
FIA-FSP

Forest Science Board

Timber Growth and Value Program

Research Strategy 2006–2016

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Timber Growth and Value Program Research Strategy 2006–2016

1.0 Context

Forest Science is one of seven programs in British Columbia's Forest Investment Account (FIA) to promote sustainable forest management. The FIA Forest Science Program (FIA-FSP) focuses on applied research and the extension of forest science results to meet the information needs and priorities of those who plan and manage British Columbia's public forest lands.

The program seeks to improve sustainable forest management by:

1. developing knowledge that addresses key short- and long-term forest management challenges
2. delivering existing and new information to practitioners, managers, and policy-makers.

The FIA-FSP funds three programs: Sustainability, Timber Growth and Value, and Forest Extension. A 14-member Forest Science Board (FSB) advises the Deputy Minister of Forests and Range (MoFR) on FIA-FSP strategies and priorities. The FSB relies on Program Advisory Committees (PACs) to assess issues and information needs within their program areas; evaluate available knowledge; identify knowledge gaps and strategies to address them; and make recommendations on priority issues, themes, and topics for annual funding support. The PACs also recommend mechanisms for delivering their programs.

This document is the strategy for the FIA-FSP Timber Growth and Value Program. It is updated periodically to reflect changing priorities and expectations of the overall program. Section 2 outlines the Timber Program Advisory Committee (TPAC) mandate and structure. Section 3 describes the program's strategic framework. Section 4 outlines the priority-setting process. Section 5 discusses program delivery and Section 6 the research implementation timeline. Appendix 1 presents the scores for research topic priorities that were used to determine the eligible research topics in 2007/08. Appendix 2 includes detailed descriptions of the research themes and topics.

2.0 TPAC Mandate and Structure

2.1 TPAC Mandate

The TPAC mandate has two components:

- developing and periodically updating a 10-year strategy for addressing short- and long-term research priorities related to improving timber growth and value within the scope of the FIA-FSP
- developing and implementing an efficient and effective process for determining annual research priorities that meet defined business needs.

In fulfilling this mandate, the TPAC:

- advises the Forest Science Board on critical issues, knowledge gaps, and information needs relevant to the Timber Growth and Value Program
- annually recommends research priorities for the FIA-FSP Research Call for Proposals
- reviews and comments to the Board on the annual recommendations for maintenance of long-term research installations.

2.2 TPAC Membership

The TPAC consists of approximately 14 members, with 12 appointed by the Board from across the forest sector, and two representatives of the provincial extension provider who designs and implements the provincial forest extension program. Membership should reflect a geographically balanced complement of people from government agencies, First Nations, forest companies, the consulting community, academia, and research institutes. At least one Board member sits as an *ex-officio*, non-voting member of the TPAC, thus serving as a liaison between the two bodies.

The TPAC meets several times each year to discuss research priorities, set out a strategy for delivery, and address other issues at the request of the Forest Science Board. PAC members are encouraged to consult with providers and users of forest science within their area of expertise or geographic region, including groups that collect and maintain resource information.

3.0 Strategic Framework

Investments made through the FIA-FSP are expected to contribute to the government's goal of having a leading edge forest industry that is globally recognized for its productivity, environmental stewardship, and sustainable forest management practices. The Board and its PACs work to focus investments on high priority research and extension that address user needs, avoid duplication, and leverage funds by attracting money from other sources.

3.1 Program Strategies

The *FIA-FSP Strategic Plan 2004-2008* sets out the vision and strategic goals of the FIA-FSP, and identifies priority themes in each program area. Within the parameters of the Strategic Plan, each PAC evaluates available knowledge, identifies gaps, examines opportunities for cooperative research and leveraging funding, and makes recommendations to the Board pertinent to its program area. Component strategies for the Sustainability, Timber Growth and Value, and Forest Extension programs outline the priorities and methods to achieve each program's mandate.

The **Timber Growth and Value Program** focuses on research to improve:

- prediction of tree and stand growth, and wood properties and values under various management regimes and for different stand types
- forecasting of timber losses and stand development following natural disturbances
- evaluation and development of management regimes for co-production of timber and non-timber values

- effectiveness of mandated policies and practices.

