SUMMARY

LiDAR data for TFL 37 acquired in the summer of 2016 was used to analyze gaps in crown cover as a proxy for the extent of non-productive area in over 31,000 ha of stands aged 40-140 years. The results indicate that the TIPSY default OAF1 of 15% overstates the extent of non-productive area within stands in TFL 37. Where there is good alignment between the forest inventory polygons and LiDAR data the results indicate that the following non-productive area adjustment values are appropriate:

- Good sites: 4.0%
- Medium sites: 5.4%
- Poor sites: 7.2%

Applying a 15% non-productive area adjustment value where the forest inventory and LiDAR data do not align well results in:

- Good sites: 5.6%
- Medium sites: 9.5%
- Poor sites: 11.3%

A sensitivity analysis will be conducted in the TFL 37 Management Plan #10 timber supply analysis that applies the latter (conservative) factors for TIPSY yields for managed stands (current and future).

PROCESS

Use Forest Cover polygons as Base data – select stands greater than 40 years old and less than 140 years old in order to analyze stands within which trees have likely occupied the site to the extent they ever will (see Figure 1 for an example). Gaps in such stands are assumed to represent low/non-productive area within the stand.

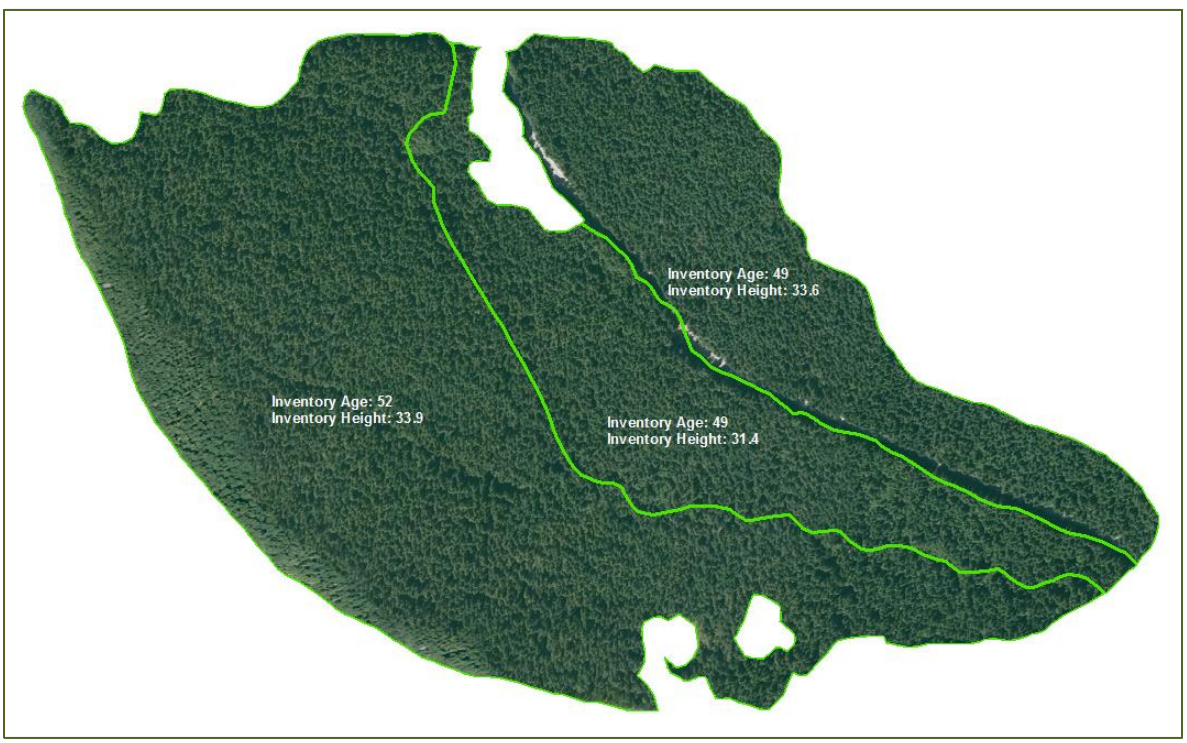

Figure 1 - Orthophoto and Inventory Data

Generate LiDAR-based crown height model for selected stands. The stands in this example (Figure 2) are classified as Good site.

