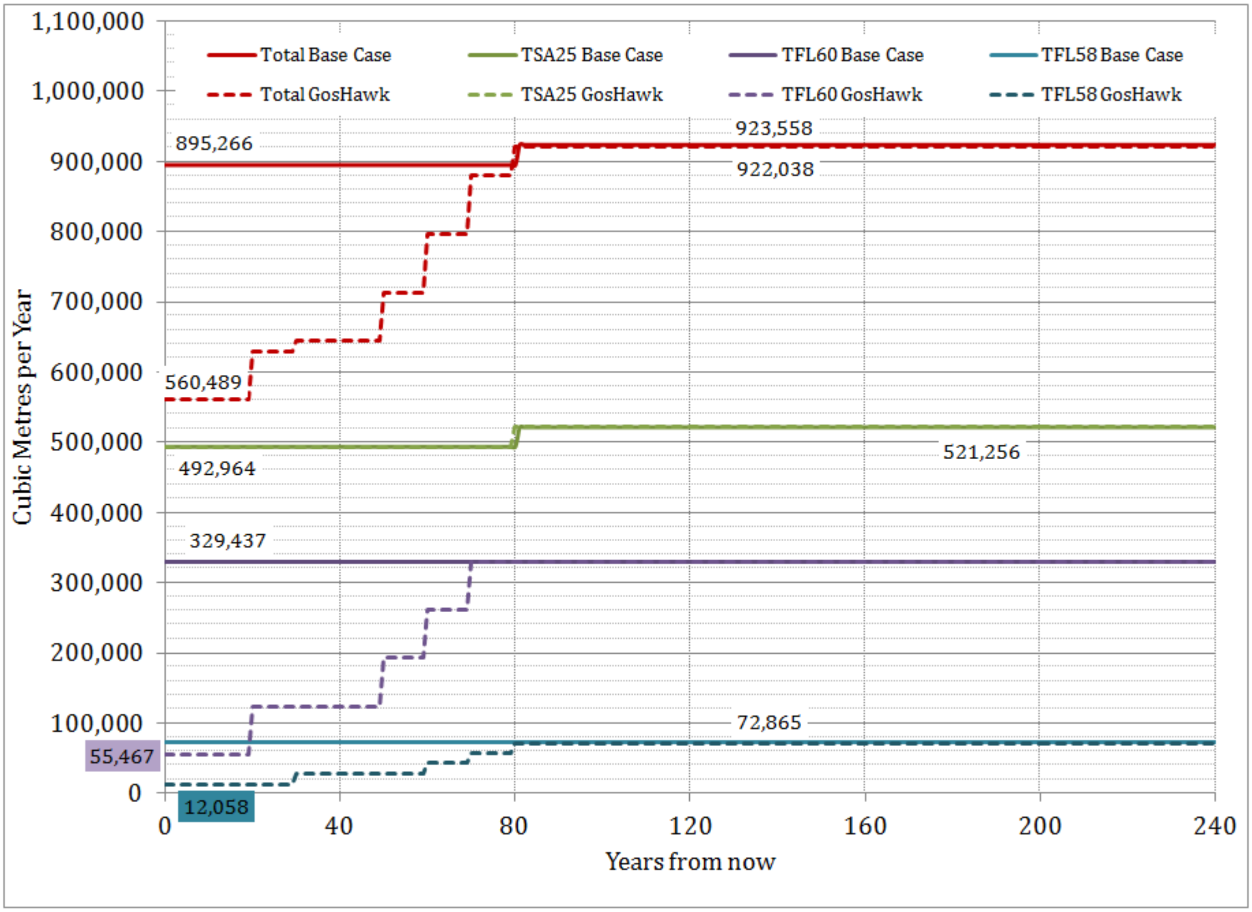

Figure 300. Known and Potential Goshawk Foraging Areas with Minimum 60% Moderate to High Suitability

In the second most constrained case harvest is prevented until at least 50% of the foraging area is moderate to highly suitable within known and potential goshawk foraging areas, resulting in an average harvest over the first 80 years 6% below base case. For TFL 58 it was 40% lower than base case and it was 7% lower for TFL 60.