Its eight themes, topics, and priorities address knowledge gaps affecting management issues, costs, or product value (Table 1). TPAC members recommended these topics and priorities. Forestry professionals province-wide and a selection of domain experts were invited to review a draft list of identified topics. TPAC members considered comments from both groups in the development of this strategy.

Table 1 Timber Growth and Value Program themes, topics, and priorities

#	Theme/Topic	Priorities
1.0	Basic research on tree growth and stand development	
1.1	Complex stands including partial cutting, variable retention	<ul style="list-style-type: none"> a Species interactions b Microclimate effects related to tree and stand growth in multi-storied stands c Natural regeneration d Mortality in seedling, sapling and pole stages
1.2	Early stand growth	<ul style="list-style-type: none"> a Subalpine fir (<i>Abies lasiocarpa</i>) b Western redcedar (<i>Thuja plicata</i>) c Yellow-cedar (<i>Chamaecyparis nootkatensis</i>)
1.3	Old stands	<ul style="list-style-type: none"> a Volume loss b Mortality
2.0	Design and analysis of silvicultural systems	
2.1	Complex stands including partial cutting, variable retention	<ul style="list-style-type: none"> a The relationship between residual stand structure and understory recruitment and development; evaluation of the results of partial cuts and the effects on stand establishment, early growth and yield, and response to management practices b Development and monitoring of the impact of various stand treatment regimes on regeneration
2.2	Even-aged stands	<ul style="list-style-type: none"> a Assessment and analysis of fertilization experiments or trials (but not the initiation of new trials) b Repressed stands c Genetic realized-gain trials d Espacement trials - remeasurement and analysis of existing trials e Interactions among silvicultural treatments (existing, not new trials)
3.0	Growth and yield modeling/predictions	
3.1	Complex stands including partial cutting, variable retention	<ul style="list-style-type: none"> a Boreal mixedwood (spruce–pine–aspen) b Fire-maintained stands c Coastal BEC zones (MH, CDF, CWH) d Interior BEC zones (ESSF, MH, SBS, ICH [NIR]) e Interior BEC zones (IDF, ICH [SIR])
3.2	Wood quality	<ul style="list-style-type: none"> a Determining impacts of silvicultural regimes on wood quality

#	Theme/Topic	Priorities
4.0	Timber losses to environmental and biotic factors (wind, drought, insects, disease, animal damage, fire)	
4.1	Stand and forest dynamics following MPB	<ul style="list-style-type: none"> a Quantification of stand and forest change and development following MPB attack, including GY modeling, and impacts on timber supply. Evaluating and estimating timber growth implications on residual trees and regenerated stands, in the understory, and in clearcut openings. Includes species interactions related to the scale and pattern of harvesting. b Growth, development, and health of residual stands (overstory and understory) across a wide range of post-attack stand types and conditions (i.e., mixed species - salvaged; mixed species - unsalvaged; pine dominant - unsalvaged) in different BEC zones. Includes mitigating losses. c Mitigating MPB losses: silvicultural treatments and regimes, such as fertilization of non-lodgepole pine stands and treatment of repressed lodgepole pine stands, to accelerate operability and enhance mid-term timber supply
4.2	Estimating stand-level losses (other than MPB)	<ul style="list-style-type: none"> a Windthrow b Ips beetles c Spruce bark beetle d Root disease (Armillaria, Phellinus) e Spruce leader weevil f Rusts: Dothistroma, Commandra, Western gall g Spruce budworm
4.3	Mitigating losses (other than MPB)	<ul style="list-style-type: none"> a Browse b Growth and yield implications of stand management at the urban interface for fire hazard protection c Spruce budworm d Dothistroma (e.g., applications of copper sulphate)
5.0	Analytical techniques and models for strategic analysis	
5.1	Integration of data and models across scales	<ul style="list-style-type: none"> a Techniques for integrating various data sources for strategic analyses (e.g., forest inventory, remote sensing, GY, and non-conventional data layers such as NTFP and tourism)
5.2	Development of novel methods to link process and empirical GY models	<ul style="list-style-type: none"> a Hybrid modeling (e.g., connecting SORTIE functionality with PROGNOSIS or TASS)
6.0	Marketable resources other than timber¹	
6.2	Non-timber forest products (NTFP)	<ul style="list-style-type: none"> a Development and assessment of techniques for producing other resources in conjunction with timber production under various silvicultural systems b Developing innovative methods to inventory and value NTFP, using multi-media and multi-scale approaches c Defining relationships between high value NTFPs, forest site conditions, and stand dynamics d Assessing impacts of environmental factors on marketable non-timber resources
6.3	Biofuels	<ul style="list-style-type: none"> a Silvicultural treatments for managing for production of biofuels, in conjunction with timber production

