Tolko Industries Ltd.
High Prairie, Alberta
FMA9700033

Coniferous
Timber Supply Analysis

March 1, 2011

Executive Summary

This report presents the results of a coniferous harvest level sensitivity analysis for Forest Management Unit (FMU) S19 where deciduous timber is not being harvested. It also confirms the accuracy of the coniferous timber yield predictions in the Salt Operating Area.

The existing approved coniferous land base was used to establish an updated coniferous harvest level for the S19 FMU (Table 1). The deciduous harvest level remains unchanged (Table 2).

Table 1. FMU S19 Recommended Coniferous Allocations (Effective May 1, 2010).

Company	**Volume Supply Area (VSA)**	**Divided Landbase Recommended AAC (m^3/yr)**	
		1-10 year period	**11-20 year period**
West Fraser Mills Ltd. (Slave Lake)	1	58,925	46,783
Lakeshore Timber Company Ltd.	2	8,596	6,833
Smoky River Loggers Ltd.	2	6,444	6,024
CTPP	2	5,527	5,166
Totals		**79,492**	**64,806**

Table 2. FMU S19 Deciduous Allocations (Effective May 1, 2010).

Company	**Volume Supply Area (VSA)**	**Single Landbase Current AAC[3] (m^3/yr)**
Tolko High Prairie	1[1] and 2	409,750
1088459 Alberta Ltd/Tolko High Prairie Joint Venture	1	50,000
Unallocated	1	46,572
Total		**506,322**

[1] VSA 1 - S19 (out) formerly known as S9 (out)

The coniferous harvest level is established using primary coniferous volume only. Secondary coniferous volume generated from deciduous operations (currently inactive) does not augment the coniferous harvest level. An updated spatial harvest sequence (SHS) has been reviewed and validated to reflect feasible operational activities of the quota holders.

Sustainable Resource Development (SRD) developed localized yield curves for individual operating areas. Where yield strata were represented with adequate numbers of plots, a weighted guide-curve approach was applied. Where plot numbers were insufficient to build satisfactory guide-curves, the approved 2004 FMP curves were used (Appendix 1).

Updated Alberta Vegetation Inventory (AVI) information for the Salt Operating Area became available in 2010. Appendix 2 describes yield curve changes resulting from the use of the 2010 AVI and the inclusion of new Temporary Sample Plot (TSP) data collected in the winter of 2010.

Stratum and age assignments were updated by relating the old plot locations to the new AVI polygons using an overlay process. New attributes were assigned to plots where more than half of the original sampled polygon fell inside the updated polygon.

The White spruce (Sw) curve was replaced with the original FMP level curve due to its low representative area. There were no pine stands sampled, therefore the FMP level curves were used.

The analysis assumed low-density Black spruce (Sb), and fully stocked deciduous leading mixedwood strata do not produce 50 m^3/ha at maturity. These stand types were removed from the timber harvesting land base. The new AVI had very little deciduous leading mixedwood area in the Salt Operating Area. There were also some changes on the deciduous land base, which do not influence this analysis.

Merchantability standards remain unchanged. Coniferous volumes were calculated using 15 cm outside bark at stump height (30 cm) to a 11 cm top diameter (inside bark). Deciduous volumes were calculated using 15 cm outside bark to a 10 cm top diameter (inside bark).

Current market conditions were addressed by the TSA assumptions used in this analysis:

1. The coniferous harvest level was maximized in the first 10 years; therefore, reconciliation volumes are not approved and not included.
2. Minimum harvest ages were increased from 70 years to 90 years for pure coniferous, to 100 years for coniferous leading mixedwoods and to 120 years for deciduous leading mixedwoods.
3. Black spruce was deferred for the first 20 years.
4. The 10-year spatial harvest sequence only included stands with heights greater than 18 metres.
5. Whitemud Operating Area pine stands were deferred for 20 years due to non-merchantability.
6. Coniferous leading mixedwoods were prioritized over deciduous leading mixedwoods to minimize incidental deciduous timber production.
7. Salt Operating Area yields were adjusted to reflect the landbase profile using:
   a. Supplementary TSP data collected by SRD and
   b. Updated AVI collected by Tolko.

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1.0 Introduction

The main objective for this project was to provide a sensitivity analysis and recommend a coniferous harvest level for Forest Management Unit (FMU) S19, using only the traditional coniferous land base. In the absence of an active deciduous operator, this is a reasonable course of action. The secondary objective was to confirm the accuracy of the coniferous predictions in the Salt Operating Area, leading to a more reliable spatial harvest sequence (SHS). The deciduous harvest level was not altered in this analysis.

The coniferous harvest level consists of primary coniferous volume. The harvest level is not supplemented with secondary coniferous volume harvested through deciduous operations. The new coniferous SHS reflects the operational activities of the quota holders, which should minimize the variance seen on the ground. The new coniferous harvest level is lower than the currently approved levels.

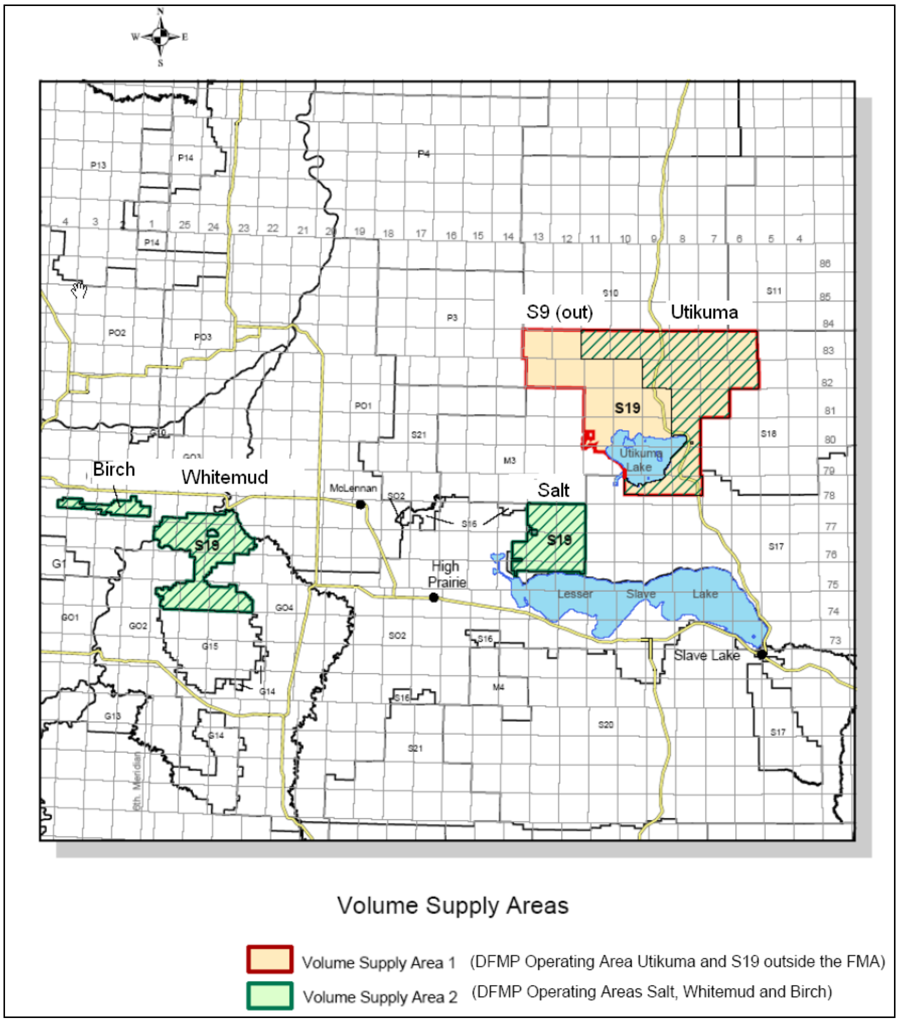


Figure 1. Overview of the volume supply areas and operating areas. S19 (out) and S9 (out) are used interchangeably in this report to describe the nine townships west of the Utikuma Operating Area. The S9 (out) designation was identified in the 2005 net land base submission and this designation has been retained in the SRD analysis.

2.0 Land base updates

The submitted land base developed by Tolko Industries Ltd. – High Prairie (Tolko) in 2005 (effective 2003) was used as the foundation for this analysis. Woodstock themes were added by referencing existing variables in the shape file.

The land base was updated to avoid sequencing stands that were no longer forested. Obvious harvest openings and visible disturbances were captured manually from the 2008 SPOT (Satellite Pour l'Observation de la Terre) imagery, and used to reset the ages of forested stands. Polygon edges either followed the Alberta Vegetation Inventory (AVI) polygon, or if necessary, large polygons were split. Yield transitions for harvesting stands from a low-density stratum followed the rules outlined in the 2005 plan. Clouds in the imagery presented challenges in conducting the land base update in the Whitemud Operating Area, so some ground errors should be expected. Linear features and land use dispositions were not updated.

Planned harvest opening boundaries provided by West Fraser Mills Ltd. - Slave Lake (WFSL) were compared to the revised active land base. The portions of the harvest openings that fell into the active coniferous land base were hard-coded into the model as first-period pre-blocks. Stands that were below the revised minimum harvest age were left in the SHS and given special exceptions in the model (i.e. were deferred from harvest). If WFSL follows the planned boundaries for their pre-blocks, they may be entering riparian buffers as identified in the submitted net land base (NLB); if there are outages, these will have to be tracked as part of the spatial harvest sequence variance.

Prior to the completion of the project, Resource Information Management Branch (RIMB) released a new official version of the AVI for the Salt Operating Area, based on air photos taken in 2005. See Table 1 for the summary of area changes by cover group for the Salt Operating Area.

The original AVI used in the approved land base was replaced and the yield strata, age and subjective deletion fields were recalculated. The remaining deletion types (i.e. buffers, access, slopes, etc.) were selected from the approved land base and the spatial file with attributes was directly incorporated into the revised modelling land base.

The majority of the mixedwood area ended up being re-interpreted as either deciduous land base (blue text), or in the low-density White spruce (Sw) strata. There was also an increase in the merchantable Black spruce (Sb), as the new age assignments improved the Timber Productivity Rating (TPR) of the stand. There were two new non-merchantable strata (curves 10 and 15), which did not contribute to the active land base. Refer to Table 2 for a summary of the changes in net area.

Refer to Table 3 for a final net area table for the entire Forest Management Agreement area (FMA). Note: only the subjective (merchantable) deletions were re-assessed with the new Salt Operating Area AVI; the remainder were taken from the original NLB submission.

Table 1. Changes in the AVI cover types, prior to applying the net down information.

Cover Group	Salt 1997 (ha)	Salt 2005 (ha)	Difference (ha)
Nonforested	4,045.40	4,354.70	+309.3
C	9,836.50	11,704.90	+1,868.40
CD	3,176.10	672	-2,504.10
DC	3,537.90	787.9	-2,750.00
D	27,859.30	30,910.20	+3,050.90
Total	**48,455.10**	**48,429.70**	**-25.4**
Total C/CD/DC	16,550.50	13,164.80	-3,385.70
Total D	27,859.30	30,910.20	+3,050.90
Total forested	44,409.80	44,075.00	-334.80
Pct C/CD/DC	37%	30%	
Pct D	63%	70%	

Table 2. Changes in the net land base area per yield strata for the Salt Operating Area

Yield curve	Description	Original (ha)	Updated (ha)	Difference (ha)
1	Low density, good Decid	2,470.4	1,901.9	-568.5
2	Low density, med/fair Decid	2,884.7	6,808.7	3,924.0
5	High density, good, Decid	10,022.4	11,059.6	1,037.2
6	High density, med/fair Decid	11,177.8	10,055.0	-1,122.8
9	Low density DC	1,826.9	509.0	-1,317.8
10	High density DC	1,344.8	0.0	-1,344.8
11	Low density CD	1,355.7	479.1	-876.6
12	High density CD	1,882.7	157.8	-1,724.8
13	Low density SW	992.2	2,515.5	1,523.3
14	Low density PL	88.7	377.7	288.9
15	Low density SB	1,027.9	0.0	-1,027.9
16	High density SW	624.9	421.0	-203.9
17	High density PL	28.5	36.8	8.3
18	High density SB	232.9	1,089.0	856.1
	Total	35,960.5	35,411.1	
	Total active Con LB	9,405.2	5,585.9	
	Total active Dec LB	26,555.3	29,825.2	

Note: In Table 2, the blue text identifies the mixedwood area re-interpreted as deciduous landbase.

Table 3. Final area summary by deletion type for all operating areas.

Code	Description			Area (ha)	
1	Water polygons			15,251.4	
2	Dispositions			18,888.6	
3	Rec lake buffers			65.7	
4	Swan nesting buffers			369.6	
5	Lake buffer			15,532.2	
6	River and large hydro feature buffer			5,135.0	
7	Stream buffer			7,095.2	
8	Anthro non-forested (including updates)			5,418.8	
9	Naturally non-forested			19,559.7	
10	Merchantable deletions			78,659.5	
11	Recent burns			33.3	
12	Non-FMA lands inside the boundary			4,658.1	
	Sub-total (passive land base)				170,667.2
		DEC	CON		
0	No deletion type (active land base)	146,405.9	58,567.8		205,766.7
	Grand Total				376,433.9

3.0 Yield curve changes

Rather than use the Forest Management Plan (FMP) submitted yield curves, this analysis started with Sustainable Resource Development (SRD) developing a set of yield curves that were localized to the individual operating areas. For yield strata with an adequate number of plots, a weighted guide-curve approach was applied. If there were not enough plots to build a satisfactory guide-curve, the original FMP curves that were submitted in 2004 were used. Refer to Appendix 1.

New AVI information for the Salt Operating Area became available in 2010, which had an impact on the previous local yield estimations. Appendix 2 describes the changes in the yield curves that were made based on the new AVI as well as inclusion of new Temporary Sample Plot (TSP) data collected by SRD in the winter of 2010.

Most of the previous localized curves were invalidated and new curves were developed. Strata and age assignments were updated by relating the old plots to the new polygons using an area-based overlay process. New attributes were assigned to the plot if more than half of the original sampled polygon fell inside of the replacement polygon. Due to its representative area, the low-density Sw curve was not considered an accurate and reliable curve. The Sw curve was replaced with the original FMP level curve. There were no pine stands sampled, therefore the FMP level curves were used.

The other change with a direct annual allowable cut (AAC) impact was the assumption that low-density Sb and the fully stocked (deciduous-coniferous) DC strata no longer produce 50 m^3/ha at maturity and these stand types were removed from the active land base. The new AVI had very little DC area in the Salt Operating Area. There were also some changes on the deciduous land base, which do not influence this analysis.

The merchantability standards of the curves were not changed. Coniferous volumes were calculated at 15 cm top diameter outside bark (DOB) and 11 cm bottom diameter inside bark (DIB). Deciduous volumes were predicted at 15/10. Any changes to the merchantability assumptions should be handled after the analysis is complete using the appropriate conversion factors.

Tolko had developed a model based on a 10-year period, which was not altered. All stands were re-aged using 2009 as the base year, and the decadal classes were re-calculated using a floor function. All yields referenced the new age in the model.

4.0 Model changes

A new Woodstock model was written to emulate what Tolko had developed through SILVASYM (Silvacom Ltd. model). There were several changes made to the SRD model to produce a SHS that would reflect the probable operations of the coniferous quota holders. This should result in less spatial variation in the field and the desired future forest conditions are more likely to be produced. The projected harvest levels should also be more sustainable from both a volume and a desired product perspective.

4.1 Land base designation

The 2005 harvest level was calculated using a single land base. Stands were queued for harvesting based on when they provided the optimal total volume and could be used for either coniferous or deciduous production.

Both the absence of a deciduous operator and the desire for larger diameter coniferous trees make this approach infeasible. The land base was split into a coniferous and deciduous portion in a manner similar to other approved plans. The merchantable portions of the coniferous-deciduous (CD) and DC strata contributed to the primary coniferous AAC, but would produce incidental deciduous volume that would need to be addressed. The incidental coniferous volume from pure deciduous (D) stands was not tracked for this analysis.

4.2 Profile considerations

Most of the concerns surrounding the 2005 SHS related to finding merchantable volume that fit the desired profile of large, tall coniferous trees. The following changes in timber supply analysis modelling assumptions were incorporated:

- The minimum harvest ages were raised from 70 years to an older age that would likely produce larger diameter coniferous trees. The pure coniferous stands, CD mixedwoods and DC stands were eligible for harvesting at 90, 100 and 120 years respectively. Pre-blocked stands were exempt. As Tolko did not develop piece size curves, it is anticipated that managing ages will be a reasonable proxy.

- Sb was deferred from the first 20 years of the planning horizon, partly to provide a more economically competitive sequence. This was balanced by allowing the Sb to comprise a maximum of 5% of the primary coniferous volume, per operating area and per period for the remainder of the planning horizon. Sb will be part of the profile in the future, but will never be a dominant species. Exceptions were made in some cases in the Whitemud Operating Area (and Salt Operating Area for some periods) to allow additional flexibility in building the spatial harvest sequence.

- Height restrictions were put in place to ensure that the majority of the stands in the ten-year SHS were greater than 18 m tall. Height age curves were not available; therefore, this restriction was only applied to the first ten years.

- The old growth targets established in the FMP were emulated in this analysis through goal programming, which started in year 30. As identified in the new inventory and updates, there is not enough old growth available in the first ten years; therefore, some time was required for adequate area to reach a merchantable harvestable age.

- Pine stands from the Whitemud Operating Area were deferred for 20 years. Forest health reports that there were red trees sighted in the area in 2007, therefore there may be opportunity for salvage volume. A pine strategy was not integrated into this plan because the pine stands were too young and small to meet the short-term merchantability rules. The pine stands in the S9 (out) portion are on the edge of the current holding zone.

4.3 Incidental deciduous concerns

In order to minimize the amount of incidental deciduous volume produced by the model, weighted objectives were added.

- Where possible, at least twice as much coniferous volume came from the CD stands as the DC stands on a per operating area basis.

- When a DC stand was scheduled, a priority system was used to select those with a higher coniferous crown closure before those with a lower coniferous crown closure.

- At least 30% of the primary coniferous volume per period and operating area had to be taken from pure spruce, pine or black spruce (from either low or high-density stands).

It should be noted that there is still a high amount of incidental deciduous produced by the SHS. The S19 area, in particular the Utikuma Operating Area, is dominated by mixedwood and deciduous stands. Refer to Figure 2 in the Harvest Profile section for the estimated amount of deciduous volume produced.

Between the changes in the incidental deciduous, and the replacement AVI for the Salt Operating Area, it is expected that there will be some changes on the deciduous AAC as well. This issue was not analysed as part of this project.

4.4 Volume supply areas and flow policy

The even-flow policy was enforced at the FMA level, while the operating areas within the volume supply areas (VSA) were allowed to vary by 5% to allow for operational flexibility. In order to allow an easier transition into the sustainable harvest level, a surge cut was permitted provided it met the guidelines from the *"Alberta Forest Management Planning Standard"*. The guidelines are as follows: A maximum short-term harvest uplift of 25% above a baseline even-flow level is allowed, providing that it does not negatively impact the long-term baseline even-flow level by more than 10%.

The volume flow rules surrounding the VSA1 area (consisting of the Utikuma and S9 (out) Operating Areas) were not altered. A single sustainable harvest level (even-flow +/- 5%) was calculated for these two operating areas. Volumes could be provided from either operating area without any flow restrictions. In some periods, the volume predominantly comes from the S9 (out) portion. The intent in the 2005 plan was to offer this coniferous volume exclusively to WFSL.

The flow rules for VSA2 (consisting of the Salt, Whitemud and Birch Operating Areas) were altered for this analysis. Originally, the entire VSA was considered one unit, and had a single even-flow value calculated for it. The new analysis used separate sustainable harvest flows (even-flow +/- 5%) for the Salt Operating Area, and for the combined Whitemud/Birch Operating Areas. The total available VSA2 volume is the sum of these two sustainable sources.

The situation in VSA2 is complicated. Since Lakeshore receives all the volume scheduled in the Salt Operating Area, they end up with a decrease in their allotted percentage within the VSA. The reasoning was that operating in their historic area was more important than maintaining their allocated percent across VSA2.

5.0 Spatial harvest sequence

Once the aspatial targets had been set in Woodstock, stands were sequenced using Woodstock. A 2 ha minimum opening size was used, but stands within 20 m could be aggregated together when assessing size.

Sequencing was done in phases. The first twenty years were blocked for all operating areas using Stanley. This should create a spatial pattern that meets the aspatial goals, but does not bias between two stands of a similar type. A manual cleaning exercise was done to regroup these randomly selected blocks within the same harvest period to improve the operational efficiency. If needed, eligible stands were added to improve the spatial pattern and to top up the expected volumes.

After the first manual grouping, the first part of the modelling process was repeated to produce a full 80 years of spatial blocks. This pattern was locked in, and the long-term aspatial harvest levels (years 90-160) were calculated in response to the impact of this pattern.

The tables in Section 7.0, Results and allocation, reflect the final spatial numbers.

6.0 Merchantable volume validation

In order to confirm that the SHS would produce the expected coniferous volume, a series of 102 operational plots were placed in a random selection of stands found in the first ten years of the draft SHS. Plots were only collected in the Utikuma, Salt, and S9 Operating Areas of the FMA to balance cost and statistical demands. Analysis was completed using a box-plot approach through Statistical Analysis Software (SAS), where the predicted yields were compared to the quartile distribution of the new samples.

The samples taken in the Utikuma Operating Area showed that the predicted volume should be present for the majority of the strata. The only stratum of concern was the low-density DC stands, which only existed in WFSL's pre-blocks. The ten-year sequence for the Utikuma Operating Area was left as planned.

The sampled strata in the S9 Operating Area showed more variability in the sampled coniferous volumes than we saw in the Utikuma Operating Area. In general, the sampled coniferous volumes are consistent with the predicted yields. In some strata, the volumes are lower than average, but within one quartile of the predicted value.

There were complications with the Salt Operating Area because the AVI was replaced after the field samples had been collected. The updated yield strata associated with the draft SHS changed and half of the SHS ended up in the deciduous land base. Combined with the recalculation of the harvest levels, few blocks that had been sampled ended up in the new SHS. This new data should not be used to validate the yield strata in the Salt Operating Area.

7.0 Results and allocation

The modelling process confirmed that harvesting the approved coniferous AAC of 167,031 m^3/year from the traditional coniferous land base is not sustainable. The mid and long-term response to maintaining the current harvest levels were not acceptable to the department.

The process established that VSA1 has a higher sustainable primary coniferous harvest level than VSA2 because of the nature of the local forest. The forest in the Utikuma Operating Area contains a fair amount of mixedwood stands, which contributes to the coniferous land base at the cost of incidental deciduous production. The replacement AVI in the Salt Operating Area shifted a large amount of mixedwood area into the deciduous land base, dropping the primary coniferous harvest levels. This will affect the quota percents, as VSA1 now produces a higher proportion of the FMA level coniferous volume than it did previously.

Tables 1-5 provide a walk-through on how the new harvest levels affect the current approved allocations.

Table 4. Revised Volume scheduled (m^3 per decade)

Time frame	Total FMA	Utikuma / S9 (VSA1)	Whitemud / Birch (VSA2)	Salt (VSA2)
Ten year surge cut	794,919	589,245	119,714	85,959
Mid-term (spatial)	620,135	445,450	112,648	62,037
Long-term (aspatial)	627,376	447,168	116,579	63,630

Table 4 shows the new decadal primary coniferous volumes for the total FMA level, the VSA1 portion (Utikuma and S9 Operating Areas), the Whitemud/Birch portion of VSA2, and the Salt portion of VSA2. The ten-year surge cut for years 1-10, reflects both the manual clustering and the harvest profile changes. The mid-term covers the average coniferous volume produced during years 11-80, and have been blocked using Stanley. The long-term aspatial number captures the impact of the spatial portion, and the changes in growing stock from years 81-160.

Table 5. Revised Volume scheduled (m^3 per year)

Time frame	Total FMA	Utikuma / S9 (VSA1)	Whitemud / Birch (VSA2)	Salt (VSA2)
Ten year surge cut	79,492	58,925	11,971	8,596
Mid-term (spatial)	62,013	44,545	11,265	6,204
Long-term (aspatial)	62,738	44,717	11,658	6,363

Table 5 is based on the same assumptions as Table 4, but shows the annual volumes (m^3/year).

Table 6. Percent of total annual coniferous volume

Time frame	Total FMA	Utikuma / S9 (VSA1)	Whitemud / Birch (VSA2)	Salt (VSA2)
Ten year SHS	79,492	74.13%	15.06%	10.81%
Mid-term (spatial)	62,013	71.83%	18.17%	10.00%
Long-term (aspatial)	62,738	71.28%	18.58%	10.14%

Table 6 converts the new annual volumes into percentages, relative to the total FMA volume for each time period. This is a consistent approach to what was seen in the approval document, and can be compared to the approved percentages found in Table 7.

Table 7. Currently approved percents

Time frame	WFSL (VSA1)	Lakeshore (VSA2)	Smoky (VSA2)	CTP (VSA2)
Percent of total	64.20	13.88%	11.8%	10.12%
Percent of VSA	100.00	38.77%	32.96%	28.27%

Table 7 shows the currently approved allocation percentages from the 2005 approval decision. There was no surge cut in the 2005 plan, therefore the percentages reflect the 160-year planning horizon.

The new VSA1 percentage is approximately 10% higher than in the approved plan. The intent of the 2005 plan was to allocate the full VSA volume to WFSL. WFSL would see a gain in their percent allocation, but a drop in their allocated volume because of the reduction in available coniferous AAC. The volume allocated to VSA2 drops proportionally, and has to be divided between the three remaining operators.

Table 8. Allocated volumes using the current allocation percents within VSA2

Time frame	Total	WFSL (VSA1) Utikuma	Lakeshore (VSA2) Salt Unit	Smoky (VSA2) Whitemud/Birch Units	CTP (VSA2) Whitemud/Birch Units
Ten year surge cut	79,492	58,925	8,596	6,444	5,527

Table 8 shows the total available volume to each operator in m^3/year in VSA2. The volume for Lakeshore is comprised of 100% of the available volume within the Salt Operating Area, which will change their percentage of the VSA2 volume. The remaining volume within VSA2 in the Whitemud and Birch Operating Areas was split between Smoky River Loggers and Coniferous Timber Permit (CTP) operators, based proportionally on the approved percentages. The spatial harvest sequence would need to be divided between the operators prior to beginning operations.

The total volume found in the SHS file is marginally higher due to rounding errors between the two systems. The decadal volume is 794,942 m^3 of coniferous, rather than 794,919 m^3 in the aspatial playback.

8.0 Harvest profile

- There is a high amount of incidental deciduous produced during the first 20 years of the SHS (see figure 2).
    - Specifically, this is a concern in the Utikuma Operating Area. (Previously it had been a concern in the Salt Operating Area as well, but now stands that were mixedwood stands are either deciduous or non-merchantable). Because of the predominance of the mixed-wood strata, and the limited amount of mature timber, the model cannot avoid producing incidental deciduous without compromising the coniferous cut any further.

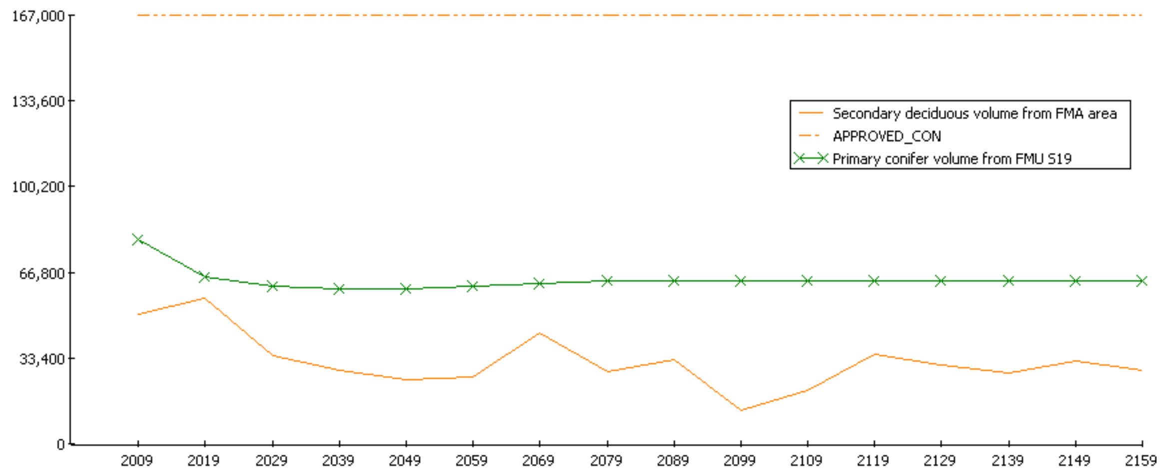


Figure 2. The primary coniferous volume (shown as the green line) is associated with a high amount of incidental deciduous volume (orange solid line). As a reference, the currently approved coniferous harvest level is shown (dashed orange line).

- There is a strong reliance on pine stands in the mid-term timber supply (see figure 3, blue bars). The SHS may need to be revisited in the future dependent on the results of the mountain pine beetle (MPB) surveys.

- The rules around the merchantable Sb harvest for the Salt Operating Area had to be modified slightly when blocking years 40-60. The aspatial target was exceeded, and approximately 10% of the total coniferous harvest ended up coming from Sb stands. The model needed to include these stands to meet the minimum block size of 2 ha while still producing the aspatial volume targets.

- There is a harvest transition rule that low-density stands transition to fully stocked stands after harvesting. In the Salt Operating Area, the new AVI showed that approximately a third of the coniferous net land base is now part of the low-density Sw strata. If this transition is not supported by silvicultural practices, the long-term harvest levels may not be present. A sensitivity run showed that if we follow the 80 year SHS, but fail to improve the stand density through silvicultural practices, the long-term harvest drops by an additional 18%.

The 20-year draft SHS can be found in Figure 4. It has been manually grouped together by SRD but has not been field checked beyond the WFSL pre-blocks. Volumes produced by the SHS are reflected in the above tables.

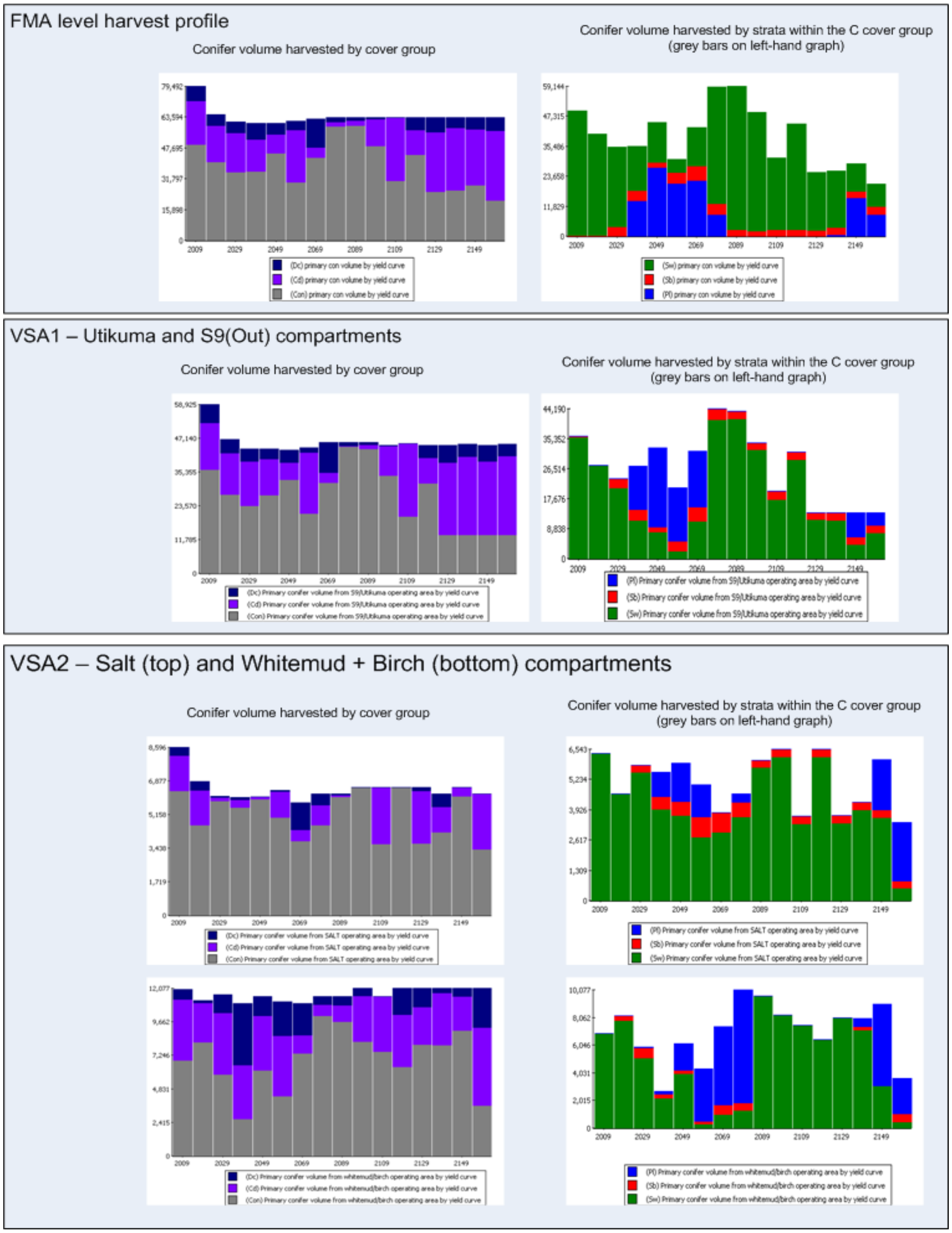


Figure 3. Harvest profile for the FMA and for the operating areas. The first 80 years are spatial; the remaining 80 are aspatial values. Species and cover group labels are identified in the individual legends.