Table 7 summarizes the remaining sensitivities. When constraints are applied only to the foraging habitats around known nests the timber supply impacts are negligible. That is true whether the moderate and high suitability is constrained at the 40, 50 or 60% level. Also, the timber supply impacts are negligible when constraints are set to 40% moderate to high suitability for both known and potential nests.

Area of application (Known & Potential Nests)	Percent FMLB required above 80 years and 18 metres	Impact rank (1 = largest; 6 = smallest)	Average harvest level of first 80 year relative to the base case (100% = no impact; 0% = no harvest)			
			TFL58	TFL60	TSA25	HG
K&P	60	1	36%	48%	100%	76%
K&P	50	2	60%	93%	100%	94%
K&P	40	3	100%	99%	100%	100%
K	60	4	100%	99%	100%	100%
K	50	5	100%	99%	100%	100%
K	40	6	100%	100%	100%	100%

Table 7: Summary of Goshawk Sensitivity Results

Figure 31 shows that even in the base case where there are no constraints for managing goshawk foraging around either known or potential nests, foraging quality can be expected to improve. The provisions of the LUOO that are modeled in the base case ensure that within about 70 years 43 of the 47 known and potential nests will be at the upper level (60% moderate to high suitability) of the draft federal recovery strategy.

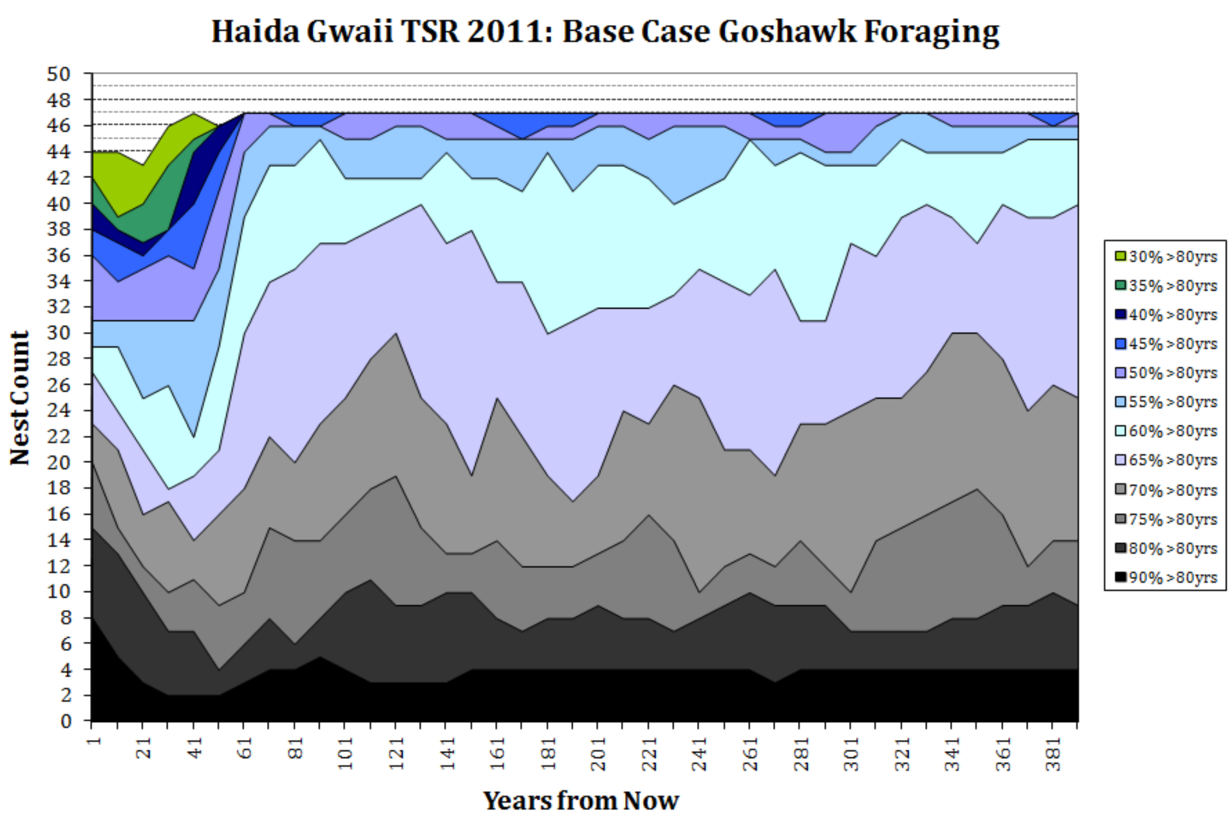

Figure 31. Goshawk foraging habitat recovery rates over time using base case inputs.

Figure 32 shows the same indicator, but for the most constraining of the sensitivities. In this case it takes about 10 years less than base case until about 42 of the 47 known and potential nests will be at the upper level (60% moderate to high suitability) of the draft federal recovery strategy.

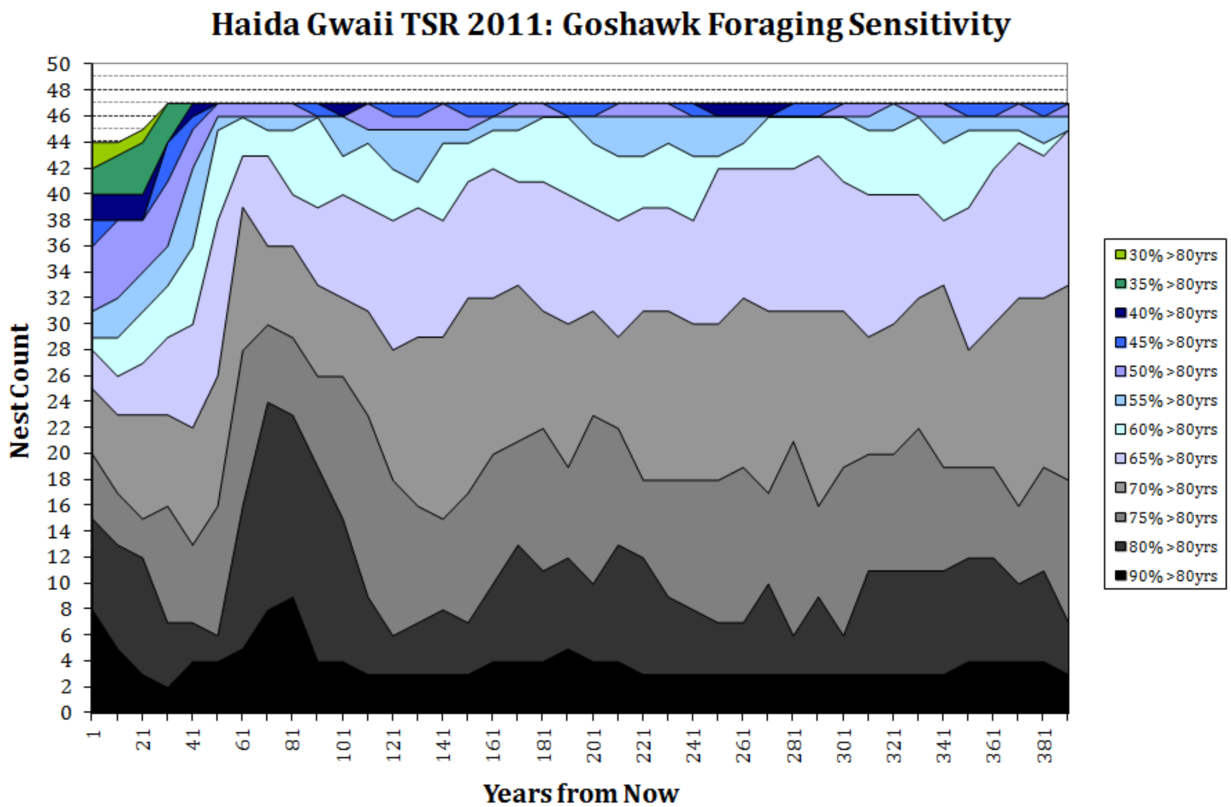

Figure 32. Goshawk foraging habitat recovery rates in most constraining goshawk sensitivity.

