

Site Index (Productivity) Estimation Program

Progress Report and Five-year Plan 2000-2001 to 2004-05

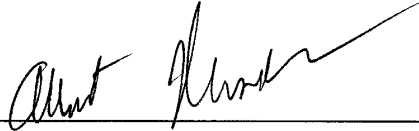
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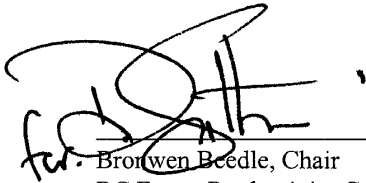
Site Productivity Working Group
A Joint Ministry, Industry and Academic Working Group

January 14, 2000

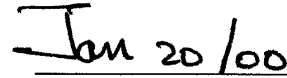
The Site Productivity Working Group submits *Site Index (Productivity) Estimation Program: Progress Report and Five-year Plan 2000-01 to 2004-05* to the BC Forest Productivity Council for approval.



Albert Nussbaum, Chair
Site Productivity Working Group



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BC Forest Productivity Council



Date

APPROVED/ ~~NOT APPROVED~~

Executive Summary

The Site Productivity Working Group (SPWG) was formed in 1993 in response to the need for improved information and tools for estimating site index and the productivity of commercial forest sites in British Columbia. The working group is comprised of experts from industry, academia and the Ministry of Forests, and reports to the Forest Productivity Council of British Columbia. Its recent work has been funded by Forest Renewal BC and guided by a rolling five-year plan. This document is an update to that plan for the period 2000–2001 to 2004–05.

This document sets out a five-year plan of action recognizing that:

- estimates of growth and yield are key to determining allowable annual cut (AAC) and that AAC is linked to forest jobs and community stability;
- investment decisions in silviculture must be based on knowledge of the outcome of those investments;
- new, more accurate estimates of site productivity are expected to help mitigate downward pressures on AAC in many areas of the province;
- it is inefficient to duplicate research efforts in industry, academia or government. Cooperative programs can effectively and efficiently meet forest managers' needs for site index and site productivity tools.

Priority project areas are consistent with the Forest Productivity Council's *Forest Productivity Strategy 1999-2003*. The Council's priority areas pertinent to SPWG include complex stand work (and determination of site productivity), and site productivity tools and measurement. The plan outlined here calls for annual expenditures increasing from \$577,038 in the 2000/01 fiscal year, to approximately \$865,000 per year for the following years through to 2005.

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1. Introduction

1.1 The importance of site productivity

The achievement of many of our environmental, social and economic goals in forest management depends on knowledge of forest growth rates. Site index is a measure of the productive capacity of a site. It is a key variable in predicting the growth and yield of timber and therefore is important for British Columbia's industrial and economic development.

Accurate estimates of site index help ensure that forest management is guided by sound investment decisions. We need to know that our silviculture expenditures will result in the greatest possible benefit. The productivity of various tree species in specific landscapes and ecosystems is a key determinant to silviculture investments.

Estimates of growth and yield are also key variables in the determination of allowable annual cut (AAC). Inaccurate estimates may contribute to predicted fibre shortages and/or negative environmental impacts, which can put forest jobs and communities at risk. With today's economic and environmental challenges, AAC decisions must be based on sound scientific evidence.

Site index is defined as the average height that top height trees of a given species can achieve at breast height age 50 when they are able to grow to their full potential.

Site index estimates are used primarily in:

- silviculture to describe site quality, aid in formulating appropriate prescriptions, schedule and rank treatments, and predict stand growth and yield;
- timber supply analyses to estimate years to green-up, the size of the operable landbase, the minimum harvestable age, the yield of regenerated stands, and the growth of existing stands; and
- inventory as a basic descriptor of site quality and to project inventory volume growth.

1.2 British Columbia's commitment to site productivity

In July 1993, government, industry and academic representatives were formally brought together as the Site Productivity Working Group (SPWG) to deal with site index and site productivity issues at a strategic level. The group works cooperatively, and sometimes in partnership, with other groups and individuals already working on site productivity research. The SPWG regularly liaises with others across the province through meetings, workshops, conference calls and user needs surveys. The SPWG reports to the Forest Productivity Council of British Columbia (FPC).