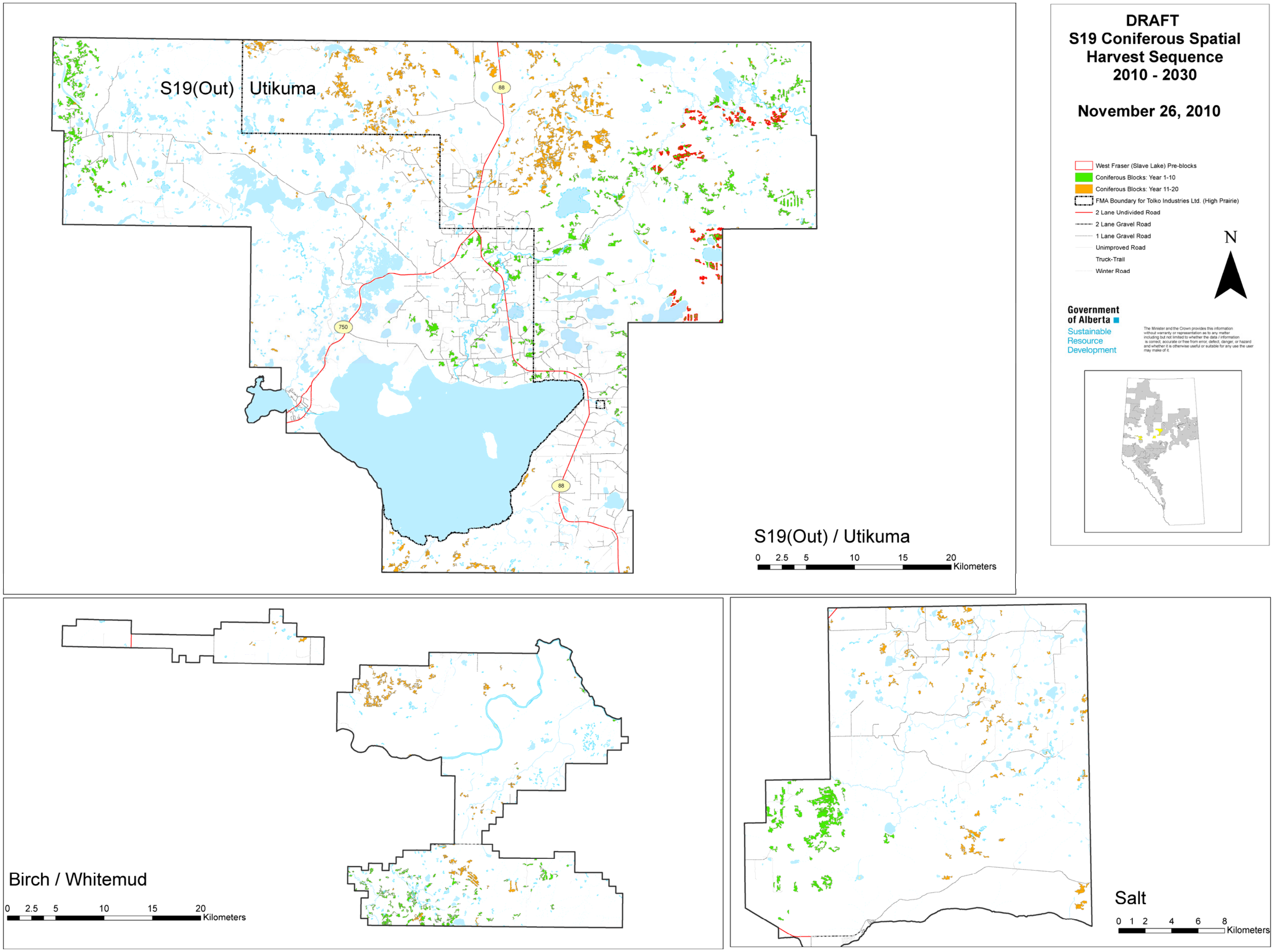


Figure 4. 20-year spatial harvest sequence map by operating area.

Appendix 1 - Tolko Industries Ltd. (High Prairie) Forest Management Agreement Area Salt Operating Area Yield Analysis

Appendix 1

Tolko Industries Ltd. (High Prairie) Forest Management Agreement Area
Salt Operating Area Yield Analysis

Background
The wood supply for the Salt Operating Area in the Tolko Industries Ltd. – High Prairie (Tolko) Forest Management Agreement (FMA) area is in question based on Lakeshore Timber Company Ltd. observed coniferous harvest volume in the first few years of sequenced cutblocks is lower than the projected volumes. The following exercise was undertaken to evaluate whether or not the available data supports modification of the existing yield estimates to better reflect yields specific to the various operating areas in the Tolko FMA area. Temporary sample plot (TSP) data from the original yield curve development was used for this evaluation.

The following map depicts the location of the four operating areas in the Tolko FMA area. The Salt Operating Area is the operating area, which was originally in question. This exercise localizes yield estimates specific to the Salt Operating Area, Utikuma Operating Area and for the combined Whitemud and Birch Operating Areas.

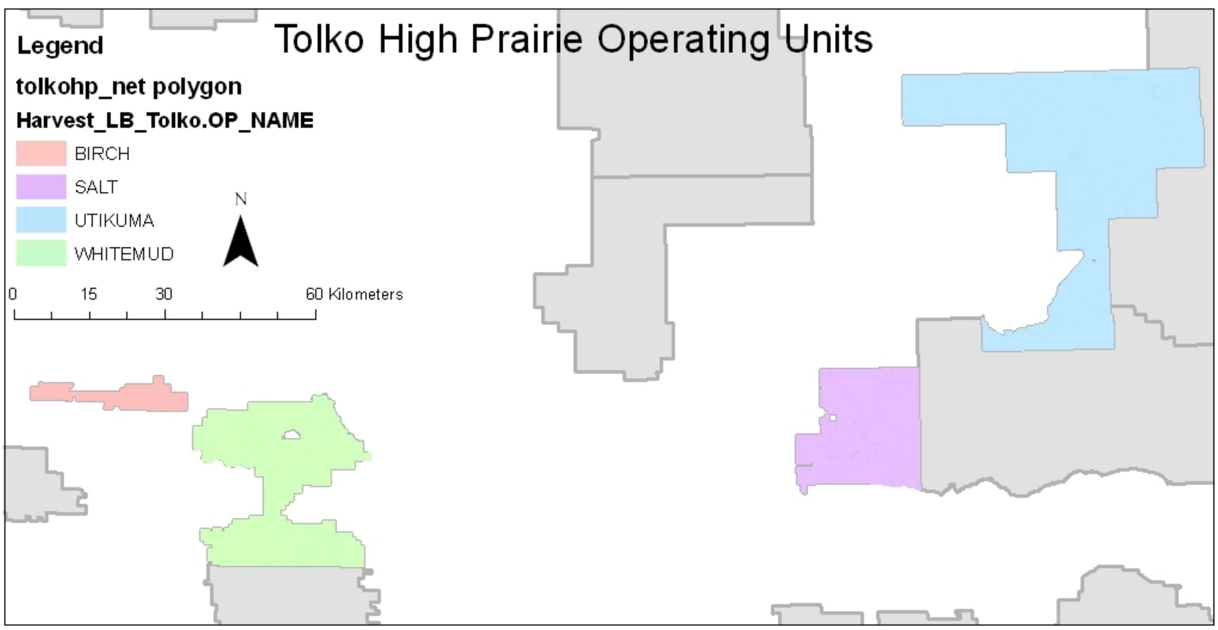


Figure 1. Overview of operating areas within Tolko's FMA.

Yield curves used in the Forest Management Plan (FMP) timber supply analysis (TSA) were developed using TSP data from all of the four operating areas in the FMA area, as well as data sources outside the FMA area (i.e. Tolko Buchanan FMA area TSPs and Slave Lake Pulp FMA area TSPs). The resulting yield estimates were applied to all operating areas in the FMA area.

Salt Operating Area Characteristics

The focus of this analysis is on the Salt Operating Area. It is important to note that the majority of the coniferous cut in this operating area is incidental coniferous yield from the deciduous strata. The break down of the landbase in the Salt Operating Area by strata is presented in Table 1 (note that these may not represent final net landbase areas but should be a reasonably close approximation). The area in the spatial harvest sequence (SHS) by strata is also included in Table 1. This highlights the relative importance of incidental coniferous, with over 95% of the area scheduled for harvest, in the 10-year spatial harvest sequence being in deciduous strata.

The number of TSPs from the Salt Operating Area by strata is also depicted here. This is currently the sole source of data available to localize or guide yield curves to better reflect observed yields in this operating area.

Table 1. Net landbase area, SHS area and number of TSPs by strata.

unit	YC_STRAT	Net Landbase Area		Spatial Harvest Sequence Area		TSP_COUNT
		ha	%	ha	%	
SALT	A-AB-C-PL-A	89	0.2		0.0	
SALT	A-AB-C-SB-A	1,030	2.9	5	0.1	
SALT	A-AB-C-SW-A	1,019	2.8	31	0.5	30
SALT	A-AB-CD-A-A	1,524	4.2	36	0.5	36
SALT	A-AB-DC-A-A	1,847	5.1	38	0.6	36
SALT	A-CD-C-PL-A	29	0.1		0.0	
SALT	A-CD-C-SB-A	231	0.6	2	0.0	18
SALT	A-CD-C-SW-A	598	1.7	3	0.0	18
SALT	A-CD-CD-A-A	1,873	5.2	84	1.2	36
SALT	A-CD-DC-A-A	1,325	3.7	105	1.6	42
SALT	MX-AB-D-A-G	2,470	6.9	147	2.2	24
SALT	MX-AB-D-A-MF	2,890	8.0	1,269	18.9	18
SALT	MX-CD-D-A-G	10,022	27.9	3,298	49.2	36
SALT	MX-CD-D-A-MF	11,014	30.6	1,684	25.1	46

Localization Results

Where data was deemed sufficient, a guide curve approach was used to localize the base FMP yield estimates specific to each operating area. Existing yield estimates for the Tolko FMA area, as documented in the FMP, were used as the base yield curves. The data was used to guide the magnitude of the yield estimates for coniferous and deciduous yield components. The resulting multipliers for coniferous and deciduous yield, for strata that had 24 or more TSPs, are presented in Tables 2, 3 and 4 as fields "ind_c" and "ind_d", respectively (note that multipliers larger then one indicate an upward adjustment in yield and multipliers less then one indicate a downward adjustment in yield). Where data was insufficient to guide the yield estimates the base curve is adopted as a best approximation.

Note that based on the SHS in the Salt Operating Area the good site, closed density, deciduous strata (MX-CD-D-A-G) represents almost half of the area being harvested. According to the TSP data, the incidental coniferous in this stratum is observed to be close to zero; thus, the multiplier ("ind_c") of 0.06. This stratum's yield adjusted will have the single biggest impact on the incidental coniferous cut in the Salt Operating Area.

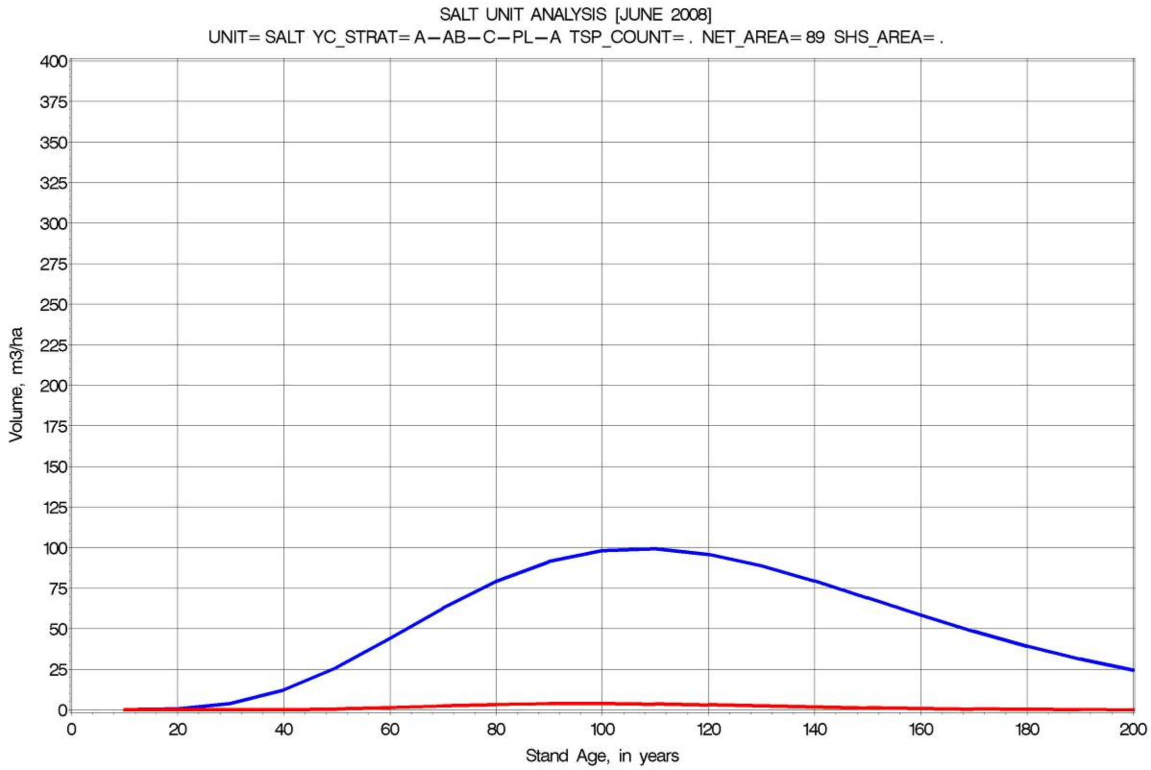
SALT Operating Area Guide Curve Results

Table 2. Salt Operating Area guide curve multipliers for coniferous and deciduous components.

unit	YC_STRAT	TSP_COUNT	net_area	shs_area	ind_c	ind_d
SALT	A-AB-C-PL-A		89			
SALT	A-AB-C-SB-A		1,030	5		
SALT	A-AB-C-SW-A	30	1,019	31	0.49	0.26
SALT	A-AB-CD-A-A	36	1,524	36	0.84	1.20
SALT	A-AB-DC-A-A	36	1,847	38	0.77	0.76
SALT	A-CD-C-PL-A		29			
SALT	A-CD-C-SB-A	18	231	2		
SALT	A-CD-C-SW-A	18	598	3		
SALT	A-CD-CD-A-A	36	1,873	84	1.25	0.75
SALT	A-CD-DC-A-A	42	1,325	105	0.92	1.19
SALT	MX-AB-D-A-G	24	2,470	147	0.38	0.88
SALT	MX-AB-D-A-MF	18	2,890	1,269		
SALT	MX-CD-D-A-G	36	10,022	3,298	0.06	1.19
SALT	MX-CD-D-A-MF	46	11,014	1,684	1.40	0.92

The graphics of the resulting yield estimates are presented in the following pages. The following legend is applicable for all of the graphics:

- Red solid line represents the original FMP deciduous yield estimate
- Red dashed line represents the guided deciduous yield estimate which is fit to data observed in the specified operating area
- Red dots represent the deciduous yield observations from the specified operating area plot data
- Red stars are the age class mean deciduous yields of the specified operating area data
- Blue solid line represents the original FMP coniferous yield estimate
- Blue dashed line represents the guided coniferous yield estimate to fit data observed in the specified operating area
- Blue dots represent the coniferous yield observations from specified operating area plot data
- Blue stars represent the age class mean coniferous yields of the specified operating area data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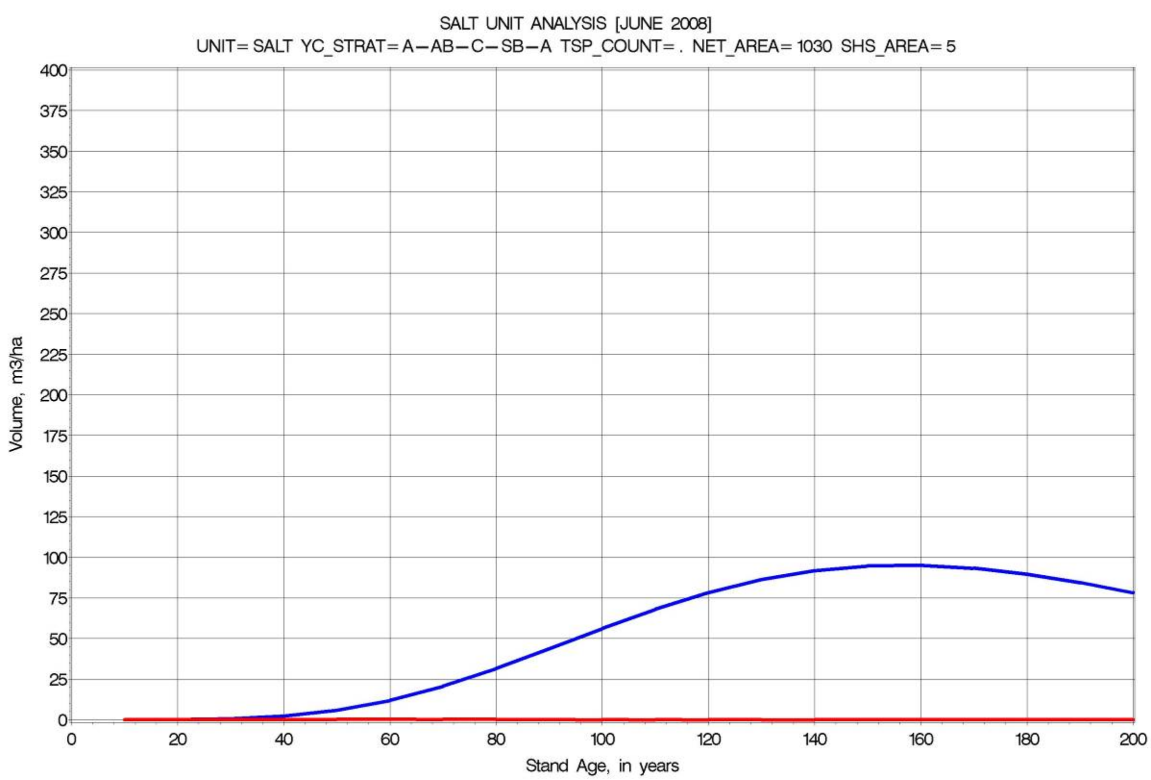
Volume, m3/ha
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400
Stand Age, in years
0
20
40
60
80
100
120
140
160
180
200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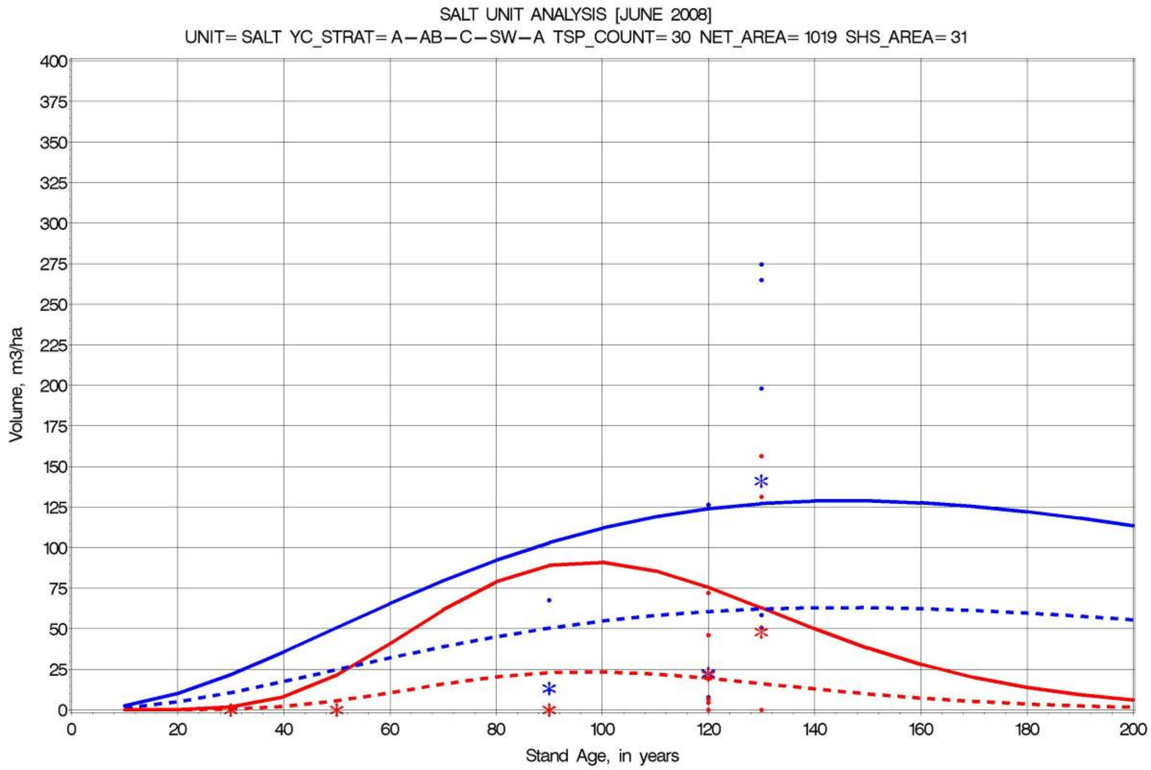
Volume, m3/ha
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400
Stand Age, in years
0
20
40
60
80
100
120
140
160
180
200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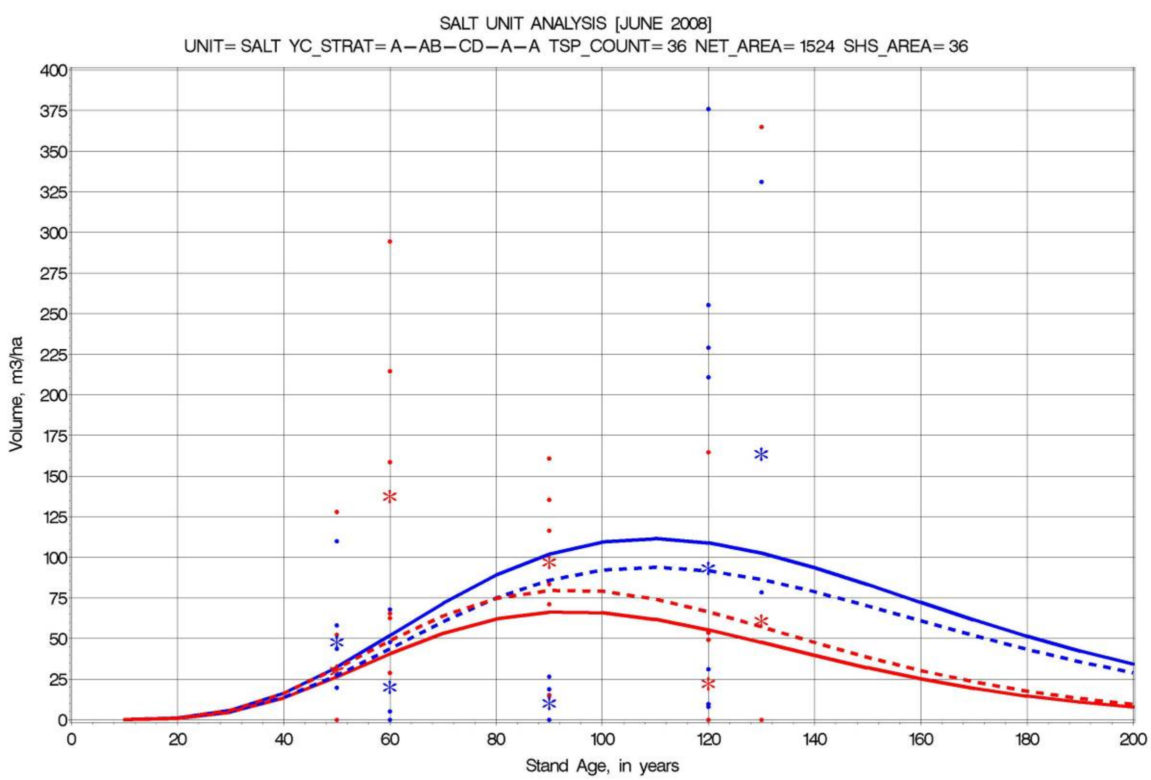
Volume, m3/ha
Stand Age, in years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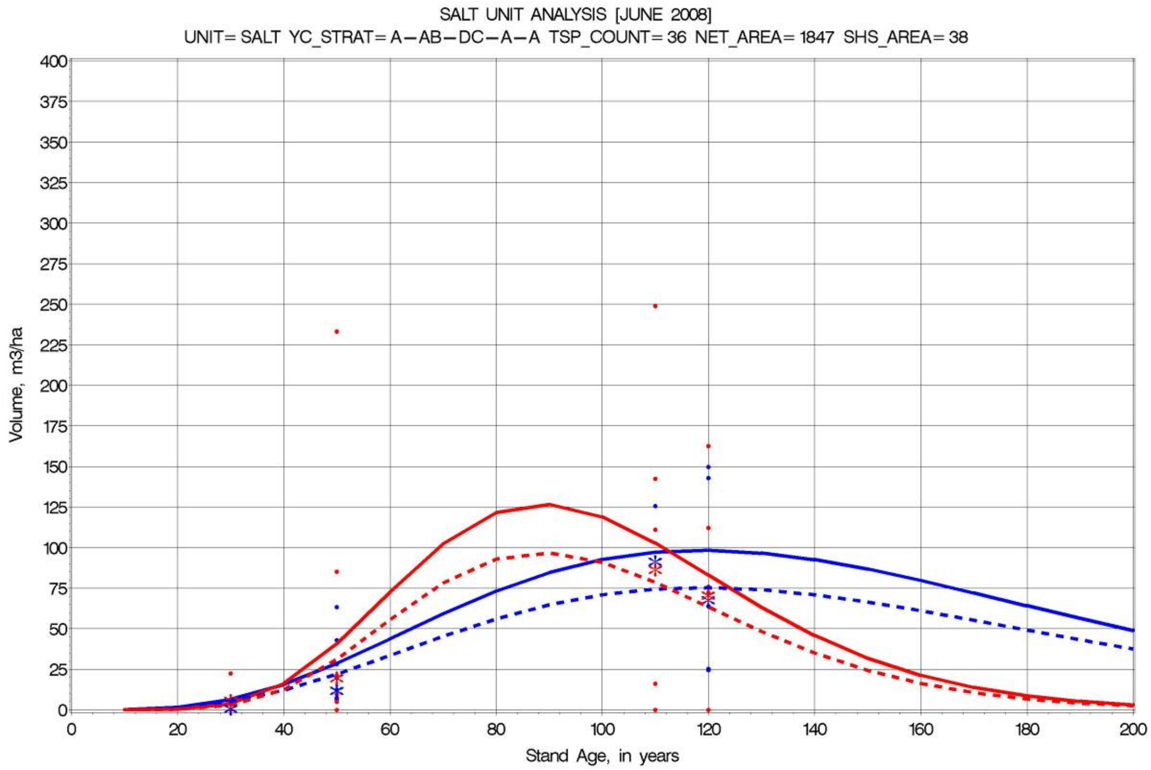
Volume, m3/ha
Stand Age, in years



SALT UNIT ANALYSIS [JUNE 2008]
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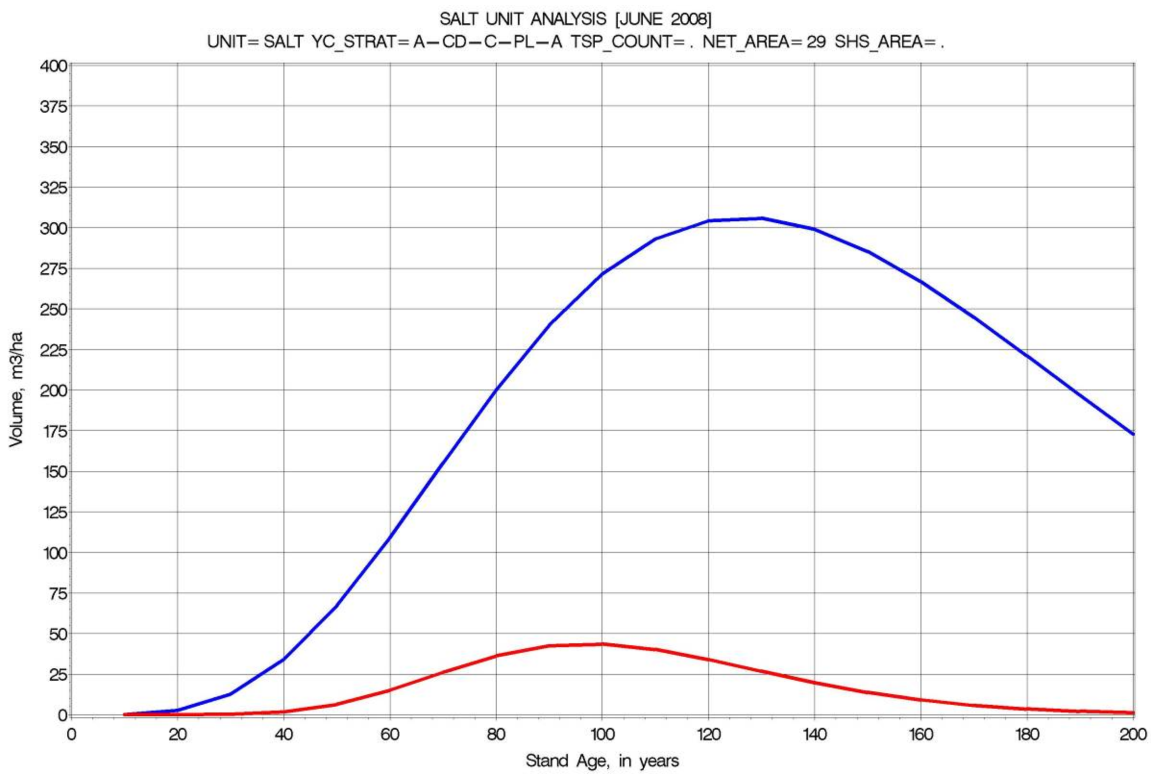
Volume, m3/ha
Stand Age, in years