6 Other Issues and Uncertainties

6.1 Economically Inoperable Areas

Generally speaking, stands that are on steeper ground and with less volume per hectare are more likely to be too expensive to harvest. The process by which certain stands were removed from the base case THLB as economically inoperable is described in the data package.

The economic operability of stands was defined by the types of stands that were harvested in the last 10 years using block data from the Electronic Commerce Appraisal System (ECAS). In other words, if companies could manage to harvest them in the last 10 years, then they reasonably represent merchantable stand types for future harvests. The base case assumed that this 10 year average would include natural fluctuations in market conditions (Figure 32).

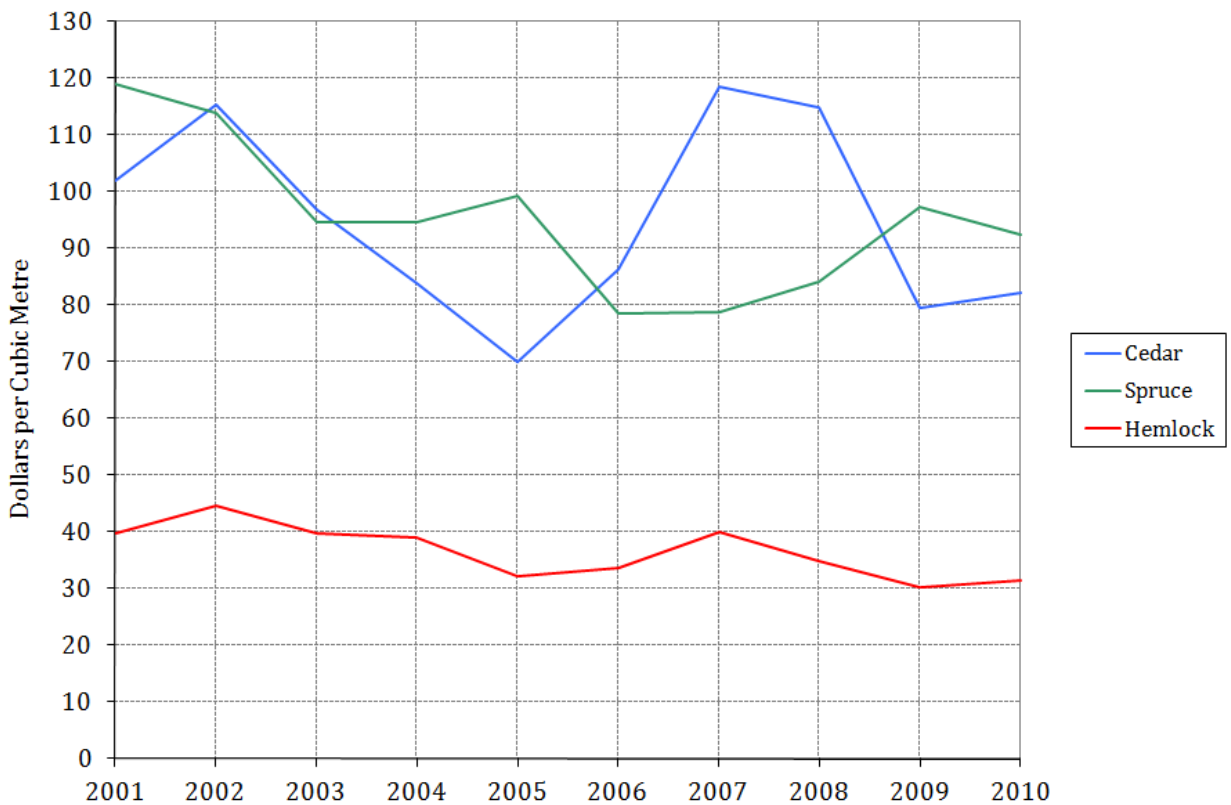

Figure 312. Average Annual Coastal Log Prices from Revenue Branch

This method for defining operable stands is based on the concept that when prices are high, lower value stands may become operable, and conversely when prices are low, only high value stands are operable. A volume per hectare threshold was set for each species and slope class category above which 99% of those recent harvests occurred. Natural stands below that threshold were identified as most likely being too expensive to log and were therefore removed from the THLB. It is possible that at some point in time log prices may be higher and/or logging costs lower than they are today. That would tend to make it more affordable to harvest some of the lower volume stands on steeper ground. This potential situation was not analysed but the THLB could increase by some un-quantified amount if there was more economically accessible ground.

