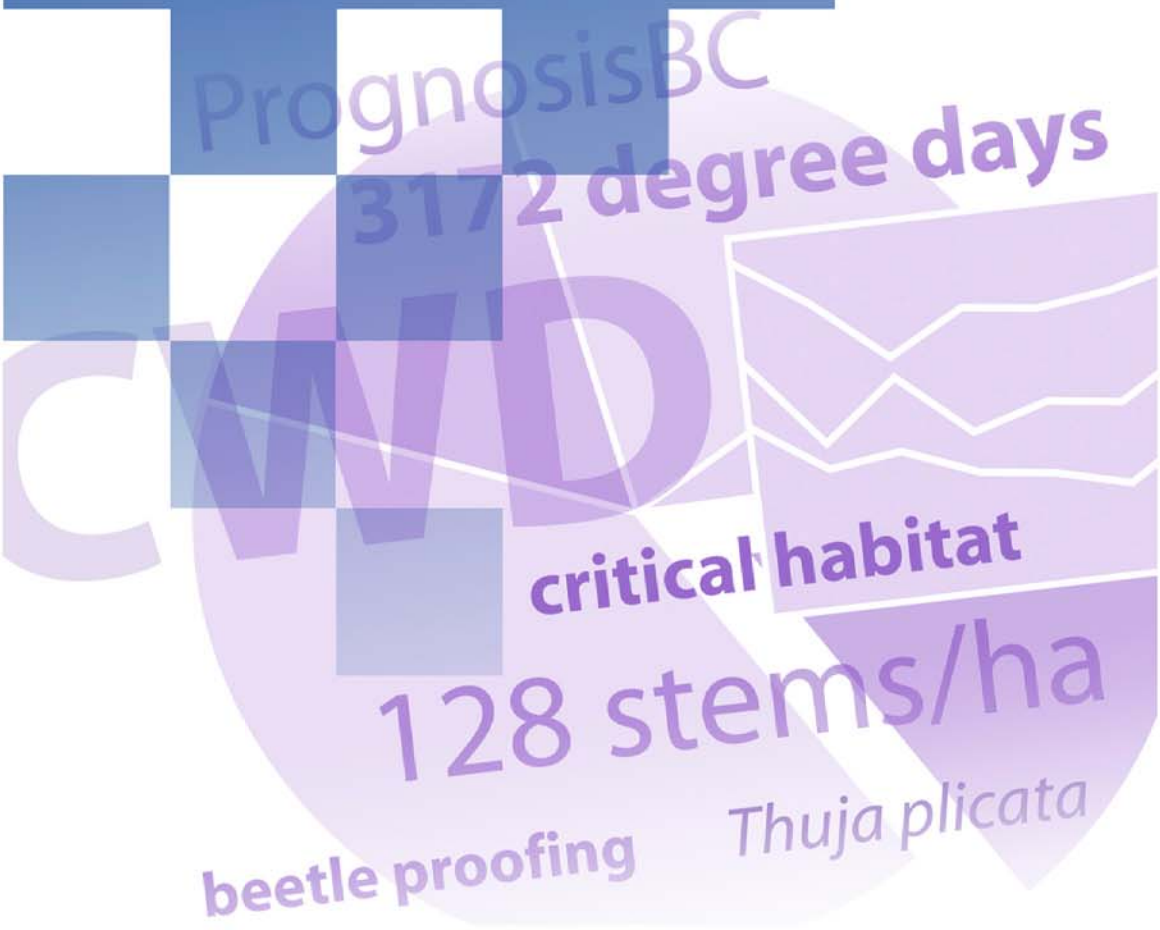
Synopsis of FIA-FSP Research Projects
(2004–2009)

FIA Forest Investment Account
Forest Science Program



Synopsis of FIA-FSP Research Projects (2004–2009)

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More information on the FIA Forest Science Program can be found at
www.fia-fsp.ca

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Synopsis of FIA-FSP Research Projects (2004–2009)

A. Document Overview

This document provides an overview of ongoing and completed research projects funded through the Sustainability and Forest Growth and Value Programs under the FIA-Forest Science Program (FIA-FSP). Other FIA-FSP projects, including long-term research installations, graduate student research, and research syntheses are not presented here. This document addresses projects that were initiated between 2004 and 2009 and incorporates final results of projects completed by March 2009. Additional information on specific projects is available in the report and publication repository of the Forest Investment Account[1]. General information on the structure and intent of the research program is available on the FIA-FSP website[2].

Section B presents summary tables showing the number and value of projects funded in each research program. Section C presents summaries of all research projects funded by the FIA-FSP since 2004. Project summaries are organized by program, theme, topic, and focus. Projects that were initiated prior to the development of the current classification system (pre-2005) were re-classified under the current system. When a project could not be classified at all levels of the current strategy hierarchy, it is classified as far as possible followed by "unclassified," indicating it could not be classified any further (e.g., "1.0 Unclassified" indicates the project fits within theme 1, but does not fit within any of the topics under this theme).

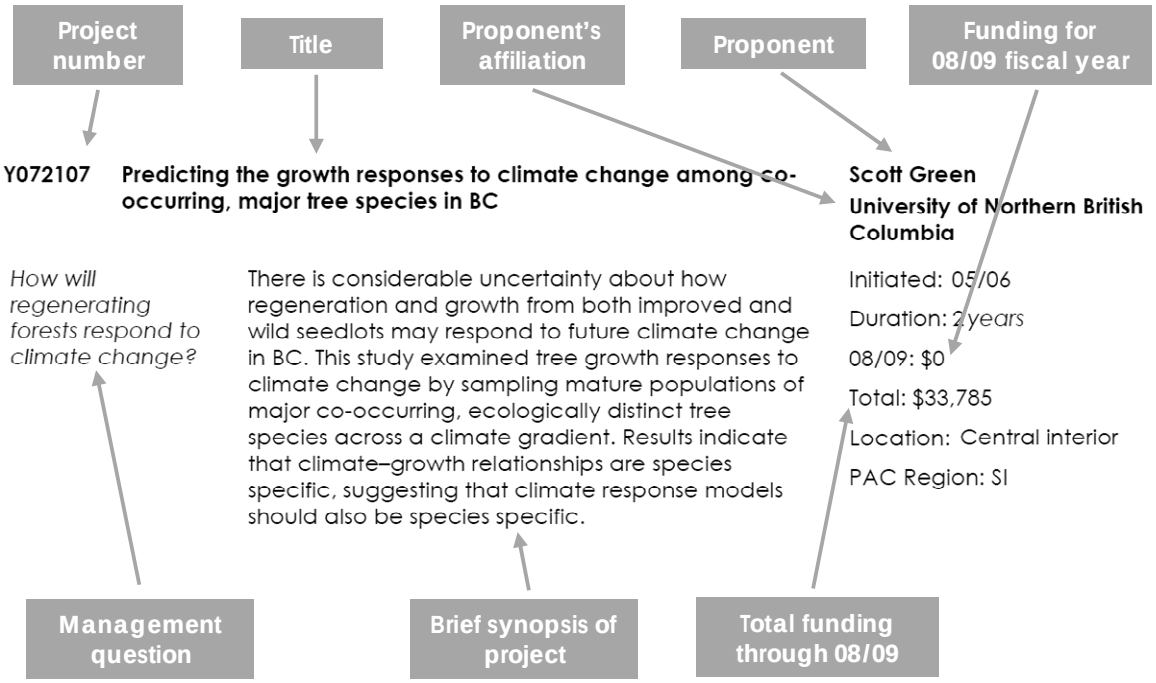
Figure 1 shows an example project summary, with explanations for some fields. Information presented in the project summaries is current to the most recent year for which the project was active. As a result, the names of some proponents (e.g., government agencies, companies) may differ from their current designations.

Appendix I contains the 2008/09 project hierarchies from the Sustainability and Timber Growth and Value Program Strategies. Appendix II contains a list of all funded projects, presented by organization and contact name.

[1] http://www.for.gov.bc.ca/hcp/fia/searchreports.htm

[2] http://www.fia-fsp.ca

Figure 1 Sample project summary.



B. Research Program Overview

Table 1 **Sustainability Program: number of projects and funding disbursed for projects initiated 2004/05 to 2008/09**

This table only contains themes and topics under which projects have been initiated. A complete list of themes and topics can be found in Appendix I.

The totals in this table do not include additional funding for ongoing projects that will be committed in the 2009/10 and 2010/11 fiscal years.

		2004/05–2008/09	
Theme (bold) and Topic		**#**	**$**
S 1	**Basic research to support sustainable forest management**	**112**	**12,748,898**
S 1.1	Riparian and aquatic ecology and management	18	2,071,584
S 1.2	Soil biology, ecology, and productivity	5	1,401,965
S 1.3	Landscape ecology and management	12	1,206,607
S 1.4	Stand-level ecology and management	46	4,315,680
S 1.5	Disturbance ecology and management (fire, wind, pests, disease, pollutants, and invasives)	6	394,661
S 1.6	Watershed function and management	19	3,077,265
S 1.8	Ecological restoration	1	35,812
S 1.9	Climate change	5	245,323
S 2	**Decision support tools for sustainable forest management**	**14**	**1,297,057**
S 2.1	Modelling resource availability, dynamics, and sensitivity to management and disturbance	12	1,021,469
S 2.6	Developing or refining ecological risk assessment tools	2	275,588
S 3	**Indicators, thresholds, monitoring systems**	**58**	**4,973,322**
S 3.1	Development of indicators and monitoring systems	33	2,815,141
S 3.2	Ecological sustainability	16	1,441,078
S 3.3	Social, cultural, and economic sustainability	7	471,175
S 3.4	Methods for balancing social, cultural, economic, and environmental values	2	245,927
S 4	**Scientific information to support policy, regulations, and their implementation**	**37**	**4,434,171**
S 4.1	Species at risk recovery	37	4,434,171
S	**Other strategic projects**	**15**	**1,531,288**
	Totals	**236**	**24,984,736**

Table 2 **Forest Growth and Value Program: number of projects and funding disbursed for projects initiated 2004/05 to 2008/09**

This table only contains themes and topics under which projects have been initiated. A complete list of themes and topics can be found in Appendix I. "Unclassified" indicates projects that could not be classified any further under the current strategy.

The totals in this table do not include additional funding for ongoing projects that will be committed in the 2009/10 and 2010/11 fiscal years.

		2004/05–2008/09	
Theme (bold) and Topic		**#**	**$**
F 1	**Basic research on tree growth and stand development**	**37**	**3,406,005**
F 1.0	Unclassified	3	407,701
F 1.1	Complex stands, including partial cutting, variable retention	30	2,796,051
F 1.3	Old trees and stands	4	202,253
F 2	**Design and analysis of silvicultural systems**	**39**	**4,300,538**
F 2.0	Unclassified	6	1,423,819
F 2.1	Complex stands arising from partial cutting, variable retention, and multi-species planting	28	2,508,872
F 2.2	Even-aged stands	5	367,847
F 3	**Stand dynamics modeling**	**24**	**2,936,837**
F 3.0	Unclassified	2	137,385
F 3.1	Complex stands, including partial cutting, variable retention	21	2,464,552
F 3.2	Wood quality	1	334,899
F 4	**Response of trees and stands to disturbance**	**51**	**4,458,502**
F 4.0	Unclassified	1	77,188
F 4.1	Stand and forest dynamics following the mountain pine beetle epidemic	27	2,454,800
F 4.2	Estimating and/or mitigating stand-level losses	14	1,162,824
F 4.3	Mitigating losses (other than MPB)	7	685,188
F 4.4	Site productivity impacts	2	78,502
F 5	**Analytical techniques and models for strategic analysis**	**7**	**527,819**
F 5.1	Development of novel methods to integrate data and models across scales	3	220,563
F 5.2	Development of novel methods to link GY models to process, climate, hydrology, wildlife, and other models	1	61,253
F 5.3	Techniques for scheduling harvesting after MPB attack	3	246,004
F 6	**Marketable resources other than timber**	**7**	**632,805**
F 6.2	Non-timber forest products (NTFPs)	7	632,805

Theme (bold) and Topic		2004/05–2008/09 #	$
F 7	**Climate change**	**14**	**881,361**
F 7.0	Unclassified	1	47,234
F 7.1	Predicting effects of climate change on forest health and condition (e.g., insects, disease, fire)	2	69,432
F 7.2	Predicting effects of climate change on growth and productivity	6	452,153
F 7.3	Responding to ecosystem shifts	3	274,364
F 7.4	Physiological and adaptive responses of species and seedlots	2	38,178
F 8	**Forest harvesting and engineering studies**	**7**	**733,754**
F 8.1	Salvaging MPB-killed timber	7	733,754
F	**Other strategic projects**	**11**	**596,513**
F	**Unclassified**	**8**	**753,824**
	Totals	**205**	**19,227,958**

In addition to projects funded directly through the Sustainability and Forest Growth and Value Programs, an additional five projects ($356,589) were funded under the Future Forest Ecosystems Collaborative Research Initiative (FFE-CRI) and 4 projects ($363,266) were funded under the Growth and Yield Modelling Collaborative Research Initiative (GYM-CRI).

C. Summaries of Current and Completed FIA-FSP Research Projects

Sustainability Program

S 1 Basic research to support sustainable forest management

S 1.1 Riparian and aquatic ecology and management

S 1.1.0 Unclassified

M065007 Compendium of fish/forestry reports

David Maloney
Ministry of Forests and Range

What are the effects of forestry practices on watershed processes and fish populations?

Many resource managers have concerns about the interaction of forestry practices and fish populations. Over the last 30 years a large amount of fish–forestry research has been conducted with the province, which allows identification of where and why mistakes were made. This project assembled a bibliography of material pertaining to fish–forestry interactions in British Columbia up to 2005. The resulting bibliography has made this information available to all through the fish–forestry website.

Initiated: 05/06
Duration: 1 *year*
09/10: $0
Total: $15,519
Location: Interior
MFR Region: P

Y061091 Small streams on fans: recognition of hydrogeomorphic hazards

David Wilford
Ministry of Forests and Range

Extension project

This project completed the province-wide extension on the fan project. Specifically, the project involved publishing the methods and results from previous work, and conducting workshops on methods and techniques for identifying hazards and developing management responses. The project saw the completion of a Land Management Handbook (LMH27) describing the hazard classification scheme and a peer-reviewed publication presenting the case for recognizing the hydrogeomorphic riparian zone.

Initiated: 05/06
Duration: 1 *year*
09/10: $0
Total: $18,999
Location: Province-wide
MFR Region: P

Y073062 Cumulative watershed effects of forestry practices on stream ecosystems

Yixin Zhang
University of British Columbia

What are the relationships between physical and ecological processes that result from cumulative watershed effects of forestry practices?

Cumulative watershed effects (CWEs) have not been well examined and studies of cumulative impacts of forestry practices on biodiversity and ecosystem processes remain a vital area of research. The investigators compared watersheds with different forest practices histories by using a multivariate modeling technique to examine the relationship between multiple environmental variables and the ecological responses of benthic communities. Results indicate significant impacts of past forestry practices on the richness and abundance of benthic invertebrates, suggesting the influence of these past practices on habitat alteration and present-day biodiversity.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $249,115
Location: Coast
MFR Region: C

S 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

Y051038 Stream habitat and rainbow trout responses to clearcut logging in north-central British Columbia

Scott G. Hinch
University of British Columbia

What are the medium- and long-term responses of riparian systems to logging treatments?

Medium- and long-term studies examining the effects of streamside harvesting on lake-headed, small stream ecosystems are virtually non-existent in temperate interior regions. This study builds on short-term (1–2 yrs) results from a study examining the effects of different logging treatments in riparian reserve zones on stream temperatures and on rainbow trout populations, by extending analysis into the medium term (6 yrs). Results indicate that lake-headed streams are able to support relatively aggressive levels of harvesting, with observed stream habitat and rainbow trout responses possibly related to inter-annual variation rather than to logging treatment.

Initiated: 04/05
Duration: 1 *year*
09/10: $0
Total: $67,032
Location: North-central interior
MFR Region: NI

Y061038 Rainbow trout bioenergetic and stream dissolved oxygen responses to clearcut logging in north-central British Columbia

Scott Hinch
University of British Columbia

What are the effects of streamside harvesting on small streams and their resident fish populations in the sub-boreal biogeoclimatic zone?

Numerous scientific studies, primarily in coastal regions, have shown forestry practices to have deleterious effects on fish and their habitat. This study assessed post-logging stream invertebrate drift, as well as trout diet, energy allocations, and growth responses, to gain a more complete understanding of the impacts of timber harvesting around two previously studied small sub-boreal streams. It was concluded that the selective logging methods used in the study, combined with the unique thermal characteristics of sub-boreal, lake-headed streams, also likely diminished the negative impacts of high temperatures and sediment inputs that are commonly reported in studies within coastal or sub-boreal headwater systems. This underscored the potentially complex interactions among environmental and stream ecosystem physical and biological characteristics, as well as their natural variability, and highlighted the need for multi-disciplinary and long-term research to better understand the impacts of streamside clearcut logging.

Initiated: 05/06
Duration: 1 *year*
09/10: $0
Total: $51,005
Location: SBS zone
MFR Region: NI

Y061049 **Headwater stream temperature response to alternative riparian management strategies: an experimental and modeling approach**

Dan Moore
University of British Columbia

Are there effective alternatives to riparian buffers for maintaining stream temperature?

Retaining riparian forest in linear buffers can minimize the impact of forest harvesting on stream temperature, but may also incur opportunity costs to licensees. This study documents the effect of alternative riparian management strategies on stream temperature, and tests the ability of an existing model to predict stream temperature response to different treatments. Of the two strategies examined, patch retention is tentatively identified as being more effective, though firm conclusions cannot be drawn due to limitations of the study design. Results of the modeling component of this project suggest that, in addition to errors in measured depth, there are problems with processes either being incorrectly represented or missing; the sources of these errors are being addressed through ongoing research.

Initiated: 05/06
Duration: 1 *year*
09/10: $0
Total: $18,710
Location: South coast and central interior
MFR Region: P

Y071039 **A broad-scale investigation of the effects of streamside clearcut timber harvesting on small stream ecosystems in British Columbia: analyses of large-scale databases to forecast impacts on physical and thermal habitats and their salmonid populations**

Scott G. Hinch
University of British Columbia

What are the impacts of riparian forest harvesting on small stream ecosystems and their salmonid populations?

The impact of streamside forest harvesting on stream ecosystems is uncertain, with studies in the existing literature reporting conflicting results. This study attempts to address this conflict by conducting a meta-analysis of existing, published scientific fish–forestry data, and applying a predictive stream temperature model using existing stream temperature and fish inventory data that have been collected throughout BC. Results indicate that post-logging effects are largely independent of stream size and gradient. While removal of large wood (LW) had a significant impact on measured response variables, in the absence of LW removal, salmonid populations were found to be resilient to streamside forest harvesting.

Initiated: 06/07
Duration: 1 *year*
09/10: $0
Total: $45,192
Location: Province-wide
MFR Region: P

Y073027 **The effects of riparian harvesting on fish habitat and ecology of small headwater streams**

David Maloney
Ministry of Forests and Range

What are the effects of current management practices on water quality, channel morphology, and stream biology?

This project investigates and verifies SFM practices for management of small streams in a range of sub-boreal forest types. Using a before-after-control-impact paired study design, the project quantifies the natural functions of small streams and adjacent riparian areas, with the aim of determining if harvesting with best management practices maintains these functions. Results indicate the current management will maintain neither adequate recruitment of LWD, nor sufficient levels of shade and litterfall.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $435,066
Location: North-central interior
MFR Region: NI

Y081087 Extension of the effects of logging on export of organic matter from headwater streams in the BC Interior

Brian Heise
Thompson Rivers University

What are the effects of clearcut logging under current riparian management guidelines on the export of organic matter in high-elevation headwater streams in the BC interior?

The contributions of streams from high-elevation forests to river ecosystems with respect to diversity and abundance of invertebrates, and quantity of detritus and dissolved organic matter, is not well known but is an area of concern for both government and industry. This project evaluated the effectiveness of current riparian management practices on the export of organic matter by sampling drifting aquatic invertebrates, fine particulate organic matter (FPOM), and dissolved organic carbon (DOC) before and after clearcut logging in seventeen high-elevation streams in the southern interior of BC. Due to the high variability of drift response observed, no significant effects of logging on drifting invertebrates, FPOM, or DOC were observed, suggesting that under current riparian management practices in high-elevation forests, clearcut logging has not had short-term detrimental effects on organic matter export.

Initiated: 07/08
Duration: 1 *year*
09/10: $0
Total: $13,915
Location: Cariboo FD
MFR Region: SI

Y081216 Long-term stream habitat and rainbow trout responses to alternative riparian management in north-central British Columbia

Scott Hinch
University of British Columbia

What are the long-term (10+ years) stream habitat and rainbow trout responses to streamside clearcut logging in interior forests?

There is a relative dearth of knowledge about the effects of streamside harvesting on streams and their resident fish populations in temperate, interior regions and on lake-headed streams. Building on previous research, this project assessed the longer term (10 years) abiotic (stream temperature, dissolved oxygen, suspended sediment, and pool habitat) and rainbow trout density, standing crop biomass, distribution, and condition responses of two small, S3 lake-headed streams in north-central British Columbia to a novel streamside logging treatment whereby only mature timber within the riparian zone was removed. Results suggest that lake-headed streams exhibit different temperature and dissolved oxygen responses to riparian logging than do headwater streams, and may consequently be able to support more aggressive streamside harvesting without negative effects. The results also highlight the need to consider such factors as the type of stream, thermal regimes, the amount of available habitat and food, overall densities, flow rates, trout movement patterns, and predation levels, because it is the interplay among these factors that creates the growing environments encountered by stream-dwelling fish.

Initiated: 07/08
Duration: 1 *year*
09/10: $0
Total: $75,802
Location: Nation River watershed
MFR Region: NI

Y082276 Effect of stand structure and riparian buffer design on wind damage susceptibility and large woody debris recruitment

Steve Mitchell
University of British Columbia

What are the risks and impacts of windthrow on riparian reserves, and how should reserves be designed to minimize these risks?

The design of effective riparian prescriptions requires estimates of both the probability of, and the potential impacts of, windthrow. This project expanded an existing windthrow risk model (ForestGALES) to facilitate examination of the impacts of windthrow on large woody debris (LWD) and sediment source exposure in riparian buffers. Results indicate: the majority of windthrown trees were suspended above the stream channel; very little of the exposed sediment was close enough to the sampled creeks to result in sediment delivery; the empirically observed processes have been emulated in the LWD module of ForestGALES_BC, and will be available to users as a component of TASS 3.0. This project aims to address underdeveloped components of LWD recruitment modeling for adapting for BC conditions. Field studies will be conducted to answer what factors affect the quantity and condition of LWD that enters the stream channel in the years after a windthrow event; what factors affect the volume of sediment exposed; and how management actions affect the volume of windthrow and sediment exposure. The riparian management refinements will be made available to practitioners through the ForestGALES_BC -TASS interface.

Initiated: 06/07
Duration: 2 *years*
09/10: $0
Total: $134,777
Location: Coast
MFR Region: C

Y092289 Source distances and delivery processes for large woody debris recruitment to small streams from riparian forests

Tom Johnston
Ministry of Environment

How can site-specific riparian buffer widths be determined to maintain a specified proportion of expected LWD inputs with a given probability?

Riparian buffer widths to maintain large woody debris (LWD) inputs are usually based on a single delivery mechanism (tree fall). However other LWD delivery mechanisms are strongly connected to the physical processes that determine channel type and size; thus, characteristics of a stream reach such, as channel type, channel size, confinement, and the nature of the riparian vegetation may provide information about the relative influence of different LWD delivery mechanisms and the buffer width needed to maintain normal inputs of functional LWD. This project determined LWD source distance curves as functions of channel type (riffle–pool, cascade–pool, step–pool) and size (bankfull width) over a wide range of biogeoclimatic zones. These data were used to construct statistical models of the distribution of source distances that supplied 90% of the cumulative distributions of LWD pieces and LWD volume entering the streams. In general, these statistical models performed better than direction tree-fall process models in predicting actual LWD inputs. The observed data on LWD sources and the statistical models should provide a stronger technical basis for riparian buffer regulations designed to maintain near-normal inputs and characteristics of LWD to small streams.

Initiated: 07/08
Duration: 2 *years*
09/10: $0
Total: $84,240
Location: Province-wide
MFR Region: P

Y103097 Recovery processes of small streams and their riparian areas from clearcutting and partial harvest riparian management

John Richardson
University of British Columbia

What are the long-term recovery dynamics of forests and streams under different riparian management approaches?

Understanding short-term and long-term changes is critical for sustainable forest management around aquatic ecosystems, since different elements of these ecosystems exhibit different rates of recovery. This project will build on past studies in the ongoing Malcolm Knapp Riparian Management experiment by documenting long-term recovery of streams and their riparian areas by sampling the fixed width riparian reserve treatments and the partial harvest watersheds for three more years. This work will provide considerable gains in understanding the long-term recovery dynamics of forests and streams from different management approaches, and will produce models that predict both short (1–5 years) and long-term (5–15 years) effects of riparian management on these systems.

Initiated: 07/08
Duration: 3 *years*
09/10: $127,585
Total: $392,314
Location: Coast
MFR Region: C

Y103241 Assessing the sensitivity of streams to riparian changes: Does channel geomorphology determine how tightly forests and small streams are linked to downstream reaches?

Trent Hoover
University of British Columbia

Does channel geomorphology determine how tightly forests and small streams are linked to downstream reaches?

Indicators of the degree to which riparian management strategies directly influence the ecology of small streams, and how those influences are transmitted downstream, are needed as tools that allow managers to determine whether stream systems are being protected by current or alternative practices. The proposed project will examine the transport and retention dynamics of fallen terrestrial insects, red alder leaf litter, and conifer needles, three types of terrestrial organic matter that function as important forest-to-stream subsidies in coastal watersheds. The study will examine how channel geomorphology mediates the ecological linkages between riparian forests and stream food webs. The results of this project will provide practitioners with additional tools when prescribing appropriate levels of riparian retention.

Initiated: 07/08
Duration: 3 *years*
09/10: $51,667
Total: $189,793
Location: Malcolm Knapp Research Forest
MFR Region: C

S 1.1.2 Riparian biodiversity of small streams and wetlands, especially in dry interior ecosystems (Retired 2008)

Y103068 Ecosystem functioning in small streams and their riparian areas in response to partial harvest riparian management

John Kominoski
University of British Columbia

How do forest harvesting operations alter the riparian connection with headwater streams and reciprocal subsidies from streams to riparian forests?

Although the consequences of timber harvesting for both streams and forest ecosystems have been extensively investigated over the past several decades, less is understood about the consequences of post-harvest forest succession on the connections between stream and riparian ecosystems. The goal of the proposed project is to determine if (a) changes in the composition of leaf litter inputs (e.g., from Douglas-fir needles to red alder leaf litter) result in changes in the abundance and diversity of benthic invertebrates; (b) how this shift translates into changes in rates of detrital processing and secondary production; and (c) whether these shifts ultimately translate into changes in stream invertebrate emergence pattern or abundance. The proposed project will clarify how forest harvesting operations may alter the riparian connection with headwater streams and reciprocal subsidies from streams to riparian forests, and will provide immediately applicable results in terms of understanding the need for, and the effects of, maintenance of riparian vegetation during forest harvest operations.

Initiated: 07/08

Duration: 3 *years*

09/10: $53,870

Total: $204,710

Location: Malcolm Knapp Research Forest

MFR Region: C

S 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

Y082031 Hydrogeomorphic response to forest disturbance: Fishtrap Creek

Brett Eaton
University of British Columbia

What are the effects of large-scale wildfire, and subsequent salvage, on watershed hydrology, sediment dynamics, and channel morphology?

