Deciduous Inventory Review

For the

Kispiox Forest District

of Northwestern British Columbia

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I) INTRODUCTION

Deciduous species such as paper birch, black cottonwood and trembling aspen are commonly found within the Interior Cedar Hemlock subzone located within the Kispiox and Cranberry TSA's. The ICHmc1, ICHmc1a, and ICHmc2 offer some of the best growing sites for deciduous species found within these TSA's. Silviculture foresters have been challenged to control deciduous species on the richer site series where conifer management has historically been the preferred option.

Increasing demand for deciduous wood products and recognition of their unique ecological characteristics has prompted the rethinking of deciduous management. Management strategies are currently being developed which will, on ecologically suitable sites, provide for the continued development and growth of these hardwood species. "The Management of Paper Birch and Trembling Aspen within the Nass and Kispiox TSA's of Northwestern British Columbia" outline important factors necessary to successfully manage these species. The above management papers outline the silvics of each species, site series selection, best management practices, and proposed stocking standards within the Nass and Kispiox TSA's. Management papers are found in Appendix B and C.

Over the last few years North American and world markets are beginning to develop for deciduous wood products. To meet these market demands, local and outside interests are being expressed as to the availability, quantity and quality of the deciduous resources from Northwestern British Columbian forests. To provide answers to these questions and set future direction on the potential of the deciduous resource in the Kispiox and Cranberry TSA's, a forest inventory assessment was needed.

The forest inventory assessment will focus on deciduous leading polygons with a greater than 50 % component of paper birch, black cottonwood, and trembling aspen. Potential available volumes would then be determined on an existing area basis under a management scenario and for the unmanaged existing volumes.

Wood quality values for the deciduous species in the Kispiox and Cranberry TSA's is unclear at this time. Wood quality generally deteriorates in unmanaged deciduous stands once trees reach 50 years or greater. Deciduous age classes (Figure 7) within the TSA's will be utilized to help provide an estimate of wood quality in the absence of cruise information.

The forest inventory assessment will also help to determine the quality and quantity of the various deciduous species so that eventually a sustainable volume of deciduous could be available to meet current and future market demands. The assessment will also aid in determining shortfalls in the inventory data set and provide recommendations to fill these data gaps.

II) METHODOLOGY

The forest inventory data set used in the most recent Timber Supply Review (TSR) for the ICHmc1, ICHmc1a, and ICHmc2 subzones was utilized to determine area, volumes, site productivity and age class estimates for deciduous leading (> 50 – 100%) species within the Kispiox and Cranberry TSA's. The deciduous species of interest included paper birch, black cottonwood and trembling aspen.

Graphs outlining area, volume, site classes (G, M, P, L, and O) and age class distribution for stands comprised of greater than 50% deciduous were produced (Figure 1). The TSR process assigns inventory volumes to each polygon based on leading species. Where minor deciduous species are present, their volume is added to the leading species' volume overestimating it. To provide a somewhat better estimate of the deciduous volumes a separate analysis was carried out. This involved removing volumes which weren't directly associated to the leading species and applying that volume to the appropriate deciduous species. Graphs were then produced for the volumes, site classes (G, M, P, L and O) and age class distribution for all deciduous species. Volume analysis was carried out for deciduous species and not by leading deciduous species.

Tables show data in raw form for each of the individual TSA's.

The volume potentially available was determined by species for the managed stands on an area basis.

Deciduous trees generally are much more susceptible to decay than conifers and typically begin to decay at a much younger age. Generally deciduous species reach full maturity between 50 - 80 years of age. Once age classes go beyond this the pulp content significantly increases.

Wood quality was then estimated by establishing a number of assumptions for individual deciduous species based on age classes. Most of the deciduous volumes found within the TSA's lie in the upper age classes, therefore they can be expected to contain a significant component of pulp .

III) RESULTS

a) AREA

i) Potential available volume increases and hypothetical AAC based on existing area of deciduous leading "Management Scenario".

Assumptions:

- G - M site classes only, remove P, L, & unclassified O site classes from the area.
- G - M site classes with a SI 25 or greater for deciduous management.
- Paper birch, black cottonwood, trembling aspen compared equally to TASS runs for red alder (SI 25 and SI 30).

- Rotation lengths based on 25-cm log with minimum volumes of 350 cubic metres/hectare.
- Thinning (PCT) at age 10 years to 800 well spaced stems per hectare.

Figure 1. Area by leading species (50-100% deciduous)

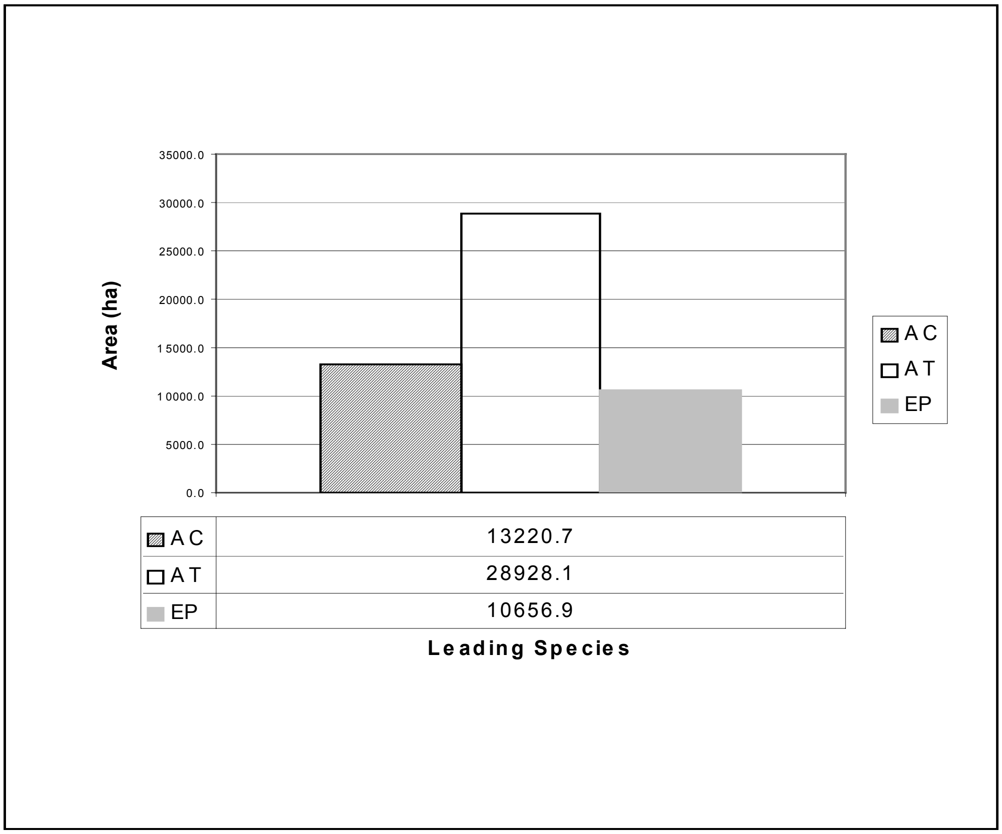
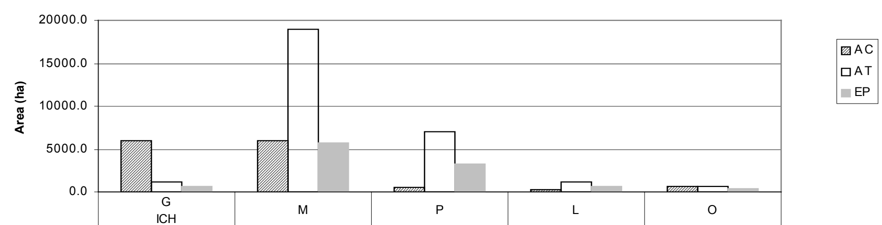


Table 1: Area by leading species by TSA (50-100% deciduous)

TSA	Leading Species			
	Ac	**At**	**Ep**	**Total**
Cranberry	7,954.7	1,681.7	580.7	10,217.1
Kispiox	5,265.9	27,246.4	10,076.2	42,588.6
Total:	**13,220.7**	**28,928.1**	**10,656.9**	**52,805.7**

The existing forest inventory utilized aerial photographs, aerial reconnaissance and ground checks to classify the forest. The inventory divided the forest into like polygons based on species, age, height, site productivity and stocking class. At the time the inventory was conducted the focus was on coniferous species. Consequently, significantly less attention was paid to deciduous leading polygons. During this study we have observed some questionable typing of deciduous leading polygons. Because of these concerns a pilot project was undertaken on one mapsheet to determine the extent of the problem and the potential costs to correct them (Appendix A). During the pilot project for example, it was observed that several polygons had been mislabeled. They were labeled NCBr, when in fact they were deciduous leading. The re-typing of the deciduous polygons for this one mapsheet showed a 25% increase in deciduous area. An ancillary benefit of this would result in a potential increase to the Timber Harvesting Land Base (THLB) for the TSA's.

Figure 2: Area by leading species by site class (50 – 100% deciduous)



	G ICH	M	P	L	O
AC	5949.0	5920.4	493.4	249.2	608.7
AT	1155.9	18924.7	7046.1	1201.5	599.8
EP	620.2	5722.8	3272.4	647.0	394.6

SI

Table 2: Area by leading species by site class (50-100% deciduous)

TSA	Site Class	Leading Species			Total
		Ac	At	Ep	
Cranberry	G	4400.0	149.0		4549.0
	M	3046.2	1320.2	550.4	4916.8
	P		89.2	29.0	118.1
	L	94.1	13.2		107.3
	O	414.4	110.2	1.4	526.0
	Cranberry Total	7954.7	1681.7	580.7	10217.1
Kispiox	G	1549.0	1006.9	620.2	3176.1
	M	2874.2	17604.6	5172.4	25651.1
	P	493.4	6957.0	3243.5	10693.8
	L	155.1	1188.3	647.0	1990.4
	O	194.2	489.7	393.2	1077.1
	Kispiox Total	5265.9	27246.4	10076.2	42588.6
	Grand Total	13220.7	28928.1	10656.9	52805.7

Black Cottonwood

13,221 ha[1] (Figure 1) – 1,351 ha (P, L, & O sites as per Figure 2) = **11,870 ha**

11,870 ha @ 350 m^3/ha = **4,145,500 m^3**

SI 25 = 4,154,500 m^3 @ 50 year rotation = Potential hypothetical AAC of **83, 090 m^3 /yr.**

SI 30 = 4,154,500 m^3 @ 35 year rotation = Potential hypothetical AAC of **118,700 m^3 /yr.**

Trembling Aspen

28,928 ha[1] (Figure 1) – 8,848 ha (P, L, & O sites as per Figure 2) = **20,080 ha**

20,080 ha @ 350 m^3/ha = **7,028,000 m^3**

SI 25 = 7,028,000 m^3 @ 50 year rotation = Potential hypothetical AAC of **140,560 m^3 /yr.**

SI 30 = 7,028,000 m^3 @ 35 year rotation = Potential hypothetical AAC of **200,800 m^3 /yr.**

Paper Birch

10,657 ha[1] (Figure 1) – 4,314 ha (P, L, & O site classes as per Figure 2) = **6,343 ha**

6,343 ha @ 350 m^3/ha = **2,220,050 m^3**

[1] operable landbase as defined by the Cranberry and Kispiox approved TSRs

SI 25 = 2,220,050 m^3 @ 50 year rotation = Potential hypothetical AAC of **44,401 m^3 /yr.**
SI 30 = 2,220,050 m^3 @ 35 year rotation = Potential hypothetical AAC of **63,430 m^3 /yr.**

Where areas which are currently deciduous leading are managed for deciduous, potentially available volumes and hypothetical AAC estimates for SI 25 and SI 30 are as follows:

Table 3: Potential volume increase and hypothetical AAC existing area – "Management Scenario"{SI 25(M) and 30(G)}

				AAC	
Ac (total m^3)	**At (total m^3)**	**Ep (total m^3)**	**All Species (total m^3)**	**Rotation Age 50 SI 25 (m3/yr)**	**Rotation Age 35 SI 30 (m3/yr)**
4,154,500	**7,028,000**	**2,220,050**	**13,402,550**	**268,051**	**382,930**

By moving from a SI 25 to a SI 30 our rotation lengths are reduced by approximately 40% with volume increases of approx. 40%. This demonstrates how important it is to have accurate SI's. A one metre difference in SI can have large impacts on yields over a rotation.