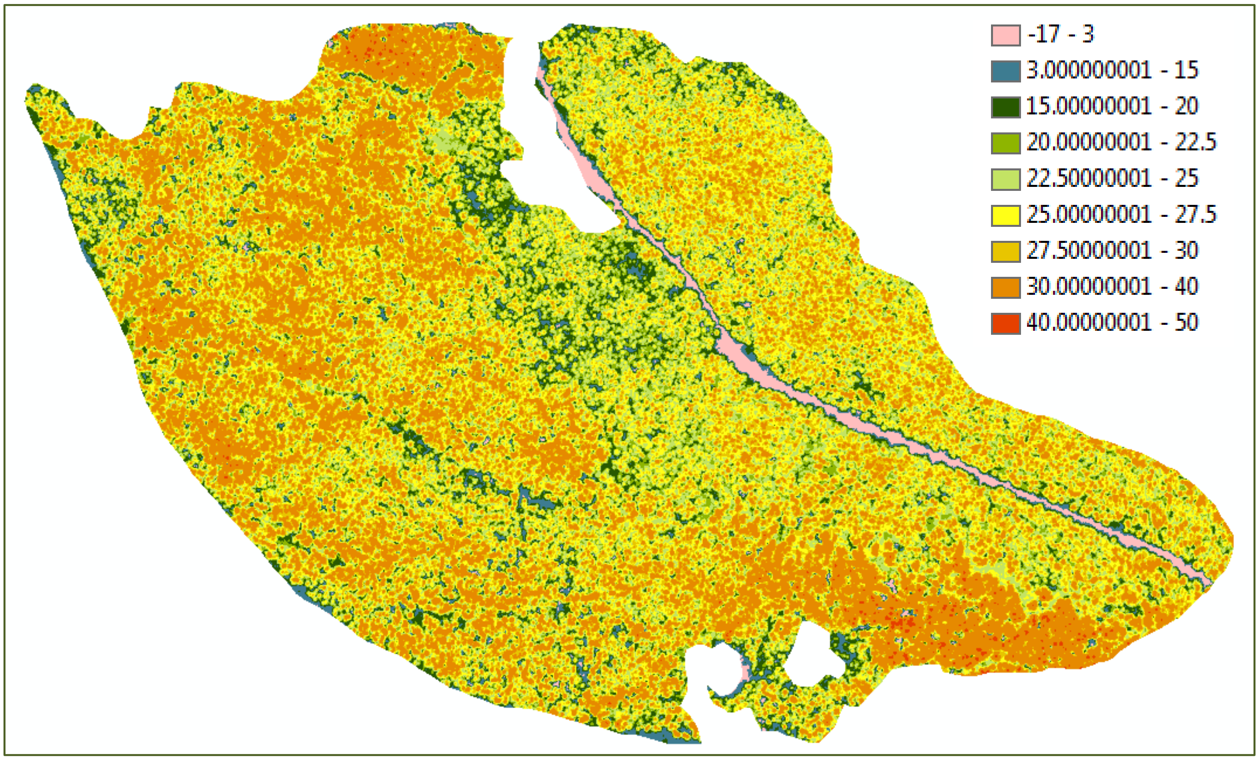

Figure 2 - Crown Height Model from LiDAR

Identify individual trees and their height – see Figure 3.

