Whiskey Jack Forest Sciences

Mountain Pine Beetle Research and Extension

An Assessment of Existing Strategies, Gap Analyses and Other Reports in Support of FIA-FSP Mountain Pine Beetle Research and Extension Priorities

DRAFT FINAL REPORT

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Executive Summary

The mountain pine beetle (MPB) epidemic, amongst all the challenges it is presenting to forest managers, industries and communities, has created an incredible learning opportunity – learning from our past omissions, mistakes, and successes; learning through collaboration and cooperation in future work; and learning through a long-term, 'bigger picture' approach, particularly with reference to future investments in forest and landscape restoration. Those challenges and the accompanying uncertainty have necessitated increasing investments in MPB research and management. The increasing MPB-research investments are coming from different funding sources [primarily the Canadian Forest Service (CFS) Mountain Pine Beetle Initiative (MPBI), and the FIA-FSP], and being driven by a number of strategies.

Conclusions
There are some general conclusions which can be drawn:

(1) The gap analyses have, collectively, resulted in very comprehensive research and extension strategies which include the highest priority knowledge needs. While some may criticise the processes involved in the gap analyses and strategy development, the end result is an excellent blueprint with which to guide MPB research for the next several years. Nevertheless, the processes have not involved certain knowledge users to any great extent: e.g., First Nations, communities, forest industries, and NGOs. This oversight needs to be rectified.

(2) The FIA-FSP MPB research strategy, in particular, is an effective strategy, and provides an excellent and flexible framework within which to make sound investments in research and extension for the next several years. There should be an adjustment made to the annual revision and planning process such that First Nations, community, and industrial sector views are included, and there should be more resources invested in an active and targeted MPB extension program.

(3) We do not have a full appreciation of the breadth, depth, and quality of our MPB knowledge base. The research completed over the past 5-7 years and currently underway covers a broad spectrum of needs, and fits very well within the strategies of the research funders and the management agencies. We have not invested enough in knowledge synthesis and analysis projects which help construct boundaries around the knowledge relevant to specific issues, and which improve decision-making, and resource planning and development Wienscyzk (2005) did an admirable job of bringing much of this information together, and has provided a very good framework with which to categorise the research projects and topics. But much more work is needed to review the research reports and results, synthesise the information and knowledge into meaningful tools or other extension products (e.g., 'best practices' guides).

(4) By operating under different research strategies, goals, and schedules, and with different needs analyses processes, funding agencies are a source of confusion to the research community and operational resource managers, and tend to discourage inter-disciplinarity and collaboration in research programs and projects. There is a need to consolidate existing strategies, goals, and funding schedules to facilitate cooperation, collaboration, partnerships, inter-disciplinarity, integration, and innovation, and to proceed with the necessary urgency to address the priority issues.

(5) The perception is that current MPB research is focused on timber supply implications only, which seem to be long on predicting a not so rosy future for industries and communities, but offer little, if any, information for the communities about mitigation and solutions across the broad range of potential economic sectors. Community-based decisions and actions need to be implemented now, and the communities need tools to do so.

(6) There is no coordinated, integrative, readily-accessible, consistent system in place to monitor MPB-altered and/or salvaged-logged forest ecosystems and landscapes in BC. If we are to learn more from our mistakes and our successes, we need to invest more into monitoring how past and current practices are doing, and how well the MPB-affected sites are regenerating. Long-term monitoring, in conjunction with support tools, can build data to validate policies/models.

(7) The gap analyses and existing strategies provide excellent coverage of the knowledge needs with respect to dealing with the MPB epidemic and its aftermath. There are differences of opinion as to what the foci (highest priorities) of the research programs should be, and the FIA-FSP in particular has tried to accommodate these differences by varying the content of the annual proposal call.

(8) The themes and topics are driving the various strategies. The program advisory committees have done a good job of justifying these themes and topics as knowledge gaps based on their knowledge and experience. It is not the general perception that these themes and topics have been justified to the same degree as operational needs.

(9) There is a pressing need for an analysis of our existing research and operational knowledge, and synthesis of this knowledge into stand- and landscape-level forest health management policies, guidelines, and 'best practices.' One component of the post-MPB aftermath which could benefit from this type of project/analysis is the regeneration (restoration) of the new forest.

(10) There has to be much greater emphasis on incorporating the results of the MPB research in BC into the very real challenges facing us in the short and medium terms. We must substantially increase our investments in extension, particularly to the First Nations and communities who are living on the land base and who are most dramatically impacted by the epidemic.

Recommendations

(1) The FIA-FSP should make every attempt to facilitate the combining of the existing MPB research strategies into one over-arching strategy.

(2) The MPB – Research Issues Steering Committee should become a province-wide body which would oversee the new collaborative MPB research strategy. This committee should have a direct working linkage with the FIA-FSP.

(3) The new MOFR Research Branch position, Research Leader, Mountain Pine Beetle, should chair the expanded MPB Research Issues Committee, and function as the coordinator of the overall, collaborative MPB research strategy.

(4) The provincial extension services provider, FORREX, must be included and funded as a major participant in the provincial MPB research program.

(5) The FIA-FSP should ensure that there is an annual review of the research strategy by operations decision-makers, community leaders, First Nations leaders and resource managers, and researchers who are involved in MPB projects or initiatives, and who live in the impacted areas. Integral to this needs analysis is an annual reporting of the progress of the FIA-FSP to the end-users; i.e. where is the FIA-FSP making a difference.

(6) While no changes or additions are recommended for the DRAFT 2007-2008 SPAC list of priorities, suggestions for additions to the priorities were made for TPAC.

(7) One of the most urgent needs is an analysis of our existing research and operational knowledge [as was done in Mitchell and Stjernberg (2005)[1]], and synthesis of this knowledge into stand- and landscape-level policies, guidelines, and 'best practices.'

(8) It is recommended that FIA-FSP support the implementation of large (landscape-level) permanent sample plots on which multiple research questions are asked and data are collected over time, and which provide benchmarks for implementing sustainable ecosystem management and recovery.

(9) It is also recommended that FIA-FSP encourage research providers, research funders, and research users to form research cooperatives, with specific collaborative roles for all parties involved. This process can be facilitated by the Research Leader, MPB Research.

[1] Mitchell, J.L. and E. Stjernberg. 2005. Strategies for managing mountain pine beetle: efficacy and economics – summary report. FERIC Advantage, Vol.6 (23). 15 pp.

1.0 Introduction

1.1 Forest Science Program

In British Columbia, the Forest Investment Account (FIA) is a provincial government mechanism to promote sustainable forest management (SFM). The FIA Forest Science Program (FIA-FSP) supports and funds initiatives and activities which address the critical knowledge required to enable science-based SFM of BC's forest resources. The FSP focuses on research supporting SFM and improving timber growth and value, and utilising forest science results and knowledge more effectively and thoroughly through extension. The Forest Science Board (FSB) provides advice about strategies and priorities for the FIA-FSP. Four program advisory committees (PACs) support the FSB in shaping the FIA-FSP by providing strategic advice and recommending funding priorities for the different programs. The PACs are: the Sustainability PAC (SPAC), Timber Growth and Value PAC (TPAC), the Long-term (LT) Research Installation PAC (LTPAC), and the Extension PAC (EPAC). SPCA and TPAC identify critical issues, information needs, and knowledge gaps in each of the program areas, and recommend the necessary research and extension priorities.

1.2 The Mountain Pine Beetle Epidemic

The mountain pine beetle (MPB) epidemic, amongst all the challenges it is presenting to forest managers, industries and communities, has created an incredible learning opportunity – learning from our past omissions, mistakes, and successes; learning through collaboration and cooperation in future work; and learning through a long-term, 'bigger picture' approach, particularly with reference to future investments in forest and landscape restoration.

These challenges and the accompanying uncertainty have necessitated increasing investments in MPB research and management. The increasing MPB-research investments are coming from different funding sources [primarily the Canadian Forest Service (CFS) Mountain Pine Beetle Initiative (MPBI), and the FIA-FSP], and being driven by a number of strategies. While there has been some attempt at coordination of these strategies, each is being implemented essentially on its own. This has led to the perception of overlap and duplication. As well, Lousier (2006)[2] concluded:

> "By operating under different research strategies, goals, and schedules, funding agencies have been a source of confusion to the research community and operational resource managers, and tend to discourage inter-disciplinarity and collaboration in research programs and projects. Also, it is difficult to integrate research approaches and designs, and it is difficult to initiate long-term innovative research because of the many funding mechanisms/restrictions."

Another perception is that the strategies are researcher- or research-organisation-driven; in other words, there has been little input, or, opportunity for input, from the end-users of research knowledge – for example, forest managers, planners, and practitioners; the communities and First Nations; and interested publics and NGOs.

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[2] Lousier, J.D. 2006. Mountain pine beetle epidemic and the future of communities and ecosystems. Proc. UBC and UNBC research synthesis and strategy workshop series. University of Northern British Columbia, Prince George, BC, and University of British Columbia, Vancouver, BC. Final unpubl. rep. p. 41.

Dealing with the MPB epidemic involves a plethora of high-priority knowledge needs. What the funding, research and management agencies have tried to do is identify and address: (a) those issues which are deemed urgent in the short term, and (b) those issues which are considered critical in the medium and long terms. Doing so involves a balancing act so that we are not overwhelmed by short-term research at the expense of the long-term sustainability of our industries, communities, ecosystems and landscapes.

2.0 Project Objectives

The overall goal of the project was to compare work already done in existing gap analyses and strategies, and compare these against MPB-related priorities identified in SPAC and TPAC strategies. The specific objectives were to:

(1) review the gap analyses by FORREX Forest Research Extension Partnership, Canadian Forest Service (Pacific Forestry Centre), and the BC Forest Service, and summarise the gaps and priorities identified;
(2) based on current understanding and limited consultation with others, identify additional knowledge gaps not mentioned in these reports.
(3) consider the processes used to identify gaps in these reports and identify particular stakeholder groups that have had little or no input;
(4) examine the SPAC and TPAC strategies and current FSB research priorities, and identify relevant MPB knowledge gaps which have not been addressed by the PACs;
(5) assess the alignment between priorities identified by the SPAC and TPAC and those identified in the reports consulted; and
(6) bring gaps in topics not covered under the R&D Biophysical research mandate of the FSB (e.g., inventory, wood products, etc.) to the attention of other more relevant programs in FII.

3.0 Methodology

The primary methods involved in this assessment were:

(1) reviewing and evaluating the current strategies and their supporting documents, the recent synthesis reports, the relevant websites, and other relevant reports as deemed appropriate; and
(2) interviewing available knowledgeable individuals who deal with MPB issues on a daily basis.

The information obtained was synthesised into a final report which features conclusions and recommendations.

3.1 Reports and Websites Reviewed

The documents and websites reviewed were:

- the FIA-FSP website and reports – strategic plan (2004-2008), business plan (2005-06), list of eligible research topics (2006-07), SPAC and TPAC research priorities (2006-07);
- the CFS MPBI R&D web site – research strategy and priorities; needs analysis;
- the BC Ministry of Forests and Range (MOFR) Mountain Pine Beetle Stewardship Research Strategy, including the stewardship needs definition (and appendices), and the gap analysis;

- the MOFR Forests for Tomorrow Research Strategy, including the challenge paper, the challenge paper response compilation and the challenge paper appendices;
- the MOFR Chief Forester's February 2006 report, "The Future Forest Ecosystems of BC – Exploring the Opportunities," including the symposium and workshop report, and the working group reports,
- the MOFR Chief Forester's June 2006 report, "The Future Forest Ecosystems of BC – Draft Recommendations for Review and Comment;"
- the FORREX report, "Mountain pine beetle: linking recent and current projects to identified needs – version 2;"
- the FORREX report, "Mountain pine beetle: DRAFT extension plan;"
- the FORREX DRAFT report, "Provincial forest extension program strategic plan for British Columbia, 2006-2010;"
- the final report from the UBC and UNBC research synthesis and strategy workshop, "Mountain pine beetle epidemic and the future of communities and ecosystems;"
- "The Mountain Pine Beetle – A Synthesis of Biology, Management, and Impacts on Lodgepole Pine,"[3]
- "Mountain Pine Beetle Symposium: Challenges and Solutions;"[4]
- the Ministry of Environment (MOE) report, "Fostering stewardship behaviour – an outreach strategy for the Environmental Stewardship Division;"
- BC First Nations Mountain Pine Beetle Action Plan;
- Beetle News, Special Edition No. 6, July/August 2006 – BC First Nations Mountain Pine Beetle Working Group;
- Mountain Pine Beetle Emergency Response – Canada-BC Implementation Strategy; and
- British Columbia's Mountain Pine Beetle Action Plan 2005-2010.

3.2 Individuals Interviewed

To identify current knowledge gaps, it was hoped to hold interviews with a select number of industry and government foresters and land managers, researchers heavily involved in MPB research, First Nations foresters and land managers, and community leaders. The names of those who were available for an interview are presented in Appendix 2. Several people contacted were unavailable or declined to be interviewed. The intent of the interviews was to discover those issues/needs not identified by the FIA-FSP PACs, or to reinforce existing SPAC and TPAC priorities.

4.0 Analysis

4.1 Mountain Pine Beetle Research in BC – Perceptions

The MPB has been a focus of various research agencies and institutions for the past few decades, and a forest management concern over much of the same period. The current epidemic has affected a wide range of interior ecosystems and landscapes, and is creating an economic boom for several interior mills and communities. The epidemic also has the interior mired in uncertainty, particularly the future economic well-being of the affected communities, and the ecological effects of the widespread salvage logging expected. Our 'conventional wisdom'

[3] Safranyik, L. and W. Wilson. 2006. The Mountain Pine Beetle – A Synthesis of Biology, Management, and Impacts on Lodgepole Pine. Natural Resources Canada, CFS, Pacific Forestry Centre, Victoria, BC. 304 p

[4] Shore, T.L., J.E. Brooks and J.E. Stone. 2004. Mountain pine beetle symposium: challenges and solutions. Proc. Symp. October 30-31, 2003, Kelowna, BC. Natural Resources Canada, CFS, Pacific Forestry Centre, Victoria, BC. 287 p.

database is being stretched to the limit as the MPB reacts to its own largesse, e.g., having to fly farther than we thought it could to find suitable hosts; colonising younger trees; and spreading to environments which have traditionally been thought as too cold for MPB survival (e.g., higher elevations, Peace River area, northwestern Alberta).

There is a widely-held perception that we do not have a good understanding of our MPB research information database; in other words we do not have a good idea of how much we know, and how good our information base is. A corollary to this point is the strong opinion that the existing research knowledge is not being extended adequately to the end-users.

There are widely divergent views on the relevant importance of short-term versus long-term research and operational trials, and monitoring programs, with the short-termers tending to be industry and government foresters and planners, and the long-termers the scientific and strategic thinking sectors.

By operating under different research strategies, goals, and schedules, and with different needs analyses processes, funding agencies are a source of confusion to the research community and operational resource managers, and tend to discourage inter-disciplinarity and collaboration in research programs and projects.

From a scientific point-of-view, the existing strategies are very good, individually and collectively, in that they are quite logical and comprehensive, and they stress, for the most part, important MPB knowledge needs.