Figure 3: Area by leading species by Age Class (50 – 100%)

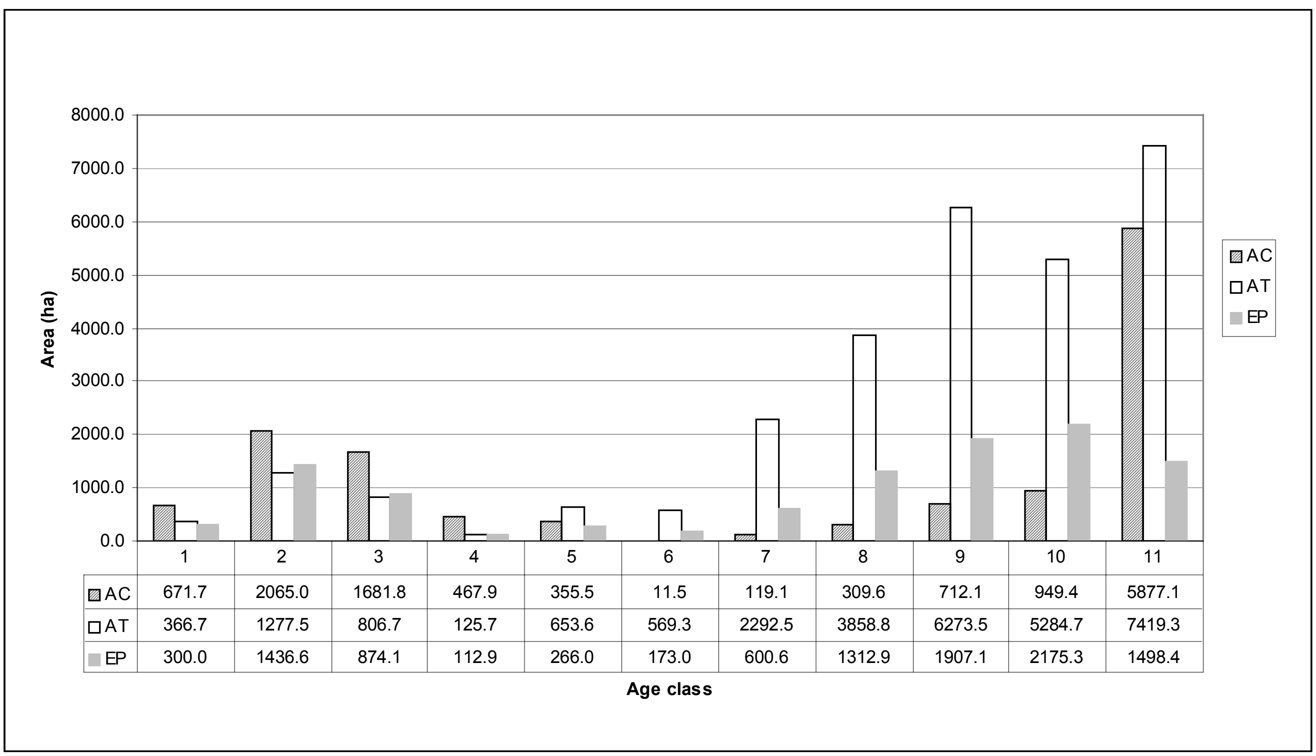


Table 4: Area of leading species by age class (50 – 100% deciduous)

TSA	Age Class	Leading Species			Total
		Ac	At	Ep	
Cranberry	1	540.1	76.6	3.6	620.4
	2	1,481.2	180.0	156.9	1818.1
	3	1,118.7	164.7	12.3	1,295.6
	4	232.2	10.2	3.0	245.4
	5	312.5	57.6		370.1
	6				
	7	4.0			4.0
	8	12.4			12.4
	9	101.9	114.2	28.3	244.4
	10	120.8			120.8
	11	4,031.1	1,078.4	376.5	5,486.0
Cranberry Totals:		**7,954.7**	**1,681.7**	**580.7**	**10,217.1**
Kispiox	1	131.6	290.1	296.4	718.1
	2	583.7	1,097.5	1,279.7	2,960.9
	3	563.1	642.1	861.8	2,067.0
	4	235.7	115.5	109.9	461.1
	5	43.1	595.9	266.0	905.0
	6	11.5	569.3	173.0	753.8
	7	115.1	2,292.5	600.6	3,008.1
	8	297.3	3,858.8	1,312.9	5,468.9
	9	610.2	6,159.3	1,878.8	8,648.3
	10	828.6	5,284.7	2,175.3	8,288.7
	11	1,846.1	6,340.9	1,121.8	9,308.8
Kispiox Totals:		**5,265.9**	**27,246.4**	**10,076.2**	**42,588.6**
Grand Totals:		**13,220.7**	**28,928.1**	**10,656.9**	**52,805.7**

Stands less than 20 years of age have the potential for pre-commercial thinning (PCT) where SI (50) are greater than 25 metres. Stand management treatments should be focused primarily on birch leading stands where end product objectives are for high valued sawlogs. Figure 3 has identified approximately 1,700 hectares of birch leading area 20 years of age or younger.

ISIS reports and an office review of opening files and records in the younger age classes (< 40 years) may also fill site productivity and growth and yield data gaps. Recent silviculture surveys give more accurate site-specific information than that provided by the forest inventory.

b) VOLUME

i) Potential hypothetical AAC based on existing deciduous volumes (site classes Good – Medium)

Assumptions:

- Remove P, L, and O site class volumes (Table 6).
- Rotation length of 50 years.

Figure 5: Volume of deciduous species (50 – 100% deciduous) within the Kispiox and Cranberry TSA's

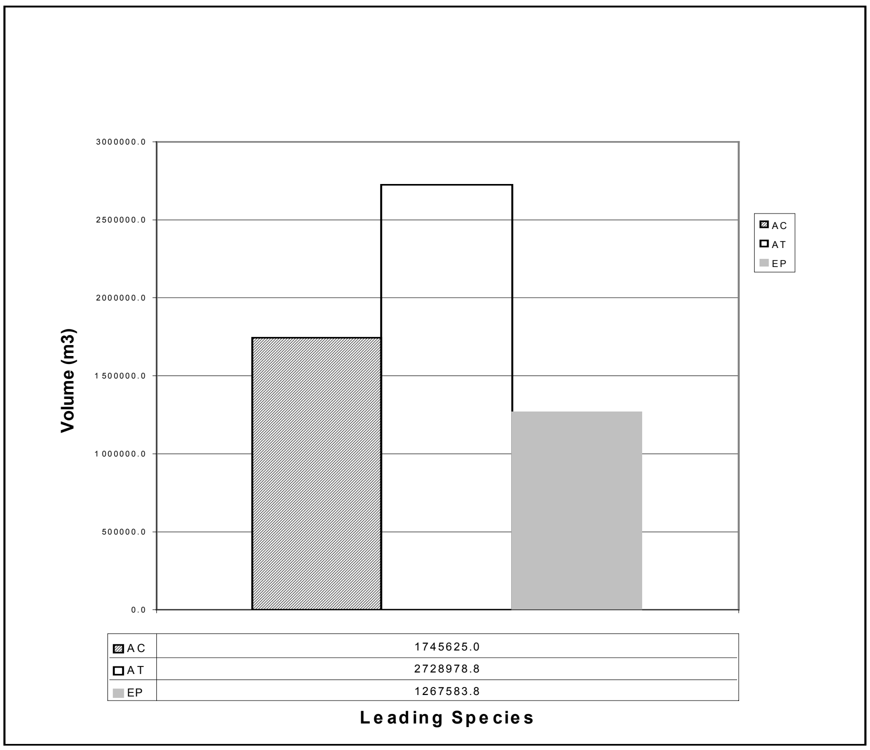


Table 5: Volume of deciduous species by TSA (50 – 100% deciduous)

TSA	Leading Species			Total (m3)
	Ac (m3)	At (m3)	Ep (m3)	
Cranberry	1,188,280.4	282,159.7	146,064.3	1,616,504.3
Kispiox	557,344.7	2,446,819.1	1,121,519.5	4,125,683.3
Total:	1,745,625.1	2,728,978.8	1,267,583.8	5,742,187.6

Figure 6: Volume of deciduous species by site class (50 – 100%) Kispiox/Cranberry TSA's

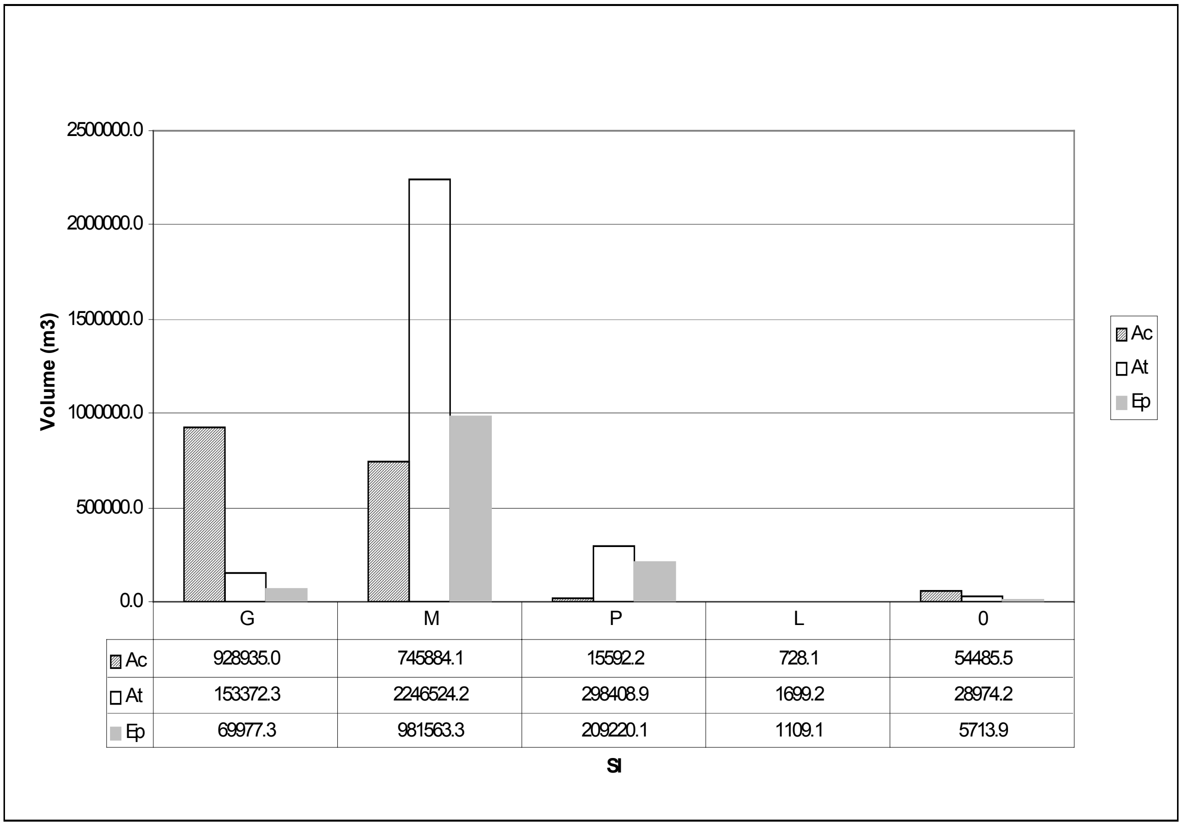


Table 6: Volume of deciduous species by site class by TSA (50 – 100% deciduous)

TSA	SI	Leading Species			Total
		Ac	At	Ep	
Cranberry	**G**	756087.7	47740.0	31994.5	835822.1
	M	387091.7	210908.3	105129.9	703129.9
	P	509.2	5176.3	4631.3	10316.8
	L	16.4	146.5	146.5	309.4
	O	44575.4	18188.5	4162.1	66926.0
Cranberry Total		1188280.4	282159.7	146064.3	1616504.3
Kispiox	**G**	172847.3	105632.3	37982.9	316462.5
	M	358792.4	2035615.8	876433.5	3270841.7
	P	15083.0	293232.6	204588.8	512904.4
	L	711.7	1552.7	962.6	3227.1
	O	9910.1	10785.7	1551.8	22247.6
Kispiox Total		557344.7	2446819.1	1121519.5	4125683.3
Grand Total		**1745625.0**	**2728978.8**	**1267583.8**	**5742187.6**

Black Cottonwood

1,745,625 m^3 (Table 5) – 70,806 m^3 (P, L, & O site classes Table 6) = **1,674,819 m^3**

1,674,819 m^3 @ 50 year rotation = Hypothetical AAC = **33,496 m^3/yr**

Trembling Aspen

2,728,979 m^3 (Table 5) – 329,082 m^3 (P, L, & O site classes Table 6) = **2,399,897 m^3**

2,399897 m^3 @ 50 year rotation = Hypothetical existing AAC = **47,998 m^3/yr**

Paper Birch

1,267,583 m^3 (Table 5) – 216,043 m^3 (P, L, & O site classes Table 6) = **1,051,540 m^3**

1,051,540 m^3 @ 50 year rotation = Hypothetical existing AAC = **21,031 m^3/yr**

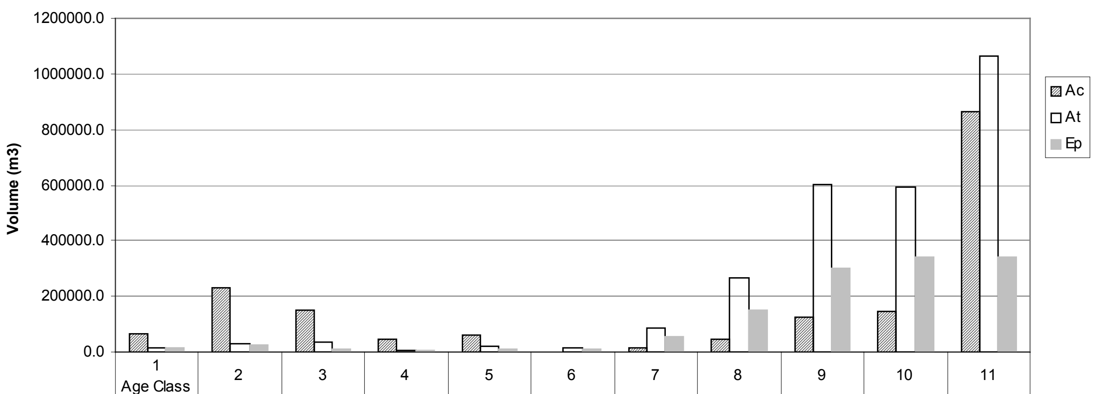
Unclassified site classes (O) have been removed from the hypothetical AAC. This volume could contribute to hypothetical existing AAC where this site class is reviewed and identified M – G.

