

Forests For Tomorrow Multiple Accounts Decision Analysis Framework Merritt TSA Testing

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Version 1.0

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1.0 Introduction

The Forests For Tomorrow (FFT) program was established by the BC Ministry of Forests and Range in an effort to ensure that stewardship issues associated with disturbed forest land without any tenure holder's regeneration obligations, are addressed. The program's key objective is to reduce the amount of Not Satisfactorily Restocked (NSR) Crown forest land in BC that lies outside industry obligations, in an effort to improve future timber supply, while also reducing risks to biodiversity, water, fish, wildlife, and habitat.¹

Currently, FFT stand level silviculture investment decisions are based predominately on a timber focused discounted cash flow model. Investments in the timber harvesting land base (THLB) must achieve an internal rate of return (IRR) of 2% or greater, based on a stand-level calculation. Where these conditions are not met, there is an opportunity for FFT managers to approve the expenditure based on benefits to non-timber resource values.

A Multiple Accounts Decision Analysis (MADA) framework was desired to integrate non-timber values into the FFT investment decision making process in a consistent manner. Development began in 2006/2007² and continued into 2007/08. This document describes the testing of the newly developed framework (Forsite, 2008) on the Merritt TSA and is a companion document to the full MADA document³.

2.0 Objective:

Evaluate the prioritization framework provided in Forsite, 2008 by applying it to the Merritt TSA and summarizing / evaluating the results to understand:

1. How the Timber Scoring works to identify high priority, high probability timber sites for reforestation treatment.
2. How the Non Timber Scoring works to identify high priority non-timber sites for reforestation treatment.
3. The implications of different Timber vs Non Timber weighting factors.
4. How missing data and/or alternative data sources impacts the results.

3.0 Area of Interest:

The Merritt TSA is located in the Southern Interior Forest Region and is shown below:

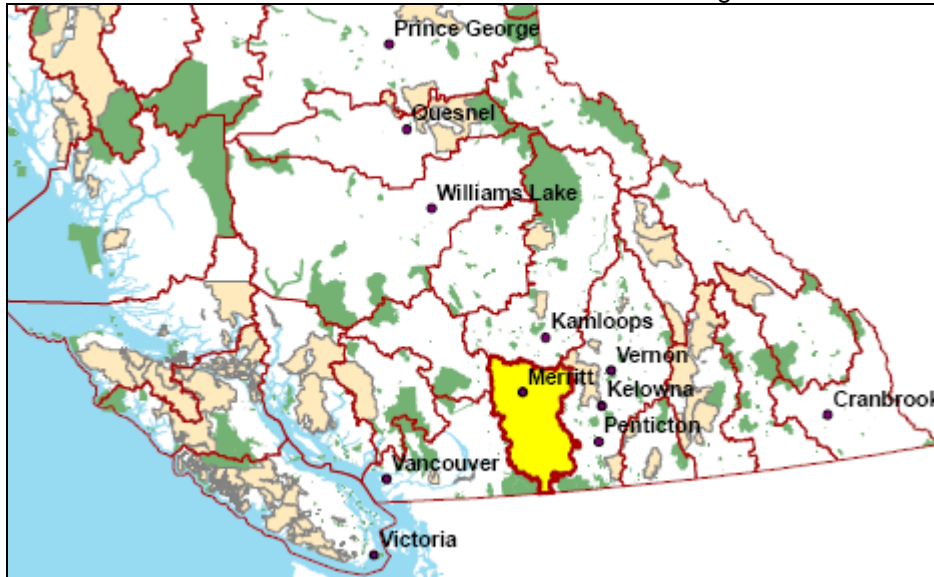


Figure 2. Location map for the Merritt TSA

¹ FFT Program Management Plan 2007. http://www.for.gov.bc.ca/hfp/fft/FFT_Mgt_Plan_2007.pdf

² Developing A Multiple Accounts Decision Analysis Process For Effective Silviculture Investment Decisions (Timberline, March 2007).

³ Integrating Timber and Non Timber Values into FFT Silviculture Investment Decisions (Multiple Accounts Decision Analysis), Forsite, March 21, 2008

This area was selected for testing because it has recently had a Type 2 Silviculture Strategy completed⁴ and has active FFT work ongoing (Forsite is current Recipient Holder).

Figure 3 shows the Timber Harvesting Land Base (THLB) and the location of community watersheds and recent fires. The prioritization included both THLB and non THLB areas in order to get a full inventory of non timber priority sites as well.

