Potential Site Index Estimates for the Main Commercial Species on TFL 45

Prepared for

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Project: IFV-031-004

31 March 2000

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Executive Summary

Potential site index (PSI) estimates were developed for the major timber crop species and site series in the CWH biogeoclimatic zone in the operable forest landbase (OFLB) of Tree Farm License (TFL) 45. Preliminary PSI estimates were first developed by experts in forest productivity and ecosystem classification in coastal BC for the target species on all site series on the TFL. The preliminary PSI estimates were adjusted using a ratio between the measured field growth and the preliminary estimate to produce the final PSI estimates. These will provide better estimates of actual productivity for post harvest regenerated (PHR) stands for application in the timber supply analysis.

Sample plots were subjectively located across the geographic range of PHR stands. The differences between the preliminary PSI estimates and the field PSI estimates ranged from 3 to 6% for the two primary timber crop species (western hemlock and coastal Douglas-fir). Differences for Pacific silver fir and western red cedar (the minor crop species) ranged from 3 to 9%.

The sampling process used to generate the ratios to adjust the preliminary estimates is biased. However, we believe this bias is minor. The actual PSI may be slightly higher or lower than our estimates but can only be known when stands reach 50 years breast height age. The impact of the potentially small bias in site index can be evaluated using standard sensitivity analyses in the timber supply analysis process where site index estimates for regenerated stands are increased or decreased by 10 percent.

Acknowledgements

This project was completed under the supervision of Gerry Sommers, *RPF* (International Forest Products Ltd.). Funding was provided through Forest Renewal BC. We thank Tim Wales (Interfor) and the staff at Knight Inlet Camp (Interfor) for their help and support. We are grateful to Fred Nuszdorfer, *RPF* (Ministry of Forests, Vancouver Forest Region) who spent time in the field with our crews at the beginning of the project. We also thank Karel Klinka, *PhD, RPF* (University of British Columbia) for his assistance in developing the preliminary potential site index estimates.

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1. INTRODUCTION

1.1 TERMS OF REFERENCE

This project was undertaken for Gerry Sommers, *RPF* of International Forest Products Ltd. (Interfor) by Guillaume Thérien, *PhD* and Hamish Robertson, *BSc* of J.S.Thrower and Associates Ltd (JST). Funding was provided through Forest Renewal BC.

1.2 BACKGROUND

Site index is the most important variable used in models to generate yield tables for timber supply analysis. Site index is often inaccurate when estimated from photo-interpreted height and age because early suppression and tree top damage cannot be detected on aerial photos. This problem occurs most often in age classes eight and nine (52% of the operable forested landbase [OFLB] on Tree Farm License [TFL] 45 [Appendix I]). Inaccurate site productivity estimates will contribute to inaccurate estimates of long term timber supply.

1.3 OBJECTIVES

The objective of this project was to:

> *Develop reliable potential site index (PSI) estimates for the timber crop species and ecosystems in the CWH biogeoclimatic zone in post-harvest regenerated (PHR) stands on TFL 45.*

The primary target tree species were western hemlock (Hw) and coastal Douglas-fir (Fdc). Secondary species were Pacific silver fir (Ba), and western red cedar (Cw). The PSI estimates will be applied to site series to generate managed stand yield tables for PHR stands for Management Plan (MP) 4.

2. METHODS

2.1 OVERVIEW

The final PSI estimates were developed in three phases:

Phase 1: **Preliminary PSI estimates** – were developed for the four timber crop species by site series in the CWH biogeoclimatic zone using experts' knowledge of forest productivity and ecosystem classification.

Phase 2: **Field sampling** – was completed to estimate actual site index across a range of sites on the TFL.

Phase 3: **Final PSI estimates** – were obtained for Hw and Fdc by applying a statistical adjustment to the preliminary PSI estimates based on the relationship between preliminary PSI estimates and field site index. Field Ba and Cw site index estimates were derived from a localized site index conversion equation before applying a statistical adjustment.

2.2 PHASE 1 – PRELIMINARY PSI ESTIMATES

Preliminary PSI estimates were developed for the timber crop tree species and site series in the CWH biogeoclimatic zone on the TFL (Appendix II). This was done by experts on ecosystem classification and forest productivity including Karel Klinka, *PhD, RPF* (University of British Columbia), Bob Green, *MSc, RPF* (B.A. Blackwell and Associates), and Guillaume Thérien, *PhD*, Tara McCormick, *BSc*, and Hamish Robertson, *BSc* (JST). These experts developed the preliminary PSI estimates using their collective knowledge and experience of the TFL and similar coastal ecosystems, as well as the Ministry of Forests (MOF) SIBEC database. Area weighted average preliminary PSI estimates by species are provided in Table 1.

Table 1. Preliminary site index statistics.

Spp	Area (ha)	Avg (m)	Min (m)	Max (m)	Std Dev (m)
Hw	31,760	25.9	9	32	4.69
Fdc	31,185	31.1	17	38	5.12
Ba	29,797	25.2	9	35	5.18
Cw	31,760	24.5	9	32	4.01

2.3 PHASE 2 – FIELD SAMPLING

2.3.1 Objective

The objective of the field sampling was to measure actual tree growth (using height and breast-height age) to estimate site index from a geographically representative sample of stands across the TFL. The field estimates were compared to the preliminary estimates and a ratio reflecting the difference was used to adjust the remaining TFL polygons.

2.3.2 Target and Sample Population

The target population was the OFLB in the TFL (Table 2, Appendix I). The sample population was all Fdc and Hw leading stands between 10 and 100 years old (total age) in the CWH biogeoclimatic zone. The sample population represents all stands where reliable site index estimates could be obtained.

Table 2. Target and sample population area.

Population	North	South	Total
Target (ha)	22,979	14,588	37,567
Sample (ha)	4,812	3,618	8,430
Sample/Target Ratio	20.9%	24.8%	22.4%

Most field sampling occurred at the head of Knight Inlet in the CWHws2, CWHms2, and CWHvm1 variants. The CWHdm subzone, and the CWHvm1 and CWHvm2 variants were also sampled in the southern reaches of the TFL, in the Johnstone Strait area. The CWHxm subzone and the CWHmm1 variant were not sampled because accurate PSI estimates for these subzones/variants already exist. The MHmm1 and MHmm2 variants were not sampled because the PHR stands are too young.

2.3.3 Stand and Plot Selection

Stands were subjectively sampled to reflect the geographic distribution of PHR stands in the TFL. Sixty-nine plots were subjectively located in ecologically homogeneous areas and four (sometimes

three) Hw or Fdc site trees were measured. Both species were present in 16 plots for a total of 85 site index observations (Table 3). Most plots were located on fresh to moist, medium to rich sites, with some located in drier and poorer sites. Sampling occurred between June 13 and August 1, 1998.