While beetle biology and ecology are still themselves of immense interest to us, today's uncertainty and urgency are focused on operational realities,[5] that is:

(1) on other forest management issues/needs:
- quantifying fibre and log quality in the MPB-killed stands,
- mid-term timber supply,
- site selection criteria for salvage harvesting,
- understanding the post-MPB response of affected ecosystems and landscapes, and
- understanding ecological impacts of salvage harvesting;

(2) on the social, cultural, and economic needs of communities and First Nations; and
(3) on the economic needs of the conventional forest sector industries and new industries trying to capitalise on the increasing availability of the MPB-killed wood.

Other perceptions of the MPB epidemic and BC's response to it are included in Appendix 3.

Two of the many challenges facing a research program are: (i) is it topical, timely, relevant, and useful; and (ii) are its results being used to improve decision making? The analysis in this report attempts to answer these two questions for the FIA-FSP SPAC and TPAC strategies.

4.2 Strengths and Weakness of the Strategies Reviewed

For the purposes of analysis, the strategies have been lumped into three categories: (a) current research funders, (b) management agencies, and (c) extension provider. Since the 'current research funders' provide the bulk of the monies being invested in research and extension projects

[5] Current 'operational realities' compiled through interviews and the author's review of selected literature.

and programs supporting the management agencies' strategies and the extension provider, the discussion will focus on FIA-FSP and MPBI.[6]

4.2.1 Current Research Funders

Strengths

There are a large number (>300) and a wide variety of research projects completed or underway in British Columbia, with the current projects funded by two sources in particular, the federal MPBI and the FIA-FSP.[7] The general strengths of the CFS MPBI and the FIA-FSP strategies are:

- each provides good coverage of identified high-priority issues/needs;
- each is logical, well-thought out, relevant, and appropriate to identified needs/issues;
- each strives for balance in short-term versus long-term knowledge needs; and
- each stresses co-operation, collaboration, partnerships, inter-disciplinarity, integration, innovation, and urgency.

Specific strong points of the FIA-FSP MPB strategy include:

- the ecological (stewardship) focus, especially in terms of ecosystem and landscape structure and processes, ecological impacts, and ecosystem sensitivity;
- the research strategy is connected to the provincial extension provider and its strategy; and
- while there is some overlap with the CFS MPBI, there does not appear to be a great amount of duplication.

Specific strengths of the MPBI strategy are its focus on the following knowledge needs:

- wood quality and processing;
- log handling and storage;
- socio-economic and community impacts;
- fire, and climate change; and
- the MPB in new environments.

Weaknesses

There are a few general weaknesses of these strategies:

a) The use of broader topics allows proponents to actually determine, in most cases, the project focus; consequently, if the proponent is a researcher, some of the key questions driving the issues tend not to be addressed as well as they need to be; do the reviewers recognise this – or do they concentrate on the technical merits of each individual proposal? There might be a need to consider targeted RFPs for some of the topics, e.g., socio-economics, and more involvement of the end-users (i.e., communities, First Nations) in issue identification and deciding on the question(s).

b) While the strategies are considered quite good, there are some questions about how priorities are determined. From an operational perspective, the existing research and extension programs are thought to be focussed too much on ecological and resource issues and not enough on operational needs and community-based concerns, too much on long-term objectives as opposed to short-term paybacks, and too much on researcher-generated (either researcher or research agency) topics versus operationally-generated topics.

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[6] The 'strengths' and 'weaknesses' defined are based on the author's conclusions after reviewing all the documents and websites.

[7] **Wiensczyk, A.M. 2005.** Mountain pine beetle: linking recent and current projects to identified needs – version 2. File Report 05-02, 31 p. FORREX-Forest Research Extension Partnership, Kamloops. BC. (www.forrex.org/publications/other/filreports/fro5-02.pdf).

c) The perception is that there has been a general lack of input, or opportunity for input, from industry and government field staff and managers, First Nations, and communities
d) There are a number of overlaps and some duplication in the two strategies.

The FIA-FSP MPB strategy does not have, in the author's view, any major structural or procedural weaknesses which need to be addressed at this time, except for a greater investment in extension projects, activities and products. The FIA-FSP MPB strategy is currently less comprehensive than MPBI, it appears to be primarily researcher- and agency-driven, and it does overlap with MPBI in the area of ecosystem function and regeneration research. While FIA-FSP has a direct connection to the extension provider, the MPBI strategy has as its major deficiency the lack of an effective extension component. Other MPBI limitations are: it appears to be primarily researcher- and agency-driven; there is some focus on currently moderate to low priority topics, e.g., detection; MPB population dynamics; management, risk assessment and control strategies; and there is some overlap with provincial strategies in the area of stand dynamics and ecosystem function, MPB biology, regeneration, and climate change.

Because of the volatility, uncertainty, and urgency associated with the MPB epidemic, it is important for the FIA-FSP and MPBI to recognise the necessity of 'staying current,' i.e., keeping communication channels open with industry and government decision-makers and practitioners, First Nations, and communities.

4.2.2 Management Agencies

The BC Ministry of Forests and Range has initiated three programs which will rely a great deal on science-based knowledge and experience for decision making: MPB Stewardship, Forests For Tomorrow, and Future Forest Ecosystems of BC. The strategies for these programs are also comprehensive, thorough, logical and well-thought out. They focus on their own goals and objectives, with some overlap among them. These three programs, while heavily reliant on research, do not have specific research budgets, but they do represent tremendous partnership opportunities for the research and extension providers.

There is considerable overlap between these three strategies collectively and those of the FIA-FSP and the MPBI, ostensibly because they will rely on the research funders to support much of the research their programs require. The FIA-FSP strategy, in particular, has tried to take these needs into account in its SPAC, TPAC and MPB strategy development and implementation. It is important that efforts be made to reduce the existing overlap and duplication as much as possible.

4.2.3 Extension Provider

The major extension provider in BC is FORREX Forest Research Extension Partnership. FORREX is dedicated to "…enabling and facilitating science and knowledge-based innovative solutions to natural resource management challenges,"[8] and the MPB represents one of the bigger challenges facing FORREX today. While FORREX is driven by an overall strategic plan ("Provincial forest extension program strategic plan for British Columbia, 2006-2010"), it also has a draft extension plan for MPB projects ("Mountain pine beetle: DRAFT extension plan"). The MPB extension plan is comprehensive, logical, thorough, well-thought out, and ambitious.

As stated in Section 4.1 above: "*There is a widely-held perception that we do not have a good understanding of our MPB research information database; in other words we do not have a good*

[8] FORREX. 2006. Provincial forest extension program strategic plan for British Columbia, 2006-2010. Prepared for FIA-FSP. p. 3.

idea of how much we know, and how good our information base is. A corollary to this point is the strong opinion that the existing research knowledge is not being extended adequately to the end-users." When one examines the information (research for only the past 5-7 years) in Wiensczyk (2005)[6] the breadth and depth of the MPB information base are obvious, as are the challenges for the extension provider.

These challenges are the basis for the FORREX MPB extension plan. We need to improve and focus our efforts to distribute MPB information and knowledge to decision-makers and forest managers. We need to keep people informed of changes to our knowledge base so that they are technically current and have the best available information. Support, in terms of staff positions and operating funds, needs to be increased substantially for FORREX to meet these challenges, particularly the needs being expressed by the affected communities and First Nations. Significant opportunities exist for new or continuing meaningful operating partnerships for FORREX, e.g., with MOE (their recent outreach strategy), and the McGregor Model Forest Association.

4.3 Comparison of the Research and Extension Strategies

When comparing the research strategies and project topic areas for existing or emerging MPB research programs in BC (Appendix 4),[9] it can be concluded that the coverage of MPB research topics is quite extensive, and, as Wiensczyk (2005)[6] has shown, quite intensive in some subject areas. Appendix 4 also includes the results of the universities' forum held in November 2005. This information represents topics which were defined, in the oral presentations and the discussion groups, as priority knowledge needs.

4.4 Current High Priority Knowledge Needs

One of the project objectives was to identify additional knowledge gaps which have not been identified in the gap analyses. Much of what follows has been gleaned from interviews conducted to date, and from reports reviewed. These topics are very similar to those identified in Lousier (2006) as high priority knowledge needs (Appendix 5). It will be obvious to the research funders that the information presented in this section does not identify major gaps which have not been included in the gap analyses reviewed. What the information does represent are differences in focus, perhaps a more operational and community-based focus.

(1) Mid-term timber supply – pressing questions
- importance and value of retention strategies:
  - retention of advanced regeneration during salvage harvesting
  - need to document release of advanced regeneration after MPB has killed the trees
  - need to document possible crop trees after MPB-kill and after salvage harvesting
  - time and motion studies needed in retention areas to determine harvesting and logging costs
  - retention for wildlife habitat; size of retention blocks/stands, habitat value
- extent and intensity of impacts of MPB on younger stands
- G&Y issues – need to test existing models for mixed stands and for releasing advanced regeneration

[9] **Lousier, J.D. 2006**. Mountain pine beetle epidemic and the future of communities and ecosystems. Proc. UBC and UNBC research synthesis and strategy workshop series. University of Northern British Columbia, Prince George, BC, and University of British Columbia, Vancouver, BC. Final unpubl. rep. pp. 45-48.

(2) Shelf life
- log quality appearing to be very important – may have a shelf life of <3 years (the summer 2006 heat wave has accelerated the drying of last summer's 'green attack' pine)
- biological shelf-life versus economic shelf-life – biological shelf-life appears to be considerably longer than the economic shelf-life
- the young, barely merchantable, trees being hit are checking quickly – how serious is this?
- wood (fibre) quality – the fibre will have a longer shelf life if alternate uses of the fibre (e.g., pellets, OSB) are considered

(3) Forest regeneration – designing the future forest
- do we know what we want to plant?
- success of under-planting versus fell, pile & burn, and planting, e.g.
- how do we factor in the impacts of projected climate change on forest regeneration programs
- is there a role for mixedwood and broadleaf management in regenerating areas?

(4) Ecological conditions of MPB-killed stands
- changes in understory light regimes and impacts on advanced regeneration, natural regeneration, and planted stock
- changes in forest floor structure, dynamics and productivity
- changes in site hydrology
- changes in watershed hydrology
- changes in habitat value and usage

(5) Ecological impacts of salvage harvesting (and site preparation)
- impacts on advanced regeneration, natural regeneration and planting success
- impacts on forest floor structure, dynamics and productivity (soil disturbance)
- impacts on in site hydrology; summer versus winter logging
- impacts on stand and watershed hydrology
- impacts on habitat value and usage

(6) Impacts of the MPB epidemic and BC's response on First Nations and community survival and well-being
- what are the timber supply implications to the social, economic, and cultural values in First Nations and communities?
- what are the economic development or diversification options available, given the changing quality of the wood resource and the ever-changing nature of the resource sectors?
- how do we assist First Nations and communities in building knowledge capacity and resources to deal with transition issues?
- how can we incorporate traditional knowledge (First Nations and experiential) into decision-making processes?
- what opportunities are there to pilot community-based resource-management models?

It is obvious that many of these questions relate to policy as well as operational practices. Some of the questions need one or more research projects and some long-term monitoring to achieve the necessary answers. Other questions can be addressed through short-term projects, some of which are research but many of which are extension.

4.5 Gap Analysis Processes

Another of the project's objectives was to consider the processes used to identify gaps and identify particular stakeholder groups who have had little or no input. The processes these programs have utilised to produce their strategies which drive their agendas are briefly described below.

4.5.1 Canadian Forest Service

MPBI

The federal MPBI was announced in 2002, and the CFS published the MPBI Epidemic Risk Reduction & Value Capture R&D Strategy in 2004. To produce the strategy, the CFS, in partnership with the BC Forest Service, conducted a series of regional scoping sessions in the interior of BC, the intention of which was to identify research topics for consideration under the MPBI. Participants included forest land managers/planners, government regulators and policy-makers, forest product manufacturers, and First Nations. A long list of topics was compiled and translated into the R&D strategy by the CFS staff.

4.5.2 BC Ministry of Forests and Range

FIA-FSP

The FIA-FSP brings together knowledge users and knowledge providers at the level of the FSP Board and the Program Advisory Committees, which provide strategic advice and recommend funding priorities. Investments must focus on high priority research areas which address user needs, avoid duplication, and leverage funds from other sources. The program is supported through a $100 million fund provided by the federal government.

Research Branch – MPB Stewardship (MPBS)

The MPBS Research Strategy was produced in a systematic, thorough process which was orchestrated by the Ministry of Forests and Range (Research Branch), and dominated by provincial government input. There was little input from industry and none from communities, First Nations, and NGOs.

Forest Practices Branch – Forests For Tomorrow (FFT)

The FFT Research Strategy was also produced in a systematic, thorough process which was orchestrated by the Ministry of Forests and Range (Forest Practices Branch), and dominated by MOFR staff. Eighteen people, primarily provincial government staff, responded to the Challenge Paper prepared and circulated by R. Keith Jones & Associates. There was little input from industry and none from communities, First Nations, and NGOs. The focus is addressing Not Sufficiently Restocked (NSR) forest lands, lands impacted primarily by the MPB and the severe wildfires in 2003

4.5.3 Deficiencies – Gap Analyses Processes

The main criticism of the provincial strategies is that the strategy development process had little, if any, input from forestry companies, First Nations, communities, and NGOs. This criticism, although widespread, is not new – provincial forest research programs, particularly those managed out of Victoria HQ, have been the recipient of such assessment for many years. This lack does not invalidate the processes utilised or the strategies produced – government researchers and operations staff have an excellent understanding of sustainable forest management resource stewardship in BC and elsewhere and have a good sense of where the

knowledge challenges lie. But, the fact remains: those people, communities and industries, which are being impacted directly by the MPB epidemic, did not participate in the process.

The CFS MPBI utilised a more inclusive process to first define their list of possible research topics but the strategy was constructed primarily by Pacific Forestry Centre staff. Again, this does not invalidate the process or the strategy.

4.6 Significant Provincial Initiatives

4.6.1 Research Branch – MPB Research Issues Steering Committee

A recommendation was made in the MPBS Research Strategy for the formation of a MPB – Research Issues Steering Committee, which is comprised of management representatives from all MPB research funding agencies (e.g., MOFR, FIA, and the CFS MPBI). This Steering Committee has been formed and is functional. The mission of the steering committee is to coordinate, promote, and ensure collaboration in research to resolve MPB stewardship research issues, and to promote the extension of the research. The benefits of the steering committee were identified as: (a) ***consistent priorities*** amongst all funding agencies for allocating research funding; (b) ***expertise*** in all relevant forest research disciplines (the partners will bring additional expertise in MPB research); and (c***) experience in coordinating research*** (the steering committee and proposed partners currently coordinate many MPB research projects). It was also recommended that:

- the Steering Committee would review the coordinated MPB stewardship research strategy annually and ensure that it adequately reflects current issues and priorities;
- the Steering Committee members encourage collaborative multi-disciplinary research because many of the MPB issues are multi-disciplinary in nature; and
- the Steering Committee should develop partnerships with other MPB research agencies to promote collaboration and to help direct MPB research to the highest priority areas;
- an MPB Research Issues web page be implemented to provide a communication link between researchers and practitioners.

4.6.2 Research Branch: Research Leader, Mountain Pine Beetle.

A new position, that of Research Leader, Mountain Pine Beetle, has been established to provide leadership for, and coordination of, the MOFR MPB research program. The MOFR MPB research program supports policy development and ensures that work is directed towards fulfillment of MOFR objectives. The Research Leader will engage in planning activities, communicate and interact with clients and MPB funding agencies, and provide general coordination and management functions to ensure that MPB-related research is carried out to meet client needs. The Research Leader will also provide scientific leadership and advice to internal and external scientists and forestry professionals throughout the province, and scientific information to assist in the development of scientifically-based standards, legislation and policies related to MPB issues.