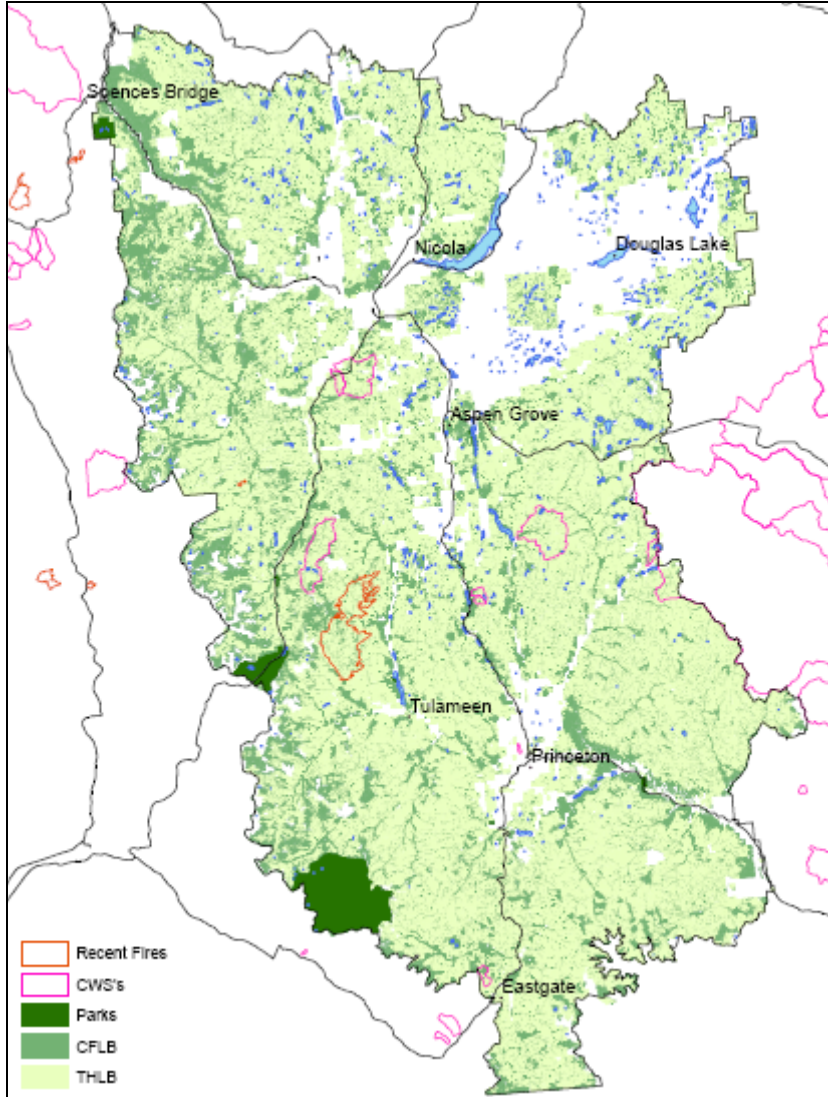


Figure 3. THLB, CWS's, and fires in the Merritt TSA

4.0 Methods:

As per the framework provided in the companion MADA document (Forsite 2008), the steps listed below were followed.

1. Build a GIS resultant/database;
2. Identify Candidate Areas for Prioritization;
3. Assign Timber Priority Scores to Candidates;
4. Assign Non Timber Priority Scores Candidates;
5. Calculate Multiple Accounts Scores for Candidates.

⁴ Merritt TSA Enhanced Type 2 Silviculture Strategy Analysis, Timberline Natural Resource Consultants, Nov 2006.

Each of the prioritization steps is discussed in more detail below.

STEP 1: Build GIS Resultant / Database

The following data layers were incorporated into a single GIS resultant / database:

Table 1. Data sources used to build the Merritt FFT multiple accounts database

Issue	Source	Comments
Landbase definition (THLB, CFLB)	Timberline Type 2	IFPA vintage – no updates
Parks, private lands, woodlots, etc	Timberline Type 2	IFPA vintage – no updates
Silvicultural Status	RESULTS (June 2007 extract)	ID logging, free growing status, and previous spacing or pruning.
Forest Cover	Timberline Type 2	Provides SI, ages, %PI, etc
Recent Fires (1998-2007)	MoF Forest Analysis and Inventory Branch	Lawless fire is the only major fire during this time.
2006 MPB attack levels	2006 forest health overview flights	Only used IBM attack areas – classified into nil, trace, low, mod, severe, very severe attack.
Likelihood of Natural Regeneration	Timberline Type 2	Based on Arbourtech's model that uses ecosystems, aspect, %PI, age, and crown closure.
Existing Roads	TRIM/LRDW	These were buffered to ID areas within 300m and 1km of roads.
Stand Merchantability	Timberline Type 2	Based on Arbourtech's merchantability model. Stands are assigned a net value based on historical lumber/chip values and appraisal costs.
Community Watersheds	LRDW	
Designated Sensitive Watersheds	n/a	
Visual Quality Objectives	Timberline Type 2	
BC Gazetteer (population centers)	LRDW	Towns, villages, municipalities, and communities were used.
FN / Public Areas of Interest	Not used.	No available mapping.
OGMAs	Timberline Type 2	
Landscape Units and Biodiversity Emphasis Areas	Timberline Type 2	
Recreation Trails and Sites	LRDW	Points, lines (trails) and polygons (sites) were obtained.
Wildlife Habitat Areas (WHA's)	http://www.env.gov.bc.ca/wld/frpa/iwms/wha.html	
Deer Winter Range	Timberline Type 2	Shallow snowpack (PP, BG, IDFx_), Mod Snowpack (IDF, MS, ICHx_/d_), Deep ICH other, ESSF.
Moose Winter Range	Timberline Type 2	
High Value Caribou Habitat	n/a	Not Applicable.
High Value Grizzly Habitat	n/a	No mapping available.
High Value Fish Habitat	n/a	No mapping available.
OR and OP Ecosystems	n/a	Designations in forest cover mapping were not suitable as they are considered non forested areas.

STEP 2: Identify Candidate Areas for Prioritization

The areas that were considered current candidates for FFT treatments were those on crown land that had been impacted by fire or MPB and had no silvicultural obligations on them. The landbase meeting this definition will change in the future as new stands are impacted by MPB. The land base was not limited to the THLB so that the framework can be used to prioritize treatments for non timber perspectives as well.

Candidates were:

1. Within the Crown Forested Land Base and not in parks.
 - a. The CFLB definition and parks designation in Timberline's Type 2 dataset were used. These effectively ensured candidates were outside parks, private lands, woodlots, Indian Reserves, non forest areas, etc.
2. Free of silvicultural obligations.
 - a. This was achieved by excluding any logged areas where RESULTS records indicated that the area was not free growing, or any areas logged after 2000. Licensee records for blocks were also consulted to check free growing status.
3. Impacted by fires or currently impacted MPB.
 - a. Any areas identified as being within fires that occurred from 1998 to present were included.
 - b. Any areas with IBM attack (trace to very serve) in the 2006 forest health overview mapping were included. The low levels were included because the subsequent year when surveys occur will see the severity of attack increasing.
4. For mature stands impacted by MPB, there was little or no expectation of salvage.
 - a. Any areas currently identified in licensee data or FTA as a pending harvest block (CP's, TSL's, etc) were expected to be salvaged (excluded).
 - b. A lot of other areas will also be subject to salvage but could not be identified. This issue was dealt with in the scoring portion of the MA analysis.

STEP 3: Assign Timber Value Scoring:

Timber value scores were assigned as per **Error! Reference source not found.** in the MADA document (Forsite, 2008).

- THLB provided by Type 2 Silviculture Analysis
- Buffers around existing roads were created in this project.
- Likelihood of natural regeneration was predicted by the Arbourtech model used in the Type 2 Analysis.
- Fires, stand ages, and current MPB attack levels provided by the data sources in Table 1. Five year old MPB attack was not addressed because the amount of attack present 5 yrs age was not considered significant enough to warrant inclusion. Mature PI stands considered 'low salvage potential' were stands with a site index of <15 for this test. All other stands were considered high salvage potential. An additional criteria around PI on cable harvesting terrain (>=50% slope) was considered but not implemented.
- PI percent and disturbance levels were provided by the data sources in Table 1.
- History of spacing and pruning was obtained from RESULTS data queries (Activities Table, Activity Base field with values of PR or JS).
- Merchantability ratings were provided by the Arbourtech model used in the Type 2 Analysis.