2.3.4 Site Index

Sampling was done to MOF SIBEC standards.[1] Site index was estimated using total height and breast-height age (including the 1998 growing season). Age was not corrected (even if height growth had not ceased) so field site index estimates may be conservative. *Sitetools*, (version 3.0) was used with the MOF height-age equations (for Fdc and Hw trees older than 30 years) and MOF growth intercept equations (for Hw trees less than 30 years old)[2] to estimate site index. The plot site index for each species was computed as the average site index of the individual tree site species in each plot.

Table 3. Field site index estimates.

Site Series		Hw					Fdc				
		N	Avg (m)	Min (m)	Max (m)	SD (m)	N	Avg (m)	Min (m)	Max (m)	SD (m)
CWHdm	01	4	28.5	27.1	30.0	1.2	3	33.3	32.3	35.0	1.5
	05	2	34.7	33.1	36.2	2.2	1	41.2	41.2	41.2	
CWHms2	01	10	25.2	17.1	32.3	4.7	10	31.9	22.8	35.8	3.7
	03	1	21.0	21.0	21.0		1	25.0	25.0	25.0	
	04	12	30.1	24.1	33.8	2.6	15	37.2	32.9	42.0	2.6
	05	1	32.1	32.1	32.1						
	06	1	28.1	28.1	28.1		1	35.2	35.2	35.2	
CWHvm1	01	1	26.5	26.5	26.5						
	05	6	32.6	27.8	35.9	3.3					
	06	1	25.1	25.1	25.1						
CWHvm2	01	1	31.1	31.1	31.1						
	06	2	31.3	26.3	36.3	7.1					
CWHws2	01	7	24.6	20.3	30.8	3.6	3	30.8	28.3	33.8	2.8
	04	1	22.2	22.2	22.2		1	29.6	29.6	29.6	

2.3.5 Site Index Conversion Equations

Localized site index conversion equations were developed for Ba and Cw. These equations were built by pairing a Hw site tree with an adjacent (20 m radius) Ba or Cw site tree of the same site series. These site index conversion equations were fit using the geometric mean regression (GMR)[3], the method used by the MOF. The local equations were used to derive a Ba and a Cw site index estimate for each Hw field site index observation.

2.4 Phase 3 – Final PSI Estimates

The preliminary PSI estimate for each polygon was adjusted using a ratio reflecting the relationship between the preliminary PSI and the field site index estimate. The ratio-of-means for each species and subzone or variant combination was used (Appendix III). A single ratio was computed for

[1] Nigh, G., D. Meidinger, and A. Mirza. 1998. SIBEC Sampling and Data Standards version 3.0. BC Ministry of Forests, Misc. Report 075, Revised April 7, 1998. 4 p.

[2] MOF growth intercept equations for Fdc were considered too optimistic for TFL 45; height-age equations were used instead (approved by Gordon Nigh, MOF Research Branch).

[3] Nigh, G.D. 1995. Site index conversion equations for mixed species stands. BC MOF Research Report No 1, Victoria. 20 p.

both the CWHvm1 and the CWHvm2 variants for Hw, Ba, and Cw because there were not enough samples in the CWHvm2. A ratio of 1.0 was assumed for all species in the CWHxm and CWHmm1 variants and for Fdc in the CWHvm variants.

3. RESULTS

3.1 STATISTICAL ADJUSTMENT

The preliminary PSI estimates were adjusted by applying the estimated ratio by subzone and species (Appendix III, IV). The ratios ranged from 0.953 to 1.088 while the standard error of the ratios ranged from 0.038 to 0.173 (Table 4).

Table 4. Statistical adjustment results.

Spp	Subzone	N	Ratio	SE of Ratio	95% CI of Ratio	Avg Prelim PSI	Avg Adj Prelim PSI	SE of Adj Prelim PSI	95% CI Adj Prelim PSI
Hw	CWHdm	6	1.018	0.122	[0.896, 1.914]	28.6	29.1	3.5	[20.2, 38.1]
	CWHms2	25	1.035	0.064	[0.971, 2.006]	24.1	24.9	1.5	[21.8, 28.1]
	CWHvm	11	1.006	0.100	[0.906, 1.912]	28.7	28.9	2.9	[22.5, 35.3]
	CWHws2	8	0.970	0.115	[0.855, 1.825]	22.6	22.0	2.6	[15.8, 28.1]
	Average	*50*	*1.016*			*25.9*	*26.3*		
Fdc	CWHdm	4	1.054	0.149	[0.905, 1.959]	32.6	34.3	4.9	[18.9, 49.8]
	CWHms2	27	1.031	0.038	[0.995, 2.028]	30.5	31.5	1.2	[29.1, 33.8]
	CWHws2	4	1.061	0.173	[0.888, 1.949]	27.2	28.9	4.7	[13.9, 43.9]
	Average	*35*	*1.039*			*31.1*	*32.3*		
Ba	CWHms2	25	1.037	0.068	[0.969, 2.006]	23.2	24.1	1.6	[20.8, 27.4]
	CWHvm	11	0.953	0.107	[0.846, 1.799]	28.7	27.4	3.1	[20.5, 34.2]
	CWHws2	8	1.007	0.120	[0.887, 1.894]	21.9	22.0	2.6	[15.8, 28.2]
	Average	*44*	*1.011*			*25.2*	*25.5*		
Cw	CWHdm	6	1.088	0.119	[0.969, 2.057]	26.5	28.8	3.2	[20.7, 36.9]
	CWHms2	25	1.088	0.071	[1.017, 2.105]	23.1	25.1	1.6	[21.8, 28.5]
	CWHvm	11	1.031	0.105	[0.926, 1.957]	27.2	28.1	2.9	[21.7, 34.5]
	CWHws2	8	1.037	0.126	[0.911, 1.948]	21.1	21.9	2.7	[15.6, 28.2]
	Average	*50*	*1.067*			*24.5*	*26.1*		

3.1.1 Hw Ratio Adjustment

The average adjusted PSI for Hw is 26.3 m (Table 4) and is a 1.6% increase over the preliminary PSI estimates. The average field site index estimates for each subzone were within 3.5% of the preliminary PSI estimates. The precision around the adjusted preliminary site index ranged from ±3.1 to ±8.9 m. The distribution of potential site index classes slightly shifted in the upper range after adjustment (Figure 1).