Table 7: Potential hypothetical AAC summary table based on existing deciduous volumes, site classes Good-Medium @ 50 year rotation

Ac (m^3/yr)	At (m^3/yr)	Ep (m^3/yr)	All Species (total m^3/yr)
33,496	47,998	21,031	102,525

c) WOOD QUALITY

Figure 7: Volume of deciduous species by age class (50 – 100% deciduous)



Age Class	1	2	3	4	5	6	7	8	9	10	11
Ac	67520.1	228610.8	152036.5	43230.1	58704.3	1025.1	15382.3	42896.9	126562.2	147051.8	862604.8
At	15667.2	29142.0	37495.9	3994.1	20489.0	13917.0	84670.6	267076.6	601242.7	593102.6	1062181.2
Ep	15696.7	25020.7	9657.0	3417.5	9457.1	9237.5	57462.9	151741.6	302622.1	341207.0	342063.7

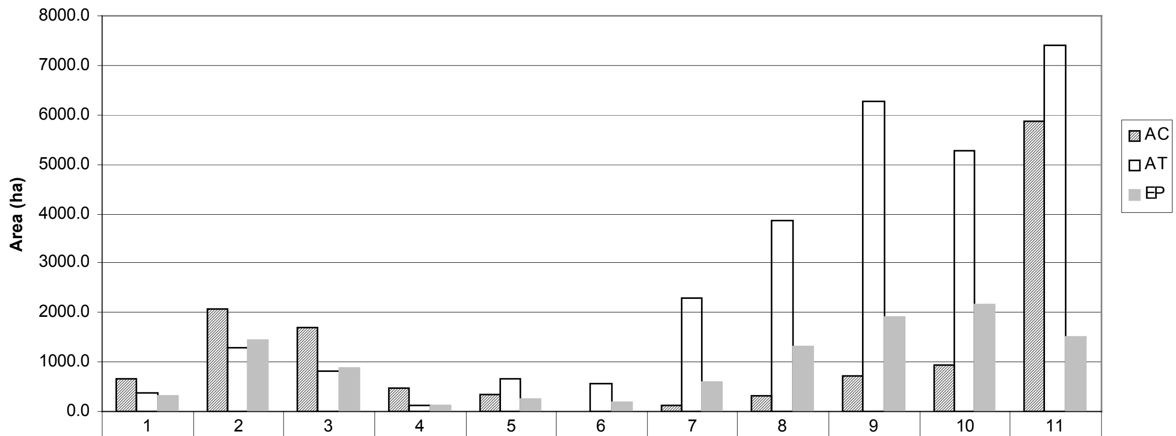
Age Class

Kispiox/Cranberry TSA's

Table 8: Volume of deciduous species by age class for TSA's

Age Class	Species	TSA Cranberry	TSA Kispiox	TSA Total	Total Volume by Age Class
1	**Ac**	67520.1	0.0	67520.1	
	At	15667.2	0.0	15667.2	
	Ep	15696.7	0.0	15696.7	98884.0
2	**Ac**	228610.8	0.0	228610.8	
	At	29142.0	0.0	29142.0	
	Ep	25020.7	0.0	25020.7	282773.5
3	**Ac**	151919.5	116.9	152036.5	
	At	37051.2	444.7	37495.9	
	Ep	7748.8	1908.2	9657.0	199189.4
4	**Ac**	40883.5	2346.6	43230.1	
	At	959.1	3034.9	3994.1	
	Ep	707.7	2709.7	3417.5	50641.7
5	**Ac**	54091.5	4612.8	58704.3	
	At	8935.4	11553.5	20489.0	
	Ep	1893.6	7563.5	9457.1	88650.4
6	**Ac**		1025.1	1025.1	
	At		13917.0	13917.0	
	Ep		9237.5	9237.5	24179.6
7	**Ac**	418.3	14964.1	15382.3	
	At	76.6	84594.0	84670.6	
	Ep	222.3	57240.6	57462.9	157515.9
8	**Ac**	2498.3	40398.6	42896.9	
	At	135.3	266941.3	267076.6	
	Ep	32.2	151709.5	151741.6	461715.1
9	**Ac**	15330.5	111231.7	126562.2	
	At	13818.5	587424.2	601242.7	
	Ep	10779.2	291842.9	302622.1	1030427.0
10	**Ac**	18286.2	128765.6	147051.8	
	At	535.1	592567.5	593102.6	
	Ep	95.3	341111.7	341207.0	1081361.4
11	**Ac**	608721.5	253883.3	862604.8	
	At	175839.1	886342.1	1062181.2	
	Ep	83867.7	258196.0	342063.7	2266849.8
Grand Totals:		**1616504.3**	**4125683.3**	**5742187.6**	

Figure 8: Area by leading species by age class (50 – 100% deciduous)



	1	2	3	4	5	6	7	8	9	10	11
AC	671.7	2065.0	1681.8	467.9	355.5	11.5	119.1	309.6	712.1	949.4	5877.1
AT	366.7	1277.5	806.7	125.7	653.6	569.3	2292.5	3858.8	6273.5	5284.7	7419.3
EP	300.0	1436.6	874.1	112.9	266.0	173.0	600.6	1312.9	1907.1	2175.3	1498.4

Age class

Table 9: Volume by leading species by age class by TSA (50 – 100% deciduous)

		Lead Species			
TSA	**SI**	**Ac**	**At**	**Ep**	**Total**
Cranberry	1	85,281.7	13,602.3	0.0	98,884.0
	2	237,594.9	22,950.2	22,228.4	282,773.5
	3	165,507.6	29,407.7	1,804.3	196,719.6
	4	42,111.8	72.0	366.6	42,550.4
	5	52,008.0	12,912.6		64,920.6
	6				
	7	717.2			717.2
	8	2,665.8			2,665.8
	9	15,658.5	19,918.8	4,351.0	39,928.3
	10	18,916.6			18,916.6
	11	639,411.0	174921.1	54,096.3	868,428.4
Cranberry Totals		1,259,873.1	273784.7	82,846.5	1,616,504.3
Kispiox	1	0.0	0.0	0.0	0.0
	2	0.0	0.0	0.0	0.0
	3	133.7	376.8	1,959.2	2,469.8
	4	1,923.0	2,721.1	3,447.2	8,091.3
	5	3,526.2	13,778.7	6,424.9	23,729.8
	6	815.7	14,136.5	9,227.4	24,179.6
	7	12,143.3	103,258.4	41,397.0	156,798.6
	8	30,223.0	322,657.5	106,168.9	459,049.3
	9	76,079.5	711,037.1	203,382.2	990,498.8
	10	100,914.9	719,861.4	241,668.5	1,062,444.8
	11	257,535.5	987,181.1	153,704.7	1,398,421.4
Kispiox Totals		483,294.7	2,875,008.5	767,380.1	4,125,683.3
Grand Totals		**1,743,167.8**	**3,148,793.2**	**850,226.6**	**5,742,187.6**

Figure 7 illustrates that a high proportion of the volumes are in the upper age classes. For all deciduous species poor wood quality is typically associated with age classes 50 years and higher.

To determine a general estimate of wood quality based on pulp and/or sawlog volumes the following assumptions have been made:

- Age classes 81 years +
  - Ac 80% total volume pulp
  - At 100% total volume pulp
  - Ep 80% total volume pulp
- Age classes 51 – 80 years
  - Ac 50% volume pulp
  - At 50% volume pulp
  - Ep 50% volume pulp

- Age classes 1 – 50 years Ac 20% volume pulp
  At 20% volume pulp
  Ep 20% volume pulp

Table 10: Summary of pulp and sawlog volume estimates by deciduous species based on existing volumes for all site classes.

Ac (m^3)			At (m^3)			Ep (m^3)		
Total	**Pulp (60%)**	**Sawlogs (40%)**	**Total**	**Pulp (90%)**	**Sawlogs (10%)**	**Total**	**Pulp (72%)**	**Sawlogs (28%)**
1,745,625	1,048,647	696,978	2,7278,980	2,460,718	268,262	1,267,583	910,585	356,998

Upper age classes 81 years plus make up approximately 65% of the Ac volume, 82% of the At volume, and 78% of the Ep volume. The majority of this volume is pulp quality with a minor component of sawlogs.

Younger stands 35 – 80 years include a higher percentage of sawlogs which may be harvested earlier to offset the high pulp component.

IV) <u>Recommendations</u>

1) Original forest inventory classification was focused primarily on coniferous species. Mapsheets within the Kispiox and Cranberry TSA's will need an updated reclassification of the deciduous component.

   A trial mapsheet (103P.068 Cranberry TSA) was reclassified so direct comparisons of polygon size and species composition, could be made to the existing inventory data set (Appendix A). It was found that deciduous leading polygons overall were 25% larger than originally recognized. NCBr complexes which do not contribute to the THLB were also found to be misclassified resulting in an under estimation of deciduous volumes.

2) Site series most conducive to deciduous management need more accurate site productivity estimates. SIBEC estimates for deciduous species is required.

   Destructive sampling within a random number of deciduous polygons for each deciduous species would assist in providing site series productivity and the development of deciduous species of growth curves.

3) The deciduous component available for harvest has to be more accurately identified. Net downs derived from higher level plans, access constraints, for biodiversity purposes, etc. need to be rectified.

4) An ISIS report of all existing deciduous age classes is necessary. Primary focus should be in the younger age classes (< 20 years) which afford stand treatment opportunities.

Opening files could then be used to assist in determining species composition, site productivity estimates, and pest considerations.

Openings with Dothistroma should be assessed to determine the potential of hardwood management. This should be done before investments to improve conifer stocking levels are considered.

5) The site indexes within Good, Medium, Poor, Low and the Unclassified (O) site classes need to be updated. Site indexes within the various site classes are too broad. For example, it was found that within the good site class that the range in site indexes was from 2.2 to 39.8.

This certainly brings into question the accuracy of the area within the various site classes. Primary concerns are in the good and medium site classes where deciduous management is to be focused.

The Unclassified (O) site class needs to be categorized. Predictive ecosystem mapping would may be a valuable tool where ISIS records are not available.

6) Better estimates of wood quality primarily in age classes 81+ and above is needed. Actual cruise information with inclusion of destructive sampling within a broad range of polygons is necessary.

7) A management paper is required for black cottonwood as was done for paper birch (Appendix B) and trembling aspen (Appendix C).

V) <u>Conclusions</u>

To determine the viability of deciduous management in the Kispiox and Cranberry TSA’s, volume and area estimates of the resource were needed. This was obtained using existing forest inventory information for deciduous (Ac, At, Ep) leading polygons (50–100% deciduous).

Deciduous management in the future will be focused on the established deciduous leading (50-100%) areas. Site classes must be in the Medium-Good categories with SI’s 25 or greater. Questions about the area within the Medium-Good site classes exists, and more research is required to better define the operable land base.

Potential volume increases and hypothetical AAC’s were determined for the existing deciduous leading area and the existing deciduous volumes. The hypothetical AAC for the existing deciduous leading area was determined from a management scenario using a series of assumptions which were then modeled using TASS to produce yield tables.

Hypothetical AAC's over a 50 year rotation were then also determined for the existing deciduous volume on only the Medium-Good site classes over a 50 year rotation.

The hypothetical AAC determinations based on the existing deciduous volumes when compared to the potential of managed stands on an area basis is quite distinct. Hypothetical AAC's based on existing deciduous volumes for all species (Table 7) on a 50 year rotation is 102,525 m3/yr. Under the management scenario using the current existing deciduous leading area the hypothetical AAC's are considerably higher. For example, TASS runs for red alder on SI 25 @ 50 year rotations show hypothetical AAC's of 268,051 m^3/yr (Table 3) for all deciduous species, while for the SI 30 sites hypothetical AAC's increase by 40% to 382,930 m^3/yr. Rotation lengths within the SI 30 sites are reduced to 35 years or 40% lower than on the SI 25 sites.