5.0 Conclusions and Recommendations

5.1 Conclusions

Because of the longer-term nature of research programs, and because the impacts of research results can be broader temporally and spatially, it is important to always evaluate research programs in a 'bigger picture' context. In BC, the MPB epidemic is forcing us to think about more than the beetle itself and the current dilemmas we face. Not only do we have a broad geographic area affected, we have wicked issues facing communities and First Nations in terms of their livelihoods and long-term viability and well-being. We have an important emerging program, *The Future Forest Ecosystems of BC*, which brings a long-term, holistic, and restorative perspective which is completely applicable to many of the challenges of the aftermath of the MPB. The conclusions and recommendations offered in this report are done so within the context of the messages coming from the Future Forest Ecosystems of BC Symposium and Workshop held in December 2005:

- "Circumstances have created both a need and an appetite for **change**,[10] opening a pathway to consider **new and innovative responses**. The effects of climate change, global competition in forest products markets, and new working relationships between governments at all levels and First Nations are examples of phenomena opening the door to change.
- The need to adopt a principle of managing for **resilience of systems** (in this case ecosystems, but similarly for the social, cultural, and economic systems). This was seen by participants as a much more grounded strategy for dealing with uncertainty and natural variability than focusing on unattainable objectives such as stability.
- Adoption of a **strong knowledge-based and inclusive approach** to setting objectives and assessing risk. This includes areas of new or expanded research, better use of existing knowledge, scenario modeling and better methods of valuing a broad range of environmental services.
- Building **adaptive management** into forest management practices and decision-making models, including an assessment of current policies and structures for their ability to address the resilience principle. This was seen as an essential strategy for dealing with uncertainty.
- A need to constantly **track the interactions** between changes to ecosystems, human communities and economies, and respond with a mind to balance and resilience."

5.1.1 MPB Research in BC

There are some general conclusions which can be drawn from the information reviewed, including the interviewees' comments, and the observations in Appendix 3.

(1) We do not have a full appreciation of the breadth, depth, and quality of our MPB knowledge base. We have not invested enough in knowledge synthesis and analysis projects which help construct boundaries around the knowledge relevant to specific issues, and which improve decision-making, and resource planning and development (Appendix 3).

(2) The research completed over the past 5-7 years and currently underway covers a broad spectrum of needs, and fits very well within the strategies of the research funders and the management agencies. Wienscyzk (2005) did an admirable job of bringing much of this

[10] The highlighting done for the purposes of this report.

information together, and has provided a very good framework with which to categorise the research projects and topics. But much more work is needed to review the research reports and results, synthesise the information and knowledge into meaningful tools or other extension products (e.g., 'best practices' guides).

(3) By operating under different research strategies, goals, and schedules, and with different needs analyses processes, funding agencies are a source of confusion to the research community and operational resource managers, and tend to discourage inter-disciplinarity and collaboration in research programs and projects. There is a need to consolidate existing strategies, goals, and funding schedules to facilitate cooperation, collaboration, partnerships, inter-disciplinarity, integration, and innovation, and to proceed with the necessary urgency to address the priority issues.

(4) The perception is that current MPB research is focused on timber supply implications only, which seem to be long on predicting a not so rosy future for industries and communities, but offer little, if any, information for the communities about mitigation and solutions across the broad range of potential economic sectors. Community-based decisions and actions need to be implemented now, and the communities need tools to do so.

(5) There is no coordinated, integrative, readily-accessible, consistent system in place to monitor MPB-altered and/or salvaged-logged forest ecosystems and landscapes in BC. If we are to learn more from our mistakes and our successes, we need to invest more into monitoring how past and current practices are doing, and how well the MPB-affected sites are regenerating. We preach but do not readily practice adaptive forest management in BC. Long-term monitoring, in conjunction with support tools, can build data to validate policies/models.

5.1.2 Additional Knowledge Gaps

As alluded to above, the gap analyses and existing strategies provide excellent coverage of the knowledge needs with respect to dealing with the MPB epidemic and its aftermath. There are differences of opinion as to what the foci (highest priorities) of the research programs should be, and the FIA-FSP in particular has tried to accommodate these differences by varying the content of the annual proposal call. Nevertheless, there are three concluding points, relative to the FIA-FSP and MPBI strategies, to stress at this point:

(1) The themes and topics are driving the various strategies. Some of the themes and topics are very broad while others are more specific. The program advisory committees have done a good job of justifying these themes and topics as knowledge gaps based on their knowledge and experience. It is not the general perception that these themes and topics have been justified to the same degree as operational needs. It would be very useful to look at these themes and topics in a broader, stakeholder context; i.e., how does the research fit the common interest; how is the research addressing operational needs, how will the information be applied; what changes do we anticipate; what policies, regulations, and/or practices will be affected; how will the information result in better stewardship?

(2) Closely related to the first point is the urgent need for an analysis of our existing research and operational knowledge, and synthesis of this knowledge into stand- and landscape-level forest health management policies, guidelines, and 'best practices.' It is critical that the analysis and synthesis be conducted in the 'broad picture' perspective. One component of the post-MPB aftermath which could benefit from this type of project/analysis is the regeneration (restoration) of the new forest.

(3) There has to be much greater emphasis on incorporating the results of the MPB research in BC to the very real challenges facing us in the short and medium terms. We must substantially increase our investments in extension, particularly to the First Nations and communities who are living on the land base and who are most dramatically impacted by the epidemic.

5.1.3 Gap Analyses Processes

The gap analyses have, collectively, resulted in very comprehensive research and extension strategies which include the highest priority knowledge needs. While some may criticise the processes involved in the gap analyses and strategy development, the end result is an excellent blueprint with which to guide MPB research for the next several years. Nevertheless, the processes have not involved certain knowledge users to any great extent: First Nations, communities, forest industries, and NGOs. This oversight needs to be rectified.

5.1.4 FIA-FSP MPB Research Strategy

The FIA-FSP MPB research strategy is an effective strategy, and provides an excellent and flexible framework within which to make sound investments in research and extension for the next several years. There should be an adjustment made to the annual revision and planning process such that First Nations, community, and industrial sector views are included, and there should be more resources invested in an active and targeted MPB extension program.

5.2 Recommendations

5.2.1 Provincial Research Infrastructure

Lousier (2006) provided some recommendations with regard to MPB research infrastructure in BC (Appendix 6). These recommendations were based on information and views expressed by a total of about 200 participants in the two university sessions. Because those recommendations are highly relevant to the MPB research programs in BC, they are summarised below:

(1) **The FIA-FSP should make every attempt to facilitate the combining of the existing MPB research strategies into one over-arching strategy.** This involves different agencies, different levels of government, and different sources and amounts of funding. This strategic collaboration would result in a common set of MPB research goals and objectives for BC, one schedule for an annual call-for-proposals, one format for proposal submission, limited amount of overlap between agencies, and a consistent, coordinated proposal review process. This strategic consolidation will also promote inter-disciplinarity, integration, partnership-building, shared research capacity, and innovation in research.

(2) **The MPB – Research Issues Steering Committee should become a province-wide body which would oversee the new collaborative MPB research strategy** referred to above. This committee should have a direct working linkage with the FIA-FSP.

(3) The new MOFR Research Branch position, Research Leader, Mountain Pine Beetle, should chair the expanded MPB Research Issues Committee, and function as the coordinator of the overall, collaborative MPB research strategy.

(4) **The provincial extension services provider, FORREX, must be included and funded as a major participant in the provincial MPB research program** so that an effective job of delivering MPB research information and management knowledge to the stakeholders, end-users, communities, First Nations, and the general public is possible.

5.2.2 On-going Needs Analysis and Reporting

The FIA-FSP, working with the Chair of the Research Issues Steering Committee, should ensure that there is **an annual review of the research strategy** by operations decision-makers, community leaders, First Nations leaders and resource managers, and researchers who are involved in MPB projects or initiatives, and who live in the impacted areas. Integral to this needs analysis is **an annual reporting of the progress of the FIA-FSP** to the end-users; i.e. where is the FIA-FSP making a difference.

5.2.3 FIA-FSP MPB Research Priorities for 2007-2008

The draft SPAC and TPAC research priorities for 2007-2008 are shown in Tables 1 and 2. This proposed list broadens the scope of the FIA-FSP call for proposals, but still retains the program's primary foci: ecosystem and landscape science; decision support for sustainable forest management and stewardship; and timber growth and value.

Based on the information gleaned through this project, no changes or additions are recommended for the SPAC list of priorities, but the following are recommended for the TPAC list (see the highlighted portions of Table 2):

- **Theme 4.0 (Timber losses to MPB), Topic 4.1, Priority c – add "mixedwood management, broadleaf management, and underplanting"** to the list of silvicultural treatments and regimes.

- **Theme 4.0, Topic 4.1, Priority b – add: "Included also would be determining the extent and intensity of MPB impacts on younger stands (25-30-year-old plantations)"** Younger stands/plantations are being hit at an increasing rate, and, because the younger stems have a higher proportion of sapwood, the dead stems are drying out faster and checking more severely (Hawkins and Sheldon, pers. comm.).

- **Theme 4.0, Topic 4.1, Priority b – Add: "and testing models for mixed stands and for releasing advanced regeneration."**

- **Theme 10.0, Priority a – add ("in terms of both sawlog and fibre").**

5.2.4 Additional Priorities

Information and Knowledge Management

A tremendous amount of MPB information has been accumulated over the past many years, and some of the best is emerging from the FIA-FSP and MPBI. The emphasis, for too long now, has been on the knowledge accumulation side – things are quickly 'getting out of hand,' with so much information and knowledge accumulating and so little being synthesised, analysed, extended and applied effectively.

As defined in Lousier (2006), one of the most urgent needs is **an analysis of our existing research and operational knowledge** [as was done in Mitchell and Stjernberg (2005)[11]], and **synthesis of this knowledge into stand- and landscape-level policies, guidelines, and 'best practices**.' The analysis should be undertaken around certain themes, with a small working group of experts assigned to each theme. The themes should be selected by the MPB Research Issues Steering Committee, coordinated by the Research Leader, MPB Research, and must have meaningful input from resource management operations, communities, and First Nations. This working group would be responsible not only for the outline and approach to each 'best practices' guide[12], but also ensuring that the guides are user-friendly and accepted and utilised by the operations staff. An important component of these 'best practices' guides will be information on how to implement adaptive management approaches and long-term monitoring programs.

Long-term Monitoring

If we are to solve large-scale problems, we need large-scale projects with large-scale and long-term commitments of funding and human resources. And if/once we achieve these solutions, how do we integrate them down to the operational level? The policy level?

It is recommended that **FIA-FSP support the implementation of large (landscape-level) permanent sample plots** on which multiple research questions are asked and data are collected over time, and which provide benchmarks for implementing sustainable ecosystem management and recovery.

Research Cooperatives

We need collaborative decision-making principles to guide management under the tremendous uncertainty resulting from the MPB epidemic. Managing salvage harvesting and subsequent falldowns will require strong support for extensive collaboration possible through partnerships.

It is also recommended that **FIA-FSP encourage** research providers, research funders, and research users to form **research cooperatives**, with specific collaborative roles for all parties involved. This can be facilitated by the Research Leader, MPB Research.

Acknowledgements

I am grateful for the advice, assistance, guidance, and information provided by Gerry Still and Dan O'Brien. A special acknowledgement is extended to the four consummate professionals who took precious time out of their very busy schedules to talk about MPB issues with me.

[11] Mitchell, J.L. and E. Stjernberg. 2005. Strategies for managing mountain pine beetle: efficacy and economics – summary report. FERIC Advantage, Vol.6 (23). 15 pp.

[12] These proposed 'best practices' guides are similar to the reforestation handbooks recommended by: Jones, R.K., T. Vold, and G. Nigh. 2006. Ministry of Forests and Range Forests For tomorrow Research Strategy. Ministry of Forests and Range, Victoria, BC. http://ww.for.gov.bc.ca/htp/fft/.

Table 1. FIA-FSP sustainability DRAFT[13] program topics, 2007-2008.

Theme 1.0 Ecosystem structure, function and processes, and biodiversity related to forest management	
Topic 1.1 Riparian ecology and management of small streams	
Priority d.	Consequences of MPB salvage and management on riparian character and function of small streams and wetlands, and other aquatic habitats (e.g., channel morphology, stream temperature, organic matter dynamics)
Topic 1.3 Coarse filter approaches to maintaining biodiversity at the landscape level	
Priority a.	How do various landscape-level attributes contribute to achieving coarse0filter biodiversity conservation goals (e.g., seral stage distribution, patch size distribution, ecosystem representation in reserves, riparian networks)?
Priority b.	Can current management practices, such as MPB salvage operations, retention and partial cutting, create or maintain structures and processes that are effective in maintaining key elements of biodiversity at landscape scales?
Priority c.	How do different landscape level management approaches affect different species?
Topic 1.4 Effectiveness of stand-level structures and habitat in maintaining biodiversity	
Priority a.	What are appropriate stand-level targets and configurations of stand-level structures in cutblocks in order to maintain biodiversity (e.g., in MPB attacked areas)?
Priority b.	What are appropriate targets and configurations of stand-level structures in dry forest and open range (grassland, shrubland) in order to maintain biodiversity?
Priority c.	How effective are management strategies in creating stand-level structures and how effective are these in maintaining stand-level biodiversity, non-timber forest values and rangeland habitat?
Priority d.	How do riparian buffers and their design contribute to maintenance of stand-level wildlife habitat and biodiversity (aquatic, riparian, and upland)?
Topic 1.5 Natural disturbance ecology	
Priority a.	What is the dominant type, intensity, frequency, pattern, and scale at which historic natural disturbance (e.g., fires, wind, insect and disease infestations) occur in different areas of the province? What are the rates of tree mortality, tree fall down and tree decomposition for those dominant disturbances?
Priority b.	To what degree can large areas of dead trees (e.g., killed by insects, disease or windthrow) meet resource management objectives?
Priority c.	Measuring the effectiveness of various approaches for managing biodiversity, including emulation of natural disturbance pattern?
Priority d.	How do natural disturbance processes including gap creation affect forest regeneration, succession and wildlife habitat of landscape and site scales?
Priority e.	How do insects and disease affect structural and spatial diversity (including forest regeneration), wildlife habitat, and the occurrence of wildfire?
Topic 1.6 Watershed function	
Priority a.	Developing methods for landslide risk assessment and landslide avoidance
Priority b.	Evaluating the physical, biological and cumulative effects of forest management (including salvage harvesting), natural disturbance (e.g., fire, mass wasting, MPB), and range practices on watershed processes (e.g., streamflow quantity and timing, water quality, water table response), channel morphology, and aquatic habitat (e.g., salmon spawning grounds)
Theme 2.0 Decision support tools for sustainable forest management	
Topic 2.1 Habitat supply modeling	
Priority a.	Developing, calibrating and validating habitat models to priorities identified in Section 1.0 (Ecosystem structure, function and processes….), Section 3.2 (Thresholds…) and for decision support related to priorities in Section 4 (Species at risk…). NTFPs may also be treated in this manner.
Topic 2.3 Watershed response	
Priority a.	Developing, refining and validating spatially explicit watershed models that address the effects of forest development and natural disturbance on: peak flow, timing of flow, effect on critical aquatic habitat, effect on ground water, and water quality.
Topic 2.6 Ecological risk assessment frameworks	
Priority a.	Developing frameworks and models and for evaluating the resilience and sensitivity of ecosystems to change with emphasis on the hydrological, geophysical, and aquatic resources of MPB infested areas at the watershed and landscape scales

[13] Draft received August 9, 2006.