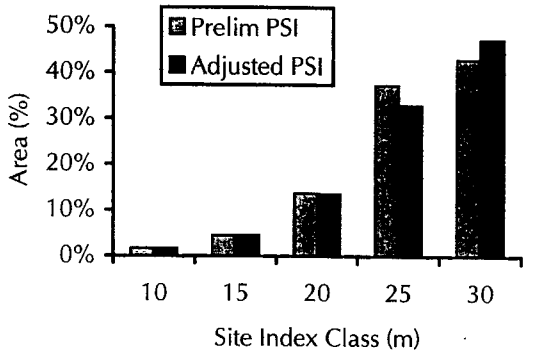

Figure 1. Hw PSI distribution before and after statistical adjustment.

3.1.2 Fdc Ratio Adjustment

The average adjusted PSI for Fdc is 32.3 m (Table 4). This is a 3.9% increase over the preliminary PSI estimates. The adjustment ratios ranged from 1.031 to 1.064. The precision around the adjusted preliminary site index ranged from ±2.1 to ±15.5m. The PSI site class distribution decreased in the 25 m class following the adjustment, and increased in the 30 m and 35 m classes (Figure 2).

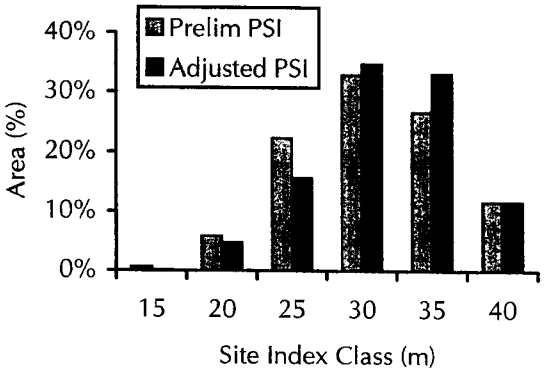

Figure 2. Fdc PSI distribution before and after statistical adjustment.

Preliminary PSI estimates were based on trends in southern sub-maritime biogeoclimatic units (e.g., CWHms1) where growing season water deficits and more continental temperature regimes reduce productivity. The experts expected a similar pattern for TFL 45 but the observed productivity was more typical of maritime climates. This is likely due to low persistent morning cloud and fog that occurs in mid to late summer with high-pressure weather systems. This weather phenomenon does not occur in the southern sub-maritime units.

3.2 Site Index Conversion Equations

Thirty-one Ba-Hw site tree pairs were sampled (13 in the CWHws2 variant, 10 in the CWHms2 variant, four in the CWHvm2 variant, and three in the CWHvm1 variant). The GMR line was:

$$SI_{Ba} = 6.0 + 0.749 \times SI_{Hw}$$

where SI_{Ba} is Ba site index (m) and SI_{Hw} is Hw site index (m). The correlation for the regression was 70.1% with a standard error of the estimate of 3.3 m. This equation showed a lower slope than the MOF equation, giving higher Ba site index estimates and lower Hw site index estimates than predicted from the MOF equation (Figure 3).

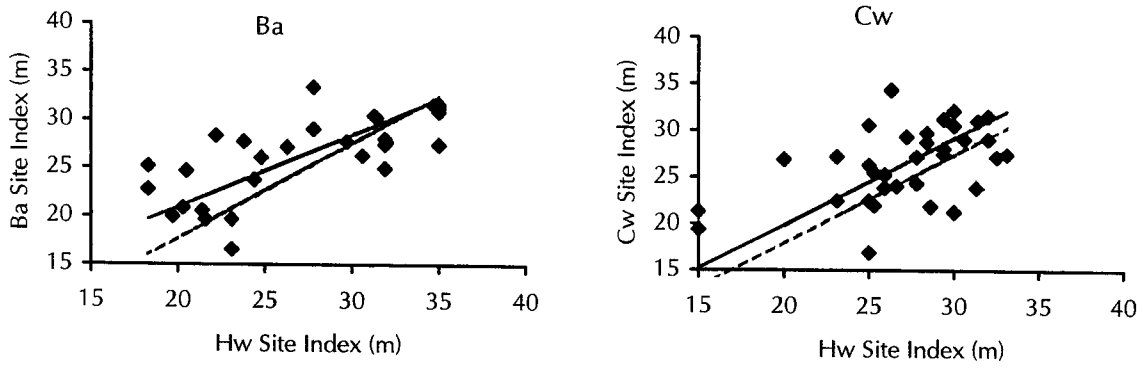

Figure 3. Relationship between Ba-Hw and Cw-Hw site indices (dotted line is the MOF equation).

The Cw-Hw site index conversion equation was developed using 34 site index pairs (28 in the CWHms2 variant, two in the CWHvm1 variant, two in the CWHws2 variant, one in the CWHdm subzone, and one in the CWHvm2 variant). The GMR line was:

$$SI_{Cw} = 1.1 + 0.938 \times SI_{Hw}$$

where SI_{Cw} is the Cw site index (m) and SI_{Hw} is the Hw site index (m). The correlation for the regression was 49.8% with a standard error of the estimate of 4.1 m. This equation showed a similar slope but higher intercept (approximately 2.3 m) when compared to the MOF equation (Figure 3).

3.2.1 Ba Ratio Adjustment

The average adjusted PSI for Ba is 25.2 m (Table 4). This is a 1.1% increase over the preliminary PSI estimates (Ba adjustment ratios ranged between 0.953 and 1.037) (Table 4). The precision of the adjusted preliminary site index ranged from ±3.3 to ±6.9 m. The distribution of PSI classes was similar following statistical adjustment (Figure 4).

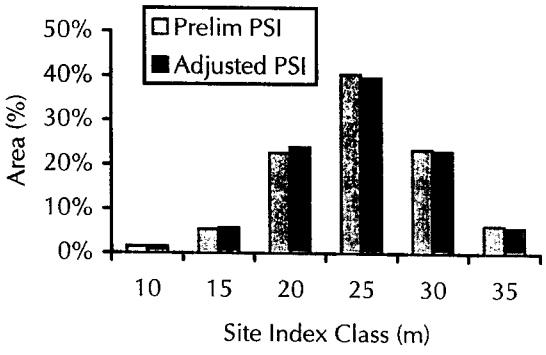

Figure 4. Ba PSI distribution before and after statistical adjustment.

3.2.2 Cw Ratio Adjustment

The average adjusted PSI for Cw is 26.1 m (Table 4). This is a 6.7% increase over the preliminary PSI estimates (Cw adjustment ratios ranged between 1.031 and 1.088 [Table 4]). The precision of the adjusted preliminary site index ranged from ±3.3 to ±8.1 m. The distribution of PSI classes decreased in the 20 m class and increased in the 30 m following adjustment (Figure 5).

