
FSB

Forest Science Board

Sustainability Program

Research Strategy 2009–2014

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Abbreviations

AAC	Allowable annual cut
ATV	All-terrain vehicle
BEC	Biogeoclimatic ecosystem classification
CDC	Conservation Data Centre
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
EBM	Ecosystem-based management
FFEI	Future Forest Ecosystems Initiative
FFE-CRI	Future Forest Ecosystems Collaborative Research Initiative
FIA	Forest Investment Account
FIA-FSP	Forest Investment Account Forest Science Program
FNAG	First Nations Advisory Group
FPAC	Forest Growth and Value Program Advisory Committee
FREP	Forest Resource Evaluation Program
FRPA	<i>Forest Range and Practices Act</i>
FSB	Forest Science Board
GYM-CRI	Growth and Yield Modelling Collaborative Research Initiative
LOI	Letter of intent
LTR	Long-term research
LTRI	Long-term research installation
MFR	Ministry of Forests and Range
MPB	Mountain pine beetle
NDT4	Natural Disturbance Type 4 (ecosystems maintained by frequent low-intensity fires)
NTFP	Non-timber forest product
PAC	Program Advisory Committee
PFEP	Provincial Forestry Extension Program
PVA	Population viability analysis
PwC	PricewaterhouseCoopers
SFM	Sustainable forest management
SARA	<i>Species at Risk Act</i>
SPAC	Sustainability Program Advisory Committee

Sustainability Program Research Strategy 2009-2014

1.0 Context

Forest Science is one of five programs in British Columbia's Forest Investment Account (FIA) to promote sustainable forest management (SFM). The FIA Forest Science Program (FIA-FSP) focuses on applied research to develop knowledge that addresses crucial short- and long-term forest management challenges, and the extension of forest science results and existing information to meet the needs and priorities of those who plan and manage British Columbia's public forest lands.

The FIA-FSP funds three major programs: Sustainability, Forest Growth and Value, and Forest Extension. A fourteen-member Forest Science Board (FSB) advises the Deputy Minister of Forests and Range (MFR) on FIA-FSP strategies and priorities. The FSB relies on Program Advisory Committees (PACs) to assess forest management challenges and information needs within their program areas; evaluate available knowledge; identify knowledge gaps and strategies to address them; and make recommendations on themes, topics, and research issues for annual funding.

This document sets out the strategy for the FIA-FSP Sustainability Program. It is updated periodically to reflect changing management priorities and the expectations of the FSB. Section 2 describes the Sustainability Program strategic framework. Section 3 outlines the mandate and structure of the Sustainability Program Advisory Committee (SPAC). Section 4 presents an overview of the Sustainability Program research themes and topics. Section 5 outlines the process of establishing research priorities. Section 6 discusses program delivery, including the link to extension of research results. Appendix 1 contains descriptions of the research themes, topics, and issues. Appendix 2 presents the process and criteria for scoring research issues.

2.0 FIA-FSP Strategic Framework

Investments made through the FIA-FSP are expected to contribute to the government's goal of having a leading-edge forest industry that is globally recognized for its productivity, environmental stewardship, and sustainable forest management practices. The Board and its PACs work to focus investments on high-priority research and extension that address user needs, avoid duplication, and leverage funds by attracting money from other sources. Figure 1 illustrates the strategic framework for FIA-FSP research.

Figure 1 Strategic Framework for FIA-FSP research.



2.1 Program Strategies

The *FIA-FSP Strategic Plan 2009–2014* sets out the vision and strategic goals of the FIA-FSP, and identifies priority themes in each program area. Within the parameters of the Strategic Plan, each PAC evaluates available knowledge, identifies gaps, examines opportunities for cooperative research and leveraging funding, and makes recommendations to the Board pertinent to its program area. Component strategies for the Sustainability, Forest Growth and Value, and Provincial Forest Extension programs outline the priorities and methods to achieve each program's mandate.

2.2 Research Priorities and Project Selection

Each year, the SPAC and the Forest Growth and Value Advisory Committee (FPAC) review their program strategies in consideration of current management challenges to determine whether any new topics or research issues should be added. Following adjustments to the strategies, the PAC members engage in a process of ranking the research issues to define regional priorities for research. Based on these priorities, the PACs recommend to the Forest Science Board the research issues that should be eligible for funding. Following Forest Science Board review and recommendation to the Deputy Minister of Forests and Range, the approved research issues shape the annual Research Call for Proposals.

In addition to priorities for research identified through the Research Program strategies and funded through the Call for Proposals, collaborative initiatives may be established to address specific research topics that lend themselves to a collaborative effort by a discrete set of researchers, based on 3-year business plans approved by the Board. The first two pilots of this approach were initiatives focused on growth and yield modelling and future forest ecosystems (see Section 6.3).

2.3 Implementation, Monitoring

The Forest Science Board and PACs obtain feedback on FIA-FSP processes and projects through several mechanisms, including:

- involvement of the provincial forest extension provider (FORREX) on the Board, committees, and working groups
- information from the FIA-FSP Program Administrator, PricewaterhouseCoopers (PwC) (Call for Proposals process, project implementation, project deliverables)
- analyses and support from the FIA-FSP Secretariat, Cortex Consultants (e.g., analysis of funding allocations and project outcomes, relative to the Program Research Strategy)
- communication with members of the PACs and the First Nations Advisory Group
- periodic surveys of the researchers and users of forest science
- review of programs, proposals and project deliverables.

2.4 First Nations in the FIA-FSP

The FIA-FSP operates under the following principles with respect to First Nations involvement in the program:

- First Nations and non-First Nations have parallel paths and processes
- Each contributes understanding to the other's path
- Harmonization is possible on issues where the groups share common interests
- The harmonization process is respectful and equitable.

These principles are applied to ensure that indigenous interests are included in program strategies and considered in identifying research priorities, determining eligible topics for funding, and setting guidelines for the annual Call for Proposals. The FIA-FSP has developed a First Nations Harmonization Strategy that will guide harmonization activities for the period 2009–2014.

A First Nations Advisory Group (FNAG), consisting of approximately ten First Nations people with experience in research (including Aboriginal forest research) and forest land-base activities, identifies First Nations research and extension interests related to the FIA-FSP and works with the FPAC and SPAC to update the research program strategies and determine annual research priorities. Currently, FNAG members represent the coast, northern interior, and southern interior, and academic, community, and industry perspectives.

3.0 SPAC Mandate and Structure

3.1 SPAC Mandate

The SPAC mandate has two components:

- develop and periodically update a 5-year strategy for addressing short- and long-term research priorities related to sustainability within the scope of the FIA-FSP
- develop and implement an efficient and effective process for determining annual research priorities.

In fulfilling this mandate, the SPAC:

- advises the Forest Science Board on critical issues and knowledge gaps relevant to the Sustainability Program
- annually recommends research priorities for the FIA–FSP Research Call for Proposals
- annually reviews and comments to the Forest Science Board on other components of FIA-FSP (e.g., long-term research installations, graduate student research funding, directed research).

3.2 Relationship between the Sustainability Program and the Forest Growth and Value Program

The Forest Growth and Value program is focused on the growth of forests, interactions within and among forest stands, responses of forests to disturbance, and how forests yield valued products and services. The Sustainability program is focused more broadly on the forest ecosystem and how key components of the ecosystem function to produce services (e.g., productive soils, water, habitat, and biodiversity). The Sustainability program also considers how land management activities affect social and cultural values. Both programs emphasize efforts to develop new data, knowledge, and tools that support sustainable management of forest ecosystems and yield the appropriate mix of ecosystem services and other products valued by society. As a result the boundary between the two programs is fuzzy and there is some overlap in topics and issues. The PAC chairs meet on a regular basis to minimize the overlap and to ensure that the strategies allow the Forest Science Board to focus research priorities and to guide researchers when submitting funding applications.