Current knowledge does not allow accurate prediction of stream channel response, rate of change of response, or the time scale at which response and recovery may be expected to occur, following major wildfire events such as the 2003 McLure fire near Kamloops. This study documented the timing and magnitude of initial changes in channel morphology, hydrology, sediment supply, and sediment mobility in Fishtrap Creek in the aftermath of the McLure Fire. The results suggest that channel disturbance is an integral component of maintaining the overall quality of aquatic habitat for a channel network: so long as disturbances are permitted to occur but do not occur in all reaches at the same time, then the overall health of the stream network will be maintained; however, the overall health of the system may be severely compromised if either the disturbance mechanisms are suppressed or if a single disturbance event is so widespread that all of the morphologic life cycles become synchronized.

Initiated: 06/07

Duration: 2 *years*

09/10: $0

Total: $76,741

Location: Southern interior

MFR Region: SI

S 1.1.5 Sensitivity of wetland ecosystems to alternative riparian management strategies including livestock use (Retired 2007)

Y103232 **Effects of livestock grazing in southern Interior wetlands: interactions with amphibians, benthic macroinvertebrates, vegetation, and breeding waterfowl**

Lauchlan Fraser
Thompson Rivers University

Do grazing-related changes to riparian flora and fauna influence breeding waterfowl, and does off-site water development reduce trampling effects of cattle in wetlands?

Research has shown that livestock grazing can alter wetland water quality, biodiversity, and productivity directly, through removal of biomass, soil compaction and trampling, and nutrient inputs, as well as indirectly by changing plant competitive interactions through selective herbivory and nutrient loading. This project will measure changes in water quality, wetland vegetation, amphibians, and benthic macroinvertebrates along a grazing intensity gradient in depressional wetlands in the IDF and BG biogeoclimatic zones; evaluate changes to wetland-related biota and water quality associated with off-site water development; identify the natural range of variability of response variables associated with minimally disturbed wetlands; and identify thresholds of biotic and physical variables associated with grazing disturbance. The result will be an improved understanding of how grazing influences these complex interactions, thus contributing to maintaining the biodiversity, productivity, habitat, and forage production values of wetlands.

Initiated: 07/08

Duration: 3 *years*

09/10: $59,584

Total: $222,942

Location: Depressional wetlands in the Kamloops and Merritt areas

MFR Region: SI

S 1.1.6 Biodiversity value of wetland riparian zones, especially in dry Interior ecosystems (Retired 2007)

Y082305 **Quickbird high-resolution satellite imagery for riparian TEM classification**

Sarah Gergel
University of British Columbia

Is high spatial resolution imagery suitable for accurate Terrestrial Ecosystem Mapping and discrimination of landforms in riparian areas?

High spatial resolution satellite imagery may be useful in overcoming the challenge of accurately mapping the structural complexity within riparian stands over broad areas. However, this new technology presents a suite of technical challenges related to image classification. This project assessed the feasibility of using high spatial resolution imagery and object-based classification techniques to map riparian areas, discriminate late seral forest associations, and identify alluvial stream reaches. Results indicate that late seral forests can be well discriminated from early seral stands solely on the basis of spectral and/or textural information, and that identification of riparian landforms is best accomplished using high-resolution LiDAR-derived DEM and a multi-scale classification approach.

Initiated: 06/07

Duration: 2 *years*

09/10: $0

Total: $68,418

Location: BC, Alberta

MFR Region: P

S 1.2 Soil biology, ecology, and productivity

S 1.2.2 Effects of forest management (e.g., coarse woody debris retention, green tree retention, soil disturbance allowances, salvage of MPB-killed stands) on soil ecology and site productivity. Research needs are particularly focused on biological, chemical, and physical attributes (Retired 2008)

Y062093 Ten-year soil fauna responses to soil compaction and organic matter removal at Sub-Boreal Spruce LTSP

Shannon Berch
Ministry of Forests and Range

How do soil mesofauna and macrofauna communities respond to different levels of soil disturbance?

Timber harvesting and site preparation modify a variety of physical and chemical properties in the soil, consequently affecting soil pore space, composition, and amount of organic matter, soil temperatures, and soil moisture. This project, part of the long-term Soil Productivity Study, examines changes to and responses of soil mesofauna and macrofauna communities to different levels of soil disturbance applied 10 years earlier. Project results indicate that soil compaction has a significant impact on soil fauna, with the magnitude and duration of soil compaction (and associated impacts) exacerbated by removal of the forest floor.

Initiated: 04/05
Duration: 2 *years*
09/10: $0
Total: $48,042
Location: Topley, Prince George, Williams Lake
MFR Region: NI

Y073049 green-tree retention: a tool to maintain ecosystem health and function

Sue Grayston
University of British Columbia

What is the potential of green-tree retention as a tool for maintaining soil communities?

This project examines the potential of green-tree retention as a tool for maintaining soil communities. The study uses an existing research installation to observe the effect of different retention strategies on the diversity and functioning of soil communities. Ectomycorrhizal diversity was substantially diminished 10 m from green-tree patches, with no observed effect of patch size, suggesting that dispersed retention would be more effective for maintaining ectomycorrhizal inocula. However, patches 20 m in diameter were optimum for maintaining soil hydrolytic enzyme activity.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $530,352
Location: Elk Bay, Vancouver Island, site of STEMS 2.
MFR Region: C

Y073064 Ectomycorrhizae and networks: their role in facilitating Douglas-fir regeneration under water, site, and climatic stresses

Suzanne Simard
University of British Columbia

What is the role of ectomycorrhizae (ECM) and common mycorrhizal networks (CMNs) in facilitating Douglas-fir regeneration, growth, and young stand development in the Interior Cedar–Hemlock and Interior Douglas-fir zones?

This project investigated the role of ectomycorrhizae in the physiology and ecology of Douglas-fir. It included four separate projects: (1) the role of common mycelial networks in facilitating artificial and natural regeneration of Douglas-fir; (2) the role of ectomycorrhizal fungi in interspecific carbon transfer between birch and Douglas-fir; (3) the influence of birch on the ectomycorrhizal fungal community in Douglas-fir stands of different ages; and (4) the role of ectomycorrhizal fungi in establishment of Douglas-fir across a wide range of sites that vary in soil moisture regime. Results indicate that mycorrhizae and associated networks significantly influence plant communities by controlling patterns of seedling survival, growth and carbon acquisition. Detailed results can be found in associated publications.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $189,133
Location: ICH zone
MFR Region: SI

Y073084 Long-term Soil Productivity study

Shannon Berch
Ministry of Forests and Range

What are the impacts of soil compaction and organic matter removal on near-term and long-term soil and forest productivity over a full timber rotation?

The BC long-term Soil Productivity (LTSP) study is designed to investigate the impacts of soil compaction and organic matter removal on near-term and long-term soil and forest productivity over a full timber rotation. Measurements of soil properties, understorey vegetation, microclimate, and tree productivity occur at scheduled periods throughout the rotation. The LTSP project results are used in the development and application of indicators, such as standards for soil disturbance and retention of woody debris, used in the FRPA soils value regulations and effectiveness evaluation.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $337,277
Location: Southern and central interior
MFR Region: SI; NI

Y073250 Soil conditions and tree growth in BC's forests: factors affecting ecosystem response to forest practices

Chuck Bulmer
Ministry of Forests and Range

How do we improve our ability to predict the effects of machine traffic on soils and forest productivity?

Soil-based parameters are very useful for evaluating forestry practices such as access development and harvesting because they underpin many important ecosystem processes, are relatively resistant to change in natural systems, yet can be strongly affected by forest management. This project used both field and laboratory investigations to explore new measures of soil physical conditions and their effect on soil productivity and ecological sustainability on a variety of site types in BC. The study produced several specific conclusions contributing to the researchers' management question, and the methods used provide the foundation for a comprehensive picture of limitations within the rooting environment.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $297,160
Location: Southern interior
MFR Region: SI

S 1.3 Landscape ecology and management

S 1.3.0 Unclassified

Y061116 Refinement of the BEC classification for selected subzones of the former Nelson Forest Region

Dennis Lloyd
Ministry of Forests and Range

How can classification of BEC subzones and variants be improved?

Many subzones/variants within the provincial biogeoclimatic classification system (BEC) do not have adequate site series classification. This project used an expanded field plot database to revise the classification of some subzones/variants, and collected additional field plot data to fill data gaps at the extremes of the moisture gradient. Outcomes of the project included a BEC field guide for the east Kootenays, which will facilitate the use of BEC as a common language to identify, describe, and distinguish ecosystems.

Initiated: 05/06
Duration: 1 *year*
09/10: $0
Total: $48,279
Location: former Nelson Forest Region
MFR Region: SI

S 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

Y092094 Lichen biodiversity in deciduous wetland swales

Darwyn Coxson
University of Northern British Columbia

Are current assumptions about alder swales providing effective protection for this landscape-level attribute?

Alder swales, corridors of alders adjacent to streams and in wet seepage areas, represent an important linear feature of sub-boreal and boreal landscapes and may function as important refugia for lichen biodiversity. This research determined the aerial extent and topographic features of alder swales in two sites (Aleza Lake Research Forest and TFL 30), and compared lichen abundance and biodiversity within swales to other areas. The findings indicate the importance of alder swales as refugia for lichen biodiversity and point to their importance in landscape-level planning.

Initiated: 07/08
Duration: 2 *years*
09/10: $0
Total: $74,149
Location: Prince George and Mackenzie FDs
MFR Region: NI

S 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

M085266 Developing retention strategies to maintain landscape-level wildlife habitat and biodiversity during the salvage harvesting of mountain pine beetle attack areas in the Southern Interior Forest Region

Walt Klenner
Ministry of Forests and Range

How can the effects of MPB salvage harvesting on wildlife habitat and biodiversity at the landscape-level be mitigated through appropriate design of salvage harvest retention strategies?

Salvage harvesting in MPB-attacked stands is likely to diminish stand structure that would have remained following the initial attack, and unless retention strategies are adequately developed and applied, undesirable effects on wildlife habitat are likely to be a consequence. This project conducted an extensive literature review of landscape-level wildlife habitat issues and dialogue with operational staff and planners focused on specific landscape-level features that are important to wildlife and biodiversity, and developed a synthesis of information relating to retention planning to maintain wildlife habitat in landscapes where extensive salvage harvesting is projected to occur. The results from this project have been made available to forest managers through two *BC Journal of Ecosystems and Management* articles and several workshops.

Initiated: 07/08
Duration: 1 *year*
09/10: $0
Total: $24,810
Location: Southern interior
MFR Region: SI

M086006 Landscape strategies for mountain pine beetle management: some stewardship implications

Douglas Steventon
Bulkley Valley Centre for Natural Resources Research and Management

How should salvage harvesting of MPB-attacked and at-risk stands be done to best achieve wildlife and non-timber values stewardship goals?

As harvest rates are dramatically increased in response to the MPB epidemic, there is a need to understand the relative efficacy of alternative management strategies in achieving resource stewardship goals. This project uses simulation modeling experiments to explore the effect of varying assumptions of management policies, climate change, and disturbance on habitat, home-range abundance and population outcomes for several hypothetical wildlife species profiles. Habitat value and potential population size declined dramatically with the beetle outbreak and associated salvage cutting, and choice of management strategy had a long-term effect on population recovery potential, even under assumptions of increasing stochastic disturbance due to climate change.

Initiated: 06/07
Duration: 2 *years*
09/10: $0
Total: $54,456
Location: Nadina FD
MFR Region: NI

M086037 Implications for grizzly bears and moose of forest management in response to the 1970s mountain pine beetle infestations in the Flathead Drainage

Bruce McLellan
Ministry of Forests and Range

How have grizzly bears and moose responded to past salvage operations in MPB-killed areas?

Changes in forest structure and management resulting from the current MPB infestation will have significant implications for grizzly bears and moose. This project conducted field studies in an area attacked by MPB in the late 1970s to investigate the response by grizzly bears and moose to the subsequent salvage operations in the area. Results suggest that observed changes in cub production and survival had little to do with salvage harvesting, while road development and the spatial distribution of cutblocks and immature stands appear to increase grizzly bear mortality risk; no significant relationships were observed for moose.

Initiated: 06/07
Duration: 2 *years*
09/10: $0
Total: $142,290
Location: Flathead Valley
MFR Region: SI

Y072044 Ecologically based connectivity indices for landscape monitoring

David Huggard
Consultant

How can connectivity planning be improved?

While connectivity is seen as a critical component for maintaining landscape biodiversity, current methods for addressing connectivity are primarily subjective and consequently have several limitations. This project developed two ecologically based indices of connectivity based on individual dispersal costs and potential genetic connectedness. The project successfully developed a dispersal-based approach for indexing connectivity, and piloted the approach to evaluate four operational planning scenarios for a large landscape unit in south-central BC. However, the genetic isolation approach was not successfully developed due to programming problems that could not be resolved within the limited project budget.

Initiated: 05/06
Duration: 2 *years*
09/10: $0
Total: $33,600
Location: Haida Gwaii
MFR Region: C

Y083062 **Coarse-filter approaches for the conservation biology of canopy lichens in wet cedar–hemlock and Sub-Boreal Spruce forests of central-interior BC**

Darwyn Coxson
University of Northern British Columbia

How should conservation biology priorities be determined for remaining old forest stands within BC's upper Fraser river watershed, what steps should be taken to insure that biological values are maintained within remaining old forest stands, and what forestry practices will best maintain associated biodiversity values?

The widespread adoption of clearcut forest harvesting as the dominant silvicultural system in the wet belt forests on the windward slopes of BC's interior mountain ranges has fragmented many of these old forest stands, creating a mosaic of different-aged forest stands. This project examined key environmental factors supporting "old-growth associated" lichen biodiversity at a landscape-level, as well as the impact of both conventional and alternative forest harvesting practices on canopy lichen communities. As an outcome of the work, the authors recommend: the adoption of partial-cut or variable retention harvesting in managed forests within the ICHvk2 to insure greater retention of canopy biodiversity over multiple harvest rotations; the designation of remaining cedar-leading old forest stands in wet toe-slope positions of the upper Fraser river watershed (in the ICHvk2) as protected areas or old-growth management zones; and the placement of buffer zones around remaining cedar-leading old forest stands in wet toe slope positions.

Initiated: 05/06

Duration: 3 *years*

09/10: $0

Total: $153,996

Location: Upper Fraser River Valley, in Prince George FD

MFR Region: NI

Y093014 **Evaluating effectiveness of forest management practices at sustaining biological diversity in northeastern British Columbia**

Fred Bunnell
University of British Columbia

How can adaptive management and monitoring projects be focused on key areas to verify that management practices are maintaining biodiversity at the landscape scale and to reveal shortcomings in current management practices?

This projected developed and tested cost-effective means for identifying whether different species are likely to be sustained by existing coarse-filter management practices. The analysis focused on Canfor's tenure in northeastern BC and used two broad methodologies: assigning species to monitoring groups within the Species Accounting System, and employing coarse-filter analyses. Both methods rely on available data to create a cost-effective system. These methodologies will yield 3 significant outcomes: 1) permit recommendations that will improve forest planning and practice, 2) expose inadequacies or omissions in SFM plans that provide focus to implementation and effectiveness monitoring , and 3) reveal inadequacies in current monitoring approaches.

Initiated: 06/07

Duration: 3 *years*

09/10: $0

Total: $132,735

Location: Northern interior

MFR Region: NI

S 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

Y073005 Evaluating large-scale forest zoning to improve the efficiency of timber production and biodiversity objectives

Fred Bunnell
University of British Columbia

Is strategic zoning an effective tool for maintaining biodiversity at the landscape scale?

Strategic zoning, an important coarse-filter approach to maintaining biodiversity at the landscape scale, distributes the production of competing forest resources into separate areas. This project developed a zone allocation model that uses ecological, economic, and social indicators to locate zones over large landscapes. Projected profits were unaffected by allocation of management activities into three zones (timber, habitat, conservation), while maintaining or exceeding target levels for indicators.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $229,806
Location: Chetwynd/Fort St. John
MFR Region: NI

Y073006 Group selection systems to maintain caribou habitat in high-elevation forests (ESSFwc3) in central BC

Michaela Waterhouse
Ministry of Forests and Range

How effective are different silvicultural systems at maintaining mountain caribou habitat?

This project continues testing silvicultural systems that can be used to maintain mountain caribou habitat. Specifically, it involves monitoring arboreal lichens, vegetation, and stand structure. A focus of this project was providing relevant and timely information and extension products to support sustainable forest management. Key results include reduced growth of fir and pine in smaller openings, and maintenance of caribou foraging habitat when 30% of the stand is removed in groups.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $171,008
Location: Quesnel Highland
MFR Region: NI

S 1.3.4 Are there species or groups of species that can be used to infer habitat condition for a variety of other species – if so, which ones? (Retired 2007)

Y051058 Evaluating a structural basis for monitoring biodiversity

Michael Gillingham
University of Northern British Columbia

What indicator species are suitable for monitoring species diversity in the IDF?

This project developed specific species-structure models for measuring and monitoring species diversity in IDF subzones. Model performance was evaluated against field observations, and the effects of temporal variation on reliability were assessed. Overall, models performed poorly when validated with an independent dataset. Models that included spatial aspects of stand structure generally performed better than aspatial models.

Initiated: 04/05
Duration: 1 *year*
09/10: $0
Total: $49,271
Location: Williams Lake
MFR Region: SI

Y103131 Using few species to assess the sustainability of many species

Fred Bunnell
University of British Columbia

Are there species or groups of species that can be used to infer habitat condition for a variety of other species; if so, which ones?

There are too many species for each to be addressed individually in planning, practise, and monitoring for sustaining biodiversity. This project documents ways of simplifying the task and employing cost-effective coarse-filters by exploiting two patterns in nature: (1) some species have very similar habitat affinities that are well documented, but often not generalized, and (2) other species show responses to habitat change that are poorly understood but highly correlated and repeatable. The results of this work will identify a smaller number of species that can credibly assess the likelihood that other species will be present, thus providing credible approaches to planning for sustaining biodiversity and monitoring apparent success in planned efforts.

Initiated: 07/08

Duration: 3 *years*

09/10: $35,573

Total: $127,780

Location: TFLs 14, 37, 39,and 48

MFR Region: P

S 1.4 Stand-level ecology and management

S 1.4.0 Unclassified

Y061085 Impact of retaining woody debris and forest floor habitats on stand-level diversity of soil collembola

Shannon Berch
Ministry of Forests and Range

What are the effects of forest practices on soil organisms (esp. collembola)?

A previous study by the authors indicated that soil compaction and organic matter removal had reduced the density of soil mesofauna, specifically oribatid mites. This project looks at the effects of forest harvesting on collembola, another taxa of soil mesofauna with a life-history different from mites. Initial findings indicated that collembola were heavily impacted by soil compaction and forest floor removal, and that this impact was often still evident 10 years after treatment.

Initiated: 05/06

Duration: 1 *year*

09/10: $0

Total: $16,182

Location: SBS zone near Prince George, Topley, Williams Lake.

MFR Region: P

S 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

Y083027 Amphibians as indicators of wetland habitat conservation under variable retention harvesting

William J. Beese
Western Forest Products Inc.

What factors influence where pond-breeding amphibian species reproduce, and can this information be packaged such that forestry field personnel working on proposed blocks can identify and prioritize ponds for retention?

Small wetlands are important breeding, foraging, and cover habitats for amphibians and also help to maintain genetic connectivity across the landscape, yet many wetland habitats are not protected from the impacts of forest harvesting under the *Forest and Range Practices Act*. The objectives of this project were to identify characteristics of small wetlands used by breeding amphibians, package that information as a wetland assessment field card for forestry workers when assessing the location of retention patches in proposed cutblocks to maximize amphibian and wetland conservation, and to field-test the assessment card. Based on the assessment results and recommendations made by the volunteer foresters via a field card evaluation form, a final version of the field card was produced, extensively promoted, and distributed to foresters on the south coast in 2008.

Initiated: 05/06
Duration: 3 *years*
09/10: $0
Total: $62,438
Location: TFLs 39 and 44
MFR Region: C

Y092147 Structural recovery in second-growth forests on Lyell Island, Haida Gwaii

Audrey Pearson
Ecologia

How do forest structure and composition recover following logging in both upland and riparian forests?

Baseline information is needed on structural and compositional recovery of second-growth stands for both tree and understorey species in riparian and upland forests to develop targets and management guidelines and to determine the effectiveness of stand-level attributes for maintaining biodiversity. This project examined differences in forest structure and composition from different eras of logging on Lyell Island by comparing measurements of second-growth structure and composition with reconstructed estimates of original stand characteristics from historical air photos, forest cover maps, abundance and species composition of stumps and logs remaining on the ground, air photo interpretation, and othehistoricalical data sources. The study found that second-growth forest structure is highly variable, especially in the riparian zone, as a function of logging methods and the number of residual trees left. Despite the presence of introduced deer, cedar has continued to regenerate on Lyell Island over the past century, indicating that second-growth forests may potentially be valuable in the future as sources of cedar for cultural use.

Initiated: 07/08
Duration: 2 *years*
09/10: $0
Total: $177,719
Location: Lyell Island, Haida Gwaii
MFR Region: C

Y093256 Retention patches: windthrow and recruitment of habitat structure

Douglas Steventon
Ministry of Forests and Range

How does windthrow affect habitat value and longevity in retention patches?

This study examined wildlife tree, coarse woody debris, and windthrow characteristics of 157 retention patches left in harvested areas of the Kispiox (mostly ICHmc), and Bulkley/Morice (mostly SBSmc, EFFSwv/mc) Timber Supply Areas in the early to mid 1990s. Patches added substantially to habitat elements in the harvested areas. The study shows that windthrow is not a significant issue overall, but if minimizing windthrow is desired then previous rule-of-thumb criteria still apply: create larger patches (>1 ha) of minimum perimeter, oriented to minimize exposure to prevailing winds in topographically sheltered sites.

Initiated: 06/07
Duration: 3 *years*
09/10: $0
Total: $91,234
Location: Bulkley-Stikine and Nadina FDs
MFR Region: NI

Y102065 Effect of stand-level retention on carabid beetles in coastal BC

William J. Beese
Western Forest Products Inc.

Can response curves of indicator species to level and type of stand retention be developed that establish biodiversity targets and thresholds over ranges of stand-level retention levels and patterns?

Assessing how alternative stand-level retention levels and management zones over managed landscapes for maintaining forest attributes that sustain biodiversity and essential ecosystem functions is key to ensuring long-term sustainability of managed forest ecosystems. Using 5 previously established experimental Variable Retention Adaptive Management (VRAM) sites in coastal forests as treatments, responses (abundance, biomass and diversity) of carabid beetles to type and level of retention 4-6 years post-harvest will be monitored over 2 years. Results will be used to develop species response curves to retention levels for this biodiversity indicator.

Initiated: 08/09
Duration: 2 *years*
09/10: $44,280
Total: $88,560
Location: Van. Is, Mainland Coast, Haida Gwaii; CFR
MFR Region: C

Y103280 The ecology and management of dry Douglas-fir forests: the Opax Mountain Silvicultural Study

Andre Arsenault
Ministry of Forests and Range

What are the ecological impacts of alternative harvesting practices on dry Interior Douglas-fir forests?

The Opax Mountain Silvicultural Systems Study is a long-term, multi-disciplinary, multi-agency research study of the ecological impact of alternative harvesting practices on a dry Douglas-fir forest in the Interior with a very strong extension component that has produced numerous public presentations, peer-reviewed scientific publications, and university theses. The current proposal focuses on the completion of extension material on data being collected in 2006–2007 and on the remeasurements of wildlife response to treatments and changes in forest structure 12–15 years after harvest. Results of the project will help meet several high-priority information needs, including: harvesting cost and operations logistics, forest regeneration; nutrient cycling and soil productivity; pest management; floral and faunal diversity; and historical patterns of natural disturbances.

Initiated: 07/08
Duration: 3 *years*
09/10: $87,480
Total: $263,467
Location: 30 km north of downtown Kamloops
MFR Region: SI

S 1.4.2 Effectiveness of management strategies in creating site-level structures and in the maintenance of site-level biodiversity, non-timber forest products, and rangeland habitat (Retired 2008)

M085007 Can wildlife tree patches conserve sensitive species in MPB impacted landscapes?

Craig DeLong
Ministry of Forests and Range

What environmental conditions and CWD characteristics influence lichen and bryophyte diversity and abundance, and how effective are wildlife tree patches at conserving these sensitive organisms in MPB-impacted landscapes?

The influence of coarse woody debris characteristics resulting from MPB attack on lichen and bryophyte species has not been well examined for sub-boreal spruce forests in central British Columbia. This project examined the influence of site-level and landscape-level CWD characteristics on macrolichen and bryophyte communities. The results indicate that availability of CWD in a range of decay classes is necessary to conserve a range of lichen and bryophyte species, and that the current size and configuration of wildlife tree patches do not seem to conserve liverwort and sensitive moss species over time, suggesting that retention of larger patches is required.

Initiated: 07/08
Duration: 1 *year*
09/10: $0
Total: $34,560
Location: SBS
MFR Region: NI

M085166 Assessing the effectiveness of management strategies in creating and maintaining stand-level biodiversity on large-scale mountain pine beetle cutblocks in the Arrow Boundary Forest District

John Innes
University of British Columbia

Are timber cruise data and FREP pre-harvest data useful for establishing baseline conditions for FREP stand-level Biodiversity assessments?

Assessing trends in forest ecosystems requires a thorough understanding of a benchmark or condition against which changes can be measured. This study assessed the efficacy of using pre-harvest timber cruise and Forest and Range Evaluation Program (FREP) data to establish baseline reference conditions in FREP stand-level Biodiversity (SLB) assessments on mountain pine beetle salvage cutblocks in the Arrow Boundary Forest District. The research identified potential limitations of using timber cruise statistics and other pre-harvest information as baseline information, such as misrepresentation of rare forest elements and the absence of data on important stand structural attributes, and concludes that additional work could identify ways to improve the compatibility, efficiency, and utility of these data in FREP stand-level Biodiversity monitoring.

Initiated: 07/08
Duration: 1 *year*
09/10: $0
Total: $28,404
Location: Arrow Boundary FD
MFR Region: NI

M086047 Effects of a mountain pine beetle epidemic on northern caribou habitat use, migration, and population status

Deborah Cichowski
Bulkley Valley Centre for Natural Resources Research and Management

How has the "grey-attack" phase of the current mountain pine beetle epidemic affected migration, landscape-level and stand-level habitat use, and forage site selection by the Tweedsmuir-Entiako caribou population?

Because an MPB epidemic of the current size is unprecedented on caribou ranges in BC, information on how caribou habitat, caribou habitat use, and population dynamics might be affected are lacking. This project assessed the effects of the "grey-attack" phase of the current MPB epidemic on caribou migration, landscape-level and stand-level habitat use, and forage site selection. Preliminary results suggest that forage selection and winter habitat use patterns remained similar to those prior to mountain pine beetle attack.

Initiated: 06/07
Duration: 2 *years*
09/10: $0
Total: $82,527
Location: Tweedsmuir-Entiako
MFR Region: NI

Y051034 Distributional ecology of alectorioid lichens in the ICH

Trevor Goward
Enlichened Consulting Ltd.

What factors affect hair-lichen distribution and abundance in the ICH and ESSF?

Hair-lichens may be unable to withstand prolonged burial by snow, which can have important forage-availability implications for mountain caribou. This study examined stand-scale patterns of hair-lichen distribution in the mid-seral conifer stands. The authors identify several ecological factors influencing lichen distribution (e.g., species of host tree, ventilation). They also note a high predictability of hair-lichen community structure in mid-seral stands, which could be used to guide future management decisions.