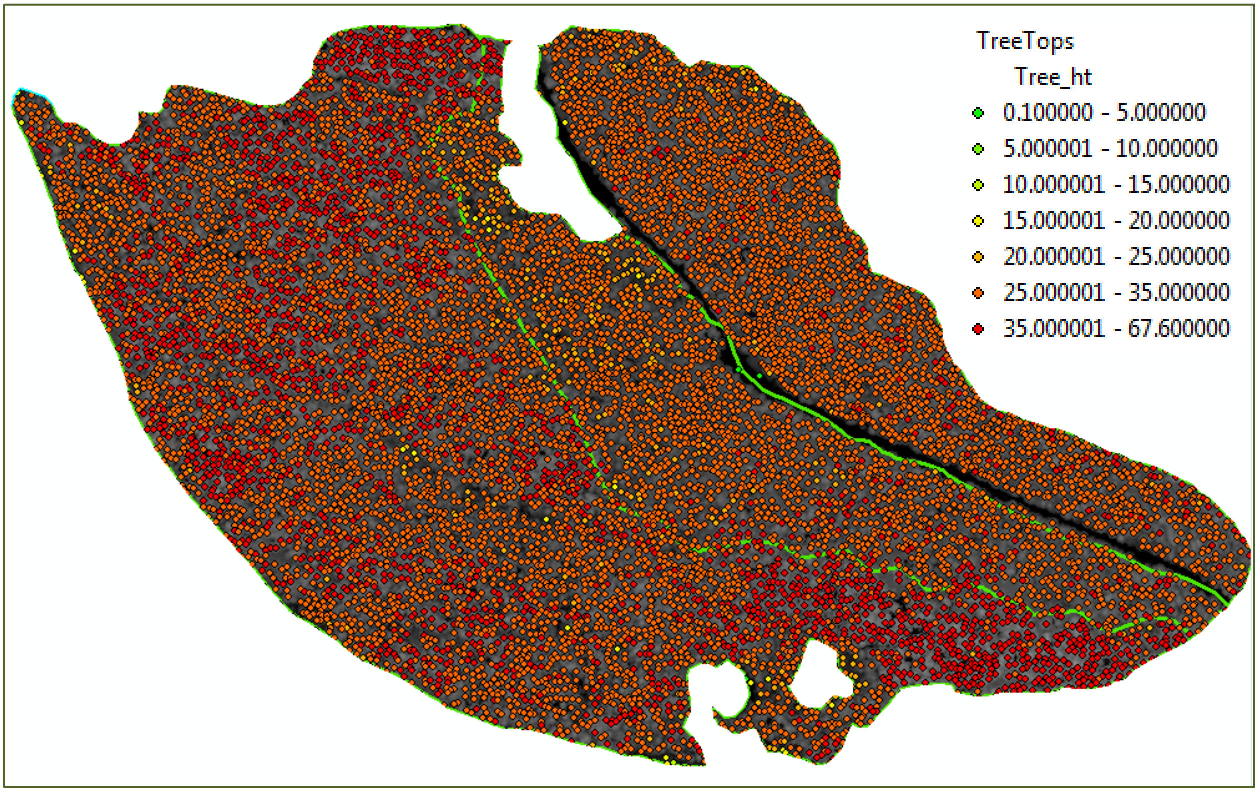

Figure 3 - Individual trees and heights from LiDAR

As an aside, the 85th percentile (mean + 1 standard deviation) of the identified individual tree heights from the LiDAR data in this sample was 36.8m. The average projected inventory height (VDYP 7) was 33m. The corresponding MP #10 analysis unit (using TIPSY) height at age 50 is 29m.

Create polygons of area where there is no crown cover above the 10m height threshold and determine the percent of the underlying forest cover polygon – see pink polygons in Figure 4. A 10m height threshold was selected to represent non/low productive areas within the stands. This 10m height is referenced in the VRI ground sampling procedures as the split between the tree layer and the tall shrubs layer (refer to Figure 5).

Note the influence of the road corridor in the upper right – labels are area factor of polygons where there is no crown cover above 10m ("non-productive area adjustment" factor).