3.3 SPAC Membership

The SPAC consists of approximately fourteen members from across the forest sector and two members representing the provincial forest extension provider. Membership reflects a geographically balanced complement of people from government agencies, First Nations, forest companies, the consulting community, academia, and research institutions. Members have knowledge and expertise in topics and issues related to the Sustainability Program. Although there is no official Board representation on the SPAC, Board members may attend SPAC meetings and PAC Chairs are encouraged to attend FSB meetings.

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

4.0 Overview of the Sustainability Program Research Strategy

The Sustainability Program focuses on research to improve:

- understanding and modelling the relationships between ecosystem structure, biodiversity, habitat values, social and cultural values, and the effects of natural disturbance and human activities on ecosystems
- the identification and evaluation of sustainable forest management indicators, functional targets, and thresholds
- effectiveness of mandated policies and practices.

4.1 Research Themes, Topics, and Research Issues

The strategy of the Sustainability Program is to focus research using a hierarchical framework of themes, topics, and research issues. Four themes are broadly categorized as basic research, decision support, indicator development, and policy support. Together, these themes outline an adaptive management cycle (Figure 2) concerning the development of information to support sustainable forest management (SFM). Biophysical information provides fundamental knowledge for managing and for developing decision support tools. Indicator development enables assessments about whether management practices are meeting objectives. Ultimately, biophysical information, decision support tools, and monitoring results are used to inform policy. Policy adjustments affect sustainable management activity, and the cycle continues.

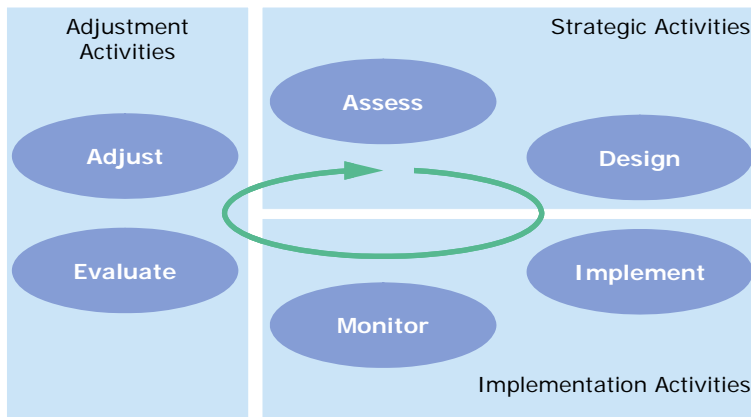
Each of the four research themes contains topics that characterize general research issues (Table 1). In the biophysical (basic research) theme, these topics largely pertain to deriving knowledge about forest resource values other than those that have explicit market value – the latter being addressed by the FPAC. The SPAC biophysical topics (under Theme 1) are related to, and intended to address, the forest values identified by the *Forest and Range Practices Act*: biodiversity, cultural heritage, fish/riparian, forage and associated plant communities, recreation, resource features, soils, visual quality, water, and wildlife.

Research on decision support (Theme 2) is categorized by topics relating to development of tools for forecasting supply of forest resource values, refinement of ecological classification, ecological risk assessment, and cumulative impacts analysis.

Topics pertaining to indicator development (Theme 3) include indicators of ecological, socio-economic, and socio-cultural sustainability; identification of indicator thresholds; and methods to balance ecological, socio-economic, and socio-cultural indicators.

In the policy support (Theme 4), topics pertain to those areas of current forest policy that are considered to need further development, including species at risk recovery, First Nations and other human community resilience, ecosystem-based management, management of non-timber forest resources, and forest planning and practices regulations.

Figure 2 Adaptive management cycle.



Individual topic areas within each theme are further categorized into research issues that are intentionally worded to attract proponents of specific research projects. The research issues receive the majority of attention and review by the SPAC each year. These issues are designed to be flexible in content to allow the SPAC to focus the annual Call for Proposals on the most significant current challenges faced by those who plan and manage British Columbia’s public forest lands. Research issues usually include reference to the effects of some mechanism of change for which we lack sufficient knowledge to plan and conduct SFM (e.g., mountain pine beetle [MPB] salvage harvesting, livestock use, natural disturbance, variable retention, global climate change).

Table 1 Sustainability Program current themes and topics¹

Theme (bold)/Topic (not bold)	
1	Basic research to support sustainable forest management
1.1	Riparian and aquatic ecology and management
1.2	Soil biology, ecology, and productivity
1.3	Landscape ecology and management
1.4	Stand-level ecology and management
1.5	Disturbance ecology and management
1.6	Watershed function and management
1.10	Range ecology and management

¹ Missing numbers in this table indicate themes and topics that have been retired from the program as a result of shifting priorities or reorganization of program structure. Furthermore, the numbering indicates the order in which themes or topics were added to the program, and does not indicate priority.

Theme (bold)/Topic (not bold)	
1.11	Cultural heritage resources
1.12	Fish and wildlife ecology and management
1.13	Visual quality and recreation
1.14	Social, cultural, and economic dimensions of SFM
1.15	Biogeochemical cycling and budgets
1.16	Biology, ecology, and productivity of non-timber forest products
2	Decision support tools for sustainable forest management
2.1	Modelling resource availability, dynamics, and sensitivity to management and disturbance
2.4	Developing or refining ecological classification systems
2.6	Developing or refining ecological risk assessment tools
2.7	Assessment of cumulative effects
2.8	Methods of alternative valuation
3	Indicators, thresholds, and monitoring systems
3.1	Development of indicators and monitoring systems
3.2	Ecological sustainability
3.3	Social, cultural, and economic sustainability
3.4	Methods for balancing social, cultural, economic, and environmental values
4	Scientific information to support policy, regulations, and their implementation
4.1	Species at Risk recovery
4.2	Impact of forest policies and practices on First Nations and rural community resiliency
4.3	Ecosystem-based management
4.4	Management and regulation of non-timber forest resources

4.2 Research Implementation Timeline

The ability to establish long-term research goals in a 5-year strategy is limited for several reasons. First, biophysical research often requires 5–10 years before meaningful results are achieved. Second, the structure of the FIA-FSP restricts long-term planning because projects are limited to 3 years before having to reapply for funding, and the specific projects selected through the competitive call process is uncertain. Finally, unforeseen management issues arise that may shift priorities for the program (e.g., the need to address issues arising from the MPB epidemic or concerns about global climate change).

Given the challenges associated with setting long-term research goals, the Sustainability Program research strategy has been designed with the flexibility to address uncertainty about future management needs and funding availability. The strategy encourages proposals across many themes and topics, while avoiding the danger of spreading research efforts too thinly. Interaction between this focus and funding cycles means that some important issues will not be addressed in the annual Call for Proposals. The specific themes, topics, and research issues funded in a given year will be the result of balancing the urgent needs of high-profile management issues against addressing the longer term knowledge gaps related to implementing sustainable forest management.

4.3 Long-term Research

Long-term studies are vital to achieving the goals of the FIA-FSP; however, the FIA-FSP does not have sufficient funding to create a separate envelope for new long-term research. Proponents of new long-term studies are encouraged to identify short-term scientific and extension goals and products within the longer-term context of their studies and to submit proposals for funding through the Call for Proposals. Once a long-term research project has produced meaningful results within a 3-year project timeframe, it can continue to submit proposals for portions of the research, or submit proposals for maintenance or remeasurement activities (e.g., to collect data to quantify treatment effects) through the Long-term Research Installation (LTRI) envelope. The LTRI envelope provides a small amount of funding for the maintenance of infrastructure, basic and repetitive measurements, and some remeasurement of experiments where such measurements are essential to long-term success and do not have an immediate scientific objective. Both FPAC and SPAC will evaluate the success of this approach on an ongoing basis.

The FSB recognises that this process places significant limitations on the funding of new long term research and has struck a Long-term Research Working Group to evaluate the successes and failings of the existing process and to make recommendations for improvement.

5.0 Setting Annual Funding Priorities for Research

Each year in late April the PACs begin a process of ranking research issues to define the eligible topics for the Research Call for Proposals. The extent to which the research program strategy is updated, and the amount of information the PACs take into consideration for scoring research issues (e.g., research syntheses, gap analyses), depends on the research funding cycle, with the greatest effort expended in years with larger amounts of funding available for allocation to new projects.