Initiated: 04/05
Duration: 1 *year*
09/10: $0
Total: $39,447
Location: Wells Gray Park
MFR Region: SI

Y051073 Understanding and predicting snag and CWD dynamics in Sub-boreal Spruce and Engelmann Spruce–Subalpine Fir forests

Craig DeLong
Ministry of Forests and Range

How do different forest management strategies affect the supply of snags and CWD?

Snags and coarse woody debris (CWD) are important habitat elements, but it is difficult to set measurable benchmarks for their distribution and abundance based on current knowledge. This project improves an existing spatio-temporal forest dynamics and management model (including a snag and CWD dynamics model) to project the impacts of different forest management strategies on the distribution and supply of snags and CWD over time. Preliminary model runs in wet subalpine spruce forests indicate cause for concern regarding the impact of forest management on deadwood supply over the next rotation.

Initiated: 04/05
Duration: 1 *year*
09/10: $0
Total: $46,411
Location: McGregor Plateau and Rocky Mountains
MFR Region: NI

Y062053 **Implications of landscape composition and pattern in managed sub-boreal forests**

Douglas Steventon
Bulkley Valley Centre for Natural Resources Research and Management

What are the effects of alternative timber harvesting rates and patterns on dilution of marten and northern flying squirrel habitats?

This project examines potential implications to wildlife of the rate and spatial patterning of MPB-related forest harvesting. A spatio-temporal model is used to project alternative timber harvesting rates and patterns, and is linked to species' response models to assess the effects of habitat dilution on northern flying squirrel (*Glaucomys sabrinus*), and red squirrel (*Tamiascuiris hudsonicus*). Preliminary results indicate a weak influence of current beetle-kill on average squirrel abundance. To reduce habitat impacts of salvage harvesting, study results support a clumped harvesting strategy that avoids stands with <50% overstorey mortality and/or substantive understorey.

Initiated: 04/05
Duration: 2 *years*
09/10: $0
Total: $98,213
Location: Morice and Lakes TSAs
MFR Region: NI

Y071158 **Structural recruitment: factors affecting survival and growth of residual immature trees after clearcut overstorey harvesting**

Ruth Lloyd
Bulkley Valley Centre for Natural Resources Research and Management

What factors affect the survival and development of residual immature subalpine fir trees in clearcut areas?

Retention of residual stems is a key component of operational CWD retention practices and considerable effort has been invested in maintaining them. However, the survival and growth of residual immature trees in clearcut areas in BC after harvest are poorly understood. This project investigated factors affecting the survival and development of residual immature subalpine fir trees in areas clearcut between 1995 and 2000 with the intent of providing guidance to the appropriate abundance and configuration of future residual immature tree retention in clearcut areas. Over 60% of the residual subalpine fir trees present after harvest did survive for at least the 7–12 years between harvest and survey; contrary to expectations, windthrow was not a significant cause of mortality.

Initiated: 06/07
Duration: 1 *year*
09/10: $0
Total: $30,830
Location: Northern interior
MFR Region: NI

Y073001 **Beetle families of British Columbia**

Geoffrey G.E. Scudder
University of British Columbia

No question - field guide

To understand the effectiveness of forest management actions in protecting arthropod diversity, it is essential to be able to identify the elements of this diversity. This project developed illustrated keys to all families of insects in the province. Previous funding from FRBC, FII, and FSP has supported description of 263 families, and an additional two years of funding from FSP brought the project to completion.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $150,633
Location: Province-wide
MFR Region: P

Y073220 **Harvesting and site preparation treatments to develop and maintain open canopy conditions in dry-belt Douglas-fir forests: the Isobel Project**

Walt Klenner
Ministry of Forests and Range

What is the optimum way to maintain open canopy conditions in dry Douglas-fir forests?

The main objective of this project is to develop and apply prescriptions to maintain prolonged open canopy conditions in dry Douglas-fir forests in a cost-effective manner, while maintaining timber, forage, and ecological values. Several different stand management treatments were applied in 2002–2003, and the responses of a wide range of attributes were monitored using permanent sample plots and vegetation plots. Monitoring results address five key management issues: conifer regeneration, understorey composition and abundance, understorey productivity, fuel loading, and timber attributes.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $263,937
Location: Isobel Lake, north of Kamloops
MFR Region: SI

Y073363 **VR emulating canopy gaps in coastal forests: an operational trial and experiment**

Lori Daniels
University of British Columbia

How can variable retention (VR) silviculture be used to create and maintain forest structure, function, and processes?

The broad context for this project is to better understand how to use variable retention (VR) silviculture to create and maintain forest structure, function, and processes. Specifically, this project uses a replicated field experiment to test for differences between natural gaps and gaps created by VR silviculture. Ultimately, these empirical data will be used to develop criteria and guidelines to predict/assess the impacts of VR silviculture on composition, structure, and stand dynamics of forests in the very wet hypermaritime Coastal Western Hemlock (CWHvh) biogeoclimatic subzone.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $148,126
Location: Near Bamfield
MFR Region: C

Y081268 **Harvesting and site preparation treatments to develop and maintain open canopy conditions in dry-belt Douglas-fir forests: the Isobel Project**

Walt Klenner
Ministry of Forests and Range

What is the relative efficacy of different management options in achieving open conditions, and their effects on timber and ecological indicators in the dry-belt Douglas-fir forests of the Southern Interior Forest Region?

The Isobel Project has been established by the Southern Interior Forest Region NDT4 Committee to develop and apply prescriptions to maintain prolonged open canopy conditions in dry Douglas-fir forests in a cost-effective manner, while maintaining timber, forage, and ecological values. This project 1) completed a survey of post-treatment Douglas-fir beetle induced tree mortality, 2) quantified tree radial growth response to prescribed fire, 3) quantified livestock use of permanent sample plot areas outside of exclosures, and 4) prepared manuscripts on (a) the relationship between prescribed fire tree scorch severity and secondary Douglas-fir beetle mortality, and (b) the growth and survival of rough fescue transplant plugs in relation to understorey light conditions, livestock management and the level of competition by pre-existing vegetation. Results suggest that prescribed fire may lead to high levels of increased secondary mortality of mildly scorched trees that likely attract Douglas-fir beetle as well as diminished radial growth, effects which may compromise timber values, but would favour the increased survival and growth of bunchgrass that grows and survives best under open canopy conditions.

Initiated: 07/08
Duration: 1 *year*
09/10: $0
Total: $34,955
Location: 20 km northwest of Kamloops
MFR Region: SI

Y083008 **Stand structure and maintenance of biodiversity in green-tree retention stands at 30 years after harvest: a vision into the future**

Thomas Sullivan
University of British Columbia

How do mixed-species stands salvaged following MPB infestation compare to uncut stands in terms of stand structure and development of late seral forest conditions?

Retention of standing fir or larch trees as seed trees to provide a secondary species to naturally regenerating lodgepole pine has been a common harvest/salvage approach since the 1970s, making it possible to do a retrospective investigation of the influence of MPB-salvage harvesting of lodgepole pine on stand structure and biodiversity 30 years after cutting. This project compared several indicators of sustainability and biodiversity, including stand structure attributes, population dynamics of small forest floor and arboreal mammals, and seasonal ungulate habitat use, between 30-year old stands of lodgepole pine with a range of green-tree fir retention to uncut mature and old-growth stands. For 22 of 24 response variables measured, the seed-tree stands were the same or higher than the uncut stands, indicating that wildlife habitat and biodiversity seem similar 30 years after harvesting compared with uncut mature/old-growth forests.

Initiated: 05/06
Duration: 3 *years*
09/10: $0
Total: $170,402
Location: Summerland
MFR Region: SI

Y083183 **Assessment of the effectiveness of green-tree retention in maintaining the diversity of and promoting the recolonization by ectomycorrhizal fungal species into harvested areas of coastal forest**

J.A. Tony Trofymow
Natural Resources Canada

How do different levels of individual green-tree retention affect ectomycorrhizal diversity and recolonization of the regenerating forest?

Ectomycorrhizal (EM) fungi are an important component of biodiversity, and are useful indicator species for assessing the effects of variable retention (VR) forestry. This project extended previous research by examining how different levels of individual green-tree retention affects EM diversity, and how EM fungal species on retained trees recolonize the regenerating forest. Although the important role of EM fungi in tree physiology has been documented and known for years, less is known about their importance in forest growth in the long-term. Results indicate that ectomycorrhizal richness and root colonization increased insignificantly with increasing tree retention, leading to the recommendation that forest managers consider using the highest level of green-tree retention possible, until long-term effectiveness of single-tree retention can be evaluated.

Initiated: 05/06

Duration: 3 *years*

09/10: $0

Total: $92,523

Location: South Vancouver Island and the Sunshine Coast

MFR Region: C

Y091154 **Reassessment of arboreal lichen biomass at the Pinkerton Mountain Silvicultural Systems Site 10 years after partial cutting**

Darwyn Coxson
University of Northern British Columbia

Can partial cutting methods maintain high-elevation habitat for endangered mountain caribou?

Partial cutting systems have often been proposed as a means of maintaining canopy lichen abundance and diversity in managed forests – an important consideration as canopy lichens are vital winter forage for mountain caribou. However, most assessments of the effectiveness of specific harvest practices in maintaining canopy lichens are based on immediate post-harvest measurements. This study reports on the response of canopy lichen communities 10 years after harvesting in a partially-cut stand at Pinkerton Mountain, in BC's central interior. Results of lichen loading studies indicate that, although partial-cut harvesting is an effective strategy for maintaining winter forage for mountain caribou, it cannot substitute for maintaining core habitat in a natural state.

Initiated: 08/09

Duration: 1 *year*

09/10: $0

Total: $34,357

Location: Pinkerton Mtn, Prince George FD; NIFR

MFR Region: NI

Y091155 **Design of riparian zones: temporal response of secondary productivity to stream geomorphology and classification**

Warren Warttig
International Forest Products Ltd.

Can maintaining variable buffer widths associated with stream and forest characteristics retain biodiversity in RMZ?

A key objective of EBM is ensuring that riparian buffers in managed conserve secondary productivity in both RMZ and adjacent stands. Using a replicated, transect-based study design applied to a total of 9 coastal S3 streams (27 sites) stratified by geomorphology and adjacent stand age, diversity and biomass of carabid beetles were obtained from pitfall traps located along transects from stream edge, through the riparian zone, and into the adjacent forest upslope. The study found relatively distinct carabid communities in the different types of buffers associated with the geomorphology of the stream. Riparian buffers were observed to retain distinct communities of carabids which are not lost or degraded when the adjoining forest blocks are harvested. Although clearcuts and immature sites adjacent to the buffers initially lost biomass, species, and diversity, a subsequent recovery was observed and forest species were not entirely lost from these blocks.

Initiated: 08/09

Duration: 1 *year*

09/10: $0

Total: $36,266

Location: TFL54. TFL57, CWHvh subzone; CFR

MFR Region: C

Y092095 **Forest ecosystem recovery following disturbance: a retrospective analysis of historical disturbances on the southern BC coast**

Brad Seely
University of British Columbia

What old-growth structures are present in second-growth forests, do different disturbances develop different structures, and when do old-growth structures develop in second-growth forests?

Quantitative second-growth data are essential to properly evaluate coarse-filter biodiversity, ecological risk assessment, and timber supply assumptions currently shaping ecosystem-based management for coastal LRMPs. This project characterized the ecological condition and level of ecosystem recovery toward "old-growth" stand conditions and the development and growth of residual stands and post-disturbance regeneration cohorts through a retrospective examination of existing coastal second-growth forest stands that have developed after human-caused and natural disturbances. Results showed that second-growth stands began to reach the threshold for old-growth stands around 150-200 years after a stand-replacing disturbance. Data collected from the project were used to calibrate the ecosystem-based forest growth model FORECAST; the model performed well in projecting the development of structural old-growth attributes in second-growth stands in the hypermaritime region of the CWH zone on Vancouver Island.

Initiated: 07/08

Duration: 2 *years*

09/10: $0

Total: $81,008

Location: Near-coastal areas of western and northern Vancouver Island and the adjacent mainland coast

MFR Region: C

Y093268 Fisher habitat ecology in the Peace River region

Eric Lofroth
Ministry of Environment

What are the habitat requirements of fisher in the Peace Region and how do those differ from habitat management guidelines elsewhere in the province?

Poor understanding of habitat needs for fisher in the Peace region hamper the ability of forest licensees to adequately manage for fisher habitat. This project identified the characteristics of maternal denning habitat, and described and identified habitat use patterns for fisher in the Peace region to provide information to land management planning processes and habitat supply analyses. Recommendations for maintaining natal dens and foraging areas were summarized and extended to land managers in the Peace River Region, and candidate Wildlife Habitat Areas have been identified.

Initiated: 06/07
Duration: 3 *years*
09/10: $0
Total: $108,508
Location: Kiskatinaw River near Dawson Creek
MFR Region: NI

Y102102 Are northern goshawks and forest harvesting compatible? An examination of the effects of different harvest practices on northern goshawk nest productivity

William Harrower
Thompson Rivers University

Can models of northern goshawk habitat quality be improved to better enable comparative assessments of forest management options to habitat supply for this indicator species?

Northern goshawks are a widely distributed forest predator and considered an indicator of sustainable forest practices in both the coast and interior. Existing habitat models for this species will be refined through statistical analyses of the productivity and habitat attributes measured at interior nest sites monitored for 6 years, and validated with geographically extensive habitat sampling studies. Resulting habitat models will be linked to existing spatial projections of historical and future forest conditions to assess risks to goshawk habitat supply of current and alternative forest management practices.

Initiated: 08/09
Duration: 3 *years*
09/10: $59,400
Total: $94,082
Location: East Kootenays, Rocky Mountain FD
MFR Region: SI

Y102122 Contrasting spring and fall grazing regimes for effects on grassland biota

Donald Thompson
Thompson Rivers University

How can operational grasslands be more effectively managed to promote elements of biodiversity?

Maintenance of species diversity on operational grasslands is essential to achieve the goals of sustained range production and grassland species conservation. Using an established experimental set of 64 grazing treatment pastures, abundances of plant species, small mammals, and several invertebrate guilds, will be assessed in response to the treatments. Results will be used to refine hypotheses about grassland trophic relationships and define guidelines for grazing cycles that maximize grassland pasture condition and species diversity.

Initiated: 08/09
Duration: 3 *years*
09/10: $54,054
Total: $128,901
Location: Grasslands N. Of Kamloops
MFR Region: SI

Y102136 Relations between riparian disturbance and habitat attributes in the Southern Interior of BC

Adam Wei
University of British Columbia

How can riparian buffer designs for interior forests be improved?

Despite the known importance of riparian areas for sustaining terrestrial and aquatic habitat functions, knowledge of the effects of disturbances in the riparian zone on LWD dynamics, aquatic habitat and vertebrates is incomplete. Using an existing experimental installation, wildfire, MPB infestation and harvesting disturbance effects on in-stream wood dynamics (recruitment and transportation), wood-associated aquatic habitat and vertebrates will be assessed. The results will be used for establishing tested riparian buffer designs and management thresholds in the southern interior region.

Initiated: 08/09
Duration: 3 *years*
09/10: $59,972
Total: $126,608
Location: Okanagan Lake basin
MFR Region: SI

Y102164 Harvesting and site preparation treatments to develop and maintain open canopy conditions in dry Douglas-fir forests: the Isobel Project

Walt Klenner
Ministry of Forests and Range

Can desired conditions in dry Fd stands in the IDFxh be maintained through combinations of silviculture, fire management, and grazing objectives?

The long-term efficacy of silvilcultural prescriptions and management actions designed to maintain open canopy conditions in dry Douglas-fir (e.g., IDFxh) forests for achieving a range of forest values are uncertain. Using resampling of 169 plots at the interior Isobel experimental treatment site, this multi-year study will measure a range of soil, light, understorey and stand attributes in relation to silvicultural and fire treatments. Results will be used to set objectives for fuel management, forage thresholds for native ungulates and livestock, and harvest prescriptions that sustain desired open forest conditions.

Initiated: 08/09
Duration: 3 *years*
09/10: $65,124
Total: $118,116
Location: 20 km NW of Kamloops, Kamloops FD; SIFR
MFR Region: SI

S 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)

Y071312 The suitability of stand-level retention to mountain caribou foraging and movement requirements

Robert Serrouya
Simpcw Development Corporation

How are caribou paths influenced by the matrix of old and young stands? How do caribou make use of forest/cutblock edges? Do caribou select partial cut stands available in ESSF-plateau forests?

It has been suggested that young forests are not only rarely used by mountain caribou, but may even be harmful since they (1) impede caribou movements by forcing them to circumvent young and mid-aged forests, and (2) support higher densities of predators. This project investigated the factors that may influence caribou movements in landscapes with a history of forest harvesting by tracking, and subsequently mapping, the actual paths followed by caribou in managed landscapes. Results indicate that caribou displayed preference for portions of the landscape with more old forest, less clearcut area, and generally avoided crossing deep into clearcuts; even partial cuts with low retention (< 50%) were selected more than clearcuts because these stands appeared to provide increased foraging opportunity to mountain caribou relative to clearcuts.

Initiated: 06/07
Duration: 1 *year*
09/10: $0
Total: $35,060
Location: Columbia, and Okanagan-Shuswap FD
MFR Region: C

Y093167 **Coarse woody debris in the East Kootenays: understanding sources and dynamics to guide targets for sustainable forest management**

Lori Daniels
University of British Columbia

What is the natural range of variation of coarse woody debris in the absence of human-induced fires and fire suppression?

This project examined the processes that historically generated CWD and the age, decay rates, and residence time of snags and logs of different species, information that is critical to ensure that appropriate quantities of CWD suitable for wildlife use are maintained in managed stands over the short and long-terms. Results of natural disturbance research show that low-to-moderate severity fires burned once every 40 years, on average, in at least 25% of the Montane Spruce (MS) biogeoclimatic zone of southeastern BC, a significant contrast with the fire regime described for the MS Zone in the Biodiversity Guidebook, which suggests that stand-replacing fires dominated and burned once every 150 years. These results have important implications for managing CWD and overall stand structure to achieve SFM objectives.

Initiated: 06/07
Duration: 3 *years*
09/10: $0
Total: $164,646
Location: East Kootenays and Southern Rocky Mountain Trench
MFR Region: SI

Y093324 **Abundance of critical wildlife habitat attributes in relation to forest management practices**

Walt Klenner
Ministry of Forests and Range

How do different variable retention systems contribute to short- and long-term habitat supply?

Although there is considerable literature linking stand structures such as large live trees and snags and downed wood to biodiversity, and consensus that alternative silvicultural systems are available and can be applied operationally to retain key habitat structures in managed stands, little information is available to evaluate the likely contribution of different variable retention systems to short- and long-term habitat supply. This project addressed this knowledge gap by using the stand model TASS (Tree and Stand Simulator) to simulate a range of clearcut, partial cut, and variable retention practices in three different forest types and compare the likely development of critical habitat features relative to development of an unmanaged stand. The information gained in this study will help managers consider the likely effect on habitat supply when selecting variable retention harvest systems for a particular site.

Initiated: 06/07
Duration: 3 *years*
09/10: $0
Total: $128,367
Location: Southern interior
MFR Region: SI

Y102041 Early-seral forest stands and their relationship to wildlife populations and ecosystem stability

Karl Larsen
Thompson Rivers University

What are the long-term implications of an increasing predominance of younger-aged forest stands to predator-prey dynamics and ecological functions in dry-belt Douglas-fir forests of the Southern Interior Forest Region?

Science and ecosystem-based planning of forest harvest policies in 'working forests' requires broader understanding of the relationship between stand age and ecological function to reduce the risk of disruption or gradual loss of functions and species in landscapes being increasingly intensively managed. In this 3-year study occurring across a range of forest age classes, dispersal, survival, settlement, and reproductive patterns of two important prey species (red squirrels; yellow-pine chipmunks) and their predators will be assessed using telemetry, reproduction measurements, and mortality studies. This characterization of the effects of stand age on the distribution and dynamics of key predator-prey species will help characterize how an increasing predominance of early- to mid-seral stands across the landscape may be affecting the long-term ecological functioning of managed forests.

Initiated: 08/09
Duration: 3 *years*
09/10: $51,300
Total: $87,372
Location: Kamloops FD, SIFR
MFR Region: SI

Y103156 An experimental study of variable-retention harvest methods on forest birds

Ann Chan-McLeod
University of British Columbia

What are the effects of a range of variable retention harvesting system designs on avian communities?

Variable retention (VR) harvesting is a promising technique for maintaining biodiversity while allowing timber extraction; however, many questions remain regarding how to best design VR systems to maximize their effectiveness. This project will evaluate the effects of various dispersion patterns, retention levels, patch sizes, and opening sizes on avian communities, since birds represent the full spectrum of wildlife habitat requirements, exhibit well-defined relationships to stand-level structure and habitat, and are significant biodiversity indicators of other taxonomic groups. The results of this work will help to address key VR design issues such as what and how much structure to retain, and how to distribute the structures across space.

Initiated: 07/08
Duration: 3 *years*
09/10: $58,051
Total: $194,375
Location: Coast
MFR Region: C

Y103244 Creation of habitat for small mammal prey and their predators on clearcuts: coarse woody debris in piles and windrows

Thomas Sullivan
University of British Columbia

Could post-harvest debris piles and windrows on cutblocks act as "middens" and "corridors", respectively, both initially after harvest, and as the new forest develops?

Provision of debris piles and windrows on clearcuts, and subsequently in young forests, may provide habitat for small mammal prey and their predators, thereby helping to offset the negative effects of clearcut harvesting on thermal and security cover for these species. This project will examine the effectiveness of such post-harvest debris piles and windrows by monitoring the responses of small mammal prey species and terrestrial predators to the following treatments: (1) CWD dispersed uniformly over each unit (control); (2) CWD distributed into several small piles (2–3 piles per ha); and (3) CWD distributed into windrows, connecting to a forest edge (either a reserve or riparian buffer). This study will provide a comprehensive database for small mammal prey and predator responses to treatments.

Initiated: 07/08
Duration: 3 *years*
09/10: $38,880
Total: $123,309
Location: Summerland, Salmon Arm, and Vernon.
MFR Region: P

S 1.4.4 How effective are such derived structures in maintaining stand-level biodiversity? Effects of management practices on some NTFPs are also of interest in this context (Retired 2006)

Y093052 Does retention of downed wood help maintain stand-level functional biodiversity of mycorrhizal fungi in EESF clearcuts?

Melanie Jones
University of British Columbia

Does retention of CWD on clearcuts help increase functional biodiversity of the soil microflora?

Ectomycorrhizal (ECM) fungi form important functional and biomass components of forest soils. It is hypothesized that trees colonized by a number of functionally diverse ECM fungi are better able to exploit the wide array of organic and inorganic sources of nutrients present in forest soils. This project examined the extent to which the retention of coarse woody debris increases ECM diversity following harvest by sampling taxonomic and functional diversity of ECM fungi at the Sicamous Creek Silvicultural Systems Trial. Although initial results showed no indication that the retention of CWD had a medium term effect on either the structure or function of the ectomycorrhizal fungal community, subsequent studies sampling roots in close proximity to CWD showed that once the CWD has begun to decay it provides an environment for fungi with specific functional traits. Hence, the retention of CWD on harvesting sites should help retain a wider functional diversity of ectomycorrhizal fungi.

Initiated: 06/07
Duration: 3 *years*
09/10: $0
Total: $92,655
Location: ESSF
MFR Region: SI

Y093300 Downed wood in riparian areas and its contribution to stand-level biodiversity

John Richardson
University of British Columbia

To what extent, and through what mechanisms, does large downed wood in riparian areas contribute to stand-level biodiversity?

In riparian areas, trees are often retained for shade and to supply large woody debris (LDW) to streams. However, LWD in riparian areas is also likely to contribute to biodiversity both directly and through indirect food-web effects. This project examined the contribution of large wood to riparian areas by describing patterns of biological diversity across a suite of sites relative to the amount of LDW and adding downed wood through falling suppressed and stressed trees in sites paired with unmanipulated control plots along the same stream. The study showed no effects of artificially increased LDW on small mammal or carabid beetle abundance. Explanations for this result include: 1) the supply of large wood was already sufficient, 2) newly fallen large wood requires some years of conditioning prior to having value as cover, or 3) large wood is not the limiting resource for the two groups of forest floor organisms examined.

Initiated: 06/07

Duration: 3 *years*

09/10: $0

Total: $99,625

Location: Province-wide and Alberta

MFR Region: C

Y093322 Can the important microbial diversity and nutrient cycling characteristics of old-growth Douglas-fir forests be maintained in managed second-growth forests?

Richard Winder
Canadian Forest Service

Can woody debris in younger forest stands be managed to sustain the key microbial communities in old-growth soils, thereby providing a positive impact on the protection of biodiversity?

Understanding the effects of forestry-related activities on soil microbes is important for evaluating forestry management practices, because soil microbes affect the complexity of niches available for other biotic components of a forest ecosystem. This project compared and contrasted the diversity of soil microbes in old-growth vs. managed (thinned) Douglas-fir forests to help determine whether second growth forests can be managed to sustain the function of key microbial communities , and if so whether this will contribute to protection of biodiversity. Results indicated that maintaining old-growth levels of coarse woody debris preserves the diversity and structure of key soil organisms (N-fixers and methanotrophic bacteria) in most respects, and that variable retention stands can be managed to maintain functional performance of methanotrophic and nitrogen-fixing bacteria.

Initiated: 06/07

Duration: 3 *years*

09/10: $0

Total: $216,065

Location: Coastal forest of southern Vancouver Island

MFR Region: C

Y093329 Measuring success in managing for saskatoon berries and other traditionally important plants

Michael Keefer
Keefer Ecological Services

How effective are different forest harvest treatments for enhancing for saskatoon and other key cultural plant species traditionally valued by the Nlaka'pamux?

This project draws on traditional Nlaka'pamux forest management techniques and modern techniques to better understand the management of traditionally important plants. The study compared the effects of four experimental silvicultural treatments on Saskatoon vigour and berry production. Results to date have confirmed the need for active management of the Saskatoon resource in the Siska Creek watershed. Along with conifer thinning, selective control of abundant woody shrub species through burning or pruning could prove beneficial for Saskatoon berry production and should be included in future experimental site prescriptions, with careful monitoring to avoid unintentional enhancement of shrubby competitors and invasive alien species.

Initiated: 06/07
Duration: 3 *years*
09/10: $0
Total: $88,236
Location: Southern Interior/Coast transition near Lytton
MFR Region: SI

S 1.4.5 Effectiveness of riparian buffers and their design in maintaining site-level wildlife habitat and biodiversity. Research needs are particularly focused on upland, riparian, and aquatic habitats (Retired 2008)

M085112 Stand-level harvesting in mountain pine beetle affected stands and impact on riparian-based cultural resource management zones

Chris Ortner
Skeetchestn Indian Band

What is the effectiveness of stand-level structures in maintaining the relative health of indigenous plants of cultural importance to the Skeetchestn Indian Band within well-designed riparian zones (Cultural Resource Management Zones) ?

The recent exponential expansion of mountain pine beetle in the Kamloops area has opened a new opportunity for continuation of previous work studying the ecological impacts, and the effect on cultural values, of low-impact harvesting techniques within riparian zones. The project will explore the effectiveness of stand-level structures and habitat in maintaining biodiversity within Cultural Resource Management Zones (CRMZs) established as riparian buffers in the Kamloops TSA, and indicate their contribution to stand-level biodiversity. Results will be communicated to the community, and extended to forest companies and policy makers in the Kamloops TSA. Integration of findings into Forest Stewardship Plans and future Site Plans will enable a more efficient referral process, with improved outcomes for the Skeetchestn community.