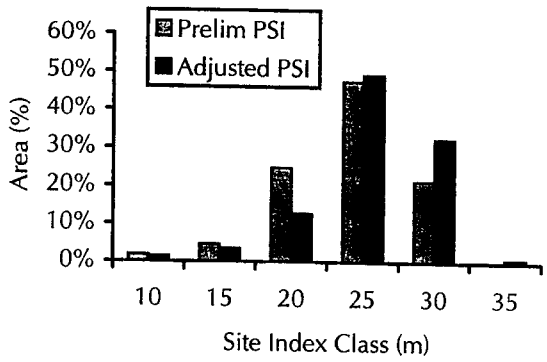

Figure 5. Cw PSI distribution before and after statistical adjustment.

4. DISCUSSION

4.1 SAMPLING BIAS

The process used in this project had four major potential sources of bias affecting the adjustment ratios:

1. The sample population was different from the target population.
2. Sample plots were subjectively located.
3. The relationship between preliminary PSI and field site index estimates was assumed to be constant within a subzone or variant.
4. The adjustment ratios were calculated using field site series while adjusted PSI estimates were assigned to photo-interpreted (map) site series.

An unbiased sampling design could not be used because PSI cannot be estimated everywhere in the target population. Similar studies have used biased sampling designs, but this study has more potential for bias. However, the impact of bias on the adjusted preliminary PSI estimates is probably small and the adjusted preliminary PSI estimates were accurate for the timber crop species and site series.

The magnitude of the potential bias is in the order of 1.0 m for the most common sites and could be up to 2.0 m for less common sites series. The impact of a 1.5 m difference (for example) in site index can be assessed using the standard sensitivity analysis in timber supply analysis. This possible difference could create a 5% reduction in site index, leading to a 10% volume reduction. The standard sensitivity of volume estimates for PHR stands will provide some information about the impact of this potential bias.

4.2 Comparison With Other Estimates

Three different site index estimation methods were compared, based on the current leading species in the inventory. These methods were:

1. the current inventory site index (base case, hereafter called CI),
2. SIBEC estimates (age class 1 to 7), Old Growth Site Index (OGSI) estimates (age class 8 and 9), and CI if SIBEC or OGSI is not available (hereafter called SIBEC-OGSI), and
3. the adjusted preliminary PSI estimates, where available, or otherwise the CI (hereafter called SIA).

The CI consistently yielded lower site index estimates than the other methods. Conversely, the SIBEC-OGSI and SIA methods gave similar Hw and Ba results (Table 5, Figure 6) and the SIA method gave higher Fdc and Cw site index estimates. The SIA method increased site index from 7.1 to 8.0 m when compared to the CI. The absolute differences between the average site index calculated from the SIA and the CI methods were consistent across species. This consistency probably indicates a constant bias in site index in the CI method.

Table 5. Average site index by estimation method and difference from the CI method.

Spp	Area	CI	SIBEC-OGSI			SIA		
		SI	SI	Difference		SI	Difference	
	(ha)	(m)	(m)	(m)	(%)	(m)	(m)	(%)
Hw	20,372	15.8	22.6	6.8	43.0	23.8	8.0	50.6
Fdc	5,847	22.8	25.2	2.4	10.5	30.5	7.7	33.8
Ba	4,158	14.5	21.0	6.5	44.8	22.2	7.7	53.1
Cw	3,355	18.5	19.6	1.4	7.6	25.6	7.1	38.4

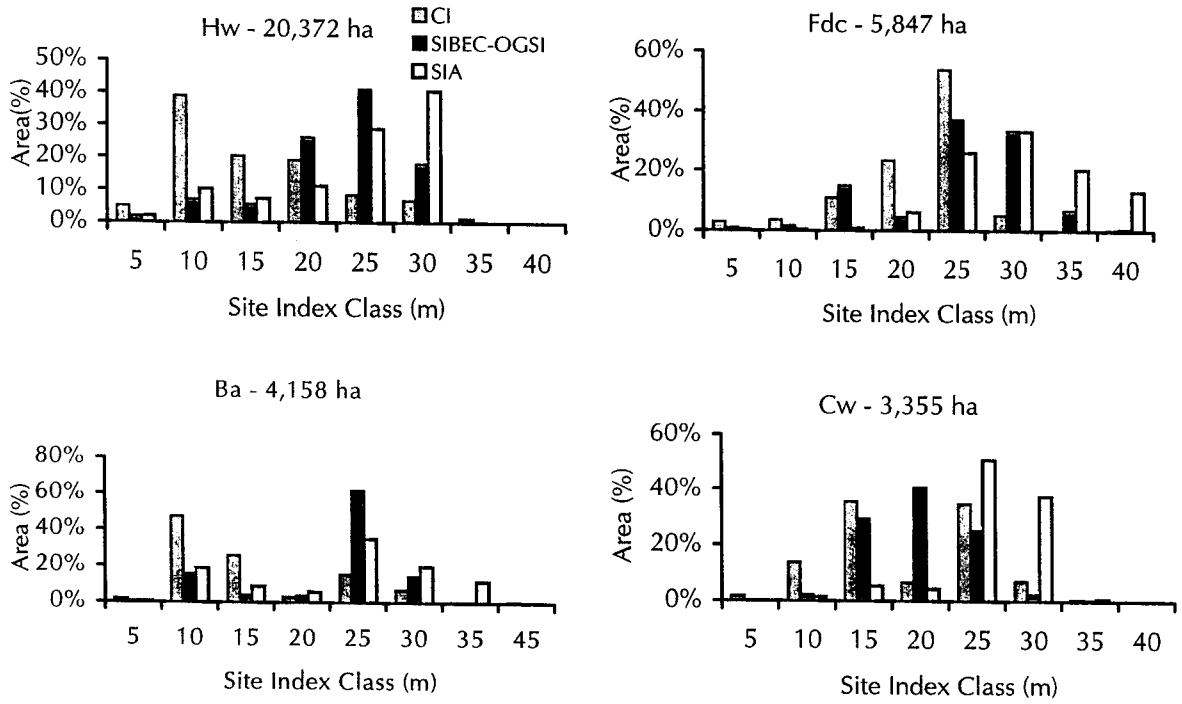

Figure 6. Distribution of site index estimates for each timber crop species.

A lack of good Cw productivity information can explain the difference between the SIBEC-OGSI and the SIA estimates for Cw. The Cw SIBEC estimates tend to have low reliability in the CWH zone in the Vancouver Forest Region.[4]

4.3 Comparison Of SIBEC And Adjusted Preliminary Site Index Estimates

The reliability of the MOF SIBEC database varies by site series/species combinations. Those with a high reliability ranking give more accurate site productivity estimates. The adjusted preliminary PSI estimates were compared to the SIBEC estimates for the highly reliable combinations (Table 6).