STEP 4: Assign Non Timber Value Scoring:

Non timber value scores were assigned as per **Error! Reference source not found.** in the MADA document (Forsite, 2008).

- Community watersheds were identified. No designated watersheds or domestic watersheds exist in the TSA.
- Post MPB ECA's were calculated using the assumption that all PI leading stands over 30 yrs old have an ECA of 100% (worst case scenario). Gross watershed areas were assessed. Natural non-forest areas counting as 0% ECA, while unnatural nonforested areas (agriculture, urban areas, etc) were treated as 100% ECA. ECA ha were determined for each polygon in the watershed using the recovery curve in the IWAP guidebook, and then summed, and divided by the total watershed area to get % ECA.
- H60 lines identifying the sensitive portions of watersheds did not exist and were therefore not used.
- Disturbance levels in each VQO polygon were calculated by dividing the CFLB area less than 20yrs old by the total CFLB area.
- Fire Interface Zones were identified using a 10km buffer around localities, towns, villages, communities, and cities mapped in the BC Gazetteer. No data was ever provided by Protection Branch.

- No mapped areas of FN or public concern were available.
- Recreation points, polygons and lines (trails) were obtained from the LRDW and then buffered by 1km.
- OGMAs, LU's and BEO's were provided by the datasets listed in Table 1.
- WHA's were obtained from the ministry website listed in Table 1.
- Wildlife and fish values were identified as described in Table 1. (No caribou, grizzly, or high value fish habitat datasets were available).
- Open forest and open range ecosystems were not used because no suitable dataset could be found.

STEP 5: Assign Multiple Account Scoring:

Once scoring for timber and non-timber values was completed and each was standardized out of 10, multiple account scoring was determined for three scenarios:

1. Equal Consideration of Timber and Non Timber Values (50/50 contributions)
2. Heavy Timber Emphasis (75% timber, 25% non timber)
3. Heavy Non Timber Emphasis (25% timber, 75% non timber)

5.0 Results

Candidate Stands Profile:

The stands identified as FFT candidates for prioritization are described below. They are predominately in the THLB and have an average site index of 13.9m.

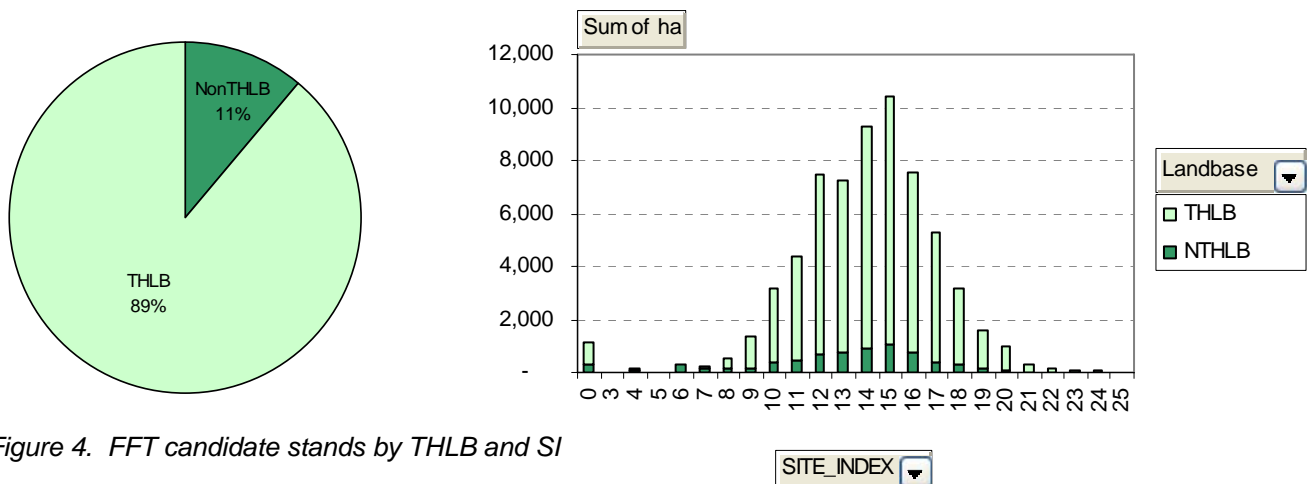


Figure 4. FFT candidate stands by THLB and SI

The candidate area is summarized into the three main stratum of interest to FFT in the table below. The majority of the candidate area falls in the mature MPB stratum:

FFT Stratum	Area	%
Fires	5,795	9%
MPB Immature (<60yrs)	4,976	8%
MPB Mature (>60yrs)	54,098	83%
Total	64,869	100%

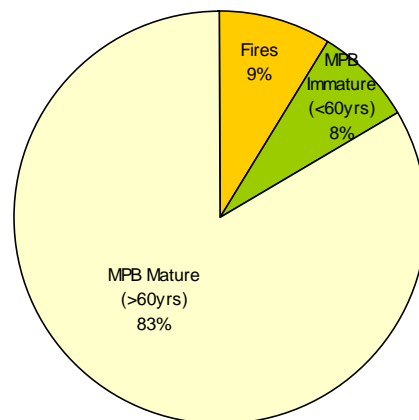
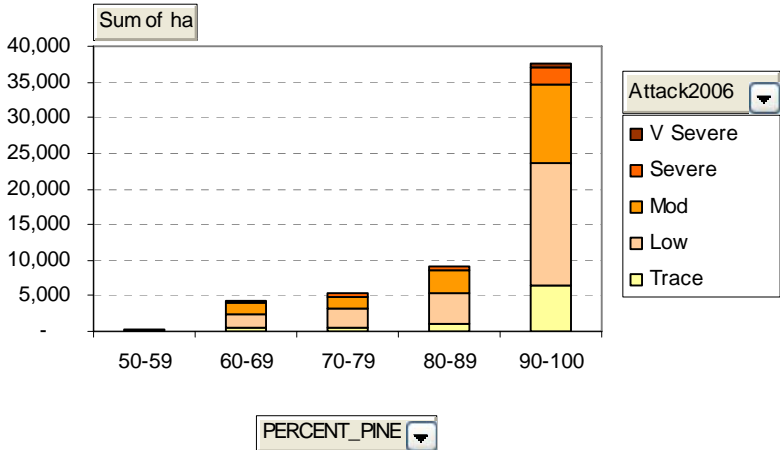


Figure 5. FFT candidate stands by type

The large area of mature MPB stands occurs because no filtering for salvage potential has occurred at this stage. All stands currently impacted by MPB are included as candidates.