Initiated: 07/08
Duration: 1 *year*
09/10: $0
Total: $35,677
Location: Deadman and Durand Watersheds
MFR Region: NI

Y062114 Implications of static riparian reserve zones for long-term function of naturally migrating river channels

Jordan Rosenfeld
Ministry of Water, Land, and Air Protection

How effective are fixed-width riparian buffers for maintaining natural LWD loadings in streams?

Present fixed-width riparian buffers may not ensure natural/adequate levels of LWD recruitment from riparian zones due to migration of the stream channel. This project modeled stream channels in different geomorphic contexts to determine how channel migration rate affects the long-term adequacy of present fixed-width buffers for maintaining natural LWD loadings in streams. Results indicate that current regulated buffer widths in BC are only adequate when erosion rates are low-average for narrow streams, and low for mid-sized streams.

Initiated: 04/05
Duration: 2 *years*
09/10: $0
Total: $78,918
Location: Province-wide
MFR Region: P

Y073151 Does logging elevate ultraviolet radiation exposure of streams impact juvenile coho?

Max L. Bothwell
Environment Canada

What is the effect of increased exposure to ultraviolet radiation (UVR) received by streams following logging on juvenile coho?

Currently, there is no way to determine if logging operations expose stream-rearing coho to excessive levels of UVR. This project sought to develop a bioassay technique for UVR exposure of juvenile coho based upon the amount of photo-protective sunscreen compounds in their skin. The bioassay procedure developed is sensitive, reliable, and easily capable of detecting differences in the amounts of UVR exposure of coho in different reaches of the same river. Logged sites with significant slash debris left in the stream channel and the concomitant elevated DOC levels had lower potential UVR exposure than even unlogged streams.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $215,754
Location: Vancouver Island
MFR Region: C

Y091153 Analysis of riparian restoration techniques on biodiversity: use of invertebrate indicator species to determine appropriate restoration options for ecological recovery of riparian stands

Warren Warttig
International Forest Products Ltd.

Can old-growth attributes in coastal second-growth riparian forests be restored through silviculture?

Effective management and restoration of riparian zone forests in managed landscapes is essential to sustain the diversity of ecological and economic values provided by these forests. Using a transect-pitfall trap design in 6 thinned/unthinned treatments in second-growth riparian zones of coastal forests, the relative abundance and species diversity of beetles, other invertebrates, small mammals, and amphibians was measured; patterns of association among taxa relative to distance from the stream, treatments, and vegetation was assessed. Characterization of the assemblages in treated versus untreated riparian buffers aimed to identify whether silvicultural treatments are successful in providing old-growth attributes to the riparian forest. Results indicate that objectives aimed to introduce old-growth attributes do appear to be relatively successful.

Initiated: 08/09
Duration: 1 *year*
09/10: $0
Total: $34,106
Location: coastal CWHvh subzone
MFR Region: C

Y093301 Long-term trends in amphibians in riparian reserves: are riparian reserves effective for their conservation?

John Richardson
University of British Columbia

What is the impact of various riparian area management alternatives on amphibian populations and community composition?

Despite world-wide concerns for declining amphibian population and the possible role of amphibians as sensitive ecosystem indicators, there has been little evaluation of riparian reserves for these species in BC. This project continued the evaluation of the rates of amphibian population recovery following harvest on six experimental sites established at UBC's Malcolm Knapp Research Forest in 1997. The results show that for most species a 30 m riparian reserve was equivalent to control sites in terms of relative abundances, indicating that these reserves provide a measure of conservation value for amphibians in managed stands. The exception to this pattern was the common western red-backed salamander which actually was higher in relative abundances in clearcut sites, contrary to other reports.

Initiated: 06/07
Duration: 3 *years*
09/10: $0
Total: $72,288
Location: Province-wide and Alberta
MFR Region: C

Y103157 Structure and functional values of riparian buffer strips for sustaining floristic diversity in interior forested landscapes

Lyn Baldwin
Thompson Rivers University

How important are riparian buffer strips of different widths for sustaining ground layer vegetation, including plants with cultural significance?

The importance of riparian buffer strips for terrestrial biota and for regional biodiversity is being increasingly recognized. However, most studies on the effectiveness of buffer strips in protecting terrestrial biota have largely ignored riparian vegetation, focussing instead on vertebrates. This project will evaluate the importance of riparian buffer strips of different widths in sustaining ground layer vegetation, including plants with cultural significance for the Secwepemc community. This research will have a strong analytical focus on developing and testing quantitative diversity indices to help in the operational planning and monitoring of buffer strips, and the recognition of culturally significant plants will allow the results to be partnered with Secwepemc cultural knowledge.

Initiated: 07/08

Duration: 3 *years*

09/10: $14,580

Total: $99,080

Location: Heller Creek watershed and Greenstone Mtn

MFR Region: SI; NI

S 1.4.7 What are appropriate targets and configurations of stand-level structures in dry forest and open range (grassland, shrubland) needed to maintain biodiversity? (Retired 2007)

Y093302 Dry forests and grasslands: stand structures, habitat, and small mammals as indicators of biodiversity

Thomas Sullivan
University of British Columbia

What are appropriate targets for stand-level structures in dry forests and open range grasslands to maintain biodiversity, and what indicators can be used to determine if biodiversity targets are being achieved?

Several small mammal species could be used as indicators of biodiversity in the Douglas-fir, ponderosa pine, and bunchgrass zones of the Southern Interior of BC. This project examined the influence of partial cutting systems on residual stand structures and small mammal indicators of biodiversity at 10 years after harvesting in dry Douglas-fir forests, and the capacity of relatively undisturbed open range habitats (grasslands and shrublands) in ponderosa pine and bunchgrass zones to support viable populations of indicator small mammal species. Results showed that small mammals associated with closed forest canopies were absent from clearcuts but present in areas harvested with retention, indicating that the retention systems studied enable timber extraction and maintenance of mature forest habitat for small mammals.

Initiated: 06/07

Duration: 3 *years*

09/10: $0

Total: $134,820

Location: Province-wide and Alberta

MFR Region: SI

Y093314 **Determining stand-level structures in dry Douglas-fir forests that maintain appropriate levels of ectomycorrhizal genetic diversity to facilitate Douglas-fir regeneration**

Suzanne Simard
University of British Columbia

What sizes and configurations of green-tree retention patches are most effective in conserving the mycorrhizal fungi linking overstorey Douglas-fir trees with understorey cohorts?

The common mycorrhizal network (CMN) associated with residual trees in cutover or burned areas appears to facilitate new regeneration by providing mycorrhizal inoculum, carbon, and water from the mature trees. This project characterized the spatial extent, structure, and genetics of CMNs linking overstorey Douglas-fir trees with understorey cohorts in mature and old-growth forests in the IDFdk. Key findings include: 1) large trees act as hubs for underground networks in these areas, and should be retained to facilitate understorey regeneration; 2) partial retention prescriptions should include aggregates of ten trees or more to provide a refuge for ectomycorrhizal fungal communities; 3) gaps 60 m or less between hubs of retained trees help maintain the structural and functional continuity of belowground networks; 4) the presence of Rhizopogon fungi species may be a useful indicator of stand connectivity because they colonize trees of all ages, they are prevalent across the range of Douglas-fir, and their morphology is well adapted for long-distance networking; and 5) the retention of coarse woody debris in advanced stages of decay promotes the growth of Rhizopogon species.

Initiated: 06/07
Duration: 3 *years*
09/10: $0
Total: $165,029
Location: Dry-belt Douglas-fir forests immediately north of Kamloops
MFR Region: SI

Y103240 **Sustainable management of the ponderosa pine parkland ecosystems in the Thompson River watershed after the mountain pine beetle epidemic**

Alan Vyse
Thompson Rivers University

What are the short- and long-term ecological impacts of the mountain pine beetle on ponderosa pine parkland stands, what is the disturbance history in these stands, and what target stand or stands should be the focus of future sustainable management?

Southern Interior ponderosa pine stands have not been actively managed for decades; however, they have high recreational and ecological value and have been economically valuable in the past. The high levels of mortality caused by the current MPB epidemic are creating growing pressures for active management, but there is a very limited scientific foundation for guiding ecological restoration efforts. This project will study the short- and long-term ecological impacts of the MPB on the current ponderosa parkland stands, determine the disturbance history in these stands, and identify what target stand or stands should be the focus of future sustainable management. The results of this work will provide the necessary scientific foundation for "managing" the restoration of this ecosystem.

Initiated: 07/08
Duration: 3 *years*
09/10: $58,028
Total: $193,033
Location: Thompson River valley from Lytton to Chase and Barriere
MFR Region: SI

S 1.5 Disturbance ecology and management (fire, wind, pests, disease, pollutants, and invasives)

S 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

Y051202 Quantification of disturbance processes along a temperature and moisture gradient in sub-boreal forests

Kathy J. Lewis
University of Northern British Columbia

What are the spatial and temporal patterns of small-scale disturbance in mature, spruce–subalpine fir forests found across the central Interior of British Columbia?

Little is known about small-scale disturbance patterns and processes within the sub-boreal and subalpine ecosystems of central British Columbia, since the conventional paradigm has focused on stand-replacing fire as the primary agent of disturbance in these ecosystems. An emerging body of literature suggests, however, that small-scale disturbances within central British Columbia can play an important role in stand-level forest dynamics. This study sought to describe and compare the spatial and temporal patterns of small-scale disturbance in mature, spruce–subalpine fir forests found across the central Interior of British Columbia by developing canopy tree stem-maps, analyzing species structure and composition, and assessing the spatial-temporal patterns of disturbance using a suite of dendroecological and statistical techniques. The results of this study provide further evidence that small-scale disturbances are important ecological processes in sub-boreal and subalpine forest ecosystems.

Initiated: 04/05
Duration: 1 *year*
09/10: $0
Total: $20,627
Location: Interior plateau to McGregor Foothills
MFR Region: NI

Y062233 Development and analysis of a British Columbia natural disturbance database

Stephen Taylor
Natural Resources Canada

How can natural disturbance risk be incorporated into forest management?

Knowledge of the natural disturbance pattern, frequency, and probability of occurrence is needed to develop sustainable forest management plans and practices. This project builds on previous work that developed a digital atlas of major natural disturbances in BC forests by developing methods and techniques for incorporating natural disturbance probabilities and losses into operational, strategic, and fire management plans. The project produced documentation and extension materials describing the natural disturbance database, determined and documented wildfire and insect infestation size distributions by BEC subzone, developed statistical models of annual wildfire probability for each of the six Ministry of Forests Fire Centre regions, developed an approach for incorporating stochastic natural disturbance scenarios in timber supply analyses, and developed an approach to estimating the probability of wildland/urban interface fire events.

Initiated: 04/05
Duration: 2 *years*
09/10: $0
Total: $159,048
Location: Province-wide
MFR Region: P

S 1.5.3 Effects of natural disturbance processes on soil productivity, forest regeneration, forest succession, and wildlife habitat at both landscape and site levels

M085226 The response of caribou terrestrial forage lichens to forest harvesting and mountain pine beetles in the East Ootsa and Entiako areas

Deborah Cichowski
Bulkley Valley Centre for Natural Resources Research and Management

What is the response of terrestrial caribou forage lichens to mountain pine beetle attack and forest harvesting?

As the recent mountain pine beetle outbreak has affected significant areas of mature lodgepole pine caribou winter range in the East Ootsa and Entiako areas, information is needed on how the outbreak affects caribou terrestrial forage lichens in these areas. This project assessed the response of terrestrial forage lichen species to MPB and the associated salvage logging. Results to date show that, over the entire study, lichen abundance on MPB-affected forested ecosystems declined progressively from 16% in 2001 to 10% in 2007, with the rate of decline in lichen cover diminishing or stopping in most site series after 2005.

Initiated: 07/08

Duration: 1 *year*

09/10: $0

Total: $50,187

Location: East Ootsa area in Nadina FD, and Entiako Protected Area

MFR Region: NI

M085281 Mountain pine beetle as an agent of enhanced hair lichen biomass, with implications for the winter ecology of mountain caribou

Andre Arsenault
Ministry of Forests and Range

How does the distribution of epiphytic hair lichens (Bryoria) within mountain caribou winter range respond to landscape-scale die-off of lodgepole pine?

Hair lichens in the genus Bryoria provide critical winter forage for the endangered Mountain Caribou of southern inland British Columbia; however, nearly 40 years of studies have failed to provide a working model of Bryoria distributional ecology with which to predict the response to landscape-scale die-off of lodgepole pine. This project sought to test a recently developed predictive model of Bryoria distributional ecology against qualitative field observations. Though the model must necessarily be regarded as hypothetical, field experience to date has shown it to be a powerful predictor of hair lichen distribution within winter range of Mountain Caribou, and is recommended for use by resource managers until such time as a more quantitative model can be constructed.

Initiated: 07/08

Duration: 1 *year*

09/10: $0

Total: $29,598

Location: The range of the mountain caribou

MFR Region: SI

S 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

M085168 Effects of cumulative disturbances on an endangered whitebark pine–cladina lichen ecosystem

Sybille Haeussler
University of British Columbia

How might non-linear ecosystem shifts occur in response to cumulative stress from insects, disease, and climate change, resulting in a loss of ecosystem diversity?

Recently established provincial parks in the subalpine wilderness of west-central BC are, unfortunately, insufficient to protect the whitebark pine–lichen ecosystems in this region, which are under threat from the cumulative effects of climate change, native mountain pine beetle, introduced white pine blister rust, and fire exclusion. This project consisted of a preliminary study to investigate how these endangered ecosystems have changed over the past 30 years in response to these cumulative threats. Recommendations resulting from this work include the reintroduction of lichen ecological communities through prescribed fire and/or a let-burn policy to maintain subalpine biodiversity and the initiation of seed collection from apparently rust-resistant whitebark pine trees to allow restoration planting.

Initiated: 07/08

Duration: 1 *year*

09/10: $0

Total: $77,678

Location: Junction Burnie & Clore R

MFR Region: P

S 1.5.6 Contribution of large areas of dead trees (e.g., killed by insects, disease, drought, or windthrow) to resource management objectives

M085126 Predicting biodiversity maintenance after bark beetles and MPB management

Kathy Martin
University of British Columbia

What are the impacts on avian communities of epidemic and post-epidemic MPB conditions and of beetle management activities?

The current mountain pine beetle outbreak in BC, the largest insect epidemic recorded in North American history, has raised the concern that avian population dynamics may be strongly impacted by the cumulative effects of insect outbreaks and the associated management responses. This project examined several aspects of the impact of insect outbreaks and beetle management activities on avian biodiversity. Numerous results have been reported in several peer-reviewed journal articles in various stages of publication.

Initiated: 07/08

Duration: 1 *year*

09/10: $0

Total: $57,523

Location: Riske Creek and Seven Mile Lake

MFR Region: SI

S 1.6 Watershed function and management

S 1.6.0 Unclassified

M065006 Determining the impact of MPB-killed forest and elevated harvesting on snow accumulation, and the projected impacts on melt and peak flow

Sarah Boon
University of Northern British Columbia

What are the potential impacts of forest canopy alterations due to MPB infestation and salvage harvesting on snow accumulation, localized weather conditions, snow melt, and subsequent peak flows?

Differences in the forest canopy due to either natural regeneration or salvage harvesting of MPB-attacked stands have significantly different impacts on regional hydrology, and hence downstream geomorphology, aquatic ecology, and ecosystem function. This project measured snow accumulation, micrometeorological conditions, and canopy cover in non-infested, infested, and salvaged stands (near Vanderhoof) to derive duration, timing, and peak rates of snow melt, which were then extrapolated to the watershed scale. Results suggest that maintaining canopy cover to continue the interception process through forest retention during salvage harvesting is the most effective way to reduce the impacts of beetle infestation on run-off, peak flows, and regional hydrology.

Initiated: 05/06
Duration: 1 *year*
09/10: $0
Total: $18,902
Location: Quesnel watershed
MFR Region: SI

Y073273 Tsitika River sediment budget project

Rod Hudson
Ministry of Forests and Range

How do the effects of coastal forest management practices affect road drainage, sediment production, and transport processes?

Previous work by the authors suggests road deactivation measures that may reduce sediment yield from stream crossings. The current project involves collecting relevant field data and developing a physically based model to integrate the effects of forest management practices related to road drainage, and sediment production and transport processes. A primary goal of the project is to extend the results to other areas by using a method that is firmly rooted in hydrologic and geomorphic processes.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $335,491
Location: Tsitika River, Vancouver Island
MFR Region: C

Y073327 Evaluation of fire site rehabilitation methods in terms of controlling erosion and sedimentation

David Findlay Scott
University of British Columbia

How effective are various surface treatments for reducing soil erosion and debris flows following wildfire?

Soil erosion and debris flows are two of the hazardous consequences of wildfires, and are of particular interest in the wildland/urban interface. This study examines the effectiveness of bark mulch, straw, needle cast, and grass seeding as surface treatments to reduce soil losses after wildfires. The results indicate that the bark mulch, needle cast, and straw mulch are effective in reducing soil losses, producing significantly less sediment than either the control or seeded plots.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $95,146
Location: Okanagan Mountain, Cedar Hills, Curry Creek, north of Cherryville, Barriere area
MFR Region: SI

Y073328 Testing the H60 concept in the Interior Watershed Assessment Procedure by process hydrology studies

David Findlay Scott
University of British Columbia

Which zone in a watershed makes the dominant contribution to the water in the peak flows?

The current approach to tracking water through a watershed assumes a direct and immediate link between snowmelt from the upper 60% of catchment area and surface flow, with little lag in delivery of water from the snowpack to the stream. This project uses tracers and water chemistry to determine the zone in the watershed that makes the dominant contribution to the water in the peak flows, and thus test the H60 concept assumptions. Preliminary results indicate that both tracers used were detectable, with a short time lag between melt and detection in the stream flow; however, further work is still required.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $74,857
Location: Southern interior
MFR Region: SI

S 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

Y062324 Coastal fan destabilization and forest management

Tom Millard
Ministry of Forests and Range

What is the extent of forestry-related fan destabilization in coastal BC and how can watersheds be ranked for hazard and risk?

Fans are a common feature in coastal BC and forestry operations are known to have caused both environmental and operational problems. This project examined a sample of alluvial and colluvial fans in coastal British Columbia, the geomorphic processes on these fans, and the ways in which forest operations interact with these processes. It was found that although many fans had some degree of impact from forest operations, in general the most damaging of these impacts were associated with old logging practices; many fans were observed that had not been impacted by forest management activities, demonstrating that forest management on fans can be successful.

Initiated: 04/05
Duration: 2 *years*
09/10: $0
Total: $35,150
Location: Province-wide
MFR Region: P

S 1.6.3 Developing methods for landslide risk assessment and landslide avoidance (Retired 2008)

M086035 Measurement and modeling of mountain pine beetle impacts on the annual forest water balance

Darryl Carlyle-Moses
Thompson Rivers University

What is the impact of MPB attack and related management practices on annual forest water balance?

Changes to the composition of forests as a result of MPB and associated harvest activities will have site-specific impacts on hydrologic variables at different spatiotemporal scales, yet little is known about the hydrological effects of partial versus complete stand mortality or of the time to reach hydrologic recovery in these areas once regeneration begins. This project undertook a detailed study to explore the MPB impacts on precipitation, interception, and evapotranspiration losses under different MPB and related management scenarios. The results of this research suggest that the quantitative importance of canopy interception loss is not impacted by mountain pine beetle while trees are at the green and red attack stages, whereas total evapotranspiration may be reduced by 40–50% under green and red attack stages compared to healthy forests.

Initiated: 06/07
Duration: 2 *years*
09/10: $0
Total: $86,487
Location: Thompson Plateau
MFR Region: SI

S 1.6.5 Evaluating the physical, biological and cumulative effects of forest management (including salvage harvesting), natural disturbance (e.g., fire, mass wasting, MPB mortality), 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) (Retired 2008)

Y051047 Debris flow occurrence and major storm cycles, Kalum Forest District

James W. Schwab
Ministry of Forests and Range

What are the climate–debris flow interactions in logged watersheds?

This project develops a system to predict the occurrence of landslides, which can be used to develop reliable forestry operation shutdown guidelines and to understand climate–debris flow interactions. Hydrometerologic thresholds for the initiation of landslides are determined using climatological, meteorological, and hydrological data sources. A simple three-level classification of landslide risk is provided, based on storm intensity and forecast rainfall amounts.

Initiated: 04/05
Duration: 1 *year*
09/10: $0
Total: $88,200
Location: Lower Skeena and Nass River watersheds
MFR Region: C

Y051077 Forest management on alluvial and colluvial fans

David John Wilford
Ministry of Forests and Range

What are the effects of logging practices on the hydrogeomorphic processes that influence alluvial and colluvial fans?

Prior research was conducted by the authors to determine the spatial and temporal characteristics of hydrogeomorphic processes that influence alluvial and colluvial fans, and to determine site and watershed factors that can be used to identify hydrogeomorphic processes that pose hazards to fan stability and forest land use. The project compiled this research and other forestry experience on fans to produce extension materials that provide guidance for sustainable forest management practices.

Initiated: 04/05
Duration: 1 *year*
09/10: $0
Total: $23,731
Location: Province-wide
MFR Region: P

Y051293 Hydrologic decision-making tools for sustainable forest management in rain-dominated coastal BC watersheds

Younes Alila
University of British Columbia

Which current forest practices maintain watershed processes and enable sustainable management of water quantity?

The overriding objective of this project is to extend the value of the Carnation Creek field experiment by answering key operational questions related to forest management scenarios other than the actual management scenario implemented at the site. Specifically, the project evaluates which current forest practices effectively maintain watershed processes and identifies which practices will allow us to sustainably manage water quantity and associated risks within the context of natural hydro-climatic variability. The results of this study suggest that in rainfall-dominated watersheds of coastal British Columbia with high precipitation, steep topography, and thin, permeable soils, the peak discharge regime is fairly robust to land-use changes arising from forest management. However, these results deal merely with changes to water quantity that manifest within the channel network and make no claim as to the impact that forest management has upon other aspect of the hydrologic regime.

Initiated: 04/05
Duration: 1 *year*
09/10: $0
Total: $59,850
Location: Carnation Creek, Vancouver Island
MFR Region: C

Y073017 Ecology and management of riparian–stream ecosystems: a large-scale experiment using alternative streamside management techniques

John Richardson
University of British Columbia

What are the effects of alternative management regimes on aquatic organisms, aquatic habitat, riparian organisms, and water quality?

This study uses a before-after control-impact (BACI) design to assess the effects of four treatments (clearcut with 0- , 10- , and 30-m buffers, and 50% partial cut to streambank) on aquatic organisms, aquatic habitat, riparian organisms, and water quality. The study documented harvesting impacts on streams for all the buffer treatments, relative to untreated controls, for a wide range of stream attributes including water temperature, solute concentration, algal biomass, stream invertebrates, and terrestrial invertebrates. The authors suggest that riparian reserves are not as effective as might be hoped, and that we must start asking questions about how much change the systems can tolerate and how long it will take for them to recover to a particular reference point.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $599,530
Location: Coast
MFR Region: C

Y073115 Snow, road, soil moisture, and harvest distribution effects on streamflow at Upper Penticton Creek

Rita Winkler
Ministry of Forests and Range

What are the effects of various harvesting and road building practices on watershed hydrology and riparian systems in the Southern Interior?

This project is a continuation of the long-term Upper Penticton Creek (UPCr) Watershed Experiment. The current funding contributes to projects examining the basic hydrology of the watershed, investigating the effects of various harvesting and road building practices on riparian systems, and extending the results of completed research including the provision of operational interpretations. The study found significant changes associated with forest harvesting in stand-scale water balance processes, peak flow regimes, nitrogen cycles, and water quality.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $288,006
Location: Upper Penticton Creek
MFR Region: SI

Y073222 Carnation Creek: forestry impacts and watershed recovery processes in a small coastal drainage

Peter Tschaplinski
Ministry of Forests and Range

What is the impact on stream temperature of clearcut harvesting in a coastal drainage?

This study is part of the larger Carnation Creek project, which has the objective of determining the mechanisms, rates, and levels of natural resource recovery in a harvested coastal drainage by quantifying long-term changes in biological and physical watershed processes. Specifically, this project collected measurements of angular canopy density (ACD)—a measure of the amount of direct solar radiation reaching a given stream—at several locations in the Carnation Creek drainage. As in previous years, the highest shade density was measured in section 2 (part of the riparian buffer) and the section with the least amount of shade was in section 5 (part of the intensively logged area).

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $503,593
Location: South Island FD
MFR Region: C

Y073294 Forest management in interior British Columbia: moving beyond equivalent cut area (ECA)

Younes Alila
University of British Columbia

What is the combined influence of topography and vegetation on the spatial variability of snow accumulation and melt at the watershed scale?

Although the effects of topography, wind redistribution, or vegetation on snow accumulation and snowmelt are known, few experiments have been able to reveal the relationships between the spatial variability of SWE and topographic or vegetative controls at larger scales. The objectives of this study were (1) to develop a sampling design that reveals the combined effect of topography and forest canopy on SWE, (2) to estimate the variability of snow accumulation at the plot and watershed scale, and (3) to estimate the spatial correlation of SWE. It was found that elevation, forest cover, and aspect all show strong relationships with snow accumulation and snowmelt within the watershed and together explain most of the large-scale variability; however, their relative influence changes so much among years that no empirical generalizations can be made.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $299,260
Location: Cotton Creek, south Kootenays
MFR Region: SI

Y073367 Effects of logging on export of organic matter from headwater streams

Brian Heise
Thompson Rivers University

What contribution do fishless, headwater streams make to downstream fish-bearing reaches in terms of aquatic invertebrates, fine particulate organic matter, and dissolved organic carbon for the stream food web?

Concern has been expressed that clearcut logging of headwater streams may be depriving downstream fish populations of food. This project assesses the contribution of fish food and organic matter from fishless headwater streams to lower, fish-bearing streams. Preliminary results indicate a significant increase in invertebrate abundance and biomass at the Eagle Lake/Westman Creek study area. However, the high variability of drift response at the Horsefly site precluded the detection of any potential effects of logging. Additional sampling remains to be completed.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $241,827
Location: ESSF BEC zone
MFR Region: SI

S 1.6.6 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 (Retired 2006)

M075036 Using GIS and time series analysis to evaluate impacts of large-scale salvage logging on hydrology in the BC Interior

Adam Wei
University of British Columbia

What are the impacts of large-scale salvage logging or disturbance on watershed hydrology?

Although the need to understand cumulative impacts of land use change on hydrology for relatively large watersheds is widely recognized, research at this scale is limited. In this study, the impacts of forest harvesting on hydrology of the Bowron and Willow watersheds were evaluated by various statistical methods including time series analysis, non-parametric tests, and wavelet analysis. Results showed that forest harvesting in the Willow watershed significantly increased mean and peak flows for annual and spring snowmelt periods, but it did not have any significant effect on low flows in all study periods, whereas the Bowron watershed showed either no significant, or inconclusive, responses to large-scale logging. Results clearly demonstrate that any attempt to generalize hydrological response to forest harvesting in large watersheds or to extrapolate the results from one watershed to others must be done with caution.

Initiated: 06/07
Duration: 1 *year*
09/10: $0
Total: $51,660
Location: Northern interior
MFR Region: NI

S 1.6.7 Effects of large woody debris recruitment on stream channel type and state

Y051107 Simulation of large woody debris recruitment and dynamics associated with wildfire disturbance and harvesting in headwater streams of the BC Interior

Adam Wei
Okanagan University College

What are the processes involved in riparian LWD recruitment and in-stream dynamics?