Wood quality information is not available for the deciduous species within the Kispiox/Cranberry TSA's. To get some estimates of pulp and sawlog volumes age class distributions were used. Deciduous species within unmanaged stands start to decay early in the life cycle, therefore it has been assumed that the upper age classes (81+) are generally of poorer quality. All deciduous species have the vast majority of their volumes in these upper age classes (Table 10). For example, ninety percent of the trembling aspen volume, or 2,460,718 m^3, is estimated to be of pulp quality.

Deciduous management has limited potential within the Kispiox and Cranberry TSA's if the existing deciduous volumes are managed on a 50 year rotation. The poor wood quality limit economic ventures. However using the "Management Scenario" SI 25 sites yield potential annual volumes of 268,051 m^3, while SI 30 sites yield much higher potential annual volumes of 382,830 m^3. The "Management Scenario", using SI 25 sites, is deemed a conservative approach when forecasting potential future volumes. There are large areas of higher SI sites within the Kispiox and Cranberry TSA's, however more work is required to determine actual area breakdown by SI.

Following an adopted intensive management regime for the paper birch, trembling aspen, and black cottonwood (with primary emphasis on paper birch), substantial increases in yield and improvement in wood quality can be expected. This is especially true on the higher site index sites which have the potential to reduce rotation lengths while providing high valued end products in a shorter period of time than coniferous species.

APPENDIX A: Pilot Project – Delineation of Deciduous Polygons Within Mapsheet 103P068, Kispiox Forest District

Pilot Project: Delineation of Deciduous Polygons Mapsheet 103P.068,Kispiox Forest District

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Pilot Project

Delineation of Deciduous Polygons within 103P. 068

Kispiox Forest District

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1.) Introduction

As illustrated in the attached forest cover map 103P. 068 scale 1: 20 000, the area is located within Kispiox Forest District and was managed by Skeena Cellulose Incorporation. Geographically, the area is located along Highway 37 (East Site), and starting near Cranberry River Junction and Highway 37. There is evidence of a number of deciduous polygons, which are located predominantly on the southern portion of the map. The last inventory was done over thirty years ago, and the licensee is uncertain about the quality and accuracy of existing forest types. Especially, since the last inventory, there have been large changes in the deciduous component of the forest cover and the licensee intends to find out to what degree the existing data is inaccurate.

2.) Methods

The procedure for this analysis generally follows the standards for forest inventory. This general sequence of analysis was developed:

- •Review of the current forest cover map
- •Highlighting of polygons with deciduous species in the main canopy
- •Photo preparation
- •Delineation of new polygons
- •Creation of transparent overlays
- •Comparison of "new types" with forest cover map existing polygons

a) Review of the 103P.068 Forest Cover Map

The office review of the existing forest cover map was completed taking special consideration to deciduous species. Note that the majority of the deciduous polygons are located along Cranberry River within Riparian Management Areas, and also in between existing openings (cut blocks logged in the early 1990's). Some deciduous stands have originated after wildfire of which evidence is noticeable on east facing slopes.

b) Aerial Photography Preparation

Color aerial photography on average scale 1: 12 000 was used. All photographs were marked with direction and organized to flight lines.

c) Delineation of Deciduous Polygons

The delineation focus was identifying deciduous leading polygons with trees over 15 years old. A minimum size of 2.0 hectares was chosen for the polygons. Typing was done according to inventory standards (VRI Photo Interpretation Procedures March 1999), that is, all the polygons were closed and linked to double line features. However, in this project, standards were adopted only to delineate deciduous polygons and create a working overlay. The line was drawn with permanent ink. The final delineation will be completed during the attribute estimation process after field calibration is completed. No silviculture stratum was identified since silviculture files were not available at this time. Delineation was conducted to distinguish observable changes:

- •Age,
- •Species,
- •Height,
- •Crown closure,
- •Stand structure.

To maintain consistency and quality, delineated polygons will be reviewed after the field phase and revisited for quality control.

3.) Results

Area changes:

A metric area grid has been used to estimate the area of new deciduous polygons. Total new area of deciduous polygons is 991 hectares. Approximately 25% increase, 247 hectares in comparison to the forest cover map. The majorities of changes were delineated in proximity and within previously logged cut blocks. This significant difference is due to the fact that the existing inventory is old and delineation of polygons at the time was focused on conifer species.

a) NCBR

According to VRI standards Non Commercial Brush (NCBR) polygons no longer exist, since the new inventory is geared to classify all the vegetation.
Within 103P.068, 47 hectares were designated as NCBR. However, within this area are noted a significant component of deciduous trees including Red Alder (Dr), Trembling Aspen (At) and Birch (E). In many instances trees are small which makes it difficult to determinate correct species composition and site values.

b) Volume

The total area of deciduous species has increased by about 25%, 247 hectares. Assuming that average merchantable volume of deciduous stands within Kispiox Forest Products is approximately 150 m3 per hectare, the increase of volume within one map sheet 103P.068 is 37 050 m3. New delineation revealed that a total of 991 hectares accounts for deciduous stands, which translates to 148 650 m3 of merchantable volume.

c) Accessibility and Resource Management Areas

Resource Management Areas are predominantly located along Cranberry River. Here are located large homogeneous Cottonwood polygons. Some of the polygons have a scattered Spruce component. New delineation revealed many discrepancies in comparison to the existing forest cover map; more than 90% of polygons have different line work. Conservatively, 50% of polygons located in proximity to Cranberry River are accessible. Other deciduous polygons within map 103P.068 are easily accessible through existing network of forest roads.

4.) Conclusion

There are four main highlights in this analysis:

- The estimated volume is 148 650 m3, increase of 25% (37 162m3) in comparison to existing forest cover map (111 487m3)

- There is a minimum of 25% more deciduous polygons than appear on the forest cover map,
- Generally, line work of old inventory is incorrect in over 90% of instances, and does not reflect reality on the ground,
- Most deciduous polygons are easy accessible through existing roads.

Many of the deciduous polygons have a conifer component varying from 5 to 20%. It is especially along Cranberry River where scattered spruce is present within old cottonwood stands. Areas previously logged are now containing a number of aspen and birch young stands which were never previously mapped. Map review shows obvious differences between the old delineation and the new one.

5.) Recommendations

i) Performed delineation shows that the old forest cover map is incorrect and should be reclassified to incorporate deciduous species. The new Reserve Management Area along Cranberry River should be defined. Fieldwork prior to polygon estimations should incorporate old NCBR areas to verify existing vegetation. Fieldwork should confirm all stands and sites attributes. It is recommended to conduct field calibration phase to assist the photo interpreter in improving local knowledge. Calibration points establishment should be conducted as per Vegetation Ground Calibration (ground Call) Data Collection Procedures. Polygon for sampling should be chosen to reflect a wide array of deciduous polygons. There will be an emphasis on site productivity, forest types, accessibility, and wood quality**.**

ii) New data should be incorporated into the next Timber Supply Review.

APPENDIX B: MANAGEMENT OF PAPER BIRCH IN THE ICHMC1, ICHMC1A AND ICHMC2 SUBZONES OF NORTHWESTERN BRITISH COLUMBIA

Management of Paper Birch

In the

ICHmc1, ICHmc1a and ICHmc2 Subzones

of Northwestern British Columbia

Kim Haworth, R.P.F.
Silviculturist
Kingfisher Forest Sciences

Date: March 20, 2003

Management of Paper Birch (Betula papyrifera Marsh.)

In the

ICHmc1, ICHmc1a and ICHmc2 Subzones

of Northwestern British Columbia (Nass and Kispiox TSA's)

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Date: March 20, 2003

Summary

The depressed state of the forest industry in Northwestern B.C. has resulted in the need for professionals to review opportunities to improve the economic state of the industry. One option identified was to examine the economic feasibility of hardwood species.

This paper examines Paper Birch (*Betula papyrifera* Marsh.) in the ICHmc1, ICHmc1a and ICHmc2 subzones in the Nass TSA and Kispiox TSA. It reviews the silvics of the species, site series conducive to its development, stocking standards, potential end product objectives, and provides some best management practices.

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I) <u>INTRODUCTION</u>

Paper birch (*Betula papyrifera* Marsh.) is a fast growing, naturally occurring species found throughout all of British Columbia predominating east of the Coast Mountains. The focus of this study area is in the Interior Cedar Hemlock moist cold subzone Nass variant (ICHmc1), Amabilis Fir phase (ICHmc1a) and Hazelton variant (ICHmc2) contained within the Nass and Kispiox TSA's.

Paper birch is not only becoming more valued for its wood properties but it is also gaining recognition for its biodiversity and aesthetic values. Some of the positive ecological characteristics common to paper birch include disease resistance (<u>*Armillaria*</u> and *Phellinus*), frost resistance, wind firmness, rapid nutrient cycling and the transfer to neighboring conifers, potential nitrogen fixation, and fire resistance (adventitious buds).

Within the ICHmc1, ICHmc1a and ICHmc2 subzones there are several site series (Table 1), which have the moisture/nutrient regimes favorable to the development of pure and mixed stands of paper birch. Paper birch prefers fresh to very moist soils with medium to very rich nutrients. Site series with these edatopic conditions are also preferred by other deciduous species such as trembling aspen and black cottonwood. Paper birch can be found in mixed stands in association with conifer species such as spruce, pine, hemlock, cedar, balsam fir and pacific silver fir. Although paper birch can be found in association with black cottonwood on similar sites, it doesn't compete well with this species especially on floodplain site series. Paper birch and trembling aspen have similar growth patterns and are more compatible where growing together on similar sites.

Rich growing sites conducive to birch management are very difficult and expensive for forest managers to regenerate in what has historically been conifer management. It can for example, often take two or three manual brushing treatments for conifers to meet free growing conditions and fulfillment of basic silviculture obligations. Birch management under these conditions would likely reduce the number of brushing treatments necessary to one.

There are many challenges in the management of paper birch in pure and mixedwood stands. Inventories have to be refined so that wood quality and value can be determined within individual polygons identified to be birch leading. Growth and yield data gaps are common for this species. More work is required to determine site productivity and associated yields. A first step is the developing of site indices for site series within the ICHmc1 and ICHmc2 subzones. These data gaps will need to be resolved so that the validity and value of paper birch can be identified.

II) <u>SILVICS OF PAPER BIRCH</u>

The Paper Birch Managers' Handbook for British Columbia* provides an excellent framework for those considering paper birch management. It is best supplemented with local knowledge and experience.

Silvics of paper birch will be focused on the ICHmc1, ICHmc1a and ICHmc2 subzones.

d) Origin

Paper birch is a shade intolerant pioneer species which becomes established and competitive following disturbances. Harvesting and low-moderate intensity burns are the main disturbance patterns on which paper birch develops.

Because of its immunity to *Phellinus* and resistance to *Armillaria*, paper birch often develops within root rot centers.

e) Reproduction

iii) Seed

Male and female reproductive structures are found on the same tree (monoecious). Seed production begins at about age 15 with optimum production at 40 to 70 years of age. Trees produce good cone crops every other year therefore seed-tree is a preferred silviculture system in the management of birch.

Staminate catkins over winter and grow to maturity in the spring. Pollination occurs during a short period. Seed cones must be open when the male cones release their pollen, usually in mid May to early June.

The small double winged seeds are generally dispersed by the wind with most seeds falling within 30 to 60 meters of the parent tree. Seed is shed from September through November.

Seeds lay dormant through the winter on and below the snowpack.

Germination generally occurs best on mineral or mixed mineral/organic soils capable of holding moisture through extended periods. The small seeds are sensitive to soil moisture, light and temperature, therefore seedbeds that are protected from high moisture or temperature gradients will produce better germinants.

Optimal germinant performance can be expected on soils with pH greater than 5.0.

A seedbed with a mixture of humus and mineral soil in moderate to full sunlight will perform the best. First year seedlings usually grow to approximately 5 to 12 centimeters in height.

iv) Vegetative (Coppice/Sprouts)

Adventitious buds on the tree base usually near or below ground level sprout following fire or cutting. Numerous sprouts may form, with thinning of 3 to 7 per stump within 10 years of disturbance.

Where using coppice/sprouting as a vegetation method, stumps cut close to the ground tend to promote root collar sprouting which provides a more stable coppice stock than those from the stump.

Sprouting is reduced as trees age. Trees greater than 100 years old have a 30–40% chance of sprouting. Sprouting can be enhanced when carbohydrates have been reallocated to the roots at the end of the growing season. This occurs generally in late September to early April.

Although this is an acceptable method of regeneration, natural seeding is preferred. It is not uncommon for diseases to be transferred from the existing stump to the sprouts.

f) Juvenile Stage to Maturity

Although paper birch does not exhibit the rapid early growth characteristics of broad leaf species such as alder or black cottonwood, it is still greater than conifer species present on the richer site series (Table 1).

Paper birch initial densities can vary up to extremes of 30,000 stems per hectare with rapid self-thinning because of the shade intolerance of this species. Paper birch self prunes very well until shading no longer impacts branch/leaf development. Density control at an early age is critical to producing trees of adequate size and form to meet end product objectives.