The level of MPB attack by percent PI in the candidate stands is shown below. The majority of the attack has occurred in the 90-100% PI stand types (37,491 ha) and is low to moderate in severity (2006 data).



Timber Value Scoring:

Raw timber scores ranged from -50 to 159 and were then standardized to between 0-10 (see Figure 6). The highest scoring sites are described below:

- THLB areas in the Lawless fire with a low probability of natural regeneration, good site indexes and good future economics.
- Young free-growing or pre1987 THLB areas heavily impacted by MPB with >70% PI on good site indexes and with good future economics.
- Mature THLB stands on good sites with >70% PI that have been heavily impacted by MPB and have a low potential for salvage occurring (approximated with SI <15).

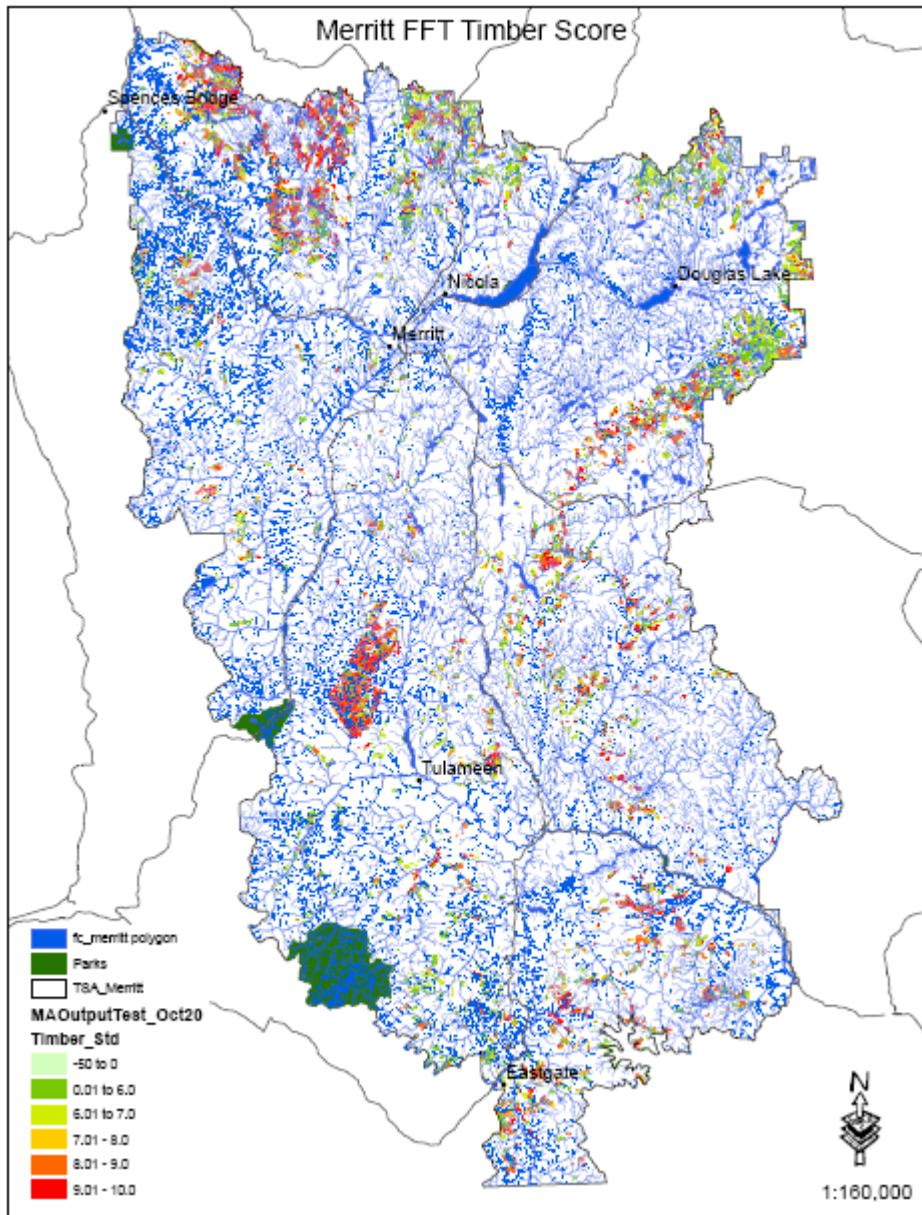


Figure 6. Pure timber ranking results

Non Timber Value Scoring:

Raw non timber scores ranged from -5 to 6 and were then standardized to between 0-10. The highest scoring sites were located where large numbers of values overlapped (CWS' in fire interface zones with VQO's, Recreation values, Deer winter range, and Moose winter range, etc). See Figure 7. The Lawless fire appears to have little non-timber associated with it.