¹ Topic 6.1 was reorganized and assigned to other topic areas in this theme.

#	Theme/Topic	Priorities
7.0	Climate change	<ul style="list-style-type: none"> a Predicting the effects of climate change on growth and yield at the tree, stand, and landscape levels b Predicting effects of climate change on forest health and condition (e.g., insects, disease, fire) c Responding to ecosystem shifts including: establishment or new, and reassessment of existing species and genecology trials; understanding ecosystem resilience; assessing risk
8.0	Forest harvesting and engineering studies on salvaged MPB-killed timber	<ul style="list-style-type: none"> a Forest engineering studies relating to designing efficient, cost-effective, and environmentally appropriate methods of harvesting and hauling MPB-killed timber b Studies to quantify the rates and amount of deterioration of MPB-killed timber for forest product use in relation to timber supply, harvest scheduling, and salvage operations

3.2 Annual Priorities

Research themes and topics are reviewed and updated annually in consideration of feedback from research users and researchers. The Sustainability and Timber PACs identify research priorities that shape the September Research Call for Proposals. Expert review committees evaluate all proposals. Based on their recommendations and PAC priorities, the Board recommends the allocation of available funds to research projects.

When approved by the Deputy Minister of Forests and Range, the Board's recommendations for research, extension, program development, and administration constitute the annual FIA-FSP Business Plan.

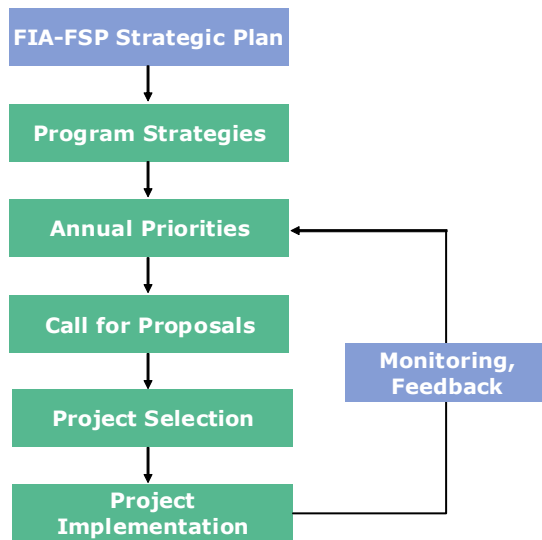
3.3 Monitoring

Progress monitoring and feedback to the Board and PACs occur through several mechanisms, including:

- feedback from the administrators of the Call for Proposals process (PricewaterhouseCoopers)
- forestry community communication with individual PAC members
- response to broadcast invitations for comments on this strategy
- reviewing proposals and project deliverables
- feedback from the provincial forest extension provider (FORREX).

To monitor research progress on priority topic areas, successful research projects are correlated with priority topics to determine whether key issues are being addressed and additional work is needed.

Figure 1 illustrates the strategic framework for FIA-FSP research.

Figure 1 Strategic framework for FIA-FSP research.

4.0 Program Priority-Setting

Early in each fiscal year, the Sustainability and Timber Growth and Value PACs set priorities to define the eligible topics for the September Research Call for Proposals. This process includes reviewing the program strategy; considering the program's relevance to key interests and initiatives; reviewing the funding of program themes, topics, and priorities to date; considering research activities being carried out by other agencies and opportunities for collaborative work; identifying new issues and/or priorities since the previous year; and scoring the program themes, topics, and priorities.