Although large woody debris (LWD) has been recognized as a critical component of many headwater streams, little is known about LWD recruitment and dynamics. This project developed a model of riparian LWD recruitment and dynamics, and linked model output with an ecosystem model called FORECAST. The LWD model was used to evaluate the impacts of wildfire disturbance and harvesting scenarios on LWD recruitment processes and dynamics in the headwater streams. Results indicate a large difference in LWD dynamics between wildfire and harvesting in lodgepole pine forests.

Initiated: 04/05
Duration: 1 *year*
09/10: $0
Total: $45,380
Location: Southern and central interior
MFR Region: SI

Y051108 In-stream LWD as a sustainability indicator at spatial and temporal scales for headwater streams of the BC Interior

Adam Wei
Okanagan University College

What are the processes involved in riparian LWD recruitment and in-stream dynamics?

Although there is concern over the potential impacts of forest practices on fish habitat due to reduction of large woody debris (LWD) being recruited to fish-bearing streams, little is known about the characteristics and variability of LWD in forested streams within the BC Interior. This project examined the relationship between in-stream LWD, channel morphology, and aquatic habitat across various spatial and temporal scales in headwater streams. Spatial distribution and abundance of LWD were found to be related to bankfull width. Variability in morphological and ecological roles of LWD suggest that LWD may be an appropriate indicator for riparian forest management.

Initiated: 04/05
Duration: 1 *year*
09/10: $0
Total: $68,250
Location: Southern interior
MFR Region: SI

Y062170 Functional large woody debris in small streams: what is it?

Dan Hogan
Ministry of Forests and Range

What are the best management practices for supplying functional LWD from riparian areas adjacent to small riffle–pool and step–pool streams?

The lack of an operational and physically meaningful definition of large woody debris (LWD) prevents us from designing effective riparian management prescriptions. This research develops a process-based definition of LWD scaled to the size of a channel. The results imply that as channel width increases, stable values of debris roughness and the blockage ratio decrease, suggests that logs at the critical threshold of stability are more geomorphically effective in relatively small channels as both the debris roughness and the blockage ratio increase with decreasing channel size.

Initiated: 04/05
Duration: 2 *years*
09/10: $0
Total: $79,049
Location: Province-wide
MFR Region: P

Y073127 An experimental approach to evaluating impacts of the recent Okanagan Mountain Park Fire and other disturbances on large woody debris recruitment and transportation processes

Adam Wei
University of British Columbia

What is the annual input, output, and transport rate of LWD in aquatic/riparian ecosystems?

Given the importance of large woody debris (LWD) in streams as structures and aquatic habitat, understanding the dynamic properties of LWD has become an important issue in riparian and watershed management. This project examined the influence of various disturbances on LWD input, output, and transfer processes by collecting field data to construct an annual budget (i.e., input-outputs) of LWD in the aquatic/riparian ecosystems of the study area. The study showed a net loss of LWD on old-growth sites, a net gain of LWD on wildfire sites, and no net change in LWD on MPB-filled sites.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $82,896
Location: Southern and central interior
MFR Region: SI

S 1.8 Ecological restoration (Retired 2008)

S 1.8.1 Evaluating the effectiveness of restoration techniques on mitigating forest encroachment and in-growth in NDT4 ecosystems (Retired 2008)

Y073069 Understorey succession following ecosystem restoration of ingrown dry forests

Reg Newman
Ministry of Forests and Range

How will understorey grassland and open forest vegetation recover following different levels of thinning and prescribed burning in overstocked stands of IDF and PP forests?

This project assessed the recovery of understorey grassland and open forest vegetation following different levels of thinning and prescribed burning in overstocked stands of IDF and PP forests in the Rocky Mountain Forest District. The objective was to determine the effect of harvesting, slashing, and spring burning on the composition of the understorey herbaceous and shrub layer over time. Results indicated a positive, exponential relationship between forage biomass and understorey light levels, dominated by forbs of the IDF site and grasses on the PP site. Insufficient time has passed since application of treatments to properly assess the restoration potential of the treatments.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $35,812
Location: Southern interior
MFR Region: SI

S 1.9 Climate change (Retired 2008)

S 1.9.2 Understanding how biological communities and ecological processes, at both the stand and landscape levels, might respond to projected changes in climate (Retired 2008)

Y102076 Effects of climate change on high-elevation plant communities and their ecological processes

Suzanne Simard
University of British Columbia

Will spatial and temporal variability in the composition and distribution of high-elevation ecosystems under new climatic conditions improve colonization and regeneration forecasts for climatically sensitive species?

Monitoring changes in climatic and ecological gradients across high-elevation sub-alpine and alpine environments is ideal for revealing flora and micro-climatic conditions in response to climate change. By combining geographically extensive analysis and mapping of variation in high-elevation community structure with analysis of variations in micro-climate, plant community composition, and soil properties at replicate monitoring sites using the European Commission's GLORIA protocols, ecosystem-level responses to climate change can be quantified. Results will characterize the sensitivity of high-elevation ecosystems to climate changes and contribute to global and regional monitoring of these ecosystems.

Initiated: 08/09
Duration: 3 *years*
09/10: $31,749
Total: $61,642
Location: West Cariboo Mtns; Quesnel, Central Cariboo, 100-Mile House FDs
MFR Region: SI

Y102110 Assessing alternative forest management strategies under climate change

Harry Nelson
University of British Columbia

What sustainable forest management strategies may be effective under possible climate change scenarios?

Current forest management policies and models that assume invariance in key biophysical and climactic conditions over the planning period are likely failing to represent both forest dynamics and management options under climate change. Through design of (1) climate-change-dependent forest dynamics models of growth and yield, disturbance regimes, regeneration potential linked to likely climate changes, (2) a cellular automaton-based spatial forest planning model, and (3) specification of alternative management strategies, projections of economic and ecological forest values will be made for a case study management unit (TFL-48). Results will be used to assess efficacy of new and alternative management strategies under changing climates.

Initiated: 08/09
Duration: 2 *years*
09/10: $57,834
Total: $118,314
Location: TFL48, Peace FD; NIFR
MFR Region: NI

Y102120 Future vegetation structure and vertebrate distributions based on changes in moisture balance and temperature

Fred Bunnell
University of British Columbia

How should silvicultural planning and operational practices respond changing patterns of species distribution and ecological function caused by climate change?

Effects of climate change are likely to profoundly affect species distributions and abundance BC, but determining land-use and forestry practices that are appropriate is difficult. Available datasets and models will be used to develop models of key climatic variables, and project future vegetation and vertebrate species distribution and relative abundance under climate change. The resulting maps will show likely changes and help reveal potential modifications to silvicultural practices for sustaining efficient forestry and biodiversity.

Initiated: 08/09
Duration: 3 *years*
09/10: $49,140
Total: $98,250
Location: Province-wide
MFR Region: P

S 1.9.3 The influence of climate change on the interactions among wildland fire and wildland fire behaviour, the appropriate management responses, and the ultimate impacts of wildland fire on other resources (Retired 2008)

Y102111 Wildfire risk in a changing climate

Stephen Taylor
Canadian Forest Service

How might fire management and silviculture strategies need to be altered under climate-altered fire regimes?

Wildfire behaviour and its consequences for forest ecosystems and values are likely to be greatly modified by the effects of climate change. Projections of future fire behaviour and effects on forest structure will be made by linking outputs of GCM model scenarios and fine-scaled stochastic weather to models of fire risk and tested in a stochastic timber supply model on a pilot area. Results will demonstrate methods for estimating impacts of changed fire regimes on forest structure and harvest levels under future climate changes.

Initiated: 08/09
Duration: 2 *years*
09/10: $66,096
Total: $139,536
Location:
MFR Region: P

S 1.9.4 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) (Retired 2008)

Y091081 How will climate change affect the distribution and competitive performance of *Centaurea maculosa* and *Linaria vulgaris* in south interior grasslands?

Lauchlan Fraser
Thompson Rivers University

How can management guidelines for grassland ecosystems be modified to account for effects of global warming on invasive species?

Anticipated disruptions of plant community composition and distributions as a result of climate change may be accelerated because of asymmetrical responses of native and invasive species to changing climate patterns. The purpose of this study was to test the effects of climate change on two invasive grassland plants (spotted knapweed and yellow toadflax) in a field experiment and a greenhouse study. The focus of the field study was to determine if biotic and abiotic parameters differ between sites dominated by invasive species and those dominated by native grassland. The results showed that long-term invasions of these species do not seem to result in any significant changes in the biotic or abiotic environment. The focus of the greenhouse study was to compare the competitive dominance of invasive and native plants through a pair-wise trail involving two temperature and two water regimes. Results provide preliminary evidence that the role of competition may be reduced under climate change, and instead, species that are better able to tolerate these climate-induced stressful site conditions will be at an advantage.

Initiated: 08/09

Duration: 1 *year*

09/10: $0

Total: $32,400

Location: 100 Mile House, Kamloops FDs; SIFR

MFR Region: SI

S 2 Decision support tools for sustainable forest management

S 2.1 modeling resource availability, dynamics, and sensitivity to management and disturbance

S 2.1.1 Development of spatially-explicit models related to Theme 1.0 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

M085236 Implications of salvage scale: mountain pine beetle and integrity of woodland caribou winter ranges

Scott McNay
Resources North Association

What are the likely effects of MPB-related timber salvage on the integrity of critical habitat used by threatened herds of woodland caribou in north-central BC?

Much of the MPB salvage harvesting in the Mackenzie TSA may potentially occur in or adjacent to UWRs, and is therefore expected to affect both the quality and quantity of habitat supply for woodland caribou. This project used simulation modeling to assess the potential influence of the current and forecasted MPB epidemic on woodland caribou UWRs, and to explore timber salvage policies that would optimize the ongoing quality of low-elevation caribou winter ranges and recovery of MPB-killed timber. The results suggest that: from a timber perspective, increases in allowable harvest, when focusing on pine, are justifiable because the observed fall down in timber supply did not appear to be a function of fibre availability; the outlook for supply of high-quality winter range for use by caribou was not encouraging; all scenarios supported the notion that there were obvious tradeoffs to consider.

Initiated: 07/08

Duration: 1 *year*

09/10: $0

Total: $37,599

Location: Fort St. James and Mackenzie FDs

MFR Region: SI

Y071064 Extension of habitat supply tools: the caribou habitat assessment and supply estimator

Scott McNay
McGregor Model Forest Association

How can caribou habitat supply modeling in north-central British Columbia be made accessible to a wider user base at a lower cost-per-use?

Much attention has been placed on the habitat requirements of woodland caribou since they were designated as a species at risk. One of the products of this research is a spatio-temporal habitat supply model CHASE (Caribou Habitat Assessment and Supply Estimator). However, this model has highly specialized and labour-intensive operation requirements. This project seeks to automate the model application procedures to reduce the complexity of its application. As a result of this project, the CHASE model will become much more accessible to a wider pool of users at a lower cost.

Initiated: 06/07

Duration: 1 *year*

09/10: $0

Total: $39,914

Location: Mountain caribou recovery planning areas in BC

MFR Region: P

Y073348 **An ecosystem approach to planning for sustainable management of mountain goat resource values and timber supply**

Scott McNay
McGregor Model Forest Association

How can the effectiveness of current mountain goat habitat management policy best be monitored?

Development of BC's forests may have a negative impact on mountain goat populations due to the apparently static nature of their resource use. This project conducted an extensive review of information from inventory, monitoring, and modeling of mountain goats and their habitats in north-central British Columbia, and from other studies of mountain goats around BC and adjacent jurisdictions. The goals was to refine interim management recommendations, and to develop a rationale for the choice of specific criteria and indicators potentially useful in monitoring the effectiveness of managing habitat for mountain goats within the context of sustainable forest development and current policy. It is suggested that routine assessment of indicators use at least three comparative analyses to determine effectiveness: (1) proximity to objective, (2) thresholds based on assumed patterns of natural disturbance, and (3) cumulative impacts.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $330,955
Location: Mackenzie TSA
MFR Region: NI

Y081212 **Addressing information exchange needs around analysis and decision processes that use forest estate models and their inherent linkages to habitat supply models and sustainability indicators**

Jeff Stone
Ministry of Forests and Range

What is the current state of forest estate models, and how can these models be appropriately used to provide or link directly to needed information on habitat supply and desired indicators of resource sustainability other than or in conjunction with timber supply?

An international conference was held in June 2007 in Victoria BC to allow resource analysts, forest managers, and decision makers to share experiences, knowledge, and ideas around using forest estate models in making decisions for the sustainability of our forests. This project provided logistical support through FORREX for final conference preparation, funding for printed materials and needed assistance for the rental and professional set up of the audio-visual equipment. The conference was a large success, and based on the participant response to the conference, it was a needed forum for the exchange of information and networking among resource modellers and managers.

Initiated: 07/08
Duration: 1 *year*
09/10: $0
Total: $9,572
Location:
MFR Region: P

Y082027 **Incorporation of wildlife habitat capability into the multi-value, spatially explicit, complex cutblock ecosystem management model LLEMS**

Hamish Kimmins
University of British Columbia

How can the ability to forecast the effects of partial harvesting systems or variable retention management on the development of forest structure associated with wildlife habitat supply be incorporated into forest planning models?

Existing forest planning models are not typically designed to allow assessment of the effects of variable retention management on the development of forest structure associated with wildlife habitat supply. This ought to extend the abilities of the Local Level Ecosystem Management Simulator (LLEMS, a spatially explicit forest planning model being developed to allow assessment of variable retention management strategies on a series of economic, ecological, and social indicators of SFM), to assess the impacts of management activities at the large cutblock or watershed scale on spatial and temporal patterns of wildlife habitat supply. A habitat suitability model was completed as planned, and several forest-type-specific habitat indices and spatial metrics related to fragmentation and patch size distributions were identified for subsequent incorporation into LLEMs.

Initiated: 06/07
Duration: 2 *years*
09/10: $0
Total: $135,373
Location: Central Cariboo FD
MFR Region: NI

Y082028 **Landscape analysis of habitat supply and effects on populations of the northern spotted owl in BC: extension of results**

F. Louise Waterhouse
Ministry of Forests and Range

How can habitat supply modeling be used to assist stakeholders and decision makers consider trade-offs between species habitat management and other resource uses in developing "Recovery Plans" for species-at-risk?

The Canadian Spotted Owl Recovery Team has developed a management/habitat-focused model framework for investigating questions on the northern spotted owl population, critical habitat goals, and management trade-offs between species habitat and other resource uses. This project focused on extension by developing two manuscripts presenting further technical details on the framework and the findings associated with its application, in the context of current scientific literature on reserve design modeling and recovery planning for species at risk.

Initiated: 06/07
Duration: 2 *years*
09/10: $0
Total: $14,320
Location: Chilliwack and Squamish FDs
MFR Region: C

Y082057 **Developing a science-based framework to identify and designate "temperature sensitive streams" for sustainable riparian forest management in the BC Interior**

Marc Nelitz
Ministry of Environment

How can available datasets and analytical frameworks be combined to allow scientifically rigorous and defensibe designation of temperature-sensitive streams across the entire province?

Although BC regulations allow for the designation of temperature sensitive streams (TSSs) to protect critical fish-bearing streams from thermal impacts due to forestry activities, there are currently no objective methods or decision-support tools to identify and designate those streams that require such protection. The purpose of this project was to gather the data, apply analytical approaches, and demonstrate a "proof of concept" to rigorously and defensibly designate TSSs for sustainable forest management in the BC interior. The project was successful in that the predictions were reasonable, the methods innovative, and the framework was suitable to the Ministry of Environment's needs for designating TSSs, but additional improvements must be made before the framework can be used for formal TSS designation purposes.

Initiated: 06/07
Duration: 2 *years*
09/10: $0
Total: $64,916
Location: Northern and southern interior
MFR Region: SI

Y092160 **The application and evaluation of an ecosystem model to project the recovery of old-growth attributes in second-growth stands**

Brad Seely
University of British Columbia

How can the reliability and quality of model projections of the development of old-growth attributes in second-growth stands be improved?

The Ecosystem Recovery Project was established by the BC Ministry of Forests and Range in 2003 to assess how quickly specific old-growth characteristics can develop in second-growth stands resulting from both harvesting and natural disturbance agents. The project has produced an extensive database of information that was used to validate the FORECAST and LLEMS models developed at UBC and already in use within the BC forest industry for developing SFM plans. The model evaluation results provide clear support for the use of the FORECAST model for projecting the development of structural old-growth attributes in second-growth stands of the CWHvh and ICHmc subzones in the Prince Rupert Forest Region.

Initiated: 07/08
Duration: 2 *years*
09/10: $0
Total: $103,059
Location: CWHVh2 and SS
MFR Region: C

Y092259 Enhancing the resiliency of the Tweedsmuir-Entiako caribou to the current mountain pine beetle outbreak

Don Morgan
Bulkley Valley Centre for Natural Resources Research and Management

Which areas within the range of the Tweedsmuir-Entiako caribou population are appropriate for forest salvaging activities and road building, which are not, and where can stand-tending activities lead to an accelerated recruitment of good caribou habitat?

This project used collaborative modeling, influence diagrams, and scenario analysis techniques to capture existing research and opinions on caribou and habitat ecology, evaluate current woodland caribou habitat, determine how it is being modified by the current MPB outbreak, and identify forest management strategies with potential to enhance the resilience of the population. The results were expected to be applied by engaging resource managers in the Nadina and Vanderhoof Forest Districts, including forest licensees, Morice-Lakes Innovative Practices Agreement participants, government ministries, and First Nations; however, the project was cancelled after its first year and no results were made available.

Initiated: 07/08

Duration: 1 *year*

09/10: $0

Total: $45,893

Location: Tweedsmuir-Entiako caribou range

MFR Region: NI

Y103137 Developing and validating habitat-based management models for species at risk in northeastern BC

Fred Bunnell
University of British Columbia

How can knowledge and conservation of the 5 at risk species of warblers in northeastern BC be improved through a more refined adaptive monitoring and modeling framework that can provide direct and timely feedback to management?

Five species of warbler, all restricted to the northeast corner of BC, have been designated under the *Forest and Range Practices Act* and regulations as "at risk". However, their status and trends are difficult to assess because they are hard to detect using roadside surveys, are regionally rare, and occur at the western end of their range. This project will explore two complementary approaches: a design-based approach aimed at improving the effectiveness of field surveys and a model-based approach aimed at using habitat models to target sampling in areas that will reduce uncertainty to create a framework for assessing the status and trends of warblers in the northeast and evaluate the effects of management practices. Together, the design- and model-based approaches will enable us to provide practical guidelines for monitoring, modeling and managing warbler species "at risk" in northeastern BC.

Initiated: 07/08

Duration: 3 *years*

09/10: $22,216

Total: $103,032

Location: Peace and Fort Nelson FDs

MFR Region: NI

Y103282 **Landscape habitat-supply modeling to develop and test management scenarios that balance ecological and socio-economic indicators**

Walt Klenner
Ministry of Forests and Range

Can multiple-scenario habitat-supply modeling be used to help identify forest management practices that are likely to maintain desired habitat conditions across large spatial and temporal scales?

Multiple-scenario landscape assessments can help identify unrealistic expectations and illustrate the utility of specific stand and landscape management practices that favour achieving and maintaining desired habitat conditions at both the stand and landscape scale. This project proposes to (1) incorporate stand-level information in the TELSA (Tool for Landscape Scenario Analyses) landscape planning tool, (2) further develop the suite of landscape indicators to reflect current technical information and perspectives, (3) demonstrate the utility of landscape-level habitat supply modeling in addressing operational issues, (4) synthesize the outcomes from case studies and the published literature to develop broadly applicable habitat supply management principles, and (5) communicate the results to operational foresters and planners and to the broader scientific community. The outcome of this work will be the development of approaches and tools to quantify the short- and long-term habitat conditions that are likely to develop under different forest management scenarios.

Initiated: 07/08
Duration: 3 *years*
09/10: $54,000
Total: $160,145
Location: Southern interior
MFR Region: SI

S 2.1.2 Development of methods to evaluate the effectiveness of habitat capability models in identifying high-value habitat

Y081231 **Developing fish habitat models for broad-scale forest planning in the BC southern Interior**

Marc Porter
Ministry of Environment

How can empirical fish distribution models be improved to predict distribution, abundance, and habitat quality of key fish species at finer spatial scales?

Limitations of the 1:50,000-scale empirical models currently being used by the BC MOE to assist in identifying fisheries-sensitive watersheds are that they are based on out of date environmental statistics that have been superseded by improved and vetted statistical information, that they only predict fish occurrences at the watershed scale, not at the nested stream-reach scale, and that they do not assess the relative quality of habitats across 1:50,000 stream reaches. This project employed habitat and barrier information within the province's 1:50K GIS layers and provincial fish occurrence /abundance datasets to build empirical models for predicting both the distribution of key fish species and the relative quality of rearing habitat within a defined pilot area. The project was successful in generating intermediate to high accuracy statistically valid models for predicting distribution in watersheds and macroreaches of the defined pilot area for four key species at the 1:50K scale.

Initiated: 07/08
Duration: 1 *year*
09/10: $0
Total: $52,908
Location:
MFR Region: SI

S 2.6 Developing or refining ecological risk assessment tools

S 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

M085276 Peak flow and water yield responses to mountain pine beetle infested and salvage logged watersheds in the Kootenays

Younes Alila
University of British Columbia

What is the magnitude of the impact of MPB infestations and salvage logging on water yield and peak flow regimes?

Concerns for water quantity, water quality, and fisheries resources have raised questions about the impact of MPB on annual water yield and peak flows. This project combined watershed-scale modeling with results from recent stand-level studies of infested forests to quantify the effects of various mountain pine beetle salvage logging scenarios on the water yield and peak flow regimes at the heavily instrumented Cotton Creek watershed site. modeling results indicated that the peak flow regime is most sensitive to logging at the upper elevation since the peak flow of the freshet is generated at the time snow is melting from this upper elevation band, and that changes in flood magnitude translate into dramatic changes in flood frequency, thus the larger the magnitude of a flood event the more frequent it may become.

Initiated: 07/08
Duration: 1 *year*
09/10: $0
Total: $86,443
Location: South of the Cranbrook
MFR Region: SI

M086039 Peak flow and water yield responses to mountain pine beetle infested and salvage logged watersheds

Younes Alila
University of British Columbia

What are the effects of MPB infestation and treatments on streamflows?

The effects of MPB infestation and the subsequent mitigation and salvage efforts on streamflows is largely unknown and may or may not mimic that of conventional timber harvesting. This project conducted distributed hydrology model simulations to quantify the effects of MPB infestation and treatments on peak flow and water yield regimes during the first few critical years following treatment, at the Upper Penticton Creek Experimental Watersheds. The findings of this research suggest that peak flow regimes are fairly tolerant to the current level of harvesting in this particular watershed, but that further harvesting operations may affect this element significantly.

Initiated: 06/07
Duration: 2 *years*
09/10: $0
Total: $189,145
Location: Northern and southern interior
MFR Region: P

S 3 Indicators, thresholds, monitoring systems

S 3.1 Development of indicators and monitoring systems

S 3.1.0 Unclassified

Y061118 **Spatial and temporal response of bryophytes to silvicultural and site preparation treatments in high-elevation forests at Sicamous Creek**

Dennis Lloyd
Ministry of Forests and Range

What are the effects of forest management practices on bryophytes?

Several studies have shown that the effect of forest harvesting on bryophytes can be both severe and long lasting, but little research has been done in BC. This study remeasures the bryophyte response to silvicultural and site treatments 11 years post-harvest, at an existing long-term research installation. The study showed significant differences in the bryophyte communities among both silvicultural and site preparation treatments.

Initiated: 05/06
Duration: 1 *year*
09/10: $0
Total: $37,490
Location: Sicamous Creek Silvicultural Systems Research Site
MFR Region: SI

Y061171 **Assessment of data requirements and development of multi-scale habitat classification methods for refining strategic habitat**

F. Louise Waterhouse
Ministry of Forests and Range

Can fine-scale habitat attributes for Spotted Owl be inferred from existing inventory data and remote sensing?

Current inventory data for BC's forests contain limited information on fine-scale habitat attributes that are critical for describing the habitat of the northern spotted owl. This study assessed the feasibility of using statistical relationships among readily available inventory data (including maps and remotely sensed imagery) to infer the occurrence of fine-scale habitat elements. The project provided an assessment of potential data sources, and a protocol for estimating fine-scale structural attributes using extant data. However, the project was not able to reliably infer habitat elements from the data sources evaluated.

Initiated: 05/06
Duration: 1 *year*
09/10: $0
Total: $40,541
Location: Chilliwack, Squamish, and Cascade FDs
MFR Region: C

Y061173 **Replacement of fire-damaged LTSP plots: Rover Creek ICH installation**

Shannon Berch
Ministry of Forests and Range

No question - plot replacement

Three plots from the province-wide long-term Soil Productivity (LTSP) study were burned in wildfires, leaving the experimental design incomplete. This project replaced these plots on new sites. This replacement was critical to the successful interpretation of data from the ICH replicates.

Initiated: 05/06
Duration: 1 *year*
09/10: $0
Total: $49,295
Location: Rover Creek, near Nelson
MFR Region: SI

Y071154 Linking range health assessment methodology with science

Reg Newman
Ministry of Forests and Range

Do forest health assessment methods provide adequate assessments of ecosystem function and condition of rangelands?

This project assessed two different range health assessment methods (MoFR upland assessment method and GCC method for fescue grasslands) to determine their measurement sensitivity and their ability to provide information about the response of rangeland ecosystems to management. The assessment scores of the two methods were found to be related to the majority of quantitative indicators considered in the study, and in general the two methods provide similar findings. The authors conclude that users can be confident in the scientific validity and reliability of the two methods. However, they provide a list of weaknesses in the methods and suggestions for improvement.

Initiated: 06/07
Duration: 1 *year*
09/10: $0
Total: $46,734
Location: Southern interior
MFR Region: SI

Y072029 Utility of carabid beetles as indicator species for monitoring biodiversity effects from variable retention harvesting practices

William J. Beese
Western Forest Products Inc.

What are the effects of patch size in variable retention systems on carabid beetle populations?

Carabid beetles have been shown to be good indicators of old-growth communities and edge conditions. To improve our understanding of this relationship in variable retention (VR) harvesting systems, the authors will examine the effect of patch size on carabid beetle communities. The results of this work will help to differentiate the effects of patch size and proximity of patches on carabid beetles in a VR cutblock, which may lead to the development of more effective VR layouts.

Initiated: 05/06
Duration: 2 *years*
09/10: $0
Total: $96,599
Location: TFLs 39 and 44
MFR Region: C

Y072093 Recovery of soil carbon and nitrogen ten years after harvesting and site preparation at Sicamous Creek

Graeme Hope
Ministry of Forests and Range

How do harvesting and site preparation affect soils in high-elevation sites?

There have been no published studies investigating medium-term changes in soil properties in the high-elevation forests of the BC Interior. This project will use a field sampling program to expand the timeline of previously collected and published data on changes in soil properties following harvesting. The intent of this research is to understand how different harvesting and site preparation disturbances affect soil productivity in the medium term.

Initiated: 05/06
Duration: 2 *years*
09/10: $0
Total: $46,552
Location: Sicamous
MFR Region: SI

S 3.1.1 Assessment of the Forest Resource Evaluation Program (FREP) indicators and monitoring systems

Y051112 Development of sustainability indicators for turbidity impacts on stream ecosystems

Jordan Rosenfeld
Ministry of Water, Land, and Air Protection

How can the effects of low-level turbidity on the growth of juvenile salmonids be predicted?

Turbidity is a key indicator of water quality and stream condition due to its direct negative effects on fish growth. This project used a drift-foraging bioenergetics model to quantitatively predict the impact of turbidity on juvenile salmonid growth rates. The resulting model accurately predicts decreases in growth due to high turbidity, and is available in a spreadsheet version for use by managers and biologists.