The overall difference between the SIA and the SIBEC estimates for these site series/species combinations was 1.1 m. Since SIBEC estimates are in 3 to 4 m classes, a difference of 1.1 m is negligible. Only four site series/species combinations showed a significant difference between the two estimation methods (CWHvm1/07 Ba, CWHvm1/01 Cw, CWHmm1/01 Fdc, and CWHvm1/06 Hw). All other combinations showed similar site index estimates between estimation methods.

The similarity between the adjusted preliminary PSI estimates and the highly reliable MOF SIBEC estimates is a strong indication that the adjusted preliminary PSI estimates are reliable in other site series in TFL 45. This similarity also shows that ecological conditions on the TFL had little impact on productivity when compared to the highly reliable MOF SIBEC estimates.

Table 6. Comparison between adjusted preliminary PSI and SIBEC site index estimates.

Sp	Subzone	Site Series	Area (ha)	SIBEC (m)	SIA (m)	Difference (m)
Ba	CWHvm1	01	3,681	28	27.6	-0.4
		05	1,096	28	29.5	1.5
		07	2,177	28	33.4	5.4
	Wtd Average		*6,954*			*1.7*
Cw	CWHdm	01	674	28	28.3	0.3
	CWHvm1	01	3,681	24	28.9	4.9
	Wtd Average		*4,355*			*4.2*
Fdc	CWHdm	01	674	32	33.7	1.7
		03	136	24	26.4	2.4
		05	377	36	36.9	0.9
		07	136	40	40.1	0.1
	CWHmm1	01	661	28	32.0	4.0
	CWHvm1	01	3,681	36	34.0	-2.0
		03	1,367	32	29.0	-3.0
		05	1,096	36	37.0	1.0
	CWHxm	01	269	32	31.0	-1.0
		03	103	24	24.0	0.0
		05	100	36	35.0	-1.0
		07	22	40	38.0	-2.0
	Wtd Average		*8,622*			*-0.7*
Hw	CWHdm	01	674	32	29.5	-2.5
	CWHvm1	01	3,681	28	30.2	2.2
		05	1,096	28	31.2	3.2
		06	428	24	32.2	8.2
		07	2,177	32	32.2	0.2
	CWHxm	01	269	24	27.0	3.0
	Wtd Average		*8,325*		*1.8*	
Total	*Wtd Average*		*28,256*			*1.1*

[4] Ministry of Forests 1997. Site Index Estimates by Site Series for Coniferous Tree Species in British Columbia. BC Ministry of Forests, Victoria. 265 p.

5. CONCLUSIONS AND RECOMMENDATIONS

1. The adjusted PSI estimates are more accurate than those currently available in the inventory database, the MOF SIBEC database, or OGSI equations. Therefore, we recommend that:

   The adjusted preliminary PSI estimates (Appendix IV) be used to estimate forest productivity for PHR stands in the next timber supply analysis for TFL 45.

2. The MH biogeoclimatic zone does not have reliable forest productivity estimates. Practitioners require more understanding of the effects that elevation has on forest productivity in high elevation areas. Therefore, we recommend that:

   Methods be developed to obtain more reliable PSI estimates for the MH biogeoclimatic zone.

3. To maintain current site index estimates for the TFL, we recommend that:

   The PSI estimates be updated when new forest productivity information becomes available.

   Silviculture surveys, monitoring plots, Vegetation Resources Inventory plots, and special surveys and projects can be used to update the estimates.

APPENDIX I – TFL 45 LANDBASE

Location

TFL 45 is located northeast of Campbell River on the southern mid-coast. Most of the TFL is at the north end of Knight Inlet. Smaller blocks are located at the south end of Johnstone Strait in areas surrounding Phillips Arm, Frederick Arm, and West Thurlow Island (Figure 7). The total TFL area is 232,057 ha[5] of which 224,919 ha (97%) is productive forest. The total operable forested landbase is 37,567 ha (17% of the productive forest).

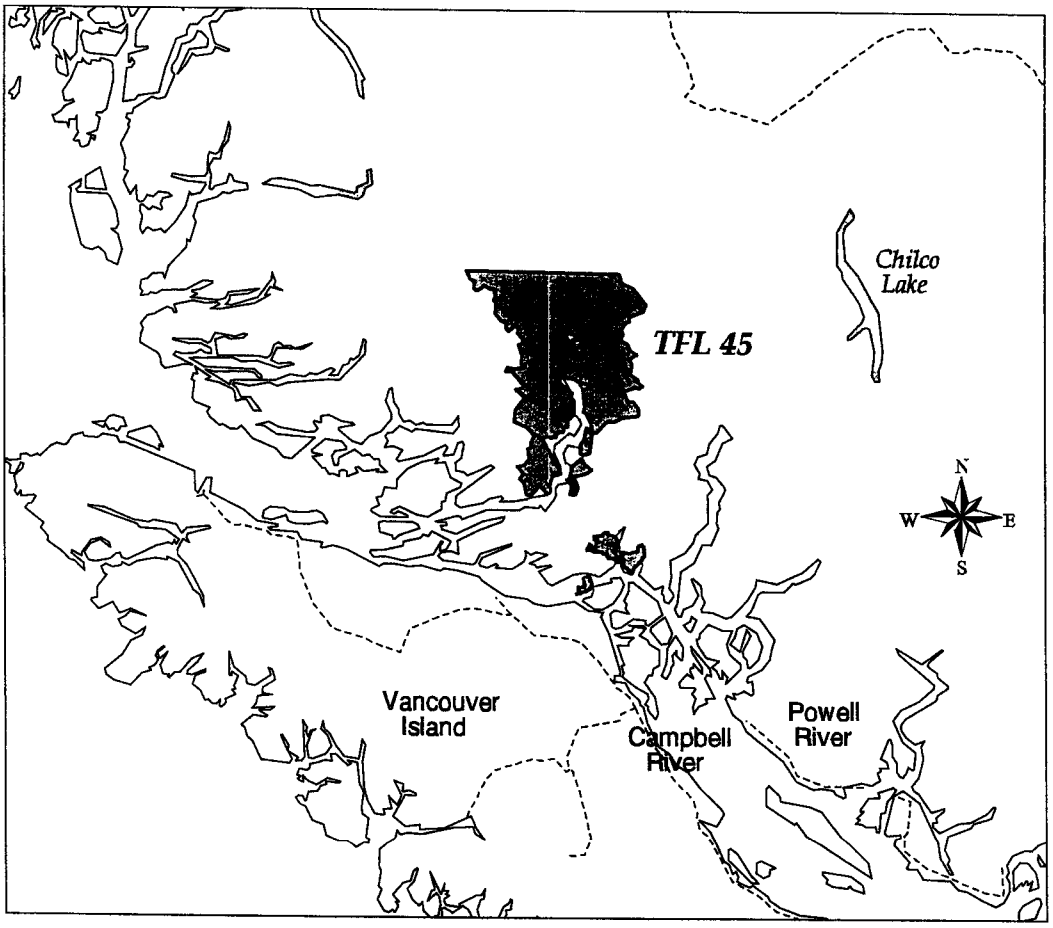

Figure 7. Location of TFL 45 on the mid-coast of BC.