The vision of the SPWG is to:

coordinate the development of site productivity estimation techniques that provide the means to accurately estimate the productivity of any forest stand in British Columbia.

This vision is consistent with those of the Ministry of Forests' Growth and Yield Program strategy and the Forest Productivity Council of British Columbia.

The *mandate* of the SPWG is to:

identify, prioritize and implement research into site index and site productivity estimation and measurement techniques, in order to improve the accuracy of growth and yield projections and, ultimately, to enhance our knowledge of British Columbia's forests, and hence its commercial value.

Current SPWG activities are guided by FPC priorities in a "rolling" five year plan. Funding has been provided by Forest Renewal BC (FRBC) since 1994.

1.3 Priority project areas

The FPC outlined their priorities for considering project areas in the Forest Productivity Strategy 1999-2003. The four priority areas are:

1. Complex Stands (including developing tools for assessing and projecting stand structure, modeling for forest level applications, assessment of response to management practices, determination of yield projections, and determination of site productivity)
2. Wildlife/Habitat/biodiversity (forest measurement linkages)
(specific project areas will be developed by the FPC Biodiversity Working Group, which was recently formed)
3. Inventory Projection Tools
4. Site Productivity Tools and Measurement

The SPWG took these issues into account in the preparation of its five-year strategy.

2. Site Index Tools and Techniques

2.1 Site index tools

The following site index tools are currently in use or are being developed for use within British Columbia. Appendix 1 indicates the status of the main site index tools currently used in British Columbia.

Height–age (Site Index) Models: estimate height as a function of site index and age (commonly used to estimate site index from height and age).

Growth Intercept Models: estimate site index from height and age; for young stands.

Species Conversion Models: estimate the site index of one species from that of another species in a mixed stand.

Site Index Biogeoclimatic Ecosystem Classification (SIBEC) Models: estimate site index from BEC unit and site series (or other classification level within the BEC system).

Years to Breast Height Models: estimate years to breast height from site index.

Operational Adjustment to Site Index Study (OASIS): technique to apply SIBEC to a landbase.

Old Growth Site Index (OGSI) Adjustments: estimate site index for a regenerated stand from site index of old-growth stand.

2.2 Data collection standards

The SPWG has documented standards for the collection of data to build site index tools. The following data collection standards are available from the SPWG coordinator.

Stem Analysis: minimum standards for stem analysis to develop height–age, site index, and growth intercept models.

SIBEC: minimum standards for data collection and quality assurance for use in the development of SIBEC models.

Old Growth Site Index (OGSI) Adjustments: data collection procedures for paired plots, and relocation and remeasurement of logged TSPs.

3. Program Expenditures

3.1 Program expenditures 1995-96 to 1999-2000

The SPWG has sponsored projects with total expenditures close to \$9.5 million during the past five years. Expenditures by project area are identified in Table 1.

Table 1. Expenditures by project area from 1995–96 to 1999-00

Project Area	1995–96 (\$)	1996–97 (\$)	1997–98 (\$)	1998-99 (\$)	1999-00 (\$)
1. OGSi	791,500	3,734,000	1,500,000	–	-
2. SIBEC	370,000	210,000	509,400	387,500	347,000
3. Height–age, site index, and growth intercept models	386,000	204,900	333,500	202,500	101,000
4. Field judgement	–	–	18,750	20,000	12,000
5. Biophysical	–	–	22,500	25,000	0
6. Species conversion	–	–	18,000	10,000	4,000
7. Uneven-aged/Partial cut	10,000	–	95,500	100,000	100,000
8. Years to breast height	–	–	45,000	50,000	5,000
9. Communications	–	–	6,750	25,000	8,038
Totals	1,557,500	4,148,900	2,549,400	860,000	577,038*

* Estimated spending to the end of the fiscal year (March 31, 2000).

3.2 Proposed budget 2000-01 to 2004-05

The estimated costs for 2000-01 to 2004-05 are presented in Table 2.