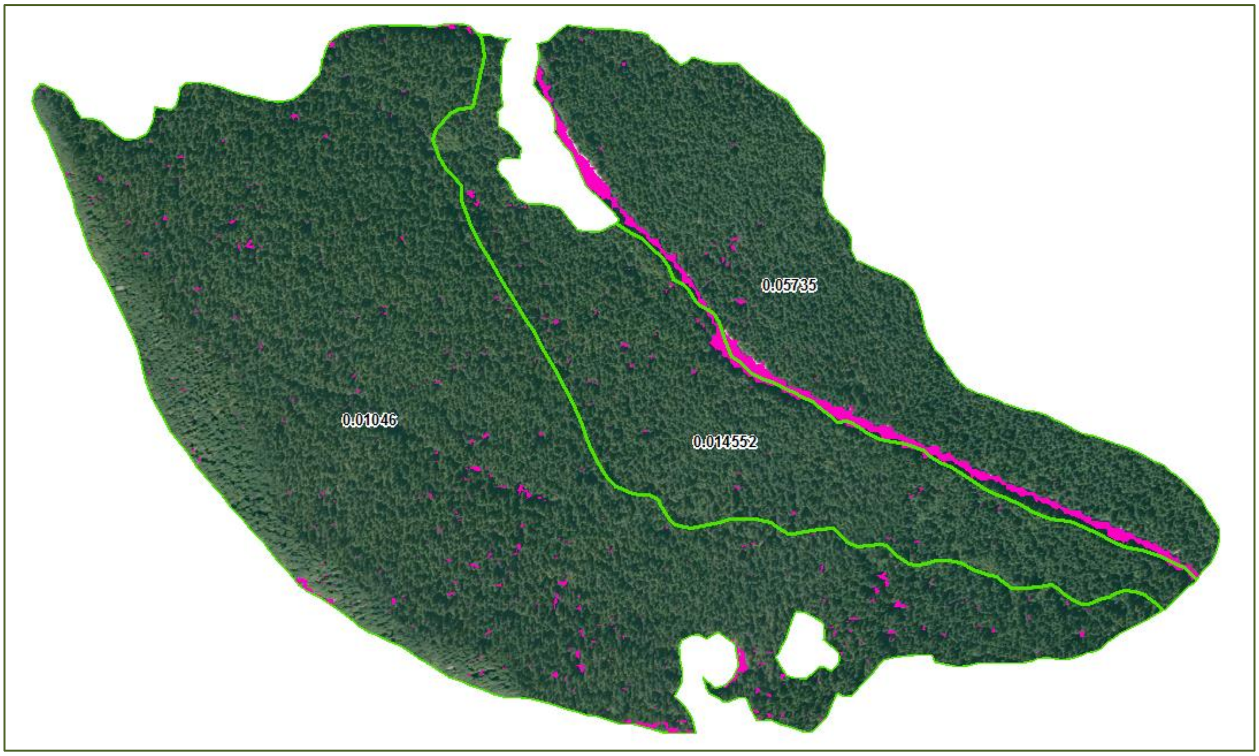

Figure 4 - Orthophoto with inventory polygons and gap factors

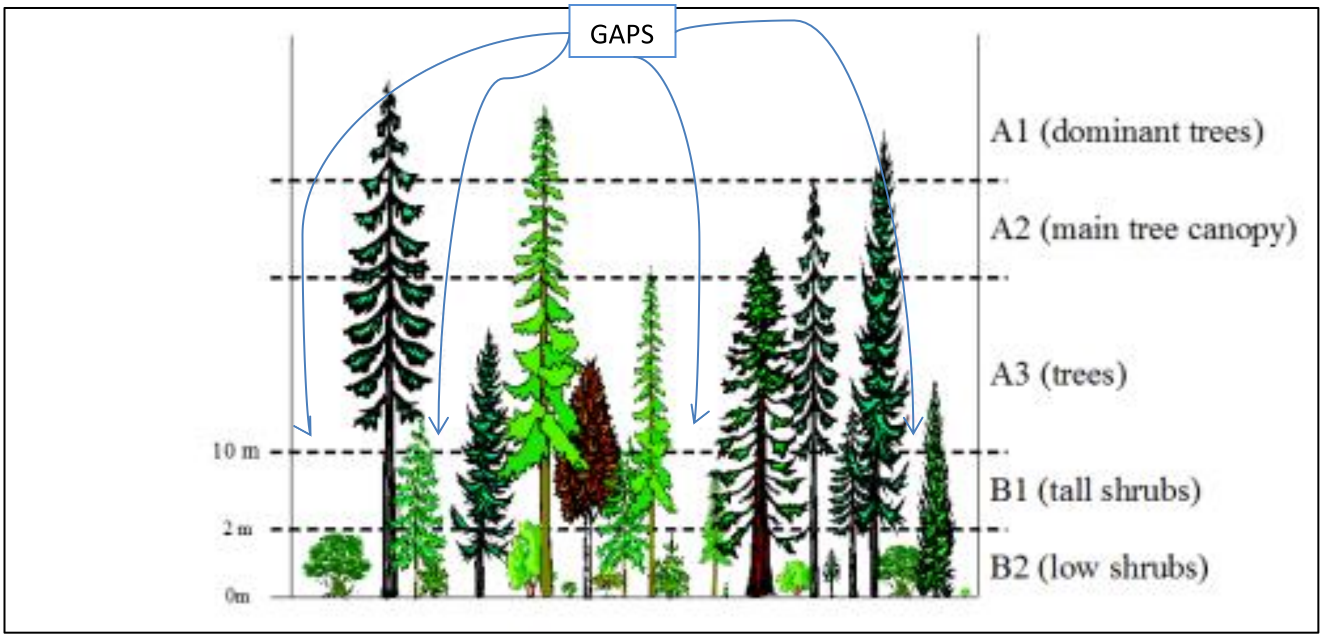

Figure 5 - Diagram of concept for identifying gaps (Figure 7.8 in VRI Ground Sampling Procedures Version 5.4, March 2017)

Repeat the step above recognizing road corridor. Note reduced percent of polygon in upper right (reduced from 5.735% to 1.167%) in Figure 6.