[5] A new forest inventory for TFL 45 should be available in the Spring 2000. Area statements may be different in the new inventory.

Forest Cover

Leading Species

The most common timber crop species on the TFL are Hw, Fdc, Ba, and Cw (Table 7). Minor species include spruce (Sx, Se, and Ss), black cottonwood (Ac), yellow cedar (Yc), and red alder (Dr). Timber harvesting in the northern portion has occurred primarily in the lower reaches of the river systems draining into Knight Inlet. Most of this area has been regenerating to Fdc, Hw, or Cw leading stands. In the south, particularly around Phillips Arm and West Thurlow Island, most area has been regenerating to Hw and Ba.

Age Class Distribution

Timber harvesting began in the southern areas of the TFL around 1914. In Knight Inlet, harvesting began about the same time, but most (13,500 ha) has occurred since the mid 1950s. Currently, 52% (19,496 ha) of the OFLB is age class eight (141 years) or older (Table 7).

Table 7. Area distribution by species and age class in TFL 45.

Species[a]	Age Class (ha)										Total	
	0	1	2	3	4	5	6	7	8	9	*(ha)*	%
Ac									99		*99*	0.3
Ba		759	233	8		2	45	3	3,103	6	*4,158*	11.1
Cw		1,515	248	18	61	5	7		1,500		*3,355*	8.9
Dr			40	200	122				419	9	*790*	2.1
Fdc		1,836	2,529	94	29	39	106		1,215		*5,847*	15.6
Hw		2,766	1,937	890	1,445	863	204	38	12,096	133	*20,372*	54.2
Mb			25	42					10		*77*	0.2
Pl									6		*6*	0.0
Pw							1				*1*	0.0
S		8		1							*9*	0.0
Se		84									*84*	0.2
Ss		111	391	48	23	72	30		421		*1,096*	2.9
Yc		130							464	15	*609*	1.6
None	5	1,060									*1,065*	2.8
Total (ha)	*5*	*8,269*	*5,402*	*1,302*	*1,679*	*981*	*393*	*41*	*19,333*	*163*	*37,567*	
Total (%)	0.0	22.0	14.4	3.5	4.5	2.6	1.0	0.1	51.5	0.4		100

[a] Some polygons (1,065 ha) less than 3 years old have not been assigned a leading species.

Site Index Distribution

Typically, site index distribution follows a bell-shaped (or normal) distribution. Forest cover inventory site index estimates for the four timber crop species did not follow such a distribution and were lower than what experts would expect for this part of the province (Table 8, Figure 8).

Table 8. Current forest cover site index statistics.

Spp	Area (ha)	Avg (m)	Min (m)	Max (m)	Std Dev (m)
Hw	20,372	15.8	4.3	40.5	7.3
Fdc	5,847	22.8	7.0	40.0	6.0
Ba	4,158	14.5	4.9	43.0	6.5
Cw	3,355	18.5	6.0	38.9	5.6

Ecological Classification

Climate

The northern portion of the TFL is influenced by both maritime and continental climates. Cold outflow air from the Interior Plateau and the large glaciers surrounding the study area create extreme winter temperatures, which, combined with moist coastal air masses, characterize the submaritime and subcontinental climates. The winter months are cool and wet with heavy snowfall and the summers are cool, but relatively dry.[6] Climatic variation occurs with elevation and aspect.

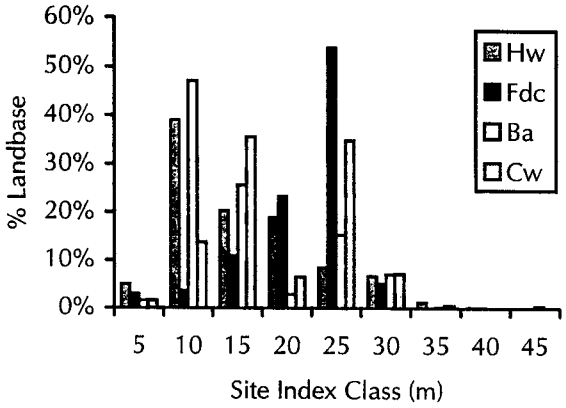

Figure 8. Current forest cover inventory site index distribution.

The Klinaklini and Franklin drainages are particularly affected by these climatic patterns. The upper reaches of the Sim drainage also have this strong submaritime influence, with the maritime influence increasing in the lower reaches. The southern portion of the TFL is influenced by a maritime climate that is moist and mild with relatively minor seasonal temperature variation. This varies with elevation and aspect.

Biogeoclimatic Units

In the north, the CWHms2 variant extends from sea level to 600 m in the Klinaklini and Franklin river drainages. The CWHws2 variant is between 600 and 1,000 m, with the MHmm2 variant above. The upper reaches of the Sim drainage are in the CWHws2 and MHmm2 variants, but the rest of the drainage is classified as the CWHvm1, CWHvm2, and MHmm1 variants.

In the south, the CWHxm2 subzone begins at sea level on West Thurlow Island and rises into the CWHmm1 variant. The areas around Phillips Arm are classified as the CWHdm (sea level to 300-400 m), CWHvm1 (up to 600 m), CWHvm2 (600-900 m), and the MHmm1 subzone/variants (above 900 m).

In 1998, Bob Green (B.A. Blackwell and Associates Ltd.) revised the distribution of the biogeoclimatic units in the TFL (Table 9). Previous mapping in the Klinaklini and Franklin watersheds reflected the belief that there was a stronger maritime influence in Knight Inlet than is actually the case. Field verification proved that the submaritime influence is stronger. Local glaciers and outflow winds from the Interior Plateau create cold winter temperatures that are

[6] Discussions with Bob Green October 15, 1999

characteristic of a sub-maritime climate. As a result, the CWHvm1, CWHds1, and CWHms1 variants in the Klinaklini and Franklin watersheds were grouped together and designated as the CWHms2 variant. In the south, the CWHmm1 variant on the eastern side of West Thurlow Island was expanded and the CWHxm2 variant was proportionally reduced.