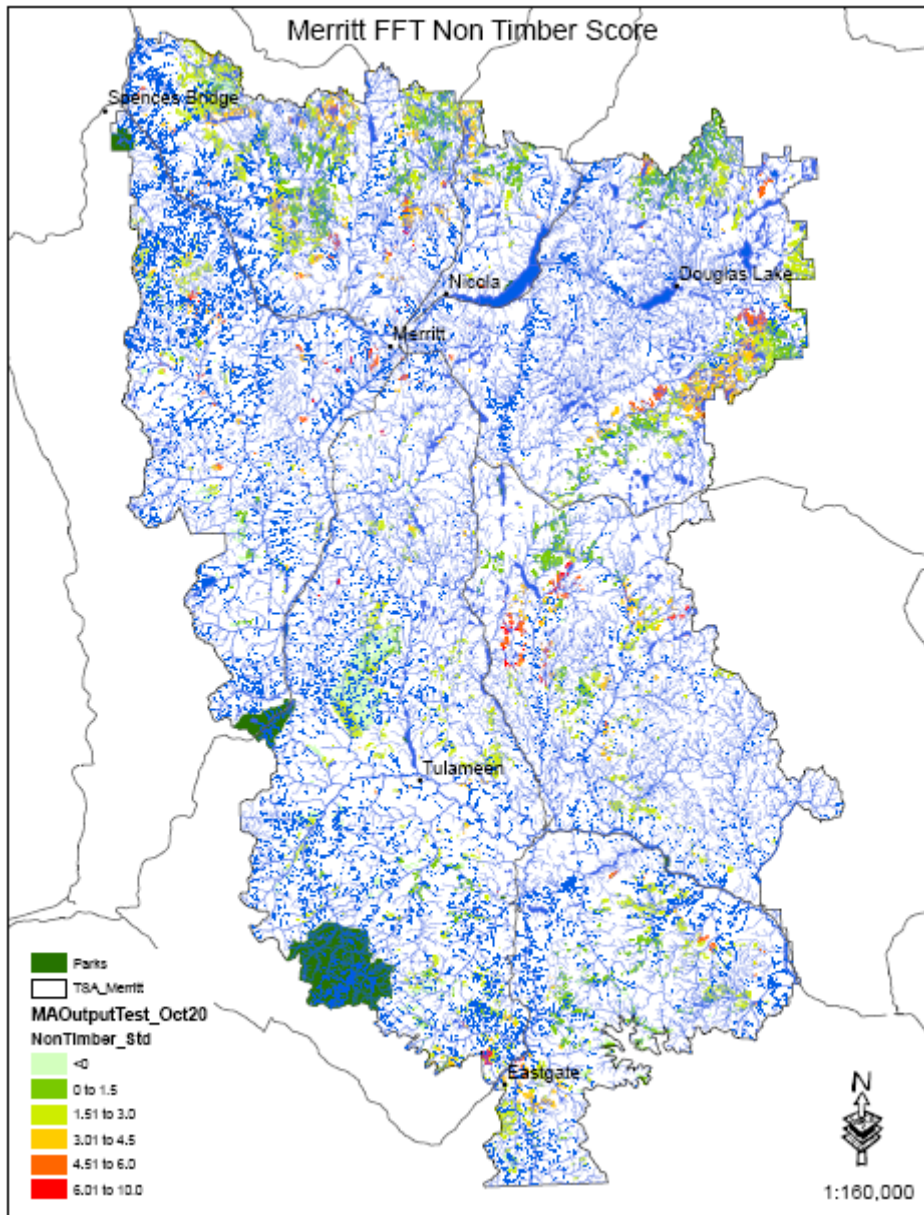


Figure 7. Pure non timber ranking results

Multiple Accounts Scoring:

The pure timber and non timber results were combined into three Multiple Accounts scenarios:

1. MA Timber Focused Scenario (75% Timber, 25% Non Timber)
2. MA Equal Timber and NonTimber Scenario (50%/50%)
3. MA Non Timber Focused Scenario (25% Timber, 75% Non Timber)

The results are mapped in Figure 8 below.

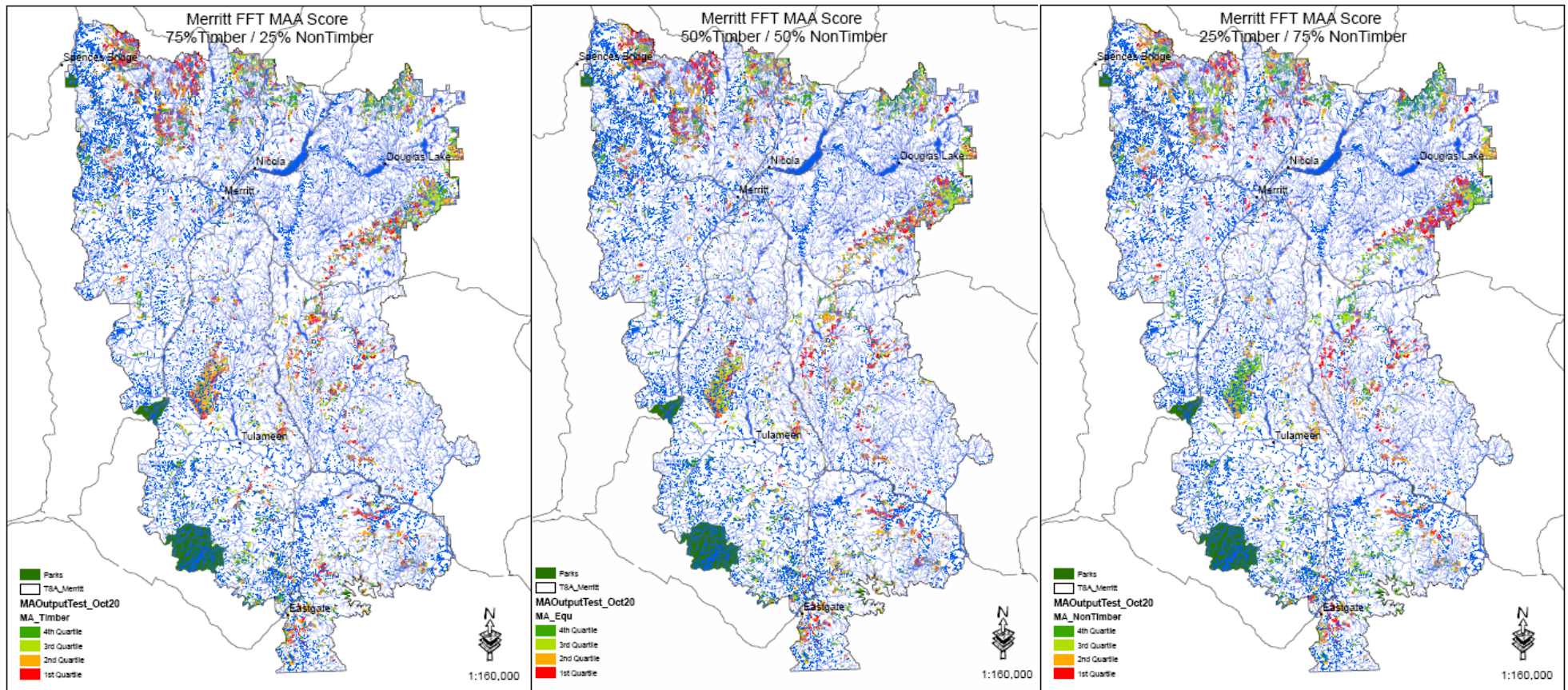


Figure 8. FFT priority stands for the three Multiple Accounts scenarios (Timber Focus, Equal Timber/Non Timber, and Non Timber Focus).

These results show a trend away from the fire areas as more emphasis is put on non-timber values in the multiple accounts scoring. This occurs because the fire areas have lower non timber value scores than the broader FFT candidate population. This shift is also seen in the graph below. The graph also shows a generally increasing trend in immature MPB areas indicating that these are generally correlated with higher non timber values. For example, the best timber sites (1st Quartile) include only 1% of its area from immature MPB, while the best non timber sites includes 13% of its area in immature MPB (Figure 9).