4.1 Scoring Process

The scoring process has five steps:

- amending and/or confirming the topics and priorities under each Program theme
- assigning preliminary scores to each priority, and distributing to PAC members
- canvassing of constituents by members, assigning a score to each priority, and identifying any theme, topic, or priority issues (including the need to add new topics or priorities)
- compiling a group scoresheet and distributing to PAC members as background for a group discussion
- confirming the PAC's final scores.

Using the scores, the PAC recommends eligible topics and priorities for the Call for Proposals to the Forest Science Board (See Appendix 1).

4.2 Limitations to the Setting of Research Priorities

Priority development and research delivery have the following limitations:

- information on research needs is incomplete
- understanding of research needs is imperfect
- the scoring system has a relatively coarse resolution and small number of criteria
- funding constraints limit the scope of the research themes considered and research topics recommended
- resolution of geographic strata is not optimal for the evaluation of many research topics
- the relative importance of the evaluation criteria varies by individual, agency, and company.

5.0 Program Delivery

5.1 Program Delivery Models

Effective program delivery is facilitated by administrative and contractual mechanisms that maximize the portion of program funds directed to research activities while meeting fiscal and legal requirements. Program delivery mechanisms are the purview of the Forest Science Board.

Research resources and needs vary with the types of research. Considerations in the choice of delivery mechanism for specific research themes or topics could include:

- abundance and availability of human resources capable of undertaking the work
- dispersion or centralization of expertise needed for the work (centralized in one group vs. dispersed across many agencies or companies)
- access to knowledge capital, including models that are not readily transferred for further development
- access to research installations and data that are not readily available to other researchers for logistical or technical reasons
- project longevity (short-term vs. long-term and ongoing research).

Possible administrative mechanisms vary from an open request for proposals (RFP) administered and monitored annually, to directed program funding delivered and monitored in accordance with an approved business plan. Table 2 compares the suitability of an RFP process and directed program delivery. Where considered appropriate, program delivery will be pursued. Growth and yield modeling is a topic area under consideration for development of a business plan with directed funding to business plan components.

Table 2 Considerations in employing a request for proposal or directed program delivery

Considerations	RFP preferred	Program delivery preferred
Abundance/scarcity of human resources	abundant	scarce
Dispersion/centralization of expertise	dispersed	centralized
Access to knowledge capital	accessible	not widely accessible
Access to research installations and data	accessible	not widely accessible
Project longevity	short	long

5.2 FIA-FSP Call for Proposals

The FIA-FSP currently uses a call for proposals process to solicit research projects, and a program delivery approach to implement the Provincial Forest Extension Program (PFEP).

The FIA-FSP Call for Proposals follows a two-stage competitive process, based on the current research priorities set by the Forest Science Board on advice from the PACs. The first stage involves a letter of interest (LOI) that briefly describes the proposed project. Proponents whose LOIs pass the first review phase are invited to submit a detailed proposal (second stage). Expert review committees evaluate all proposals. Based on their recommendations and PAC priorities, the Board recommends the allocation of available funds to research and extension projects. When approved by the Deputy Minister of Forests and Range, these recommendations constitute the annual FIA-FSP Business Plan.

5.3 Research Problem Analysis, Synthesis, and Gap Analysis

In 2006/07, the TPAC will commission research syntheses and gap analyses on theme 3, growth and yield modeling/predictions; and theme 4, marketable resources other than timber.

6.0 Research Implementation Timeline

Research on priority topics must be delivered over a period of years, due to limitations of funds, skilled researchers, and biological requirements associated with long-term research. Research priorities will change as information from ongoing research addresses knowledge gaps, as forest management operational needs change, and as new issues arise. Therefore, research priorities will be updated annually, and over time, priority topics will change.