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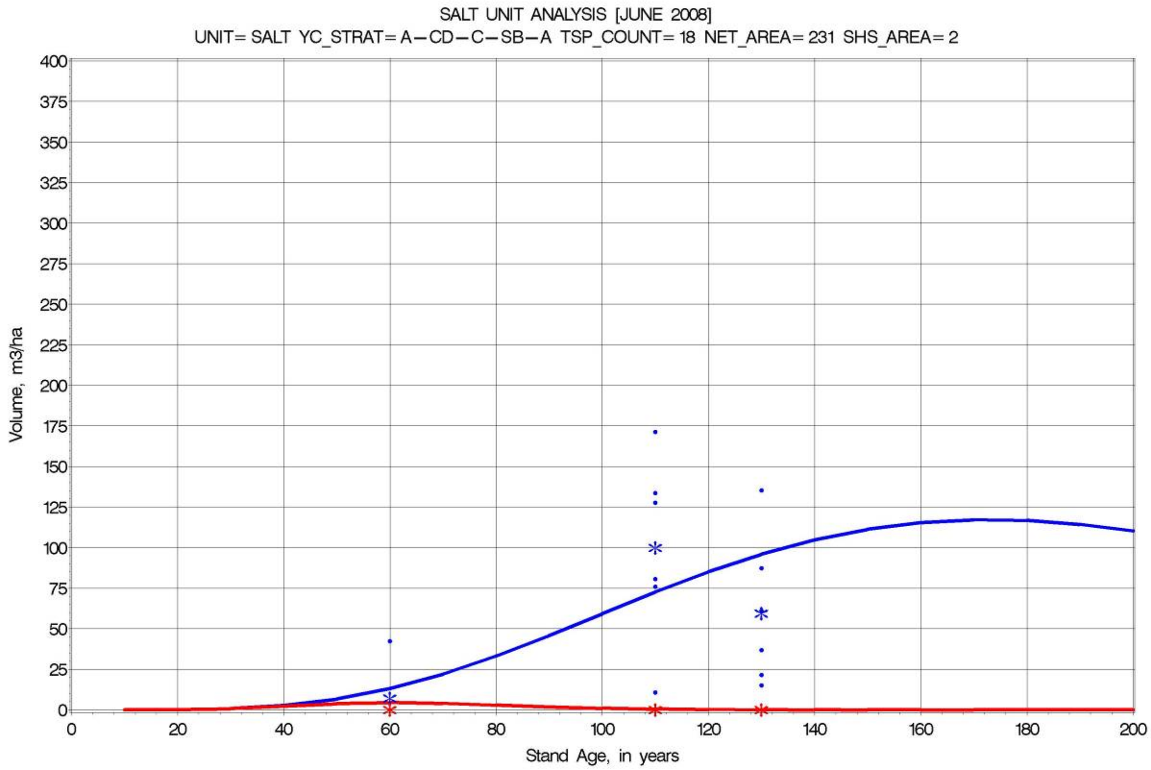
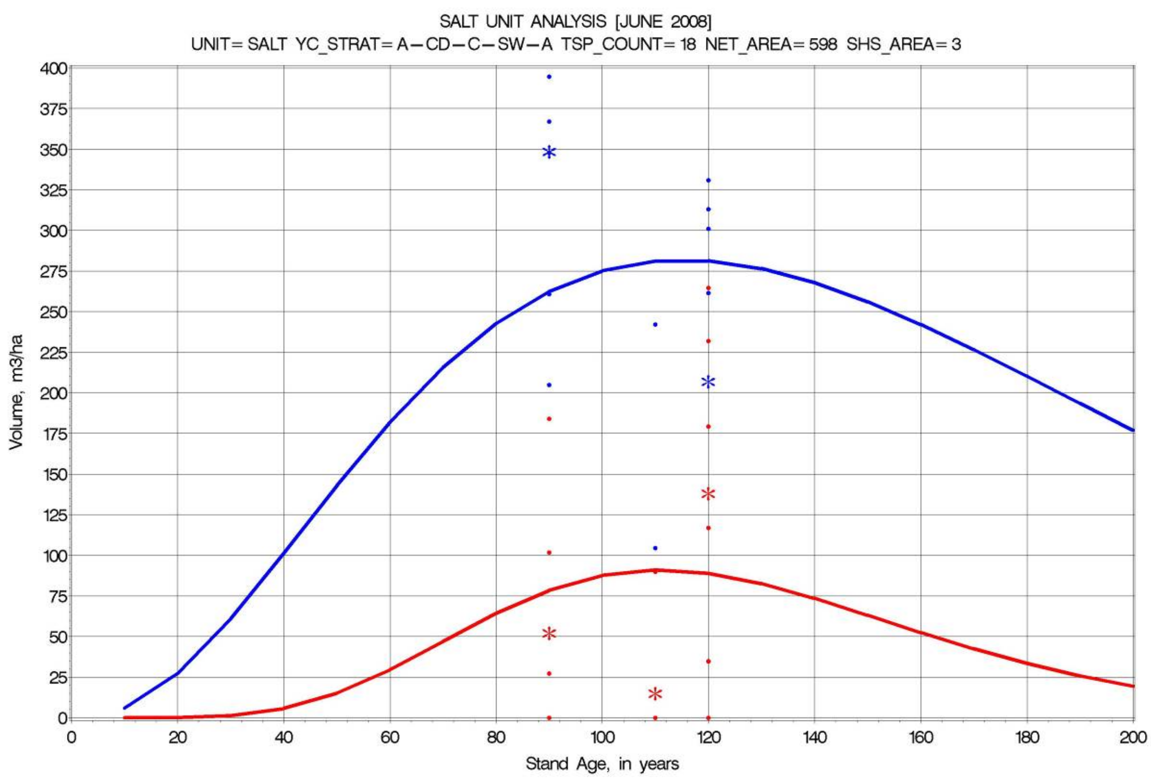
Volume, m3/ha
Stand Age, in years


SALT UNIT ANALYSIS [JUNE 2008]
UNIT= SALT YC_STRAT= A—CD—C—SB—A TSP_COUNT= 18 NET_AREA= 231 SHS_AREA= 2
Volume, m3/ha
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400
0
20
40
60
80
100
120
140
160
180
200
Stand Age, in years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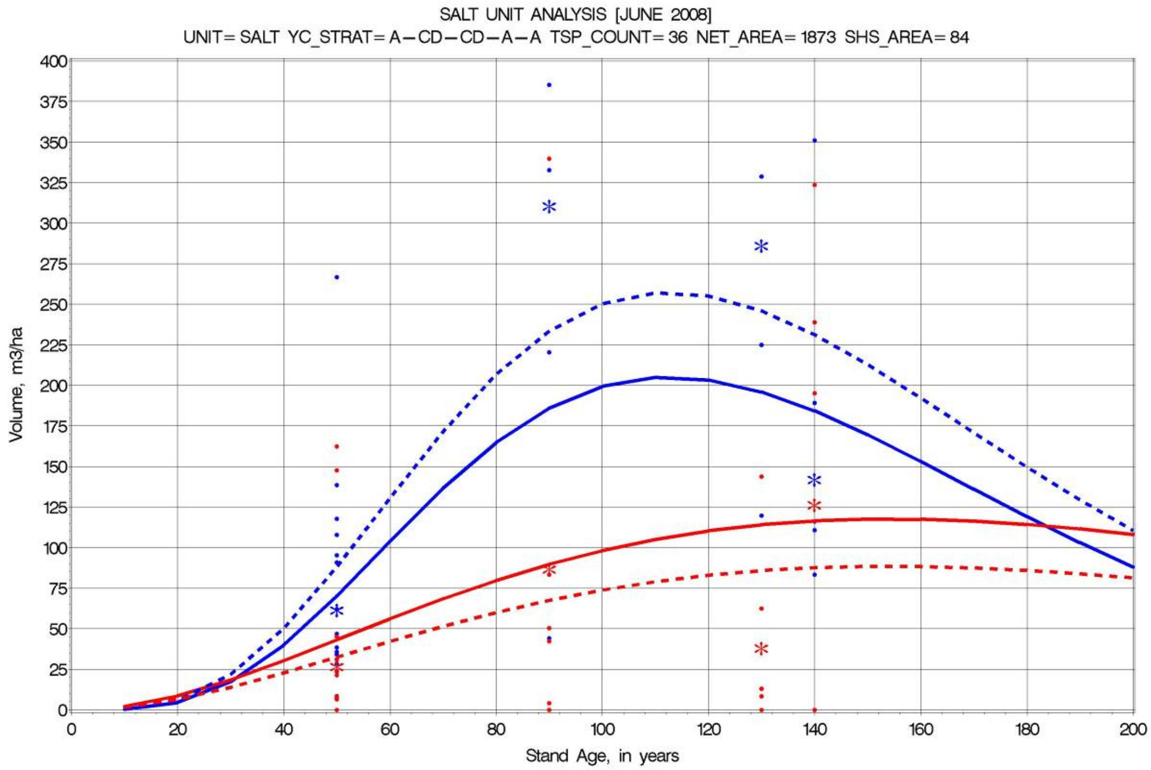
Volume, m3/ha
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400
0
20
40
60
80
100
120
140
160
180
200
Stand Age, in years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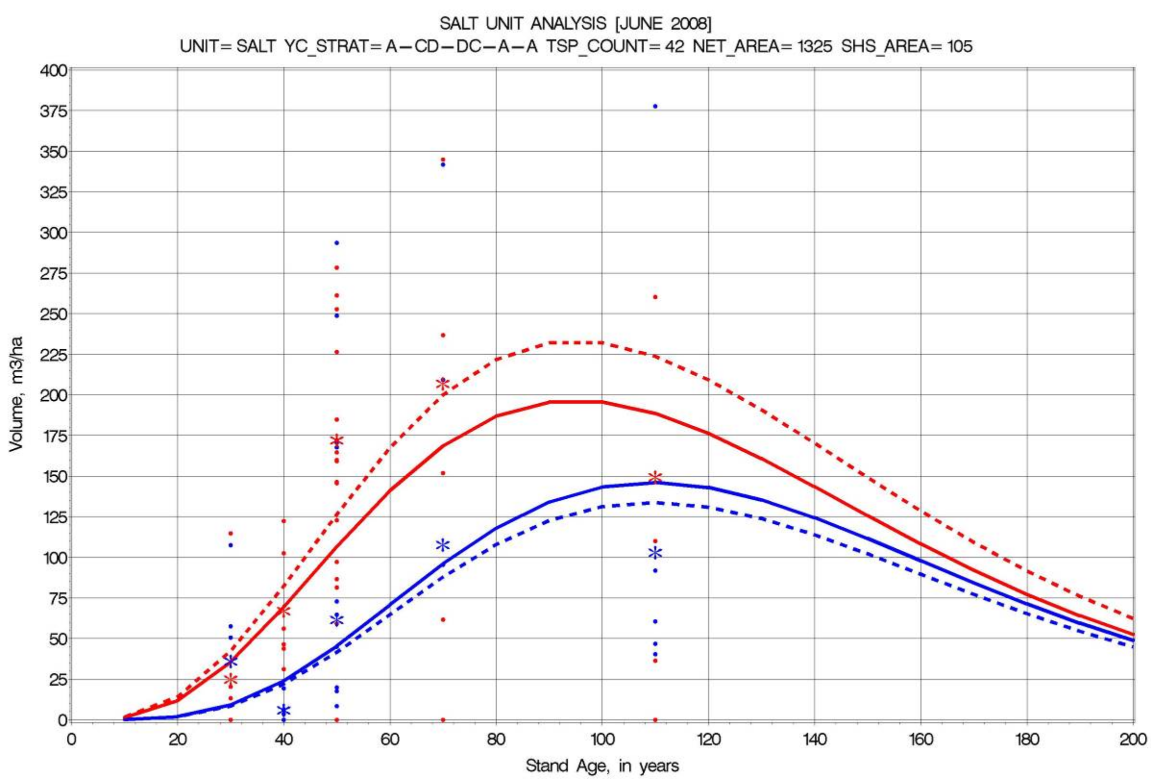
Volume, m3/ha
Stand Age, in years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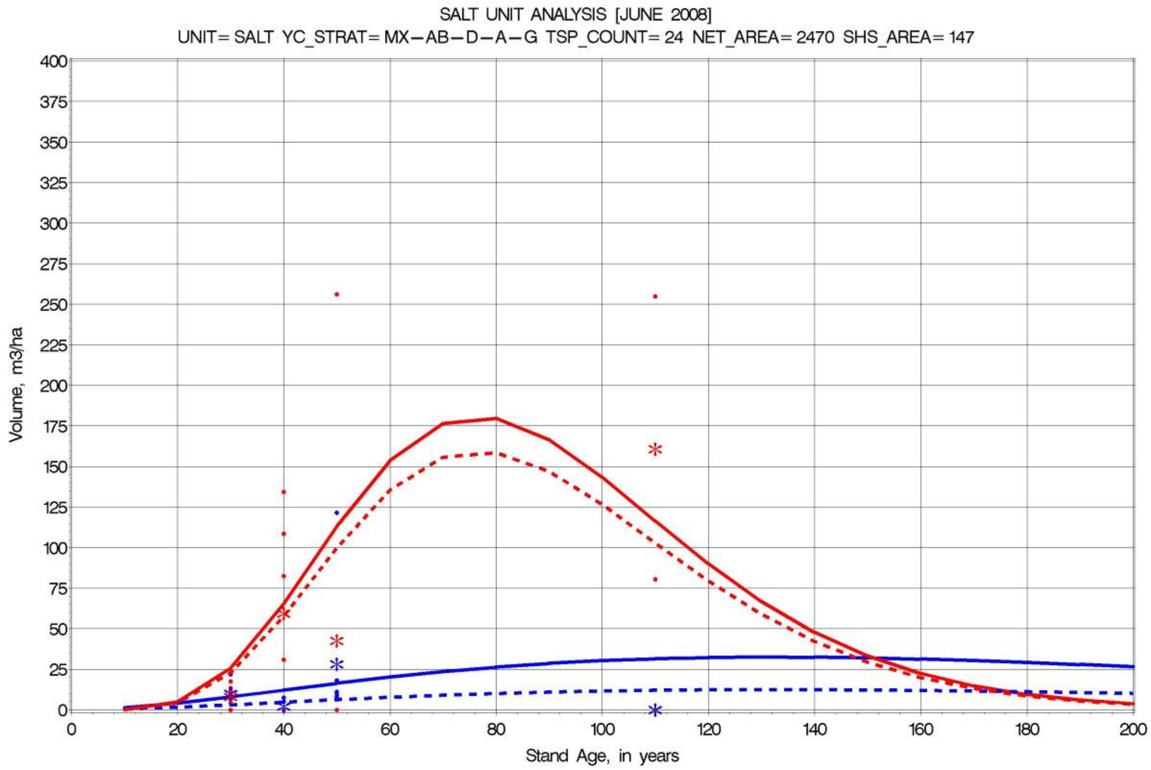
Volume, m3/ha
Stand Age, in years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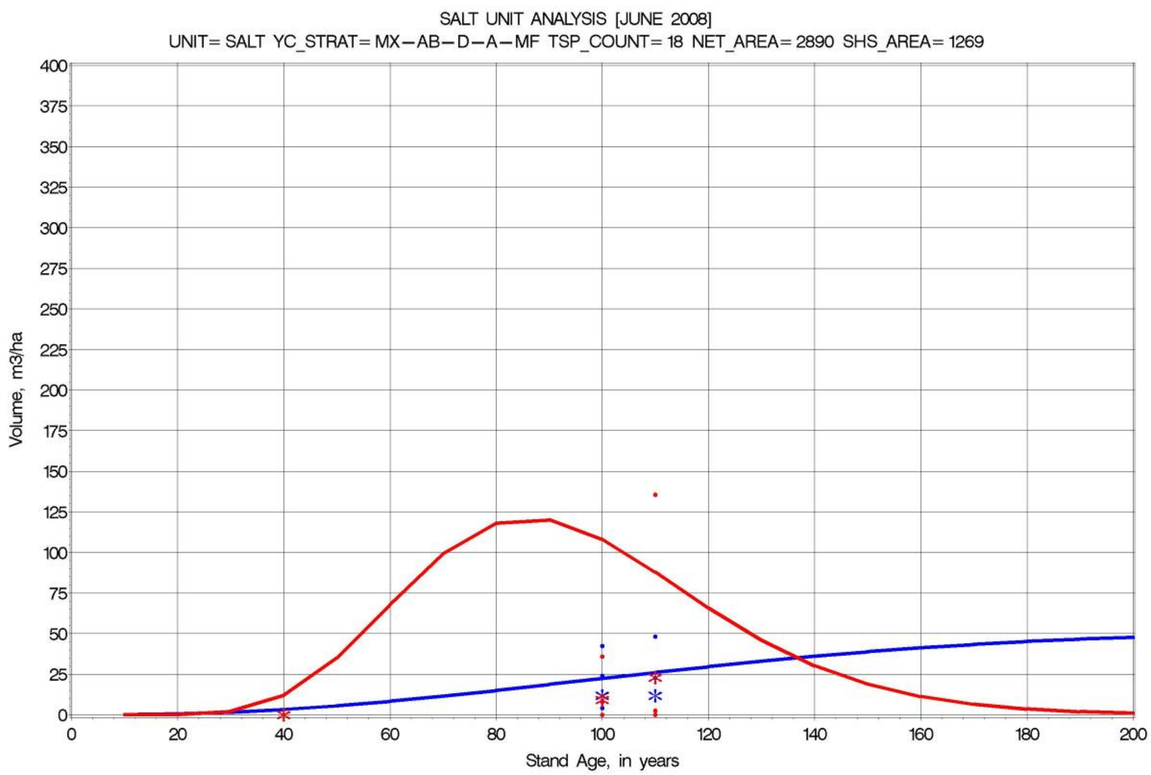
Volume, m3/ha
Stand Age, in years


SALT UNIT ANALYSIS [JUNE 2008]
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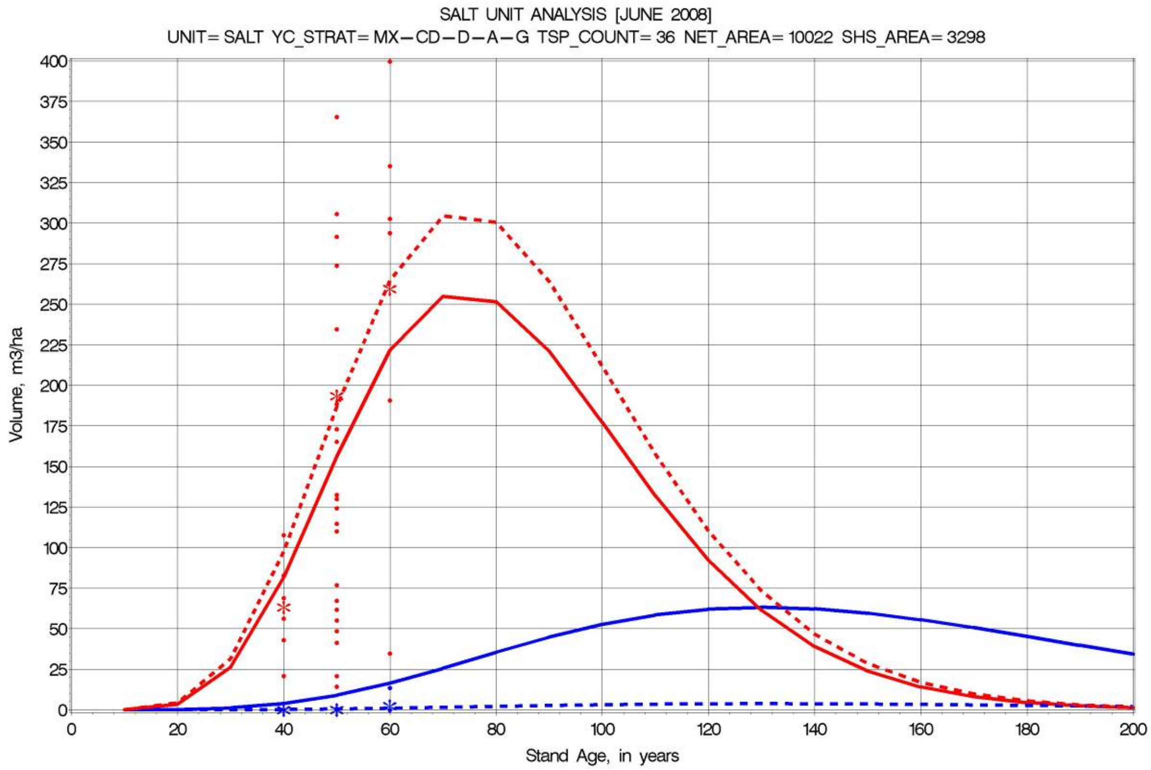
Volume, m3/ha
Stand Age, in years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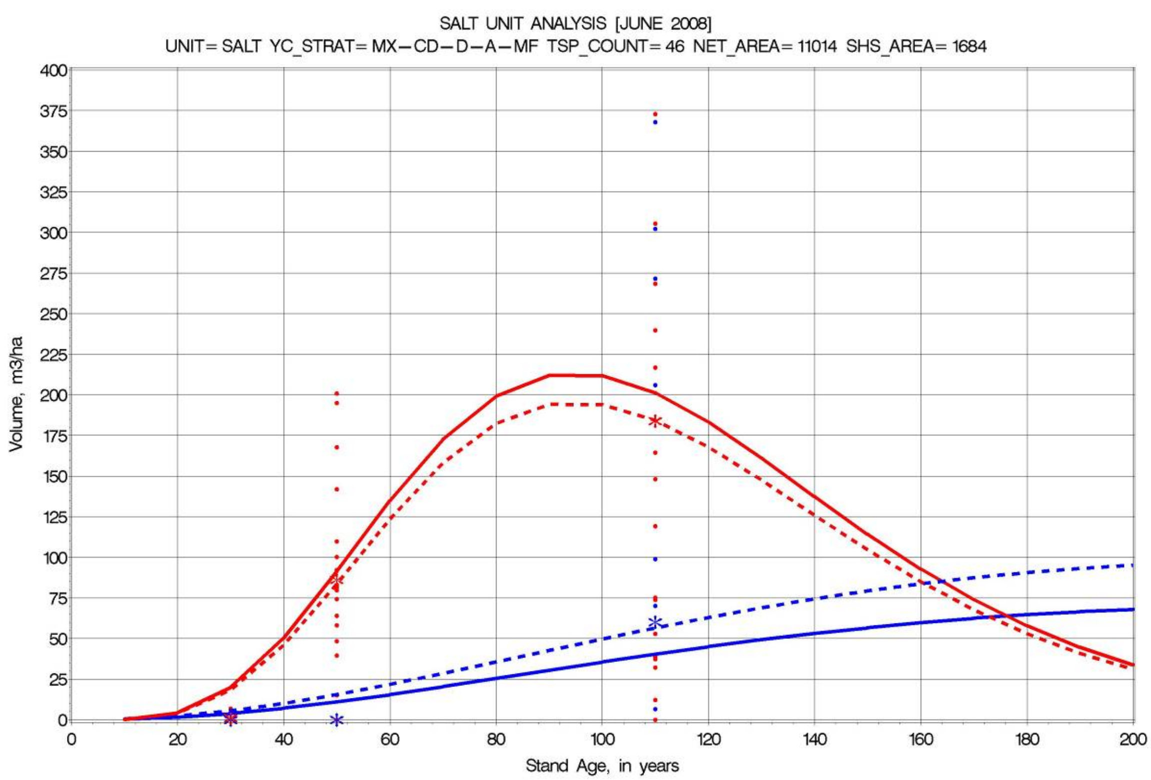
Volume, m3/ha
Stand Age, in years
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400
0
20
40
60
80
100
120
140
160
180
200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Volume, m3/ha
Stand Age, in years
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400
0
20
40
60
80
100
120
140
160
180
200

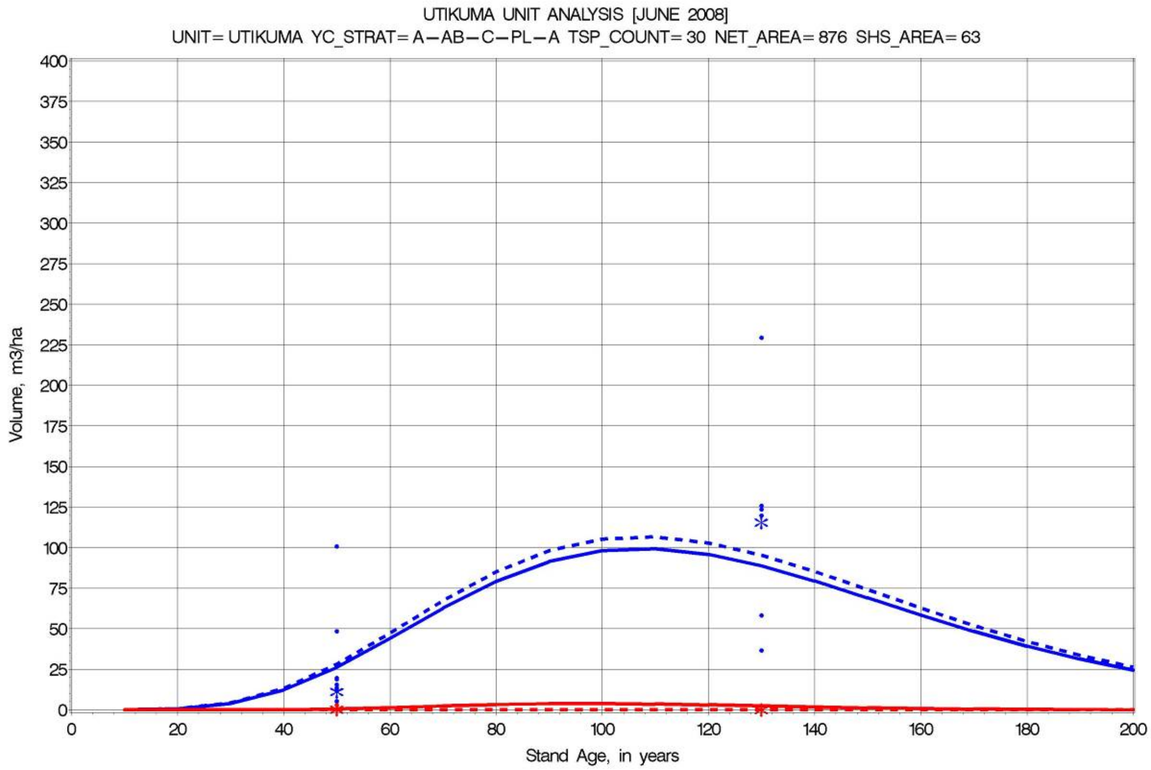
UTIKUMA Operating Area Guide Curve Results

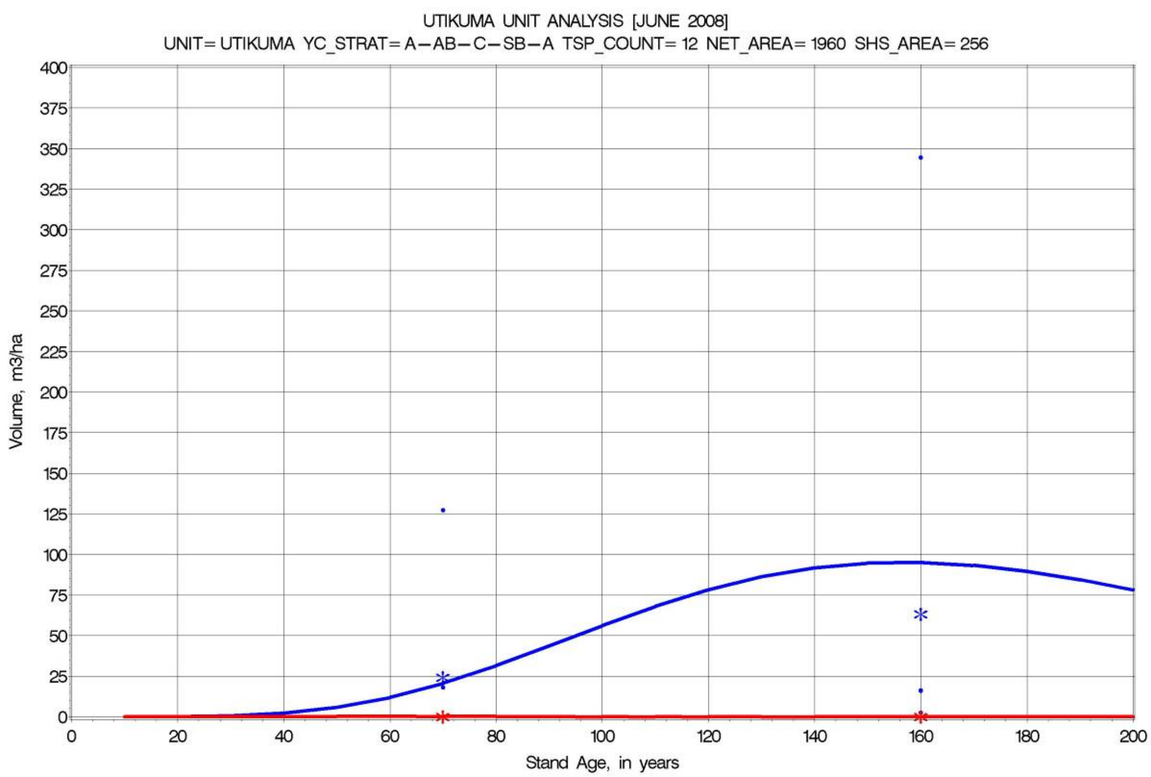
Table 3. Utikuma Operating Area guide curve multipliers for coniferous and deciduous components.

unit	YC_STRAT	TSP_COUNT	net_area	shs_area	ind_c	ind_d
UTIKUMA	A-AB-C-PL-A	30	876	63	1.07	0.04
UTIKUMA	A-AB-C-SB-A	12	1,960	256		
UTIKUMA	A-AB-C-SW-A	48	4,998	655	0.85	1.03
UTIKUMA	A-AB-CD-A-A	36	3,499	270	0.47	1.08
UTIKUMA	A-AB-DC-A-A	42	3,909	205	0.24	1.08
UTIKUMA	A-CD-C-PL-A	12	1,128	18		
UTIKUMA	A-CD-C-SB-A	6	563	7		
UTIKUMA	A-CD-C-SW-A	18	5,548	476		
UTIKUMA	A-CD-CD-A-A	48	3,942	896	1.01	0.77
UTIKUMA	A-CD-DC-A-A	42	4,060	450	0.63	0.92
UTIKUMA	MX-AB-D-A-G	18	1,808	882		
UTIKUMA	MX-AB-D-A-MF	57	5,320	1,828	1.96	1.08
UTIKUMA	MX-CD-D-A-G	192	12,303	2,633	1.40	0.87
UTIKUMA	MX-CD-D-A-MF	84	21,772	4,040	1.11	0.78

The graphics of the resulting yield estimates are presented in the following pages. The following legend is applicable for all of the graphics:

- Red solid line represents the original FMP deciduous yield estimate
- Red dashed line represents the guided deciduous yield estimate which is fit to data observed in the specified operating area
- Red dots represent the deciduous yield observations from the specified operating area plot data
- Red stars are the age class mean deciduous yields of the specified operating area data
- Blue solid line represents the original FMP coniferous yield estimate
- Blue dashed line represents the guided coniferous yield estimate to fit data observed in the specified operating area
- Blue dots represent the coniferous yield observations from specified operating area plot data
- Blue stars represent the age class mean coniferous yields of the specified operating area data