Table 2. Estimated annual costs for SPWG five-year plan

Project	Short term (\$)	Medium term (\$)		Long term (\$)	
	2000-01	2000-02	2002-03	2003-04	2004-05
1. Complex stands	180,000	180,000	180,000	180,000	180,000
2. SIBEC	310,000	330,000	330,000	330,000	330,000
3. Height-age and growth intercept	260,000	245,000	245,000	245,000	245,000
4. Default site index	20,000				
5. Years to breast height	75,000	75,000	75,000	75,000	75,000
7. Communication	40,000	35,000	35,000	35,000	35,000
Totals	885,000	865,000	865,000	865,000	865,000

4. Proposed Strategy 2000–01 to 2004–05

4.1 Proposed projects for 2000–01

Table 3. Projects proposed for 2000-2001

Project area	Project type		
	Develop new tool	Evaluate existing tool	Extension
Complex stands**	<p>CONTINUING:</p> <p>Extend 1998 work linking basal area growth and site index.</p> <p>Liaison/coordinate work with Stand Level Working Group to determine estimation tool and data needs for complex stands.</p> <p>NEW:</p> <p>Ep-Fd-Cw species site index conversions in mixed ICH and IDF stands. Concurrently, gather preliminary data to determine feasibility of developing a conversion for understorey conifers and site index.</p> <p>Ep-Sx conversions in the BWBS.</p>	<p>Develop a working plan for testing of existing SI estimation methods in complex stands and test in selected stands.</p>	<p>Communicate 1999 results.</p> <p>Extend results of radial increment project (with caution).</p>
SIBEC	<p>CONTINUING:</p> <p>Complete OASIS procedures manual.</p> <p>Complete re-design of SIBEC database and input new data.</p> <p>NEW:</p> <p>Update broadleaf component of SIBEC guide.</p> <p>Directed sampling will also target site series with complex stands structure.</p>	<p>Comparisons of SIBEC guide to new data.</p> <p>Evaluating alternative approaches to SIBEC application.</p>	<p>Communicate 1999 results.</p> <p>Promote SIBEC guide and provide SIBEC data collection training.</p>
OGSI			<p>Continue to assist with data collection and application issues for OASIS.</p>

Project area	Project type		
	Develop new tool	Evaluate existing tool	Extension
Height–age, growth intercept and site index models	<p>CONTINUING: Develop height–age models from existing data.</p> <p>NEW: Investigate height growth reduction factors.</p> <p>Developing strategy for GI modelling.</p>	<p>Compare performance of SIBEC, growth intercept and height-age to determine when to use each.</p> <p>Evaluate new models for BI, PI, and Sx in ESSF.</p> <p>Test growth intercept models against data from silviculture experiments.</p>	<p>Distribute results of tests of the performance of growth intercept models.</p> <p>Distribute growth intercept and height–age models for Cwi and others if possible.</p> <p>Communicate 1999-00 results.</p>
Field judgement	<p>NEW: Improving estimates for young stands on FIP file.</p>		<p>Communicate 1999-00 results.</p>
Species conversion	<p>CONTINUING: Model Hw–Cw.</p> <p>Update FS 660 table.</p> <p>Data collection.</p>		<p>Produce extension note for models and distribute revised FS 660.</p>
Years to breast height	<p>CONTINUING: Complete 1998 Sw work.</p> <p>Assess ytb and yt green-up in managed stands for other species.</p> <p>NEW: Fdc juvenile height growth.</p>		
Stem analysis database	<p>CONTINUING: Continued maintenance.</p>		
Communication	<p>CONTINUING: Maintain/Enhance internet site.</p> <p>Develop extension materials.</p> <p>Conduct regular program review.</p> <p>Assess SPWG program priorities in light of impact on timber supply analysis.</p>		<p>Hold meeting with site index tool users.</p> <p>Continue biannual tech. meetings.</p>

* See Appendix 2 for a list of tree species codes.

** Complex stands, for our purposes, are grouped as either uneven-aged and multi-storied (and maybe single species) or mixed species (and usually exhibiting a vertical structure).