Appendix 1 – Scoring Research Priorities

Scoring System

Research priorities were set by geographic region to aid in ranking research needs across highly diverse provincial forests. Regional rankings were aggregated to the provincial level for development of the provincial program. There is no expectation of equal funding being accorded to each region by the FSB; rather, efforts will be made to address the highest priority needs at the provincial level.

Research topic priorities are scored for each region² in consideration of the size of knowledge gap (the degree to which lack of knowledge is affecting management, cost, or value), the urgency of the priority, and the percentage of the region to which the priority applies. Table 3 shows how these criteria are combined to develop a score from 1 (highest) to 8 (lowest).

Table 3 Scoring system used to rank research topics

KNOWLEDGE GAP (large, medium, small)	URGENCY (great, moderate, low)	% of REGION (>50%, <50%)	Short-form assessment	SCORE
LARGE	Great	>50%	LG>	1
LARGE	Great	<50%	LG<	2
LARGE	Moderate	>50%	LM>	3
LARGE	Moderate	<50%	LM<	4
LARGE	Low	>50%	LL>	5
LARGE	Low	<50%	LL<	6
MEDIUM	Great	>50%	MG>	2
MEDIUM	Great	<50%	MG<	4
MEDIUM	Moderate	>50%	MM>	4
MEDIUM	Moderate	<50%	MM<	6
MEDIUM	Low	>50%	ML>	5
MEDIUM	Low	<50%	ML<	7
SMALL	Great	>50%	SG>	3
SMALL	Great	<50%	SG<	5
SMALL	Moderate	>50%	SM>	5
SMALL	Moderate	<50%	SM<	6
SMALL	Low	>50%	SL>	7
SMALL	Low	<50%	SL<	8

Research Priority Scores 2007/08

Table 4 lists the scores for research topic priorities for the 2007/08 fiscal year. The priorities with scores of 1, 2, 3, or 4 were designated as eligible topics for the 2007/08 Call for Proposals.

² Ministry of Forests and Range administrative regions were used (Coast, Southern Interior, and Northern Interior).

Table 4 2007/08 scores for Timber Growth and Value Program topic priorities
Columns 4 to 6 indicate relevance to the Future Forest Ecosystem Initiative (FFEI), identified First Nations issues (FN), and Mountain Pine Beetle (MPB)

#	Theme/Topic	Priorities	FFEI	FN	MPB	Score		
						Coast	N. Int.	S. Int.
1.0	Basic research on tree growth and stand development							
1.1	Complex stands including partial cutting, variable retention	Species interactions				5	4	4
		Microclimate effects related to tree and stand growth in multi-storied stands				2	2	2
		Natural regeneration		FN	MPB	3	3	3
		Mortality in seedling, sapling and pole stages				4	3	3
1.2	Early stand growth	Subalpine fir (<i>Abies lasiocarpa</i>)				8	6	6
		Western redcedar (<i>Thuja plicata</i>)				5	5	5
		Yellow-cedar (<i>Chamaecyparis nootkatensis</i>)				5	8	8
1.3	Old stands	Volume loss				5	6	4
		Mortality				5	5	5
2.0	Design and analysis of silvicultural systems							
2.1	Complex stands including partial cutting, variable retention	The relationship between residual stand structure and understory recruitment and development; evaluation of the results of partial cuts and the effects on stand establishment, early growth and yield, and response to management practices		FN		2	2	2
		Development and monitoring of the impact of various stand treatment regimes on regeneration				2	2	2
2.2	Even-aged stands	Assessment and analysis of fertilization experiments or trials (but not the initiation of new trials)				4	6	6
		Repressed stands				8	7	6
		Genetic realized-gain trials				5	5	5
		Espacement trials - remeasurement and analysis of existing trials				8	8	8
		Interactions among silvicultural treatments (existing, not new trials)				7	7	7