UTIKUMA UNIT ANALYSIS [JUNE 2008]
UNIT= UTIKUMA YC_STRAT= A—AB—C—PL—A TSP_COUNT= 30 NET_AREA= 876 SHS_AREA= 63
Volume, m3/ha
Stand Age, in years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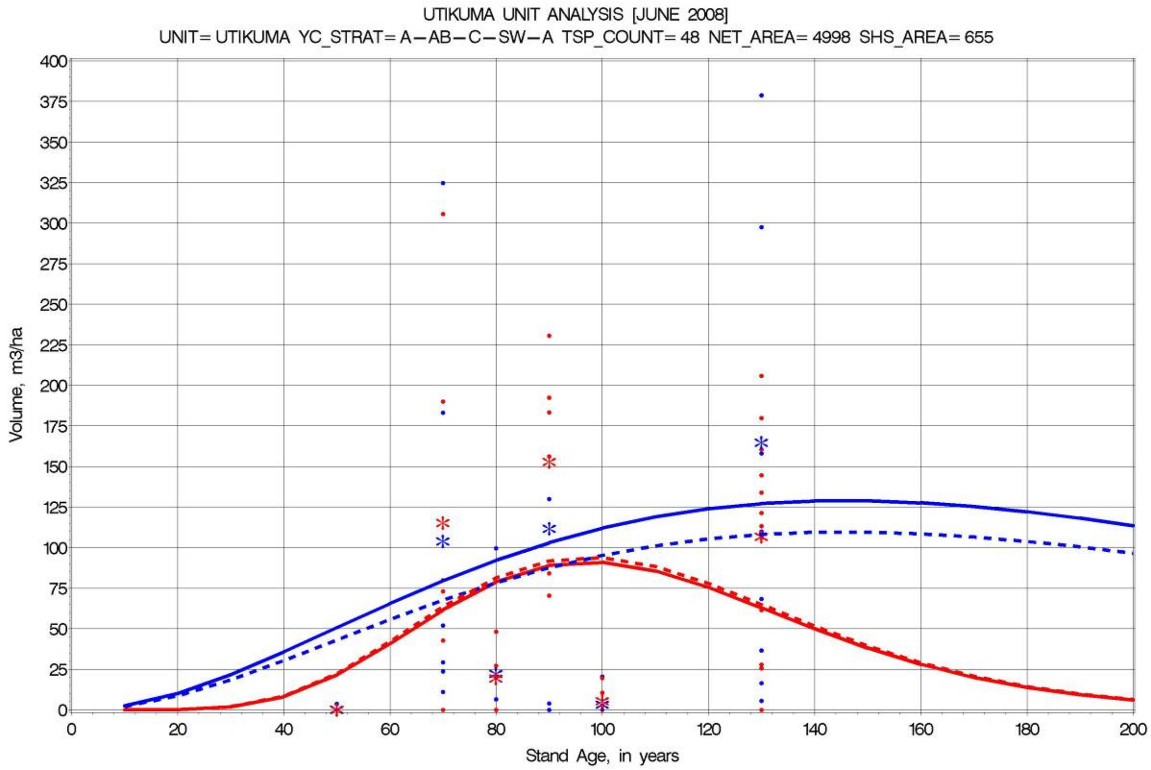
Volume, m3/ha
Stand Age, in years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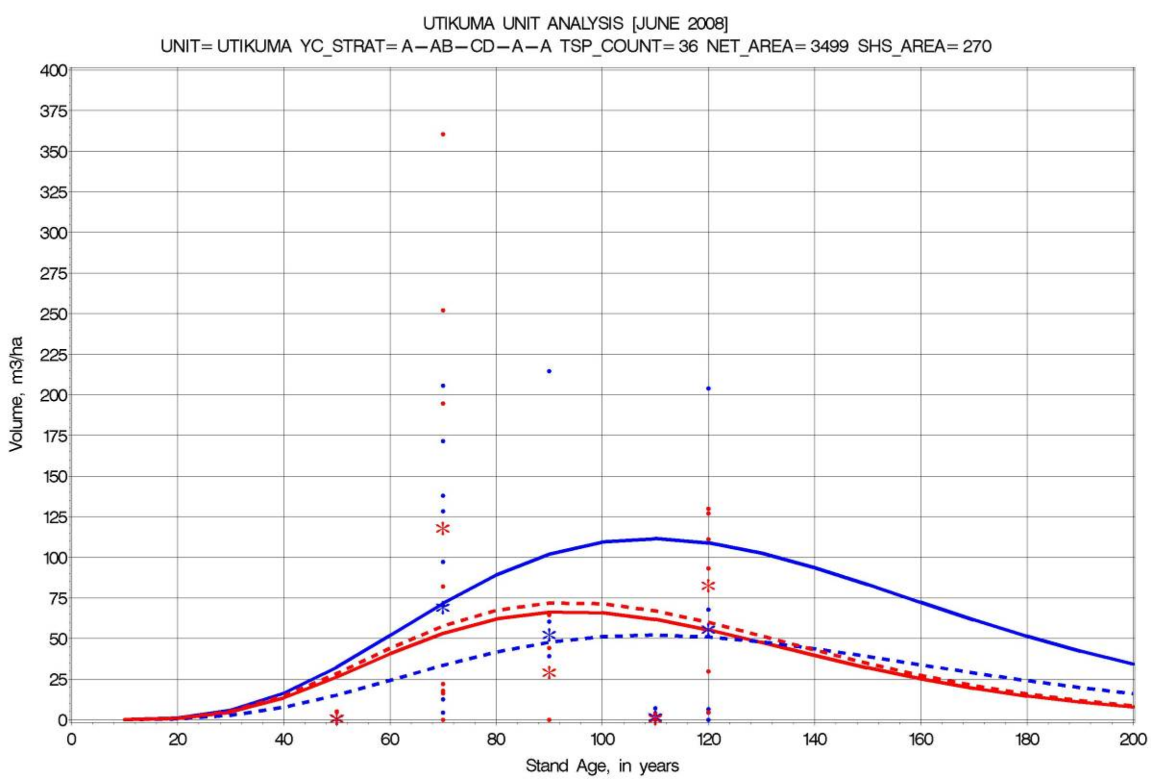
Volume, m3/ha
Stand Age, in years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Volume, m3/ha
Stand Age, in years

UTIKUMA UNIT ANALYSIS [JUNE 2008]
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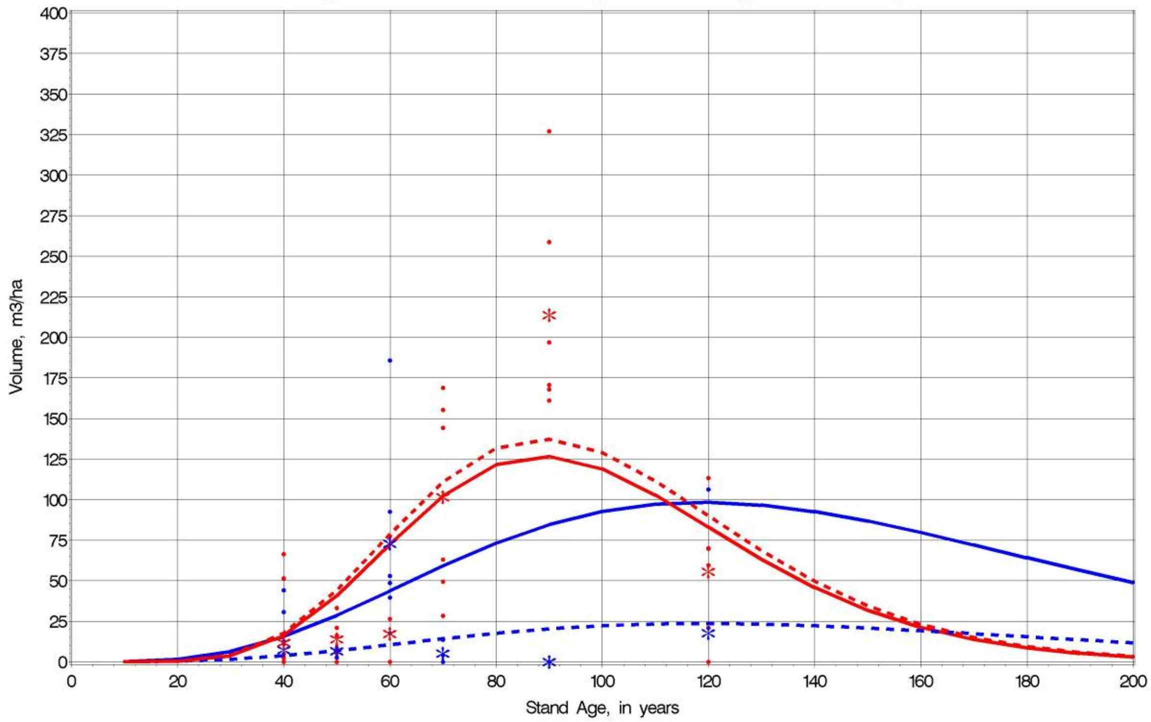

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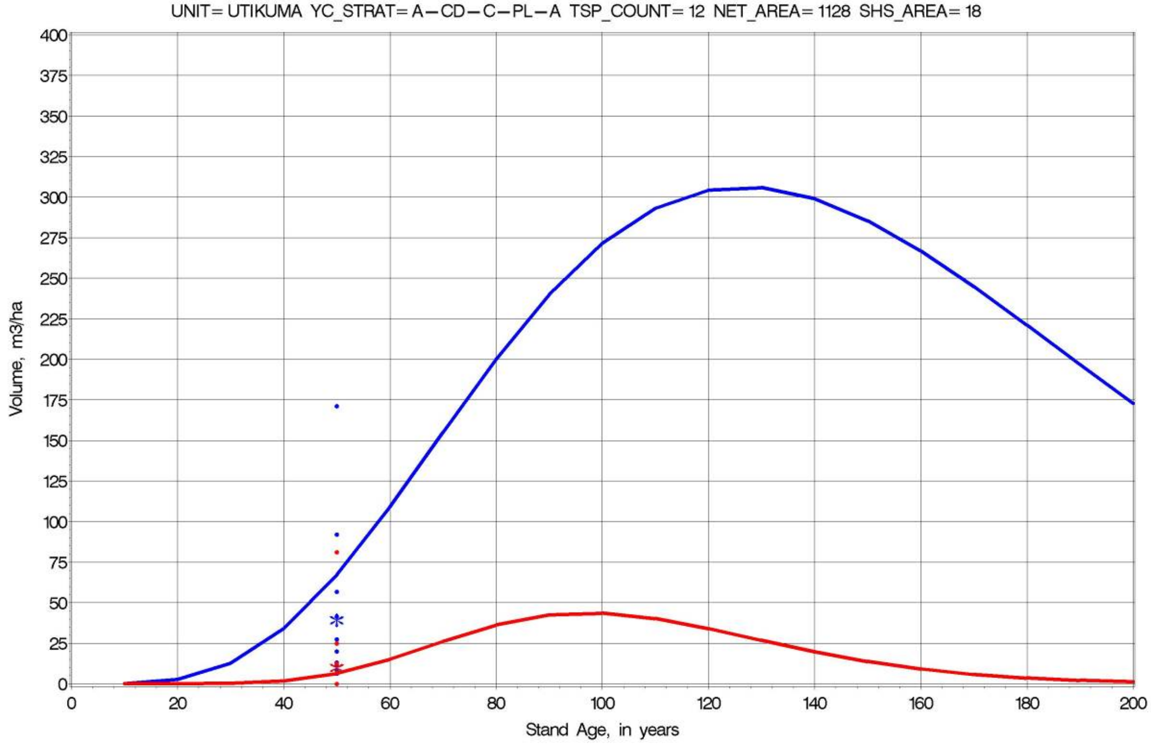

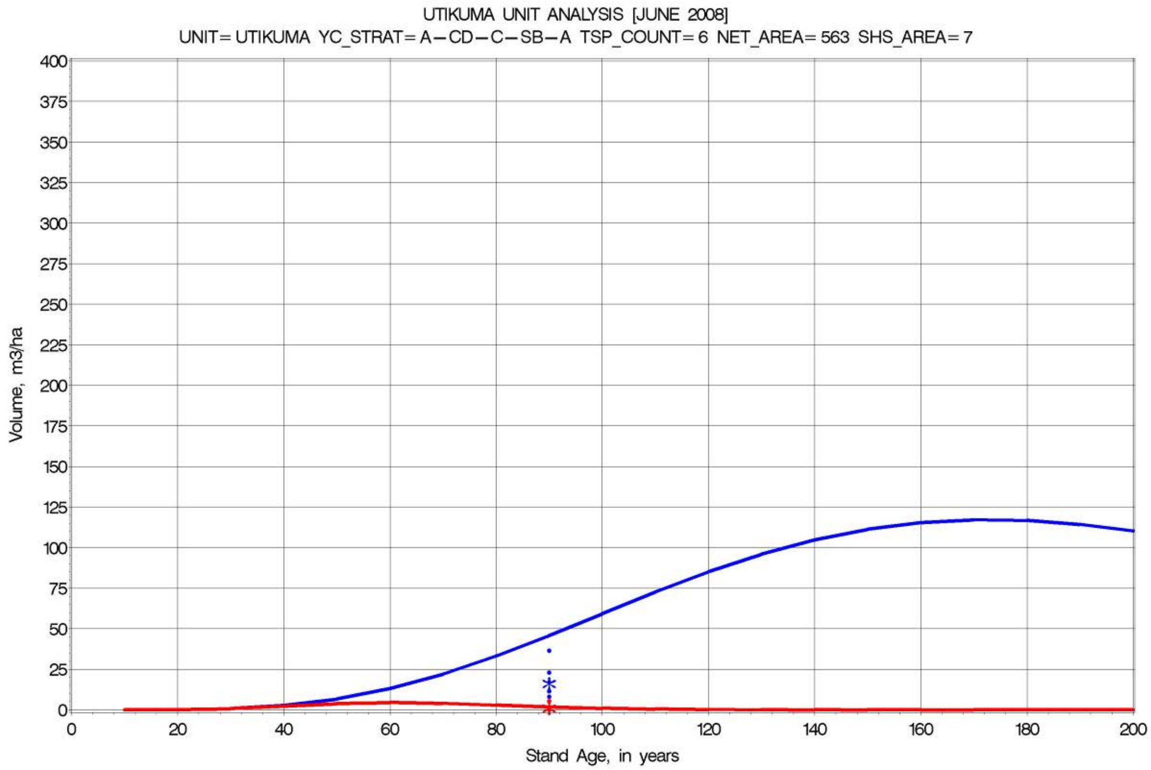
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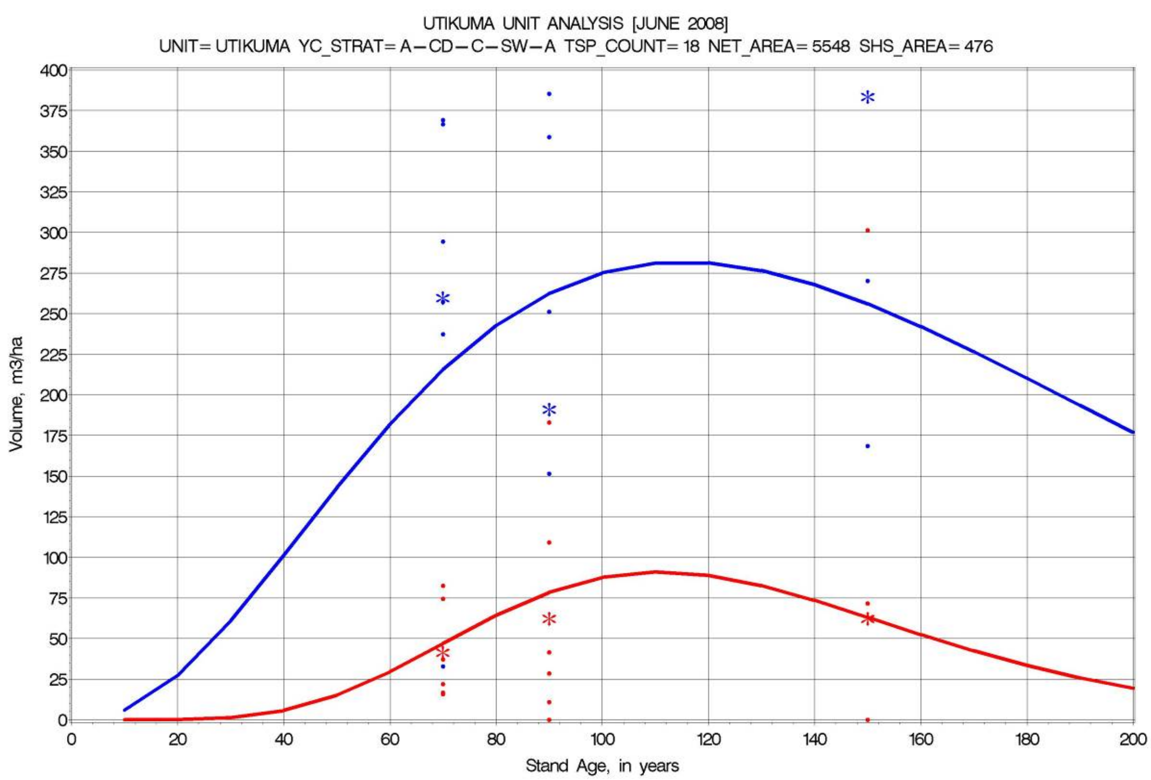
UNIT= UTIKUMA YC_STRAT= A—CD—C—SB—A TSP_COUNT= 6 NET_AREA= 563 SHS_AREA= 7
Volume, m3/ha
Stand Age, in years
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400
20
40
60
80
120
140
160
180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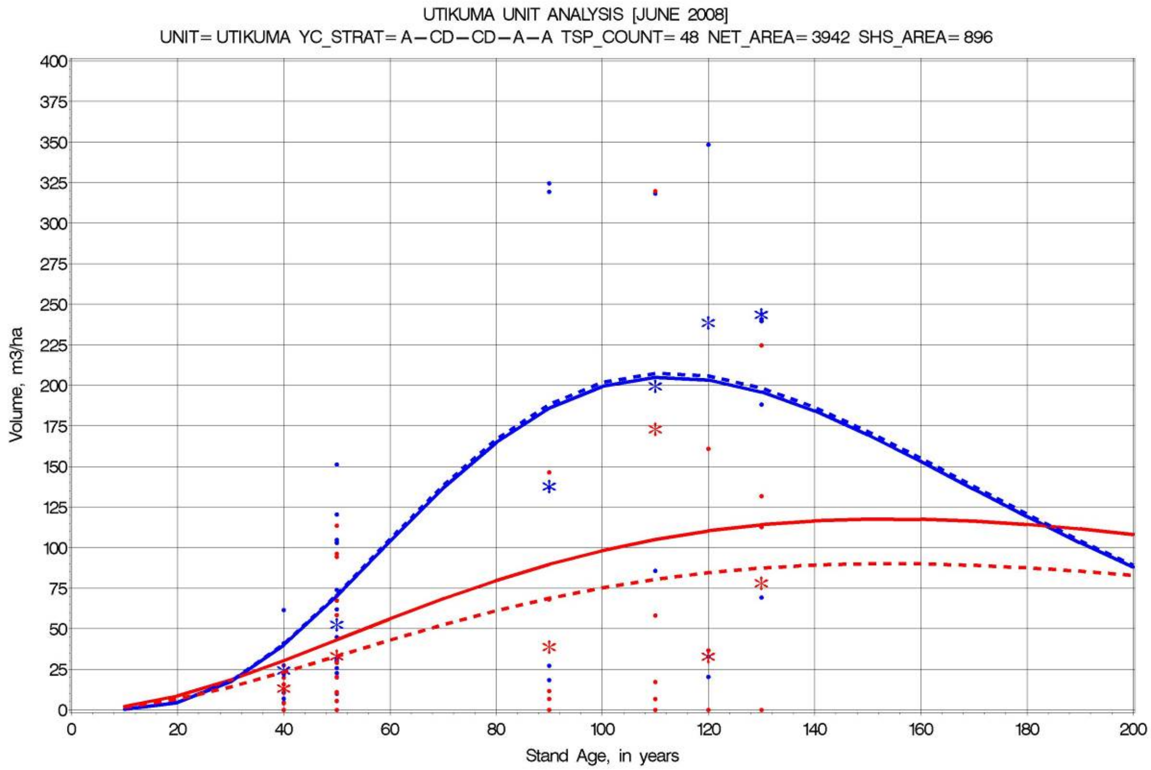
Volume, m3/ha
Stand Age, in years
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400
20
40
60
80
120
140
160
180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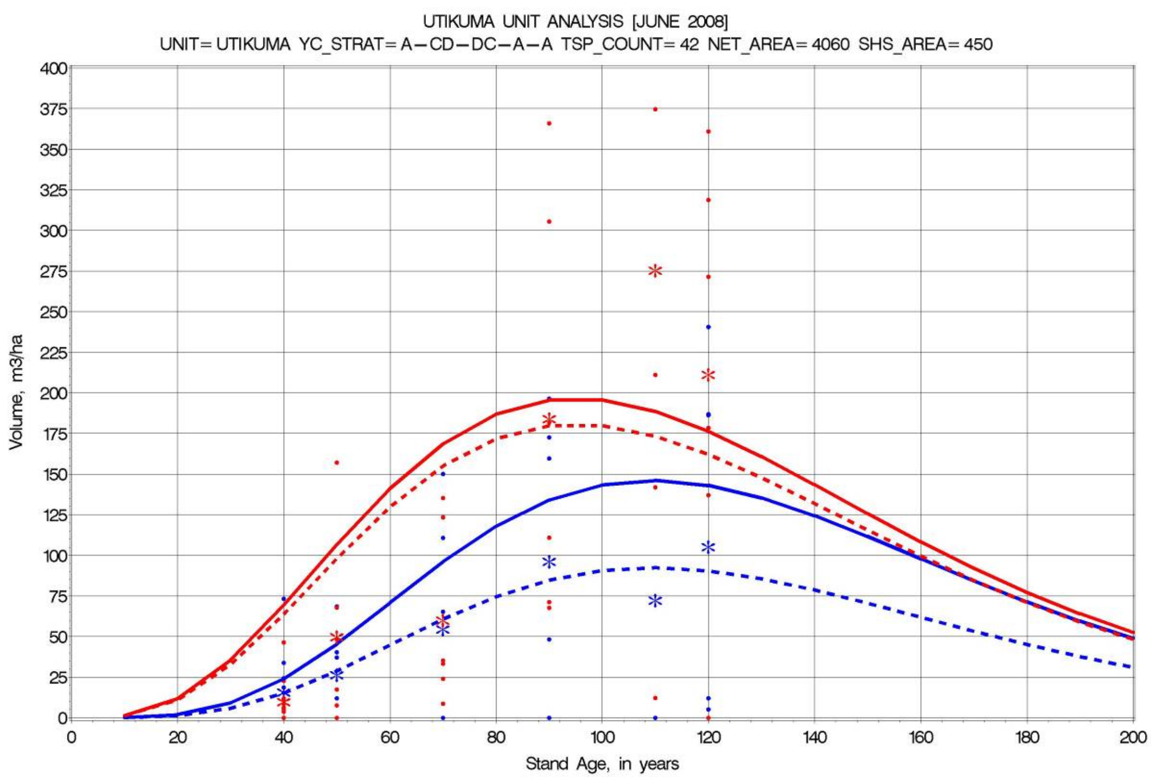
Volume, m3/ha
Stand Age, in years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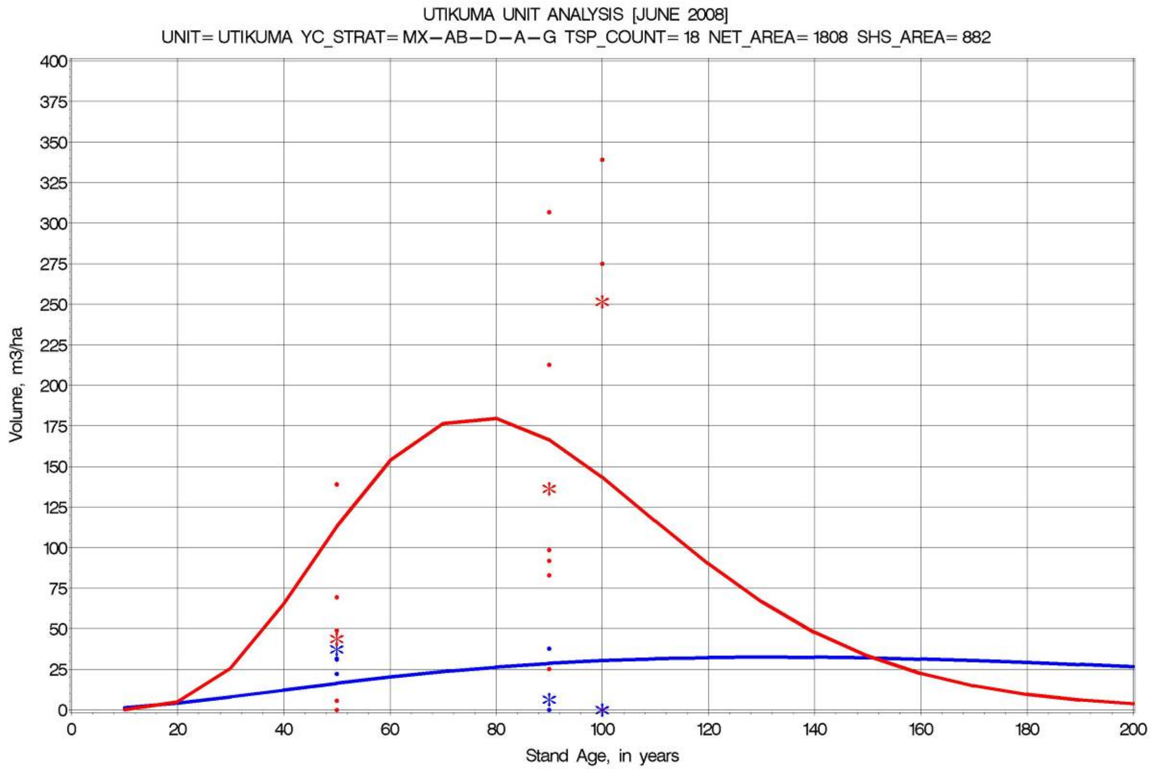
Volume, m3/ha
Stand Age, in years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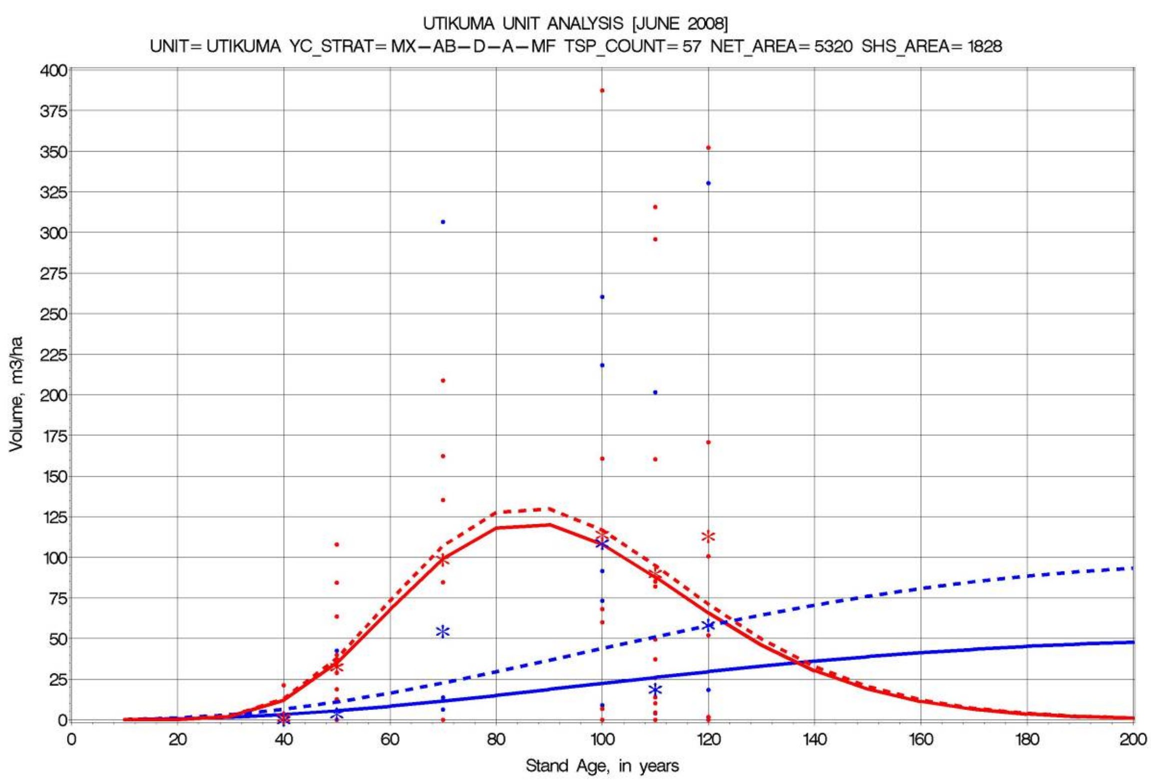
Volume, m3/ha
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
0
20
40
60
80
100
120
140
160
180
200
Stand Age, in years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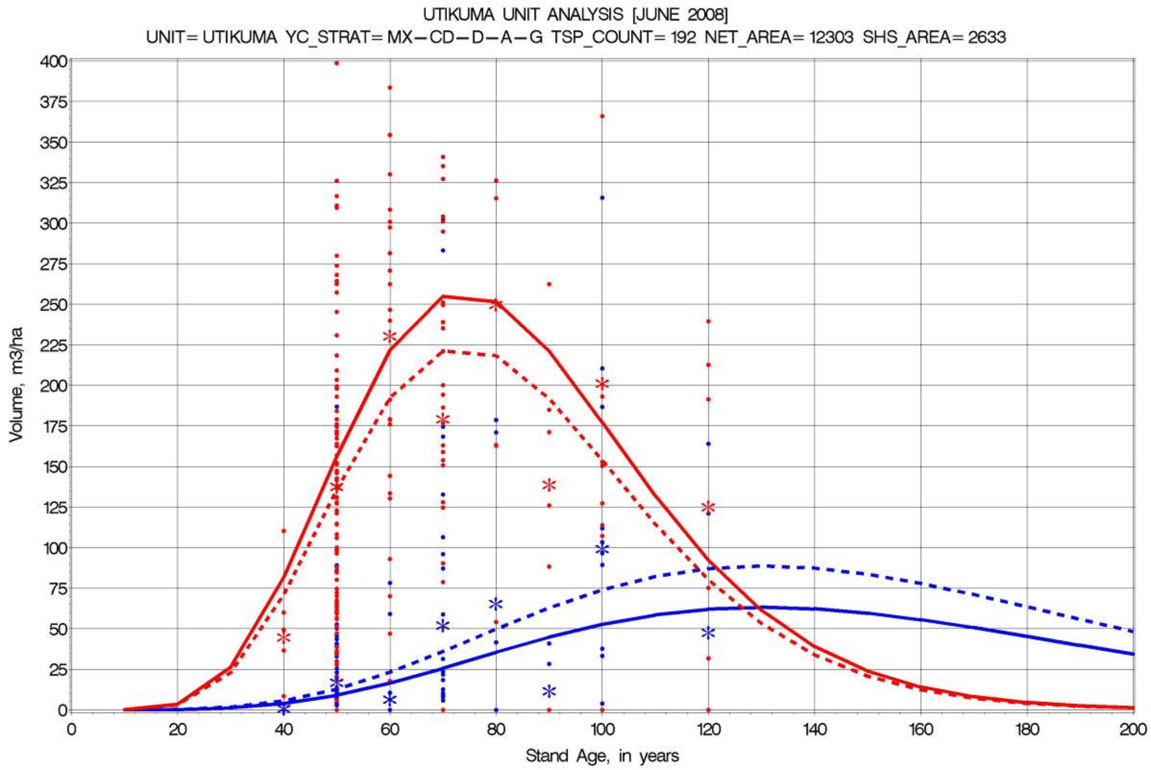
Volume, m3/ha
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
0
20
40
60
80
100
120
140
160
180
200
Stand Age, in years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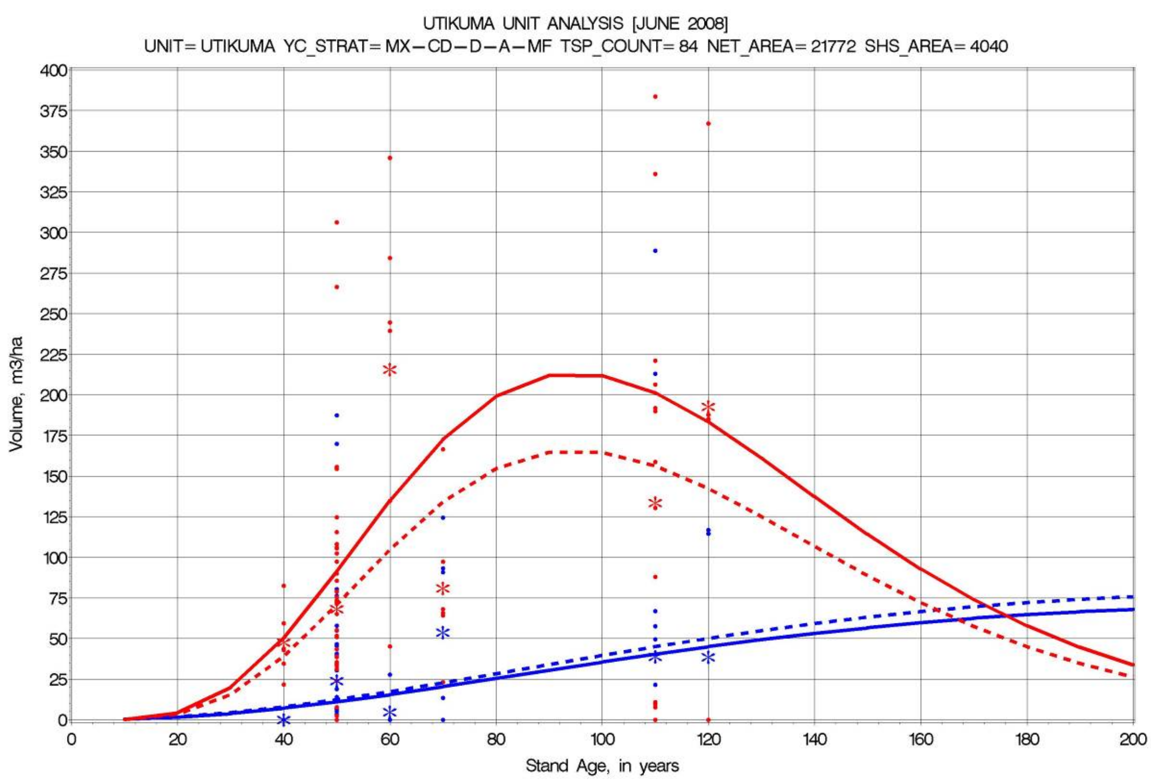
Volume, m3/ha
Stand Age, in years