4.2 Goals by project area: 2001–02 to 2004–05

Table 4. Goals by project area: 2001–02 to 2004–05

Project	Activities
Complex stands	<ul style="list-style-type: none"> continue to develop methods for estimating site productivity in complex stands.
SIBEC	<ul style="list-style-type: none"> determine SIBEC data gaps. additional OASIS refinements. collect site series/site index data to refine SIBEC models. produce second approximation of site series correlations. assess performance of SIBEC models.
OGSI	<ul style="list-style-type: none"> extension
Height–age growth intercept site index models	<ul style="list-style-type: none"> determine priorities for height–age and growth intercept model development (BC data sources). proceed with height–age and growth intercept model development (BC data sources). validate the currently existing height–age and growth intercept models with BC data. grouping height-age curves where feasible. continue develop height reduction factors.
Field judgement	<ul style="list-style-type: none"> develop techniques to replace/improve field judgement estimates
Species conversion	<ul style="list-style-type: none"> develop conversion equations as needed.
Years to breast height	<ul style="list-style-type: none"> develop years to breast height functions. assess performance of existing ytb models.
Communications	<ul style="list-style-type: none"> continue extension activities.

5. Summary

Site index is a crucial variable in predicting the growth and yield of forest stands. More work is required before we can accurately estimate the productivity of all forest stands in British Columbia. This five-year plan sets out a course of action that recognizes the following:

- Estimates of growth and yield are key variables in the determination of allowable annual cuts (AACs). Inaccurate estimates may contribute to predicted fibre shortages and/or negative environmental impacts, which in turn, can put forest jobs and communities at risk. With today's economic and environmental challenges, AAC decisions must be based on the soundest scientific information available. Recognizing that our site index tools are inadequate in many situations, the current five-year plan will help reduce the degree of risk inherent in many of today's AAC decisions.
- Improved silviculture investment analysis will lead to an enhanced ability to identify appropriate prescriptions and treatment regimes, and a greater capacity to quantify benefits and results. The current five-year plan will continue to improve the capacity of government and industry to make wise investment decisions and to understand treatment benefits.

Continued efforts to address site index and productivity issues are essential in order to develop sound rationales for investment decisions and to ensure the timely development of site productivity measurement tools. We have presented a five-year plan that will continue to improve the quality of decisions. This is vital in maintaining British Columbia's commitment to sustaining jobs, the economy, communities and environmental integrity.

Appendix 1. Status of Site Index Tools

Site index tool	Available for these species/regions	Comments on limitations	Under development
Height–age	Coast (1): Ac,* Ba, Cw, Dr, Fd, Hw, Ss Interior (2): At, Bl, Cw, Ep, Fd, Hw, Lw, Pl, Pw, Py, Sx	Coast: Data for Hw curves contained no samples from coastal BC. Interior: a) Data for At, Cw, Ep, Lw, Pw, and Py curves contained no samples from interior BC. b) Bl curve is actually the curve for coastal Ba.	Projects leading to new or improved height–age models: Coast: (J) Dr, Ac, Mb Interior: (A) Cw (B) Bl, Pl, and Sx in the ESSF (B) At, Sb.
Growth intercept	Coast (3): Fd, Hw, Ss Interior (4): Bl, Fd, Hw, Pl, Sx		Projects leading to new growth intercept models: Interior: (A) Cw (B) Lw
SIBEC	Publication and field guide inserts with SIBEC predictions for most conifer species on most forest ecosystems in all regions of the province (5).		OASIS project to develop method to apply SIBEC to landbase (I). SIBEC database with metadata linked to detailed plot data and data entry program.
OGSI	Hw in Kalum TSA (6) and Pl in central BC (7). OGSI adjustments for key species in all regions of the province as part of the provincial OGSI project (10, 11).		Implementation issues being addressed (D).
Field judgement	Original GMPL table available for all species in all regions (8). All blank SI estimates for forest cover polygons in ISIS will be updated with SIBEC-based SI estimates by March 1999 (F). Table for each district depicting SIBEC-based distribution of ISIS area by site index class will be distributed by March 1999 (F).	Recent data indicates significant bias in this table.	