Paper birch is considered a short-lived species. In even-aged, unmanaged stands trees mature in approximately 50–70 years. Few trees live longer than 150 years, however there are exceptions. Through natural succession, birch-leading stands are eventually replaced with shade tolerant conifer species.

g) Principal Pests and Damaging Agents

In the ICHmc1, ICHmc1a and ICHmc2 subzones pest and damaging agents can cause reforestation concerns. Some of the local pest and damaging agent concerns are listed below:

Mammals

The primary concern for regenerating paper birch is moose damage. Extensive browsing and antler rubbing may have significant impacts on selected sites. Before any stand tending activities are considered, a good assessment of current moose impacts will have to be made.

Beaver damage can also be a major concern in selective areas. Where identified as a concern, management strategies will have to be developed and implemented to minimize future losses.

Voles can cause girdling of root collars usually less than 10 centimeters in size. Intensive forest management should only be considered once trees are large enough and the threats of future mortality impacts are low to moderate.

Sapsuckers can cause damage to the main stem. The main impact is a reduction in wood quality. Mortality is rare.

Pathogens

Birch is immune to Phellinus and resistant to Armillaria root rots and may provide some protection to neighboring conifers from these diseases.

Seed trees and leave trees are susceptible to a condition known as post logging decadence similar to birch dieback. This can lead to top die back and even mortality. Seed trees will likely be impacted by this condition, however, it usually takes years before tree mortality ensues and by then natural seeding should have occurred. To prevent this condition more applicable to mixedwood management, no more than one third of the basal area should be removed at any one time.

Red heart, a reddish brown discoloration of the central part of the stems, is a defect that limits the uses of paper birch in specialty products. It is unclear what causes this but it may be due to parasitic organisms. It is thought that through density control and proper site selection, incidence of this pest concern will be reduced.

Fire

Fire is a major concern in the management of paper birch. The bark is highly flammable and even large trees can be killed with moderate fires.

Insects

Forest tent caterpillars and leaf minors are also concerns but are generally cyclic in nature and mortality is rare.

Abiotic

Abiotic events such as early fall and late spring snow events can cause extensive damage in poor height to diameter ratio stands. Height to diameter ratios must be considered prior to stand tending operations. Thinning early will balance height to diameter ratios and make trees less susceptible to snow and wind events.

Mammals, insects, pathogens and abiotic concerns are expensive to remedy once damage or incidence levels are detected. Early monitoring and developing reforestation management strategies, which address local pest concerns, are the best strategies to reforestation success.

III) SITE SERIES SELECTION OF PAPER BIRCH WITHIN THE ICHMC1, ICHMC1A AND ICHMC2 SUBZONES AND VARIANTS.

Paper birch will grow on a wide range of different site conditions within the ICHmc1, ICHmc1a and ICHmc2 subzones. It performs best however on nutrient rich sites with moisture regimes from fresh to very moist. The richer site series (table 1), which meet these conditions, are the focus of paper birch management.

Management of pure stands of paper birch should only be focused on richer sites that are currently established with birch stocking levels of 50% or greater. Site specific decisions where stocking levels are below this can be made to manage for pure birch if stocking is evenly distributed over the site and natural seeding is practical. Sites with poor birch distribution should be considered primarily for mixedwood or conifer management.

Table 1: Site series for the best growth of paper birch in the ICHmc1, ICHmc1a, and ICHmc2.

BEC-Variant	Site Series	Edatope (Nutrient / Moisture)
ICHmc1 Moist Cold Subzone (Nass Variant)	 * 01a – Hw – Step Moss 03 – HwB1 - Oak fern 04 – HwB1 - Devils Club 05 – Act Sx - Dogwood (Floodplain)	 Medium/Fresh-Moist Medium-Very Rich / Fresh-Very Moist Medium-Very Rich / Fresh-Very Moist Rich-Very Rich / Fresh-Very Moist
ICHmc1a Moist Cold Subzone (Nass Variant Amabilis Fir Phase)	 * 0la – HwBa – Bramble 02 – HwBa – Oak Fern 03 – HwBa - Devils Club-Lady Fern	 Medium/Fresh Medium-Rich/Fresh-Very Moist Rich-Very Rich/Fresh-Very Moist
ICHmc2 Moist Cold Subzone (Hazelton Variant)	 * 0la – Hw-Step Moss 03 – HwCw-Oak Fern 04 – CwHw-Devils Club-Oak Fern 05 – Sx- Devils Club-Lady Fern 06 – ActSx-Dogwood (floodplain) * 52 - $SxEp-Thimbleberry-Hazelnut 53 - $AtEp-Dogwood (Seral) 54 - $SxEp-Devils Club (Seral)	 Medium/Fresh-Moist Medium-Very Rich/Fresh-Very Moist Rich –Very Rich/Fresh-Very Moist Medium-Very Rich/ Fresh-Very Moist Rich-Very Rich /Fresh-Very Moist Medium/Fresh-Moist Medium-Very Rich/ Fresh-Very Moist Medium-Very Rich/ Fresh-Very Moist

* Only on nutrient regime medium-rich and moisture regime fresh-moist. Poorer and drier portions of site series should be managed for mixedwood or conifer management.

Soils should not be rapidly well or poorly drained (Mottles/Gleying). Although paper birch is tolerant of flooding, standing water should not be present during the active growing season.

Currently we cannot attach site indices for paper birch based on site series. It can be generally stated that managed stands occurring on the best site series for paper birch will range from 25-35 meters at age 50. Local growth curves are required for paper birch.

h) Other criteria for the selection of Paper Birch:

Management of paper birch has been focused primarily on end product objectives such as sawlogs, veneer, pulp, etc. There are other potentially marketable value added products that can be extracted from paper birch which have yet to be seriously assessed. These include products made from the bark such as baskets, canoes and chemicals for the pharmaceutical industry. Birch sap is conducive for syrup production and is highly sought after in today's European markets.

Some of the ecological characteristics and site contributions of paper birch include:

- aesthetic values
- disease resistance to root rot (*Phellinus*/*Armillaria*) and potential for a decrease impact on neighboring conifers.
- frost resistance and early season growth
- wind firmness
- nutrient cycler
- flood and drought tolerant
- abundance and diversity of carbon compounds below ground
- ectomycorrhizal diversity enabling conifers better access to moisture and nutrients
- good habitat for a wide variety of wildlife species

Paper birch has unique qualities that can only be attributed to this species. With more research and marketing, paper birch may provide an industry beyond just its wood properties.

IV) BEST MANAGEMENT PRACTICES

Regeneration emphasis should be on natural (seeding) reforestation when managing for paper birch in pure or mixed stands. Artificial reforestation should be used primarily for fill planting areas void of natural stocking.

a) Harvesting

Paper birch is shade intolerant therefore only selective silviculture systems will adequately provide target stocking levels.

Seed-Tree, Group Selection or a modified Shelterwood are the silviculture systems most likely to achieve reforestation objectives.

Paper birch produces seed every year with good seed crops approximately every two years. Seed dispersal is usually by wind with most of the seed landing within 30 to 60 meters of the parent tree.

To ensure adequate seeding, seed trees should be spaced approximately every 50 meters or 5–10 seed trees per hectare. Seed trees should be single stemmed and of good form and vigor. Care should be taken during the harvesting phase to minimize the damage on leave trees including the root system.

Other silviculture systems should be designed similarly to Seed-Tree to maximize the success potential of natural seeding.

b) Site Preparation

Paper birch germination and seedling development is based on mineral or mixed mineral/organic soils capable of holding moisture through extended periods. The small seeds are sensitive to soil moisture, light and temperature thus seedbeds which provide full sunlight, moist soil conditions, and warm temperatures will provide the optimum conditions for germination and seedling development. Site preparation objectives should strive to meet these conditions.

Harvested areas with high slash loads or developed brush complexes are primary candidates for site preparation. Without adequate site preparation, natural regeneration is unlikely and risky.

Even with summer harvest and proper planning it is unlikely that an adequate number of evenly distributed, mineral or mixed mineral/organic seedbeds will exist after harvest. To determine seedbed numbers and distribution it may be appropriate to carry out mineral seedbed surveys. If mineral seedbed surveys indicate inadequate seedbeds to provide target stocking levels, a site preparation treatment will be required.

Mineral seedbeds can be provided by a number of techniques. It is important however that the method chosen doesn't provide the potential for site degradation or over stocking.

Mechanical site preparation techniques using low ground pressure equipment such as tracked hoes can provide site-specific seedbeds and distribute them across the site. Other low ground pressure machines, which create mixed mineral/organic seedbeds, will also achieve site preparation objectives.

Light-moderate intensity broadcast burns that provide mineral soil exposure may also provide adequate conditions for paper birch natural regeneration. This tool requires a high degree of planning so that reforestation objectives are achieved without putting other values at risk. Burning is generally restricted to clear-cut systems which may not meet non-timber value objectives. Stocking is likely to be patchy and fill planting will probably be needed.

c) Planting

Planting involves the collection of seed/seed storage, sowing of seed to produce seedlings, seedling handling/storage and finally out planting.

Planting should be used to supplement stocking, where there have been shortfalls in the natural regeneration system and not for establishment purposes. To minimize the need for additional brushing treatments fall planting should occur within no more than two growing seasons following harvesting. This method of reforestation is in the early stages of development. Until issues such as provenance, stock types, specialized nurseries, and pest concerns are better researched, planting will remain risky and expensive.

Where planting is required and seed from local provenances has been secured sowing can take place at a recognized nursery. Nurseries must reduce the nutrient levels within the seedling to make them less palatable to mammals such as hares, voles and moose.

Stock types should be large enough (PSB 412) to adequately support the root system of a one year old tree. Seedlings should be short in nature (<50cm) and contain buds all along the shoot.

Planting should take place once the threat of frost is over and when soils contain adequate moisture. Where mammals such as hares, voles and/or moose have been identified as concerns, planting should be delayed later into the spring. This will allow alternate food sources time to develop.

Trees should not be planted in microsites with poor soil drainage (i.e. skunk cabbage).

Trees should be planted deep (2 - 5cm below root collar) and where possible the root collars should be protected from direct sunlight to prevent sunscald. Planters must take extra care when securing the seedling into the soil medium so that damage to the shoot/stem doesn't occur.

d) Brushing

Paper birch is shade intolerant therefore planted stock is at risk on the richer site series where birch management has been recognized. Herbaceous and woody plants will actively compete with birch on these rich growing sites.

Early detection of brushing concerns and follow up treatments are critical to plantation performance.

Manual treatments should be scheduled following full leaf out (mid-late June). Full knockdown of all competing brush within a 1.5 meter radius of individual crop trees should be one of the brushing conditions.

Where practical, density control of natural stocking may be carried out at the time of brushing. Natural stocking should be approximately 4 – 6 meters in height and free of mammal damage before density control is considered.

Where silviculture systems are implemented to provide natural regeneration it is probable that brushing will not be required. Typically these stands are very dense.

e) Thinning

To meet end product objectives of high quality sawlogs birch density control will most likely be required. This is especially true of naturally regenerated stands.

Where densities exceed 3000 stems per hectare repression thinning or pre-commercial thinning (PCT) is recommended to part of the basic silviculture obligation prior to a declaration of free growing.

Prior to any PCT treatments pests and abiotic concerns must be assessed. PCT treatments may have to be delayed or final densities adjusted, to account for these concerns.

PCT to approximately 1000 well-spaced stems per hectare would allow for adequate stocking to meet end product objectives (high quality sawlogs) and recognized mortality losses of approximately 20%.

Pre commercial thinning should be scheduled prior to full leaf to facilitate identification and selection of the best crop trees. Treatment timing should also consider the period of diameter elongation. The developing cambial layer is very delicate and easily damaged between late April -early July. Where snow levels are acceptable thinning in the Fall/Winter months is also practical.

Where natural stocking is void or unacceptable and vegetative sprouts are present, thinning to a single dominant sprout is recommended. Sprouts developing near the root collar are preferred over those developing on the stump.

Brush saws or chainsaws may be used for treatment. Stumps should be cut flat and low to the ground.

For leave trees to continue and maintain good diameter development plus meeting the objective of high quality sawlogs, a commercial thinning (CT) treatment may be necessary in the future. The CT treatment is expected to be market driven and trees thinned will pay for the treatment costs.

Commercial thinning should be considered when trees achieve heights of approximately 15 meters. CT should not be scheduled during the period of diameter elongation or the hot summer months.

f) Pruning

When growing in high densities, birch self-prunes very well. Maintaining densities to levels that balance increases in crown size and diameter, with the need to develop clear boles and small knot sizes, have been recognized during the thinning process and should reduce the need for pruning treatments.

If demand for birch clear wood is foreseen as a primary end product objective, pruning may have to be reconsidered.