#	Theme/Topic	Priorities	FFEI	FN	MPB	Score		
						Coast	N. Int.	S. Int.
3.0	Growth and yield modeling/predictions							
3.1	Complex stands including partial cutting, variable retention	Boreal mixedwood (spruce-pine-aspen)		FN		8	2	8
		Fire-maintained stands		FN		8	5	5
		Coastal BEC zones (MH, CDF, CWH)				2	8	8
		Interior BEC zones (ESSF, MH, SBS, ICH [NIR])		FN		8	2	2
		Interior BEC zones (IDF, ICH [SIR])		FN		8	8	4
3.2	Wood quality	Determining impacts of silvicultural regimes on wood quality				4	4	4
4.0	Timber losses to environmental and biotic factors (wind, drought, insects <incl. MPB>, disease, animal damage, fire)							
4.1	Stand and forest dynamics following MPB	Quantification of stand and forest change and development following MPB attack, including GY modeling, and impacts on timber supply. Evaluating and estimating timber growth implications on residual trees and regenerated stands, in the understory, and in clearcut openings. Includes species interactions related to the scale and pattern of harvesting.		FN	MPB	8	2	2
		Growth, development, and health of residual stands (overstory and understory) across a wide range of post-attack stand types and conditions (i.e., mixed species - salvaged; mixed species - unsalvaged; pine dominant - unsalvaged) in different BEC zones. Includes mitigating losses.			MPB	8	2	2
		Mitigating MPB losses: silvicultural treatments and regimes, such as fertilization of non-lodgepole pine stands and treatment of repressed lodgepole pine stands, to accelerate operability and enhance mid-term timber supply			MPB	8	2	2

#	Theme/Topic	Priorities	FFEI	FN	MPB	Score		
						Coast	N. Int.	S. Int.
4.2	Estimating stand-level losses (other than MPB)	Windthrow				4	7	7
		Ips beetles				8	3	3
		Spruce bark beetle				8	2	2
		Root disease (Armillaria, Phellinus)				4	4	4
		Spruce leader weevil				6	6	6
		Rusts: Dothistroma, Commandra, Western gall				8	5	5
		Spruce budworm				8	7	7
4.3	Mitigating losses (other than MPB)	Browse				4	4	4
		Growth and yield implications of stand management at the urban interface for fire hazard protection				8	4	4
		Spruce budworm				8	7	4
		Dothistroma (e.g., applications of copper sulphate)				8	6	6
5.0	Analytical techniques and models for strategic analysis							
5.1	Integration of data and models across scales	Techniques for integrating various data sources for strategic analyses (e.g., forest inventory, remote sensing, GY, and non-conventional data layers such as NTFP and tourism)		FN		3	3	3
5.2	Development of novel methods to link process and empirical GY models	Hybrid modeling (e.g., connecting SORTIE functionality with PROGNOISIS or TASS)				4	4	4

#	Theme/Topic	Priorities	FFEI	FN	MPB	Score		
						Coast	N. Int.	S. Int.
6.0 Marketable resources other than timber³								
6.2	Non-timber forest products (NTFP)	Development and assessment of techniques for producing other resources in conjunction with timber production under various silvicultural systems		FN		4	4	4
		Developing innovative methods to inventory and value NTFP, using multi-media and multi-scale approaches				5	5	5
		Defining relationships between high value NTFPs, forest site conditions, and stand dynamics		FN		2	2	2
		Assessing impacts of environmental factors on marketable non-timber resources				6	6	6
6.3	Biofuels	Silvicultural treatments for managing for production of biofuels, in conjunction with timber production				7	7	7
7.0 Climate change								
		Predicting the effects of climate change on growth and yield at the tree, stand, and landscape levels	FFEI			3	3	3
		Predicting effects of climate change on forest health and condition (e.g., insects, disease, fire)	FFEI			3	3	3
		Responding to ecosystem shifts including: establishment or new, and reassessment of existing species and genecology trials; understanding ecosystem resilience; assessing risk	FFEI			3	3	3
8.0 Forest harvesting and engineering studies on salvaged MPB-killed timber								
		Forest engineering studies relating to designing efficient, cost-effective, and environmentally appropriate methods of harvesting and hauling MPB-killed timber			MPB	8	6	6
		Studies to quantify the rates and amount of deterioration of MPB-killed timber for forest product use in relation to timber supply, harvest scheduling, and salvage operations		FN	MPB	8	2	2

³ Topic 6.1 was reorganized and assigned to other topic areas in this theme.