5.1 Considerations

During the priority-setting process the PACs consider:

- the existing research program strategy
- direction from the Forest Science Board regarding priority research
- allocation of funding to date under program themes, topics, and research issues
- research results to date in addressing defined management issues
- research carried out by other agencies
- new issues and (or) priorities identified by PAC members since the previous year
- scoring criteria (see Appendix 2 for more detail).

5.2 General Principles

The SPAC follows five general principles in establishing annual priorities for research:

- continue with strategic priorities as outlined, keeping focused on identified needs; some topics may not necessarily be addressed by FIA-FSP in each year of funding
- where possible, fund research in each of the four themes
- consider regions explicitly in identifying priority research issues
- review potential overlap and opportunities for collaborative funding with other research programs
- review specific research issues and account for emerging or urgent management issues and priorities.

5.3 Scoring Process

The scoring process has four steps:

1. Confirm and, if necessary, amend the topics and research issues under each Program theme.
2. Score each research issue and identify where new topics or research issues are needed (done by individual SPAC members based on their expertise and consultation with colleagues).
3. Compile the responses of individual members and distribute as background for a group discussion on the score for each research issue.
4. Confirm the final score for each research issue, by region, based on the compiled responses and group discussion among PAC members.

Scores are assigned to each research issue based on i) size of knowledge gap, ii) level of urgency, iii) regional significance, and iv) importance to sustainable forest management.²

The system for scoring research issues is not intended to produce final recommendations for priority research; rather, it is used as a tool to facilitate discussion. The scores are used to focus discussion where a research issue is close to the threshold priority for funding, or there is significant disagreement among SPAC members about the priority of a particular research issue. In these cases, the individual scoring criteria are used to focus discussion on the final priority for each research issue. Through discussion the SPAC may adjust the final score based on the scoring criteria and other factors they feel are relevant. This process is intentionally subjective, recognizing that even a fully automated scoring system would be subjective in the way criteria were chosen and applied. Setting the final priority for research issues through discussion ensures that the resulting decision is based on sound reasoning rather than artifacts of a formulaic approach.

Research issues are scored separately for each provincial forest region³ to aid in ranking research needs across highly diverse provincial forests. There is no expectation of equal funding being

² See Appendix 2 for details on the system for scoring research issues.

allotted to each region; rather, efforts will be made to address the highest priority needs across the province.

6.0 Program Delivery

6.1 Program Delivery Models

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

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

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

Possible administrative mechanisms include an open call for proposals administered and monitored annually to collaborative research initiatives delivered and monitored in accordance with an approved business plan. Table 2 summarises the factors used to determine which approach is used. The FIA-FSP has employed primarily a Call for Proposals process, but will pursue collaborative research initiatives (based on directed program delivery), where considered appropriate.

Table 2 Considerations in employing a call for proposals or a collaborative research initiative

Considerations	Call for proposals preferred	Collaborative research initiative preferred
Abundance/scarcity of human resources	abundant	scarce
Dispersion/centralization of expertise	dispersed	centralized
Access to knowledge capital	accessible	not widely accessible
Access to research installations and data	accessible	not widely accessible
Project longevity	short	long

³ Ministry of Forests and Range administrative regions are used (Coast, Southern Interior, and Northern Interior).

6.2 FIA-FSP Call for Proposals

The FIA-FSP currently uses a Call for Proposals process to solicit research projects consistent with the Forest GV Program and Sustainability Program research strategies. This is managed by PricewaterhouseCoopers (PwC) and does not directly involve the FPAC and SPAC members although they may serve on project review panels.

The Call for Proposals follows a two-stage competitive process. Proponents submit letters of intent (LOIs) for their projects, which are evaluated based on logistical criteria such as the cost of the project, its fit with annual research priorities, and the appropriateness of the project team. Based on these criteria, a subset of LOI proponents are invited to submit a full proposal (second stage), which undergoes a scientific peer review. The final list of funded projects is based on the outcome of this peer review and available funding.

Available funds for new research initiated through the Call for Proposals are allocated annually to maintain approximately equal funding of the Sustainability and Forest Growth and Value programs. The Board seeks to balance funding among projects of 1 to 3 years, to ensure that new projects of varying terms can be approved each year. Once approved, a multi-year project will be funded for its full term (up to 3 years), contingent on an annual review of progress against deliverables and submission of an updated workplan. Projects requiring longer than 3 years must submit a new letter of intent to the Annual Call every 3 years.

6.3 Collaborative Research Initiatives

Within FIA-FSP, collaborative research initiatives are intended to foster a more strategic, efficient, and stable funding environment for priority research of a collaborative nature. A steering committee annually evaluates and sets priorities based on input from the Board and PACs, and key strategic documents from other sources in British Columbia. Based on these priorities, the committee constructs an annual business plan that identifies priority projects and project leaders to develop project plans. The committee reviews the resulting project plans and provides feedback to enhance project effectiveness and collaboration. Delivery of the annual research business plan to FSB coincides with the annual PAC planning cycle in preparation for the annual FIA-FSP Call for Proposals.

Research proposals initiated under the collaborative research initiative are submitted for review by external experts. Approved collaborative research projects are administered by PwC, similar to other FIA-FSP research projects. The collaborative research steering committee reviews each project yearly in conjunction with annual business planning. Continued funding is based on performance (with PwC input) and continued alignment with the evolving collaborative research initiative strategy.

Currently, there are two collaborative research initiatives, the Growth and Yield Modelling Collaborative Research Initiative (GYM-CRI) and the Future Forest Ecosystems Collaborative Research Initiative (FFE-CRI).

Growth and Yield Modelling Collaborative Research Initiative

In 2007, the FSB established a Growth and Yield Modelling Collaborative Research Initiative (GYM-CRI) under the Sustainability Program. The GYM-CRI is the Board's first collaborative research initiative.

The GYM-CRI is intended to foster a more strategic, efficient, collaborative, and stable funding environment for priority growth and yield (GY) research. GY models have become critical tools in predicting future forest values under a wide range of alternative management regimes, natural disturbances, and climate change scenarios. Stand structure predictions from GY models serve as key inputs for predictions of future timber and non-timber values including habitat, biodiversity, and visual quality. GY models increasingly serve as synthesis platforms to integrate applied research in other fields (e.g., genetics, nutrition, pathology, entomology).

The GYM-CRI builds on the priorities established by FPAC for GY modelling (Theme 3 in the Forest Growth and Value Program) and previous FIA-FSP investments in GY modelling. The GYM-CRI is developed by a standing GYM-CRI committee representing GY model users and researchers. The committee annually evaluates and sets GY modelling priorities based on input from the Board and PACs, and key strategic documents from other B.C. sources (e.g., First Nations, Future Forest Ecosystems Initiative, MPB). Based on these priorities, GYM-CRI constructs an annual business plan that identifies priority projects and works with project leaders to develop project plans. The GYM-CRI committee reviews the resulting project plans and provides feedback to enhance project effectiveness and collaboration. Delivery of the annual GYM-CRI business plan to FSB coincides with the annual PAC planning cycle in preparation for the annual FIA-FSP Call for Proposals.

The Growth and Yield Modelling Subprogram Business Plan and Strategy 2009–2012 (July 2008) outlines the development of five projects: four strategically important and established GY models reflecting different approaches and applications, and one short-term project focusing on post-MPB regeneration. The four models (FORECAST, PrognosisBC, SORTIE, and TASS) have all received prior FSP support and are the main established models in B.C. at this time.

Research proposals initiated under the GYM-CRI are submitted for review by external experts. Approved GYM-CRI projects are administered by PwC, similar to other FIA-FSP research projects. The GYM-CRI committee will review each project yearly in conjunction with annual business planning. Continued funding will be based on performance (with PwC input) and continued alignment with the evolving GYM-CRI strategy.