Given that some of the volume thresholds used for the base case were quite low (i.e. less than 100 cubic meters per hectare) it was believed to be more likely that the economically operable area had been overestimated than underestimated for the base case. Therefore more thought was given to a more conservative outlook in which log prices might be lower and/or logging costs higher in the future.

For this assessment the minimum volume per hectare threshold was raised to the level above which 90% of recent harvests occurred. These higher per hectare volume thresholds increased the amount of area considered economically infeasible to harvest from 85,644 to 153,245 hectares. While significantly more land (about 80%) was classified as economically inoperable using this approach, the THLB decreased by only 5.6%. This relatively small reduction results because many areas that are newly classified as economically inoperable were excluded from the base case THLB for other reasons such as terrain stability or EBM requirements.

The 5.6% smaller THLB was not forecast in a sensitivity test. However it is fair to expect that 5 to 6 percent lower harvest levels throughout the analysis horizon would be the result of such a test.

6.2 Site Index Adjustment (SIA)

As described in the data package, a site index adjustment study was published in 2010. It was based on a proprietary biophysical model for SI and also developed adjustment factors from field measurements. The product of that study was a geographic point layer that covers TSA 25 and provides site index assignments (potential site index or PSI) for hemlock and spruce leading stands.

The sampling population was in stands between 10 and 60 years old. On TSA 25 there are 12,634 spruce and hemlock leading hectares of THLB between 10 and 60 years old where those SI assignments can be applied. That is about 10% of TSA 25's THLB and 6.3% of the total THLB.

Ninety eight percent of that area had TEM/SIBEC estimates in the base case. The area weighted average (AWA) base case SI in that area was 24.1m. The PSI for the same area is 25.8m. Although no sensitivity forecast was done for this, it is reasonable to expect only a small increase in timber availability from a 1.7m taller SI on 6% of the THLB.

Consideration was also given to the effect of using PSI on spruce and hemlock leading stands older than 100 years within the THLB of TSA 25. Stands meeting those criteria amount to 12,135 hectares of which 98% used LAR for SI in the base case. Their AWA base case SI is 24.9m while their AWA PSI is 24.0m. It is expected that a 0.9m decrease in SI applied to about 6% of the THLB would lead to slightly less timber available in the forecast in the mid to long-term.

6.3 Potential Bird Habitat

The net down tables provided for the base case in the data package (pp. 7-10) properly account for THLB reductions due to potential goshawk habitat and potential blue heron nesting sites. However, they were not netted from the modeling data-set and so were allowed to contribute to the harvest forecasts. The THLB of the model data set should have been about 1% lower than it was, and decision makers were informed of this difference.

6.4 Forestry Licence to Cut

An existing Forestry Licence to Cut (FLTC) within TSA 25 will soon become a First Nations Woodland Licence. The contribution to the base case harvest is shown in the chart below.

Over the first 80 years, an average of about 152,000 m^3/yr or 16.2% of the base case is harvested from the FLTC area. Subtracting about 5% for non-recoverable losses leaves an estimate of about 144,700 m^3/yr. Over the entire forecast horizon, an average of about 135,605 m^3/yr or 14.1% of the base case is forecast to come from the FLTC are. Subtracting NRLs leaves a reduced forecast estimate of 129,300 m^3/yr.

Additional analysis is planned for the Woodland Licence in which it is modeled as a compartment with a controlled timber flow, in the same manner as the TSA, TFL 60 and TFL 58 were throughout the analysis.