If pruning is to be considered, research is required to determine treatment timing, methodologies, and growth impacts. Pruning should be based on tree height and not age.

g) Growth and Yield

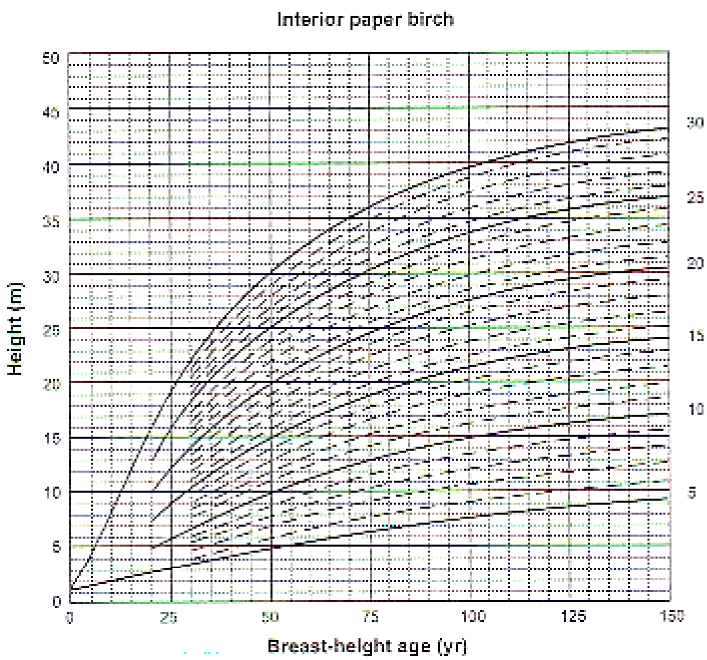
Most of the growth and yield information being used in British Columbia comes from European and United States sources.

J. S. Thrower and Associates in co-operation with Research Branch staff in the Ministry of Forests are currently calibrating Tree and Stand Simulator Model (TASS) for paper birch. Assessments of stand volumes based on different treatment regimes can then be modeled and assessed.

SIBEC and growth interrupt estimates for site productivity is also not available for birch.

Research is in its infancy on paper birch, however preliminary results are being provided on the growth and yield of this species. The Paper Birch Managers' Handbook for BC is a very good source for capturing research findings in and outside British Columbia. The Handbook contains site indices curves and a site index table, reproduced below, for paper birch in British Columbia. These can be used for unmanaged trees where in age classes 30 and beyond. Trees younger than 30 years of age will be difficult to accurately apply the site index curves.

Figure 1. Site index curves for paper birch in British Columbia[1]



[1]Curves are based on aspen, base age of 50 years at breast height.

Table 2: Site index table for paper birch in British Columbia[1]

S / bh age (years)	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	bh age (yrs)
10	18	22	25	29	32	35	38	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10
15	13	16	18	20	23	25	27	29	31	34	36	38	40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15
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190	-	-	-	-	-	5	5	6	7	7	8	8	9	10	10	11	12	12	13	14	15	15	16	17	18	18	19	20	21	21	22	23	190
195	-	-	-	-	-	5	5	6	6	7	8	8	9	10	10	11	12	12	13	14	15	15	16	17	17	18	19	20	21	21	22	23	195
200	-	-	-	-	-	5	5	6	6	7	8	8	9	10	10	11	12	12	13	14	14	15	16	17	17	18	19	20	20	21	22	23	200

Site Index	5	6	7	8-9	10-12	13-17	>= 18
Years to bh	9	8	7	6	5	4	3

The original data source is Alberta Forest Service (1985). The table and the corresponding site index curves in Figure 1 were based on the following formulation:

$H = 1.3 + (S - 1.3)\, b_1/b_2$

$b_1 = 1 + \exp\{6.879 - 1.32 \text{ In } 50 - 0.618 \text{ In } (S - 1.3)\}$

$b_2 = 1 + \exp\{6.879 - 1.32 \text{ In } A - 0.618 \text{ In } (S - 1.3)\}$

$ytb = 1.3 + 38.56/S$

Where H = top height (m); S = site index (height at 50 years breast height age); A = breast-height age (years); ytb = number of years to reach breast height (1.3 m); In - natural logarithm; and exp = exponential function to the base e.

Growth curves are also needed for managed birch stands.

Site series within the ICHmc1, ICHmc1a, and ICHmc2 conducive to birch management need site indexes attached to them so that site productivity estimates can be quantified at the local level.

Local trials such as the paper birch thinning trial near Legate Creek in the Kalum Forest District will also provide better growth and yield information on a local level. Trial information is available at the Kalum Forest District office.

V) Paper Birch Regeneration Guidelines and Stocking Standards

Table 3: Stocking Standards

Stocking standard (well spaced stems/ha)		Regen Delay (yr)	Free Growth Earliest	Free Growth Latest	Minimum Inter–Tree (m)	Repression [1] Level Density Total Stems/Hectare
TSS	MSS					
1000	700	3	7	10	2	3000

[1] Paper birch management end product objectives are for high valued sawlogs. To meet this objective and where total stems exceed 3000 stems per hectare, pre-commercial thinning is required to a density of 1000 well spaced stems per hectare to meet free growing obligations.

VI) Recommendations

1) Develop local growth curves for paper birch and other hardwood species (trembling aspen/black cottonwood).

2) Establish site productivity estimates for site series (Table 1) conducive to paper birch management.

3) Determine the quantity and quality of existing birch stands within the Nass, Kispiox, and Cranberry TSA's. Deciduous management into the future should be focused on existing stands dominated with hardwood and where cottonwood is the leading species.

4) Promote paper birch over trembling aspen and black cottonwood, except on floodplain sites. Floodplain sites (Table 1) should be managed for pure cottonwood.

5) Paper birch should be managed for the end product objective of high valued sawlogs through short rotations.

6) Paper birch should only be intensively managed on site series as identified in Table 1. Poorer sites should be managed for mixedwood or conifer management.

7) Paper birch reforestation strategies should focus on processes which will maximize the success potential of natural regeneration (seed-in).

8) Markets should be developed for products other than lumber/veneer. Birch sap and bark are unique features of this species which have not been exploited.

9) Use ISIS reports to determine birch-leading stands in the younger age classes (< 40 years). Determine the ecologically suitable area (Table 1) and focus stand management treatments on stands younger than 20 years of age. ISIS reports and opening records can be used to obtain species composition, site productivity estimates and pest considerations.

10) In openings where damaging agents such as *Dothistroma* are impacting conifer stocking, hardwood management should be considered to offset the reduction in conifer stocking levels. Consideration should be given where adequate hardwood stocking exists and prior to investing in increasing conifer stocking levels.

11) Develop a mixedwood strategy for both the TSA's.

12) Produce a Management paper for black cottonwood.

VII) CONCLUSIONS

Paper birch in pure stands and on ecologically suitable sites provides a viable alternative to conifer management within the ICHmc1, ICHmc1a and ICHmc2 subzones located within the Nass and Kispiox TSA's. Ecologically suitable site series for the associated subzones have been identified and can be found in Table 1. Paper birch management should be concentrated within these site series.

Paper birch is not only being sought after for its wood properties but interest is also being expressed for its bark and sap. Bark is being commonly used for such products as baskets, canoes and even chemicals for the pharmaceutical industry. Birch sap is being produced into syrup which is highly sought after in European markets. As birch management evolves these value added products could lead to the development of new industries.

Paper birch also has unique ecological characteristics. These include disease resistance to root rots common in conifers, nutrient replenisher, and ectomycorrhizal diversity which enables neighboring conifers to better access moisture and nutrients. Birch is also frost, drought and flood tolerant. It also contributes aesthetic and biodiversity values.

Paper birch is often resistant to diseases common to conifer species. Under circumstances such as *Dothistroma* paper birch stocking could be used to supplement stocking losses of the conifer component. This would prevent additional costs required to supplement inadequate conifer stocking levels.

Best management practices have been developed for paper birch which should minimize costs and risks in establishment while providing a high quality end product. Best management practices, including silviculture systems, have been designed to provide natural regeneration. Artificial reforestation is to be used primarily for fill planting areas void of natural stocking.

Paper birch end product objectives are for high valued sawlogs suitable for veneer and lumber products. Natural regeneration strategies often lead to high stand densities. To meet end product objectives some form of density control is required when repression levels of 3000 stems per hectare occur. In this event and to meet stocking standards (Table 3) a pre-commercial thinning to a density of 1000 well spaced stems per hectare is necessary before the stand can be declared free growing.

The recommendations section certainly makes it clear that birch management is not without its challenges. However, on ecologically suitable sites and with proper management strategies birch should provide a viable alternative to conifers. On high site indices sites paper birch can be grown on shorter rotations than conifers while producing high quality sawlogs. Birch can also be used to offset conifer stocking losses caused by pests and diseases and the incurred costs to increase these stocking levels.

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APPENDIX C: MANAGEMENT OF TREMBLING ASPEN IN THE ICHMC1, ICHMC1A AND ICHMC2 SUBZONES OF NORTHWESTERN BRITISH COLUMBIA

Management of Trembling Aspen

In the ICHmc1, ICHmc1a and ICHmc2 Subzones of Northwestern British Columbia

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Date: March 25, 2003

Management of Trembling Aspen (Populus tremuloides Michx.)

In the ICHmc1, ICHmc1a and ICHmc2 Subzones of Northwestern British Columbia (Nass and Kispiox TSA's)

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SUMMARY

The depressed state of the forest industry in Northwestern B.C. has resulted in the need for professionals to review opportunities to improve the economic state of the industry. One option identified was to examine the economic feasibility of hardwood species.

This paper examines trembling aspen (P*opulus tremuloides* Michx.) in the ICHmc1, ICHmc1a and ICHmc2 subzones in the Nass TSA and Kispiox TSA. It reviews the silvics of the species, site series conducive to its development, stocking standards, potential end product objectives, and provides some best management practices.

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I) <u>INTRODUCTION</u>

Trembling aspen (P*opulus tremuloides* Michx) is a fast growing, naturally occurring species found throughout British Columbia predominating east of the Coast Mountains. The focus of this study area is in the Interior Cedar Hemlock moist cold subzone Nass variant (ICHmc1), Amabilis fir phase (ICHmc1a), and the Hazelton variant (ICHmc2) contained within the Nass and Kispiox TSA's.

Within the ICHmc1 and ICHmc1a and ICHmc2 subzones several site series have the moisture/nutrient requirements favourable to the development of pure and mixed stands of trembling aspen. Trembling aspen prefers fresh to very moist soils with medium to very rich nutrient status. Site series with these edatopic conditions are also preferred by other deciduous species such as paper birch and black cottonwood. Trembling aspen can be found in mixed stands in association with conifer species such as spruce, pine, hemlock, cedar, and balsam fir and pacific silver fir. Although trembling aspen can be found in association with black cottonwood on similar sites, it doesn't compete well with this species, especially on floodplain site series. Trembling aspen and paper birch have similar growth patterns and are more compatible where growing together on similar sites.

Rich growing sites conducive to aspen management are very difficult and expensive for Forest Managers to establish in what has historically been conifer management. It can often take for example, two or three manual brushing treatments for conifers to meet free growing conditions and achievement of basic silviculture obligations. Aspen management under these conditions would eliminate the need for brushing treatments and the associated costs.

Trembling aspen is now becoming more popular for its wood properties. Products such as oriented strand board, pulp and paper, lumber, veneer, containers, pallets, match splints and chopsticks are commonly made from aspen and are in demand worldwide. Log quality and value will improve as we move into second growth management.

Biodiversity and aesthetic values are also key components of this species. Aspen provides beautiful fall colours and a wide range of habitats for resident insects, mammals and bird species.

Some of the ecological properties of aspen include a high tolerance to frost, nutrient recycling improving humus quality and forest growth, and resistance to fire (suckers).

There are many challenges in the management of trembling aspen in pure and mixedwood conditions. Local inventories have to be refined so that wood quality and value can be determined within deciduous polygons identified to contain a high aspen component. Growth and yield data gaps are common for this species. More work is required to determine site productivity and yields. A good first step is developing site indices for locally acceptable site series within the ICH subzones and variants. Growth models will need to be calibrated based on local conditions so that more accurate yield estimates can be made. These shortfalls amongst others will need to be addressed so the validity and value of aspen management can be recognized and practiced.

II) SILVICS OF TREMBLING ASPEN

The Aspen Managers Handbook for British Columbia* provides an excellent framework for those considering aspen management. It is best supplemented with local knowledge and experience.

Silvics of trembling aspen will be focused on the ICHmc1, ICHmc1a and ICHmc2 subzones.

h) Origin

Trembling aspen is a shade intolerant pioneer species, which becomes established and competitive following disturbance. Harvesting and low-moderate intensity burns are the main disturbance patterns on which trembling aspen becomes established.

The high light levels and increases in soil temperature stimulate root suckering and the rapid colonization of aspen.

i) Reproduction

v) Seed

Flowers are typically unisexual with male and female trees occurring in separate clones. Perfect flowers may be formed on a small percentage of males and female trees.

Seed production usually begins once trees are between 10 and 20 years of age, with optimum production at about 50 to 70 years. Females produce adequate seed crops annually, with good cone crops every 4 to 5 years.

Flowers generally appear in April to May before leaves develop. Pollination occurs by wind and fruits usually ripen in May – June, or in about six weeks time. Seed dispersal takes place within days after ripening. The cottony seed is lightweight and dispersed readily by wind for distances up to several kilometres.