Table 9. Area (ha) by site series.

Site	CWH							MH[a]			*Total*	
Series	dm	mm1	ms2	vm1	vm2	ws2	xm	mm1	mm2	mmp	*(ha)*	*(%)*
01	674	661	3,510	3,681	1,484	3,504	269	226	1,605		15,614	42.4
01s				105	10						115	0.3
02	8		397	14	6	23	25	51	325		848	2.3
03	136	213	2,893	1,367	616	1,333	103	5	13		6,677	18.1
04	9		1,302	20		309		9			1,649	4.5
05	377	33	3	1,096	12	9	100	4	76		1,709	4.6
06	14	271	1,704	428	371	1,154	15	10			3,967	10.8
07	136	18	467	2,177	109	1	22	18	46		2,993	8.1
08			343			0		1			345	0.9
09			135	127	68	5		8	10		353	1.0
10			41	45	8	1					95	0.3
11		5	163	0	95	36					299	0.8
12	2	53	11				2				68	0.2
13				16							16	0.0
14				84							84	0.2
NP	14	2	707	299	67	699	2	52	155	20	2,015	5.5
Total area	*1,369*	*1,256*	*11,676*	*9,458*	*2,844*	*7,073*	*538*	*384*	*2,229*	*20*	36,848	
(%)	3.7	3.4	31.7	25.7	7.7	19.2	1.5	1.0	6.1	0.1		*100*

[a] 719 ha were not classified to site series level in the MH operable forested landbase.

APPENDIX II – PRELIMINARY POTENTIAL SITE INDEX ESTIMATES

Table 10. Hw preliminary PSI estimates (m) for CWH subzones.

Site Series	dm	mm1	ms2	vm1	vm2	ws2	xm2
01	29	29	26	30	28	24	27
02	10	10	10	10	10	9	10
03	22	22	20	23	21	16	20
04	22	22	27	23	21	25	20
05	30	30	27	31	29	25	28
06	31	31	28	32	29	26	28
07	31	31	28	32	30	26	29
08	31	31	N/A	32	30	N/A	29
09	N/A	N/A	N/A	32	20	N/A	N/A
10	N/A	N/A	10	N/A	10	9	N/A
11	10	10	20	N/A	18	18	10
12	20	20	N/A	22	N/A	N/A	20
13	N/A	N/A	N/A	10	N/A	N/A	N/A
14	N/A	N/A	N/A	20	N/A	N/A	N/A

Table 11. Fdc preliminary PSI estimates (m) for CWH subzones.

Site Series	dm	mm1	ms2	vm1	vm2	ws2	xm2
01	32	32	31	34	31	27	31
02	18	18	18	18	18	17	18
03	25	25	24	29	26	21	24
04	28	28	35	30	27	31	27
05	35	35	32	37	35	28	35
06	33	33	38	34	31	34	32
07	38	38	38	38	36	N/A	38
08	38	38	N/A	38	36	N/A	38
09	N/A	N/A	N/A	38	N/A	N/A	N/A
10	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12	N/A	N/A	N/A	N/A	N/A	N/A	N/A
13	N/A	N/A	N/A	N/A	N/A	N/A	N/A
14	N/A	N/A	N/A	N/A	N/A	N/A	N/A
15	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 12. Ba preliminary PSI estimates (m) for CWH subzones.

Site Series	dm	mm1	ms2	vm1	vm2	ws2	xm2
01	N/A	28	25	29	27	23	N/A
02	N/A	10	10	10	10	9	N/A
03	N/A	21	19	22	20	16	N/A
04	N/A	23	26	24	22	24	N/A
05	N/A	30	26	31	29	24	N/A
06	N/A	31	27	32	29	25	N/A
07	N/A	35	27	35	32	25	N/A
08	N/A	35	N/A	35	32	N/A	N/A
09	N/A	N/A	N/A	35	18	N/A	N/A
10	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11	N/A	N/A	18	N/A	16	16	N/A
12	N/A	18	N/A	20	N/A	N/A	N/A
13	N/A	N/A	N/A	N/A	N/A	N/A	N/A
14	N/A	N/A	N/A	18	N/A	N/A	N/A
15	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 13. Cw preliminary PSI estimates (m) for CWH subzones.

Site Series	dm	mm1	ms2	vm1	vm2	ws2	xm2
01	26	27	24	28	25	22	25
02	11	11	11	11	11	10	11
03	22	22	21	23	20	16	21
04	23	23	25	24	21	23	22
05	28	28	25	30	27	23	27
06	28	28	26	30	27	24	27
07	30	30	26	31	28	24	30
08	30	30	N/A	31	28	N/A	30
09	N/A	N/A	N/A	32	20	N/A	N/A
10	N/A	N/A	10	N/A	10	9	N/A
11	10	10	22	N/A	20	20	10
12	22	22	N/A	22	N/A	N/A	22
13	N/A	N/A	N/A	10	N/A	N/A	N/A
14	N/A	N/A	N/A	22	N/A	N/A	N/A

APPENDIX III – ADJUSTMENT RATIO STATISTICS

Table 14. Adjustment ratio statistics for Hw and Fdc.

Subzone/Variant	Site Series	Hw N	Hw Prelim PSI	Hw Field SI	Hw Ratio of Means	Fdc N	Fdc Prelim PSI	Fdc Field SI	Fdc Ratio of Means
CWHdm	01	4	30.0	28.5		3	33.0	33.3	
	05	2	30.0	34.7		1	35.0	41.2	
	Wtd Avg	*6*	*30.0*	*30.5*	*1.018*	*4*	*33.5*	*35.3*	*1.054*
CWHms2	01	10	27.0	25.2		10	32.0	31.9	
	03	1	21.0	21.0		1	25.0	25.0	
	04	12	27.0	30.1		15	35.0	37.2	
	05	1	28.0	32.1					
	06	1	28.0	28.1		1	38.0	35.2	
	Wtd Avg	*25*	*26.8*	*27.8*	*1.035*	*27*	*33.6*	*34.7*	*1.033*
CWHvm1	01	1	31.0	26.5					
	05	6	31.0	32.6					
	06	1	33.0	25.1					
	Wtd Avg	8	31.3	30.9	0.989				
CWHvm2	01	1	29.0	31.1					
	06	2	30.0	31.3					
	Wtd Avg	3	29.7	31.2	1.051				
CWHvm1 & vm2	*Wtd Avg*	*11*	*30.8*	*31.0*	*1.006*				
CWHws2	01	7	25.0	24.6		3	28.0	30.8	
	04	1	25.0	22.2		1	31.0	29.6	
	Wtd Avg	*8*	*25.0*	*24.3*	*0.970*	*4*	*28.8*	*30.5*	*1.061*

Table 15. Adjustment ratio statistics for Ba and Cw.