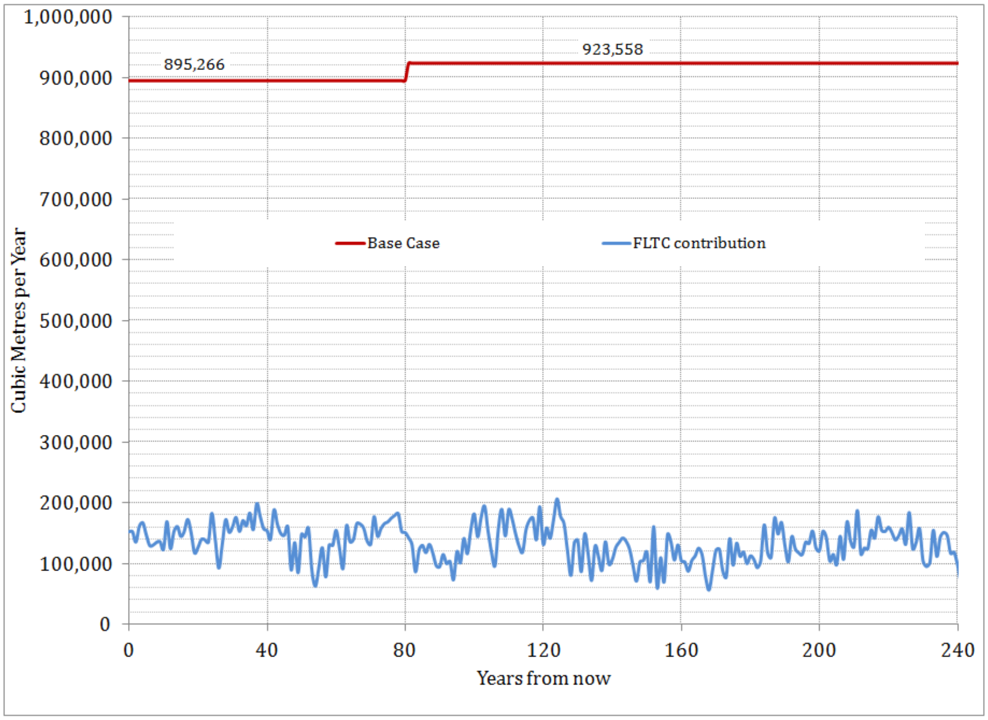

Figure 32: Contribution of FLTC Area to Base Case

7 Summary of Results

The following factors reduce the forecast amount of available timber:

1. Using 20% older MHAs lowered the forecast by 6.5%
2. Using inventory (Site Tools) SI lowered the forecast by 6.2%.
3. Increasing the hydrologic green-up requirement to 14 metres lowered the forecast
    - by 1.7% for the first 20 years,
    - by 6.4% from 80 to 120 years and,
    - by 3.4% from 120 to 200 years.
    - only TFL 58 was impacted in the short term; 31.3% lower
4. Using the 90th percentile threshold for identifying economically inoperable areas would likely lower the forecast by 5 to 6 percent.
5. Correctly applying the potential goshawk habitat and blue heron nesting site net-downs is expected to lower the forecast by 1%.

The following factors increase the forecast amount of available timber:

1. In the base case alternative forecast the initial harvest level could only be raised by 4.1% for 10 years
2. Combining the management units allowed the harvest to be raised by 10.3% for 40 years and by 5.1% for the next 40 years.
3. Using 20% younger MHAs allowed the harvest to be raised

- by 10.7% for the first 20 years,
- by 7.1% from 21 to 40 years, and
- by 3.2% from 41 to 60 years.
- LTHL was 1% lower

4. Taper and loss volume adjustments increased the potential harvest
   - by 21.0% for the first 20 years,
   - by 13.7% from 21 to 40 years, and
   - by 6.7% from 41 to 80 years.
5. Lowering the hydrologic green-up requirement to 7 m allowed for a small increase in short term supply, but this impact was insignificant relative to the alternative base case harvest forecast.
6. Consistently risk managing several LUOO requirements increased the potential harvest by 8.0% for the first 80 years, and by 3.1% thereafter.
7. Applying SIA potential SIs would allow at most a slightly higher harvest forecast (increase of less than 1%).