Seed viability is high, however of short duration, even under ideal conditions (2-4 weeks). Aspen seed is not dormant and natural germination occurs within a day or two of dispersal if a suitable seedbed is reached. Only under ideal conditions will seeds develop into seedlings. Seedlings are then highly susceptible to damage from heat, drought and fungi.

Regeneration through natural seed-in is rare and highly unreliable.

* E.B. Peterson and N.M. Peterson March 1995, FRDA Report 230

vi) Vegetative (Root Suckers)

Trembling aspen reproduces vigorously following disturbances by means of root suckering. Stump sprouting is rare and will not contribute in any significant way to regeneration.

Root suckers are produced primarily from buds formed in the same season on the shallow lateral roots (upper 10 cm). For abundant and vigorous sucker production, light and heat must reach the forest floor. Areas with high slash loading will restrict sucker production. Suckers develop initially from the parent tree and quickly develop their own root systems. Root suckers can be found as far away as 25 metres from the parent tree but 10 metres is more common.

Sucker development appears to be suppressed by auxin transport to the roots from the aerial portion of the tree. Where auxin is halted by cutting or some other form of disturbance (which kills the main stem), auxin levels decline in the roots. In addition, cytokinins can no longer move out of the roots, resulting in an increase in the ratio of cytokinins to auxin which stimulates root suckering.

Carbohydrate reserves in the parent will have an impact on sucker development until suckers can photosynthesize for themselves. Disturbances during the dormant season (October to April) will likely lead to the highest vigor and density of root suckers.

Suckering produces extensive clones of genetically identical trees. Trees of different clones vary in their suckering ability, phonology, growth rates and disease resistance.

Tree age does not have an impact on suckering capacity unless the stand is breaking up as a result of old age and decay. More suckers are produced from older parents (50 years +) provided they are healthy at the time of cutting.

j) Juvenile Stage to Maturity

Trembling aspen is an aggressive pioneer species. Suckers can grow up to two metres in height during the first growing season following disturbance. Sucker densities can be in excess of 100,000 stems per hectare but because of shade intolerance self-thinning occurs rapidly. Aspen self prunes very well until shading no longer impacts branch/leaf development.

Optimum period of biomass production with the maximum mean annual increment and minimum stem decay in natural unmanaged stands occurs between 20 to 60 years of age. From 60 to 120 years stands become more susceptible to disease and decay with natural succession and conifer development occurring.

k) Principal Pests and Damaging Agents

In the ICHmc1, ICHmc1a and ICHmc2 subzones the primary concern for regenerating stands of trembling aspen is moose damage damage.

Extensive browsing and antler rubbing of branches and the main stem may have significant impacts on selected sites. Field observations indicate that many of the mature aspen stands have been heavily damaged by resident moose populations. Impacts to wood quality at the forest level are unknown. Cruise plots with destructive sampling as part of the methodology is needed to determine wood quality impacts.

Other mammals such as beavers, porcupines, hares and voles can also impact wood quality and increase mortality levels.

Insects such as forest tent caterpillar and large aspen tortrix are also endemic but are generally cyclic in nature and mortality is rare. There are no practical or economical methods of controlling these pests once established.

Pathogens such as *Phellinus tremulae* (aspen trunk rot), *Ciborinia whetzelii* (inkspot disease), *Melampsora medusae* (leaf rust) and *Venturia macularis* (aspen shoots leaf blight) are common in trembling aspen stands. Proper site selection and shorter rotation lengths will reduce volume and wood quality impacts.

Fire is also a major concern in the management of trembling aspen. Aspen bark is very thin and even low intensity fire can cause mortality.

Abiotic events such as snow damage and wind breakage can also have impacts on stand development and future yields.

Mammals, insects, pathogens, and abiotic concerns are expensive and impractical to remedy once damage or incidence levels are detected. Proper site selection, early monitoring, and developing reforestation management strategies, which address local pest concerns, are the best strategies for reforestation success.

III) <u>SITE SERIES SELECTION FOR TREMBLING ASPEN WITHIN THE ICHMC1, ICHMC1A AND ICHMC2 SUBZONES AND VARIANTS</u>

Trembling aspen will grow on a wide range of different site conditions within the ICHmc1, ICHmc1a and ICHmc2. Aspen performs best however on nutrient-rich sites with moisture regimes from fresh to very moist. The richer site series which meet these conditions are the focus of trembling aspen management within the above subzones and variants.

Management of pure stands of trembling aspen should only be focused on richer sites that are currently established with aspen stocking levels of 50% or greater. Site specific decisions where stocking levels are below this can be made to manage for pure aspen if clones are evenly distributed over the site and root suckering will meet target stocking objectives. Sites with a more random distribution of clones should be considered for mixed wood or conifer management.

Table 1: Site series selection for the best growth of Trembling Aspen

Biogeoclimatic Designation	Site Series	Edatope (Nutrient / Moisture)
ICHmc1 Moist Cold Subzone (Nass Variant)	* 01a – Hw – Step Moss 03 – HwBl - Oak fern 04 – HwBl - Devils Club 05 – ActSx - Dogwood (Floodplain)	Medium/Fresh-Moist Medium-Very Rich / Fresh-Very Moist Medium-Very Rich / Fresh-Very Moist Rich-Very Rich / Fresh-Very Moist
ICHmc1a Moist Cold Subzone (Nass Variant Amabilis Fir Phase)	*0la – HwBa – Bramble 02 – HwBa – Oak Fern *03 – HwBa - Devils Club-Lady Fern	Medium/Fresh Medium-Rich/Fresh-Very Moist Rich-Very Rich/Fresh-Very Moist
ICHmc2 Moist Cold Subzone (Hazelton Variant)	*0la – Hw-Step Moss 03 – HwCw-Oak Fern 04 – CwHw-Devils Club-Oak Fern 05 – Sx- Devils Club-Lady Fern 06 – ActSx-Dogwood (floodplain) * 52 - $SxEp-Thimbleberry-Hazelnut 53 - $AtEp-Dogwood (Seral) 54 - $SxEp-Devils Club (Seral)	Medium/Fresh-Moist Medium-Very Rich/Fresh-Very Moist Rich –Very Rich/Fresh-Very Moist Medium-Very Rich/ Fresh-Very Moist Rich-Very Rich /Fresh-Very Moist Medium/Fresh-Moist Medium-Very Rich/ Fresh-Very Moist Medium-Very Rich/ Fresh-Very Moist

*Only on nutrient regime medium-rich and moisture regime fresh moist. Poorer and drier portions of site series should be managed for mixedwood or conifer management.

Soils should not be rapidly well (sandy texture) or poorly drained (gleyed/mottled). Although trembling aspen is highly tolerant of flooding, standing water should not be present during the active growing season.

Currently we cannot attach a site index for trembling aspen based on site series. It can be generally stated that managed stands occurring on the best site series for trembling aspen will range on the, from 20 – 25 metres at age 50. Local growth curves do not exist for aspen and should be a future product of research.

l) Other criteria for the selection of Trembling aspen

Management of trembling aspen has been focused primarily on end product objectives such as pulp and paper and oriented strand board. Aspen as with most other hardwood species have unique ecological characteristics. Some of the ecological characteristics and site contributions of trembling aspen include:

- aesthetic values
- frost resistance and early season growth
- nutrient recycler (especially calcium, magnesium and nitrogen) to soil surface layers.
- contains high levels of potassium in leaves, wood, bark and litter.
- once present relatively easy to regenerate from root suckers.
- clones are genetically identical.
- effective capturer of carbon during rapid growth in its first 20 years of development.
- flood and drought tolerant.
- provides good habitat for a wide variety of wildlife species.

IV) BEST MANAGEMENT PRACTICES

Trembling aspen produces large volumes of seed almost annually, however seed-in rarely occurs and is unreliable to meet reforestation objectives. Root suckers or sprouts form from buds developing on shallow roots of the parent tree. Suckers develop quickly when light levels intensify and soil temperatures increase. Root suckers are the preferred and most successful form of aspen regeneration.

Silviculture systems and techniques therefore should be designed to optimize the development of root suckers to meet aspen reforestation objectives.

m) Harvesting

Trembling aspen is shade intolerant; therefore only selective silviculture systems will adequately provide target stocking levels. Group Selection, modified shelterwood and clearcutting are the silviculture systems most likely to meet reforestation objectives.

Silvicultural systems should be chosen which would promote healthy and vigorous root suckers from aspen parent trees. To promote the development of healthy and vigorous root suckering, harvesting systems and methodologies must consider the following:

- Because root suckers develop predominantly in the upper 10 cm of the soil horizon soil disturbance and compaction during harvest must be minimized.
- Ground harvesting carried out in the winter months with frozen ground conditions and/or with an adequate snow pack will minimize negative impacts on the soil medium.

- Carbohydrate root reserves are also at the highest levels during the inactive growing season. Late fall and early spring cutting should provide optimum conditions for root suckers to develop.
- To promote high light levels and the increases in soil temperatures necessary to promote root suckering slash loading must be addressed. To prevent site preparation treatments following harvest it is preferred that slash loading be dealt with during or immediately following harvest operations.
- To promote higher light levels, increases in soil temperatures and rapid decomposition harvest debris should be scattered evenly over the site.

The preferred method of harvest would be clearcutting with harvesting carried out primarily under winter conditions. For biodiversity purposes and where burning is not chosen as a site preparation tool, other silvicultural systems such as group selection or modified shelterwood should be considered.

n) Site Preparation

High slash loads will restrict light intensity and reduce soil temperatures thus negatively impacting root sucker development. If during the harvesting phase slash loading was not reduced, a site preparation treatment may be required.

Evenly distributing slash over the harvested area should be adequate for root suckers to develop. Treatment should be carried out as soon after harvest as possible. Equipment and treatment timing must consider soil compaction and disturbance concerns.

A moderate intensity broadcast burn may be an option if slash loading becomes extreme. Broadcast burning takes a great deal of planning and other values can be put at risk if implemented poorly. Burning should only be considered under extreme slash loading conditions.

Maintenance of the rootstock in its current condition should be the primary goal when choosing a site preparation option. Treatments which adversely affect soils and aspen roots in the upper 10 cm should be avoided.

o) Planting

Planting is not seen as a viable reforestation technique at this time. The main advantage to aspen management is its ability to regenerate naturally. If aspen planting is required the economics of aspen management comes into question.

During the pre-harvest planning stages, strata should be identified where natural aspen reforestation is unlikely to occur. Under these circumstances mixedwood strategies or conifer management should be applied.

p) Brushing

Where managing for pure aspen, brushing treatments are not required.

q) Thinning

The current management objectives of managing for fibre precludes the need for thinning treatments. Where management objectives change and end product uses such as high quality sawlogs or veneer logs become of interest, thinning may be necessary.

Thinning treatments may be put at risk by porcupines, beavers and moose. Sunscald, snow and wind damage are also concerns for developing stands.

r) Pruning

Aspen is a self-pruner when growing in high densities. Current management objectives are for fibre production and not for clear wood, therefore pruning at this time is not deemed necessary.

As management objectives change and high values are put on clear wood pruning may become viable.

s) Growth and Yield

Localized growth and yield information for aspen in the ICHmc1 and ICHmc2 subzones and variants is poor. SIBEC and growth intercept estimates of site productivity have yet to be refined for trembling aspen.

The Aspen Managers Handbook for British Columbia contains site index curves tables (table 2) and site index curves (figure 1) for aspen in British Columbia. These can be used for trees where in the age ranges of 35 and beyond. It will be difficult to apply the site index curves on trees younger than 35 years of age.

Site series (Table 1) within the ICHmc1, ICHmc1a, and ICHmc2 conducive to aspen management need site indexes assigned to them so that site productivity can be quantified at the local level.

J.S. Thrower and Associates in cooperation with research branch staff from the Ministry of Forests are currently calibrating Tree and Stand Simulator Model (TASS) for trembling aspen. Results are expected in 2004. Assessments of stand volumes based on different site indices can then be modeled for a broad range of treatment regimes.