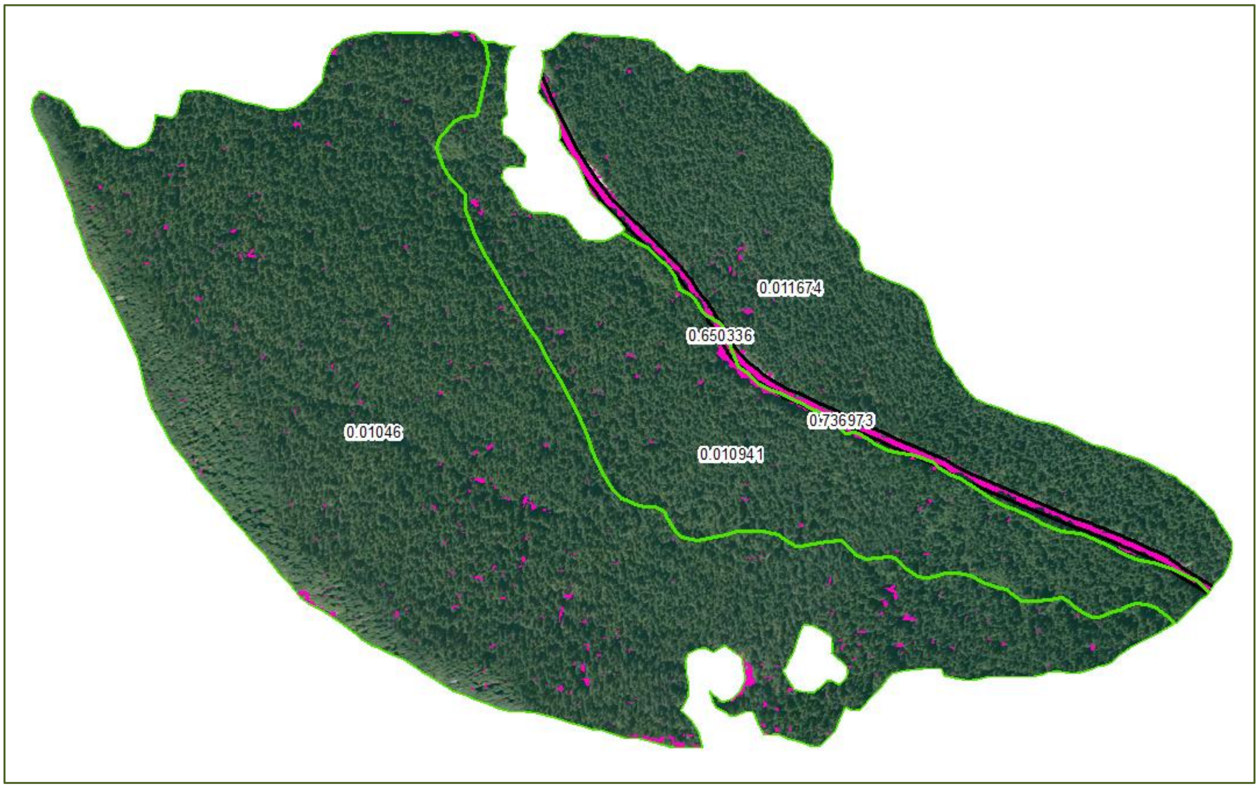

Figure 6 - Orthophoto with inventory polygons and gap factors recognizing road corridor

CHALLENGES

Two challenges were identified related to the data used:

1. Spatial alignment of forest cover polygons relative to the LiDAR data, and
2. Forest cover not updated for depletion to match timing of the LiDAR acquisition.

An example of the first challenge is indicated below in Figure 7 and Figure 8. This stand is identified as 41 years old in the inventory. However, it appears that the very northern portion is older and should be in the polygon to the north (i.e. the stand boundary should be revised southward to exclude the unmanaged stand type). The crown height model confirms the stand is less dense within this northern permimeter and as a result the non-productive area adjustment factor for this stand is greater than it would be if the boundary was more spatially accurate.

Figure 7 - Orthophoto and Inventory Data – note change in stand structure near northern perimieter