Appendix 2 – Research Themes and Topic Descriptions

1.0 Basic research on tree growth and stand development

Description

Improve the understanding of basic biological processes such as competition for light, nutrients, and moisture, and the resulting allocation of carbon that regulates tree growth and stand development. This information is needed to improve operational models and decision-support tools.

1.1 Complex stands (including partial cutting, variable retention)

Complex stands include multiple species, stands with structural diversity, and mixed stands of conifers and hardwoods.

Priority areas for research:

- species interactions
- microclimate effects related to tree and stand growth in multi-storied stands
- natural regeneration
- mortality in seedling, sapling, and pole stages

1.2 Early stand growth

This topic includes critical processes and dynamics of early stand establishment and growth that affect crop tree performance.

Priority should be given to research on the following species:

- subalpine fir (*Abies lasiocarpa*)
- western redcedar (*Thuja plicata*)
- yellow-cedar (*Chamaecyparis nootkatensis*)

1.3 Old stands

Old stands include those being retained for non-timber purposes, or that remain in inventory for long periods due to the age structure of a management unit.

As successional processes and natural disturbance regimes are topics already covered under the Sustainability theme, priority areas for research in this topic are:

- volume loss
- mortality

2.0 Design and analysis of silvicultural systems

Description

Comparing silvicultural systems and management regimes at the stand, landscape, and forest levels to maximize timber volume and value while providing specific non-timber values of interest.

2.1 Complex stands (including partial cutting, variable retention)

Development and monitoring of silvicultural systems for complex stands (multi-species, structurally complex) at multiple scales (stand, landscape, and forest).

Priority areas for research:

- the relationship between residual stand structure and understory recruitment and development; evaluation of the results of partial cuts and the effects on stand establishment, early growth and yield and response to management practices
- development and monitoring of the impact of various stand treatment regimes on regeneration

2.2 Even-aged stands

Development and monitoring of silvicultural systems designed for efficient, high-yield timber production while providing for joint production of specific non-timber values of interest including wildlife habitat and NTFPs.

Priority areas for research:

- assessment and analysis of ongoing fertilization experiments or trials (but not the initiation of new trials)
- repressed stands
- genetic realized-gain trials
 - Field experiments studying the area-based impact of select seed across various stand densities and site qualities. Linkage to existing breeding programs is critical. Use of the Forest Productivity Council approved design is preferred.
- espacement trials (remeasurement and analysis of existing trials)
- interactions among silvicultural treatments (existing, not new, trials)
 - Our understanding of interactions among treatments is inadequate, yet treatment combinations are increasingly the operational norm.
 - Quantifying mixed-species stand growth and dynamics in response to various silvicultural regimes (e.g., spacing-pruning-fertilization). Impact on value. Interactions when various treatments are applied.

3.0 Growth and yield modeling/predictions

Description

Developing and improving models and decision support tools that predict tree and stand characteristics related to the production of timber volume and value and to non-timber values, with priority on models that support the provincial Timber Supply Review. This research may also include estimating and evaluating the impacts of management decision impacts on timber at multiple scales (stand, landscape, and forest).

3.1 Complex stands (including partial cutting, variable retention)

Models of complex stands, including those with multiple species and stands with structural diversity. Priority areas for research include:

- boreal mixedwood (spruce-pine-aspen)
- fire-maintained stands
- Coastal BEC zones (MH, CDF, CWH)
- Interior BEC zones (ESSF, MH, SBS)
- Interior BEC zones (ICH, IDF)

3.2 Wood quality

Modeling effects of stand management regimes on wood properties, grades, and value.

4.0 Timber losses to environmental and biotic factors (wind, drought, insects [including MPB], disease, animals, fire)

Description

Finding methods to predict and mitigate timber losses due to environmental factors; in particular linkages with growth and yield models (existing or under development).

4.1 Stand and forest dynamics following MPB

Research aimed at understanding and quantifying how stands will develop following MPB attack. Basic research regarding post-attack stand dynamics and succession.