Table 2: Site index table for aspen in British Columbia

(Peterson and Peterson. 1995)

Site Index Table for Interior Trembling Aspen

bh age (years)	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	bh age (yrs)
10	18	22	25	29	32	35	38	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10
15	13	16	18	20	23	25	27	29	31	34	36	38	40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15
20	10	12	14	16	18	20	22	23	25	27	29	30	32	33	35	37	38	40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20
25	8	10	12	13	15	17	18	20	21	23	24	26	27	28	30	31	33	34	36	37	38	40	-	-	-	-	-	-	-	-	-	-	25
30	7	9	10	12	13	14	16	17	19	20	21	22	24	25	26	27	28	20	21	32	33	34	35	37	38	39	40	-	-	-	-	-	30
35	6	8	9	10	12	13	14	15	17	18	19	20	21	23	24	25	26	27	28	30	31	32	33	34	35	37	38	39	40	-	-	-	35
40	6	7	8	9	11	12	13	14	15	17	18	19	20	21	23	24	25	26	27	28	30	31	32	32	33	34	35	36	37	38	39	40	40
45	5	6	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	30	31	32	33	34	35	36	37	38	45
50	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	30	31	32	32	33	34	35	36	50
55	5	6	7	8	9	9	11	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	31	32	33	34	55
60	-	5	6	7	8	9	10	11	12	12	13	14	15	16	17	18	19	20	24	22	23	24	25	26	26	27	28	29	30	31	32	33	60
65	-	5	6	7	8	8	9	10	11	12	13	14	15	15	16	17	18	19	20	21	22	23	24	25	25	26	27	28	29	30	31	32	65
70	-	5	6	6	7	8	9	10	11	11	12	13	14	15	16	17	17	18	19	20	21	22	23	24	25	26	26	27	28	29	30	31	70
75	-	5	5	6	7	8	9	9	10	11	12	13	13	14	15	16	17	18	19	19	20	21	22	23	24	25	26	27	27	28	29	30	75
80	-	-	5	6	6	7	9	9	10	11	11	12	13	14	15	16	16	17	18	19	20	21	21	22	23	24	25	26	27	28	28	29	80
85	-	-	5	6	6	7	8	9	9	10	11	12	13	13	14	15	16	17	18	18	19	20	21	22	23	23	24	25	26	27	28	29	85
90	-	-	5	5	6	7	8	8	9	10	11	11	12	13	14	15	15	16	17	18	19	20	20	21	22	23	24	25	26	26	27	28	90
95	-	-	5	5	6	7	8	8	9	10	10	11	12	13	14	14	15	16	17	18	18	19	20	21	22	23	23	24	25	26	27	28	95
100	-	-	5	5	6	7	7	8	9	9	10	11	12	12	13	14	15	16	16	17	18	19	20	20	21	22	23	24	25	25	26	27	100
105	-	-	-	5	6	6	7	8	8	9	10	11	11	12	13	14	14	15	16	17	18	18	19	20	21	22	23	23	24	25	26	27	105
110	-	-	-	5	5	6	7	8	8	9	10	10	11	12	13	13	14	15	16	17	17	18	19	20	21	21	22	23	24	25	25	26	110
115	-	-	-	5	5	6	7	7	8	9	9	10	11	12	12	13	14	15	15	16	17	18	19	19	20	21	22	23	23	24	25	26	115
120	-	-	-	5	5	6	7	7	8	9	9	10	11	11	12	13	14	14	15	16	17	18	18	19	20	21	22	22	23	24	25	26	120
125	-	-	-	5	5	6	7	7	8	8	9	10	11	11	12	13	14	14	15	16	17	17	18	19	20	20	24	22	23	24	25	25	125
130	-	-	-	-	5	6	6	7	8	8	9	10	10	11	12	13	13	14	15	16	16	17	18	19	19	20	21	22	23	23	24	25	130
135	-	-	-	-	5	6	6	7	8	8	9	10	10	11	12	12	13	14	15	15	16	17	18	18	19	20	21	22	22	23	24	25	135
140	-	-	-	-	5	5	6	7	7	8	9	9	10	11	12	12	13	14	14	15	16	17	17	18	19	20	21	21	22	23	24	25	140
145	-	-	-	-	5	5	6	7	7	8	9	9	10	11	11	12	13	14	14	15	16	17	17	18	19	20	20	21	22	23	24	24	145
150	-	-	-	-	5	5	6	7	7	8	8	9	10	11	11	12	13	13	14	15	16	16	17	18	19	19	20	21	22	23	23	24	150
155	-	-	-	-	5	5	6	6	7	8	8	9	10	10	11	12	13	13	14	15	15	16	17	18	18	19	20	21	21	22	23	24	155
160	-	-	-	-	5	5	6	6	7	8	8	9	10	10	11	12	12	13	14	15	15	16	17	17	18	19	20	21	21	22	23	24	160
165	-	-	-	-	-	5	6	6	7	8	8	9	9	10	11	12	12	13	14	14	15	16	17	17	18	19	20	21	21	22	23	24	165
170	-	-	-	-	-	5	6	6	7	7	8	9	9	10	11	11	12	13	14	14	15	16	17	17	18	19	20	20	21	22	23	23	170
175	-	-	-	-	-	5	6	6	7	7	8	9	9	10	11	11	12	13	13	14	15	16	17	17	18	19	19	20	21	22	23	23	175
180	-	-	-	-	-	5	6	6	7	7	8	9	9	10	11	11	12	13	13	14	15	16	16	17	18	19	19	20	21	22	22	23	180
185	-	-	-	-	-	5	5	6	7	7	8	8	9	10	10	11	12	13	13	14	15	15	16	17	18	18	19	20	21	22	22	23	185
190	-	-	-	-	-	5	5	6	7	7	8	8	9	10	10	11	12	12	13	14	15	15	16	17	18	18	19	20	21	21	22	23	190
195	-	-	-	-	-	5	5	6	6	7	8	8	9	10	10	11	12	12	13	14	15	15	16	17	17	18	19	20	21	21	22	23	195
200	-	-	-	-	-	5	5	6	6	7	8	8	9	10	10	11	12	12	13	14	14	15	16	17	17	18	19	20	20	21	22	23	200

Site Index	5	6	7	8-9	10-12	13-17	>= 18
Years to bh	9	8	7	6	5	4	3

The original data source is Alberta Forest Service (1985). The table and the corresponding site index curves in Figure 1 were based on the following formulation:

$$H = 1.3 + (S - 1.3)\ b_1/b_2$$

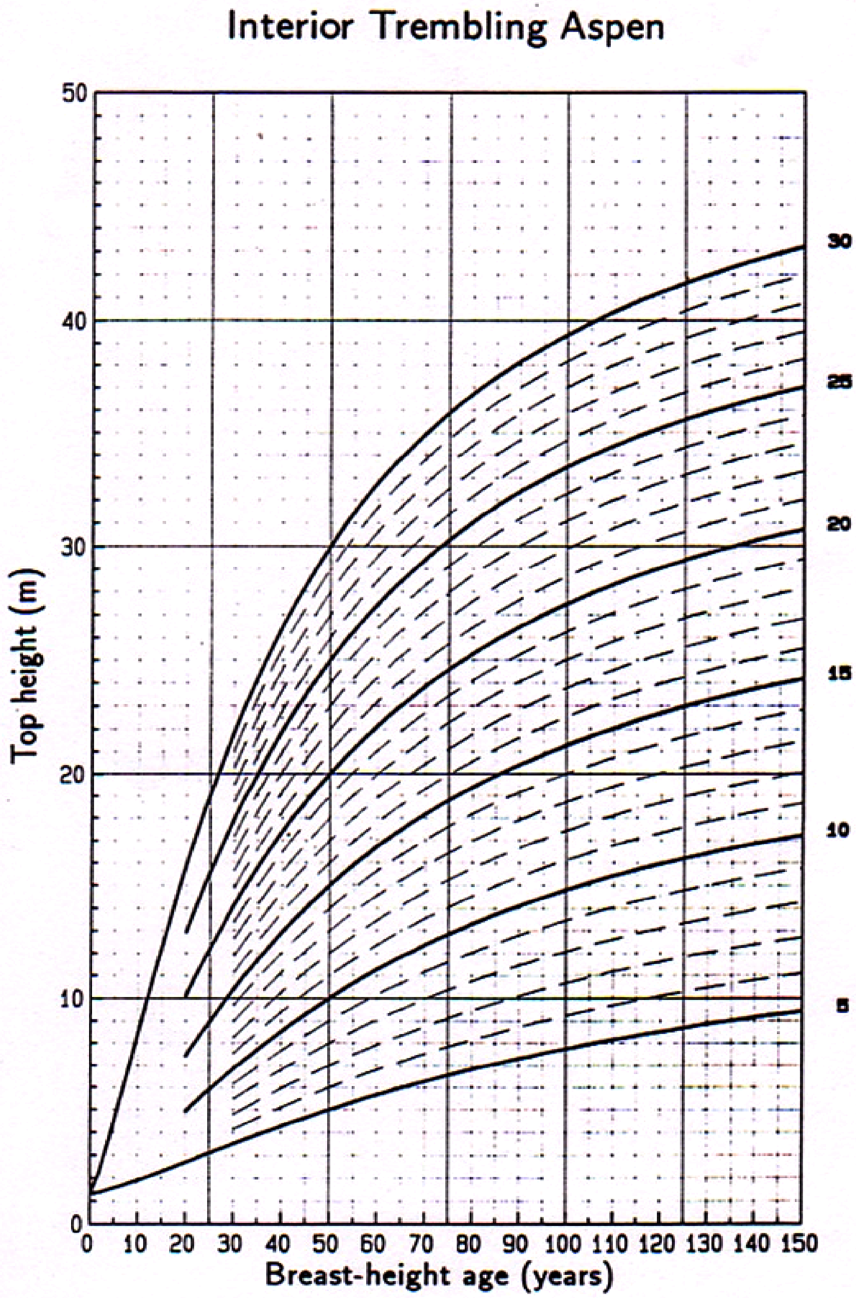
$$b_1 = 1 + \exp\{6.879 - 1.32\ \mathrm{In}\ 50 - 0.618\ \mathrm{In}\ (S - 1.3)\}$$

$$b_2 = 1 + \exp\{6.879 - 1.32\ \mathrm{In}\ A - 0.618\ \mathrm{In}\ (S - 1.3)\}$$

$$ytb = 1.3 + 38.56/S$$

Where H = top height (m); S = site index (height at 50 years breast height age); A = breast-height age (years); ytb = number of years to reach breast height (1.3 m); In - natural logarithm; and exp = exponential function to the base e.

Figure 1: Site index curve for aspen in British Columbia
Reprinted from Peterson and Peterson.1995.



V) TREMBLING ASPEN REGENERATION GUIDELINES AND STOCKING STANDARDS WITHIN THE ICHMC1, ICHMC1A AND ICHMC2 SUBZONE

Table 3: Stocking Standards

Stocking standard (well spaced stems/ha)		Regen Delay (yr.)	Free Growth Earliest	Free Growth Latest	Minimum Inter–Tree (m)
TSS	**MSS**				
3000	2500	2	5	10	1.5

VIII) RECOMMENDATIONS

13) Develop local growth curves for trembling aspen and other hardwood species (paper birch/black cottonwood).

14) Establish site productivity estimates for site series (Table 1) conducive to trembling aspen management.

15) Determine the quantity and quality of existing trembling aspen stands within the Nass, Kispiox and Cranberry TSA's.

16) Promote paper birch over trembling aspen and black cottonwood, except on floodplain sites. Floodplain sites (Table 1) should be managed for pure cottonwood.

17) trembling aspen should be managed for fibre on short rotations.

18) trembling aspen should only be intensively managed on site series as identified in Table 1. Poorer sites should be managed for mixedwood or conifer management.

19) trembling aspen reforestation strategies should focus on processes which will maximize the success potential of natural regeneration (root suckering).

20) Markets should be developed for products made from sawlogs.

21) Use ISIS reports to determine trembling aspen leading stands in the younger age classes (< 40 years). Determine the ecologically suitable area and focus stand management treatments on stands younger than 20 years of age. ISIS reports and opening records can be used to obtain species composition, site productivity estimates and pest considerations.

22) In openings where damaging agents such as *Dothistroma* are impacting conifer stocking, aspen management should be considered to offset the reduction in conifer stocking levels. Consideration should be given where adequate aspen stocking exists and prior to investing in increasing conifer stocking levels.

23) Develop a mixedwood strategy for the TSA's.

24) Produce a Management paper for black cottonwood.

IX) CONCLUSIONS

Trembling aspen in pure stands and on ecologically suitable sites provides a viable alternative to conifer management within the ICHmc1, ICHmc1a and ICHmc2 subzones located within the Nass and Kispiox TSA's. Ecologically suitable site series for the associated subzones have been identified and can be found in Table 1. Trembling aspen management should be concentrated within these site series.

Trembling aspen also has unique ecological characteristics. These include, the effective capturing of CO2 during the early growth cycle, self-thinning and pruning capabilities, nutrient recycling, and clones of genetically identically individuals. Aspen is frost, drought and flood tolerant. It also contributes high aesthetic and biodiversity values.

Trembling aspen is often resistant to diseases common to conifer species. Under circumstances such as *Dothistroma* trembling aspen stocking could be used to supplement stocking losses of the conifer component. This would prevent additional costs required to supplement inadequate conifer stocking levels.

Best management practices have been developed for trembling aspen which should minimize costs and risks in establishment. Best management practices, including silviculture systems, have been designed to provide natural regeneration (root suckering).

The recommendations section certainly makes it clear that aspen management is not without its challenges. However, on ecologically suitable sites and with proper management strategies, trembling aspen could provide a viable alternative to conifers. On high site indices sites aspen can be grown on shorter rotations than conifers. Trembling aspen can also be used to offset conifer stocking losses caused by pests and diseases and the incurred costs to increase these stocking levels.

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Appendix D: 1:250,000 Scale Deciduous Distribution Map