UTIKUMA UNIT ANALYSIS [JUNE 2008]
UNIT= UTIKUMA YC_STRAT= MX—CD—D—A—MF TSP_COUNT= 84 NET_AREA= 21772 SHS_AREA= 4040
Volume, m3/ha
Stand Age, in years

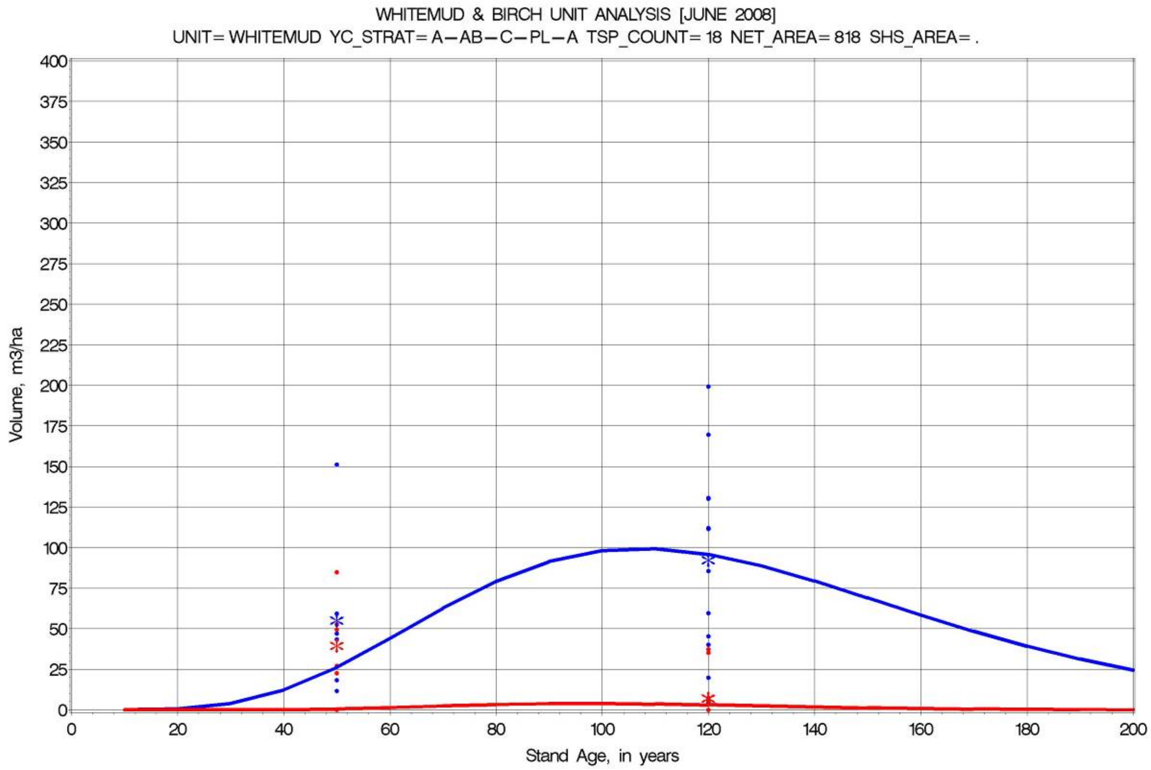
WHITEMUD and BIRCH Operating Area Guide Curve Results

Table 4. Whitemud and Birch Operating Area guide curve multipliers for coniferous and deciduous components.

unit	YC_STRAT	TSP_COUNT	net_area	shs_area	ind_c	ind_d
WHITEMUD	A-AB-C-PL-A	18	818			
WHITEMUD	A-AB-C-SB-A	6	316			
WHITEMUD	A-AB-C-SW-A	12	1,825	69		
WHITEMUD	A-AB-CD-A-A	42	1,098	96	1.08	0.75
WHITEMUD	A-AB-DC-A-A	30	1,864	46	0.95	1.63
WHITEMUD	A-CD-C-PL-A	6	461			
WHITEMUD	A-CD-C-SB-A	18	86			
WHITEMUD	A-CD-C-SW-A	21	780	108		
WHITEMUD	A-CD-CD-A-A	30	1,152	248	1.03	1.21
WHITEMUD	A-CD-DC-A-A	36	1,825	291	0.80	0.87
WHITEMUD	MX-AB-D-A-G	51	4,204	1,265	1.48	1.07
WHITEMUD	MX-AB-D-A-MF	71	7,777	1,766	0.00	1.24
WHITEMUD	MX-CD-D-A-G	148	11,294	2,915	0.20	1.14
WHITEMUD	MX-CD-D-A-MF	143	15,499	1,742	0.21	1.14

The graphics of the resulting yield estimates are presented in the following pages. The following legend is applicable for all of the graphics:

- Red solid line represents the original FMP deciduous yield estimate
- Red dashed line represents the guided deciduous yield estimate which is fit to data observed in the specified operating area
- Red dots represent the deciduous yield observations from the specified operating area plot data
- Red stars are the age class mean deciduous yields of the specified operating area data
- Blue solid line represents the original FMP coniferous yield estimate
- Blue dashed line represents the guided coniferous yield estimate to fit data observed in the specified operating area
- Blue dots represent the coniferous yield observations from specified operating area plot data
- Blue stars represent the age class mean coniferous yields of the specified operating area data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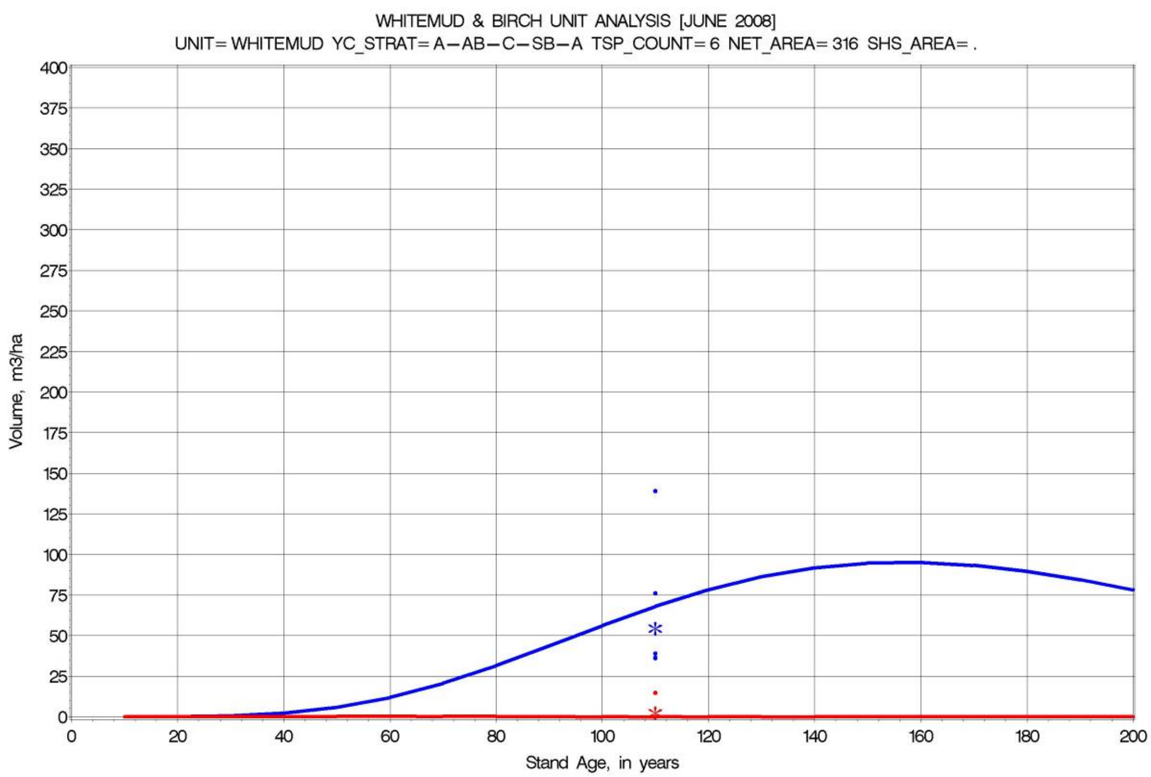
Volume, m3/ha
Stand Age, in years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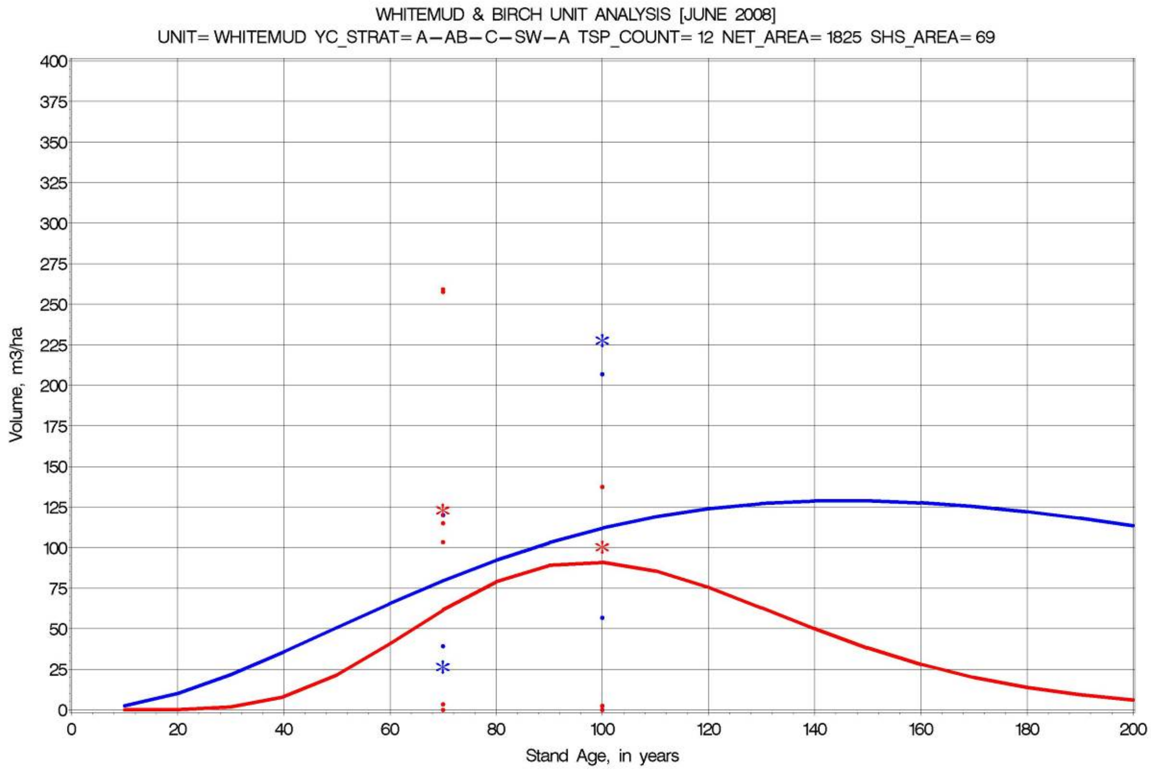
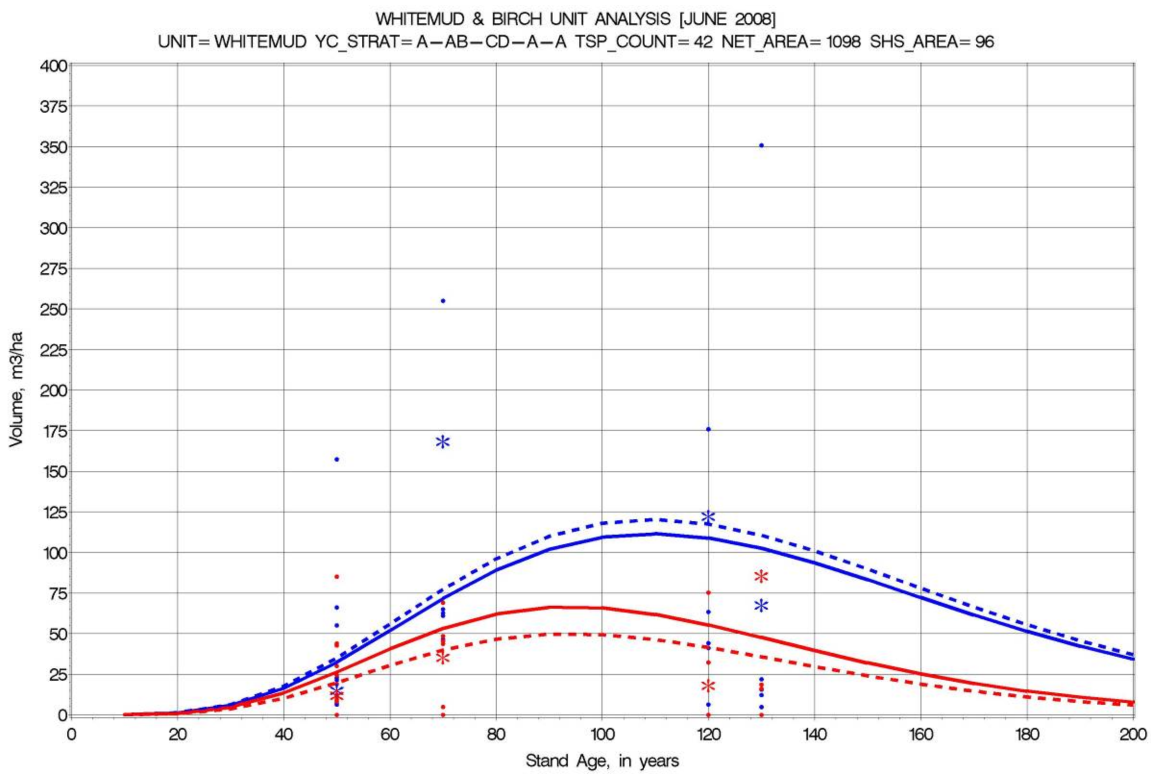
Volume, m3/ha
Stand Age, in years


WHITEMUD & BIRCH UNIT ANALYSIS [JUNE 2008]
UNIT= WHITEMUD YC_STRAT= A—AB—C—SW—A TSP_COUNT= 12 NET_AREA= 1825 SHS_AREA= 69
Volume, m3/ha
Stand Age, in years
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400
0
20
40
60
80
100
120
140
160
180
200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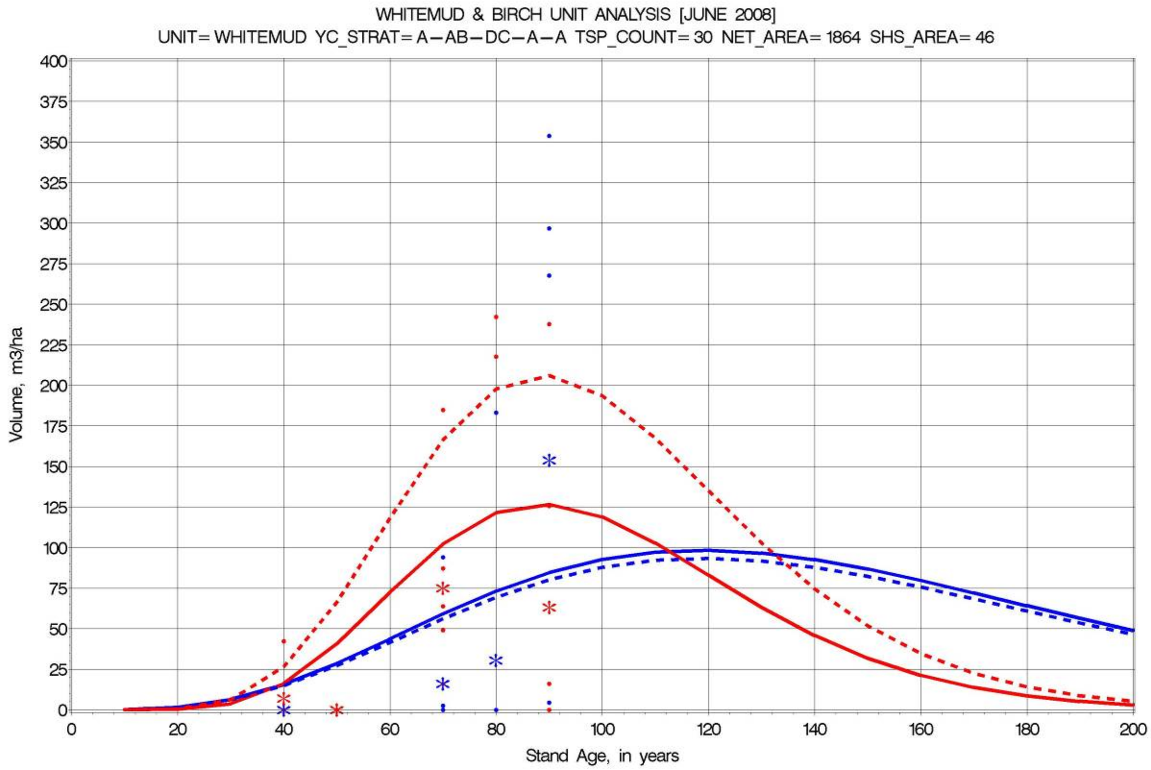
Volume, m3/ha
Stand Age, in years
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400
0
20
40
60
80
100
120
140
160
180
200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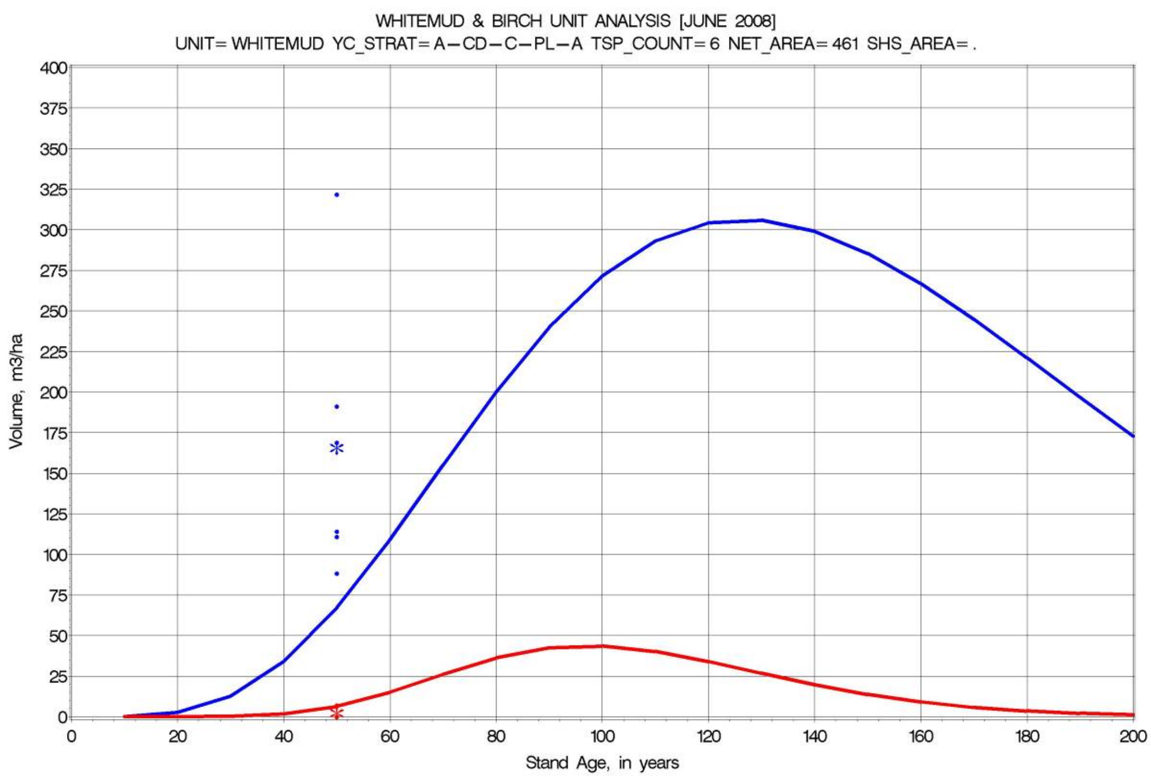
Volume, m3/ha
Stand Age, in years
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400
0
20
40
60
80
100
120
140
160
180
200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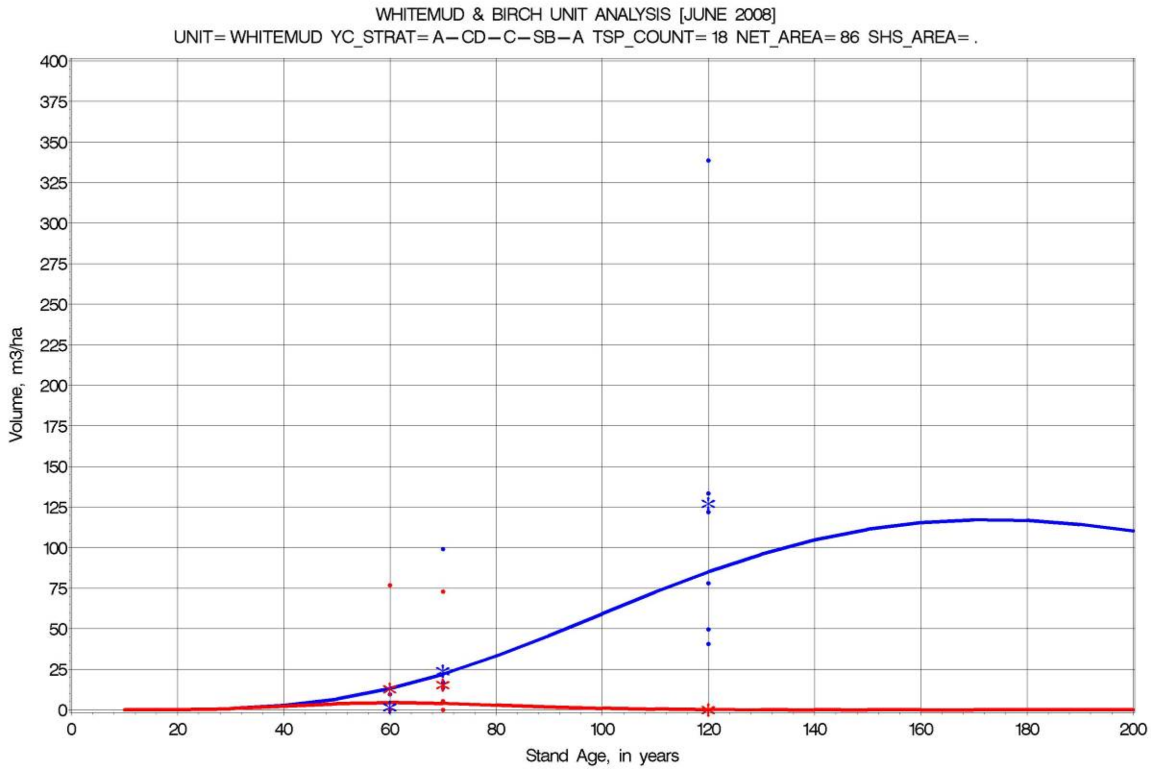
Volume, m3/ha
Stand Age, in years
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400
0
20
40
60
80
100
120
140
160
180
200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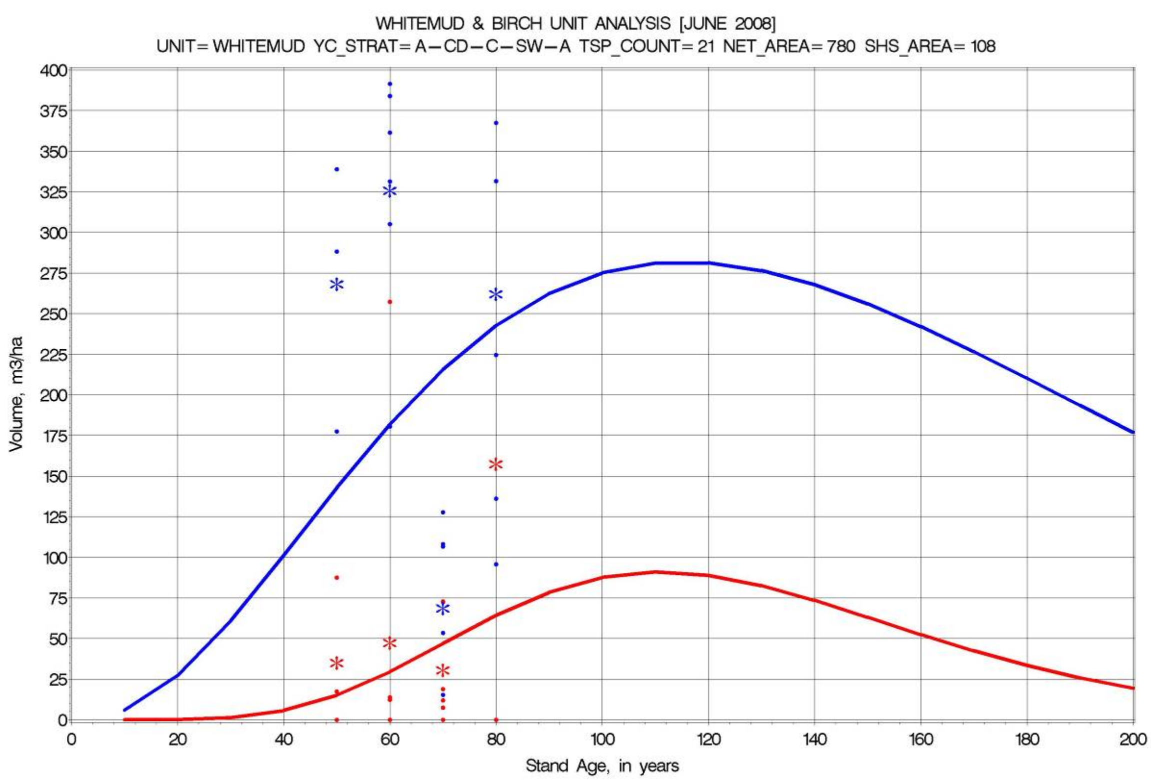
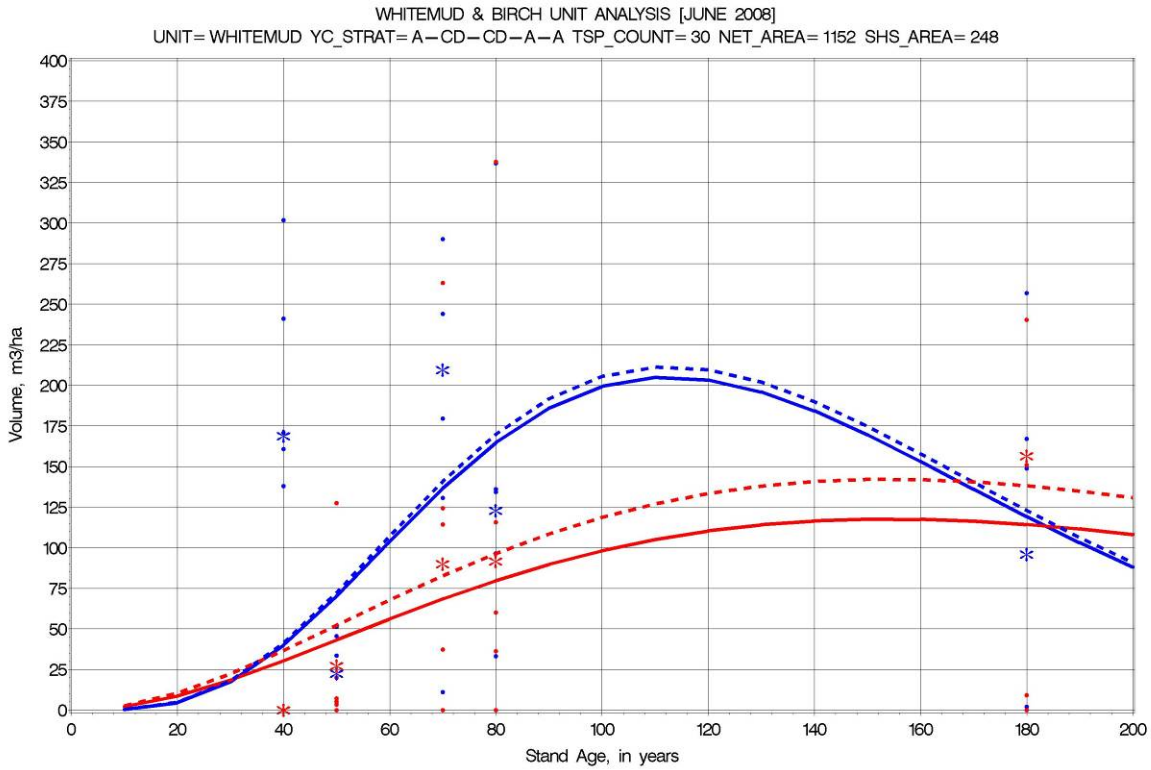
Volume, m3/ha
Stand Age, in years
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400
0
20
40
60
80
100
120
140
160
180
200