The GYM-CRI strategy explicitly relies on the FIA-FSP annual Call for Proposals to encourage and support new innovation in GY modelling (FPAC Theme 3).

Future Forest Ecosystems Collaborative Research Initiative

Climate change is a major issue confronting forest and range managers in British Columbia and elsewhere. Although the FIA-FSP has been funding research related to this topic since its inception, priority rankings on all of the many topics associated with climate change have increased in the last 2 years. At the same time, the MFR has begun the Future Forest Ecosystems Initiative (FFEI), which is focused on understanding the necessary forest and range management

actions that are required to respond to the climate change challenge. This includes changes in policy, regulations, inventory, and other aspects of forest and range management, and a research funding initiative involving collaboration between MFR scientists and scientists outside the agency.

Similar to the GYM-CRI, the collaborative research portion of the FFEI is being partially funded through the FIA-FSP as a direct delivery initiative, based on a focused business plan. Coordination of MFR research and other research agencies will take place through the PACs and the FFEI Project Committee.

Proposals for climate change research separate from the collaborative projects featured in the FFEI Business Plan will be solicited through the FIA-FSP annual Call for Proposals process.

6.4 Moving from Research to Synthesis and Extension

The primary purpose of the FIA-FSP is to provide credible, relevant, and accessible scientific knowledge to support sustainable forest management policies and practices. As an applied research program, the results of research funded by the FIA-FSP should inform a current or emerging management issue, and should be communicated to policy-makers and practitioners in a way that ensures application of the knowledge. The FIA-FSP funds the Provincial Forest Extension Program (PFEP) through FORREX, to support extension activities that make research results available to managers and practitioners (end users) and increases understanding of their research needs.

The PFEP ensures that priority extension needs are being addressed by employing a suite of communication tools. Among these tools are assessments of the needs of end users, and syntheses, such as gap analyses, that address topics of interest to end users.

To facilitate the linkage between research and extension, PFEP representatives participate on the PACs as extension specialists, in addition to bringing technical expertise to the process. At the start of the each annual PAC priority-setting process, PFEP representatives make formal presentations outlining the results from their internal strategic and operational planning processes. They may also communicate the result of research gap analyses that are relevant to the upcoming priority-setting process – especially where these analyses are directly related to the Program research strategy.

During the process of determining which topics will be eligible for funding, PAC members identify what is known on a particular subject, and whether knowledge gaps are the result of insufficient research or a lack of synthesis and extension. Recommendations for synthesis or extension are communicated to the PFEP through its representatives on the PAC. If PAC members are uncertain about what research exists on a specific topic, they may identify the need for a research gap analysis related to that topic. The PACs present this need to the FSB along with recommendations on how the need should be addressed. Possible approaches are:

- including the requested synthesis in the regular annual call for proposals
- asking FORREX to include the requested synthesis in their annual work plan

- issuing a direct award to carry out the synthesis.

The completed gap analysis would be available to PACs for consideration of decisions on eligible research in future funding cycles.

Appendix 1 – Research Themes and Topic Descriptions⁴

Four themes are used to broadly categorize research topics: basic research, decision support, indicator development, and policy support. Together, these themes outline an adaptive management cycle concerning the development of information to support sustainable forest management.

Theme 1 Basic research to support sustainable forest management

Biophysical information provides the fundamental knowledge for managing and developing decision support tools and for the subsequent development of indicators. This is the most basic form of research within the Sustainability Program.

1.1 Riparian and aquatic ecology and management

Research under this topic is focused on small streams because they comprise the majority of total channel length in a stream network and play a critical function in providing water, nutrients, sediment, and energy to downstream reaches. Considerable uncertainty and controversy surround the impacts of roads, access management, and forest harvesting around small streams, particularly in the requirements and specifications for riparian buffers.

The following issues are the focus for research under this topic:

- 1.1.1 Effects of alternative riparian management strategies (e.g., livestock use) on small stream and wetland ecosystems. Research needs are particularly focused on water quality, channel morphology, and biological effects.
- 1.1.3 Effects of small stream characteristics on levels of material and energy contributed to downstream reaches.
- 1.1.4 Effects of managing the MPB epidemic (e.g., salvage, mortality, rehabilitation, and other related management activities) on the riparian character and function of small streams, wetlands, and other aquatic habitats. Research needs are focused on channel morphology, stream temperature, and organic matter dynamics.
- 1.1.7 Effects of restoration techniques on the riparian values of small streams.

1.2 Soil biology, ecology, and productivity

Maintenance of soil productivity is essential for maintaining biological productivity, watershed functioning, and ecosystem integrity in forest and range ecosystems. In addition to understanding fundamental relationships between soil properties and management practices, it is also important to be able to correctly identify sensitive soils to avoid or minimize degradation and to prescribe rehabilitation measures to restore essential soil properties.

The following issues are the focus for research under this topic:

⁴ Missing numbers in this section indicate themes and topics that have been retired from the program as a result of shifting priorities or reorganization of program structure. Furthermore, the numbering indicates the order in which themes or topics were added to the program, and does not indicate priority.

- 1.2.1 Effects of forest and range management (e.g., coarse woody debris retention, green tree retention, soil disturbance allowances, salvage of MPB-killed stands, use of pesticides and/or fertilizers) on soil biological, chemical, and physical attributes, inter-relationships, and processes. Research needs are particularly focused on resilience of, and critical thresholds for, site productivity.
- 1.2.3 Effects of natural disturbance (e.g., MPB epidemic, fire) and/or climate change on soil organisms, nutrient cycling and availability, site productivity, and other soil processes.
- 1.2.6 Effects of grassland vegetation succession (e.g., forest in-growth and encroachment) on soil productivity.
- 1.2.7 Effects of soil rehabilitation techniques in re-establishing soil productivity.

1.3 Landscape ecology and management

Maintenance of biodiversity at a broad scale is related to the maintenance of habitat attributes for a broad array of species using a “coarse filter approach” of allocating representative ecosystems across the landscape and providing connectivity between these patches. The scientific/technical basis for allocating these patches across the landscape is poorly established. A common theme or question is “single large or several small” (SLOSS) in reference to the trade-off inherent in distributing small patches across the landscape (potentially improving representation, but fragmenting the area) versus amalgamating patches into one large unit (thus providing relatively large areas of undisturbed habitat that some species may require). The issue of scale further complicates this question in that different organisms require different areas of suitable habitat—a large patch for one species might be only a small patch for another. There is currently little authoritative information to guide selection of scale, amount, or distribution of desired habitats across the landscape, so different consultative processes in British Columbia are prescribing different approaches.

The following issues are the focus for research under this topic:

- 1.3.1 Effects of managing for landscape-level attributes (e.g., seral stage distribution, patch size frequency and distribution, tree species composition, ecosystem representation in reserves, non-timber resources, and riparian networks) on the achievement of coarse-filter biodiversity conservation objectives. Research proposals are particularly invited on the salvage, rehabilitation, or retention of stands killed by MPB, although research addressing other management issues will be equally considered.
- 1.3.2 Effects of current management (e.g., variable retention, salvage and rehabilitation of stands killed by MPB) and traditional First Nations land-management practices on the creation or maintenance of structure, composition, and ecological processes at landscape scales.
- 1.3.3 Effects of current management (e.g., variable retention, salvage and rehabilitation of stands killed by MPB) and traditional First Nations land-management practices on individual species or groups of species at the landscape scale.

- 1.3.6 Effects of climate change on the interactions among wildland fire and fire behaviour, the appropriate management responses, and the ultimate impacts of wildland fire on other resources.

1.4 Stand-level ecology and management

Current site-level harvesting practices in both old and immature stands include the retention of old-growth attributes and wildlife habitats such as green trees, wildlife tree patches, downed wood, riparian reserves, patches of residual advanced regeneration, and high stumps or stubs (created with feller-bunchers). In addition, silvicultural treatments may be used to create old-growth attributes in immature stands, such as simulating advanced decomposition by halving and hollowing variable diameter logs or hollowing out stumps; creating openings by felling stems; inoculating stems with decay pathogens; thinning around stems; and fertilizing residual trees to encourage accelerated growth. These practices provide or maintain resource features and other habitat at the site level, thus enhancing site-level biodiversity and contributing to landscape biodiversity over time.