Initiated: 04/05
Duration: 1 *year*
09/10: $0
Total: $14,280
Location: Lower Mainland
MFR Region: C

Y061025 **Effects of forest practices on the native signal crayfish, *Pacifastacus leniusculus*, in BC**

John Richardson
University of British Columbia

Are signal crayfish affected by forest harvesting and are they a sensitive indicator of forest disturbance?

As a long-lived species inhabiting streams, the signal crayfish is subject to all of the same concerns surrounding forestry impacts expressed for salmonids and other fish, and thus provides a potential indicator of change that would be reasonably easy to sample (large size), sensitive to change, and integrates long-term effects of land-use changes through its relatively long life. Extensive field surveys were conducted in the Lower Mainland with the intention of testing the hypothesis that crayfish are affected by forest harvesting. In the end there were insufficient sites where crayfish occurred to test the original question related to the potential impacts of forest harvesting.

Initiated: 05/06
Duration: 1 *year*
09/10: $0
Total: $25,571
Location: Lower Mainland
MFR Region: C

Y061074 **Development and testing of extensive-level field indicators and methods to determine whether current forestry practices are sustainably managing riparian, aquatic ecosystem, and fish habitat values**

Peter Tschaplinski
Ministry of Forests and Range

Are proposed indicators of riparian functioning appropriate for assessing the effects of forestry practices?

A list of indictors for the effects of forestry practices on riparian systems was previously developed using an expert-rules process. This project validates these indicators in the field and evaluates associated assessment procedures. The study found that the indicators provided good accurate measurements of stream condition and the assessments produced were consistent and repeatable.

Initiated: 05/06
Duration: 1 *year*
09/10: $0
Total: $60,036
Location: NE Vancouver Island, Prince George FD
MFR Region: P

Y062031 **Linking multiple indicators of biological diversity to forest management decisions**

Fred Bunnell
University of British Columbia

How effective is variable retention for maintaining indicators of stand structure and biodiversity?

Much information has been collected on the efficacy of variable retention (VR) harvesting for protecting specific ecological values at a particular scale, but there is a need to synthesize this information to better understand the overall efficacy of VR for protecting biodiversity. This study projects three key indicators through time under multiple management scenarios, and integrates the results to determine whether current management actions will sustain species across the study area.

Initiated: 04/05
Duration: 2 *years*
09/10: $0
Total: $101,905
Location: Vancouver Island
MFR Region: C

Y071033 **Direct and indirect effects of harvesting on carabid beetle community composition in regenerating sub-boreal spruce stands – refining their indicator potential through understanding of biotic interactions**

Staffan Lindgren
University of Northern British Columbia

What is the impact of red wood ants on carabid communities in post-harvest areas?

The response of carabid ground beetles, a generally accepted indicator of ecosystem health, to habitat disturbance appears to differ among regions of Canada, leading to the hypothesis that the difference may be due in part to predation and/or competition by ants. The purpose of this study was to assess the carabid community in a chronosequence of anthropogenically disturbed sub-boreal spruce forest in west-central British Columbia, and to test the influence that ants have on these communities in early post-harvest conditions. Preliminary results from this study indicate that accounting for interactions between carabids and ants is necessary in the development and implementation of models that use carabids as indicators of ecosystem health.

Initiated: 06/07
Duration: 1 *year*
09/10: $0
Total: $38,507
Location: Morice and Lakes FD
MFR Region: SI

Y071072 **Optimal sampling strategy for effective evaluation of the soils value at the cutblock level under FRPA**

Robert Magai
Selkirk Geospatial Research Centre

How can optimal sampling strategies be designed for mapping percent soil disturbance in post-harvest cutblocks?

To efficiently and effectively monitor the impacts of forest operations on soil disturbance, a means of determining the minimum sampling effort to characterize site conditions under differing timber harvesting scenarios is critical. This project applies geostatisical techniques to determine optimal grid sampling sizes and scales that minimize error or variance. The conclusion of this research is that optimal sampling strategies can be designed to sample properties of interest based on the variogram, which must be computed before deciding on the sampling size.

Initiated: 06/07
Duration: 1 *year*
09/10: $0
Total: $27,021
Location: Kootenay region
MFR Region: SI

Y071075 **Stand-level vegetation indicators for boreal mixedwood forests**

Sybille Haeussler
Bulkley Valley Centre for Natural Resources Research and Management

What are appropriate local-level vegetation indicators for monitoring biodiversity and ecological integrity of plant communities?

Local-level vegetation indicators are required to monitor biodiversity and ecological integrity of plant communities. This study developed appropriate indicators for boreal white spruce–trembling aspen mixedwood forests through analysis of vegetation and site attribute data from four silvicultural trials. These indicators were evaluated by comparing their response to forest harvesting versus wildfire disturbances. The authors identify a number of recommended vegetation indicators, as well as recommend next steps for implementing these indicators within a monitoring program.

Initiated: 06/07
Duration: 1 *year*
09/10: $0
Total: $14,314
Location: Northern interior
MFR Region: NI

Y071160 The implications of management practices for mitigating mountain pine beetle on soil-based indicators of SFM

Steven Day
Canadian Forest Products Ltd.

What are the soil sustainability implications of management actions to increase mid-term timber supply?

Harvest predictions for the Quesnel TSA indicate a significant shortfall in mid-term timber supply due to extensive MPB-related mortality of pine-dominated stands. This study examines how different management outcomes affect soil organic matter, MPB susceptibility, and mid-term timber supply. Based on the study results the authors provide management recommendations related to rotation length and fertilization regime, to achieve different management objectives (e.g., soil sustainability, timber production).

Initiated: 06/07
Duration: 1 *year*
09/10: $0
Total: $52,123
Location: Quesnel TSA
MFR Region: SI; NI

Y073026 Effects of climate change on avian communities and implications for sustainable forest management

Ann Chan-McLeod
University of British Columbia

What will be the impacts of future climate conditions on bird communities in BC's boreal forests?

Bird species are being considered as sustainability indicators in forest monitoring programs. However, certain indicators may collapse if interspecific interactions are altered by a changing climate. This study examined climate-change impacts on bird communities in BC. Using a hindcasting approach with historical bird data, the authors found that many bird species will experience changes in population size by 2020 due to climate change, with even more pronounced changes beyond 2020. For some species these changes are beneficial, while for others they are detrimental.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $128,504
Location: Boreal forest
MFR Region: NI

Y073045 A species accounting system to integrate indicators of biological diversity

Fred Bunnell
University of British Columbia

How can economic and ecological values be incorporated in an integrated measure of success in sustaining biodiversity?

This project extends a decision-support tool for exploring different approaches to forest planning and their consequences to economic and ecological values, by providing an integrated measure of success in sustaining biodiversity. This integrated measure combines the indicators of biodiversity assessed at three scales: ecosystem representation; habitat amount, structure, and distribution; and organisms.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $220,887
Location: East Kootenays
MFR Region: SI

Y073128 Benthic macroinvertebrate sustainability indicator development for SFMP and LRMP applications

Ian Sharpe
Ministry of Environment

What is an effective indicator of aquatic ecosystem health?

In BC, forest harvesting regulation is moving from prescriptive to outcome-based management, creating the need for new tools to measure the effectiveness of management practices. This project developed two bio-assessment models to compare the degree of environmental stress in a particular aquatic system, relative to reference conditions based on natural variability in model indicators. Predictions of both models were highly significant and were deemed by the authors to be acceptable for site testing.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $230,832
Location: New Nadina and Bulkley Stikine FDs
MFR Region: NI

Y082020 Indicators of biodiversity within aspen stands of the Interior Douglas-fir zone

Karl Larsen
Thompson Rivers University

What is the potential contribution of aspen-dominated stands to meeting biodiversity objectives in the Douglas-fir–dominated dry interior forests?

Evidence suggests that aspen stands within the largely Douglas-fir–dominated dry interior forests may support a relatively abundant and diverse faunal community, but the potential contribution of these stands to biodiversity has not been extensively explored. This project assessed the biodiversity contribution of these stands by comparing communities of three bioindicator species – carabid beetles, small mammals, and cavity-nesting birds – to neighbouring Douglas-fir and mixedwood stands. The results confirm that these stands support a diverse and abundant community of carabid beetles, small mammals, and cavity-nesting birds, a large volume and density of coarse woody debris and snags, and a rich and abundant community of plants, suggesting that these forests are extremely important for ecosystem integrity within the dry interior forests of BC.

Initiated: 06/07
Duration: 2 *years*
09/10: $0
Total: $59,803
Location: Kamploops
MFR Region: SI

Y082024 Sustainable forestry indicators derived from airborne LIDAR data and high spatial resolution satellite imagery

Nicholas Coops
University of British Columbia

What is the capacity of LiDAR as a tool for estimating selected indicators of forest sustainability?

Light Distance And Ranging (LiDAR) technology shows great promise as a cost-effective and time-efficient method for estimating and monitoring a variety of indicators of forest sustainability in BC. In this project the ability of LiDAR with respect to digital elevation model interpolation (DEMs being a key derivative of LiDAR data from which numerous indicators are then derived) and wildlife tree class distribution estimation was assessed. Results include the recommendation that a range of interpolation techniques and spatial resolutions be explored and validated when deriving DEM products, and a demonstration of the capacity of LiDAR to estimate the cumulative proportions of wildlife trees within forest plots.

Initiated: 06/07
Duration: 2 *years*
09/10: $0
Total: $105,279
Location: Coast
MFR Region: C

Y082172 Development of a microbial indicator database for validating measures of sustainable forest soils

Richard Winder
Natural Resources Canada

How can the use of microbial indicators to validate soil health measurements for sustainable forest management be expedited?

There is a need to gather the available information on soil microbial communities to one common point of reference, in order to fully realize the potential of these organisms as indicators of soil and forest health. To address this need, this project developed and tested a microbial indicator database using MS Access, a web-based interface for database query and data deposit, and software for indicator analysis using the database. Prototype tools have been successfully developed using a modest dataset applicable to indicators of productivity and tree loss in one area of coastal Douglas-fir forest in BC, and further expansion will allow for increased utility of the dataset in validating forest soil conservation guidelines, in B.BCCanada, and throughout the world's forests.

Initiated: 06/07
Duration: 2 *years*
09/10: $0
Total: $79,401
Location: Coast
MFR Region: C

Y083030 Terrestrial gastropods as indicator species for monitoring biodiversity effects from variable retention harvesting practices

William J. Beese
Western Forest Products Inc.

How do patterns of abundance and species diversity of gastropod fauna respond to different levels and spatial patterns of variable retention?

Terrestrial gastropods are sensitive to changes in moisture and temperature regimes of a forest, and thus may be good indicators of the effects of variable retention (VR) logging practices. This project examined patterns of abundance and species diversity of gastropod faunas at experimental sites subjected to clearcutting and various VR-treatments by comparing results of pre- and post-disturbance surveys. The study has produced a number of management recommendations to date, including: VR-groups should be as large as possible, especially in even-aged second growth stands; strategies that conserve moisture and protect sensitive riparian zones are desirable, including anchoring VR-groups on wetlands or moist depressions.

Initiated: 05/06
Duration: 3 *years*
09/10: $0
Total: $149,058
Location: TFLs 39 and 44
MFR Region: C

Y093010 Developing indicators of soil productivity, function, and biodiversity through soil biotic communities

Marty Kranabetter
Bulkley Valley Centre for Natural Resources Research and Management

What biological indicators of soil condition can be used to assess sustainability of soil productivity and to identify site-degrading forest practices?

This project investigated potential indicator species for forest management through studies of old-growth boreal stands encompassing a range of inherent site productivity. Overall results showed a large source of biodiversity associated with forest soils and substrates (6 times the diversity of the vascular plants), and a large pool of potential species for environmental monitoring. Indicators could include those species representing oligotrophic, mesotrophic or eutrophic soil conditions, and functional organization such as the balance of rare versus common species on the landscape.

Initiated: 06/07
Duration: 3 *years*
09/10: $0
Total: $100,297
Location: Boreal forest
MFR Region: NI

Y093040 Alternative indicators of the integrity of stream function as an assessment of sustainable forest management

John Richardson
University of British Columbia

What indicators of stream integrity might be applied in streams that have few or no fish species?

The project compared three alternative measures of stream condition for concordance both with one another and with assemblages of stream benthic invertebrates. The measures include algae, aquatic fungi associated with the decomposition of leaf litter (primarily hyphomycetes), and rates of breakdown of leaf litter. Results show that logged streams have much slower rates of leaf litter decomposition. The study further found that biodiversity is important: a diverse stream community can mitigate the effect on forest logging and logging road construction on stream local productivity and on fine sediment export to water reservoirs in base flow. The study concludes that, while requiring further development, leaf litter decomposition and benthic invertebrates appear to be the best indicators of forest harvesting impacts on stream ecosystems.

Initiated: 06/07
Duration: 3 *years*
09/10: $0
Total: $216,159
Location: Coast
MFR Region: C

Y093074 Hydrologic indicators for watershed sensitivity to peak flow changes in small upland watersheds

Marwan Hassan
University of British Columbia

How effective are bankfull and effective discharge as indicators of watershed sensitivity to changes in peak flow, sediment transport, and stream channel morphology?

To understand the potential effects of changes in forest cover on stream channels, particularly in small watersheds, it is necessary to understand the return periods of bankfull and effective discharges in those watersheds. This project was designed to characterize the range of return periods and evaluate the scaling relations of bankfull and effective measures of discharge, and assess the effectiveness of both discharge measures as indicators of watershed sensitivity to changes in peak flow. Results showed that bankfull and effective discharge are good indicators of watershed sensitivity; however, detailed morphological assessments are required to evaluate watershed stability.

Initiated: 06/07
Duration: 3 *years*
09/10: $0
Total: $137,860
Location: Small watersheds throughout the province
MFR Region: P

Y093282 Using GIS and multivariate statistical analysis to assess the relations between aquatic habitat indicators and forest harvesting at both stream reach and watershed scales

Adam Wei
University of British Columbia

How sensitive are commonly used aquatic habitat indicators to forest management and land use changes?

Despite significant efforts devoted to selection of forest sustainability indicators for application under the results-based Forest and Range Practices Act (FRPA), the application of many watershed indicators has not been well tested. This project used GIS and multivariate statistical analysis to assess the relationships between aquatic habitat indicators and forest harvesting. The study identified watershed- and reach-level indicators that are sensitive to forest management practices; these indicators should provide good measures of whether aquatic values are being maintained for SFM planning.

Initiated: 06/07
Duration: 3 *years*
09/10: $0
Total: $175,017
Location: Southern interior
MFR Region: SI

Y093284 Soil disturbance effects of hoe-forwarding on tree growth and site productivity

Mary-Jane Douglas
Foresol Consulting Ltd.

How does the soil disturbance associated with ground-based harvesting systems affect tree growth over the short- and long-term?

Ground-based harvesting systems disturb forest soils and may potentially lead to short- and long-term reductions in tree and forest productivity. This project assessed the long-term effects of soil disturbance on site productivity through measurement of tree growth and nutritional status in three existing field experiments established 5, 14, and 15 years ago. Results indicate that hoe-forwarding during wet soil conditions may result in reduced growth and performance of Douglas-fir and other species over the longer term. The extent of such detrimental effects can be controlled with the use of protective puncheon or mats, and by the pattern of forest harvesting. In addition, rehabilitation of localized, heavily disturbed areas will also reduce the overall level of detrimental soil disturbance across the cutblock.

Initiated: 06/07
Duration: 3 *years*
09/10: $0
Total: $79,635
Location: Coast
MFR Region: C

Y104005 Using stereoscopic high-resolution satellite imagery to assess landscape and stand-level characteristics

Denis Collins
Ministry of Forests and Range

How can landslides be most effectively detected using high-resolution multi-spectral remotely sensed imagery?

Past reviews have recommended that the Ministry of Forests and Range (MOFR) conduct regular inventories of landslides as part of the Forest and Range Evaluation Program, as there is no FRPA requirement for licensees to report landslides. This project will acquire IKONOS satellite imagery, which possesses the three main imagery properties required for effective landslide detection (high spatial resolution, multispectral data collection, and stereoscopic viewing), for 3D photogrammetric analysis and interpretation to detect landslides. The methods derived from this approach could be used by the MOFR for their ongoing inventories of landslides (and possibly other resource features such as mountain pine beetle attack sites), and would provide knowledge of landscape- and stand-level characteristics that can be derived from stereoscopic, high-resolution satellite imagery.

Initiated: 06/07
Duration: 3 *years*
09/10: $29,376
Total: $104,491
Location: Province-wide
MFR Region: C

S 3.1.6 Range health (upland and riparian) (Retired 2006)

Y071047 Impact of cattle foraging on understorey plant biodiversity (range health) using long-term exclosures

Thomas Sullivan
University of British Columbia

What is the impact of continued annual cattle grazing on vegetation and native ungulates?

Abundance and structural diversity of vegetation can act as an indicator of range health for sustainable forest management; however, the impact of annual cattle grazing on understorey vegetation in young lodgepole pine stands has not been addressed in any meaningful way. This study seeks to assess the impact of cattle grazing on vegetation communities and on habitat use by native ungulates, and develop vegetation indicators of "range health", through the analysis, synthesis, and extension of field data on understorey vegetation collected during the period 1992–2003. Results indicate that the impacts of cattle disturbance on plant community abundance and diversity, and on relative habitat use by native ungulates cannot be generalized as either detrimental or beneficial; and that of the several hundred plant community attributes analyzed, only a few have potential as indicators of grazing intensity.

Initiated: 06/07
Duration: 1 *year*
09/10: $0
Total: $37,800
Location: Summerland, Kelowna, Cariboo
MFR Region: SI

S 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

Y051116 EpHects - a cumulative effects analysis method using automated continuous pH measurements in streams

Edward J. Quilty
University of British Columbia

Can analysis of pH cycles provide an indicator of cumulative effects of forest harvesting on stream ecology?

Changes to aquatic life caused by disturbances to forest streams may cause deviations in the streams' diurnal pH cycle. This project tested the utility of using detailed analysis of pH cycles for assessment of cumulative effects of forest harvesting on stream ecology. The technique was found to be ineffective for relatively unproductive coastal streams. However, the technique was useful in higher productivity streams, indicating that it may have applicability to forested streams in the Interior of BC.

Initiated: 04/05
Duration: 1 *year*
09/10: $0
Total: $28,603
Location: Maple Ridge
MFR Region: C

Y073113 Development of indicators of stream condition, function, and capacity for juvenile salmon

Jordan Rosenfeld
Ministry of Environment

What are the best physical and biological indicators of stream conditions for rearing juvenile salmon?

The goal of this project was to determine the best physical and biological indicators of stream conditions. The project used field sampling, laboratory analysis, and statistical approaches to develop a rapid assessment protocol for assessing stream capacity for rearing juvenile salmon. Preliminary analysis indicated no relationship between fish density and the indicators assessed. However, analysis continued beyond the duration of FSP funding.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $77,696
Location: Lower Mainland and southern interior
MFR Region: C; SI

S 3.1.8 Developing and evaluating uses of remote sensing, information systems, and innovative technology to assess landscape- and stand-level characteristics (Retired 2008)

Y071006 Developing a cumulative effects model of forest aesthetics at the landscape-level: automating the spatial design and planning of variable retention

Michael Meitner
University of British Columbia

What is the relationship between timber extraction levels, visible alteration percentages, and timber availability?

As pressure to harvest in scenic vistas increases due to increasing demand for timber, Visual Resource Management aims to reduce the impact of harvests and improve their scenic design, while trying to minimize the effect on timber availability. This project develops and tests a decision support tool for designing harvest plans at the site level that minimize the negative visual impacts, for any given timber extraction level. Results suggest that there is potential for achieving increased levels of aesthetic design while also increasing timber availability.

Initiated: 06/07
Duration: 1 *year*
09/10: $0
Total: $36,006
Location: Vancouver
MFR Region: P

Y071166 Application of remote sensing to detect changes in vegetation structure from differing land treatment levels in the Kootenay region of British Columbia

Robert Magai
Selkirk Geospatial Research Centre

Can airborne remote sensing be used to detect changes in vegetation structure in response to soil disturbance?

Monitoring changes in understorey vegetation as a result of site disturbance can be labour-intensive and can benefit from innovative methods such as high-resolution remote sensing that is capable of monitoring large areas of land in short time periods. This project examines the applicability of airborne remote sensing to detect the changes in vegetation structure in response to predetermined levels of soil disturbance by comparing vegetation cover classifications derived from aerial photography with ground-estimated vegetation plots to determine the accuracy of the digital classification. Results indicate that remotely sensed data were capable of detecting severe soil disturbance patterns in the landscape but were less capable of detecting differences in different cover classes. Nevertheless, this study indicates that vegetation cover is a suitable indicator of severe soil disturbance and may be useful as a visual classification system in adaptive forest management.

Initiated: 06/07

Duration: 1 *year*

09/10: $0

Total: $28,531

Location: Low elevation forests in the east and west Kootenay of British Columbia.

MFR Region: SI

Y093062 Integration of airborne LiDAR and hyperspectral remote sensing data to support the Vegetation Resources Inventory and sustainable forest management

Olaf Niemann
University of Victoria

How can an approach that integrates LiDAR and hyperspectral remote sensing best support current and anticipated future requirements of the VRI at the management unit level?

This project implemented a medium-scale (75,000 ha) proof-of-concept study to evaluate the capability of integrated high-spatial-resolution LiDAR and hyperspectral remote sensing datasets to support Phase I and II stages of the VRI. Site-specific LiDAR-based calibration equations were developed for Phase I estimates of stand height, gross volume, crown cover, basal area, and stem density using Phase II ground-reference data. In addition, high-spatial-resolution airborne hyperspectral data was evaluated for identification of tree species composition and diversity at the stand-level. The project also considered which VRI attributes can be accurately measured using an integrated LiDAR/hyperspectral RS approach. Comparative results show that these approaches are at least on par with more traditional survey techniques; however, further work is still required to fully exploit all attributes which can be obtained from hyperspectral remote sensing and LiDAR.

Initiated: 06/07

Duration: 3 *years*

09/10: $0

Total: $197,690

Location: Southern interior

MFR Region: SI

S 3.2 Ecological sustainability

S 3.2.0 Unclassified

Y061046 Developing thresholds for a key hydrologic indicator of watershed function: equivalent cut area

Younes Alila
University of British Columbia

What are the hydrological effects of total clearcut of an entire watershed, and what is the nature of the relationship between these effects and hydrologic recovery over time?

The urgency to understand how clearcutting affects hydrology has increased with recent pine beetle epidemics and wildfires that are creating disturbances in large watersheds equivalent to 100% equivalent clearcut area (ECA). This project uses the University of British Columbia Watershed Model (UBCWM) at two interior, snow-dominated watersheds to quantify the effects of total clearcut of an entire watershed and investigate the nature of the relationship between these effects and hydrologic recovery over time. Several conclusions were drawn: (1) within the first 10 years of forest regeneration, regardless of the method of regeneration, statistically significant differences in peakflow and water yield between the regenerated forest and the control forest exist; (2) differences in peakflow and water yield are statistically insignificant after 30 years for regeneration estimated by regression analysis on MoF inventory data; (3) regenerated peakflow and water yield are smaller than the control peakflow and water yield for the regeneration estimated with TIPSY; and (4) watershed physiographic characteristics, such as aspect and watershed area, affect the magnitude of forest regeneration effects.

Initiated: 05/06
Duration: 1 *year*
09/10: $0
Total: $59,850
Location: Southern interior
MFR Region: SI

Y061143 Deriving and measuring the soil-based thresholds required for maintaining ecosystem productivity under a Sustainable Forest Management Plan

Steven Day
Canadian Forest Products Ltd.

Is soil organic matter an effective indicator of ecosystem productivity?

Maintaining ecosystem productivity is fundamental to the principles of sustainable forest management (SFM), and yet there is still no effective method for measuring and monitoring the impacts of management activities on ecosystem productivity. This project combined field measures of soil organic matter (SOM) with an ecosystem management model to derive threshold values for SOM and evaluate the practicality of implementing an SFM monitoring program around this indicator. Results indicate that SOM is an effective indicator of long-term soil productivity, and that shorter rotations can lead to a loss of SOM.

Initiated: 05/06
Duration: 1 *year*
09/10: $0
Total: $45,360
Location: Quesnel TSA
MFR Region: SI

Y071269 Range of natural variation in structural attributes of young stands: refining current indicators

Ruth Lloyd
Bulkley Valley Centre for Natural Resources Research and Management

How can the range of natural variability be used to guide retention levels when designing silvicultural treatments?

Ecosystem-based management assumes that risk to biodiversity increases as levels of retention move beyond natural levels. This project characterizes the range of natural variability (RONV) in density, size-class distributions, and cover (as appropriate) of snags, downed wood, large live trees, shrubs, and forest floor conditions in young and immature (< 60 yr) naturally disturbed stands of different disturbance origin. In addition, a multivariate classification model was developed to distinguish between tree types of natural disturbance. While for most attributes the overall RONV covered all levels of retention, the authors suggest that the mean and standard deviation could be used to guide risk analyses.

Initiated: 06/07
Duration: 1 *year*
09/10: $0
Total: $59,820
Location: Babine River Watershed
MFR Region: NI

S 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

Y082015 Developing thresholds for within-stand biodiversity indicators

Fred Bunnell
University of British Columbia

What can existing data tell us about the appropriate thresholds for within-stand biodiversity indicators?

Practically, forest managers are limited to simple approaches (stands are removed in whole or in part; trees are regenerated naturally or by humans) and to simple indices to guide harvest (simple enough to cover the large areas necessary in planning or monitoring), so a way is needed to identify a short list of habitat features that connect directly with biodiversity, are manipulated by forest practices and are readily monitored. This project collated and analyzed relevant data to extract apparent thresholds for within-stand biodiversity indicators (medium to coarse-filter). Interim conclusions include: for live trees, dead trees and down wood-diameter is the best predictor of availability to sustain biodiversity among fungi, lichens, bryophytes, invertebrates, and vertebrates; the relationship between abundance of a species and retention level in a stand can guide decisions on the relative allocation between retention within stands and landscape-level reserves; landscape-level roll ups of indicators provide significantly more guidance than within stand measures on their own.

Initiated: 06/07
Duration: 2 *years*
09/10: $0
Total: $85,179
Location: Province-wide
MFR Region: P

Y092173 **Integration of information on ectomycorrhizal fungal species for use as indicators of sustainable forestry in British Columbia**

J.A. Tony Trofymow
Canadian Forest Service

Can the ability to identify ectomycorrhizal fungal species be improved to promote the use of this taxon as an indicator of biodiversity and soil ecosystem responses to forest practices?

Ectomycorrhizal (ECM) fungi can serve as excellent fine-filter indicators of biodiversity and soil ecosystem response to forest practices. To facilitate use of ECM fungi as indicators of sustainable forestry, DNA and morphological data were prepared for ~150 ECM isolates recovered from recent FIA-FSP projects in coastal and southern interior regions. These new data plus data for 343 ECM types previously published have been posted to the BC Ectomycorrhizal Research Network (BCERN) website in common format and for 16 select species detailed descriptions and images were published in three new folios of a Manual of Concise Descriptions of Ectomycorrhizae. Recommendations include to develop the application of this indicator include developing thresholds and response curves for application in forest practices monitoring, .

Initiated: 07/08

Duration: 2 *years*

09/10: $0

Total: $47,304

Location: Coast and southern interior

MFR Region: P

Y092251 **Effects of habitat composition on the fitness of a mature forest indicator; do thresholds exist?**

Todd Mahon
Bulkley Valley Centre for Natural Resources Research and Management

Does the empirical response of northern goshawk to significant habitat loss support the fundamental principles of landscape ecology upon which landscape targets in SFM plans are generally based?