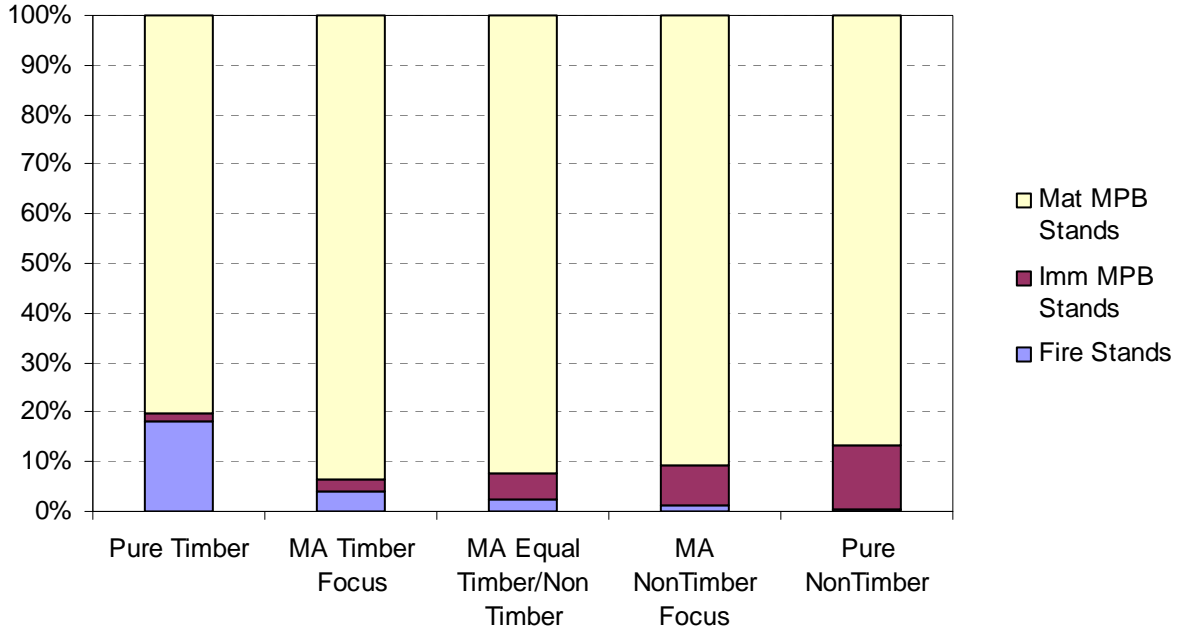


Figure 9. 1st quartile areas by FFT candidate stratum type for each scenario

In order to fully understand the implications of the multiple accounts weighting options on the results achieved, the scenarios have been compared against the pure timber scenario. The figure below shows how the first quartile (top 25% of area) timber stands are distributed in the multiple accounts scenarios.

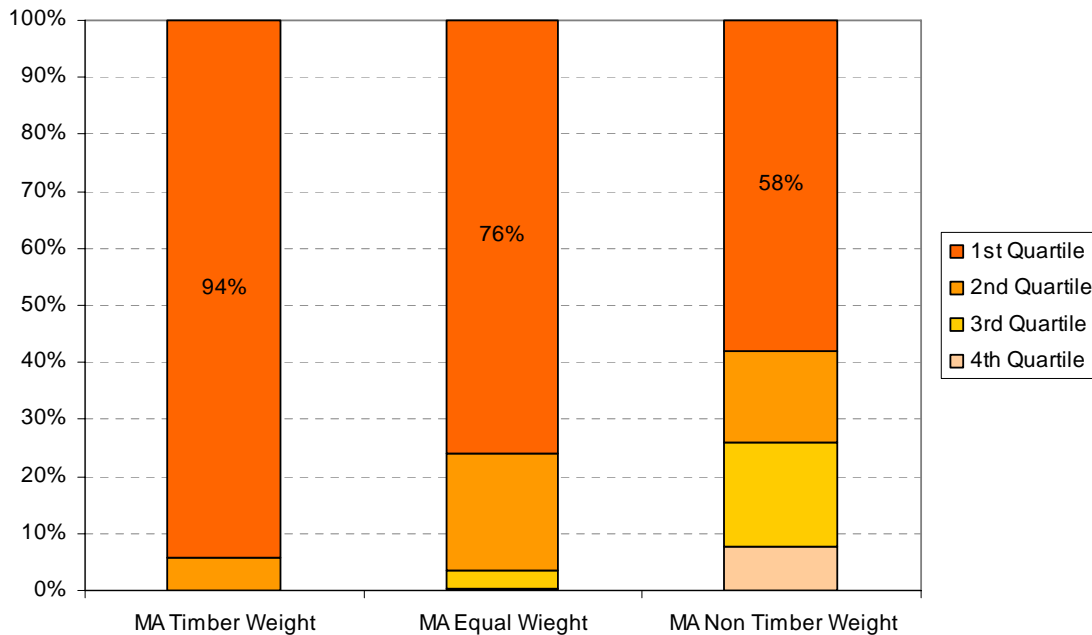


Figure 10. Location of the 1st quartile Timber Stands in other scenarios

The Multiple Accounts Timber Focused scenario managed to retain 94% of the top timber priority area in its first quartile, while the Equal and Non Timber Focus Scenarios only managed to retain 76% and 58% respectively. The Equal Weighting scenario contained 96% of the top timber priority area in its 1st and 2nd quartile areas combined.

One of the concerns for the FFT program is when treatment outside the THLB is warranted. From a pure timber point of view, THLB stands are the primary focus. The graph below shows the amount of 1st quartile stands that are in the THLB for each of the scenarios explored.