Table 1 (cont'd). FIA-FSP sustainability DRAFT[14] program topics, 2007-2008.

Theme 3.0 Indicators, thresholds and monitoring systems	
Topic 3.2 Indicator thresholds of sustainability	
Priority a.	Define the response curves for biodiversity indicators to assist in identifying thresholds for maintaining ecological resilience.
Priority b.	Determining the likely range of natural variability (biological and biophysical) of coarse- through fine-filter indicators to aid in the determination of management thresholds.
Priority c.	Defining criteria suitable for assessing the ecological representation, landscape, and site attributes needed to maintain wildlife and biodiversity, and how best to allocate them across the landscape.
Priority d.	Clarify and/or refine thresholds for indicators of change in watershed functioning (e.g., road density, equivalent clear-cut area).
Theme 4.0 Scientific information to inform policy, regulations, and FRPA practice requirements	
Topic 4.1 Species at risk – recovery research	
Priority a.	Understanding the effects of management practices (particularly forest roads, harvesting, livestock use, exclusion/re-introduction of fire, large-scale salvage) on the ecology of species at risk
Priority b.	Determining how specific threats may be mitigated or recovery mechanisms developed to assist recovery.

Table 2. FIA-FSP DRAFT[10] timber growth and value program topics.

Theme 4.0 Timber losses to MPB	
Topic 4.1 Stand and forest dynamics following MPB	
Priority a.	Quantification of stand and forest change and development following MPB attack (not including growth and yield (GY) modeling, which is being handled in the new GY modeling business planning process), and impacts in 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.
Priority 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, including mitigating losses. Included also would be determining the extent and intensity of MPB impacts on younger stands (25-30 years old); and testing models for mixed stands and for releasing advanced regeneration.
Priority c.	Mitigating MPB losses: silvicultural treatments and regimes, such as mixedwood and broadleaf management, underplanting, fertilisation of non-lodgepole stands and treatment of repressed lodgepole pine stands to accelerate operability and enhance mid-term timber supply.
Topic 4.3 Mitigating losses	
Priority b.	Mountain pine beetle 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.
Theme 5.0 Analytical techniques and models for strategic analysis	
Topic 5.3 Techniques for scheduling harvesting after MPB attack	
Priority a.	Allocation of post-attack live volumes to harvesting schedules
Priority b.	Design of retention and salvage harvesting at scales ranging from individual cutblocks through landscape units to entire management units
Theme 10.0 Forest harvesting and engineering studies on salvaging MPB-killed timber	
Priority a.	Studies to quantify the rates and amount of deterioration of MPB-killed timber (in terms of both sawlogs and fibre), and to mitigate potential losses

[14] Draft received August 9, 2006.

Whiskey Jack Forest Sciences

Mountain Pine Beetle Research and Extension

An Assessment of Existing Strategies, Gap Analyses and Other Reports in Support of FIA-FSP Mountain Pine Beetle Research and Extension Priorities

DRAFT FINAL REPORT - APPENDICES

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Forest Investment Account Forest Sciences Board

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APPENDIX 1. Summary description of existing research gap analyses and strategies

The information presented in this appendix is abridged from the reports and websites reviewed.

1.0 Mountain Pine Beetle Initiative – Canadian Forest Service

Background: The Canadian Government's forty million dollar Mountain Pine Beetle Initiative contains a Research and Development Program[1] to address research and extension needs associated with the MPB epidemic. The research agenda is aimed at being strategic, scientifically sound, and complementary to operational needs. The following benchmarks will be utilised to measure program benefits:

- strengthened forest health strategic planning and increased collaboration among sector stakeholders;
- improved market knowledge on challenges and opportunities;
- capacity development in strategic research and technology areas, and
- effective transfer of the program information and technologies to forest managers and policy makers.

Objectives: The objectives of the MPBI Research and Development Program are to:

- reduce the impact of the current mountain pine beetle epidemic; i.e., reduce the adjustment costs (economic, environmental and social) by analysis of impacts and options; and
- reduce the risk of future mountain pine beetle epidemics by improving the efficiency of forest pest monitoring, risk modeling, response timing and tools for direct control..

Program Structure: The MPB R&D Program focuses on four key processes: ecological, economic, social, and risk reduction.

Ecological processes: The current large areas of beetle-attacked forest and subsequent salvage harvesting will affect the ecological character of many interior BC ecosystems and landscapes. Key ecological questions include:

- can/should ecological integrity be maintained in beetle-damaged landscapes?
- what is the post-beetle ecological character of stands?
- what are the ecological risks and opportunities associated with alternative management regimes?
- what are the beetle impacts on regeneration?
- what is the role of fire in restoring post-beetle landscapes?
- what are the fuel- and fire-risk impacts of the beetle?
- what ecological legacies should be sought post-beetle?

***Ecological strategic objective*:** contribute to improved ecological integrity of post-beetle forest landscapes.

***Strategic Initiatives*:**

(1) Development and delivery of decision support tools to evaluate the impacts of various MPB management scenarios on post-beetle landscapes.
Specific project areas include:

[1] Information on the MPBI and the R&D Program can be downloaded from http://mpb.cfs.nrcan.gc.ca/research/about_e.html.

- Landscape level assessments of the density and distribution of damage in post-beetle areas.
- Landscape level assessments of post-beetle changes in hydrological variables (e.g., quantity, quality).

(2) Determination of the environmental risks and opportunities associated with regeneration and ecological impacts.

Specific project areas include:
- Evaluation of beetle impact on fire risk and the role of fire management on post-beetle landscape ecology.
- Refinement of fire models to reflect post-beetle impacts and examination of historic fire intervals, area distribution and severity in relation to the fire/beetle interaction.

(3) Development of stand level decision support tools to improve the ecological effectiveness of post-beetle management prescriptions.

Specific project areas include:
- Assessment of post-beetle impacts on natural regeneration and improvement options for regeneration.
- Calibration of avian habitat models (as ecological status proxies) in salvaged and unsalvaged beetle damaged stands.

Economic processes: Lodgepole pine is the largest component of the AAC in the BC interior. Several areas impacted by the beetle have had substantial uplifts in the AAC over the past three years. Timber supply and economic activity have increased in the short term and are expected to remain at current levels in the medium term. In the longer term (~15 years from now), it is expected that timber supply will be substantially reduced from these beetle-affected areas. Adjusting to the beetle's economic impacts in production, revenues and the economy will require information on a number of key questions:

- what is the timeframe for post-beetle timber recovery from affected stands?
- what will be the impact of post-beetle product profile on continued access to current markets?
- what are the aesthetic, physical, and chemical properties at risk and what is the likely market response?

***Economic strategic objective*:** Provide information to complement harvesting and production decisions and to maintain markets for manufactured products from post-beetle timber.

***Strategic Initiatives*:**

(1) Development and delivery of market support information on the aesthetic and performance properties of post-beetle wood.

Special project areas include:
- Estimation of potential value degrades by product type for post-beetle wood.
- Market analyses of potential response, by product type, to the increasing volume of post-beetle wood.
- Investigation of options and information requirements to absorb post-beetle timber.

(2) Development and delivery of market support information on the physical properties of post-beetle wood.

Specific project areas include:
- Determination of processing and product performance properties of beetle-killed timber for panel products and lumber.
- Development of a kiln-drying schedule and process for beetle-killed wood.
- Investigation of the relationship between timber quality and time since death for beetle-killed timber.

(3) Development and delivery of product and market support information on the chemical properties of post-beetle wood.

Specific project areas include:
- Determination of the chemical and processing properties of post-beetle wood for pulp and paper.
- Determination of chipping properties of post-beetle wood.
- Investigation of the relationship between pulp recovery and time since death of post-beetle wood.

Social processes: In some BC Interior communities, 40% or more of after-tax revenues is directly derived from forestry. The AAC uplifts are initially contributing to economic activity but the level of this activity will be severely challenged by fall-downs in timber supply expected in about 15 years. Resource-dependent communities will be forced to adapt to change as the forest industry restructures to address the reduced timber supply. Adjustment pressures will challenge the sustainability and structure of communities.

Key questions include:

- Can current communities be maintained with an industry restructured to compete in a post-beetle outbreak world?
- What is the socio-economic resiliency of communities in various parts of the BC interior?
- What is the current structure of the industrial base?
- What externalities (both non-timber and non-market values) are currently at risk?

***Social strategic objective*:** Provide analyses and information to assist the province and communities in the post-beetle transition.

***Strategic Initiatives*:**

(1) Development and delivery of information on the potential impacts of the current beetle infestation on resource-based communities.

Specific project areas include:
- Assessment of the economic resiliency of resource-based communities in the BC interior.
- Assessment of the current and future structure of the forest sector in BC and Alberta.

(2) Assessment of the relationship of externalities to the forest industry and the beetle-damage resource within different areas of the beetle zone.

Risk reduction: The large inventory of mature forests in the BC interior is significantly vulnerable to forest pests. This large inventory limits the effective implementation of pest risk reduction options such as stand thinning, altering the species and/or age mix, and increasing the harvesting of mature timber. Instead, a more realistic option is to pursue risk reduction by improving the efficiency of forest pest monitoring, risk modeling, response timing, and tools for direct control. The focus of this strategy is the development and deployment of decision-support tools and models to assist in early detection of pest 'hot spots,' improved stand risk estimates, beetle dispersal models, and analyses of economic risks.

***Risk Reduction Strategic Objective*:** Provide decision-support systems which will combine resource inventories and information management with scientifically credible forecasting models to reduce the risk of future large-scale epidemics.

***Strategic Initiatives*:**

(1) Analyses of MPB population response across a hierarchy of scales.
Specific project areas include:
- Stand-level assessments of MPB population response to natural enemy and competitor complexes and to stand characteristics.
- Landscape-level assessments of population response of MPB to various silvicultural regimes.
- Landscape-level assessments of population response of MPB to climate change.

(2) Spatial modeling of MPB populations across a hierarchy of scales.

Specific project areas include:
- Development of spatially explicit models for pure and pine-leading stands.
- Development of spatially explicit MPB dispersal models.
- Development of a system of integrated risk assessment models based on population dynamics and potential spatial distribution across a range of forest conditions.

(3) Enhanced tools to identify, monitor and assess response to MPB populations across forest landscapes.

Specific project areas include:
- Development of remote sensing technologies to provide improved red-attack detection and monitoring capabilities.
- Calibration of risk assessment models across a variety of forest landscapes to determine critical population thresholds what will trigger a suppression response.
- Analyses of the economic risks and options of beetle infestations.

2.0 Government of British Columbia

2.1 Mountain Pine Beetle Stewardship Research Strategy

Background: This strategy, published on July 31, 2005, is entitled, "Mountain pine beetle stewardship research strategy."[2] The development of this strategy was in response to the Ministry of Forests and Range recognition of the need to bridge the gap between the existing knowledge and the knowledge required to resolve the MPB stewardship research issues. This strategy is

[2] Available on-line at http://www.for.gov.bc.ca/hre.

supported by four companion documents: "MPB Research Stewardship Needs Definition" and its two "Appendices;" and "Gap Analysis – Research Related Stewardship Issues for the Mountain Pine Beetle (MPB) Infestation" and its "Supplemental Reference." Only a limited number of agency staff, and only one industry executive were interviewed. There was limited participation from forest operations and the geographic regions where the MPB epidemic is occurring. Only researchers from the Research Branch and the Canadian Forest Service (Pacific Forestry Centre, Victoria, BC) participated in the gap analysis workshops. This strategy does not cover socio-economic and policy issues, nor does it cover wildfire management. First Nations did not have an opportunity for input to the strategy. This strategy has no funding envelop.

Objective: The objective of this strategy is to identify the research necessary to resolve stewardship issues related to the MPB epidemic and the management of the epidemic. The strategy may be useful in helping research organisations to establish internal research priorities, and may have some role in coordinating province-wide programs and projects. A third primary role for this strategy is to assist funding agencies to coordinate and shift priorities so that the Province's 2005-2010 Action Plan objectives are addressed.

Research Structure: The strategy defines nine generic discipline groupings of research and, within each discipline, identifies research needs. The nine discipline groups are (Table 1):

- **hydrology, geomorphology, and fisheries** – research in fish-forestry interactions, watershed processes, and aquatic ecology
- **soils** – research to improve knowledge of soil and its role in forest ecosystem function, productivity, and effective management
- **wildlife, ecology, range, biodiversity** – ecological research activities related to landscape biodiversity (including old growth and range lands) and wildlife habitat
- **silviculture, growth and yield** – research to provide the tools and information to make sound resource management decisions in the practice of controlling forest establishment, composition and growth
- **strategic analysis, planning, decision support** – research to create and implement tools and information to facilitate landscape-level planning
- **climate** – research to link land resources to the global climate, and also aid assessment of the effects of future climate changes on forest ecosystems
- **entomology** – research on the effects of insects on trees and forests, in particular focusing on the operational problems in managing affected stands and evaluating treatment options
- **genetics** – research in tree breeding and genetic improvement, gene conservation, and seed transfer and climate change
- **shelf life** – research into the length of time after death that a tree will have a productive use (e.g., sawlogs, OSB, pulp, bio-fuels, habitat)

Knowledge gaps in each of the disciplines were identified as high, moderate, or low, based on importance and urgency as defined by the interviewees. The research discipline areas with the highest priority gaps were: hydrology, geomorphology & fisheries; silviculture, growth & yield; entomology; wildlife, ecology, range & biodiversity; strategic analysis, planning & decision support; and shelf life (Table 1).

Research Governance: The strategy recommended the establishment of a MPB – Research Issues Steering Committee comprised of management representatives from all MPB research funding agencies (e.g., Ministry of Forests and Range, Forest Investment Account, and MPB Initiative), which may have different funding objectives and strategies. The mission of this steering committee would be to coordinate, promote and ensure collaboration in research to

resolve MPB stewardship research issues, and to promote the extension of the research. Other benefits could include collaborative multi-disciplinary research initiatives, consistent priorities among all funding agencies, and a wider range of partnership expertise brought to the table.

Table 1-1. MOFR MPB stewardship research strategy – consolidated summary of high priority knowledge gaps.