The following issues are the focus for research under this topic:

- 1.4.1 Effects of managing for site-level attributes on maintenance of biodiversity and wildlife habitat. Research needs are particularly focused on identifying appropriate targets and configurations of site-level structures in cutblocks including those resulting from salvage of sites killed by MPB. Research needs are also focused on riparian buffers in upland, riparian, and aquatic habitats.
- 1.4.3 Identification of appropriate targets and configurations of site-level structures to maintain biodiversity in dry forest and open range (i.e., grassland, shrubland, and rangeland habitat).
- 1.4.8 Effects of forest and range management on riparian biodiversity of small streams and wetlands. Research needs are particularly focused on dry interior ecosystems.
- 1.4.9 Effects of specialized diversity-enhancing techniques (e.g., introduction of snags and spatial gaps) on the restoration of biodiversity in stands or landscapes dominated by homogeneous second-growth forests.
- 1.4.10 Effects of climate change on biological communities and ecological processes at site levels.
- 1.5 Disturbance ecology and management (fire, wind, pests, disease, pollutants, and invasives)

Disturbance ecology includes studies on the role of events such as windthrow, wildfire, floods, landslides, and insect and disease-caused tree mortality on the structure, composition and/or function of ecosystems, and the patterning of ecosystems on the landscape. The diversity of life in an ecosystem has evolved in response to the forces of natural disturbance. Maintaining biodiversity and ecosystem integrity requires that we understand the relationships between natural disturbance, ecosystem structure, composition and pattern, and habitat requirements of

the organisms living in a given ecosystem. This will enable us to design and test human interventions in nature that are informed by an improved understanding of natural disturbance patterns and processes. In addition to providing information that is generally applicable throughout B.C., some of the questions about the tenets of “ecosystem-based management” (EBM) might also be addressed by research directed at the preceding.

The following issues are the focus for research under this topic:

- 1.5.1 Characterization of historic natural disturbance patterns (e.g., fires, wind, insect and disease infestations) in different areas of the province. Research proposals are particularly invited to examine the dominant type, intensity, frequency, pattern, and scale at which disturbances have occurred, and to outline rates of tree mortality, tree fall, and tree decomposition, although research addressing other aspects of natural disturbance patterns will be equally considered.
- 1.5.2 Effectiveness of emulating patterns of natural disturbance in managing for biodiversity.
- 1.5.3 Effects of natural disturbance processes on soil productivity, forest regeneration, forest succession, and wildlife habitat at both landscape and site levels.
- 1.5.4 Comparison of the structure and composition of managed and unmanaged forests. Research proposals are particularly invited on forest management of drier ecosystems, although research addressing other ecosystems will be equally considered.
- 1.5.5 Effects of insects, disease, and subsequent forest regeneration on structural, compositional, and spatial diversity of forests; wildlife habitat; and occurrence of wildfire.
- 1.5.6 Contribution of large areas of dead trees (e.g., killed by insects, disease, drought, or windthrow) to resource management objectives.
- 1.5.7 Effects of windthrow in the design of stand-level biodiversity retention.

1.6 Watershed function and management

Forest practices can significantly influence the movement of water, sediment, woody debris, and energy through a watershed and ultimately influence streamwater quantity, quality, and flow timing, as well as stream channel geomorphology and the quality of aquatic habitat.

Watershed processes are complex and many are still poorly understood, particularly in relation to the connection between upslope and stream channel processes. Relevant and effective research may be carried out at both watershed-specific and site-specific scales – in the latter case, providing results can be extrapolated accurately to the watershed scale. Information obtained from studies of watershed processes will be used to build and improve watershed response models, which in turn will assist decision-makers in selecting appropriate management regimes to meet objectives.

The following issues are the focus for research under this topic:

- 1.6.1 Effects of up-slope disturbances on stream channel characteristics. Research needs are particularly focused on disturbances caused by MPB mortality, MPB salvage, and rehabilitation operations.
- 1.6.2 Effects of road construction and layout on watershed processes (e.g., stream flow).
- 1.6.4 Effects of patterns, levels, and methods of tree removal (e.g., variable retention, cable logging, helicopter-grapple logging) on slope stability.
- 1.6.7 Effects of large woody debris recruitment on stream channel type and state.
- 1.6.8 Effects of First Nation traditional management techniques (e.g., fire, stream alteration) on watershed function. Research needs are particularly focused on the potential contemporary application of these techniques in watershed management.

1.10 Range ecology and management

The maintenance of plant diversity, productivity, and resilience of grassland and open forest ecosystems is essential for ensuring continued provision of forage for livestock and wildlife. Inappropriate grazing, as well as non-consumptive factors, can significantly alter plant communities and influence an ecosystem's productive capacity. Improved understanding of the effects of range practices, climate change, mountain pine beetle, exotic species, and forest ingrowth/encroachment on the dynamics of these plant communities is required.

The following issues are the focus for research under this topic:

- 1.10.1 Effects of grassland vegetation succession (e.g., forest in-growth and encroachment) on forage production for livestock and wildlife habitat at both landscape and site levels.
- 1.10.2 Effects of exotic (alien invasive) species on diversity, productivity, and resilience of grassland and forest ecosystems.
- 1.10.3 Effects of restoration techniques on mitigating forest encroachment and in-growth, and in reducing wildfire intensity, in Natural Disturbance Type 4 (NDT4) ecosystems.

1.11 Cultural heritage resources

“Cultural heritage resource” is a term used to describe a large spectrum of heritage resources values. What constitutes a cultural heritage resource is a decision that can be made only by the Aboriginal people to whom the object, location, or site is of continuing importance. Cultural heritage resources should not be defined by third parties in the absence of Aboriginal people's involvement. Ensuring that cultural heritage resources are conserved or protected requires the input of Aboriginal peoples in the planning process.

Management for cultural heritage resources may often occur concurrently with the management of other values, including wildlife and biodiversity, visuals, and riparian areas; various users of the forest resource may also negatively impact cultural heritage values. Research can aid in determining methods of ensuring that cultural heritage resources are managed at the same time as other values. Research can also aid in determining how cultural heritage resources can be

conserved or protected given the many current and expected uses of the forest resource and forest landbase.

The following issue is a focus for research under this topic:

1.11.1 Rehabilitation practices, based on characterization of pre-harvest land values that result in desired future landscapes and promote important species associations at different stages of regeneration.

1.12 Fish and wildlife ecology and management

Fish and wildlife are identified as forest values distinct from biodiversity in general, in that several identified species of fish, birds, and mammals constitute important resources for subsistence use, and for recreational and commercial harvesting. The following issues are the focus for research under this topic:

1.12.1 Effects of management methods used to control populations of, or the impacts made by, invasive species.

1.12.2 Effects of restoration techniques on in-stream aquatic habitat values.

1.12.3 Characterization of population growth and range expansion of invasive species (including potentially harmful pests and pathogens). Research needs are particularly focused on early detection, prediction and control, and interactions with forest and range practices.

1.12.4 Characterization of invasive pathways and their ecological mechanisms, particularly as these are affected by forest and range practices.

1.12.5 Characterization of mechanisms of interactions (e.g., predation and competition) between invasive species and species-at-risk.

1.12.6 Identification of the species most affected by climate change that subsequently have the greatest impact on ecosystem composition and function. Research needs are particularly focused on species response, and the controlling variables causing species response to climate change.

1.12.7 Effects of climate change on the range, distribution, and impact of exotic and invasive species (e.g., role of insects and disease as biotic agents of change, and the controlling variables) on wildlife.

1.12.8 Effects of forest and range management practices (e.g., forest road development, salvage and rehabilitation of stands killed by MPB, livestock use, exclusion/reintroduction of fire) on the ecology of species at risk.