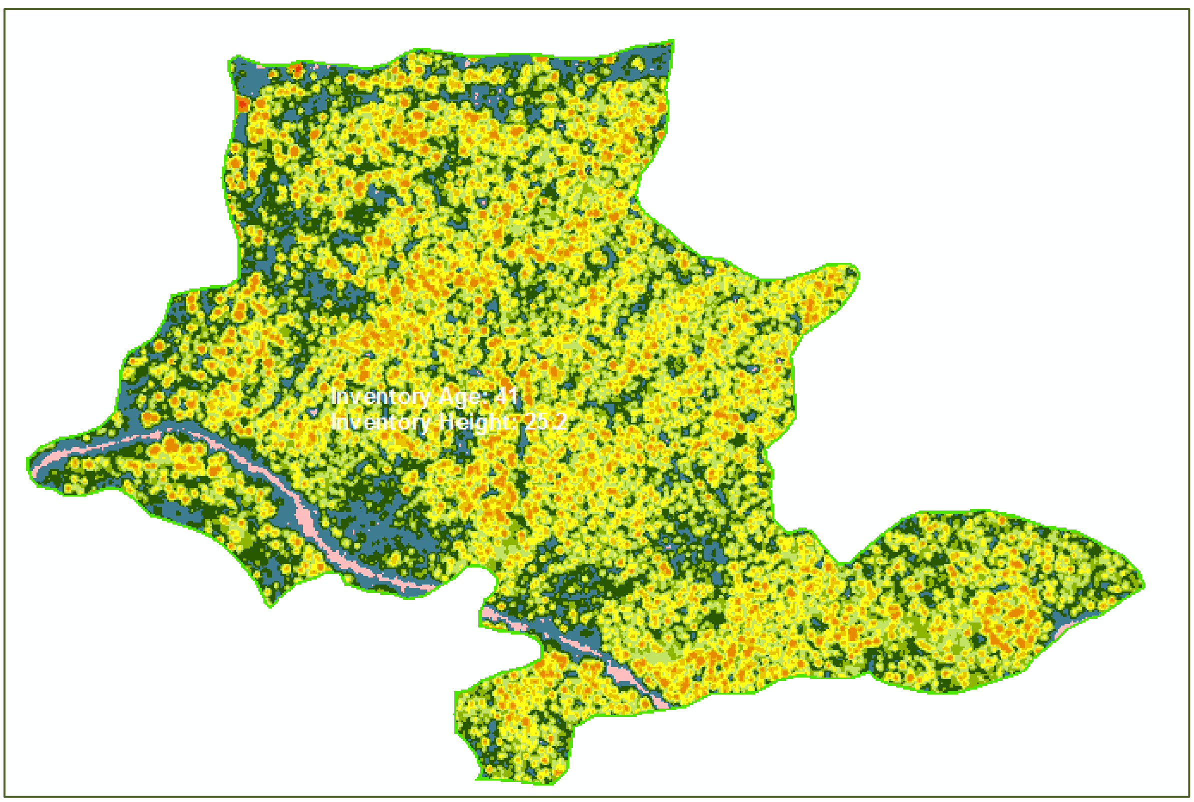

Figure 8 - Crown Height Model from LiDAR– note change in stand density near northern perimieter

An example of challenges associated with incongruent depletion updates is seen below in Figure 9 and Figure 10. The forest cover used was updated for depletion to the end of 2015 whereas the LiDAR data was flown in the summer of 2016. The stands below (figure 9) were part of the sample as the inventory indicated they were 60 years old. The crown height model (Figure 10) indicates the majority of these stands were harvested by the summer of 2016 (indicated by the pink colouring). The labels in Figure 10 are the derivied non-productive area adjustment factor for the underlying forest cover polygon.

Figure 9 - Orthophoto and Inventory Da ta

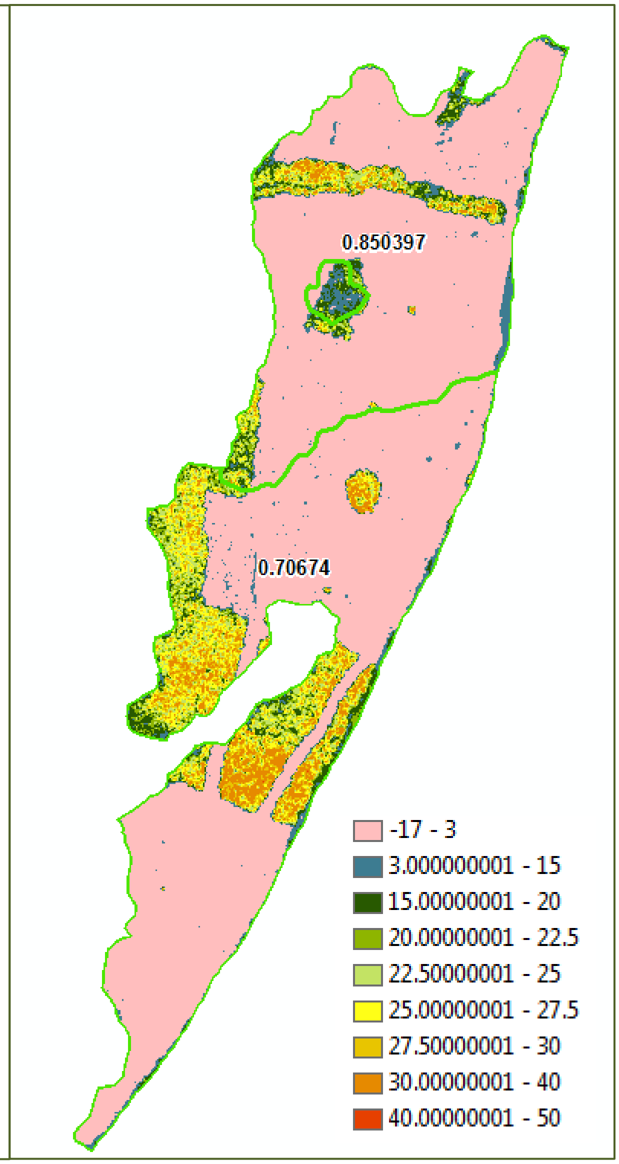

Figure 10 - Crown Height Model from LiDAR

Both challenges result in non-productive area adjustment factor within the sample stands being overstated.