Subzone/Variant	Site Series	Ba				Cw			
		N	Prelim PSI	Field SI	Ratio of Means	N	Prelim PSI	Field SI	Ratio of Means
CWHdm	01					4	27.0	27.8	
	05					2	28.0	33.6	
	Wtd Avg					*6*	*27.3*	*29.7*	*1.088*
CWHms2	01	10	26.0	24.9		10	25.0	24.7	
	03	1	20.0	21.8		1	22.0	20.8	
	04	12	26.0	28.5		12	25.0	29.3	
	05	1	27.0	30.1		1	26.0	31.2	
	06	1	27.0	27.1		1	26.0	27.5	
	Wtd Avg	*25*	*25.8*	*26.8*	*1.037*	*25*	*25.0*	*27.1*	*1.088*
CWHvm1	01	1	30.0	25.8		1	29.0	26.0	
	05	6	31.0	30.4		6	30.0	31.7	
	06	1	33.0	24.8		1	31.0	24.6	
	Wtd Avg	8	31.1	29.2	0.937	8	30.0	30.1	1.003
CWHvm2	01	1	28.0	29.3		1	26.0	30.2	
	06	2	30.0	29.4		2	28.0	30.4	
	Wtd Avg	3	29.3	29.4	1.001	3	27.3	30.4	1.111
CWHvm1 & vm2	*Wtd Avg*	*11*	*30.6*	*29.2*	*0.953*	*11*	*29.3*	*30.2*	*1.031*
CWHws2	01	7	24.0	24.4		7	23.0	24.1	
	04	1	24.0	22.6		1	23.0	21.9	
	Wtd Avg	*8*	*24.0*	*24.2*	*1.007*	*8*	*23.0*	*23.9*	*1.037*

APPENDIX IV – ADJUSTED PRELIMINARY POTENTIAL SITE INDEX ESTIMATES

Table 16. Hw adjusted preliminary PSI estimates (m) for CWH subzones.

Site Series	dm	mm1	ms2	vm1	vm2	ws2	xm2
01	29.5	29.0	26.9	30.2	28.2	23.3	27.0
02	10.2	10.0	10.4	10.1	10.1	8.7	10.0
03	22.4	22.0	20.7	23.1	21.1	15.5	20.0
04	22.4	22.0	27.9	23.1	21.1	24.3	20.0
05	30.5	30.0	27.9	31.2	29.2	24.3	28.0
06	31.6	31.0	29.0	32.2	29.2	25.2	28.0
07	31.6	31.0	29.0	32.2	30.2	25.2	29.0
08	31.6	31.0	N/A	32.2	30.2	N/A	29
09	N/A	N/A	N/A	32.2	20.1	N/A	N/A
10	N/A	N/A	10.4	N/A	10.1	8.7	N/A
11	10.2	10.0	20.7	N/A	18.1	17.5	10.0
12	20.4	20.0	N/A	22.1	N/A	N/A	20
13	N/A	N/A	N/A	10.1	N/A	N/A	N/A
14	N/A	N/A	N/A	20.1	N/A	N/A	N/A

Table 17. Fdc adjusted preliminary PSI estimates (m) for CWH subzones.

Site Series	dm	mm1	ms2	vm1	vm2	ws2	xm2
01	33.7	32.0	32.0	34.0	31.0	28.6	31.0
02	19.0	18.0	18.6	18.0	18.0	18.0	18.0
03	26.4	25.0	24.8	29.0	26.0	22.3	24.0
04	29.5	28.0	36.2	30.0	27.0	32.9	27.0
05	36.9	35.0	33.1	37.0	35.0	29.7	35.0
06	34.8	33.0	39.3	34.0	31.0	36.1	32.0
07	40.1	38.0	39.3	38.0	36.0	N/A	38.0
08	40.1	38.0	N/A	38.0	36.0	N/A	38.0
09	N/A	N/A	N/A	38.0	N/A	N/A	N/A
10	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12	N/A	N/A	N/A	N/A	N/A	N/A	N/A
13	N/A	N/A	N/A	N/A	N/A	N/A	N/A
14	N/A	N/A	N/A	N/A	N/A	N/A	N/A
15	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 18. Ba adjusted preliminary PSI estimates (m) for CWH subzones.

Site Series	dm	mm1	ms2	vm1	vm2	ws2	xm2
01	N/A	28.0	25.9	27.6	25.7	23.2	N/A
02	N/A	10.0	10.4	9.5	9.5	9.1	N/A
03	N/A	21.0	19.7	21.0	19.1	16.1	N/A
04	N/A	23.0	27.0	22.9	21.0	24.2	N/A
05	N/A	30.0	27.0	29.5	27.6	24.2	N/A
06	N/A	31.0	28.0	30.5	27.6	25.2	N/A
07	N/A	35.0	28.0	33.4	30.5	25.2	N/A
08	N/A	35.0	N/A	33.4	30.5	N/A	N/A
09	N/A	N/A	N/A	33.4	17.2	N/A	N/A
10	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11	N/A	N/A	18.7	N/A	15.2	16.1	N/A
12	N/A	18.0	N/A	19.1	N/A	N/A	N/A
13	N/A	N/A	N/A	N/A	N/A	N/A	N/A
14	N/A	N/A	N/A	17.2	N/A	N/A	N/A
15	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 19. Cw adjusted preliminary PSI estimates (m) for CWH subzones.

Site Series	dm	mm1	ms2	vm1	vm2	ws2	xm2
01	28.3	27.0	26.1	28.9	25.8	22.8	25.0
02	12.0	11.0	12.0	11.3	11.3	10.4	11.0
03	23.9	22.0	22.8	23.7	20.6	16.6	21.0
04	25.0	23.0	27.2	24.7	21.7	23.9	22.0
05	30.5	28.0	27.2	30.9	27.8	23.9	27.0
06	30.5	28.0	28.3	30.9	27.8	24.9	27.0
07	32.6	30.0	28.3	32.0	28.9	24.9	30.0
08	32.6	30.0	N/A	32.0	28.9	N/A	30.0
09	N/A	N/A	N/A	33.0	20.6	N/A	N/A
10	N/A	N/A	10.9	N/A	10.3	9.3	N/A
11	10.9	10.0	23.9	N/A	20.6	20.7	10.0
12	23.9	22.0	N/A	22.7	N/A	N/A	22.0
13	N/A	N/A	N/A	10.3	N/A	N/A	N/A
14	N/A	N/A	N/A	22.7	N/A	N/A	N/A

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