WHITEMUD & BIRCH UNIT ANALYSIS [JUNE 2008]
UNIT= WHITEMUD YC_STRAT= A—CD—C—SW—A TSP_COUNT= 21 NET_AREA= 780 SHS_AREA= 108
Volume, m3/ha
Stand Age, in years
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400
0
20
40
60
80
100
120
140
160
180
200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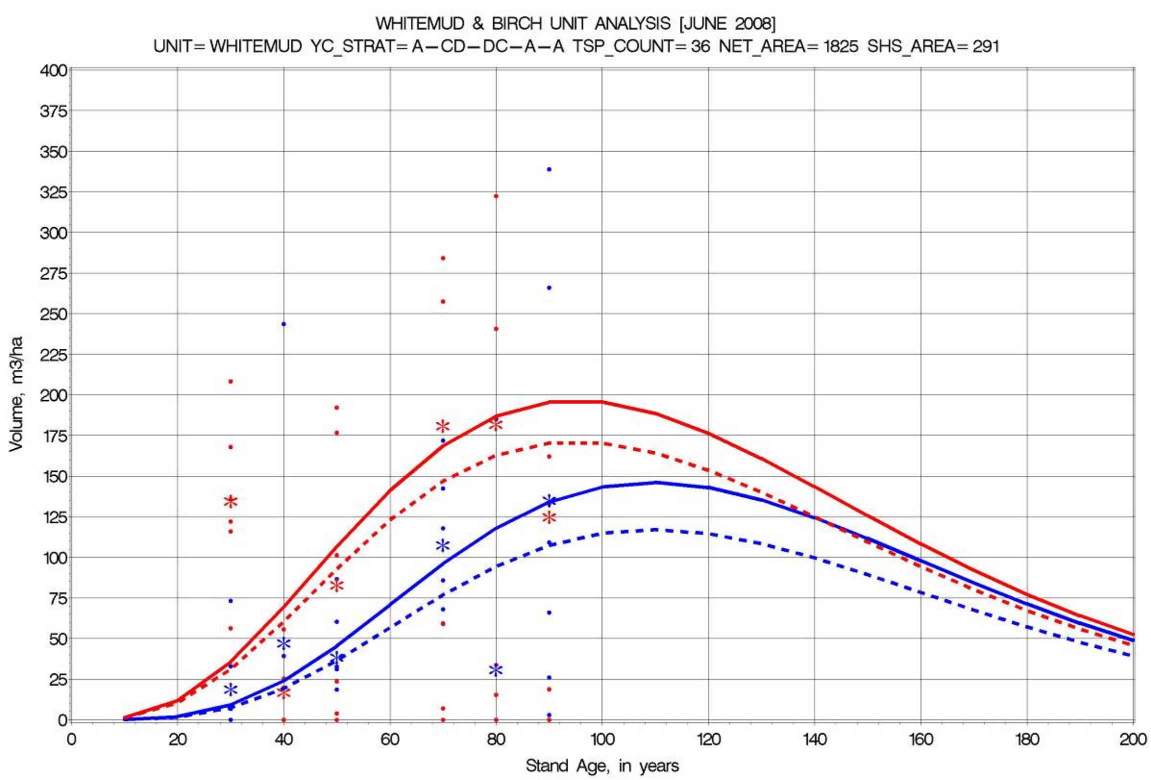
Volume, m3/ha
Stand Age, in years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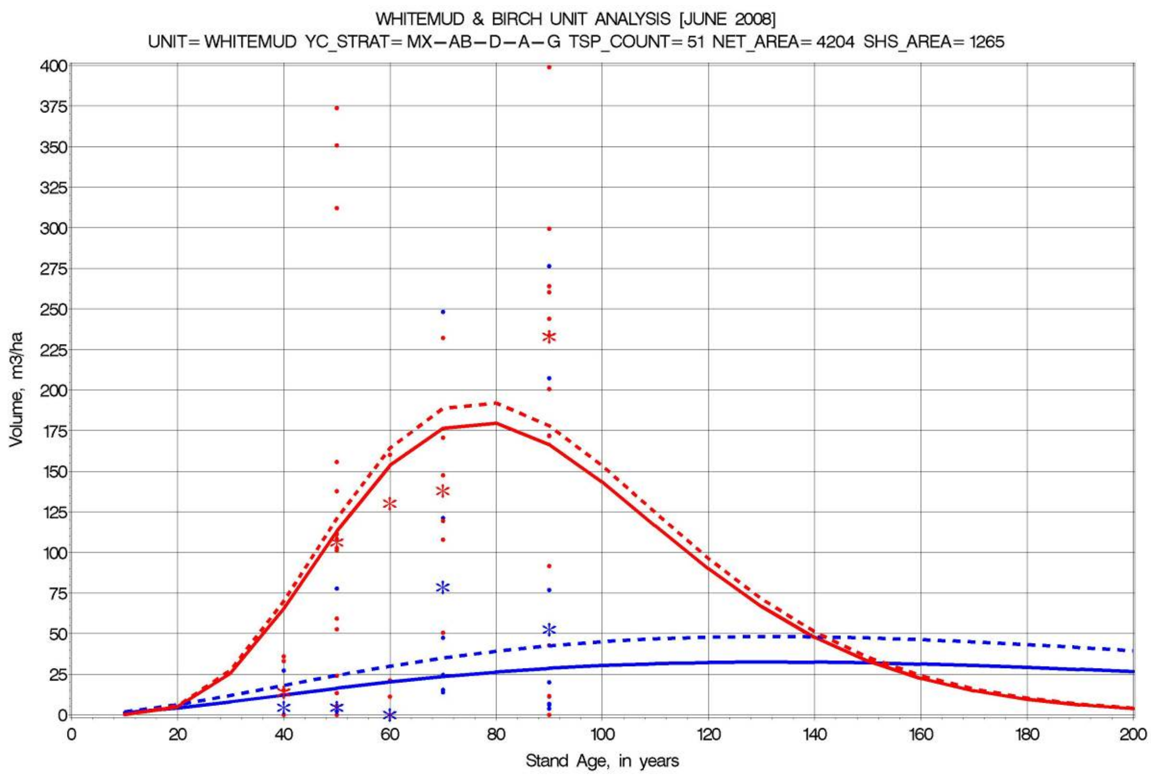
Volume, m3/ha
Stand Age, in years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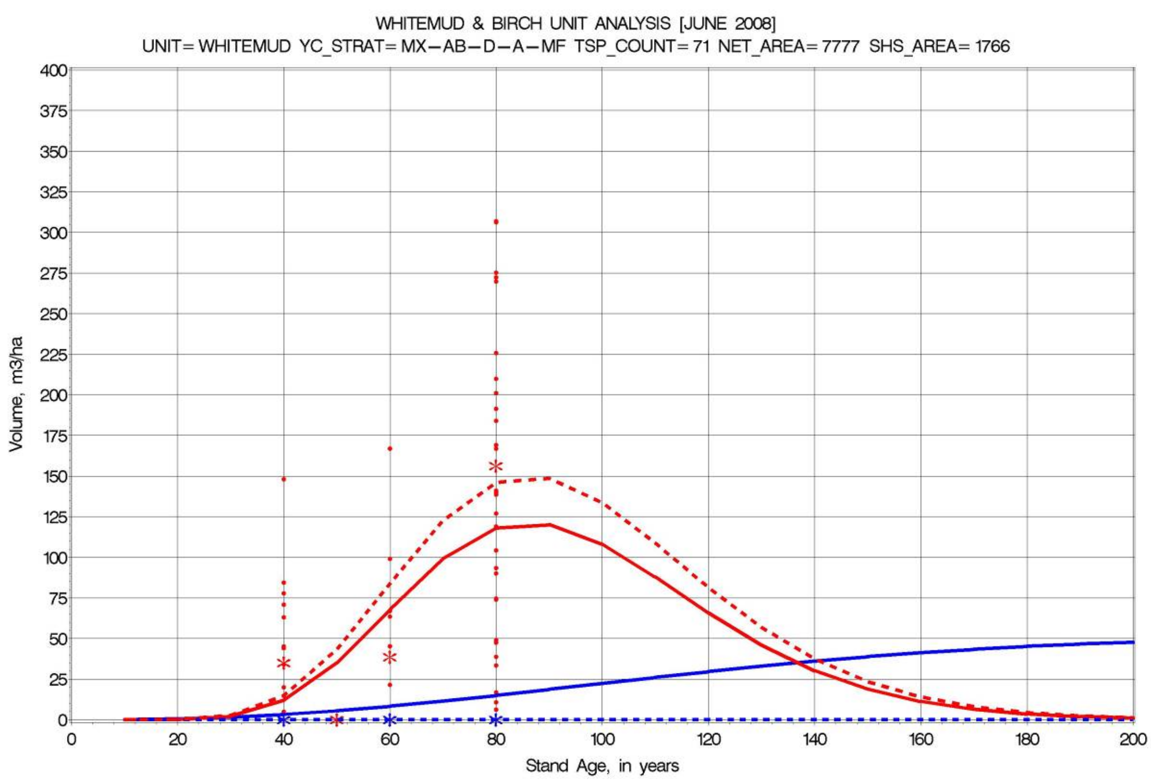
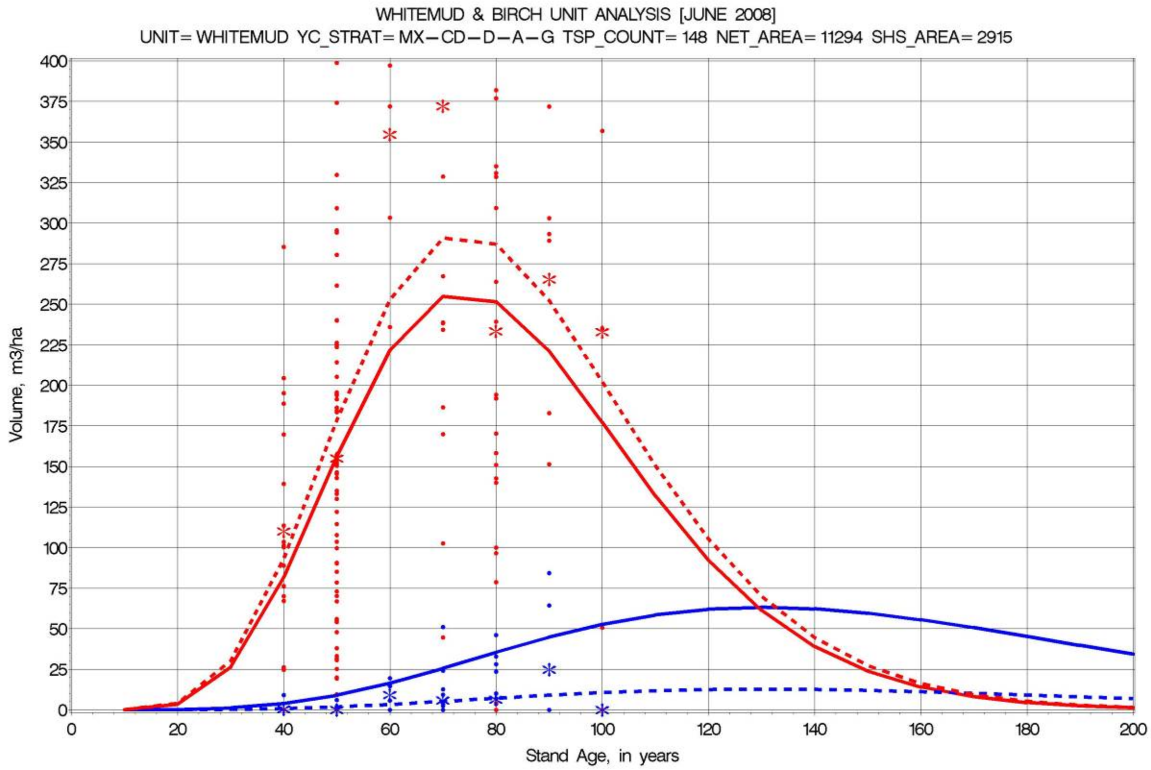
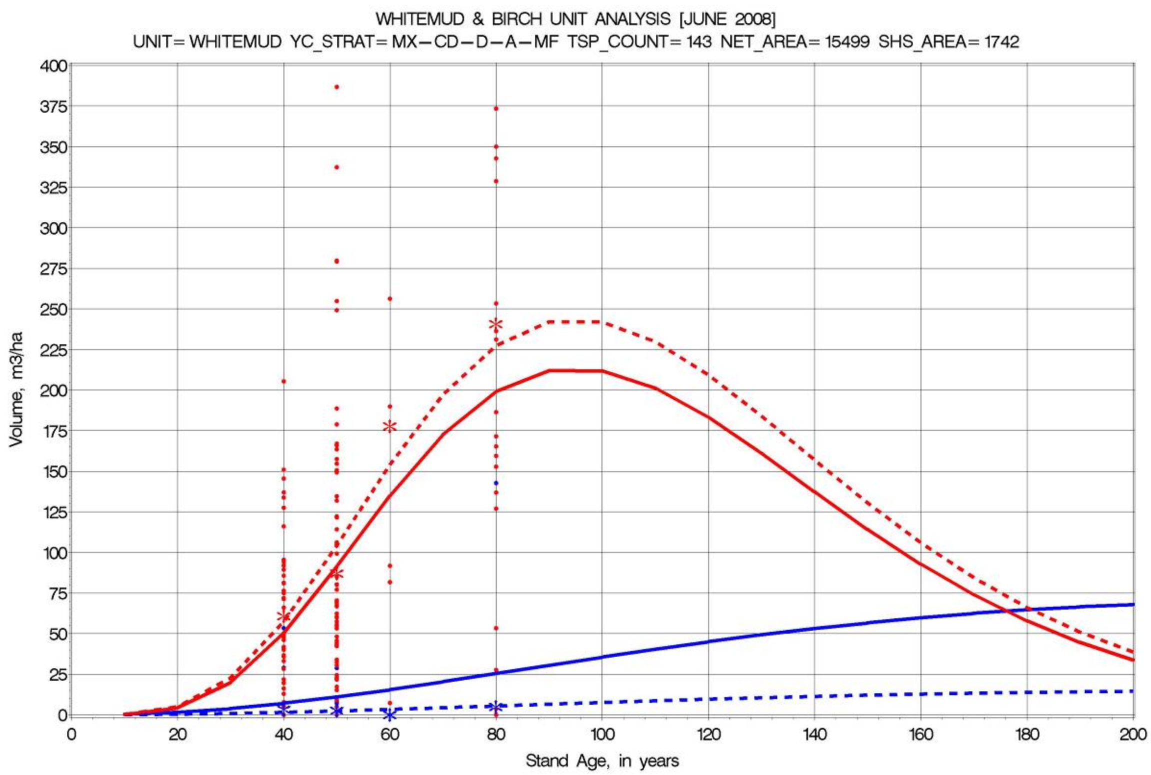
Volume, m3/ha
Stand Age, in years


WHITEMUD & BIRCH UNIT ANALYSIS [JUNE 2008]
UNIT= WHITEMUD YC_STRAT= MX—AB—D—A—MF TSP_COUNT= 71 NET_AREA= 7777 SHS_AREA= 1766
Volume, m3/ha
Stand Age, in years



WHITEMUD & BIRCH UNIT ANALYSIS [JUNE 2008]
UNIT= WHITEMUD YC_STRAT= MX-CD-D-A-G TSP_COUNT= 148 NET_AREA= 11294 SHS_AREA= 2915
Volume, m3/ha
Stand Age, in years



WHITEMUD & BIRCH UNIT ANALYSIS [JUNE 2008]
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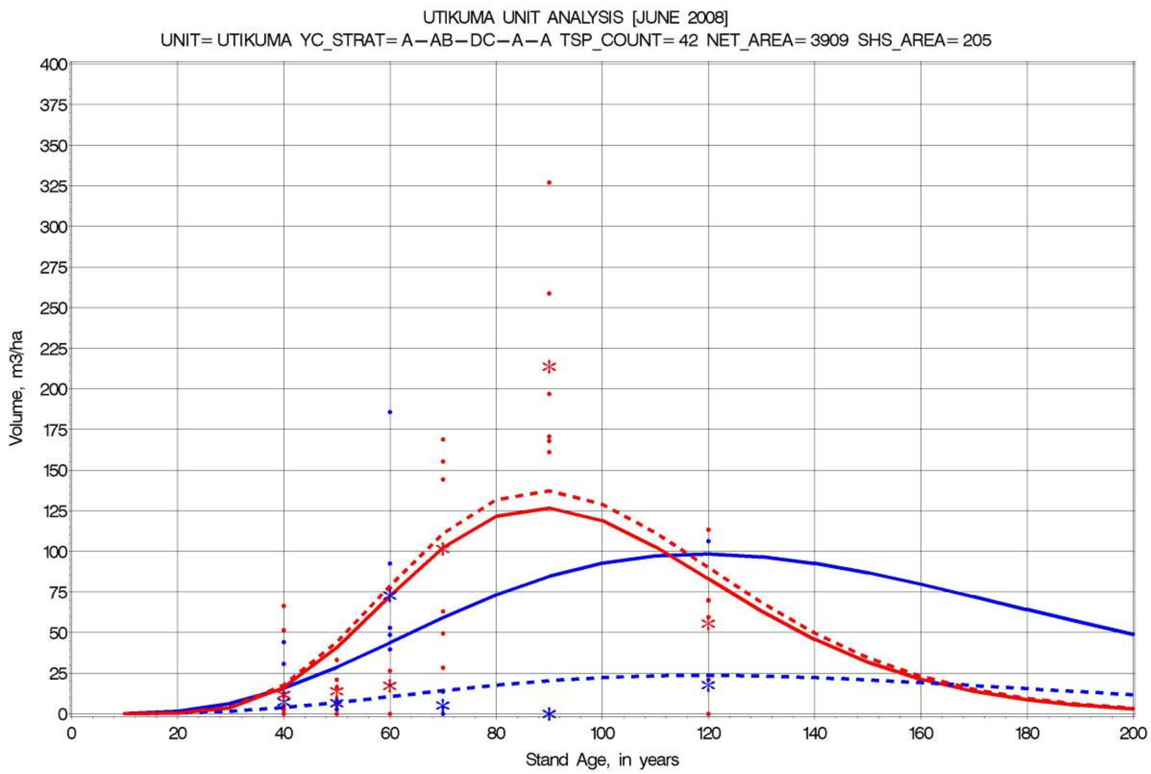
Volume, m3/ha
Stand Age, in years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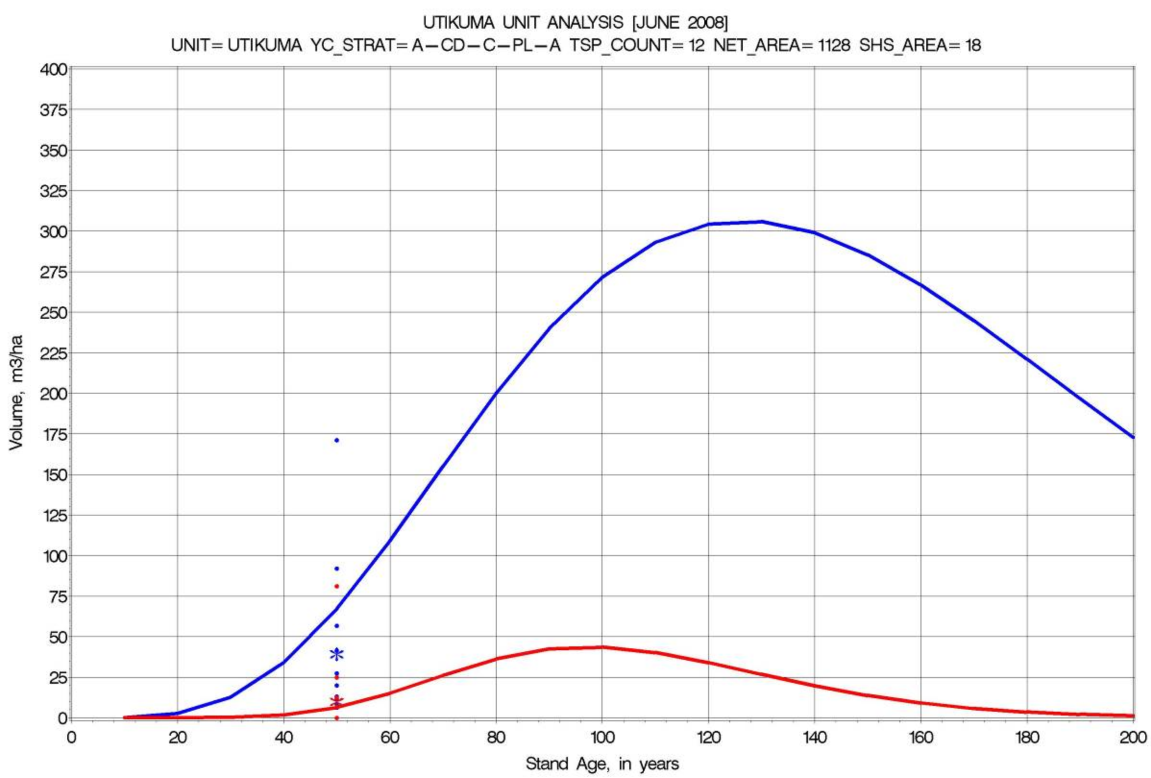
Volume, m3/ha
Stand Age, in years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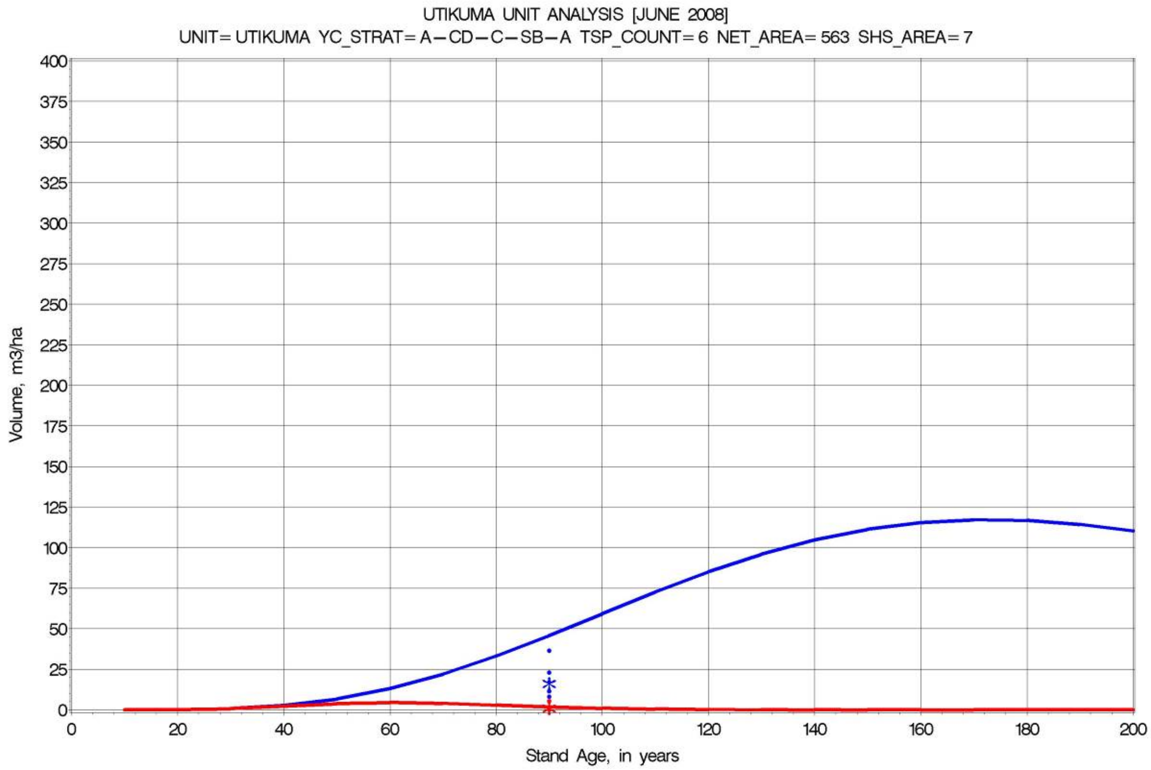
Volume, m3/ha
Stand Age, in years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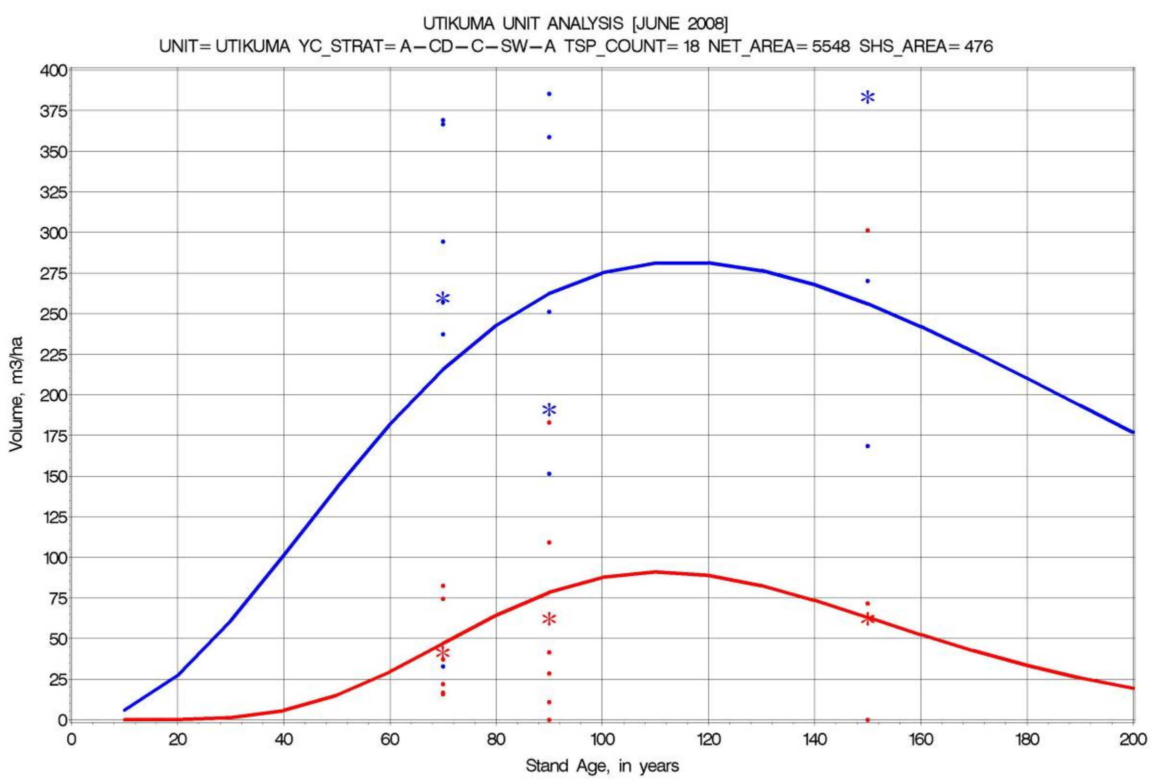
UNIT= UTIKUMA YC_STRAT= A–CD–C–SB–A TSP_COUNT= 6 NET_AREA= 563 SHS_AREA= 7
Volume, m3/ha
Stand Age, in years
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400
0
20
40
60
80
100
120
140
160
180
200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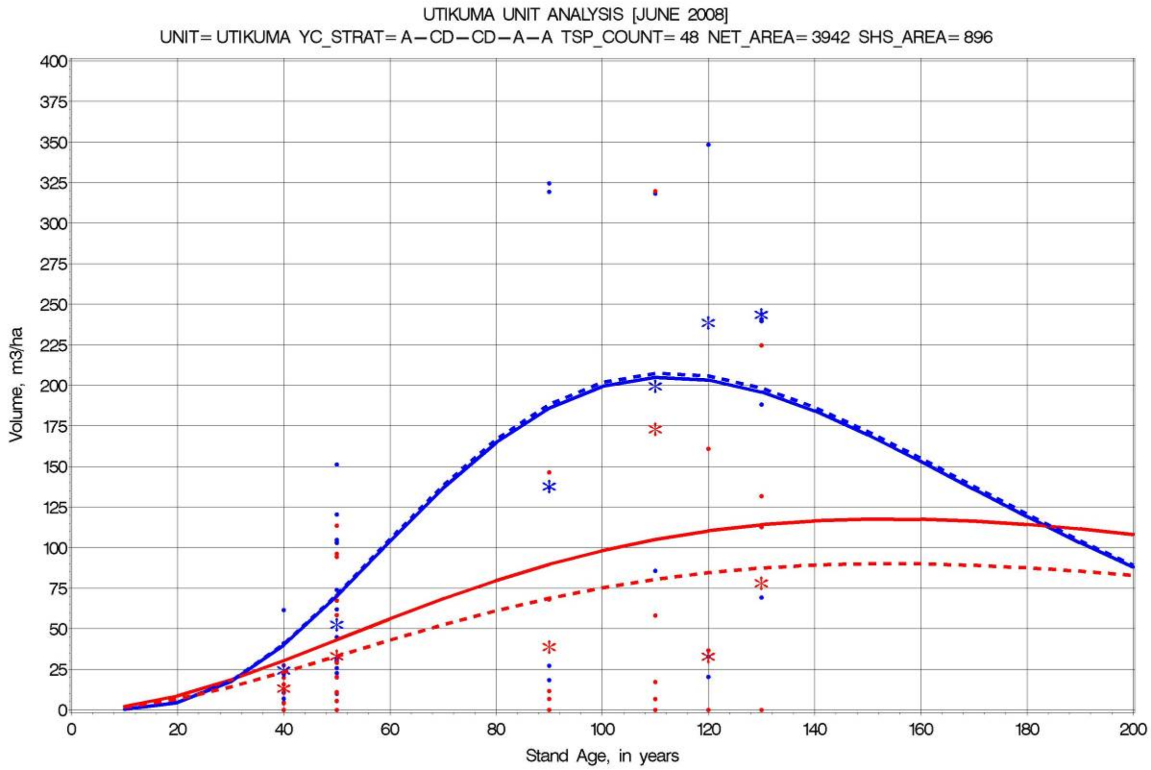
UNIT= UTIKUMA YC_STRAT= A–CD–C–SW–A TSP_COUNT= 18 NET_AREA= 5548 SHS_AREA= 476
Volume, m3/ha
Stand Age, in years
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400
0
20
40
60
80
100
120
140
160
180
200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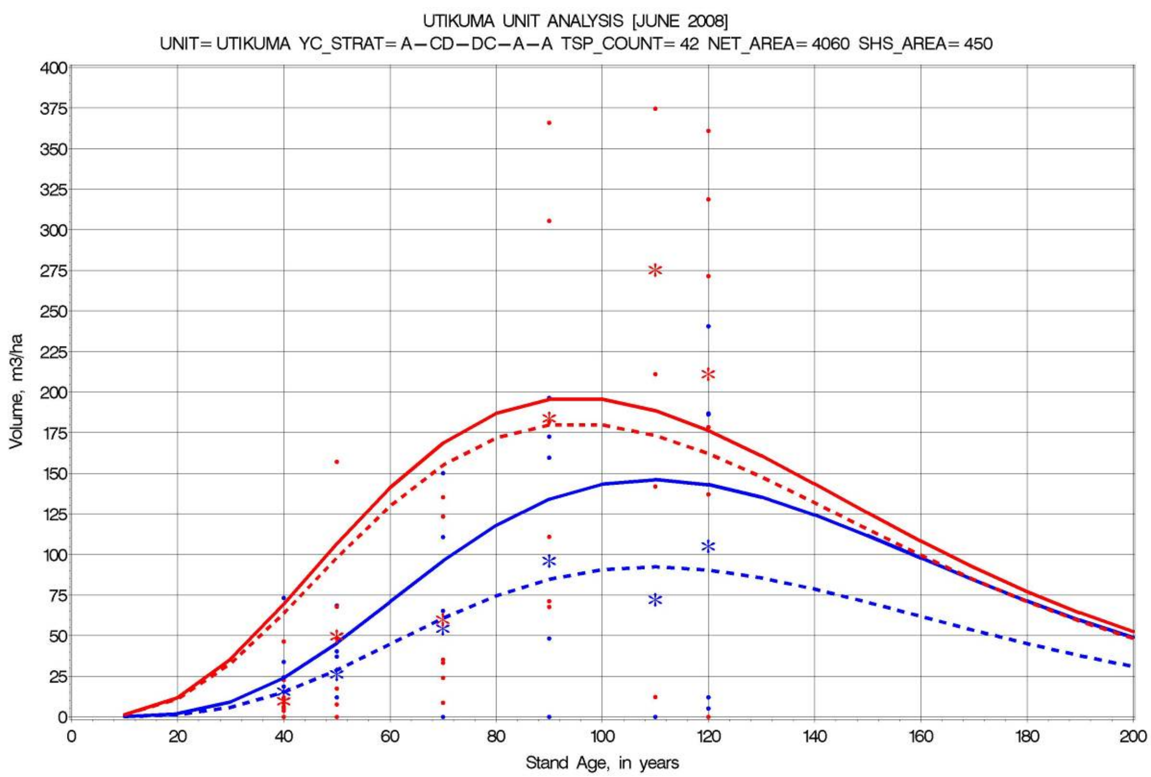
Volume, m3/ha
Stand Age, in years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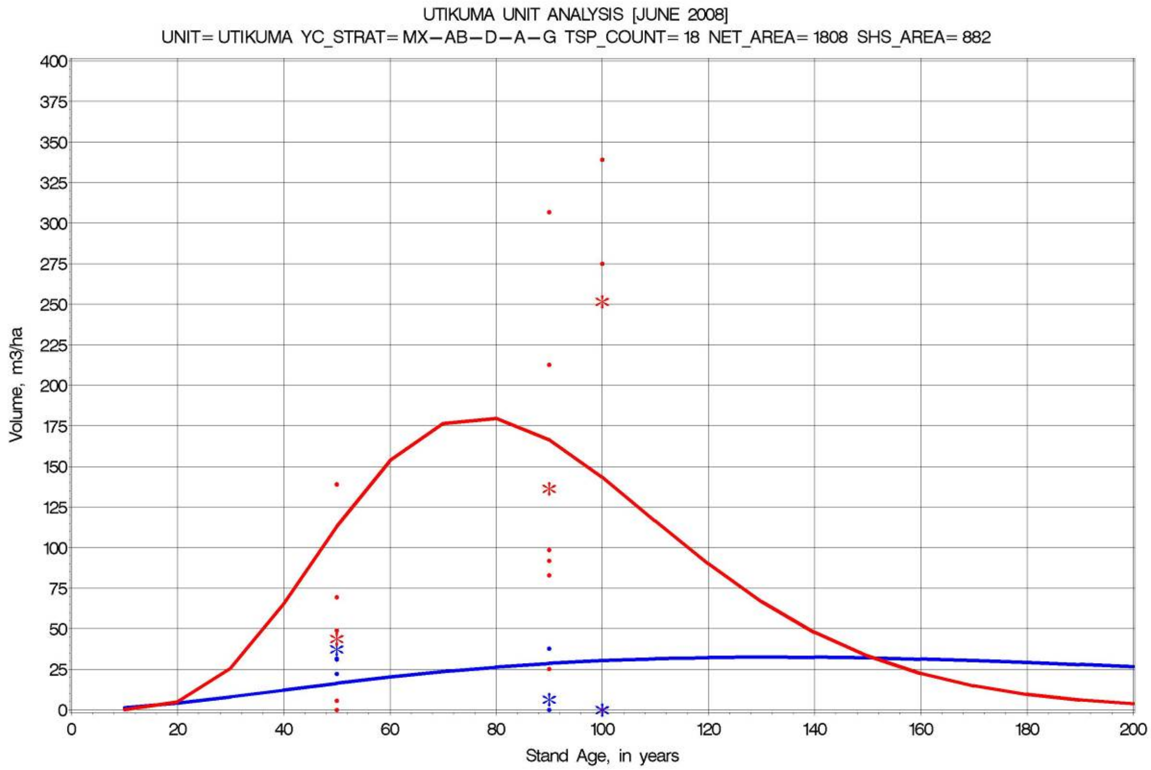
UNIT= UTIKUMA YC_STRAT= A—CD—DC—A—A TSP_COUNT= 42 NET_AREA= 4060 SHS_AREA= 450
Volume, m3/ha
Stand Age, in years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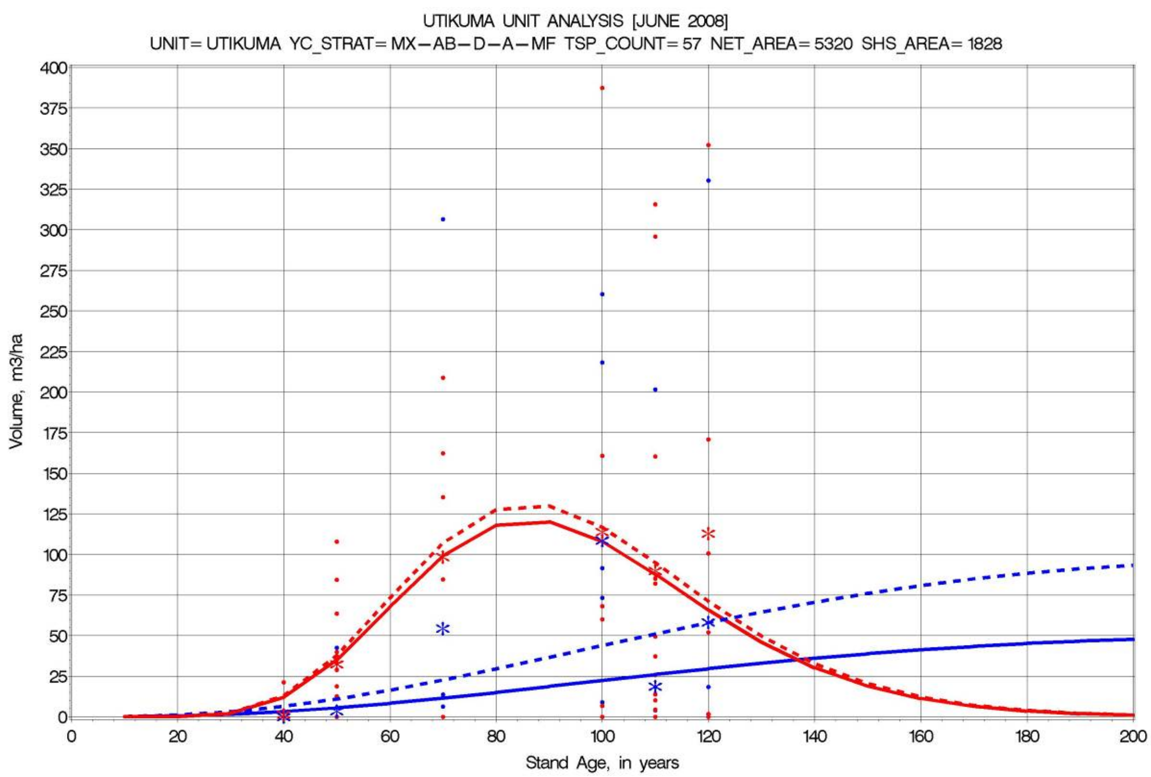
UNIT= UTIKUMA YC_STRAT= MX—AB—D—A—G TSP_COUNT= 18 NET_AREA= 1808 SHS_AREA= 882
Volume, m3/ha
Stand Age, in years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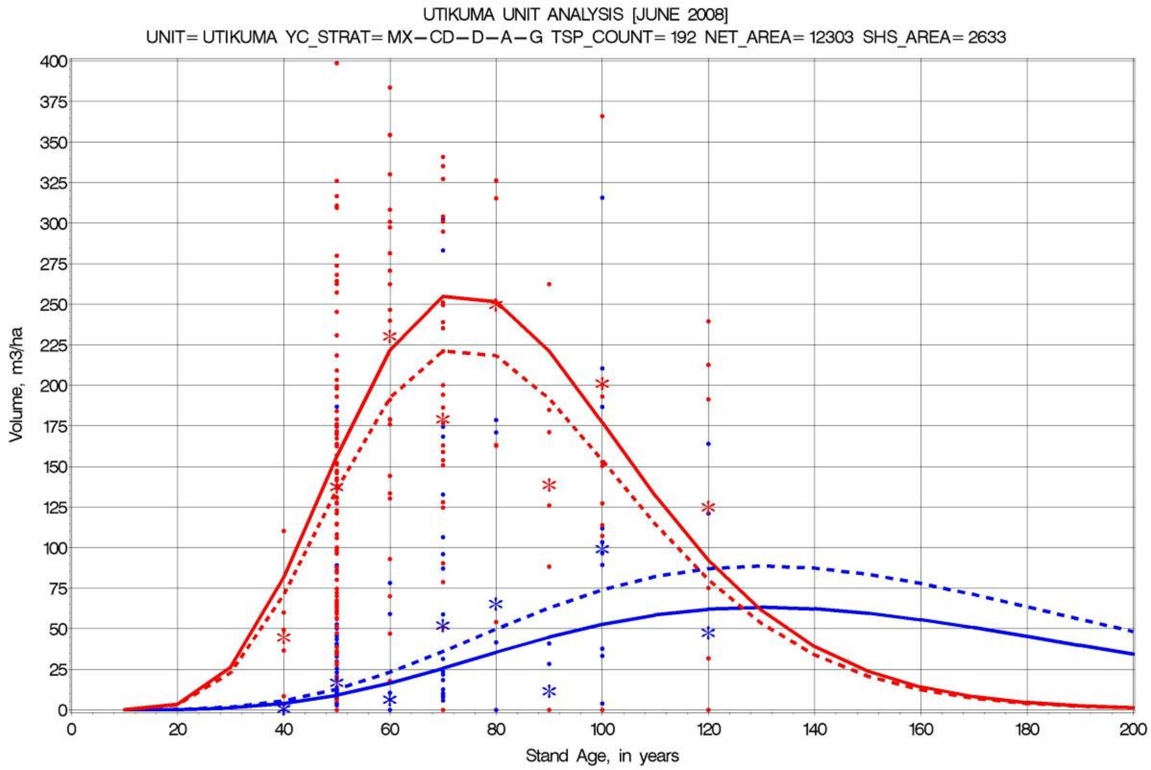
Volume, m3/ha
Stand Age, in years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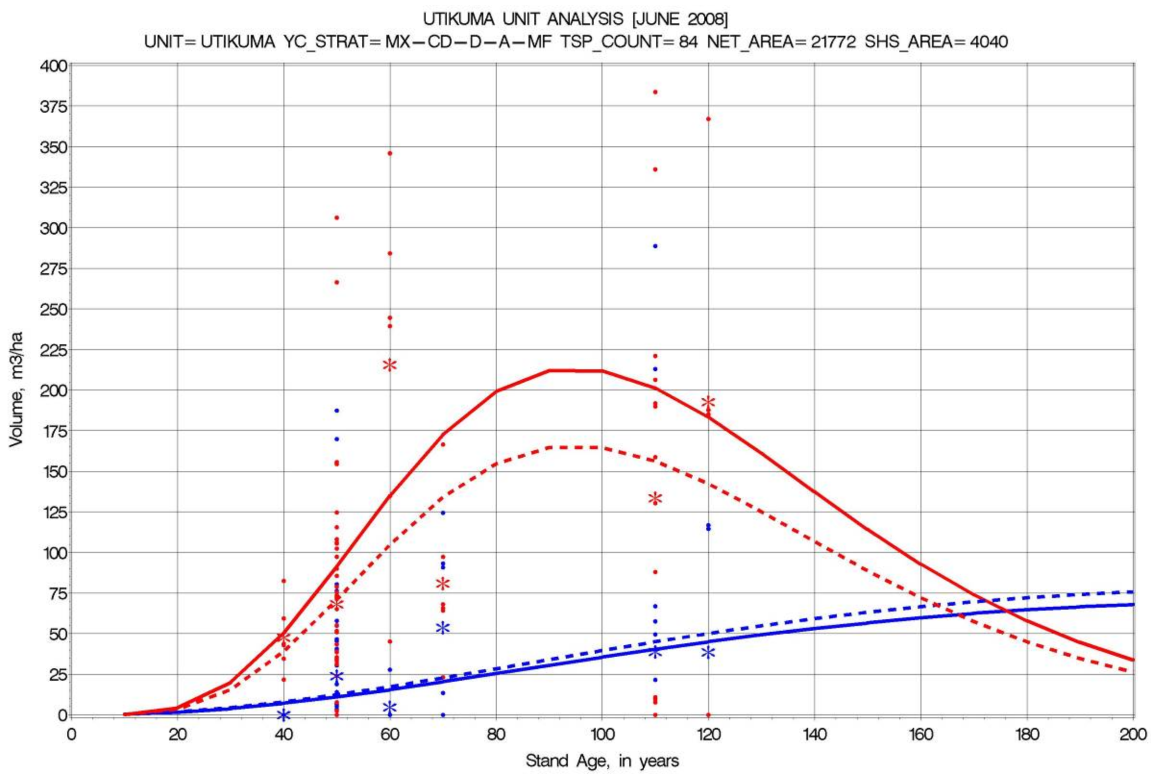
UNIT= UTIKUMA YC_STRAT= MX–CD–D–A–G TSP_COUNT= 192 NET_AREA= 12303 SHS_AREA= 2633
Volume, m3/ha
Stand Age, in years
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400
20
40
60
80
100
120
140
160
180
200