Priority should be given to research in the following areas:

- Quantification of stand and forest change and development following MPB attack, including GY modeling, and impacts on timber supply. Evaluating and estimating timber growth implications on residual trees and regenerated stands, in the understory and in clearcut openings. Includes species interactions related to the scale and pattern of harvesting.
- Growth, development, and health of residual stands (overstory and understory) across a wide range of post-attack stand types and conditions (i.e., mixed species - salvaged; mixed species - unsalvaged; pine dominant - unsalvaged) in different BEC zones. Includes mitigating losses.

- Mitigating MPB losses: silvicultural treatments and regimes, such as fertilization of non-lodgepole pine stands and treatment of repressed lodgepole pine stands, to accelerate operability and enhance mid-term timber supply

4.2 Estimating stand-level losses (other than MPB)

Biologically robust, agent-specific models that move beyond models that estimate simple overall proportional reductions. Priority is given to:

- windthrow
- Ips beetles
- spruce bark beetle
- root disease (*Armillaria*, *Phellinus*)
- spruce leader weevil
- *Dothistroma*
- spruce budworm

4.3 Mitigating losses

Strategies and management practices that mitigate losses at an appropriate operational scale and in a cost effective manner. This topic spans areas from silvicultural practices to resistance research and tree breeding, and deals with losses from factors such as root rots, pine rusts, pine mistletoe, windthrow, and drought. Priorities include:

- browse
- Growth and yield implications of stand management at urban interface for fire hazard protection
- spruce budworm
- *Dothistroma*

5.0 Analytical techniques and models for strategic analysis

Description

Development of new tools and the improvement of existing tools to support analysis of timber and non-timber forest product (NTFP) supply, or the joint production of timber and non-timber values for resource analysis or local land-use planning.

5.1 Integration of data and models across scales

Techniques for integrating various data sources for strategic analyses (e.g., forest inventory, remote sensing, GY, and non-conventional data layers such as NTFP and tourism).

5.2 Development of novel methods to link process and empirical GY models

Development of new tools, and the improvement of existing tools to support analysis of timber and NTFP supply, or the joint production of timber and non-timber values for resource analysis or local land-use planning.

6.0 Marketable resources other than timber

6.1 <Topic was reorganized and assigned to other topic areas in this theme>

6.2 Non-timber forest products (NTFPs)

Silvicultural impacts on NTFPs, and techniques for enhancing NTFP and overall stand value. Combining silviculture with botanical, experiential and traditional-use knowledge may lead to the development of better co-management practices. Assess various management practices that may improve productivity and sustainability of NTFPs. Priorities are:

- Development and assessment of techniques for producing other resources in conjunction with timber production under various silvicultural systems
- Developing innovative methods to inventory and value NTFPs, using multi-media and multi-scale approaches
- Defining relationships between high-value NTFPs, forest site conditions, and stand dynamics
- Assessing impacts of environmental factors on marketable non-timber resources.

6.3 Biofuels

Silvicultural treatments for managing for production of biofuels in conjunction with timber production.

7.0 Climate change

Description

Modeling the effects of climate change on tree and stand growth, including. Priorities are:

- Predicting the effects of climate change on growth and yield at the tree, stand, and landscape levels
- Predicting effects of climate change on forest health and condition (e.g., insects, disease, fire)
- Responding to ecosystem shifts including: establishment or new, and reassessment of existing species and genecology trials; understanding ecosystem resilience; assessing risk

8.0 Forest harvesting and engineering studies on salvaging MPB-killed timber

This topic includes forest engineering research aimed at enabling cost-effective and environmentally appropriate salvaging of timber killed by MPB. This topic does not include research related to manufacturing with timber killed by MPB (i.e., utilization of the MPB-killed logs after they reach the mill). Priorities include:

- forest engineering studies relating to designing efficient, cost-effective, and environmentally appropriate methods of harvesting and hauling MPB-killed timber
- studies to quantify the rates and amount of deterioration of MPB-killed timber for forest product use in relation to timber supply, harvest scheduling, and salvage operations.