RESULTS

Given the challenges identified, the data was summarized by grouping the resulting non-productive area adjustment factors into 5 classes:

- Less than or equal 1% (1%)
- Greater than 1% and less than or equal 2% (2%)
- Greater than 2% and less than or equal 5% (4%)
- Greater than 5% and less than or equal 10% (8%)
- Greater than 10% and less than 15% (13%)

The values in parentheses above are the values used in calculating area-weighted average factors. The total area assessed was 31,366 ha of which 22,694 ha are THLB based on the MP #10 Base Case assumptions. This equates to 23.7% of the total productive forest and 26.3% of the total THLB.

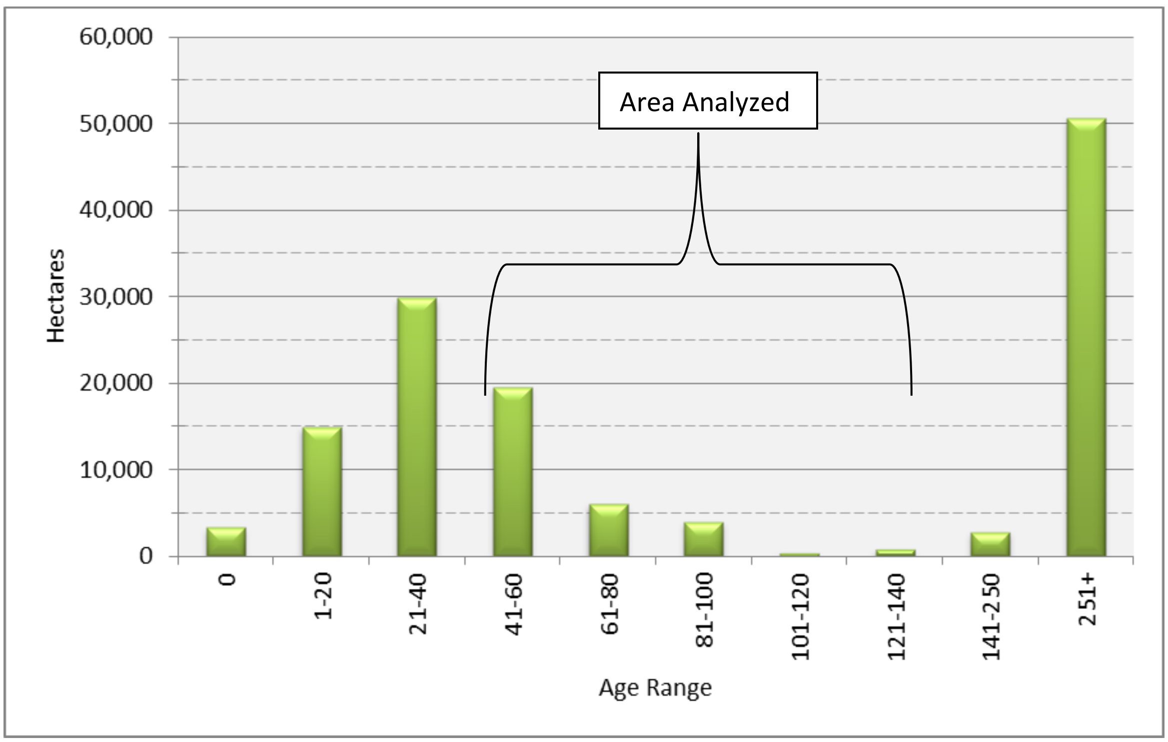

Figure 11 - Productive Forest Age Class Distribution (from MP #10 Information Package)