UTIKUMA UNIT ANALYSIS [JUNE 2008]
UNIT= UTIKUMA YC_STRAT= MX–CD–D–A–MF TSP_COUNT= 84 NET_AREA= 21772 SHS_AREA= 4040
Volume, m3/ha
Stand Age, in years
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400
20
40
60
80
100
120
140
160
180
200

Appendix 2 - Tolko Industries Ltd. (High Prairie) Forest Management Agreement Area Final Yield Curve Analysis for Determination of Coniferous AAC

Appendix 2

Tolko Industries Ltd. (High Prairie) Forest Management Agreement Area
Final Yield Curve Analysis for Determination of Coniferous AAC

This report is a summary of the data and procedures used to develop the yield curves applied by Sustainable Resource Development (SRD) in the determination of the coniferous annual allowable cut (AAC).

Temporary sample plot data

The original plot data available for constructing yield curves in the Salt Operating Area were 346 plots that were measured in 2002 in the Salt Operating Area. The use of this data for constructing the new yield curves presented the following two problems:

- The 346 Temporary Sample Plots (TSP)s were not adequate for building yield curves for all the yield strata in the operating area, and
- The 346 plots were located based on the old Alberta Vegetation Inventory (AVI) and had to be linked to the new AVI stands. The Forest Management Planning Standard requires that this linkage be made to ensure that yield estimates properly reflect the standing timber resources portrayed by the new inventory.

With no GPS information available for the TSPs, the only option available for linking the TSP data to the new AVI was to intersect the old AVI stands that were used to locate the TSPs with the new AVI polygons, and then to assign the plots to the appropriate new AVI stands on the basis of exact matches with the stands sampled using the old AVI. This approach was possible because of the requirement in the AVI Standards that old stand boundaries be retained as much as possible when updating AVI. However, the requirement of an exact match of the stands resulted in less than 60 plots being assigned to the new AVI stands.

Table 1. Summary of the number of TSPs within and outside of the Salt Operating Area used for yield curve assessment.

Yield Stratum	Number of Plots from Salt Operating Area	Number of guide plots from outside Salt Operating Area
AB-C-SB	24	36
AB-C-SW	24	102
AB-CD-A	6	120
CD-C-SB	6	48
CD-C-SW	12	63
CD-CD-A	12	120
AB-D-A-G	18	99
AB-D-A-MF	42	164
CD-D-A-G	36	394
CD-D-A-MF	54	299
Total Plot Count	234	1763

Given the small sample size that resulted, a decision was made to relax the requirement for an exact match between the stands sampled in the old AVI and the stands in the new AVI to include cases where at least 50% of the old AVI TSP stand areas match the new AVI stand areas. This process still resulted in a significant reduction in the number plots available for constructing new yield curves (see Column 2 of Table 1). This is the least preferred method of linking existing TSPs to the new AVI. The preferred approach for getting data for building yield curves, had it been an option, would have been to use plot locations based on Global Positioning System (GPS) information or, best of all, a new TSP program implemented using the new inventory coverage. A supplemental volume-sampling program was completed by SRD in the winter of 2010 to verify the initial volumes forecast in the Salt Operating Area.

Stratification

The new AVI data for the 234 TSPs were used to create new yield strata similar to the old strata. Table 2 presents a cross-tabulation of the TSPs by the old and the new yield curve strata to illustrate plot transfer between the old and the new yield strata.

Table 2. A cross-tabulation of the selected TSPs by the old and the new yield curve strata[1].

Old Yield Curve strata	**New Yield Curve strata**									
	AB-C-SB	AB-C-SW	AB-CD-A	CD-C-SB	CD-C-SW	CD-CD-A	AB-D-A-G	AB-D-A-MF	CD-D-A-G	CD-D-A-MF
-	6	0	0	0	0	0	0	0	0	0
AB-C-SW	0	6	0	0	6	0	0	6	0	0
AB-CD-A	6	6	6	0	0	6	0	0	0	12
AB-DC-A	0	6	0	0	0	6	0	12	0	0
CD-C-SB	6	0	0	0	0	0	0	0	0	0
CD-C-SW	0	0	0	0	0	0	0	6	0	0
CD-CD-A	6	6	0	0	6	0	0	0	0	0
CD-DC-A	0	0	0	0	0	0	0	6	6	30
AB-D-A-G	0	0	0	6	0	0	6	6	0	0
AB-D-A-MF	0	0	0	0	0	0	0	6	6	0
CD-D-A-G	0	0	0	0	0	0	0	0	18	6
CD-D-A-MF	0	0	0	0	0	0	12	0	6	6
Total	24	24	6	6	12	12	18	42	36	54

[1] The stand attributes that define each yield stratum are presented from left to right in the following order; stand density, broad cover group, leading coniferous species and site productivity. The natural region attributes are also included but are omitted here for brevity. A more complete description is provided in Appendix A.

Yield curve development

Due to the limited number of TSPs, a guide curve approach was explored using data from the other 3 Operating Areas (see column 3 of Table 1). Three options for guide curve development were explored:

i) The first approach utilized the plots from the same stratum, both within and outside the Salt Operating Area, to fit the yield curves for the target strata. The curves were then localized using only the plots from within the Salt Operating Area.

ii) The second option utilized only the plots from the target stratum that are located outside of the Salt Operating Area to fit the yield curves. These were then localized using the plots from the target strata within the Salt Operating Area.

iii) The third option utilized data from within the Salt Operating Area but from strata closer to the target strata (e.g., similar species composition) to guide the development of yield curves for the target strata.

After some preliminary analysis, a combination of options i) and iii) were found to produce reasonable results. These options were used to fit the new yield curves.

Graphical presentations of the individual yield curves are presented in Figures 1 to 11. These figures represent overlays of the new yield curves on the 2002 FMP yield curves along with individual plot volumes. Although the focus was on the coniferous landbase (see Table 3), the pure deciduous curves were also fitted.

Table 3. Summaries of landbase area by yield strata

Landbase	Yield stratum	Area (ha)	Total area (ha)
Deciduous	MX-AB-D-A-G	2974.60	
	MX-AB-D-A-MF	14145.60	
	MX-CD-D-A-G	104780.80	
	MX-CD-D-A-MF	16747.50	138648.50
Coniferous	A-AB-DC-A-A	942.50	
	A-CD-DC-A-A	390.80	
	A-AB-CD-A-A	608.60	
	A-CD-CD-A-A	254.60	
	A-AB-C-SW-A	4804.20	
	A-AB-C-P-A	848.30	
	A-AB-C-SB-A	5120.90	
	A-CD-C-SW-A	591.90	
	A-CD-C-P-A	83.20	
	A-CD-C-SB-A	1625.60	15270.70
Total		**153,919.20**	**153,919.20**

Table 4 presents the coefficients of the new yield curves. The model types are marked with (i), (iii) or (i & iii) to indicate if option (i), (iii) or a combination of (i) and (iii) were used respectively for fitting the yield curve for the stratum and yield component. Please note that the guide curve parameters (g) are not relevant for predicting the new yields; they were added to show the relative impact on the final curves of including plots from outside of the Salt Operating Area. A positive g indicates that new curves would have predicted higher volumes than the current levels if plots from outside the Salt Operating Area were included, and a negative g means the new curves would have been relatively lower. A combination of factors was used to assess the risk of using the new curves against the old curves. The following decisions were made:

- No new yield curves were developed for the strata shaded yellow in Table 3: A-AB-DC-A-A, A-CD-DC-A-A, A-AB-C-P-A and A-CD-C-P-A as there were no data for these four strata. Use of the old 2002 DFMP yield curves is recommended for these strata. The net landbase contribution from each of these strata is minimal.
- There were only 6 plots available for the A-AB-CD-A-A yield stratum and all of these plots were found in one age class (Figure 6). Thus, they could not be used to properly define a new yield curve. The new curve did not appear to differ much from the old curve but gave more conservative yield estimates for coniferous. These curves were used as they were considered to be of low risk, especially as the stratum is only 4% of the coniferous landbase.
- The new curves for the A-CD-CD-A-A stratum (Figure 7) are based on only 12 plots but look reasonable and are a bit lower than the old curves. This is also a low risk stratum containing only 2% of the coniferous landbase. The new curves are therefore recommended for use.
- The new curves for the stratum A-AB-C-SW-A (Figure 8) represent a significant increase in the coniferous volume. The plot data seem to support this increase. As shown in Table 2, the majority of the plots used to develop the curves for this stratum were from stands that were originally high density stands. This may explain the apparent increased volume. This is a high risk curve as this stratum constitutes about 30% of the coniferous landbase. Since the method used to arrive at this new curve is less than ideal, I recommend that the original curves be used instead.
- The new low density black spruce curve (A-AB-C-SB-A), which applies to about 34% of the coniferous landbase, looks quite low (Figure 9), hardly reaching 50 m^3/ha.This curve does not differ much from the original and is not a high risk curve since it is unlikely such stands will be sequenced for harvest. The new curve should be adopted.
- The A-CD-C-SW-A coniferous curve (Figure 10) peaks slightly lower than the old curve. The peak MAI is much lower and occurs at age (100 years), more typical of white spruce culmination ages (90 to 110) used elsewhere. These changes in the yield curve characteristics may negatively impact the contribution of this curve to the AAC. However, the new curve looks reasonable and the stratum constitutes only 4% of the coniferous landbase. The new curve should be adopted.
- The old high-density black spruce curves are not very different from the new ones (Figure 11). These curves were recommended for use.

Table 4. Parameter estimates for the new yield curves for the Salt Operating Area.

Yield Stratum	Coniferous					Deciduous				
	θ_1	g[2]	θ_2	θ_3	Model type	θ_1	g	θ_2	θ_3	Model type
MX-AB-D-A-G	0.009290	0.047336	1.565695	-	2P (i)	0.002337	0.000492	2.871207	0.020847	3P (i)
MX-AB-D-A-MF	0.000000	0.000000	7.894381	0.078882	3P (iii)	0.017317	0.006603	2.252325	-	2P (iii)
MX-CD-D-A-G	0.002692	0.003013	1.999121	-	2P (i)	0.032920	-0.001304	2.602148	-	2P (i)
MX-CD-D-A-MF	0.013709	-0.005013	2.102701	-	2P (i)	0.021684	-0.001032	2.450898	-	2P (i)
A-CD-DC-A-A	-	-	-	-	-	-	-	-	-	-
A-AB-CD-A-A	0.021959	-0.002595	2.231931	-	2P (i&iii)	0.019750	-0.006886	2.198730	-	2P (i&iii)
A-CD-CD-A-A	0.018043	0.004362	2.338743	-	2P (i&iii)	0.009245	0.006991	2.039785	-	2P (i&iii)
A-AB-C-SW-A	0.015193	0.000487	2.345320	-	2P (i&iii)	0.018797	0.013588	2.105573	-	2P (i&iii)
A-AB-C-SB-A	0.007360	0.001225	1.970099	-	2P (i)	0.078240	-0.074859	1.878216	-	2P (i)
A-CD-C-SW-A	0.014773	-0.002716	2.381028	-	2P (i&iii)	0.021887	0.000407	2.241874	-	2P (i&iii)
A-CD-C-SB-A	0.012628	-0.005894	2.166708	-	2P (i&iii)	0.047768	-0.013419	1.937280	-	2P (i&iii)

Model type 2P: $y = (\theta_1 + g * d)x^{\theta_2} \exp(-\theta_1 x)$

Model type 3P: $y = (\theta_1 + g * d)x^{\theta_2} \exp(-\theta_3 x)$

Where: x is the stand age in years; y is the coniferous or deciduous volume, and θ_1, θ_2, and θ_3 are model parameters. The variable d is an indicator variable; 0 for data from within the Salt Operating Area and 1 for data from outside the Salt Operating Area.

[2] The parameter g is a guide curve parameter which indicates the relative magnitude of the new local yield curves in Salt compared to curves developed with external data included. These parameters are redundant in estimating the new yield curves for Salt as the indicator variable d=0, but provide information on whether the new Salt yield curves are relatively lower (where g is positive) or higher (where g is negative) than curves developed with external data included.

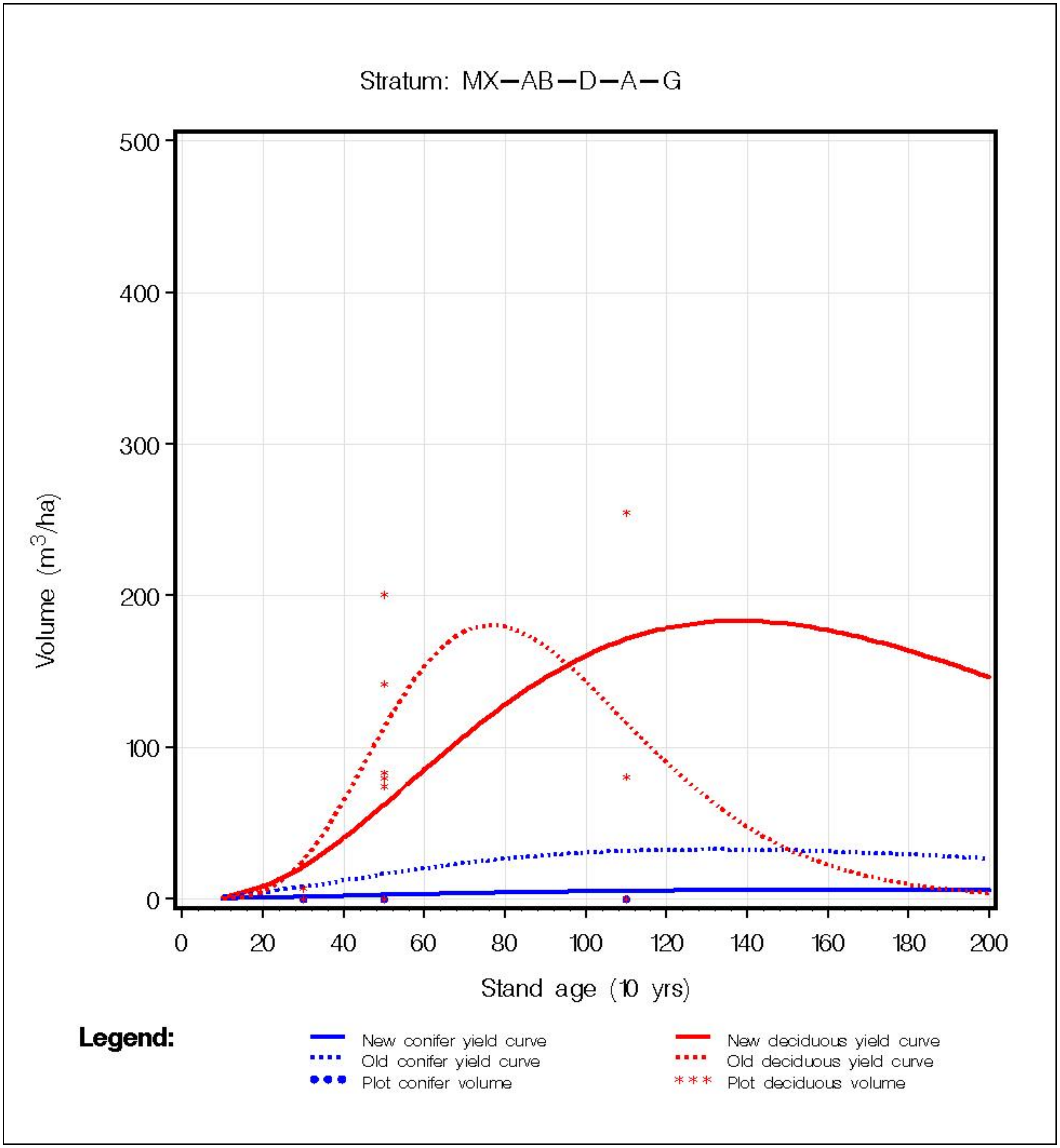


Figure 1. Low density good site pure deciduous curve.

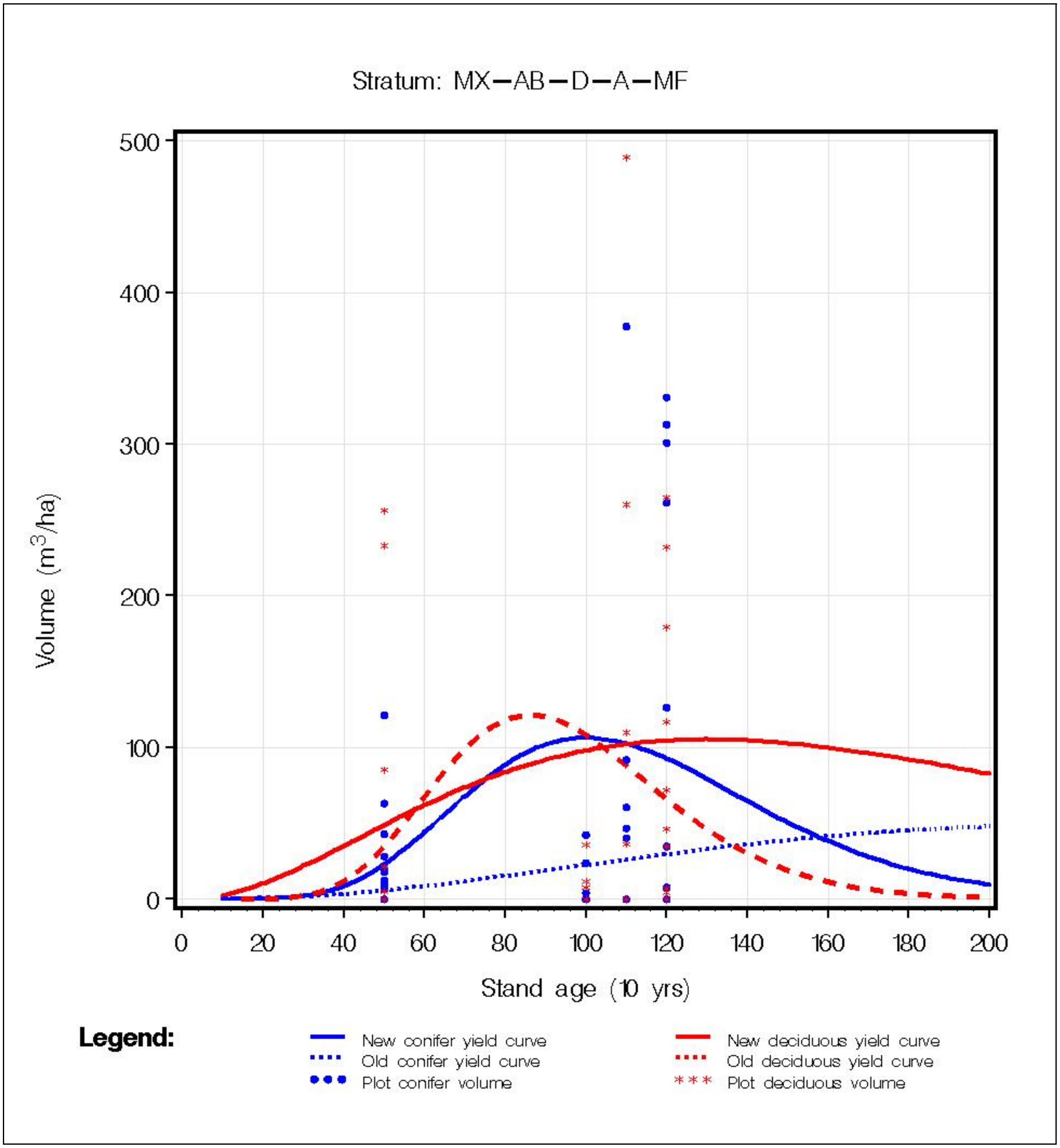


Figure 2. Low density medium - fair site pure deciduous curve.

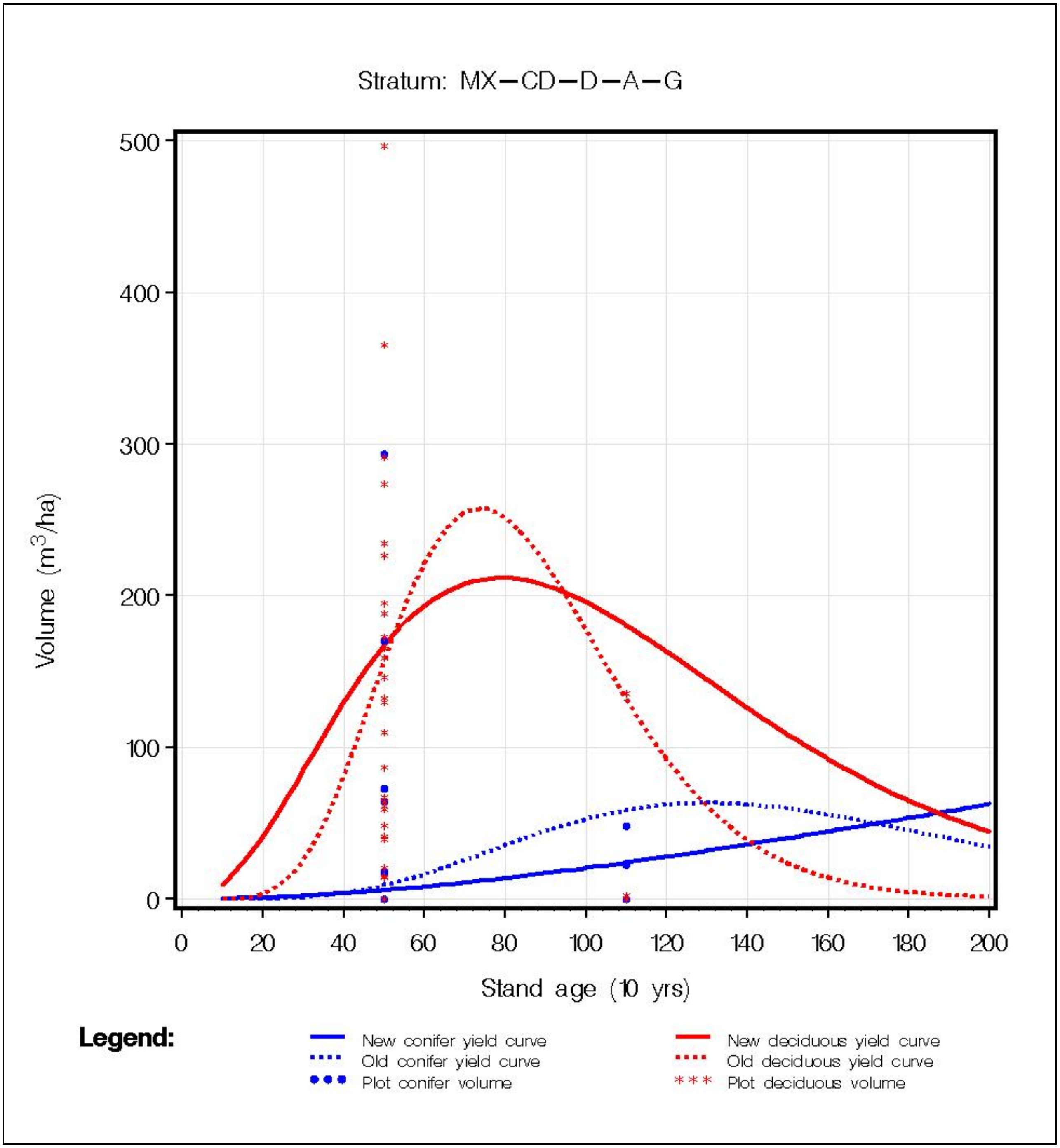


Figure 3. High density good site pure deciduous curve.