DISCIPLINE	KNOWLEDGE GAP
Hydrology, geomorphology & fisheries	Impacts of MPB infestation and salvage harvesting on the hydrological cycle (snow accumulation/melt, rainfall, evapo-transpiration, groundwater regime, water yield, and peak flows) at the watershed and landscape scale
	Impacts of MPB infestation and salvage harvesting on riparian and stream channel physical processes (water quality, large woody debris dynamics, shade, air and water temperatures, understory vegetation, sediment production and delivery, channel stability/destabilisation, and water chemistry)
	Impacts of MPB infestation and salvage harvesting on riparian and stream channel biological conditions and processes (alteration to fish spawning and rearing habitat, fish species composition and spatial distributions, and aquatic communities)
	Modeling of potential impacts and generation of risk analysis for the hydrological, geophysical, and aquatic resources of MPB-infested areas at the watershed and landscape scales
	Development of indicators for riparian function, water quality, and aquatic ecosystem health to monitor the effects of beetles and salvage operations
Wildlife, ecology, range & biodiversity	Impacts of alternative patterns of salvage harvest and no harvest at the landscape and stand scales on critical habitat for plants and animals
	Impacts of alternative patterns of salvage harvest and no harvest at the landscape and stand scales on ecological functioning
Silviculture, growth & yield	Recruitment, development and health of natural and planted regeneration across a wide range of post-attack stand types and conditions (i.e., mixed species – salvaged; mixed species – unsalvaged; pine dominant – salvaged; pine – dominant – unsalvaged) in different BEC zones
	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 – salvaged; pine – dominant – unsalvaged) in different BEC zones
	Silvicultural treatments and regimes, such as fertilisation of non-lodgepole pine stands and treatment of repressed lodgepole pine stands, to accelerate operability and enhance mid-term timber supply
Strategic analysis, planning, decision support	The effect of MPB management activities on the leading edge of the outbreak, and the rate of progress of the leading edge
	Effect of forest management activities on the nature and extent of the current outbreak
	Allocation of the post-attack live volume to harvesting schedules
	Retention and salvage harvesting design at scales ranging from individual cutblocks through landscape units to entire management units (TSAs)
Entomology	Understanding mechanisms and percentages of populations dispersing locally versus long distance
	Influence of micro-climate factors from various stand types and ages on MPB emergence
	Success rate of MPB attack in young stands
	Effects of MPB on jack pine stands; insect physiology; brood success; fungal colonisation; natural enemies; etc.
	Impact of global warming on MPB survival, virulence and distribution
	Detection of green-attacked stands before they become red-attacked
Shelf life	The shelf life of MPB-killed trees for the various forest products

2.2 Forests For Tomorrow Research Strategy

Background: The Government of BC initiated the Forests for Tomorrow (FFT) reforestation program in 2005 with a 4-year budget allocation of $86 million from 2004/05 to 2007/08 in response to the ongoing unprecedented Mountain Pine Beetle (MPB) epidemic and recent catastrophic wildfires (particularly the 2003 fires). MOFR envisions a 15-year reforestation program to ramp up quickly to a level of $96 million by 2008/09, continue at that level and then decrease. The FFT program goal is to address the increasing area of not-satisfactorily-restocked (NSR) forests, outside of industry obligations, with focus on areas affected by the MPB and large fires[3].

Reflecting on the magnitude of current and anticipated impacts, the FFT program is a huge operational initiative that necessarily will have to embrace some significant management uncertainties and investment risks. Strategic investments in research and the transfer of the applied knowledge it generates will therefore need to play an important role in reducing critical management uncertainties and investment risk. This reality of the FFT program represents the high-level business case for undertaking this supporting research.

The FFT Research Working Group recognized the need to have a well thought out research strategy that was specific to the needs of the program but was also complementary with other research strategies and initiatives. This FFT Research Strategy is therefore designed to build upon and supplement the *MPB Stewardship Research Strategy* completed in mid-2005 by identifying key knowledge gaps specific to the FFT's reforestation challenges.

The development of this FFT Research Strategy responds to the Ministry of Forest and Range's recognition of the need to bridge the gap between existing knowledge and the knowledge required to resolve FFT research issues in support of critical FFT strategic and operational challenges.

Objectives: The objectives of this strategy are to:

- focus on reducing management uncertainties and risks at the strategic to operational-level;
- align with, and contribute to, FFT program goal, objectives, desired outcomes, and tasks including those carried out by various FFT working groups;
- recognize the practical realities of the FFT timeframe and the need for timely information and knowledge wherever possible; and
- capitalize on and build upon existing and anticipated related activities and investments in research and extension, including communication, to promote awareness and use of research findings, effectiveness evaluations and monitoring.

This Strategy is intended to complement the *Mountain Pine Beetle (MPB) Stewardship Research Strategy* and the higher level *MPB Emergency Response – Canada-BC Implementation Strategy* which provides targeted funding support for MPB-related research through the Forest Investment Account (FIA) Forest Science Program.

The strategic intent of the FFT program is outlined by six program objectives. In this regard, these objectives constitute the "business drivers" presumed to be most relevant to the FFT Research Strategy and the anticipated outputs and outcomes of such research investments.

[3] The FFT Program Management Plan and additional information about FFT are available at: www.for.gov.bc.ca/hfp/fft/.

- To speed the recovery of the timber supply, biodiversity and other non-timber forest values in forest management units affected by catastrophic MPB infestations and large fires, through strategically planned reforestation and brushing.
- To revise silviculture strategies of management units catastrophically impacted by MPB, and survey, assess, and plan the high priority silviculture work not legally required by licensees.
- To ensure that licensees restore burnt plantations under free-growing obligations, by funding reforestation according to Section 108 of the *Forest and Range Practices Act.*
- To make cost-effective investments by ensuring that young forests that are established under the program achieve free-growing status.
- To update information that supports accurate timber supply forecasts, and silviculture planning, reporting and decision-making.
- To ensure a sound scientific and technical foundation by incorporating research, effectiveness evaluation, monitoring and timber supply analysis into the program decision-making framework and treatments.

In order to support FFT program objectives and in particular FFT objective #6, four key dimensions provide a framework for the FFT Research Strategy. The dimensions are:

(1) **Knowledge gap issue themes —** New knowledge is needed in a variety of biophysical discipline areas such as hydrology, geomorphology and fisheries; soils; wildlife, ecology, range and biodiversity; silviculture, growth and yield; climate; fire; entomology; genetics; and strategic analysis, planning and decision support – as identified in the MPB Stewardship Research Strategy.

(2) **Spatial/scale stratification of these gap issue themes —** new knowledge is needed at a variety of scales of decision-making within FFT. Strategic or provincial-level knowledge is needed to support FFT program-level decisions. Management unit level knowledge can support tactical decisions for Timber Supply Areas (TSAs) and Tree Farm Licenses (TFLs). Landscape-level and stand-level knowledge is needed for watershed- and site-level operational decision-making for recovery of timber and non-timber values including biodiversity.

(3) **Knowledge delivery time frame —** The temporal dimension is needed particularly given the relatively short timeframe for the FFT program (likely not in excess of 15 years) and the need to ensure that critical knowledge is provided in a timely manner to support strategic and operational needs as soon as possible. Some information needs are urgently needed in the short term (less than 2 years), whereas other information is need in the medium term (e.g., 2-5 years), or could possibly still be beneficial in a longer-term timeframe 5-15 years and beyond. In the longer timeframe, continued monitoring and analysis will be still be important to capture to those most value from the earlier investment and to ensure that the research-to-management learning ‘loops are closed off.

(4) **Methods of knowledge acquisition** include:
   - ***Knowledge synthesis,*** including the targeted development and extension of tools and techniques (best practices) from this knowledge;
   - ***Adaptive management*** from well-designed projects focused on explicit uncertainties for the purpose of accelerating the learning cycle within the FFT timeframe;
   - ***Supplementary research*** that builds on existing research projects and operational trials; and
   - ***New research*** that is done in an applied and expedited manner with focus on identified FFT knowledge gaps.

Research Structure: The strategy defines four high priority knowledge gaps:

(1) What silviculture regimes and planting stock should be used under what conditions, including retention for non-timber values?
- MOFR has 25 years experience in the development of silvicultural practices and the collection of silviculture information. Silvicultural strategies exist for each TSA and TFL; salvaging and reforestation of large-scale fires (>10 000 ha) have been ongoing for years. What was done well/what was done poorly/what was learned?
- Silviculture regime development for MPB killed areas is needed.
- Where will natural regeneration come in after fire and MPB mortality?
- Solutions to short-term obstacles to reforestation while simultaneously developing an approach to increase the probability that we will have healthy productive forests in the future.
- Climate change/forest health
  - Accommodation of climate change impacts on species selection for FFT plantations.
  - Accommodation of the interaction between climate change and forest diseases affecting the success of plantations created under FFT needs to be considered.
  - Douglas-fir review study with respect to climate change and areas that may be suitable for planting that are not currently within its distribution range.
  - Appropriate silviculture techniques that can reduce insect and disease infestations in regenerated areas.
- Hydrology
  - Regeneration success: natural versus planting, species selections with hydrology changes now and in future, brush complex development needs to be assessed.
  - Tree growth on waterlogged soils; test stock types and different species, micro-site selection
  - Develop soils-based indicators for monitoring reforestation success on waterlogged soils.
- Tree species and genetic diversity
  - Need to develop landscape and forest level species and genetic diversity targets.
- Retention
  - What are the ecological risks and opportunities associated with alternative management regimes? What ecological legacies should be sought post-beetle?
  - Acceptable amount of broadleaf tree stems in the stand necessary to maintain health, diversity, growth and development of regenerated areas.
- Cost
  - Low cost methods for re-establishing adequate crop tree stocking and vigor in unsalvaged stands need to be addressed.

(2) Assess soil hydrological effects from MPB/fires and strategies to rehabilitate waterlogged sites.
- Quantify severity and extent of soil hydrological effects from beetle kill of timber and wildfires and how these can be mitigated.
- Strategies for rehabilitation of waterlogged sites in relation to tree growth.
- Hydrological effects: is the elevation of the water table significant and how long will it persist?

(3) Seed deployment strategies, including genetic improvement.
- Develop seed deployment strategies (species mixes, seed sources); identify resistant seed sources; natural stand parent tree selections

- Seed viability and long-term storage capabilities for seed cones that were collected from dead or dying MPB pine stands.

(4) Forest fertilisation.
- Identification of candidate areas that can benefit from forest fertilization, and thus help mitigate timber supply problems.

Implementation:

The Core Recommended Strategy: The strategy recommended that the Ministry of Forests and Range develop area-specific FFT reforestation handbooks. This effort would be undertaken by research and operational staff involved in the FFT program with assistance from experts in academia, the forest industry, other provincial and federal agencies, First Nations and other stakeholders. The handbooks would contain guidelines and recommendations targeted to support strategic and operational level FFT practitioners who will be faced with having to make often unusually complex and unfamiliar reforestation decisions (such as those outlined in the previous section).

The FFT Research Strategy will provide an important design and support component for the FFT Program overall and will be influenced by broader challenges identified at the December 2005 Chief Forester's Symposium titled – *The Future of Forest Ecosystems of BC — Exploring the Opportunities.*

Tree species selection guidelines by biogeoclimatic unit are currently being updated. These guides are needed to help address species suitability at the site level based on existing local ecological characteristics. Species choices are provided in the tree species selection guidelines. The FFT reforestation handbooks would be designed to complement these guides. The handbooks would identify and characterize a further set of key factors to consider, ones that are special to the reforestation challenges that need to be addressed on FFT lands under the FFT program. The handbooks would be developed based on a synthesis of best available science-based knowledge and expert opinion. They would include projections of how various change agents may impact future forests and the implication of the affects on silviculture and nursery strategies and practices.

***Recommendation 1*:** The FFT reforestation handbooks should be prepared within the next two years based on a knowledge synthesis approach. The handbooks should embrace the following features.

- The handbooks will be 'living documents' that will be periodically revised based on improved knowledge, practical field experience and new research.
- The handbooks will be prepared for distinct ecological–administrative areas of BC affected by MPB and fires (such as the former forest regions: Prince Rupert, Prince George, Cariboo, Kamloops and Nelson); and
- During the preparation and implementation of the handbooks, that key uncertainties and risks be identified and documented to the FFT Research Working Group so that they can be considered in the next phase of FFT Research Strategy. The "research" approaches may involve any one of number of approaches such as those described in the strategy framework described earlier in Section 7.

***Recommendation 2*:** The FFT reforestation handbooks should be considered phase 1 in implementing the research strategy. The handbooks should be prepared preferably using FFT

program funds given high relevance of the work, the timely need for these products and what reforestation investments are potentially at risk without the benefit of this knowledge.

***Recommendation 3*:** Using the research framework described in section 7, that research projects be identified during the preparation of the handbooks be considered phase 2 (and possibly subsequent phases depending on the time frame) in the FFT research strategy. These projects can be supported by other existing research funding programs such as Forest Investment Account (FIA), the *MPB Emergency Response – Canada-BC Implementation Strategy* and perhaps the *Mountain Pine Beetle Initiative* of the Canadian Forest Service.

***Recommendation 4*:** The project team recommends the formation of an FFT Reforestation Handbook Task Group. The Task Group could be comprised of representatives from the FFT Research Working Group and any other FFT Working Groups that have a clear stake in FFT research initiatives. The Task Group would develop a terms of reference, secure necessary funding from the FFT Program and provide staff resource support from MOFR.

2.3 Future Forest Ecosystems of BC

2.3.1 Exploring the Opportunities

On December 6, 2005, a symposium entitled, "The Future Forest Ecosystems of BC – Exploring the Opportunities," was held at the University of Northern BC in Prince George. The symposium was followed by a series of as six concurrent workshops on December 7, 2005.[4]

Objectives: The objectives of the symposium were to:

- identify the current and potential future condition of BC's forests relative to stresses of climate change, wildfire, catastrophic pathogen and insect attacks, and other ecological change agents;
- determine how other jurisdictions have, or are planning to respond to similar stresses or changes;
- review the current forest management paradigm (legislation, tenure, policy, practices and science) regarding BC's ability to manage ecosystems in light of the forecasted changes;
- determine potential improvements in BC's forest management paradigm to effectively respond to the future; and
- identify key information needs, including how First Nations' traditional knowledge might contribute to our knowledge base.

Synopsis of the Presentations: The forests of BC are being impacted by the dynamics of environmental change and human activity in ways which were unforeseen a decade ago. Many of the assumptions that forest management professionals have relied upon to plan for the growing and harvesting of trees and for management of other important ecological services, no longer appear valid, or at least require re-examination. One of the primary challenges to these assumptions, the trend towards a warmer climate, continues unabated and even dramatic reductions in global carbon dioxide emissions will not reverse the trend for several decades.

[4] Presentation materials for most of the symposium speakers, the reports from the discussion groups, and the symposium summary can be downloaded from the Ministry of Forests and Range website**:** **http://www.for.gov.bc.ca/hts/Future_Forests/**.

Forests, covering an estimated 30% of the global landmass, contribute an array of services needed for survival. At the same time, our consumption is depleting forests' natural capital at an enormous rate, and only a significant change in approach will bring about sustainability. Simply becoming more efficient resource users will not be enough to reverse the drawdown on natural capital – it will be necessary to find mechanisms which promote restoration of capital.

Climate change predictions for BC suggest strongly that, for the foreseeable future, management regimes will have to adapt continuously to changes in temperature and moisture well outside the range of normal variability, and that rate of change is faster than in the past. The inherent uncertainty of traditional forecast methods is magnified considerably by climate change, and this suggests that new ways of thinking and predicting, as well as new ways of managing, are needed – a new paradigm. Continuing to wok within the current parameters and assumptions will result in increasing exposure to unintended negative consequences. Rather than trying to predict the specific outcome of policies, we must become better at processes of adaptive management. At the same time, it would be more effective if we managed ecosystems for "resiliency" rather that attempt to link practices to the notion of "sustainability."

The traditional ecological knowledge and practices of aboriginal people, and the concepts behind modern 'ecosystem-based management,' support the idea that natural processes and patterns need to be maintained. Current management practices, which emphasise the removal of certain ecosystem components (e.g., deciduous shrubs and trees), should be changed to practices which manage for ecological sustainability, and a range of non-traditional and non-timber forest products, including water, carbon sequestration capacity, wildlife habitat, food and medicinal plants, and recreational uses.