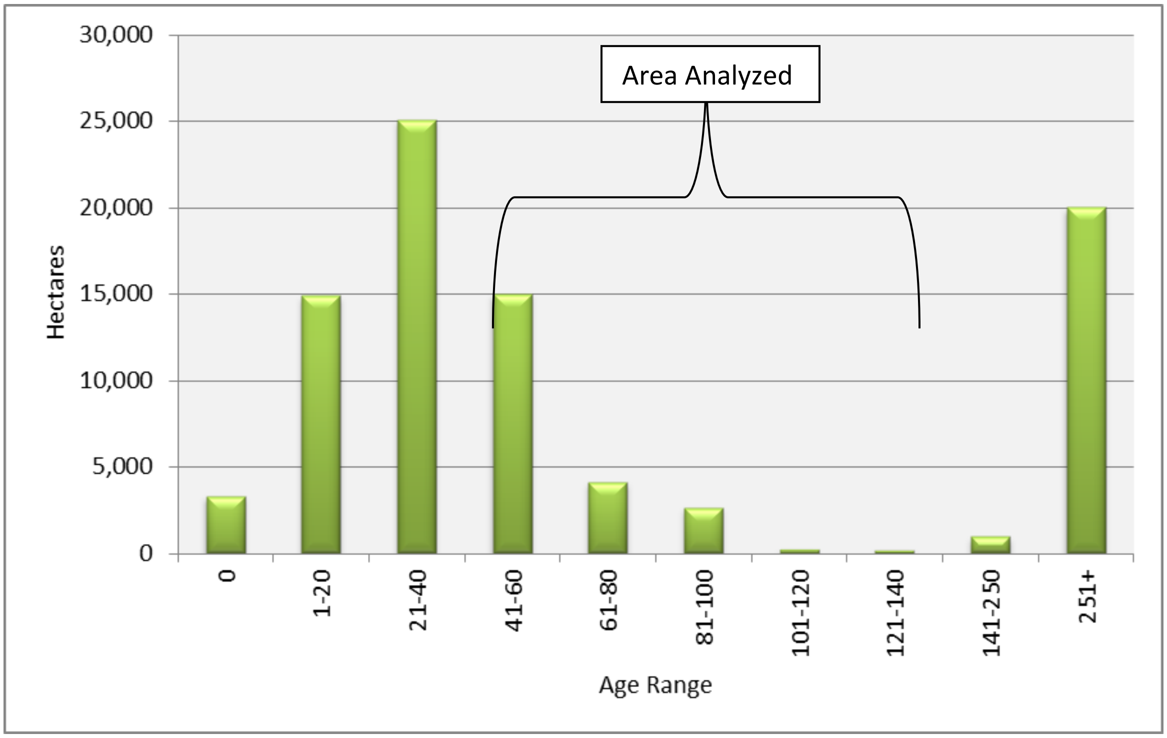

Figure 12 - THLB Forest Age Class Distribution (from MP #10 Information Package)

Excluding areas where the non-productive area adjustment factor was greater than or equal 15% results in the following:

				THLB Ha		
		Gross Ha	THLB Ha	Good	Medium	Poor
Total Area		31,366	22,694	17,687	4,586	421
Gap >10% and < 15%	Ha	2,407	1,460	1,007	406	47
	%	7.7%	6.4%	5.7%	8.9%	11.2%
Gap >5% and <= 10%	Ha	4,390	2,944	2,305	568	71
	%	14.0%	13.0%	13.0%	12.4%	16.9%
Gap >2% and < =5%	Ha	6,805	5,203	4,362	793	48
	%	21.7%	22.9%	24.7%	17.3%	11.4%
Gap > 1% and <=2%	Ha	4,313	3,591	3,194	383	14
	%	13.8%	15.8%	18.1%	8.3%	3.4%
Gap <= 1%	Ha	5,635	4,667	4,175	475	17
	%	18.0%	20.6%	23.6%	10.4%	4.0%
Area-weighted average non-productive area adjustment factor				**4.0%**	**5.4%**	**7.2%**

Overall, 79% of the sampled THLB is captured by one of the non-productive area adjustment factor classes. Applying the values listed above in parentheses for each class results in area-weighted averages of 4.0%, 5.4% and 7.2% for the good, medium and poor sites respectively.

Applying a 15% factor (TIPSY "default") for the area not captured by the above classes increases the area weighted averages to 5.6%, 9.5% and 11.3% for the good, medium and poor sites respectively. Given the results where there is this good alignment this approach is conservative.

DISCUSSION

LiDAR data can provide very detailed information down to the tree-level. This allows accurate stand-level metrics to be derived. In this analysis, the amount of area not supporting trees at least 10m tall within forest cover polygons between the ages of 40 and 140 years was determined as a proxy for the amount of non-productive area within the polygon. When modelling growth and yield with TIPSY, OAF1 is intended to account for these non-productive areas. A "default" OAF1 of 15% is applied unless better information is available.

The results indicate that on good sites, an OAF1 of between 4% and 5.6% is appropriate. In other words, applying the default 15% OAF1 would reduce yields for these stands 10-11% more for non-productive area than LiDAR data indicates is warranted. On medium site the excessive reduction is 5-10% and is 4-8% on poor sites.

Older stands within the sample are the result of less intensive management practices than have been practiced in recent times and are expected to be used in the future. As such, the overall averages determined are likely conservative relative to current practices.

A sensitivity analysis will be done using the conservative factors (incorporating "default" TIPSY OAF1 value of 15% to areas not classified with a non-productive area adjustment factor of less than 15% in weighted-average factor calculation) derived by this analysis as OAF1 for TIPSY yields for managed stands (current and future):

- Good sites: 5.6%
- Medium sites: 9.5%
- Poor sites: 11.3%