Site index tool	Available for these species/regions	Comments on limitations	Under development
Species conversion	Coast (9): Fd-Hw; Hw-Ss; Ba-Hw. Interior (9): Bl-Pl; Bl-Sx; Fd-Pl; Fd-Hw; Fd-Lw; Fd-Sx; Lw-Pl; Pl-Sx.		New species conversion equations for coastal Hw-Cw.
Biophysical	MB proprietary model.		Project suspended at this time (G).
Uneven-aged			Pilot project on the prediction of SI from basal area growth in Fdi stands will be complete by March 1999 (H).
Years to breast height	All species for which there is a recommended height-age curve (1) and (2).	Coast: Data for Hw curves contained no samples from coastal BC. Interior: a) Data for At, Cw, Ep, Lw, Pw, and Py curves contained no samples from interior BC. b) Bl curve is actually the curve for coastal Ba. c) Cw curve is actually the curve for coastal Fd. d) Pw curve is actually the curve for Sx. e) Ep curve is actually the curve for At.	Projects leading to new or improved ytb models: Coast: Dr (I) Interior: Sw (A, I)

References for published tools

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- (7) Goudie, J. 1996. The effects of stocking on estimated site index in the Morice, Lakes, and Vanderhoof timber supply areas in central British Columbia. B.C. Min. For., Res. Br., Unpubl. rep., Victoria, B.C.
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- (9) Nigh, G.D. 1995. Site index conversion equations for mixed species stands. B.C. Min. For., Res. Br., Res. Rep. 1. Victoria, B.C.
- (10) Nigh, G.D. 1998. Site index adjustments for old-growth stands based on veteran trees. Res. Br., B.C. Min. For., Victoria, B.C. Work Pap. 36.
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Project leader for work in progress

- (A) Gord Nigh, Ministry of Forests, Research Branch
- (B) Karel Klinka, UBC
- (C) Shirley Mah, Ministry of Forests, Research Branch
- (D) Colleen McKendry, Ministry of Forests, Resources Inventory Branch
- (E) John Barker, Western Forest Products
- (F) Patrick Martin, Ministry of Forests, Forest Practices Branch
- (G) Nick Smith, MacMillan Bloedel
- (H) Pat Salm, Weyerhaeuser
- (I) Bobby Love, Ministry of Forests, Prince Rupert Region
- (J) Keith Thomas, Ministry of Forests, Research Branch

Appendix 2. List of Tree Species Codes

Code	Common name
Conifers	
Ba	amabilis fir
Bl	subalpine fir
Cw	western redcedar
Cwi	interior western redcedar
Fdc	coastal Douglas-fir
Fdi	interior Douglas-fir
Hw	western hemlock
Lw	western larch
Pl	lodgepole pine
Pw	western white pine
Py	ponderosa pine
Sb	black spruce
Si	interior spruce
Ss	Sitka spruce
Sx	hybrid spruce
Broad-leaved trees	
Ac	cottonwood/poplar
At	trembling aspen
Dr	red alder
Ep	common paper birch
Mb	bignleaf maple
Ax	hybrid poplar

Appendix 3. Detailed SPWG Project Planning: Current and Next Fiscal Year

Project Area	Project Description	Fiscal Year		Project Leader	Branch Resp.	Comments
		1999/00	2000/01			
Complex stands*	New work (liaison/projects with SLWG)	72,000	50,000	Martin	FPB - Pat	
	Data collection	28,000	130,000	Martin / Nigh	FPB / RB	
SIBEC	Dr, Ep sampling	60,000		Comeau/Thomas	RB - Gord	complete 99/00
	At, Sb sampling	130,000		Klinka	RB - Gord	complete 99/00
	OASIS extension and procedures manual	20,000	30,000	Love	RB - Gord	
	Training, analyses, database	37,000	80,000	Mah	RB - Shirley	
	Data Collection	100,000	160,000	Nigh	RB - Gord	
	NEW - Deciduous supplement		40,000	Mah	RB- Shirley	
Ht-age and GI	Validation of GI	65,000	80,000	Martin	FPB - Pat	
	Maintain stem analysis database	13,000	30,000	Nigh/Vivian	RB - Gord	
	Spp/SI groups(grouping htage curves)	10,000		Nigh	RB - Gord	
	NEW - Ht Age curve work		150,000	Nigh	RB - Gord	
Field Judgement	Improving estimates	12,000	20,000	Albert	RB - Albert	
YTBH	Data Collection	5,000	75,000	Nigh	RB - Gord	
Communication	Communication projects	8,038	15,000	McKendry	RIB - Col	
	Publications (journal articles, research reports,	17,000	25,000	Nigh	RB - Gord	
	TOTAL:	577,038	885,000			

** Complex stands, for this purpose, are grouped as either uneven-aged and multistoried (and maybe single species) or mixed species (and usually exhibiting a vertical structure).