Minimum thresholds or desired ranges for landscape composition and pattern in SFM plans are generally based on principles of landscape ecology; however, there is little empirical evidence to support much of this theory. This project quantified functional habitat relationships of the northern goshawk, a wide-ranging, mature forest-dependent habitat specialist that is relatively insensitive to habitat configuration. Current results suggest that three potential habitat thresholds should be considered for landscape-scale goshawk habitat management strategies: 60%, 40%, and 20% mature forest (structural stage 6 and 7; >120 years), corresponding to high, moderate, and low probabilities of territory occupancy, respectively. These targets could be used to designate occupancy targets for each Landscape Unit within a TSA or operating area. More detailed analysis of the relationship between territory condition and occupancy will be conducted over the next year and adjusted threshold values may result from that analysis.

Initiated: 07/08

Duration: 2 *years*

09/10: $0

Total: $135,648

Location: SBS and ICH in the Lakes, Morice and Kispiox TSAs

MFR Region: NI

Y103033 Ecosystem recovery after disturbance: thresholds for biodiversity and resiliency indicators

Evelyn Hamilton
Ministry of Forests and Range

Does ecological resilience increase with productivity & adaptation to wildfire?

It is hypothesized that ecological resilience, defined as the amount of disturbance or stress that an ecosystem can absorb and still recover to the same stability domain, increases with site productivity and decreases with the length of intervals between wildfires. This study will test this hypothesis by fitting linear and non-linear mixed models to three vegetation indicators of biodiversity (rate of recovery of vegetation biomass; rate of recovery of species richness; rate of recovery of original species composition), to define response curves for measuring ecological resilience in SBS, ESSF, & ICH forest ecosystems in central BC. The results of this work will assist forest managers in determining whether proposed forest management prescriptions are likely to negatively impact upon the functioning of ecosystems; address First Nations concerns about the sustainability of forest management practices, for example, the effects of harvesting on the abundance of species with important indigenous values such as berries; and enhance development of stand decision tools such as PROBE & PROGNOSIS.

Initiated: 07/08

Duration: 3 *years*

09/10: $21,000

Total: $89,931

Location: ICH, SBS, and ESSF zones

MFR Region: SI; NI

Y103119 Determining thresholds of habitat quality for breeding birds in rangeland ecosystems in the Cariboo region

David Green
Simon Fraser University

What are the threshold levels of habitat variables related to community indices and productivity of rangeland birds, and what micro-scale habitat attributes are rangeland birds selecting for nesting habitat?

BC's rangelands are a dynamic ecosystem with change driven by grazing, fire, and changing climatic conditions; maintaining the ecological resilience of these ecosystems is of vital importance to ranching and to conserving rangeland biodiversity. This project will determine if there are thresholds of habitat quality for rangeland birds in the Southern Interior by defining response curves for the relationship between habitat structure and composition across a gradient of rangeland (dry forest and grassland) vegetation communities associated with varying levels of livestock grazing and the diversity, abundance, and productivity of rangeland birds. The results will be applied to the development of Best Management Practices for land managers from government, industry, and NGOs to promote the sustainable resource use of rangelands in the Southern Interior.

Initiated: 07/08

Duration: 3 *years*

09/10: $55,151

Total: $140,885

Location: OK Ranch, Clinton; Talking Mountain Ranch; Churn Creek Protected Area; Junction Sheep Range Prov Park

MFR Region: SI

Y103185 Food web dynamics of flying squirrels, red squirrels, and voles along a 100-year gradient of stand age following clearcut logging and wildfire

Daniel Durall
University of British Columbia

Can a better understanding of the trophic interactions and implications of fungal communities lead to the development of more sensitive indicators of changes in ecological resilience?

Less visible ecosystem components such as trophic structure and food web dynamics may be more sensitive to ecosystem perturbations and to the recovery from perturbations than the usual indicators of ecological resilience associated with landscape patterns, biodiversity, and stand structure. This project will determine the relationship between ectomycorrhizal fungi and the vertebrates known to use the fungi as a source of food, using an existing inventory of ectomycorrhizal fungi from a chronosequence of sites recently established to study possible thresholds of ectomycorrhizal fungal diversity and community structure. Understanding the relationship between mycorrhizal communities and the vertebrates that feed on them will provide important insight into how food web dynamics change as forests mature, ultimately leading to the possible development of more sensitive indicators of ecological resilience.

Initiated: 07/08

Duration: 3 *years*

09/10: $18,576

Total: $105,700

Location: ICH between Lumby, Enderby, and Salmon Arm

MFR Region: SI

S 3.2.2 Determining the likely range of natural variability (biological and biophysical) of coarse- through fine-filter indicators to aid in the determination of management thresholds (Retired 2008)

Y092066 Cost-effective indicators of soil physical condition: natural variation in the relative bulk density and associated tree growth as measures of forest productivity and ecosystem resilience

Maja Krzic
University of British Columbia

Can relative bulk density be used as a reliable and cost-effective measure of soil compaction state, and as an indicator of potential impacts to site productivity?

Recent advances in characterizing and interpreting soil physical conditions have provided land managers with an opportunity to evaluate ecosystem sustainability in a cost-effective way through the use of relative bulk density (RBD) as a measure of compaction. This project calculated RBD for six experimental forest sites in the northern interior of BC and determined thresholds for RBD in relation to tree growth for three tree species: interior Douglas-fir, Lodgepole pine and hybrid spruce. Results indicate that the presence of surface organic material mitigated compaction and was often associated with lower RBD; in addition, they suggest that soil rehabilitation should be considered on disturbed sites where soil RBD is > 0.80.

Initiated: 07/08

Duration: 2 *years*

09/10: $0

Total: $57,321

Location: Okanagan Falls, Vernon, Westwold, Kamloops, and Fort St James

MFR Region: SI; NI

S 3.2.3 Defining biophysical or indigenous knowledge-based 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? (Retired 2008)

Y051023 Refining conservation priorities in British Columbia

Fred Bunnell
University of British Columbia

Which species should be priorities for conservation efforts in BC?

Currently in BC, priorities for species conservation are based on provincial and federal lists, where the importance placed on local rarity can lead to conservation effort being diverted from globally threatened species to species at the periphery of their range. This project assigns conservation priorities to species, accounting for both the global threat to a species and the importance of maintaining peripheral populations. The project results indicate that we currently expend too much conservation effort on peripheral populations, at the expense of taxa for which the province has a high stewardship responsibility in a global context.

Initiated: 04/05
Duration: 2 *years*
09/10: $0
Total: $96,242
Location: Province-wide
MFR Region: P

Y082069 Effective landscape-level planning approaches to sustain biodiversity in the managed forests of southeastern British Columbia

Ralph Wells
University of British Columbia

How can landscape-level planning be improved to maximize complementarity (through overlap among objectives), while minimizing economic impacts for biodiversity objectives?

Decision support tools provide a framework for improving the effectiveness, efficiency, and equability of landscape-level planning efforts to conserve biodiversity on managed forest lands. This project applied the Marxan reserve network design model to meet area-based targets for selected biodiversity indicators designed to assess whether biological richness and its associated values will be sustained as proof-of-concept of a conservation approach to integrate landscape-level objectives on Crown and private lands. The project demonstrated that Marxan can be used as a decision-support tool to efficiently meet targets and maximize complementarity (through overlap among objectives), while minimizing economic impacts for biodiversity objectives in the Invermere TSA. It also resulted in some conservation objectives and targets being incorporated into Sustainable Forest Management plans by the three major forest licensees who operate in the TSA.

Initiated: 06/07
Duration: 2 *years*
09/10: $0
Total: $70,310
Location: Rocky Mountains
MFR Region: SI

Y103261 Biogeochemical indicator and threshold for assessing ecological impacts of riparian forest management on downstream ecosystems

Takashi Sakamaki
University of British Columbia

What are the impacts and zone of influence of riparian forest management activities on the physical and chemical structure of habitats and food webs in downstream ecosystems, and what indicators and thresholds are appropriate for monitoring and managing these effects?

It is unclear how forestry activities in riparian areas modify downstream ecosystems and how far along streams they affect, because specific indicators and thresholds have not been established to coherently assess effects of forest management on downstream ecosystems. The objectives of this project are to (1) analyze longitudinal transports of particulate organic matter (POM) exported from upstream riparian forest management sites, (2) analyze biological effects of the exported POM on downstream ecosystems including estuaries, and (3) propose biogeochemical indicators and thresholds to assess effects of upstream riparian forest management on downstream ecosystems. The development of these indicators and thresholds will enhance forest management schemes.

Initiated: 07/08

Duration: 3 *years*

09/10: $64,103

Total: $216,599

Location: East coast of the Vancouver Island and Sunshine Coast, Squamish River, and Chilliwack River

MFR Region: C

S 3.2.4 Development of indicator targets and management thresholds for sensitive species and ecological communities, especially those species and communities designated under the Forest and Range Practices Act and regulations as "at risk", "regionally significant", or "specified ungulates". (Also see Topic 2.1 – Resource modeling, and Topic 4.1 – Species at risk recovery research)

Y103167 Quantifying the responses of songbirds and woodpeckers to changes in habitat at the stand and landscape scales – does intensive monitoring result in different response curves?

Kelly Squires
Simon Fraser University

How do species respond to changes in habitat attributes, and can response curves be used to set reliable retention or other targets?

The measurement of abundance and reproduction, in response to habitat attributes more closely tied to known habitat requirements, will make significant contributions to the empirical assessment of the "threshold" approach to management. This project will (1) quantify the responses of forest songbirds and woodpeckers to changes in habitat attributes at the stand and landscape scales; (2) test for thresholds in responses to habitat change; (3) compare the response curves generated by intensive survey methods used in the proposed study with those generated by a related study in the same area using a standard, less intensive survey method; and (4) synthesize the literature and extend other approaches to develop a protocol to identify focal songbird and woodpecker species for northeastern BC. The results will inform target-setting, provide useful information on the effectiveness of current forest practices, and allow prediction of the likely effects of changes in management practices.

Initiated: 07/08

Duration: 3 *years*

09/10: $10,700

Total: $31,018

Location: Dunne-za territory

MFR Region: NI

S 3.2.5 Clarification/refinement of thresholds for indicators of change in watershed functioning (e.g., road density, equivalent clear-cut area)

Y092171 Equivalent clear cut area thresholds in large-scale disturbed forests

Markus Weiler
University of British Columbia

Can remote sensing technologies be used to improve predictions of changes in hydrological processes in response to large-scale canopy disturbances?

There is little empirical data or the modeling capability to explore the linkages between canopy structure and snow interception/shading of riparian areas due to the infeasibility of parameterizing existing stand-level models over large areas. This project assessed the capacity of Light Detection and Ranging (LiDAR) data to assess changes in forest cover and structure due to beetle infestation at both the individual tree and stand-level. These results were combined with field measurements of snow accumulation and melt and data from forest cover maps to derive new guidelines for the calculation of equivalent clearcut area in large-scale disturbed areas. An important conclusion is that combining the structure information derived from LiDAR technology with assessment of health status from aerial imagery provides unique quantitative data that may be used to map lodgepole pine stands according to structural attributes that are relevant to both silviculturalists and hydrologists.

Initiated: 07/08
Duration: 2 *years*
09/10: $0
Total: $152,960
Location: Between Quesnel and Vanderhoof
MFR Region: NI

Y103004 Thresholds for post-wildfire flood, erosion, and mass wasting processes

Peter Jordan
University of British Columbia

What vegetation and soil burn severity and extent is necessary to generate sufficient overland flow in a watershed to cause flooding and erosion, and what are the roles of water-repellent soils and forest floor alteration in these processes?

Normally, forest soils rarely or never generate extensive overland flow. However, changes to the soil following fire can create a threshold in hydrologic response whereby overland flow generates exceptionally high peak runoff on a watershed scale that may, in turn, cause severe erosion, debris flows, and landslides. This 3-year research project will study the thresholds of hydrologic change through field investigation of soil and hydrologic conditions following wildfires. The results of the study should provide improved science-based tools for assessing and mitigating post-fire changes in hydrology, and the risks presented by these changes to communities and infrastructure.

Initiated: 07/08
Duration: 3 *years*
09/10: $106,920
Total: $323,401
Location: Southern interior
MFR Region: SI

S 3.3 Social, cultural, and economic sustainability

S 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

Y092250 Valuing low-elevation old-growth forests of the southwestern British Columbia mainland: an application of the contingent choice and production function techniques

Wolfgang Haider
Simon Fraser University

How can cost-benefit analyses be used to understand values and conditions associated with forest management options and how can these results be integrated into forest management decisions?

This project was a comprehensive valuation of management options for the forested region of southwest mainland BC considering use and non-use values. The project consisted of two distinct components. Year 1 was a contingent choice survey measuring the existence (i.e. non-use) values that the general public of southwest mainland BC hold for species at risk and their associated habitat. Year 2 modeled the impact of sedimentation from forest road use on water quality. The general public was found to value the existence of old-growth dependent species at risk, but the greatest welfare was obtained when use values (harvesting and recreation) are balanced with non-use values (old-growth dependent species at risk). In addition, the general public is willing to pay for conservation of species at risk in the form of increased taxes, even if the risks of failure are high. Furthermore, the study found that a mixed effects model can be used to determine a watershed's optimal use that balances salmon production and the supply of clean drinking water with timber harvest. Together the results from these studies will be used to update an initial cost-benefit analysis.

Initiated: 07/08
Duration: 2 *years*
09/10: $0
Total: $77,025
Location: Lower Mainland of BC
MFR Region: C

S 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

Y093002 Common knowledge, values and perceptions of sustainable forest management held by First Nations communities

Ronald Trosper
University of British Columbia

How can First Nations' values and approaches to land management be integrated into the criteria and indicator frameworks used to guide sustainable forest management?

With the increasing allocation of timber harvesting rights to First Nations it is important to better understand aboriginal values and criteria and indicators of sustainable forest management that have been identified by indigenous peoples elsewhere. This project reviewed previous aboriginal local-level criteria and indicators, verified the relevance of those indicators and expressed them in appropriate ways, identified new criteria and indicators of SFM, and identified the priorities given to the indicators by different First Nations. The project demonstrates a methodology that allows both the expression of different First Nations values and comparison of those values with and among First Nations.

Initiated: 06/07
Duration: 3 *years*
09/10: $0
Total: $168,318
Location: Province-wide
MFR Region: P

Y093307 Improvement of social, economic, and other indicators of sustainable forest management and tools for their integration

John Innes
University of British Columbia

How do the values and priorities of various stakeholders, public groups, and First Nations affect the viability of the monitoring schemes they aim to create?

In this study, sustainable forest management (SFM) indicators employed by 13 different forest management entities in BC were analyzed according to their use and associated monitoring costs. Exploration of the data revealed that there are five distinct organizational perspectives on stewardship among the 13 case studies, primarily related to the degree of access and control to resources. These results represent important policy signals for government when attempting to craft a cohesive SFM policy across a broad scale of diverse landscapes and cultures.

Initiated: 06/07
Duration: 3 *years*
09/10: $0
Total: $98,999
Location: Campbell River FD
MFR Region: P

S 3.3.3 Development of methods to aggregate social and economic data for inclusion in forest and range land-use planning processes

Y071036 A synthesis of BC public perception survey results and techniques for quantifying social indicators in forest planning

Stephen R.J. Sheppard
University of British Columbia

What are the public's social preferences regarding management of forest resources in BC?

This project collated results from several recent studies on public perceptions related to social indicators in forest planning. The focus of the project was to communicate research results to the scientific and forestry practitioner community. Products of the project were two presentations, two extension notes, and six articles.

Initiated: 06/07
Duration: 1 *year*
09/10: $0
Total: $36,383
Location: Province-wide
MFR Region: P

Y071311 Open access, common pool resources, and non-timber values: a model for government intervention

Sumeet Gulati
University of British Columbia

How does a government know when to intervene in the commercial exploitation of common pool resources and open access situations, such as the harvesting of non-timber forest products?

The commercial harvest of non-timber forest products (NTFPs) from Crown, or public land has proceeded for decades in BC, yet no formal regime exists to incorporate these values into forest resources management. This project develops a model for evaluating institutional (market and government) failure in the exploitation of common pool resources within an unregulated open access environment, and the subsequent necessity for government intervention. The model provides policy analysts with a qualitative rationale for intervention in common pool resource situations where over-exploitation of a resource and tragedy of the commons outcome is likely, and can pinpoint attributes of the resource system where intervention is more likely to be of benefit.

Initiated: 06/07
Duration: 1 *year*
09/10: $0
Total: $14,749
Location: Southern British Columbia
MFR Region: SI

S 3.3.4 Development of approaches to quantify impacts on, and determine compensation processes for, parties affected by forest and range management activities

Y081059 Institutional mechanisms for the spatial and inter-temporal transfer of fiscal capacity in rural British Columbia

George Hoberg
University of British Columbia

Are fiduciary trust arrangements a suitable mechanism by which to transfer fiscal capacity to rural communities?

Uncertainty around future forest conditions and impacts on rural British Columbia indicate a need for institutional mechanisms, such as fiduciary trust arrangements, that transfer fiscal capacity on a regional and inter-temporal basis. Through literature review, interviews, and case study analysis, this research has identified key variables influencing the success of trust arrangements. Overall, trust mechanisms appear to be a strong structure for distributing funds and supporting community development, and allowing them to develop strong local ties and utilize existing infrastructure seems likely to increase their overall effectiveness and maximize distributional efficiency.

Initiated: 07/08

Duration: 1 *year*

09/10: $0

Total: $22,510

Location: coast and northern interior of British Columbia; Edmonton, Alberta

MFR Region: P

Y103077 Development of appropriate economic and social indicators of sustainable forest management

John Innes
University of British Columbia

To what extent can indicators derived for community forests and other bottom-up approaches in the tropics inform the development of social and economic indicators in British Columbia?

While methods to describe the environmental aspects of sustainable forest management are well developed in British Columbia, social and economic indicators remain a challenge, particularly at the scale of the forest management unit. Since much greater attention has been paid to social and economic criteria and indicators in the tropics, this project will examine the experience of tropical Latin America, with particular emphasis on the way that community forests in the neotropics have used regional criteria and indicators (C&I) schemes. The project will draw general conclusions from recently developed and also better-investigated systems of socioeconomic indicators used in community forestry settings in the neotropics, and apply this information to the development of improved social and economic C&I in BC.

Initiated: 07/08

Duration: 3 *years*

09/10: $37,908

Total: $91,100

Location: BC and International

MFR Region: P

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

S 3.4.1 Process and criteria for setting thresholds, establishing targets, and balancing ecological, economic, and social indicators (Retired 2008)

Y103271 Evaluating the ecological, economic, and social trade-offs of managing for valued plants and other non-timber forest products

Evelyn Pinkerton
Simon Fraser University

Can logging with retention, followed by a light burn to release seeds, optimize both economic value from timber harvest and the regeneration of traditionally valued forest plants?

The wide variety of plants used traditionally by First Nations people, and non-timber forest products in general, have not been well represented in forest management. This project will examine how varying types and intensities of forest disturbance, natural and silvicultural, are linked to the distribution and productivity of traditionally valued plants. The research will generate information on plant responses to the four treatments, offer clues about the causal relationships involved, and ultimately allow aboriginal communities and industry as a whole to consider possible choices from a more informed position.

Initiated: 07/08
Duration: 3 *years*
09/10: $70,721
Total: $192,412
Location: Kamloops TSA, Barriere/North Thompson, Adams Lake
MFR Region: SI

S 3.4.2 Implications and management of changing access patterns on non-timber resource use (e.g., fish, wildlife, recreation) (Retired 2008)

Y092001 Sustainable forestry, traditional economies, and community well-being: a collaborative project with Gitxaala Nation and Nuxalk Nation

Charles Menzies
University of British Columbia

Can we define important social indicators of SFM related to community health and wellbeing of Gitxaala and Nuxalk Nations?

Currently there is a lack of effective mechanisms for incorporating and complementing indigenous knowledge in land use planning, forest management, and forest-related economic development This project focused on developing a set of reliable and cost-effective First Nations specific social, cultural, economic, and environmental indicators to determine the relative strength of a community's economy expressed using measures of well-being. The project focused on identifying aspects of the 'traditional' economy (e.g., harvesting, processing, cultural practices) that indicate a healthy local culture, with the underlying assumption that well managed forests contribute to healthy local communities. A synthesis report, social indicators report, and videos were produced that outline the key areas of community wellbeing and related indicators that can be used to guide forest practices.

Initiated: 07/08
Duration: 2 *years*
09/10: $0
Total: $124,236
Location: Traditional territories of the Gitxaala and Nuxalk Nations
MFR Region: C

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

S 4.1 Species at risk recovery

S 4.1.0 Unclassified

Y072136 Establishing a science basis for recovery of woodland caribou in north-central British Columbia

Scott McNay
McGregor Model Forest Association

What do we really know about mountain caribou?

A large amount of data collection and modeling effort has been expended for mountain caribou in BC. This project will synthesize these data and publish the results via 10 publications in the peer-reviewed literature, which is essential to establishing a scientific basis for recovery planning and ongoing modeling.

Initiated: 05/06
Duration: 2 *years*
09/10: $0
Total: $112,415
Location: Mackenzie and Ft. St. James TSAs
MFR Region: NI

S 4.1.1 Determination of critical habitat requirements for species at risk where results will support development of recovery plans by recovery teams

Y062035 Ecological relationships between threatened caribou herds and their habitat in the central Rocky Mountains Ecoregion

Dale Seip
Ministry of Forests and Range

What are critical habitat requirements for caribou in the transition zone between the northern and mountain ecotypes?

Woodland caribou herds are classified into ecotypes based on differences in habitat use and forage species in the winter. To improve understanding of differences among ecotypes, telemetry and GPS surveys were conducted of spatial overlap among herds, and a resource selection model was developed for each herd across multiple seasons. The researchers concluded that resource selection and habitat use differed within and among ecotypes during all seasons, which demonstrates the need to undertake herd-specific mapping of critical habitat.

Initiated: 04/05
Duration: 2 *years*
09/10: $0
Total: $187,494
Location: Prince George, Mackenzie, and Peace FD FDs
MFR Region: NI

Y062309 Identification of critical habitat of breeding marbled murrelets

Ronald Ydenberg
Simon Fraser University

What is the relative variability, reliability, and cost-effectiveness of airphoto interpretation, aerial surveys, and ground sampling as methods for identifying Marbled Murrelet nesting habitat?

Three methods that vary in cost and effectiveness are currently used for assessing Marbled Murrelet habitat, but the trade-offs among these approaches are not fully understood. This project tested the relative utility of the three methods by comparing nest site attributes as determined through airphoto interpretation and aerial surveys against known nest sites located through ground surveys. Results confirm that both airphoto interpretation and aerial surveys can be used to identify murrelet nesting habitat, and suggest that modifications to the habitat quality classification will improve the identification of suitable nesting habitats.

Initiated: 04/05
Duration: 2 *years*
09/10: $0
Total: $121,348
Location: Desolation Sound, Sunshine Coast, and Clayoquot Sound
MFR Region: C

Y071051 Integration and extension of Marbled Murrelet habitat data collected at different scales

D.B. Lank
Simon Fraser University

How do different methods of Marbled Murrelet habitat assessments compare in terms of reliability and cost?

This project will prepare manuscripts and related extension materials that identify stand attributes that best predict nesting habitat quality for marbled murrelets for each of three assessment methods (airphoto interpretation, helicopter reconnaissance, and ground visits). An additional manuscript will present the relationships between and reliability of the three methods, contrasting the reliability and application of ground, helicopter, and airphoto assessment methods to better inform on cost/benefit trade-offs when defining areas of habitat available at different scales and selecting particular areas for conservation.

Initiated: 06/07
Duration: 1 *year*
09/10: $0
Total: $21,525
Location: Coast
MFR Region: C

Y073061 Habitat use by marbled murrelets on southwestern Vancouver Island and implications for forest management

Alan Burger
University of Victoria

What are the parameters of habitat use and spatial distributions of Marbled Murrelet nests in old seral forests?

This project used a combination of radar counts, forest cover and other inland habitat data, and marine parameters to explain habitat use and spatial distributions of the threatened Marbled Murrelet nesting in old seral forests on southwestern Vancouver Island. Study results include improved Marbled Murrelet inventories, confirmation of a stable population in Clayoquot Sound, contradiction of previous work indicating that marbled murrelets preferred to nest in fragmented habitats, further understanding of the lack of flexibility in foraging activities, predictors of habitat for prey species, improved methods for monitoring breeding success, and additional information on habitat use and social aggregations while at sea.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $244,804
Location: Vancouver Island
MFR Region: C

Y082019 Identification of critical habitat requirements for interior Western Screech-Owls

Richard Weir
Artemis Wildlife Consultants

What are the critical habitat requirements, population factors, land use issues, habitat suitability issues and prey base issues that may affect the conservation of Western Screech-Owls?

Effective conservation and habitat restoration efforts for the western screech-owl, a federally endangered resident that occurs in the dry Southern Interior, have been difficult to develop because very limited information is available about the ecology of this species in BC. This project collected information on the ecology of this species, including critical habitat requirements, to support effective population recovery efforts. The project has produced significant improvements in knowledge of this species, with numerous implications for guiding population recovery planning.

Initiated: 06/07
Duration: 2 *years*
09/10: $0
Total: $44,163
Location: Shuswap River, northeast of Lumby
MFR Region: SI

Y092158 Nest-site re-use and management of nest habitat attributes of marbled murrelets in coastal forests

Alan Burger
University of Victoria

To what extent do marbled murrelets re-use nest trees, and what are the regional and local factors affecting the availability and development of suitable nesting platforms?

Past research has improved knowledge of the forest habitats used by marbled murrelets for nesting, but significant data gaps remain that hinder conservation management compatible with sustainable timber extraction. This project collated, analyzed, and published existing data on the re-use of nests and the availability of suitable nesting platforms. Significant results include: 1) re-use of nests sites indicating a need to protect known nest sites, especially in those areas where habitat loss has been extensive; and 2) quality habitat depends on a significant proportion of the trees in a stand exceeding 60 cm in diameter. The threshold is larger (90-100 cm DBH) on East Vancouver Island, which is important because this area has been heavily developed and few such sites remain. Results have been published in journal articles and extension notes, and the collated data set has been made available for additional research on tree canopy biodiversity.

Initiated: 07/08
Duration: 2 *years*
09/10: $0
Total: $92,580
Location: Coast
MFR Region: C

Y092209 Assessing critical habitat and threats to endangered stickleback species pairs on the forested land base

Jordan Rosenfeld
Ministry of Environment

What are the critical habitat requirements and non-habitat related threats to the persistence of stickleback species pairs, and how can these threats be managed?

Stickleback species pairs are nationally and globally red listed and contribute uniquely to provincial and global biodiversity, yet little is known about their ecological requirements or habitat associations. This project identified both critical habitat and the priority habitat and non-habitat related threats to species persistence and causes of hybridization (e.g., forestry impacts, exotic species). Survey results can help clarify the habitat conditions required for stickleback species pair persistence, as well as the conditions required for speciation to initially take place. An important finding from this work to date is that crayfish are likely the causative agent of stickleback hybridization in Enos Lake and that keeping invasive crayfish (or other aquatic invasives) out of the remaining stickleback species pair lakes remains the highest management priority.

Initiated: 07/08
Duration: 2 *years*
09/10: $0
Total: $66,830
Location: Texada Island, Vancouver Island
MFR Region: C

Y092238 Reconstructing historical diets and population dynamics of the Marbled Murrelet

Peter Arcese
University of British Columbia

Is marbled murrelet population growth currently limited by diet quality and at-sea feeding conditions in the Georgia Basin and in the less impacted marine regions of west Vancouver Island and Queen Charlotte Sound?