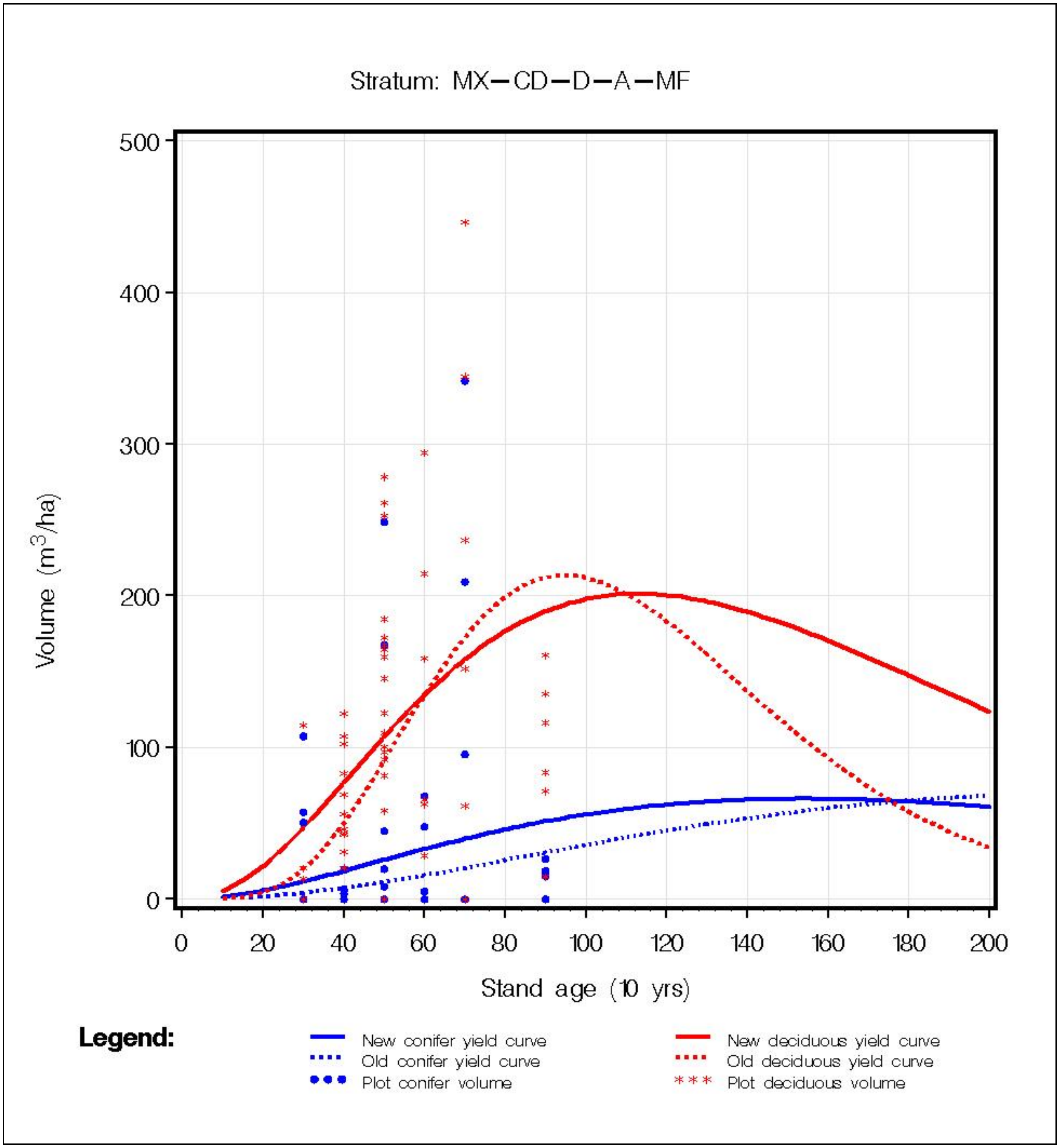


Figure 4. High density medium - fair site pure deciduous curve.

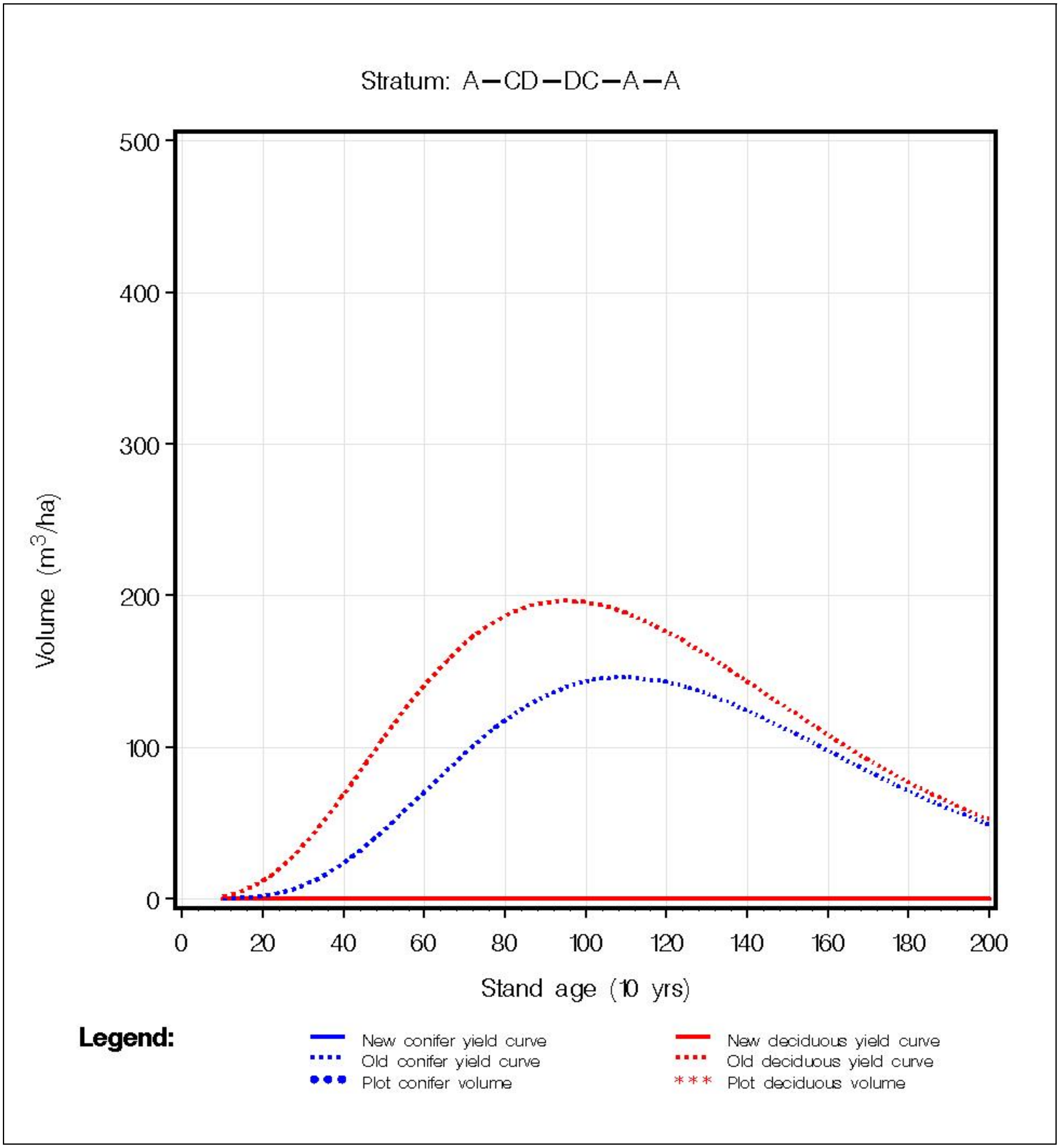


Figure 5. High density, deciduous-dominated mixedwood curve.

Note: Please revert to the old curve, as there were no data to refit this curve. No new curves are shown because there were no plots for this stratum.

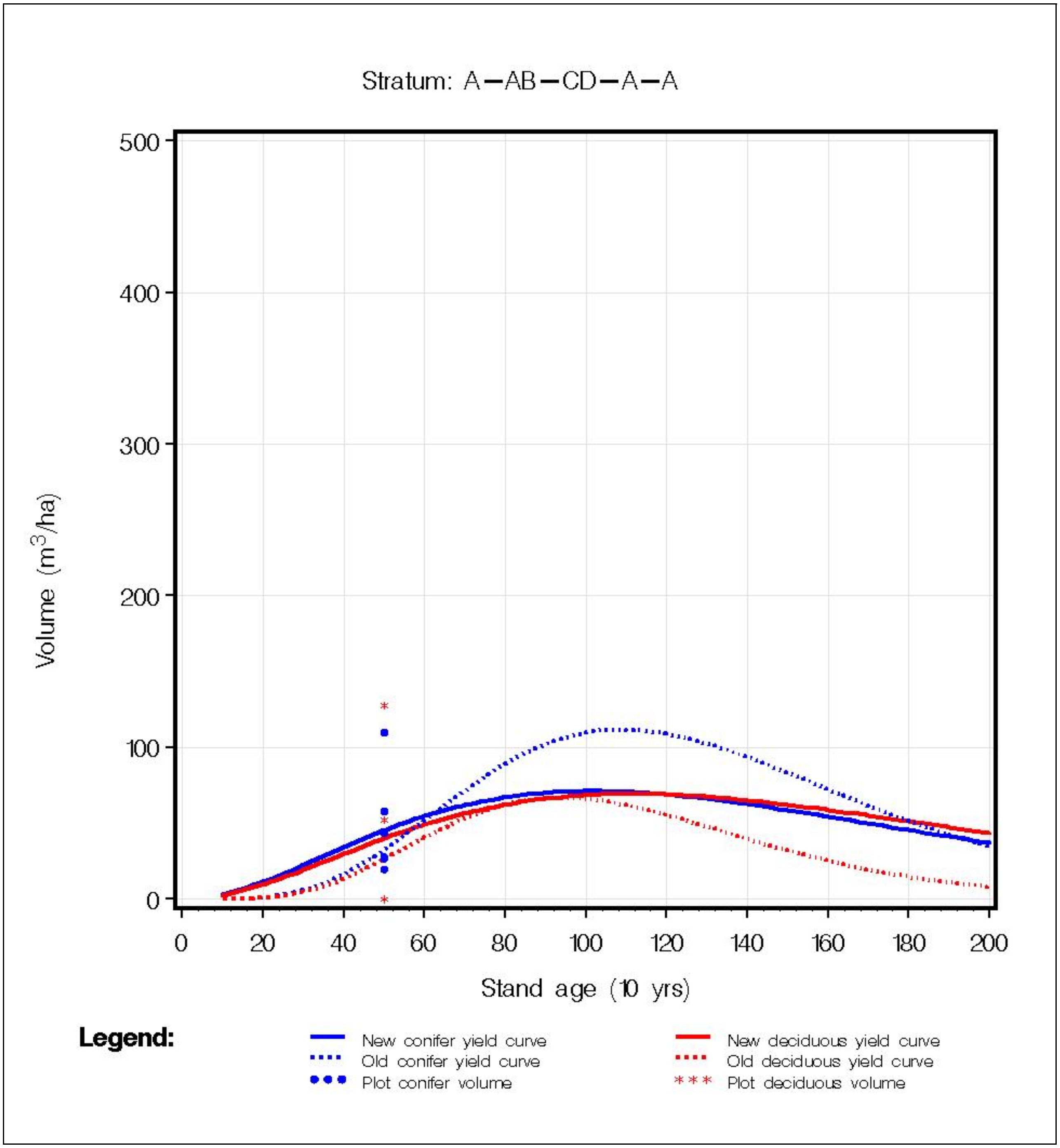


Figure 6. Low density coniferous dominated Mixedwood curve.

Note: Data for only one age class were available for localizing this curve. However, the curve looks conservative, may be low risk and is therefore recommended.

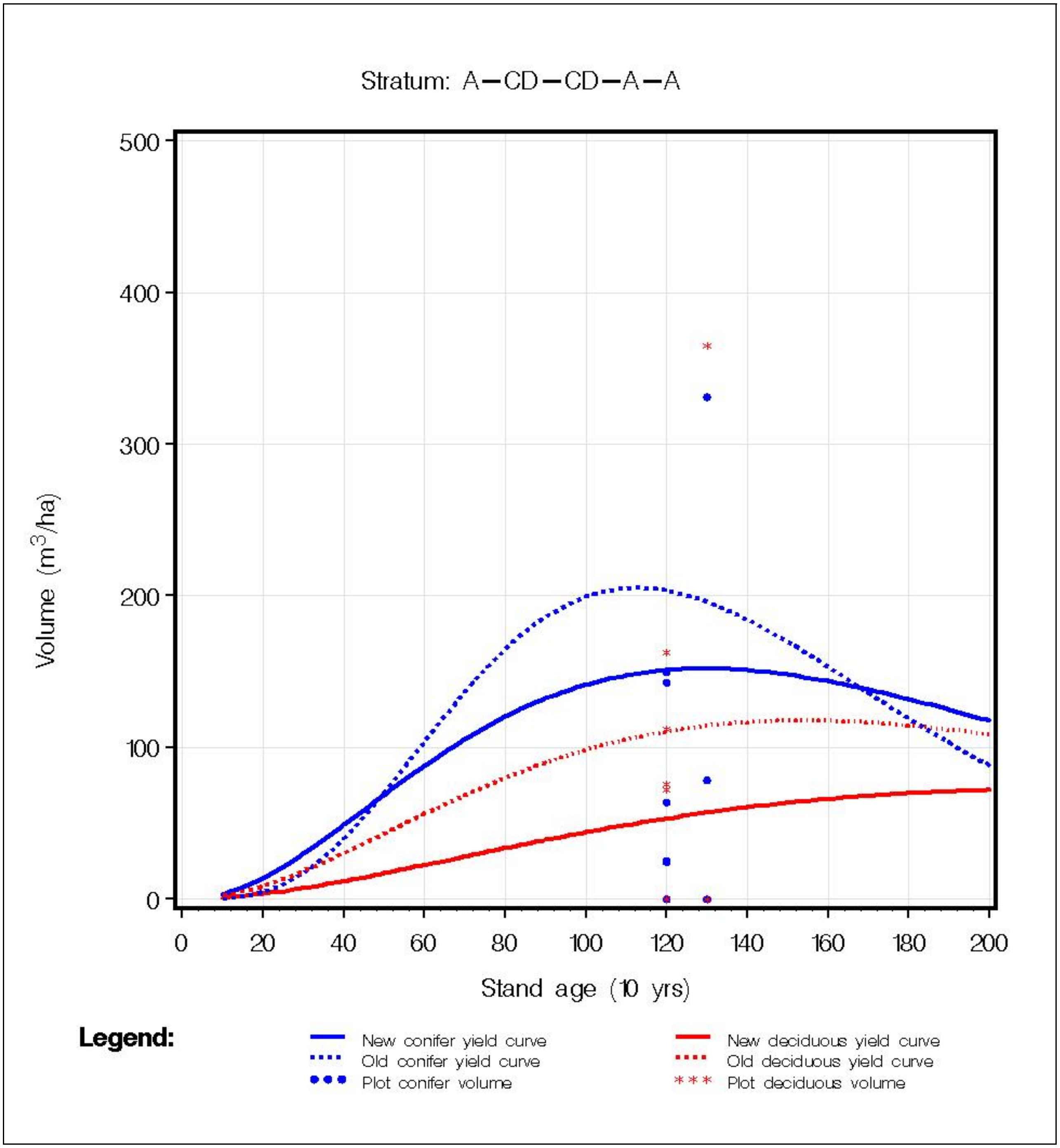


Figure 7. High density coniferous dominated mixedwood curve.

Note: This curve is based on few plots but is a low risk curve. Use of the new curve is recommended.

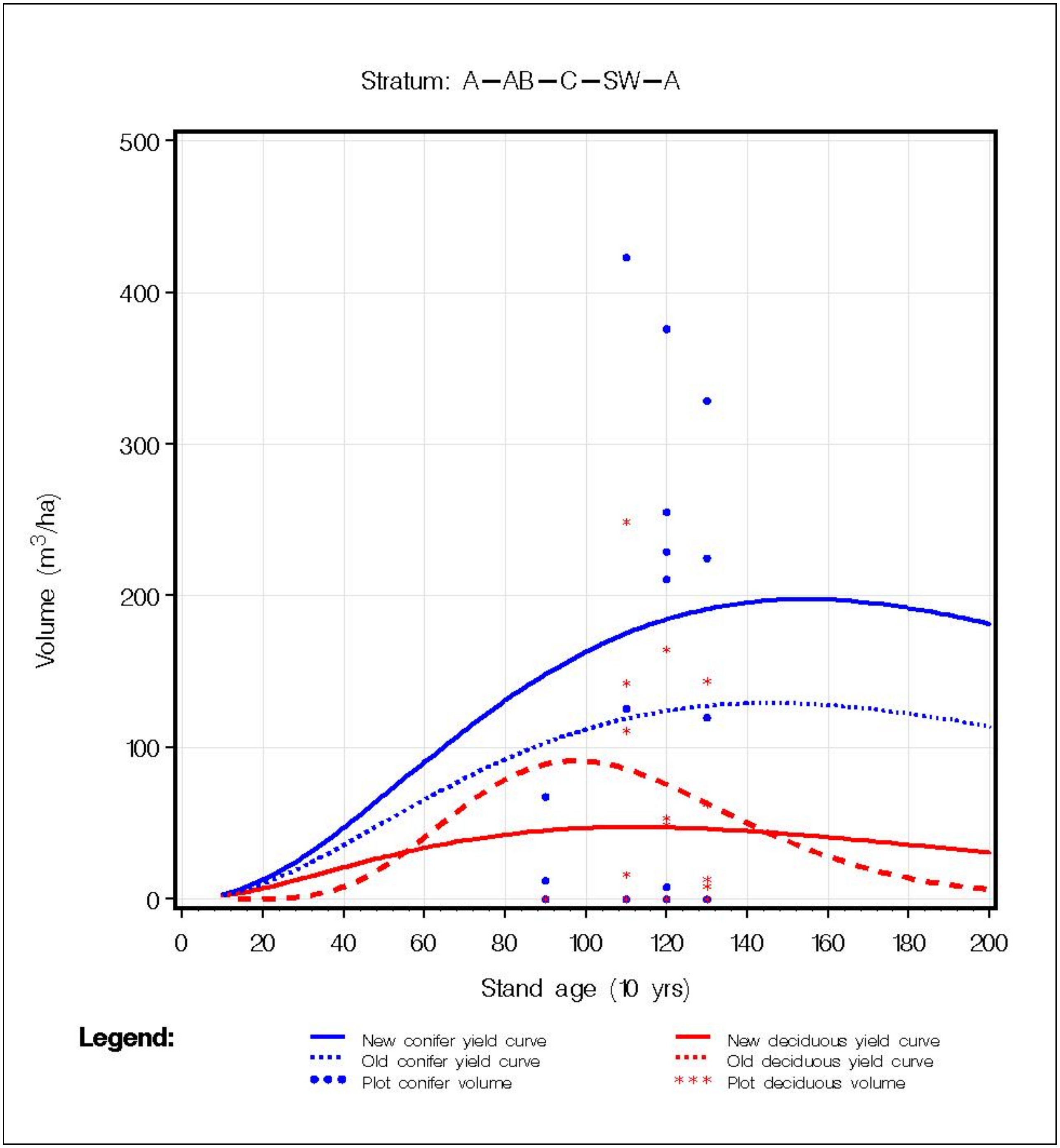


Figure 8. Low-density white spruce curve.

Note: The new curve represents a significant increase in the coniferous volume and the plot data support this. However, this is a high-risk curve as it has the potential of substantially increasing the coniferous AAC as this stratum contains 30% of the coniferous landbase. Since the method used to arrive at this new curve is less than ideal, use of the original curve is recommended.

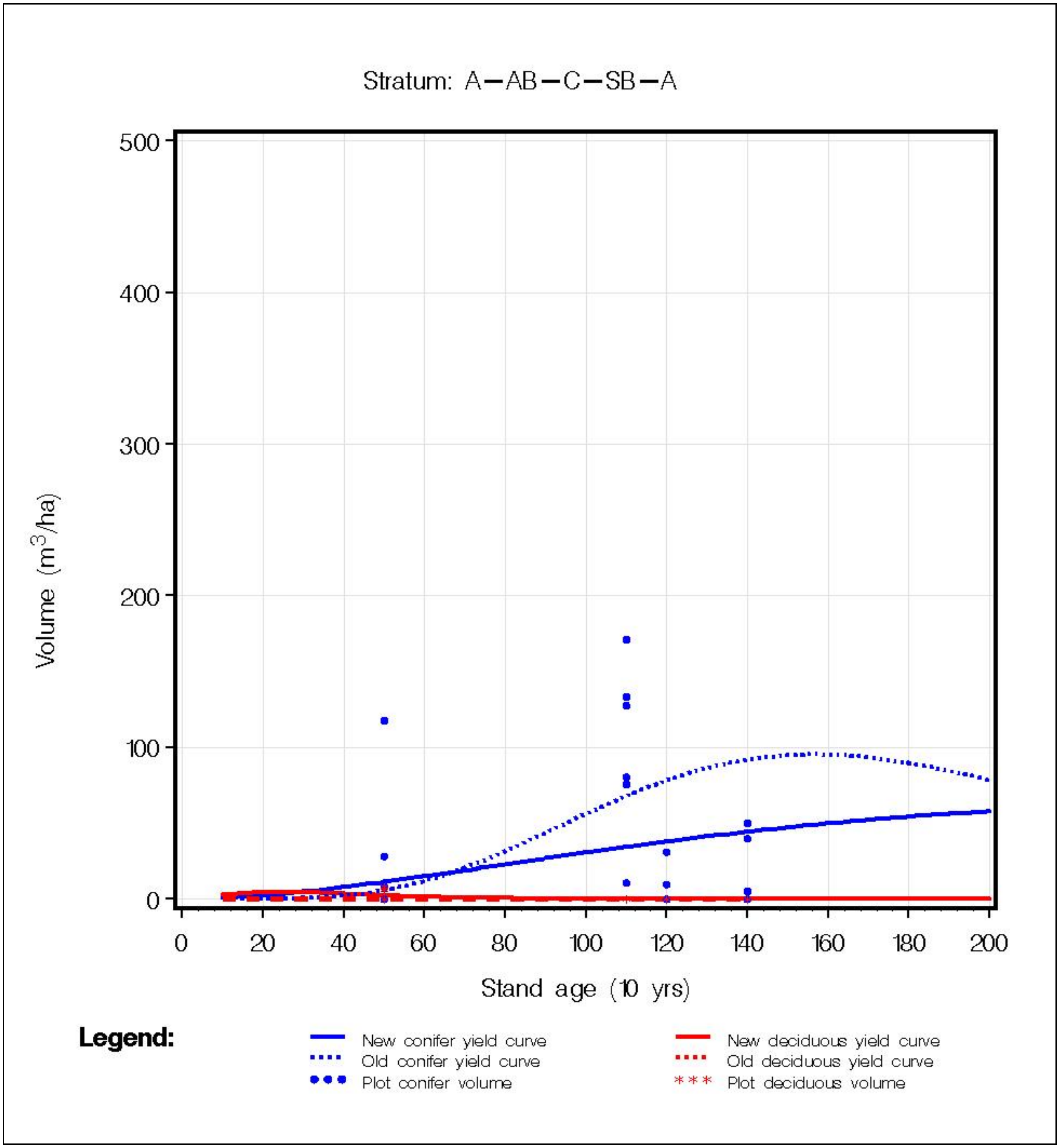


Figure 9. Low density black spruce curve.

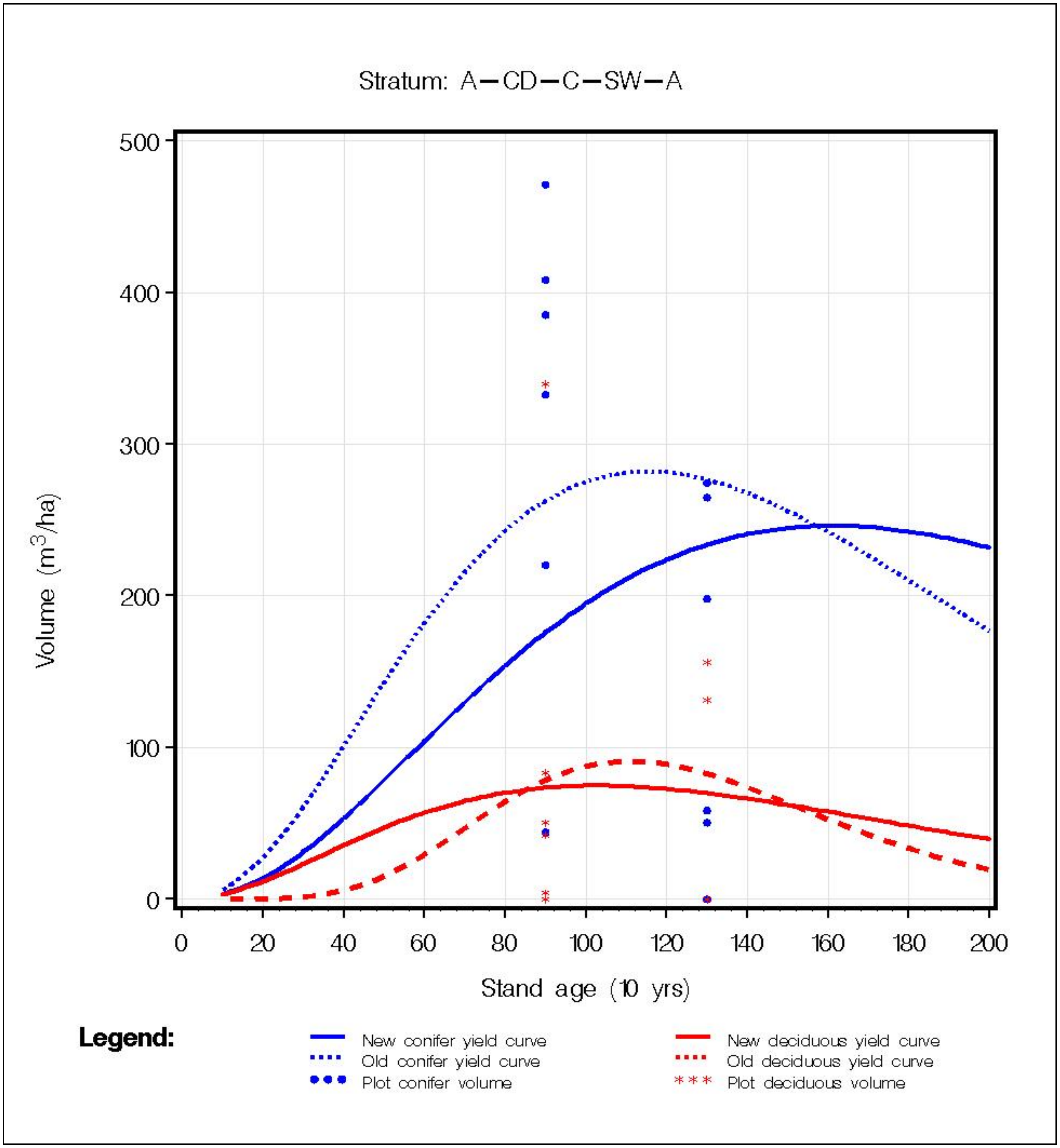


Figure 10. High density white spruce curve.

Note: The new curve is lower than the older one. However, the overall impact to the coniferous AAC may be insignificant. The data appears to support use of the new yield curves.

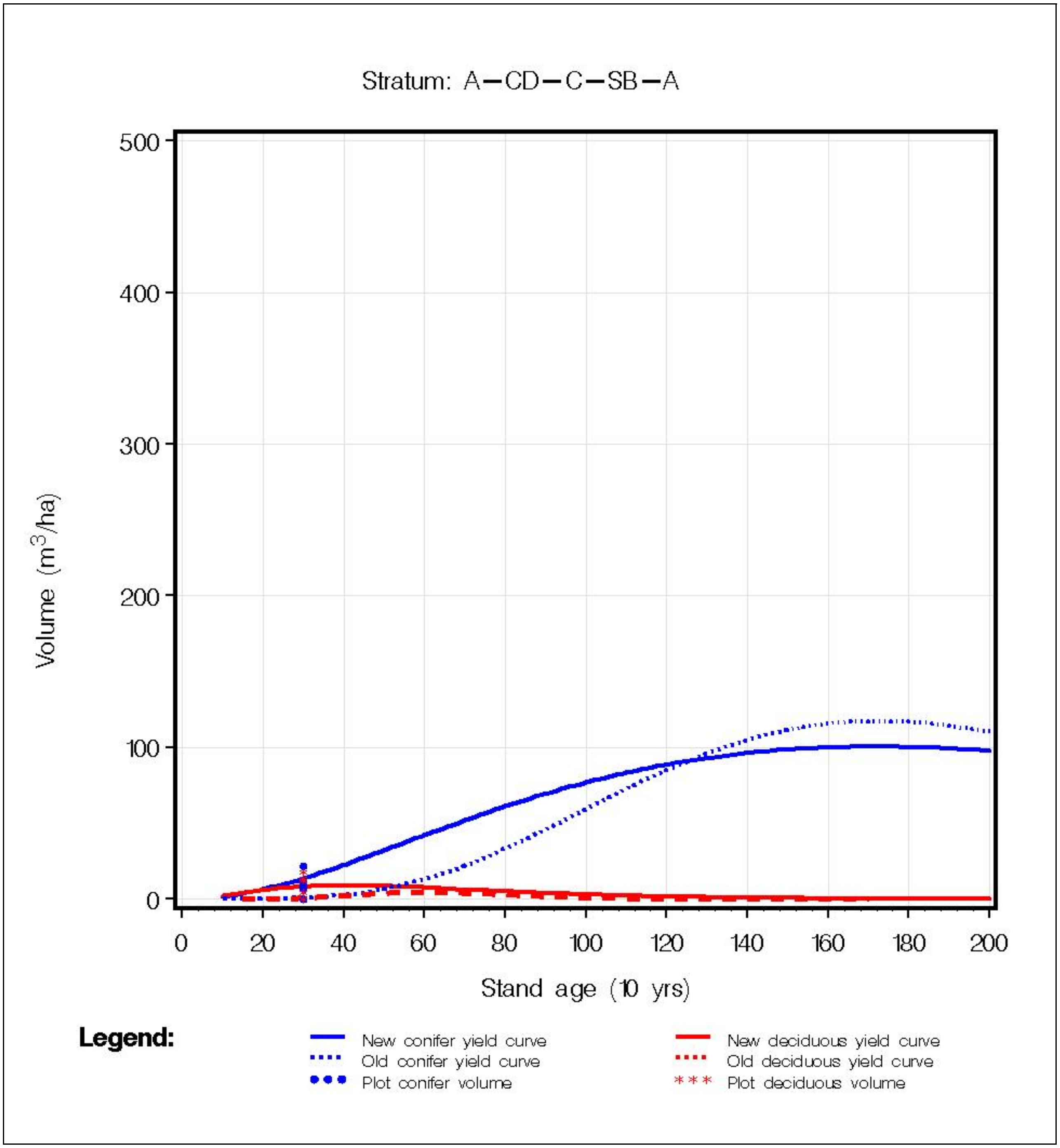


Figure 11. High density black spruce curve.

Note: Basically, the new curves are the same as the old curves

Table 5. Individual yield strata presented in report.

Yield Stratum Label	Yield Stratum Description
MX-AB-D-A-G	Central mixedwoods (MX), low density (AB), pure deciduous (D), all leading coniferous species (A), good sites (G).
MX-AB-D-A-MF	Central mixedwoods (MX), low density (AB), pure deciduous (D), all leading coniferous species (A), medium/fair sites (MF).
MX-CD-D-A-G	Central mixedwoods (MX), high density (CD), pure deciduous (D), all leading coniferous species (A), good sites (G).
MX-CD-D-A-MF	Central mixedwoods (MX), high density (CD), pure deciduous (D), all leading coniferous species (A), medium/fair sites (MF).
A-CD-DC-A-A	All natural regions (A), high density (CD), deciduous-dominated mixedwood (DC), all leading coniferous species (A) and all sites (A).
A-AB-CD-A-A	All natural regions (A), low density (AB), coniferous-dominated mixedwood (CD), all leading coniferous species (A) and all sites (A).
A-CD-CD-A-A	All natural regions (A), high density (CD), coniferous-dominated mixedwood (CD), all leading coniferous species (A) and all sites (A).
A-AB-C-SW-A	All natural regions (A), low density (AB), pure coniferous (C), white spruce leading (SW), all sites (A).
A-AB-C-SB-A	All natural regions (A), low density (AB), pure coniferous (C), black spruce leading (SB), all sites (A).
A-CD-C-SW-A	All natural regions (A), low density (CD), pure coniferous (C), white spruce leading (SW), all sites (A).
A-CD-C-SB-A	All natural regions (A), high density (CD), pure coniferous (C), black spruce leading (SB), all sites (A).

Note: The stand attributes that define each yield stratum are presented from left to right in the following order; natural regions, stand density, broad cover group, leading coniferous species and site productivity.