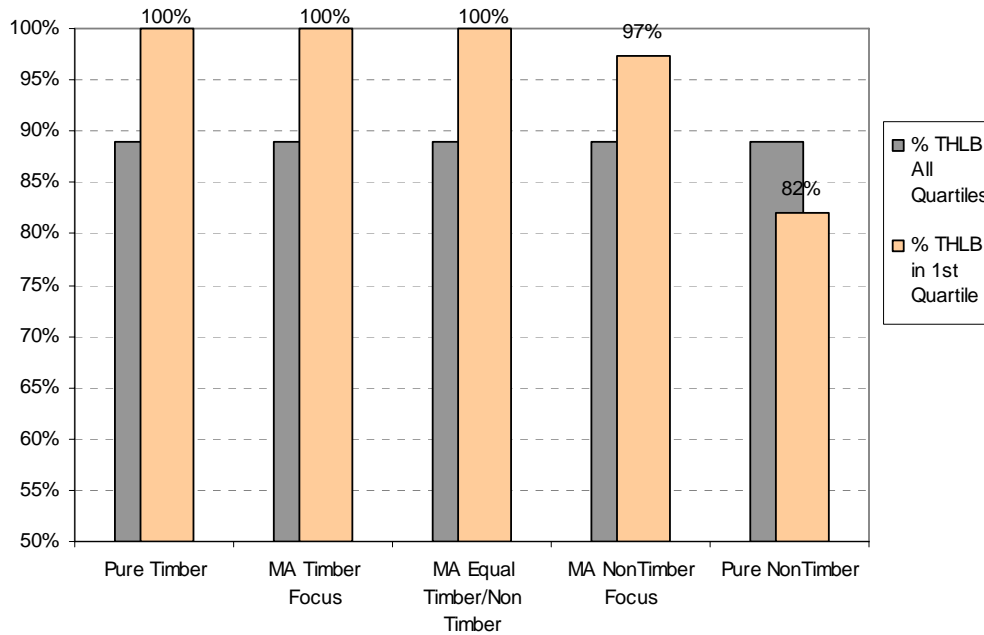


Figure 11. Percent THLB in 1st quartile of each scenario

Each of the Pure Timber, MA Timber Focus, and MA Equal weighting scenarios had 100% of their first quartile area in the THLB. It wasn't until the MA Non Timber Focus and the Pure Non Timber scenario that NonTHLB areas began to appear in the 1st quartile, and only the Pure Non Timber Scenario ended up with less THLB than the overall candidate population (89%). In summary, all scenarios but the pure non timber scenario heavily favored THLB stands relative to the candidate population. This occurred because THLB stands were scored extremely high in the timber scoring, and when used in the MA scenarios, this ensures THLB sites are favoured.

In order to ensure that no undesirable sites are being prioritized into the upper quartiles of the multiple accounts scenarios, non THLB sites and the worst stands in the Pure Timber scenario were profiled in the multiple accounts scenarios. Figure 12 shows how the THLB areas were distributed within each scenario.

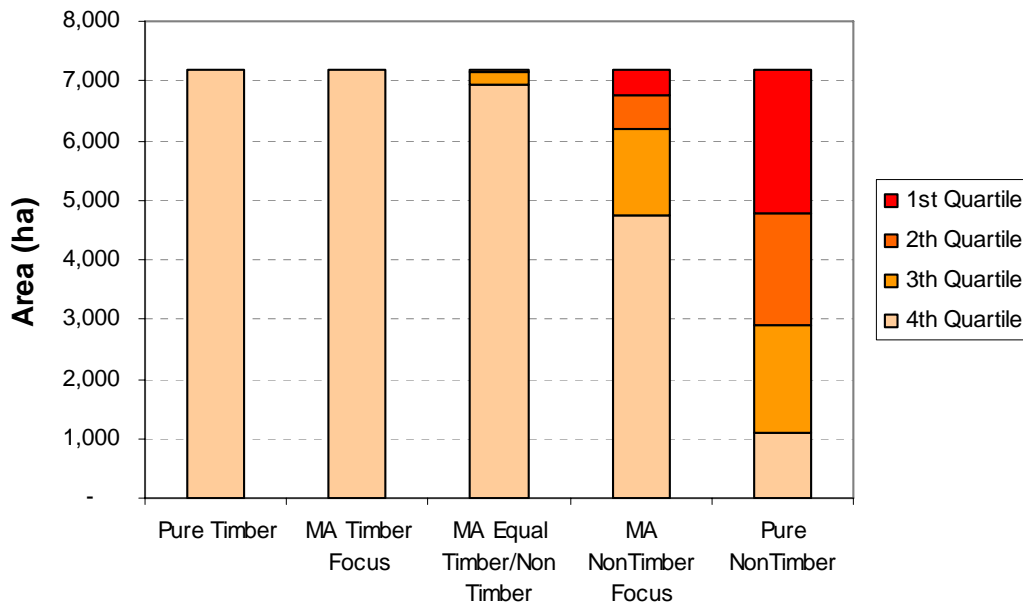


Figure 12. Distribution of all Non THLB area by quartile in each of the scenarios

The non THLB remains entirely within the 4th quartile for the Pure Timber and MA Timber Focused scenario, but it starts to show up in higher quartiles in the remaining three scenarios. The MA Non Timber and Pure Non Timber scenarios show non THLB areas in all quartiles.

Figure 13 indicates where the worst timber sites (4th quartile of the Pure Timber scenario) are located within each of the multiple accounts scenarios. These sites were almost completely restricted to the bottom two quartiles in the MA Timber scenario but began to show up more consistently in the upper quartiles in the Equal Weight and MA Non Timber scenarios. These later two scenarios could potentially lead to crews being sent to field review undesirable sites from a timber perspective.