It is impossible, at least with out current level of knowledge and technology, to understand all the variables and cause-and-effect relationships in a forest over space and time. We therefore make assumptions. Our assumptions of a decade ago, although informed by our best understanding at the time, can now be informed by new information, knowledge, experience, and perspectives. All of the change trends and uncertainties are cause for us to rethink not only our policies and practices, but also our fundamental approaches to management. We can learn to adapt by increasing our emphasis on long-term monitoring and continuity of information, by thinking about the dynamic interactions occurring, looking for ways to maintain the inherent resilience of forest ecosystems, and being truly open to adaptive management. The flexibility model is the only way to address the risks and uncertainty facing forest ecosystems in BC and the future generations who depend on them.

Synopsis of the Discussion Workshops: The working groups determined that the current forest management paradigm does not give sufficient consideration to ecological processes and principles, nor does it anticipate future changes to ecosystems created by climate change, catastrophic disturbances, and other change agents. Accordingly, the discussion groups generally favoured adapting the current forest management paradigm to achieve ecosystem resilience. Such a shift would include more direct involvement by First Nations, increased protected areas, ecosystem-based operational planning, flexible science-based forest practices, more funding and capacity to conduct long-term research and adaptive management, and increased public education. The workshop discussions centered on six topics:

(1) ecosystem process;
(2) fire;
(3) biotic disturbance agents;
(4) scientific foundation and models;

(5) species selection and genetics; and
(6) alternative models.

A summary of the highlights of each workshop discussion is available on the web site. Most of the highlights dealt with change, adaptability, flexibility, resiliency, ecosystem-based management, knowledge-based approaches, making better use of existing knowledge, knowledge gaps and needs, managing for variability, modeling and systems approaches, and new opportunities.

Common Opportunities Identified: Workshop participants identified a large number of opportunities to change current management processes and policies in ways that could significantly improve the chances of effectively managing BC's forests to meet the long-term needs of our citizens and our global obligations. Broad themes which emerged as opportunities included:

- Circumstances have created both a need and an appetite for change, opening a pathway to consider new and innovative responses. The effects of climate change, global competition in forest product markets, new working relationships between governments at all levels and First Nations are examples of phenomena which open the door to change.
- The opportunity to continue the multi-disciplinary, multi-interest dialogue and collaboration process which can then inform decision-makers at all levels.
- Emergence of a new framework or model for managing that carries forward the best attributes of our current approach, but is better able to deal with the uncertainty and risks inherent in making decisions today which have consequences for decades to come.

Common Messages Identified: The strong, common messages which were heard included:

- The need to adopt a principle of managing for resilience of systems (in this case, ecosystems, but similarly for the social, cultural and economic systems). This was seen as a much more grounded strategy for dealing with uncertainty and natural variability than focusing on unattainable objectives such as stability.
- Adoption of a strong knowledge-based and inclusive approach to setting objects and assessing risk. This includes areas of new or expanded research, better use of existing knowledge, scenario modeling, and better methods of valuing a broad range of environmental services.
- Building adaptive management into forest management practices and decision-making models, including as assessment of current policies and structures for their ability to address the resiliency principle.
- A need to constantly track the interactions between changes to ecosystems, human communities and economies and respond with a mind to balance and resilience.

Next Steps: The Chief Forester has committed to following up on the Symposium and Workshop by posting the presentations on the web site, and:

- using the workshop overview summary to begin immediately communicating to various key groups about the change agenda under discussion;
- producing complete reports from the working groups and posting them on the web site;
- producing a Symposium and Workshop Report, with input from the workshop discussion groups, and posting it on the web site;
- carrying out a high-level analysis of the concepts and recommendation arising from the presentations and workshops, and making the results available in February 2006;

- incorporating key results of the analysis into appropriate work plans; and
- supporting a continued dialogue, including broader participation, on the future forest ecosystems of BC as well as their interdependence with future social, cultural and economic circumstances.

2.3.2 Draft Recommendations

The Future Forest Ecosystems Initiative (FFEI) is a bold new venture of the Ministry of Forests and Range help maintain and enhance the resilience of BC's forest ecosystems. The explicit purpose of the FFEI is to adapt BC's forest management framework to "manage for resilience." Managing for ecological resilience requires that the forest management framework (i.e., the legislation, policy, planning, and guidance which governs forest management) enables ecosystem components such as soils, hydrology, species composition, landscape features, and natural disturbances (e.g., fire, insects and diseases) to remaining within their range of natural variability. An ecosystem's range of natural variability is called its "stability domain."

The FFEI is contemplating incremental changes to BC's existing forest management framework to maintain and enhance the resilience of forest ecosystems. The management framework is supported by and continuously improves with ongoing research, monitoring, forecasting, and adaptive management. The aim of FFEI is to manage for ecological resilience without negatively impacting the productivity of forest resources, including timber. The scope of FFEI is:

- forest ecosystems within the provincial forest land base;
- environmental and ecological aspects of forest management;
- incremental changes to existing forest management framework; and
- projects for which the Ministry of Forests and Range is the lead or partner agency.

The scope of the FFEI will likely change over time as government expands its understanding of forest ecosystem patterns and processes, agents of ecological change, and attributes of a forest management framework which are desirable to maintain and enhance ecological resilience.

The objectives of the projects recommended under the FFEI are anticipated to achieve the following:

- understand the range of natural variability of ecosystem components, including soils, hydrology, species composition, landscapes features, and natural disturbances such as fire, insects and disease;
- measure whether we are managing to maintain ecosystem components within their natural range of variability;
- predict how climate change might alter the range of natural variability of ecosystem components;
- set forest management goals and objectives which maintain and enhance ecological resilience; and
- communicate forest management goals and objectives which support ecological resilience.

The recommended projects are summarised in Table 2.

Table 1-2. Recommended projects for the Future Forest Ecosystems Initiative.

#	Objective	Brief Summary of Recommendations
1	Learning the range of natural variability of ecosystem components	• Document existing knowledge and conduct research to define the range of natural variability of ecosystem components (soils, hydrology, species composition, landscape features, and natural disturbances, including fire regimes, insects and disease • Continually update ecosystem management tools (BEC, TEM, PEM) based on new and forecasted ecosystem information
2	Measure whether we're managing to maintain ecosystem components within their range of natural variability	• Monitor the range of variability of ecosystem components • Enhance the current forest health monitoring program to provide timely information on pest incidence • Establish an adaptive management program and incentives to practice adaptive management, to promote continual improvement of policy and practices based on current and new ecological information • Enhance forest information systems so they report on species composition and diversity at multiple scales
3	Predict how climate change might alter the range of natural variability of ecosystem components	• Develop climate change projection models and a climate change monitoring system to project future climates and to monitor changes to forest ecosystems as a result of climate change • Develop tools for evaluating impacts of climate change on natural disturbance processes • Conduct risk assessments to determine potential impacts of climate change on forest and range resources • Conduct research and modeling to determine potential impacts of climate change on key species, tree seed genotypes, soil processes and productivity, and fire regimes
4a	Set forest management goals and objectives which maintain and enhance ecological resilience by adapting legislation and policy	• Evaluate current policies for wildlife tree patches, coarse woody debris, biodiversity, and partial cutting, to assess whether they enable ecological resilience • Revise species selection, free growing, and seed transfer policies and systems to improve the diversity of tree seed, tree species, stand types and ages, and their adaptation to future climates • Incorporate forest health objectives into FRPA • Examine options for legislating fire management objectives
4b	Set forest management goals which maintain and enhance ecological resilience by adapting planning and systems	• Evaluate protected areas to determine their contribution to ecological resilience • Establish a process for incorporating natural disturbance regimes into forest management planning • Improve stand growth models to better manage multi-species and complex stand types • Establish a model for analysing climate change impacts on timber supply • Develop and innovative forest health strategy which anticipates future forest health issues, management implications, and solutions which temper future impacts of insects and pathogens • Develop provincial, regional and local fire management strategies/plans which encourage reintroduction of fire on the landscape where appropriate, to allow for more natural fire-based ecosystem processes to occur • Examine options for enhancing MOFR's fire management program to deliver prescribed burning and other fire management activities
4c	Set forest management goals which maintain and enhance ecological resilience by adapting guidance	• Define ecosystem services and risks to those services, and promote their consideration in forest management planning • Promote partial cutting, green tree retention, protection of advanced regeneration, and broadleaves where appropriate
5	Communicate forest management goals and objectives which support ecological resilience	• Train users of BEC to encourage a knowledge-based approach to interpreting BEC and developing ecosystem management prescriptions • Use communications to increase awareness and understanding of climate change impacts on BC's forests • Use communication to improve government and public understanding of the role and value of fire as a natural ecosystem process • Initiate extension and dialogue on ecological resilience concepts, research, and management goals and objectives

Over the next few years, the FFE team will oversee implementation of approved projects, report on the progress and outcomes of projects, and help resolve project-specific issues which require higher level direction. In due course, the FFE team will design and implement a process to integrate the purpose and objectives of the FFEI into normal ministry business.

2.4 Forest Investment Account, Forest Science Program, Mountain Pine Beetle Research

In British Columbia, the Forest Investment Account (FIA) is a provincial government mechanism to promote sustainable forest management (SFM). The FIA Forest Science Program (FIA-FSP) supports and funds initiatives and activities which address the critical knowledge required to enable science-based SFM of BC's forest resources. The FSP focuses on research supporting SFM and improving timber growth and value, and utilising forest science results and knowledge more effectively and thoroughly through extension. The Forest Science Board (FSB) provides advice about strategies and priorities for the FIA-FSP. Four program advisory committees (PACs) support the FSB in shaping the FIA-FSP by providing strategic advice and recommending funding priorities for the different programs. The PACs are: the Sustainability PAC (SPAC), Timber Growth and Value PAC (TPAC), the Long-term (LT) Research Installation PAC (LTPAC), and the Extension PAC (EPAC). SPCA and TPAC identify critical issues, information needs, and knowledge gaps in each of the program areas, and recommend the necessary research and extension priorities. SPAC and TPAC:

- provide annual advice to the FSB on research and extension needs in each program area;
- develop and regularly update a five-year strategy for addressing short- and long-term research and extension priorities in each program area;
- recommend research priorities for the annual FIA-FSP Research Call for Proposals; and
- review and comment to the FSB on the annual recommendations of the LTPAC.

EPAC advises the FSB on provincial forest extension needs and oversees the development and implementation of the BC Forest Extension Program. LTPAC annually assesses long-term research installations in the context of the SPAC and TPAC, and recommends to the FSB, SPAC and TPAC those installations for which maintenance activities should be funded. The long-term themes identified for SPAC, TPAC and EPAC are shown in Table 1-3.

Through the $100 million provided by the Government of Canada to BC to help mitigate impacts of the MPB infestation, the FIA-FSP is now funding some aspects of MPB research. The FSP, in the autumn of 2005, provided a list of research priorities for funding MPB research (Tables 1-4, 1-5, and 1-6).[5]

[5] Some of these priorities were drawn from the priorities of the FSP Sustainability and Timber Programs (http://www.fia-fsp.ca), and some were drawn from the MOFR MPB Stewardship Research Strategy (item B. above).

Table 1-3. FIA-FSP programs (SPAC, TPAC, and EPAC) and priority themes.

PROGRAM	THEMES
Sustainability	• Ecosystem structure, function, processes, and biodiversity related to forest management • Decision tools • SFM indicators, targets, and monitoring systems • Silvicultural systems • Scientific information to inform policy, regulations, and *Forest and Range Practices Act* requirements • Synthesis of best available information to improve policies and practices
Timber growth and value	• Tree growth and stand development • Design and analysis of silvicultural systems • Growth and yield modeling/predictions • Timber losses to environmental factors (wind, drought, insects, disease) • Analytical techniques and models for strategic analysis • Synthesis of best available information to improve policies and practices
Extension	• Development and implementation of a multi-year provincial forest extension plan • Participation in FIA-FSP SPAC and TPAC • Guidance to research proponents • Synthesis of best available information to improve policies and practices • Effective processes and mechanisms to obtain information on user needs and transfer knowledge to users

The priorities identified for the 2006-2007 FIA-FSP call for proposals are illustrated in Tables 1-4, 1-5, and 1-6.

Table 1-3. FIA-FSP sustainability program topics.

Theme 1.0 Ecosystem structure, function and processes, and biodiversity related to forest management
Topic 1.1 Riparian ecology and management of small streams
Priority d. Riparian processes altered by MPB and salvage management, and the consequences for stream channel morphology and aquatic habitats
Topic 1.3 Coarse filter approaches to maintaining biodiversity at the landscape level
Priority a. Can current management practices, such as MPB salvage operations, retention and partial cutting, create or maintain structures and processes that are effective in maintaining key elements of biodiversity at landscape scales?
Topic 1.4 Effectiveness of stand-level structures and habitat in maintaining biodiversity
Priority a. How effective are management strategies in creating and maintaining stand-level attributes or structures needed by wildlife or for biodiversity?
Priority b. What are appropriate stand-level targets and configurations of stand-level structures in cutblocks in order to maintain biodiversity (e.g., in MPB attacked areas)?
Priority c. What are appropriate targets and configurations of stand-level structures in dry forest and open range (grassland, shrubland) in order to maintain biodiversity?
Priority d. How effective are such derived structures in maintaining stand-level biodiversity? Effects of management practices on some non-timber forest products are also of interest.
Priority e. How do riparian buffers and their design contribute to maintenance of stand-level wildlife habitat and biodiversity (aquatic, riparian, and upland)?
Topic 1.6 Watershed function
Priority a. Evaluating the effects of large-scale tree mortality, salvage logging, and/or accelerated harvesting on watershed processes, including peak flows, low flows, water quality, water supplies, and water table response
Theme 2.0 Decision support tools for sustainable forest management
Topic 2.6 Ecological risk assessment frameworks
Priority a. Developing frameworks and models and for evaluating the resilience and sensitivity of ecosystems to change with emphasis on the hydrological, geophysical, and aquatic resources of MPB infested areas at the watershed and landscape scales

Table 1-4. FIA-FSP timber growth and value program topics.

Theme 4.0 Timber losses to MPB
Topic 4.1 Stand and forest dynamics following MPB
Priority a. Quantification of stand and forest change and development following MPB attack (Not G & Y modeling), and impacts in 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.
Priority b. Residual stand development with and without treatments (including small- and large-scale salvage) under various levels of attack; includes mitigating losses.
Priority c . 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.
Topic 4.3 Mitigating losses
Priority b. 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.
Theme 5.0 Analytical techniques and models for strategic analysis
Topic 5.3 Techniques for scheduling harvesting after MPB attack
Priority a. Allocation of post-attack live volumes to harvesting schedules
Priority b. Design of retention and salvage harvesting at scales ranging from individual cutblocks through landscape units to entire management units

Table 1-5. FIA-FSP other topics.

Theme 10.0 Forest harvesting and engineering studies on salvaging MPB-killed timber
Priority a. Forest engineering studies relating to designing efficient, cost-effective and environmentally appropriate methods of harvesting and hauling MPB-killed timber
Priority b. Studies to quantify the rates and amount of deterioration of MPB-killed timber, and to mitigate potential losses

3.0 FORREX Forest Research Extension Partnership

3.1 Linking Recent and Current Projects to Identified Needs

Background: In autumn 2004, the BC Forest Science Board was asked by BC's Deputy Minister of Forests to determine whether the province's needs for research on MPB to combat the current infestation are being adequately addressed by the Ministry's Forest Science Program and by the federal government's Mountain Pine Beetle Initiative (MPBI). The Forest Science Board approached FORREX to gather information about research and extension activities currently addressing the needs of practitioners around the province. In response to that request, FORREX produced the report: "Mountain Pine Beetle: Linking Recent and Current Projects to Identified Needs."[6] The updated Version 2 of this report was produced in October 2005 to provide a solid core of information on MPB research needs and research programs underway. The second version builds on the original and includes information on new projects as well as new information on research and knowledge gaps identified through other processes and projects.