1.13 Visual quality and recreation

Scenic landscapes are highly valued by residents of, and visitors to, British Columbia because scenic views contribute to all recreation and tourism activities. Recreation values can be indirectly

affected by disturbance impacts on viewable landscapes as well as being directly affected by the disturbance itself.

The following issues are the focus for research under this topic:

- 1.13.1 Effects of ATV and snowmobile use on biological communities, wildlife, and wildlife habitat.
- 1.13.2 Effects of forest access, and access management, on human use of non-timber resources (e.g. fish, wildlife, recreation).

1.14 Social, cultural, and economic dimensions of SFM

Ultimately, the ecosystem services provided by forest and range resources will manifest in some social, cultural, or economic dimension. Society will value the service, the service will contribute to maintenance of culture, or the service will be converted into economic gain. Disturbances that alter the dynamics of ecosystem services will also affect the translation of services into social, cultural, or economic value.

The following issues are the focus for research under this topic:

- 1.14.1 Effects of all-terrain vehicles (ATV) and snowmobile use on biological communities, wildlife, and wildlife habitat.
- 1.14.2 Effects of forest access and access management on human use of non-timber resources (e.g., fish, wildlife, recreation).

1.15 Biogeochemical cycling and budgets

The cycling of chemical elements is a fundamental framework for studying biophysical systems and the impacts of human activities. There is currently intense interest in the cycling of carbon at a range of scales because of its important role in the global climate system and the potential influence of forest management activities on carbon sequestration. In addition, forest management and related activities can influence the cycling of other elements, including nutrients and mercury, with potentially deleterious effects on-site and in downstream aquatic systems.

Research and management issues associated with this topic are currently under review by the SPAC.

1.16 Biology, ecology, and productivity of non-timber forest products

Research and management issues associated with this topic are currently under review by the SPAC.

Theme 2 Decision support tools for sustainable forest management

Approaches to making land-management decisions have changed markedly over the past few decades. Decision makers have grown increasingly aware of risks that accompany their decisions;

the types of risks that need to be considered have also become more numerous, and the requirement for transparency in decisions has become standard. Tools used by modern era decision makers vary from simple “decision trees” to complex simulation models. Some tools are used to “record” the decision process while others are used to derive salient information from enormous amounts of data and, by doing so, support decision making. Sustainable forest management is complex, involving a large amount of information about numerous resource values; the resulting land-management decisions can affect a wide variety of stakeholders. For these reasons, tools are required to support and document the decision-making approach thereby allowing for the required transparency and availability of a basis for monitoring results of decisions.

2.1 Modelling resource availability, dynamics, and sensitivity to management and disturbance

Forests provide a range of ecosystem services, including provision of wildlife habitat and high-quality water. The focus of research issues under this topic is the application of fundamental knowledge (e.g., from research conducted under Theme 1) to the development and testing of models that can predict the effects of forest management and disturbance on ecosystem services and resource availability.

Habitat supply models are computer-driven tools that provide decision makers with information about potential habitat-related impacts of various land-use management options, including trends in the medium and long term. Habitat supply modelling research is generally needed to improve the interpretation of habitat values derived from forest-, landscape-, and stand-level ecological attributes by identifying, evaluating, and (or) constructing habitat supply models relevant to flora and fauna in British Columbia. Priority is given to those species or communities designated under the *Forest and Range Practices Act* and regulations as “at risk,” and to non-timber forest products (NTFPs), as they affect forest management.

Hydrological models are increasingly used to predict the implications of forest management and disturbance on the cycling of water at stand, watershed, and landscape scales. Some models can also simulate the associated cycling of heat and matter, such as sediment and chemical elements, and thus provide tools for assessing the sensitivity of water quantity and quality and aquatic habitat.

The following issues are the focus for research under this topic:

- 2.1.1 Development of spatially explicit models related to Theme 1 and Topic 3.2, and for decision support related to priorities in Topics 4.1 and 4.4. Research needs are particularly focused on predicting the temporal and spatial dynamics of resource values and tools that are therefore responsive to external variables such as projections of MPB spread and climate change. Needs are also focused on tools that use or improve the utility of existing inventory and other readily available data.
- 2.1.2 Development of methods to evaluate the effectiveness of habitat capability models in identifying high-value habitat.

- 2.1.4 Development of spatially explicit habitat supply models for population viability analysis (PVA) applied to species at risk as outlined in Topic 4.1.
- 2.1.5 Development of remote sensing, information systems, and innovative technology for use in assessing landscape- and stand-level forest resource characteristics.

2.4 Developing or refining ecological classification systems

Biogeoclimatic ecosystem classification (BEC) requires refinement in several areas. One need is to produce classifications for areas without a present classification or to further characterize ecosystems that are poorly sampled, including rare ecosystems (Red- and Blue-listed) as identified by the Conservation Data Centre (CDC). Another need is to develop classifications and guides or tools for seral ecosystems, particularly those with value as forage (e.g., for cattle, specified ungulates, or other wildlife). This includes the development of information to support preparation and publication of field guides.

The impact of climate change is also important, including designing and evaluating approaches that build on our knowledge of climate–species–site–succession relationships for developing and refining ecological classification systems for future management of forest and range ecosystems.

Also of value is the development of aquatic ecosystem classification systems to complement the terrestrial system classification.

The following issues are the focus for research under this topic:

- 2.4.1 Updating, reconciling, and refining BEC or its components.
- 2.4.2 Development of methods for identifying rare ecosystems.
- 2.4.3 Development of classification systems for aquatic ecosystems.
- 2.4.4 Augmentation of BEC or its components with an attribute related to the site's potential for being grazed by cattle and/or wild ungulates.

2.6 Developing or refining ecological risk assessment tools

The following issues are the focus for research under this topic:

- 2.6.1 Development of frameworks and/or models for evaluating the resiliency and sensitivity of ecosystems to change and disturbance. Research proposals are particularly invited on the hydrological, geophysical, and aquatic resources at the watershed and landscape levels, although research addressing other management issues will be equally considered.
- 2.6.2 Development of integrated risk assessment frameworks for evaluating outcomes from trade-off analysis.
- 2.6.3 Development of methods for assessing risk of landslides and landslide avoidance.

2.7 Assessment of cumulative effects

Planning for many forms of land use and resource development happens in isolation from parallel processes happening in other sectors. Impacts are typically assessed project by project; jurisdictional boundaries and lack of knowledge often limit opportunities to minimize and mitigate impacts. True impacts on ecosystem function and socio-cultural values can only be assessed in a holistic manner, such that multiple stressors and their potential synergies are assessed. Ecological and socio-cultural systems may have thresholds that the assessment of a single development plan may not be able to detect. Work is needed to independently and reliably demonstrate the existence of these synergies and thresholds in British Columbia; work is also needed to develop predictors and communication methods for anticipating and preventing such impacts.

The following issue is a focus for research under this topic:

- 2.7.1 Development of methods to assess the effects of multiple resource uses (e.g., forest and range management, energy/mineral exploration and development, access, and recreation) on ecosystem function and/or socio-cultural values.

2.8 Methods of alternative valuation

Research and management issues associated with this topic are currently under review by the SPAC.

Theme 3 Indicators, thresholds, monitoring systems

Indicator development enables assessments about whether management practices are meeting management objectives. However, the assessments are rarely conducted in a manner that allows for discrete or unqualified answers, so the development of thresholds has become crucial as a measure of risk. Topics pertaining to indicator development include indicators of ecological, socio-economic, and socio-cultural sustainability; identification of indicator thresholds; and methods to balance ecological, socio-economic, and socio-cultural indicators.

3.1 Development of indicators and monitoring systems

Sustainable forest management involves the application of criteria and indicators. To be appropriate as management tools, variables used as indicators must be sensitive to the state of a system and provide unambiguous information about the system's response to forest management. They must also be measurable using cost-effective monitoring systems that are technically sound, scientifically based, and have adequate resolution in time and space to accurately document the range of variability and the impacts of forest practices.