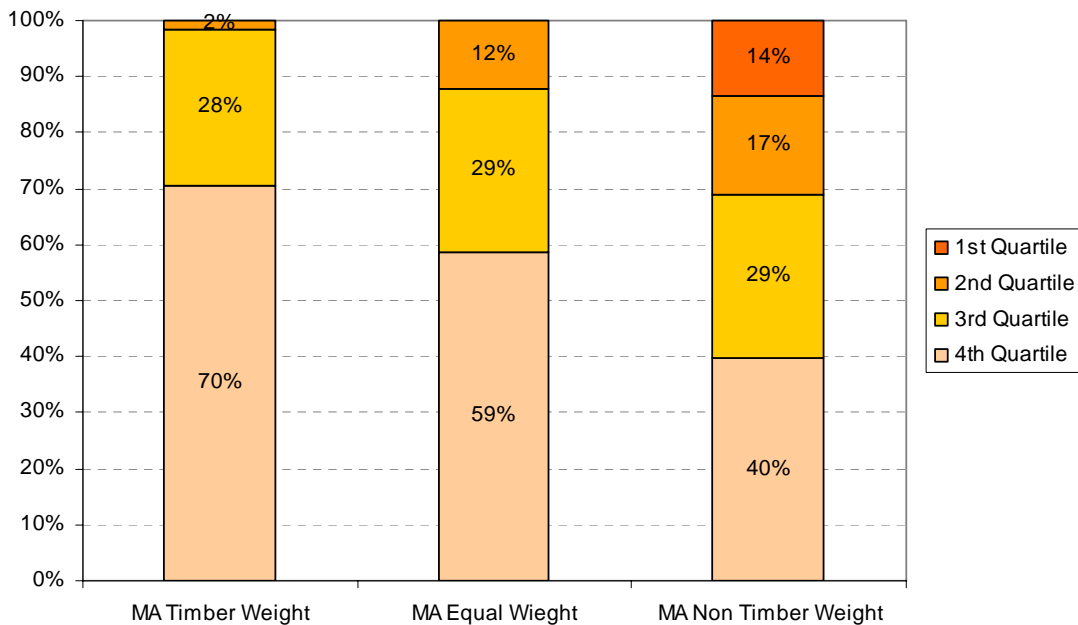


Figure 13. Distribution of the worst timber sites in the multiple accounts scenarios.

Figure 14 shows where the best non timber sites (1th quartile of the Pure Non Timber scenario) are located within each of the multiple accounts scenarios. These sites were spread out amongst all four of the priority

quartiles in MA Timber scenario but begin to occur more consistently in the upper quartiles in the Equal Weight and MA Non Timber scenarios. This occurs because these values are weighted more strongly in these scenarios. The MA timber scenario severely downgrades sites that have low or no timber values.

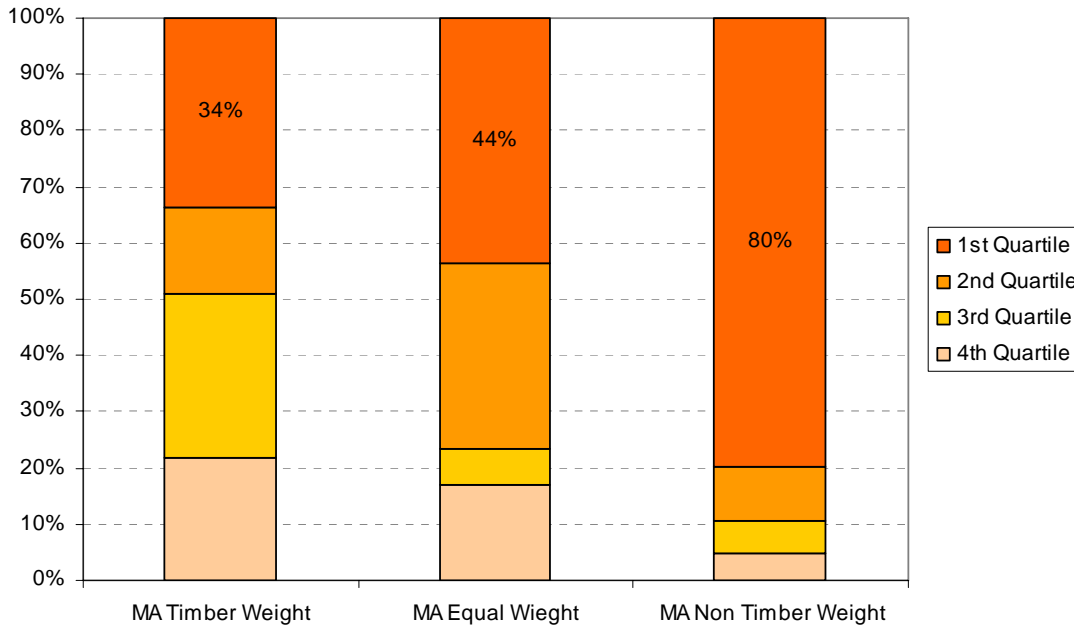


Figure 14. Distribution of best non timber sites in the multiple accounts scenarios.

6.0 Discussion

The use of separate timber and non timber assessments in multiple accounts scoring/prioritization systems appears to work well and provides significant flexibility to decisions makers to focus funding around specific objectives. Section 7 of the document *Integrating Timber and Non Timber Values into FFT Silviculture Investment Decisions* suggests the standard FFT funding envelope should use the 75% Timber / 25% Non Timber weighting scenario, while alternative funding sources or envelopes could capitalize on this MAA framework by simply specifying a different weighting of timber and non timber values.

The 75% Timber / 25% Non Timber scenario appears to be a good choice for the FFT program because:

1. It ensures sites with high timber AND non timber values (win/wins) rise to the top while maintaining the focus on areas that will improve timber supply. This scenario's first quartile contained 94% of the best pure timber sites, and when combined with the second quartile managed to capture 100%.
2. It keeps 100% of the Non THLB sites in the bottom quartile and keeps 70% of the worst timber sites in the bottom quartile.
3. The weightings are such that non THLB areas are not pushed up into the first quartile. Treatment of NonTHLB is possible under FFT but is less desirable than finding win/wins on the THLB.

Some suggestions for future improvement include:

- A more refined approach to ECA calculations for MPB impacted stands. The formula should include recognition of the % PI (% mortality) in the stand.
- A better definition of the mature MPB areas that will not be salvaged. Forest Analysis and Inventory Branch (Graham Hawkins) is currently working on detailed mapping of dead stands that will include a date when the majority of the stand was dead. This data will work well with the shelf life work being completed by MoF/FORNITEK to identify stands that are unlikely to be salvaged.

Data Issues:

- From a timber perspective, missing data should not be an issue unless one of the key data layers is missing (Forest cover, THLB, MPB attack, silviculture status of logged blocks, etc). The full suite of data layers used in the scoring will yield the best result but if some are missing (i.e. merchantability

mapping) the end result will not vary significantly. The points awarded to each of the layers is a good indicator of its importance – the more points an issue is worth the more important it is to the scoring system.

- From a non timber perspective, no hierarchy of datasets exists so it is simply a matter of capturing the values on the landbase. If no data exists for a known value, then it can be incorporated though 'local knowledge' considerations when selecting survey sites.
- Care should be taken around the natural regen/advanced regen score. If the confidence in this dataset / approach is low, the points associated with it should be scaled back or eliminated completely.

References and Citations

Forsite, 2008. Integrating Timber and Non Timber Values into FFT Silviculture Investment Decisions (Multiple Accounts Decision Analysis). March 21, 2008

Timberline, 2007. Developing A Multiple Accounts Decision Analysis Process For Effective Silviculture Investment Decisions. March 31, 2007