Objectives: The objectives of this report are to:

[6] Wiensczyk, A.M. 2005. Mountain pine beetle: linking recent and current projects to identified needs – version 2. File Report 05-02, 31 p. FORREX-Forest Research Extension Partnership, Kamloops. BC. (www.forrex.org/publications/other/filreports/fro5-02.pdf).

- identify the questions, based on the MPB priority information needs identified by practitioners and researchers, which are being or have been answered by projects funded through the Forest Science Program and the MPBI;
- identify the questions which are being or have bee answered by projects funded through alternate sources; and
- identify topic areas of focus for research projects, and topic areas in which the number of projects has been limited..

The project concentrated on currently and recently-completed MPB-related projects conducted within the last 5-7 years.

Research Structure: Through a coarse filter approach, projects were classified according to a series of topic areas (Table 1-7). The table also includes examples of some specific subject areas which fit under each topic area. The author of the report further subdivided the list of topics into three categories based on how the information would be used within the context of sustainable forest management: strategic, tactical, and operational. The strategic-level topics are those which concern broad-scale, long-term objectives or desired future conditions. Tactical-level topics are those which involve the collection, tracking, analysis, and interpretation of data and information in support of strategic-level objectives and operational practices. Information from these projects, although usually site-specific, often requires further work before the results can be used to change operational-level practices, while projects classified under 'operational level topics, have direct or immediate, site-specific applicability.

While report from FORREX did not technically produce a research strategy, it does represent a compilation and categorisation of information on 231 research projects which can be utilised for strategic purposes.

Table 1-7. FORREX topic areas for classification of mountain pine beetle research projects.

TOPIC AREA	EXAMPLE SUBJECTS
Strategic-Level Topics	
Natural structural stand dynamics and ecosystem function	• Successional patterns • MPB as a natural disturbance agent
Biodiversity and wildlife	• Impacts on general wildlife populations and habitat • Viability of ungulate winter range in MPB-killed stands • Biodiversity • Coarse Woody Debris • Old growth management areas • Impacts on non-timber forest products
Species at risk	• Specific projects dealing with species listed in SARA
Socio-economics	• Impacts on forest dependent communities • Recreation and tourism • Range values (removal of natural barriers, forage production, spread of invasive species, etc.) • Visual quality objectives • Public perceptions of epidemic • Secondary impacts of MPB infestation
Timber supply	• Decision-support systems • Growth and yield • Forest inventory • Linkages with shelf life issues
Climate change	• Role of climate change in affecting current and future outbreaks • Loss of carbon • Impacts on reforestation decisions
Access management	• Increased numbers of roads due to salvage activities • Potential for duplication if access between licencees is not coordinated

Table 1-7 (cont'd). FORREX topic areas for classification of mountain pine beetle research projects.

TOPIC AREA	EXAMPLE SUBJECTS
Tactical-Level Topics	
MPB biology	• Flight and dispersal characteristics and mechanisms • Pheromones • Host resistance (e.g., genetics) • Tree age and size impacts • Interaction between different species of beetles and MPB
MPB and other pine species	• Effects on other pine spp. (e.g., whitebark, western white, jack)
Population dynamics	• Modeling population spread • Modeling dispersal patterns
Detection	• Alternative remote sensing capabilities
Fuel loading and fire behaviour	• Forest fire risk in fully and partially MPB-killed stands • Strategies to minimise future large-scale wildfire risk • Fire behaviour in stands should a wildfire occur
Hydrological	• Water table and operable ground (change between winter and summer ground) • Watershed assessments and models • Roads and crossings, harvesting • Water quantity (peak and low flows) • Water quality – sediments, temperature • Biological components – fish, fish habitat, aquatic invertebrates, nutrients • Hydrologic recovery • Riparian management, including windthrow dynamics and indicators for riparian function development
Operational-Level Topics	
Shelf life	• Viability of standing dead MPB-killed trees
Management, risk assessment and control strategies	• 'Beetle-proofing' the future landscape • Chemical repellents • Risk assessment models, determination of stand susceptibility • Management strategies and plans (includes information on how to reduce potential for future MPB outbreaks)
Geomorphology	• Terrain stability on steep slopes of MPB-killed stands • Soil management (site disturbance) • Stream geomorphology (LWD, channel and bank stability)
Regeneration	• Amount and growth of regeneration (new and advanced) (salvaged versus unsalvaged) • Natural versus planted • Assessment procedures and survey methods
Silvicultural options/restoration	• Incremental treatment effects (e.g., spacing and then fertilisation) • Effects of no treatment (what happens if left just as is)(linkage to natural stand dynamics)
Salvage and ecosystem function	• What to harvest/salvage as it relates to maintaining ecosystem function and biodiversity • Where to leave retention areas and wildlife tree patches
Harvesting, hauling, and storage	• Harvesting safety • Reducing breakage • Haul load weight issues • Prevention of excessive drying while in storage
Product information/research	• Fibre quality (suitability for current products) • Technology • Alternate uses • Blue stain • Marketing – managing real and perceived issues of product quality and pest transfer concerns
Worker safety	• Silviculture workers and WCB
Product information/research	• Fibre quality (suitability for current products) • Technology • Alternate uses • Blue stain • Marketing – managing real and perceived issues of product quality and pest transfer concerns
Worker safety	• Silviculture workers and WCB

3.2 Mountain Pine Beetle DRAFT Extension Plan

Background: In 2005-06, the Provincial Forest Extension Plan started developing specific activities associated with addressing the information needs of various client groups dealing with the impacts of the MPB through programming in its Forest Resources Dynamics Extension Cluster. These activities have focused on coordinating the extension efforts around MPB and increasing awareness and access to information on MPB as well as increasing knowledge around the management of stands impacted by MPB and the effects of those management practices on other values. In January 2006, FORREX was asked to develop an extension program focusing solely on topics and issues related to MPB. This extension plan[7] outlines the context, needs, issues, strategic goals, desired outcomes, key audiences, indicators of success, and planned activities for the MPB Extension Program over the next two years. The foundation of this MPB extension plan is to link to the defined goals, outcome objectives, strategies and performance measures of the provincial forest extension strategic plan.[8]

Goals: The goals associated with the MPB Extension Program are:

- increased awareness by forestry professionals of current scientific, experiential, and indigenous knowledge related to MPB;
- increased knowledge, skills, and usage of current and relevant scientific, experiential, and indigenous knowledge related to MPB; and
- contribute to the achievement of the objectives in the provincial Mountain Pine Beetle Action Plan (2005-2010).

The MPB extension plan also builds upon the priority information needs/topics identified in Table 5. The draft plan is currently under review; thus, it would be premature to list and evaluate the plan and its contents in this assessment. The plan will, where relevant and appropriate, be utilised and referenced in the formation of overall recommendations.

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[7] Wiensczyk, A.M. 2006. Mountain Pine Beetle DRAFT extension plan. FORREX Forest Research Extension Partnership, Kamloops, BC. Unpubl. rep. 30 p.

[8] FORREX. 2006. Provincial forest extension program strategic plan for British Columbia 2006-2010. FORREX Forest Research Extension Partnership, Kamloops, BC. Unpul. Rep. 28 p.

APPENDIX 2. Individuals interviewed.

The individuals who were available for an interview for this project included:

- Doug Routledge, RFP, Northern Operations, Council of Forest Industries
- Steve Sheldon, RPF, Dunkley Lumber Ltd.
- Peter Baird, RPF, Canadian Forest Products Ltd.
- Chris Hawkins, PhD, University of Northern British Columbia

APPENDIX 3. General messages coming from universities' forum[9]

Participants raised a number of general messages with regard to: MPB research planning and implementation, funding and capacity; MPB priority identification and ranking; transfer of MPB research results and scientific knowledge to operations; and long-term MPB research monitoring. The general messages came from all the discussion groups, and covered research, operations and policy issues. The following messages deal only with research issues:

(1) **Apparent disregard for what we actually do know about the MPB and its management.** The MPB has been around a while – it is a natural agent of forest renewal, and it has occurred at epidemic proportions in various parts of BC over the past number of years, most recently in the Cariboo-Chilcotin in the early to mid-1980s. The MPB has been a focus of various research agencies and institutions for the past few decades, and a forest management concern over much of the same period. And, yet, this current outbreak seemingly caught the province by surprise: we ignored or down-played the warning signals, and we seem to have forgotten the lessons learned from the 1980s epidemic, from the various research and operational trials established, and from the operational experience accumulated by forest managers. We need to fully understand how we failed to foresee this MPB epidemic to ensure that the systemic problems do not reoccur.

One of the most urgent needs is an analysis of our existing research and operational knowledge, and synthesis of this knowledge into stand- and landscape-level forest health management policies, guidelines, and 'best practices.' It is critical that the analysis and synthesis be conducted in the 'broad picture' perspective, recognising that:

- there are a myriad of biotic and abiotic agents which can be threats to forest productivity;
- these agents can be threats at the stand and/or landscape level, and at different stand ages and stand conditions;
- forest health is a long-term concern; thus, integrated forest health management is continual and requires a stable, long-term commitment; and
- understanding natural disturbance ecology is essential to successful integrated forest health management.

(2) **Lack of support for community-based research.** The perception is that current MPB research is focused on timber supply implications, which seem to be long on predicting a gloomy future, but offer little, if any information about mitigation and solutions across the broad range of potential economic sectors. Decisions and actions need to be implemented now, and communities need tools to support them with these tasks. There was a common view among participants that the available information needs to be shared with communities. When appropriate, local communities should be involved as advocates for research that affects them. A key point of discussion was the possible interaction of communities, the higher-value and/or value-added forest sectors, and the non-timber forest product sector.

(3) **Identifying knowledge needs.** In light of the message in #1 above, we need to pause and contemplate our knowledge needs so that our efforts do not go solely into researching those questions associated with managing today's outbreak. In that vein, what can we learn from

[9] Extracted from: **Lousier, J.D. 2006**. Mountain pine beetle epidemic and the future of communities and ecosystems. Proc. UBC and UNBC research synthesis and strategy workshop series. University of Northern British Columbia, Prince George, BC, and University of British Columbia, Vancouver, BC. Final unpubl. rep. p. 40-43.

past and current outbreaks? Two concerns were expressed with regard to selecting knowledge needs:

- questions that have received a lot of work and funding may not necessarily be answered as yet; e.g., improving detection of red or green attack using remote sensing; and
- the gaps identified in one discussion group may not be priorities shared by the research and management communities in BC.

(4) **Research funding.** By operating under different research strategies, goals, and schedules, funding agencies are a source of confusion to the research community and operational resource managers, and tend to discourage inter-disciplinarity and collaboration in research programs and projects. Also, it is difficult to integrate research approaches and designs, and it is difficult to initiate long-term innovative research because of the many funding mechanisms/restrictions.

Research to address both the short- and long-term MPB knowledge needs requires different parties to work together. Collaboration can present some challenges, such as intellectual property issues or competition for outside funding. However, large research groups with broad mandates may produce cohesive, holistic results that might not be accomplished by small groups with a narrow focus.

An additional view was expressed that government agencies tend to invest in the short- term (looking for immediate results) but this does not support many forest heath and forest management issues which require longer-term investments in order to find effective solutions. Funding is often available for the establishment of long-term projects but not for the monitoring and re-measurement required throughout the life of the project. This discontinuity of funding has resulted in many long-term projects in BC being abandoned, with the resultant loss of investment, in both research funding and knowledge/expertise. Current challenges to forest health research are fostering long-term creativity, and the need for 'patient' investments and cooperation.

Ideally, industry would also fund the long-term research and have a stake in the continued success of the work. However, industry funding is not stable as companies can change management strategies, leave the province, or cease to exist through further industry consolidation.

(5) **Long-term research monitoring.** More research funding, and, indeed, staff resources, should be directed to monitoring. If we are to learn from our mistakes, we need to monitor how past and current practices are doing. In essence, there is no coordinated, integrative, readily-accessible, consistent system in place to monitor the forest and forest management in BC. We preach but do not readily practice adaptive forest management in BC. Monitoring in conjunction with support tools can build data to validate policies/models. We need to think about tools that deal with long-term conditions to help with model/decision making.

(6) **Effective research partnerships.** To maximise support for research projects and application of research results (extension), there is clearly a need for meaningful, working partnerships between university researchers, stewardship agencies, First Nations, forest-dependent communities, forest companies, and other stakeholders and end-users of research results. It is often fairly easy to build partnerships at the operational (ground) level, but oftentimes extremely difficult to build partnerships with the funding agencies or industry. While funding partnerships are great, they tend not to include collaboration on need definition, project design and location, operational/management relevance, and application of

knowledge, for example. Greater involvement of all players is essential if we are to produce the necessary information and knowledge quickly enough to provide the best science-based guidance to managers, decision-makers and policy analysts.

To tackle the multi-faceted and long-term nature of the MPB/salvage harvesting aftermath, it was suggested that research providers, research funders, and research users examine the formation of research cooperatives, with specific collaborative roles for all parties involved.

We need collaborative decision-making principles to guide management under the tremendous uncertainty resulting from the MPB epidemic. Managing salvage harvesting and subsequent falldowns will require strong support for extensive collaboration possible through partnerships.

(7) **Integration across research disciplines.** There is a large need for clear approaches about how we integrate information across research disciplines. If we are to solve large-scale problems, we need large-scale projects with large-scale and long-term commitments of funding and human resources. And if/once we achieve these solutions, how do we integrate them down to the operational level? The policy level? One suggestion was to implement large (landscape-level) permanent sample plots on which multiple research questions are asked and data are collected over time. This suggestion was deemed a good solution, but participants noted the lack of a viable funding source to support this type of long-term, large spatial-area research.

An additional suggestion was made to develop a good conceptual model to see how the whole picture, including resource management 'solutions,' fits together. This may facilitate the identification of knowledge gaps more quickly and effectively. This is preferable to having individual scientists/institutions/agencies each working in separate areas but not contributing to the larger goal/idea/solution.

(8) **Extension and learning.** The view was expressed that BC has not done an effective job of synthesising and transmitting MPB knowledge from scientists to management/policy makers. We need to improve and focus our efforts to distribute MPB information and knowledge to decision-makers and forest managers. We need to keep people informed of changes to our knowledge base so that they are technically current and have the best available information.

The past few years have seen an ebb in support for continuing education activities as companies and government agencies change infrastructure, reduce staff, centralise decision-making, re-focus their business models, and adapt to emerging regulatory standards. Fewer people are doing more work, with seemingly little time to foster a life-long learning ethic amongst the different sectors. This situation contravenes the expectations of results-based and adaptive management.

(9) **One size does not fit all.** In general, the point was made that, given the geographical extent of the epidemic, solutions to many of the MPB management questions may be specific for particular watersheds and communities, and, thus, the solutions to the specific questions may not have widespread applicability. For example, it was suggested that it will be difficult to generalize about salvaging harvesting method, intensity and extent from an ecological perspective. Furthermore, it is important to engage communities to find their own solutions to the impacts of the epidemic for their local economies, ecosystems and social/cultural fabric.

APPENDIX 4. General comparison of the research strategies and project topic areas.