Currently, industry and government are engaged in a number of related activities directed at identifying indicators and developing monitoring systems. Where possible, proposed new research in this area should take existing efforts into account and proponents should consider working collaboratively with industry or government staff engaged in similar activities.

The following issues are the focus for research under this topic:

- 3.1.1 Assessment of the Forest Resource Evaluation Program (FREP) indicators and monitoring systems.
- 3.1.7 Development of indicators (e.g., aquatic species such as benthic invertebrates, algae, fish) and monitoring systems to detect impacts on watershed health.
- 3.1.9 Development of indicators and monitoring systems to detect impacts on species most affected by climate change. Research needs are particularly focused on those species that have the greatest impact on ecosystem composition and function.
- 3.1.10 Assessment of indicators and monitoring systems used to detect change in wildlife habitat conditions. Research needs are particularly focused on the use of species or species groups to infer habitat condition for a variety of other species.
- 3.1.11 Development of indicators and monitoring systems to assess the maintenance of wildlife and biodiversity. Research needs are particularly focused on the use of biophysical or indigenous knowledge-based information to describe the amounts and spatial allocation of landscape, site, and ecological representation criteria.

3.2 Ecological sustainability

Having reliable and quantifiable indicators of sustainability for resource values provides for the ability to establish targets for each value. However, given the natural dynamics of ecological systems, it is unlikely that management will always be able to accomplish targets exactly or to maintain target levels with any degree of stability. It is important, therefore, to identify an appropriate range of thresholds within which, or in relation to which, management can be concluded to achieve the desired results (i.e., relatively stable equilibria that allow for some degree of dynamics). This research will contribute to the identification of methods to derive scientifically based thresholds for key indicators of forest resource values. It will also contribute to the actual definition of thresholds and targets.

The following issues are the focus for research under this topic:

- 3.2.1 Development of response curves for biodiversity indicators, including description of the range of natural variability, to assist in identifying manageable thresholds that maintain ecological resilience.
- 3.2.4 Development of indicator targets and management thresholds for sensitive species and ecological communities, especially those species and communities that are designated under the *Forest and Range Practices Act* and regulations as “at risk,” “regionally significant,” or “specified ungulates.” (Also see Topic 2.1 – Resource modelling, and Topic 4.1 – Species at risk recovery research).
- 3.2.5 Clarification/refinement of thresholds for indicators of change in watershed functioning (e.g., road density, equivalent clear-cut area).

3.3 Social, cultural, and economic sustainability

Sustainable forestry today is a matter of balance. It involves making decisions about environmental, economic, and social values. These decisions are reflected in strategic land use plans developed through public planning processes and implemented by government, licensees, and other stakeholders through operational plans.

Effective implementation of these plans requires monitoring and reporting on a set of environmental, economic, and social indicators. These indicators must be representative, reliable, and feasible. Collectively, the degree to which indicator targets are being met gives a measure of whether the values are being maintained.

The following issues are the focus for research under this topic:

- 3.3.1 Development of methods allowing for appropriate and effective participation of stakeholders, First Nations, and public in the valuation of non-timber resource uses (i.e., both consumptive and non-consumptive) and the process for their effective inclusion in forest and range management plans.
- 3.3.2 Effects of social grouping and structure (e.g., stakeholder, First Nation, and public) on the relative importance of social, economic, and ecological values in defining sustainable forest and range management.
- 3.3.3 Development of methods to aggregate social and economic data for inclusion in forest and range land-use planning processes.
- 3.3.4 Development of approaches to quantify impacts on, and determine compensation processes for, parties affected by forest and range management activities.
- 3.3.5 Characterizing the relationship between municipal/regional district planning (e.g., regional growth strategies) and forest management and land-use planning in British Columbia and ways to create linkages.
- 3.3.6 Evaluating conflicts between municipal/regional district planning (e.g., regional growth strategies) and forest management and land-use planning in B.C. and exploring ways to better coordinate them.
- 3.3.7 Development of indicators for assessing the well-being and resiliency of human communities affected by forest and range management and the respective tenure agreements.
- 3.3.8 Development of methods to use traditional and/or local knowledge and to engage rural communities and First Nations in the development of indicators for sustainable forest management.

3.4 Methods for balancing social, cultural, economic, and environmental values

A number of policies and processes are in place to assist in setting broad land- and resource-use goals and objectives. These usually involve multi-stakeholder negotiations to arrive at some mutually acceptable decisions. In the process, trade-offs between social, economic, and

environmental values are considered and made. In some cases, the implications of making such trade-offs are unclear, or the basis for evaluating the relative merits of different options is not well understood.

There is a need for reliable and cost-effective indicators that represent social, economic, and environmental values. Collectively, these indicators measure the degree to which values are being maintained. Sustainable forest management involves making balanced valuation and trade-off decisions about environmental, economic, and social values. These decisions are reflected in strategic land-use plans developed through public planning processes and implemented by government, licensees, and other stakeholders through operational plans.

The following issues are the focus for research under this topic:

- 3.4.3 Development of methods for assessing attitudes, values, and preferences of public and First Nations related to resource management policies, actions, and outcomes and for including these values in planning processes.
- 3.4.5 Development of methods to synthesize conflicts between municipal planning (e.g., regional growth strategies) and forest and range management (e.g., land-use planning) and exploration of ways to better coordinate the two processes.

Theme 4 Scientific information to support policy, regulations, and their implementation

Research is required on topics linked to provincial or federal acts, regulations, policies, or practice requirements. Proposals should identify links with the regulatory mechanism, and clearly define how results will assist in developing, evaluating, or improving the effectiveness of mandated activities. Key legislation includes the federal *Species at Risk Act* (SARA), the provincial *Forest and Range Practices Act* (FRPA), the provincial *Wildlife Amendment Act*, and the *Fisheries Act*.

4.1 Species at risk recovery

Species at risk represent a significant and immediate challenge to the goal of sustainability. Their high visibility and the irreversible nature of their loss make listed species a high and urgent priority for sustainability research.

Research should address knowledge gaps for species and ecological communities named under FRPA (in the category of Species at Risk); listed in the federal *Species at Risk Act* (SARA) Schedule 1; listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as endangered, threatened, or extirpated; or named on the British Columbia Conservation Data Centre (CDC) Red or Blue lists.

Research should also focus on knowledge gaps related to (but not limited to) the following species of immediate concern to forest managers in British Columbia: Spotted Owl, Mountain Caribou, Queen Charlotte Islands Goshawk, Marbled Murrelet, Grizzly Bear, Tailed Frog, Coho/Cutthroat Trout (small stream species), and Bull Trout.

Proposals dealing with COSEWIC-candidate species or species that are designated “Data Deficient” and that are named in the CDC Red or Blue lists will also be considered.

The following issues are the focus for research under this topic:

- 4.1.1 Determination of critical habitat requirements for species at risk where results will support development of recovery plans by recovery teams.
- 4.1.2 Clarification for, assessment of, and development of mitigation techniques for threats to species or ecosystems at risk. Research needs are particularly focused on supporting recovery of those species that experience cumulative threats or where empirical evidence about threats is apparently equivocal.
- 4.2 Impact of forest policies and practices on First Nations and rural community resiliency

Research is needed to help understand the impacts of potential changes in authorized timber harvest levels (allowable annual cut, AAC) on community resiliency.

The following issues are the focus for research under this topic:

- 4.2.1 Development and evaluation of strategies and mechanisms for enhancing resiliency of First Nations and rural communities in the face of changing timber harvest levels.
- 4.2.2 Effects of policies, regulations, and practices on First Nations and rural community resiliency (e.g., how do communities adapt to changes in harvest levels).
- 4.2.3 Development of knowledge, process, and tools to improve consideration of the resiliency of First Nations and rural communities in AAC determination.
- 4.2.5 Evaluation of effectiveness of policy, regulations, and practices in achieving socio-economic objectives.
- 4.3 Ecosystem-based management

For the Central and North Coast Land and Resource Management Plan areas, ecosystem-based management (EBM) is defined in the Government-to-Government Agreements between various First Nations and the Province of British Columbia as: “an adaptive, systematic approach to managing human activities, guided by the Coast Information Team EBM Handbook, that seeks to ensure the co-existence of healthy, fully functioning ecosystems and human communities.” A similar definition for EBM is also being developed as part of the Strategic Land Use Planning process on the Queen Charlotte Islands.