TOPIC AREA	PROJECT AREAS	STRATEGY[1]				
Strategic-Level		**CFS/MPBI**	**MFR/MPBS**	**MFR/FFT**	**FIA-FSP**	**FORUM**
Natural structural stand dynamics and ecosystem function	Successional patterns	X	X			
	MPB as a natural disturbance agent	X	X			
Biodiversity and wildlife	Impacts on general wildlife populations and habitat	X	X		X	
	Viability of ungulate winter range in MPB-killed stands		X		X	X
	Biodiversity		X	X	X	X
	Coarse woody debris		X	X		X
	Old-growth management areas		X			
	Impacts on non-timber forest products		X		X	
Species at risk	Specific projects dealing with species listed in SARA					
Socio-economics	Impacts on forest dependent communities	X				X
	Recreation and tourism					X
	Range values (removal of natural barriers, forage production, spread of invasive species, etc.)		X			X
	Visual quality objectives		X			X
	Public perceptions of epidemic					X
	Secondary impacts of MPB infestation	X	X			X
Timber supply	Decision-support systems		X		X	X
	Growth and yield		X			X
	Forest inventory		X			X
	Linkages with shelf-life issues		X		X	X
Climate change	Role of climate change in affecting current and future outbreaks	X	X	X		X
	Loss of carbon	X	X			
	Impacts on reforestation decisions	X	X	X		
Access management	Increased numbers of roads due to salvage activities				X	
	Potential for duplication of access between licencees is not coordinated					

TOPIC AREA	KNOWLEDGE NEEDS	STRATEGY				
Tactical-Level		**CFS/MPBI**	**MFR/MPBS**	**MFR/FFT**	**FIA-FSP**	**FORUM**
MPB biology	Flight and dispersal characteristics	X	X			
	Pheromones	X	X			
	Host resistance (e.g., genetics)	X	X			
	Tree age and size impacts	X	X			X
	Interaction between different species of beetles and MPB	X	X			X
MPB and other pine species	Effects of MPB on other pine species (e.g., whitebark, western white, jack)	X	X	X		X
MPB populations dynamics	Modeling population spread	X	X			
	Modeling dispersal patterns	X	X			
Detection	Alternative remote sensing capabilities	X				
Fuel loading and fire behaviour	Forest fire risk in fully and partially MPB-killed stands	X				X
	Strategies to minimise future large-scale wildfire risk	X				X
	Fire behaviour in stands should a wildfire occur	X				X
Hydrological	Water table and operable ground (change between winter and summer ground)		X	X	X	X
	Watershed assessments and models		X	X	X	X
	Roads and crossings, harvesting		X	X	X	X
	Water quantity (peak flow)	X	X	X	X	X
	Water quality – sediments, temperature	X	X		X	X
	Biological components – fish and fish habitat, aquatic invertebrates, nutrients		X		X	X
	Hydrologic recovery		X	X	X	X
	Riparian management, including windthrow dynamics and indicators for riparian function development		X		X	X

TOPIC AREA	KNOWLEDGE NEEDS	STRATEGY				
Operational-Level		**CFS/MPBI**	**MFR/MPBS**	**MFR/FFT**	**FIA-FSP**	**FORUM**
Shelf life	Viability of standing dead MPB-killed trees	X	X		X	X
Management, risk assessment and control strategies	Beetle proofing future landscapes					X
	Chemical repellents					
	Risk assessment models, determination of stand susceptibility	X				X
	Management strategies and plans (include information on how to reduce potential for future MPB attacks)		X			X
Geomorphology	Terrain stability on steep slopes of MPB-killed stands		X	X	X	X
	Soil management (site disturbance, productivity)		X	X	X	X
	Stream geomorphology (LWD, channel and bank stability)		X		X	X
Regeneration	Amount and growth of regeneration (new and advanced)(salvaged versus unsalvaged)	X	X	X	X	X
	Natural versus planted		X	X	X	X
	Assessment procedures and survey methods		X	X	X	X
Silvicultural options/restoration	Incremental treatment effects (e.g., spacing and then fertilisation)		X	X	X	X
	Effects of no treatment (what happens if left just as is) (linkage to natural stand dynamics)		X	X	X	X
Salvage harvesting and ecosystem function	What to harvest/salvage as it relates to maintaining ecosystem function and biodiversity		X	X	X	X
	Where to leave retention areas and wildlife tree patches		X	X	X	X
Harvesting, hauling and storage	Harvesting safety					
	Reducing breakage					
	Haul load weight issues					
	Prevention of excessive drying while in storage					

TOPIC AREA	KNOWLEDGE NEEDS	STRATEGY				
Operational-Level		**CFS/MPBI**	**MFR/MPBS**	**MFR/FFT**	**FIA-FSP**	**FORUM**
Product information & research	Fibre quality (suitability for current products)	X				X
	Technology	X				X
	Alternate uses	X				X
	Blue stain	X				
	Marketing – managing real and perceived issues of product quality and pest transfer concerns	X				
Worker safety	Silviculture workers and WCB					

[1] CFS/MPBI – Canadian Forest Service, Mountain Pine Beetle Initiative; MFR/MPBS – Ministry of Forests and Range Mountain Pine Beetle Stewardship Research Strategy; MFR/FFT – Ministry of Forests and Range Forests for Tomorrow Research Strategy; FORREX – Forest Research Extension Partnership; FORUM – results from Lousier (2006).

APPENDIX 5. Knowledge need priorities identified at the universities' forum[10]

These priorities are considered urgent and are recommendations for action, given the pressing timelines resource managers are facing in the beetle-affected areas. These priorities have also been designed to promote learning outcomes among those affected by and dealing with the MPB epidemic. The following are recommended as priorities for a provincial MPB knowledge program:

(1) An analysis of the existing MPB research and operational knowledge [as was done in Mitchell and Stjernberg (2005)[11]], and synthesis of this knowledge into stand- and landscape-level forest health management policies, guidelines, and 'best practices.' It is critical that the analysis and synthesis be conducted in the 'broad picture' perspective. The analysis should be undertaken around certain themes, with a small working group of experts assigned to each theme. The themes should be selected by the MPB Research Issues Steering Committee, with meaningful input from the resource management operations side.

Wiensczyk (2005) mentioned that FORREX was creating an annotated bibliographic database of published MPB-related literature. This database will be incorporated into the Natural Resources Information Network (NRIN), and could serve as an excellent resource for these analyses.

(2) In light of the urgency surrounding the salvage harvesting of MPB-killed timber, and the regeneration of the new forest, there is a need for 'best practices' guides to help operations staff in their decision making. An important component of these 'best practices' guides will be information on how to implement adaptive management approaches and long-term monitoring programs. The themes for the 'best practices' guides should be selected by the MPB Research Issues Steering Committee, with meaningful input from operations staff. Each of the themes should have a small working group of experts assigned to it. This working group would be responsible not only for the outline and approach to each 'best practices' guide, but also ensuring that the guides are user-friendly and accepted by the operations staff. [These proposed 'best practices' guides are possibly similar to the reforestation handbooks recommended by Jones et al. (2006)[12] in their Forests For Tomorrow Research Strategy report]

Some suggested themes are:

- salvage harvesting
  - matching harvesting and logging methods with post-MPB site sensitivities; opportunities for partial cutting, large-scale clearcuts, retaining advanced and natural regeneration
  - impacts of large-scale harvesting versus small-scale harvesting
  - retention of other tree species and age classes
  - feasibility and impacts of increased access requirements and post-salvage access management

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[10] Extracted from: **Lousier, J.D. 2006**. Mountain pine beetle epidemic and the future of communities and ecosystems. Proc. UBC and UNBC research synthesis and strategy workshop series. University of Northern British Columbia, Prince George, BC, and University of British Columbia, Vancouver, BC. Final unpubl. rep. p. 64-52..

[11] **Mitchell, J.L. and E. Stjernberg. 2005.** Strategies for managing mountain pine beetle: efficacy and economics – summary report. FERIC Advantage, Vol.6 (23). 15 pp.

[12] **Jones, R.K., T. Vold, and G. Nigh. 2006**. Ministry of Forests and Range Forests For tomorrow Research Strategy. Ministry of Forests and Range, Victoria, BC. http://ww.for.gov.bc.ca/htp/fft/.

- analysis of tenure systems used for many natural resource sectors and recommendations for system redesign to ensure more benefits stay in or return to rural communities, including First Nations
- timber supply: spruce, fir, subalpine fir management needed for long-term timber supply certainty – current focus is all on pine and pine beetle, with other species being ignored
- forest regeneration
  - health and condition of advanced and natural regeneration defoliation and after salvage harvesting
  - using mixed conifer stands to regenerate landscapes and meet timber supply goals
  - using mixedwood and broadleaf stands to regenerate landscapes and meet timber supply goals
  - role of remnant patches and adjacent stands in retaining forest structure, fostering seed-in, sustaining hydrological stability, and promoting landscape diversity
  - intensive forestry options
  - impacts of changing climate
  - defining product and use objectives for the new forests
- forest health
  - emigration of the MPB to new and non-traditional environments, e.g., boreal forest, Alberta
  - effects of climate change

(3) Greater focus is required on the needs of the communities affected significantly by the MPB epidemic. The high degree of uncertainty associated with continuity and volume of timber supply after the allowable salvage harvesting has been completed is motivating the communities to collaborate (e.g., the Beetle Action Coalitions) on strategies and activities to investigate the options facing them for the next 15 years (salvage harvesting) and beyond (post-salvage harvesting). The MPB Research Issues Steering Committee should support C-CBAC, OBAC, and the First Nations Beetle Action Plan in their goals, objectives and agendas. The funding agencies need to dedicate a greater share of the research funding to community-based issues and needs. Some priority action items for community-based work are:

- the packaging and transfer of available information on all aspects of the MPB epidemic to communities to reflect the view repeated at the workshop that ‘communities matter’
- support ‘community researchers’ located in study communities; a ‘help desk’ website should be created, with a person to whom communities can talk about available information and whom to contact for more details – to interpret research results for communities
- opportunities for mitigation of timber supply impacts through short-term diversification within a long-term sustainability perspective
- what are community infrastructure needs necessary to support economic diversification in the forest fibre industries
- what are the impacts of rural community transition on urban economies
- impacts of salvage harvesting on number and location of jobs, community businesses, population demographics, and economic viability
- impacts of regeneration/restoration on number and location of jobs, community businesses, population demographics, and economic viability
- economic opportunities in higher-value, value-added, recreation/tourism, and non-timber forest products sectors
- a better understanding of what portion of the benefits of natural resource use is being distributed back to rural communities in the north

(4) The interior forest ecosystems and landscapes affected by the MPB are the lifeline for many First Nations, communities, and industries in the interior of BC, and represent a substantial provincial resource as well as a substantial source of provincial revenues. Restoring and, indeed, maintaining this lifeline into the future has to be considered one of the province's highest resource management priorities for the next several decades. To be the most effective managers of this resource, and to maximise the impacts of our investments in regeneration and restoration of these ecosystems and landscapes, we need to identify and understand the ecological conditions of the post-MPB landbase. Thus, we believe that gaining this understanding is important and we recommend that it be giving a top priority ranking for the next two years. We recommend the creation of a small working group to develop a strategy, action plan, and budget for the necessary research and field work, and provide this information to the MPB Research Issues Steering Committee.

APPENDIX 6. Research infrastructure recommendations coming from the universities' forum[13]

The intent of these recommendations is not to provide a list of good ideas for consideration but to provide concrete suggestions for immediate action. It is recommended that:

(1) Every attempt should be made to combine the existing MPB research strategies into one over-arching strategy. This is may be a colossal dream since it involves different agencies, different levels of government, and different sources and amounts of funding but it must be considered. There is the perception that MPB research programs are ill-designed, scattered, and researcher-oriented, and do not do an effective job of communicating results to the stakeholders, end-users, and communities.

    This strategic collaboration would result in a common set of MPB research goals and objectives for BC, one schedule for an annual call-for-proposals, one format for proposal submission, limited amount of overlap between agencies, and a consistent, coordinated proposal review process. This strategic consolidation will also promote inter-disciplinarity, integration, partnership-building, shared research capacity, and innovation in research.

(2) The MPB – Research Issues Steering Committee should be re-structured and re-focused to become a province-wide body with participation by representatives from the research funding agencies (MOFR, FIA-FSP, CFS MPBI), as well as FORREX, other research providers (universities, FERIC, Forintek, Paprican), field practitioners, resource planners, forest industry, MOFR, MOE, MOAL, communities, First Nations, and non-timber interests/users. This committee would oversee the new collaborative MPB research strategy.

    The mission of the steering committee can remain as is, that is, to coordinate, promote, and ensure collaboration in research to resolve MPB stewardship research issues, and to promote the extension of the research. The benefits of an expanded steering committee would be: (a) ***consistent priorities***, reflective of stakeholder and end-user needs and input, amongst all funding agencies for allocating research funding; (b) ***expertise (shared capacity)*** in all relevant forest research disciplines (the partners will bring additional expertise in MPB research); (c) ***increased support*** from the resource management operations sectors and the communities for research; (d) ***more effective working partnerships*** with stakeholders; more effective and timely application of research results and scientific knowledge into practices, policies and decision making; and (e) ***experience in coordinating research*** (the steering committee and proposed partners currently coordinate many MPB research projects). The Steering Committee would continue to review the coordinated MPB stewardship research strategy annually and ensure that it adequately reflects current issues and priorities.

(3) The new MOFR Research Branch position, Research Leader, Mountain Pine Beetle, should chair the expanded MPB Research Issues Committee, and function as the leader of the overall, collaborative MPB research strategy. This position should be located in the Chief Forester's office at UNBC in Prince George, or in the office of the Assistant Deputy Minister MPB Response in Kamloops.

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[13] Extracted from: **Lousier, J.D. 2006**. Mountain pine beetle epidemic and the future of communities and ecosystems. Proc. UBC and UNBC research synthesis and strategy workshop series. University of Northern British Columbia, Prince George, BC, and University of British Columbia, Vancouver, BC. Final unpubl. rep. p. 53-57.

As chair of the MPB Research Issues Steering Committee, the Research Leader will be responsible for providing leadership for, and coordination of, the provincial research program to support policy development and to ensure that work is directed towards fulfillment of management objectives. The Research Leader will engage in planning activities, liaise with clients and MPB funding agencies, and provide general coordination and management functions to ensure that MPB-related research is carried out to meet client needs.

(4) The provincial extension services provider, FORREX, be included and funded as a major participant in the provincial MPB research program. The perception exists that we have not done a very good job of delivering MPB research information and management knowledge to the stakeholders, end-users, communities, First Nations, and the general public. The MPB has been a focus of various research agencies and institutions for the past few decades, and a forest management concern over much of the same period. And, yet, this current outbreak seemingly caught the province by surprise: we ignored or down-played the warning signals, and we seem to have forgotten the lessons learned from the 1980s epidemic, from the various research and operational trials established, and from the operational experience accumulated by forest managers. We need to fully understand how we failed to foresee this MPB epidemic to ensure that the systemic problems do not reoccur. This is a major challenge for an essential extension program.

The traditional view of extension is that it is an activity which occurs at the completion of a research project. Such a view tends to promote a disjointed, incidental approach to extension, and this is not an approach up to the challenge of providing multi-disciplinary resource management knowledge to a wide range of clients. Not all extension activities are spawned by the traditional research projects; literature reviews, problem analyses, and interpretive guides, for example, are very useful extension projects which may not even be on the research agenda.