To fully implement EBM, a number of key elements are needed, including (1) a Governance Framework that builds on Government-to-Government agreements and the consensus recommendations from the LRMP tables; (2) socio-economic policies and initiatives that seek to achieve a high level of human well-being over time; (3) conservation measures, such as land use zonation, landscape-level reserves, and legal objectives that build on FRPA objectives and guide EBM forestry activity, that in combination seek to achieve a low level of ecological risk over time; and (4) an adaptive management system that will be used in monitoring and evaluating ecological integrity and human well-being, and provide input to analysis and decision support tools.

The following issues are the focus for research under this topic:

- 4.3.1 Compare and contrast effectiveness of EBM with other current forest and range management approaches.
- 4.3.2 Assess the relative contribution of protected and inoperable areas to the maintenance of viable species populations and representative ecosystems.
- 4.3.3 Assess the relative contribution of second-growth forests to the maintenance of viable species populations and representative native ecosystems.

4.4 Management and regulation of non-timber forest resources

The forest has many values beyond conventional timber products, ranging from cultural and subsistence, to recreational and commercial. Non-timber forest products, such as wild edibles, florals, craft materials, and medicinals, as well as biomass for bioenergy, and subsistence wildlife harvest, are not adequately addressed within forest management and planning. Information is required to inform policy that would ensure both ethical and sustainable use of these resources, and enable opportunities for their development. Knowledge gaps include basic ecological information on many of the species, sustainable harvest levels, methods of monitoring both ecological and socio-economic effects of harvest or non-harvest, and opportunities and barriers for compatible management for both timber and non-timber values.

The following issues are the focus for research under this topic:

- 4.4.1 Development of information to enable policy, regulations, and practices addressing the sustainable management of non-timber forest resources.
- 4.4.2 Determination of habitat requirements for non-timber forest products (e.g., salal, pine mushrooms, huckleberry) defined at the appropriate scale.
- 4.4.3 Effects of forest and range management (e.g., forest road development, salvage and rehabilitation of stands killed by MPB, livestock use, exclusion/reintroduction of fire) on the sustainability of non-timber forest products.
- 4.4.4 Development of information to enable policy addressing the maintenance of wildlife for subsistence purposes. Research needs are particularly focused on forest and range management associated with salvage and rehabilitation of stands killed by MPB.
- 4.4.5 Evaluation of the effects of increased timber harvest levels and road access on availability of wildlife for subsistence
- 4.4.6 Evaluation of the effects of increased timber harvest levels and road access on availability of wildlife for subsistence

Appendix 2 – Scoring Research Issues

Overview

A wide range of factors must be considered when determining annual research priorities. Complex interactions among factors, and differences in the reliability and importance of specific factors to each topic and research issue, make it difficult to adequately capture the full range of possibilities in a single index. However, an index can still contribute to the FPAC and SPAC determination of research priorities. The process for developing an index collates useful information regarding key factors that may influence decisions on ranking research issues. Furthermore, the index value itself provides a useful starting point for discussions on rankings by illustrating the net outcome of documented assumptions.

To be effective, a scoring index must be simple and transparent; the influence of factors chosen as input criteria on the final index value must be intuitive and easily discerned. Therefore, the criteria used to calculate the PAC scoring index are limited to those that are relatively easy to assess and that best capture the factors that influence rankings across the entire strategy. This approach assumes that more complex factors, or factors specific to a particular issue, will be dealt with in discussions among PAC members. Thus, it is not necessary to capture *everything* in the rating index. Application of the index as a starting point for the rating process will ensure that the full expertise of the PAC is incorporated into the final rankings.

A weighted-sum index is used to score PAC research issues based on their priority for funding. Index scores and associated criteria are an input to a discussion-based process in which the PACs decide the final rankings of research issues.

A “score” for each research issue is determined using the following formula:

$$\text{Score}_j = \sum_i (C_{ij} * W_i)$$

where, for each research issue j , C_i indicates the assigned score for criterion i , and W_i indicates the *relative* weight assigned to criterion i . Currently, the SPAC uses equal weighting for all criteria. Specific recommendations on criteria and how the index should be applied are documented below to make this process, which is fundamental to establishing the annual FIA-FSP Research Call for Proposals, transparent.

Criteria

Importance to sustainable forest management

Research to support sustainable forest management is a key element of the FIA-FSP vision; therefore, importance or relevance to SFM is a key indicator of funding priority for research issues. When assessing this criterion, PAC members should consider whether obtaining answers to the questions posed by the research issue will improve the ability of practitioners to manage forest resources, improve our understanding of the issue, or support policy needs. Also, if the answers to the research issued are obtained, what would be the potential magnitude of change to forest practices?

Table A2-1 Scoring importance to sustainable forest management

Score	Description	Example
5 (high)	Research findings would provide substantial information or tools to address several key SFM issues	Effects of current management and traditional Aboriginal practices on the creation or maintenance of structure, composition, and ecological processes at landscape scales
4	Research findings would provide substantial information or tools to address one or more key SFM issues	Development of spatially explicit habitat supply models for predicting impacts of resource management practices on population viability for species at risk
3 (moderate)	Research findings would provide some information or tools to address several key SFM issues	Development of methods to assess the effects of multiple resource uses on ecosystem function and socio-cultural values
2	Research findings would provide some information or tools to address one or more key SFM issues	Effectiveness of soil rehabilitation techniques for re-establishing soil productivity
1 (low)	Research findings would not directly inform any key SFM issues	Quantifying winter respiration rates of the wee yellow dripper

Knowledge gap

This criterion captures the size of the gap between what we currently know and what we need to know to address the issue. Factors to consider include the degree of uncertainty in current information, the nature of the gap (basic knowledge of processes, treatment response, etc.) and past research effort. This criterion is different from importance to SFM because there may be some large knowledge gaps that, if filled, would not necessarily lead to significant changes in practice or policy.

Table A2-2 Scoring knowledge gap

Score	Description	Example
5 (high)	The topic is broad in scope, very little is known and little or no research has been done	Effects of climate change on biological communities and ecological processes at site levels
4	The topic is fairly broad in scope, little is known and few research studies have been done	Effects of forest and range management on riparian biodiversity of small streams and wetlands
3 (moderate)	Knowledge gap uncertain	
2	The topic is narrow in scope, much is already known and there has been significant previous research	Effects of stock type and stock handling on early survival and growth of Douglas-fir
1 (low)	The topic is very narrow in scope, much is already known and previous research is abundant	Response of coastal Douglas-fir to salmonberry control

Urgency

This criterion assesses the importance of receiving additional information on a research issue in a timely manner and the consequences of a delay in finding the answer (e.g., potential loss of an endangered species).

Table A2-3 Scoring urgency

Score	Description	Example
5 (high)	Results are needed quickly to avoid irreversible consequences	Research on an endangered species at the brink of extinction
4	Findings could have immediate application or impact	Research on MPB salvage and utilization techniques
3 (moderate)	Findings could have significant short- or medium-term application or impact	Research on natural disturbance regimes to guide landscape planning
2	Findings could have medium- to long-term application or impact	Research on soil processes affecting tree productivity
1 (low)	Findings will not have any initial application or impact, but may in the long term	Research on soil microbial diversity

Regional significance

This criterion addresses the proportion of a region affected by a particular research issue, and at what scale likely research results could be applied within the region.

Table A2-4 Scoring regional significance

Score	Description	Example
5 (high)	Applies to entire region	Effects of forest harvesting on steep, coastal headwater streams
4		
3 (moderate)	Applies greater than half of the region	Growth response of coastal Douglas-fir to partial cutting
2		
1 (low)	Applies to small portion of region	Impacts of balsam woolly adelgid on grand fir