The influence of diet quality on marbled murrelet (MAMU) populations is the least understood aspect of this species and represents a critical information gap in recovery planning efforts for the species. This research tested whether historical declines in the diet and marine habitat quality of MAMUs currently limit population growth rate in the Georgia Basin, west of Vancouver Island, and in Queen Charlotte Sound. The results indicate declining diet quality and reproductive rate in the Georgia Basin over the last century. MAMU populations were found more likely to grow and persist on the landscape where managers take steps to maximize the quality of marine foraging habitat adjacent to nesting habitat reserves. Where suitable nesting habitat exists, but murrelet populations remain in decline, managers should consider steps to improve the foraging success of murrelets during the breeding period, including the restoration of forage fish populations.

Initiated: 07/08

Duration: 2 *years*

09/10: $0

Total: $88,534

Location: Georgia Basin, west coast Vancouver Island, Queen Charolotte Sound/Haida Gwaii

MFR Region: C

Y092290 Fisher (*Martes pennanti*) habitat ecology in pine-dominated habitats of the Chilcotin

Larry Davis
Davis Environmental Ltd.

Are current stand-level management practices in pine-dominated landscapes sufficient to supply natal/maternal denning and resting sites for fishers?

Critical habitat requirements for fishers are needed for sustainable forest management plans, especially for areas impacted by the current MPB epidemic which encompasses the majority of the fisher's range in BC west of the Rocky Mountains. This multi-year project monitored previously radio-tagged fisher through the second natal/maternal denning season, collected habitat data from fisher home ranges, and supported extension activities. The results of this research provide management recommendations related to: conserving natal and maternal denning habitat, maintaining sufficient resting habitat, and maintaining landscape scale foraging habitat. In general, the forest management recommendations arising from this research are consistent with other recommendations for salvage harvesting in mountain pine beetle (MPB) impacted landscapes. Sustaining fishers in managed forests will likely require limiting harvesting in some landscapes to maintain sufficient area with forest cover and source populations for re-colonizing heavily impacted landscapes.

Initiated: 07/08

Duration: 2 *years*

09/10: $0

Total: $69,595

Location: West Chilcotin near Puntzi Lake and Anahim Lake

MFR Region: SI

Y102172 Dietary dependence of Williamson's Sapsucker on coarse woody debris-associated ants

Robert Higgins
Thompson Rivers University

Can management of CWD-levels in managed interior stands help maintain breeding habitat quality for the endangered Williamson's sapsucker?

Coarse woody debris (CWD) levels as a food substrate in managed interior stands may be a key element of recovery actions for the endangered Williamson's sapsucker (WISA). Using a sampling of WISA nest areas stratified by population, and nest productivity, the dietary dependence of breeding pairs on CWD-associated ants will be related to WISA demography. Results will be used by the WISA Action Plan team to help develop CWD retention targets for the maintenance of high-quality habitat for this species.

Initiated: 08/09
Duration: 3 *years*
09/10: $25,380
Total: $58,720
Location: BC range of Williamson's Sapsucker: Cranbrook, Okanagan-Boundary, Cascades FDs.
MFR Region: SI

Y103135 Identification of long-eared myotis bat species in British Columbia: an essential tool for developing management recommendations for bat species at risk

Laura Friis
Ministry of Environment

What combination of DNA analysis, full-spectrum acoustic analysis of bat calls, plus standard measurements provides the most reliable and cost-effective identification of BC bat species?

Most BC bat species rely on mature or old forest for roosting and foraging and many are listed or regionally significant, yet reliable identification of these species during field inventory and surveys can be very difficult. This project will develop and test methods to identify, inventory, and evaluate habitat requirements of forest bat species based on new technologies such as recent DNA research and acoustic analysis software. The results of this research will enable the development of habitat management recommendations on a species- or group-specific basis.

Initiated: 07/08
Duration: 3 *years*
09/10: $43,200
Total: $136,279
Location: Province-wide
MFR Region: P

S 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

M086048 Assessing the threat of mountain pine beetle outbreaks to whitebark pine in British Columbia

Elizabeth Campbell
Ministry of Forests and Range

Does the severity of the current MPB infestation pose risks to the future of whitebark pine in BC?

The effects of mountain pine beetle outbreaks on whitebark pine forests in British Columbia are poorly understood, but the potential for a major, negative impact on this "keystone" species is clear. This project conducted a simulation modeling study to assess and quantify past and current impacts of beetle outbreaks to predict the threat of future MPB outbreaks to whitebark pine in British Columbia. The study found substantial temporal changes in the risk of mountain pine beetle outbreaks in high-elevation whitebark pine ecosystems as climatic conditions at high-elevations become more suitable for MPB persistence.

Initiated: 06/07
Duration: 2 *years*
09/10: $0
Total: $131,678
Location: Southern interior
MFR Region: P

Y073342 **Experiments on edge effects in marbled murrelets: incorporating reproductive performance into habitat quality**

Ronald Ydenberg
Simon Fraser University

What is the relative value of "edge" versus "interior" habitat for nesting marbled murrelets with respect to edge type and larger landscape variables?

The potential influence of "edge effects" on marbled murrelets ' nesting success, and on the microclimate that supports the development of moss on branches, is important because smaller WHAs, which may be more readily constructed in many landscapes, contain proportionally more "edge" habitat. This project addressed the importance of "edge effects" on Marbled Murrelet nesting habitat quality by indexing relative predation danger and microclimate with respect to distances from edges in different landscapes. Interim conclusions indicate that edge effects and landscape effects on nest detection probability, microclimate, and predator indices vary between new clearcut, regenerating, and natural edges, and appear to differ somewhat between the two regions studied so far.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $244,111
Location: Sunshine Coast and SW Vancouver Island
MFR Region: C

Y082026 **Evaluating the potential threat of barred owls on northern spotted owl population recovery and habitat management strategies**

F. Louise Waterhouse
Ministry of Forests and Range

How does Barred Owl habitat use vary with slope and elevation?

The decline of northern spotted owl populations is coincident with the invasion and subsequent expansion of Barred Owl populations, leading to concerns that competitive effects from the Barred Owl may interact with and exacerbate the effects of other threats to Spotted Owl populations in both British Columbia and the United States. Given the lack of information on the Barred Owl's use of habitat in British Columbia, the objective of this study was to use Barred Owl detection data collected during northern spotted owl surveys from 2003 to 2005 to improve understanding of Barred Owl distribution with respect to elevation and slope. Results supported the notion that the Barred Owl is found within the elevational range of the northern spotted owl (i.e., generally at <1200 m) and, as with the northern spotted owl, this range varied slightly by ecological subregion (Maritime, Submaritime, Continental).

Initiated: 06/07
Duration: 2 *years*
09/10: $0
Total: $21,570
Location: Boreal forest
MFR Region: C

Y083042 Evaluating and refining guidelines for forested buffers for grizzly bear habitat management

Bruce McLellan
Ministry of Forests and Range

Do grizzly bears use buffers around avalanche chutes and riparian areas?

Research has shown that grizzly bears select avalanche chutes and riparian areas with a rich forb community, yet biologists wanting to ensure that these selected habitats have adjacent timber protected are unsure of which specific avalanche chute or riparian complexes to protect, how much forest should be left, or if these "buffers" can be partially harvested. This project examined grizzly bear response to forested buffers and associated attributes across a hierarchy of spatial scales. Results indicated that grizzly bears preferred chutes that were of largely herbaceous ground cover in combination with both low and tall shrubs, and of relatively steep overall gradient, while preference was negatively influenced by road access; results also clearly demonstrated the importance of open habitats to grizzly bears, but provided little to no evidence that forested conditions are of any consequence in grizzly bears' habitat preference.

Initiated: 05/06

Duration: 3 *years*

09/10: $0

Total: $169,971

Location: East and West Kootenays, with emphasis in the Elk Valley

MFR Region: SI

Y091176 Effects of a mountain pine beetle epidemic on forest floor vegetation dynamics and lichen regeneration in the Itcha Ilgachuz caribou winter range in the Quesnel TSA

John Youds
Ministry of Environment

How does understorey structure in stands regenerating following MPB infestation affect winter habitat quality for mountain caribou?

Woodland caribou in the Itcha-Ilgachuz population winter in low elevation forested habitat east of the Itcha Mountains, where they forage for terrestrial lichens in mature lodgepole pine forests. This study investigated the effects of mountain pine beetles on lichens, using 10 permanent sample plots located in the "modified harvest" portion of the Itcha-Ilgachuz caribou winter range in the Quesnel TSA. Results found a significant decrease in terrestrial caribou forage lichens and increase in dwarf shrubs during the initial stages of the mountain pine beetle epidemic (2005 to 2008). The rate of the decrease in terrestrial caribou forage lichen abundance was due to the timing and magnitude of the mountain pine beetle attack, and attributes of the site, stand, and understorey vegetation. This initial decline in terrestrial caribou forage lichens will likely not affect caribou numbers in Itcha-Ilgachuz caribou population since they limited by predation, not food.

Initiated: 08/09

Duration: 1 *year*

09/10: $0

Total: $44,820

Location: Itcha Ilgachuz caribou winter range, Quesnel TSA; SIFR.

MFR Region: SI

Y093065 Use of adaptive management to mitigate risk of predation for woodland caribou in north-central British Columbia

Scott McNay
Resources North Association

Does wolf removal improve caribou herd productivity?

This project investigated a science-based assessment of predator control to mitigate caribou mortality. The work capitalized on the legal trapping of wolves that has occurred in one study area to compare the response of this caribou herd to population dynamics of other herds using habitat supply modeling and adaptive management. The researchers also selectively removed 54 wolves in areas of high risk to caribou. Results showed treatment herd responding positively to wolf reductions; however results are preliminary and further monitoring is required to verify this result.

Initiated: 06/07
Duration: 3 *years*
09/10: $0
Total: $263,492
Location: Northern caribou recovery planning areas
MFR Region: NI

Y102050 Determining the causes and magnitude of caribou mortality during a moose population decline

Douglas Heard
Ministry of Environment

Can hunting regulations and forest harvesting/access guidelines be improved to reduce mortality on northern caribou herds as moose populations change?

Direct and indirect mortality effects on threatened northern caribou populations from forestry-moose-wolf-caribou interactions are not well understood. This multi-year study uses radio-telemetry to monitor survival and causes of death of radio-collared caribou coupled with estimates of moose and wolf densities will be used to partition seasonal sources of mortality to caribou. The results will strengthen our understanding of the predator-prey dynamics affecting northern caribou herds, and develop forest management policy for access management planning, as well as managing proximity of early seral stands to caribou range and their regeneration via silviculture.

Initiated: 08/09
Duration: 3 *years*
09/10: $32,400
Total: $60,394
Location: Parsnip R., Mackenzie FD
MFR Region: NI

Y102159 Effects of a mountain pine beetle epidemic on northern caribou habitat use, migration, and population status

Deborah Cichowski
Bulkley Valley Centre for Natural Resources Research and Management

What management strategies in caribou wintering habitats affected by MPB mortality can sustain threatened northern caribou herds?

Impacts of MPB mortality and forest harvesting on quality of winter habitat may change habitat use and population dynamics of threatened northern caribou populations. This continuing multi-year project uses radio-collars, and winter ground investigations of caribou foraging behaviour combined with habitat classifications and estimation of population parameters to determine medium-term consequences of winter habitat condition on caribou. Results will be used to define winter habitat management/salvage harvesting strategies for MPB-affected stands used by caribou herds.

Initiated: 08/09
Duration: 2 *years*
09/10: $27,000
Total: $90,504
Location: Range of Tweedsmuir-Entiako caribou herd (Vanderhoof, Nadina FDs,Tweedsmuir Park)
MFR Region: NI

S 4.1.3 Effects of management practices (e.g., forest road development, salvage and rehabilitation of stands killed by Mountain Pine Beetle, livestock use, exclusion/re-introduction of fire) on the ecology of species at risk (Retired 2008)

M086049 Response of woodland caribou to partial retention logging of winter ranges attacked by mountain pine beetle

Dale Seip
Ministry of Forests and Range

What is the response of caribou and their habitat to MPB attack, and how effective are current Ungulate Winter Range management practices?

The mountain pine beetle (MPB) infestation and associated salvage logging may have a negative effect on the Kennedy Siding caribou herd. This project monitored the response of vegetation, snow, and caribou use in salvage logged and MPB-attacked stands to evaluate the use of different stand types by caribou within the Kennedy Siding UWR. Based on results to date, the current management practices for MPB-attacked pine-lichen caribou winter ranges appear to be sound, as caribou continue to use retained portions of the ungulate winter range even when >90% of the canopy trees have been attacked by MPB.

Initiated: 06/07
Duration: 2 *years*
09/10: $0
Total: $171,061
Location: Mackenzie
MFR Region: NI

Y062074 Landscape analysis of habitat supply and effects on populations of the northern spotted owl in BC

F. Louise Waterhouse
Ministry of Forests and Range

What is the influence of structure and configuration of habitat on dispersal and regional movement patterns of the northern spotted owl?

The northern spotted owl (SPOW) is an old-growth–dependent species that is facing extirpation from BC. This project developed a management/habitat-focused modeling tool for the SPOW that evaluates the influence of structure and configuration of habitat on dispersal and regional movement patterns, and provides a framework to evaluate management options for SPOW recovery in BC. The final product could be used for guiding the implementation of the Recovery Plan, for guiding research designs of habitat inventories, and for evaluating likely impacts of innovative management options.

Initiated: 04/05
Duration: 2 *years*
09/10: $0
Total: $87,110
Location: Squamish, Chilliwack, and Cascade FDs
MFR Region: C

Y072071 Forecasting forest vegetation response to management activities aimed at reducing ungulate browse in mountain caribou winter range

Alan Vyse
Thompson Rivers University

How can predation on mountain caribou be reduced through forest management practices?

Abundance of early-seral stands may lead to reductions in local populations of mountain caribou due to increased predation. This project developed a landscape-level model to predict the effects of varying forest management approaches on the abundance of nine key ungulate winter browse species: willow, red-osier dogwood, Douglas maple, hazelnut, western redcedar, western yew, black cottonwood, paper birch, and trembling aspen. Initial results suggest that altering forest management practices would have little effect on target browse availability at the landscape-level, but could have a considerable effect at the cutblock level. However, the model requires further testing and refining before it can be used with confidence.

Initiated: 05/06
Duration: 2 *years*
09/10: $0
Total: $58,274
Location: Columbia Valley between Arrow Lakes and Mica Dam
MFR Region: SI

Y073007 Silvicultural systems to maintain northern caribou habitat in lodgepole pine forests in central BC

Michaela Waterhouse
Ministry of Forests and Range

Which silvicultural systems are effective in maintaining northern caribou habitat, including terrestrial and arboreal forage lichens, while maintaining other values?

This project is a long-term experimental trial to develop and test silvicultural systems that maintain northern caribou habitat, including terrestrial and arboreal forage lichens, while extracting timber, achieving regeneration, and maintaining biodiversity. Results indicate the initial loss of forage lichens is proportional to the area harvested, with losses concentrated in openings relative to residual forest. In both the group selection and shelterwood trials, forage lichens increased in abundance following harvesting in 1996, with a complete recovery in group selection treatments by 2004. Other factors are also considered, including biodiversity and silvicultural considerations.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $192,354
Location: Cariboo-Chilcotin
MFR Region: SI

Y073086 Quantifying forest stand and landscape attributes that influence mountain caribou habitat fragmentation and predation rates

Bruce McLellan
Ministry of Forests and Range

What are the needs for connectivity of mountain caribou habitat, both within home ranges and among populations?

The conditions needed for connectivity of mountain caribou habitat, both within home ranges and among populations, are poorly understood. This project considered movement of caribou through young forest, the effect of inter-population movement on viability, and the influence of fragmentation on the foraging efficiency of predators. Key results include (1) habitat selection and access to arboreal lichen are linked, (2) fragmentation impacts are especially prevalent at the edges of the species' current distribution, (3) predator avoidance is greater in the summer, and (4) roads exacerbate predation. These results are documented in a series of peer-reviewed publications.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $433,920
Location: Southern interior
MFR Region: SI

Y073177 Dispersal and habitat selection by juvenile Northern Goshawks in a managed forest landscape

Karl Larsen
Thompson Rivers University

How do current management practices affect post-fledging habitat selection and behaviour of juvenile Northern Goshawks?

Although the Northern Goshawk (NOGO) is known to be associated with attributes of stand structure found in mature forest, further information is required to properly manage for NOGO habitat, and potentially use the species as an indicator of mature forest. This project will examine post-fledging habitat selection of juvenile NOGOs, and determine how current forest practices around NOGO nest areas influence post-fledging habitat selection and behaviour of juvenile animals. These data are required to better define the management actions necessary for maintaining NOGOs on the landscape.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $162,400
Location: Southeastern interior
MFR Region: SI

Y073365 Development of analytic and decision models for assessing grizzly bear needs from forest management objectives

Fred Hovey
Ministry of Forests and Range

What are the effects of forestry activities and landscape conditions on grizzly bear habitat and mortality?

Currently, we do not have the tools to link human activities and landscape conditions to grizzly bear mortality. This project will develop a series of predictive models relating effects of forestry activities and landscape conditions to grizzly bear habitat and mortality. These models will be designed to link to forest harvesting/natural disturbance models so that trade-offs between timber supply, habitat supply, and mortality risks to bears can be evaluated under differing scenarios of timber management and land planning.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $251,768
Location: Southeastern interior
MFR Region: SI

Y082273 Developing stand management prescriptions to maintain suitable habitat for mountain caribou

Walt Klenner
Ministry of Forests and Range

How can suitable caribou winter habitat be maintained, recruited from younger forests, or created through stand-level treatments (i.e., partial cutting, thinning, and spacing treatments) through time?

Forest managers require a better understanding of how habitat suitability changes through time so that the spatial and temporal placement of future cutting treatments on the landbase can be optimized to sustain existing suitable habitats and recruit optimal caribou habitat (landscape recovery) while providing access to timber. This project combined an arboreal lichen model with the stand model TASS (Tree and Stand Simulator) to identify general trends in the likely lichen response to a range of natural stand conditions and partial cut harvesting options. The analysis, although incomplete, suggests that partial cut systems that remove approximately 40% of the stand volume, and where regeneration density is kept relatively low (e.g. 500 sph), should provide a balance between timber extraction and long-term arboreal lichen forage for caribou.

Initiated: 06/07
Duration: 2 *years*
09/10: $0
Total: $77,824
Location: Northern and southern interior
MFR Region: P

Y091046 Stream habitat and bull trout (*Salvelinus confluentus*) responses to MPB riparian salvage harvesting in north-central British Columbia.

Scott Hinch
University of British Columbia

How can harvest and salvage practices in interior watersheds affected by MPB-mortality be improved to ensure the medium- and long-term health of fluvial habitats and the distribution of their stream-dwelling species?

Short- and medium-term effects of forestry practices on the ecology of small streams are complex poorly understood in Interior regions. Using a comparative survey experimental design, this study proposed examining stream temperatures, stream habitat attributes, and population parameters for bull trout in forested streams (controls) and harvested/salvage-logged streams in watersheds affected by the MPB outbreak. Initial reconnaissance activities in watersheds that were previously identified as containing bull trout failed to locate a sufficient number of streams containing this species that would satisfy the requirements of the experimental design and allow for meaningful statistical comparisons. In general, the survey conducted supports current application of riparian buffers in streams containing bull trout. Future efforts to assess stream habitat and bull trout responses to riparian timber harvesting practices should be assessed using an extensive before-after experimental design in lieu of a comparative survey.

Initiated: 08/09
Duration: 1 *year*
09/10: $0
Total: $27,591
Location: Prince George FD, NIFR
MFR Region: NI

Y091088 Badger habitat use and movements in forested ecosystems

Karl Larsen
Thompson Rivers University

How can habitat quality and access in managed forests be maintained to help sustain the range of habitat types required for at-risk species such as the critically endangered badger?

Declines in habitat values in managed forests for endangered, low-density species such as badgers may limit recovery efforts because of changes in stand structure and access in response to large-scale disturbances (such as MPB mortality). In this study, radio-telemetry and GPS tracking of badgers were used to measure use of interior forest types, habitat quality, and effects of roads on mortality and associated movements. The project has provided a number of forest management recommendations related to improving habitat conditions for badgers and their prey, as well as considerations for facilitating movement across roads.

Initiated: 08/09
Duration: 1 *year*
09/10: $0
Total: $35,322
Location: Cariboo/Chilcotin Plateau, 100 Mile House FD; SIFR
MFR Region: SI

Y102010 Response of woodland caribou to partial retention logging of winter ranges attacked by mountain pine beetle

Dale Seip
Ministry of Forests and Range

How do alternative (salvage/non-salvage) stand management tactics affect winter habitat quality for woodland caribou in the years following MPB-caused pine mortality?

One important strategy for sustaining caribou populations in north-central British Columbia is retaining ungulate winter ranges (UWR) in suitable condition. Using a combination of habitat quality, behavioural/telemetry and movement studies pre- and post-MPB attack, this project is evaluating the short- and medium-term management of UWR (via salvaged and unsalvaged stands) on behaviour and populations of caribou. Results from this study will be used to evaluate and if necessary recommend changes to current UWR management practices locally and in other MPB-affected parts of the region.

Initiated: 08/09
Duration: 3 *years*
09/10: $80,676
Total: $173,313
Location: Northern interior
MFR Region: NI

Y102067 Testing relationships between habitat quality indices, forest configuration, and marbled murrelet local population size

David Lank
Simon Fraser University

Can predictive models of Marbled Murrelet habitat quality be improved to aid strategic and tactical level landscape management planning for this threatened species?

Accurately interpreting habitat classifications for population assessments in threatened species is critical for effective forest management planning at both the strategic (policy) level, and the operational (tactical) level. By combining several sources of data for marbled murrelets on the coast (population: radar counts; habitat rankings: photo-interpretation of potential nesting habitat, low-level helicopter surveys, GIS models), the population predictions from alternative models of habitat rankings will be compared. Results of this multi-year study will improve the resolution and utility of our current habitat supply models used for landscape-level planning to conserve this threatened species.

Initiated: 08/09
Duration: 3 *years*
09/10: $35,024
Total: $75,276
Location: Coast range of marbled murrelets ; CFR
MFR Region: C

Y102082 Conservation genetics and ecology of the threatened coastal giant salamander in managed forests of British Columbia: setting priorities for an integrative species recovery plan

John Richardson
University of British Columbia

How effective are alternative habitat protection measures in riparian forests in sustaining populations of threatened species?

Habitat protection measures for sustaining and recovering low-density riparian species in managed forests now also include WHAs for maintaining core populations. Field studies of habitat characteristics, demography and spatial variation in genetic markers across 5 levels of habitat protection treatments will be used to characterize their relative effectiveness for sustaining populations of the threatened coastal giant salamander. Results will assist development of integrative recovery plans for this species, while identifying ecologically sustainable methods of forest harvesting in riparian areas.

Initiated: 08/09
Duration: 3 *years*
09/10: $83,431
Total: $192,764
Location: Chilliwack R., CFR
MFR Region: C

Y102186 Identifying factors affecting the succession of terrestrial lichen communities in the Omineca Region of north-central British Columbia

Scott McNay
Resources North Association

What stand management treatments are necessary to sustain winter forage values in northern caribou ungulate winter ranges?

Maintenance of forage quality and abundance in legally-designated ungulate winter ranges is expected to be important for sustaining northern caribou herds in the long-term. This multi-year project focused on characterizing and testing soil/site, forest age, disturbance history, and climate properties of UWRs, and relate those to lichen succession and habitat quality estimates. Results will help managers concerned with threatened northern caribou populations distinguish UWRs requiring active management from those that do not.

Initiated: 08/09
Duration: 3 *years*
09/10: $49,944
Total: $88,157
Location: Fort St. James, Mackenzie FDs
MFR Region: NI

Y103008 Group selection silvicultural systems to maintain caribou habitat in high-elevation forests (ESSFwc3) in central BC

Michaela Waterhouse
Ministry of Forests and Range

Which group selection silvicultural systems are most effective at maintaining mountain caribou habitat?

Provincially, mountain caribou are red-listed and under the federal *Species at Risk Act*, are designated as Threatened. The objective of this long-term project is to develop and test group selection silvicultural systems to maintain mountain caribou habitat. The project will continue to produce many deliverables to facilitate resource management under the Cariboo-Chilcotin Land Use Plan and elsewhere in BC.

Initiated: 07/08
Duration: 3 *years*
09/10: $57,150
Total: $132,796
Location: Northeast of Likely
MFR Region: SI; NI

Y103133 Silvicultural systems to maintain northern caribou habitat in lodgepole pine forests in central BC

Michaela Waterhouse
Ministry of Forests and Range

Can silvicultural systems be designed to maintain caribou habitat, including terrestrial and arboreal forage lichens, while extracting timber, achieving regeneration, maintaining long-term site productivity, and conserving biodiversity?

The *Species at Risk Act* (SARA) designates northern caribou as Threatened in the Southern Mountains National Ecological Area, and over 181,000 ha of caribou habitat is designated for "modified harvesting" under the Cariboo-Chilcotin Land-Use Plan. This project is a long-term research trial that will investigate various aspects of caribou habitat management such as terrestrial lichen response to group selection and irregular group shelterwood systems, and the implications of the current MPB epidemic to the lichen community and the northern caribou. The results of this research will provide a sound scientific basis for the "modified harvesting options" and for SARA recovery planning.

Initiated: 07/08
Duration: 3 *years*
09/10: $57,150
Total: $166,970
Location: Itcha-Ilgachuz caribou range
MFR Region: SI

Y103201 Quantifying forest stand and landscape attributes that influence mountain caribou habitat fragmentation and predation rates

Bruce McLellan
Ministry of Forests and Range

What are the forest and landscape attributes that influence mountain caribou predation rates and habitat fragmentation?

It is increasingly clear that mountain caribou populations begin to decline before there is a shortage of foraging habitat as a result of increased predation, which is in turn linked to increasing amounts of young forests and fragmented habitat. This project will quantify forest stand and landscape attributes that influence mountain caribou habitat fragmentation and predation rates. Results will contribute to the preservation of this species through increased understanding of the predator/prey system and implications of fragmenting landscapes with young, but always aging forests.

Initiated: 07/08
Duration: 3 *years*
09/10: $134,099
Total: $461,897
Location: Entire mountain caribou range
MFR Region: SI

S Other strategic projects

Y081045 Development of cost-effective health indicators for fescue grasslands of British Columbia

Reg Newman
Ministry of Forests and Range

What are the relationships between cattle grazing, soil properties, and vegetative characteristics in fescue grassland ecosystems in southern interior BC?

Understanding the effects that cattle have on vegetation, soil, and hydrologic parameters is the first step in developing sensitive and unambiguous indicators of rangeland health. This study studied the effects of long-term cattle grazing on soil properties and vegetative characteristics of rough fescue grasslands in southern interior BC to quantify the relationships between grazing, vegetation, and soil indicators for these ecosystems. Eight parameters, within all three National Research Council principal criteria for rangeland health were found to be altered by long-term cattle grazing; percent rough fescue cover was found to be an essential indicator of the presence of functioning recovery mechanisms as no substitute indicators were found to assess this particular health category.

Initiated: 07/08
Duration: 1 *year*
09/10: $0
Total: $24,613
Location: Kamloops and Merritt
MFR Region: SI

Y081132 North American Forest Ecology Workshop: From Science to Stewardship - knowing, understanding, applying

Hamish Kimmins
University of British Columbia

What are the key needs for inductive, deductive, and integrating activities in forest ecology that will best serve the needs of policy makers and practitioners; and how well is the inherent complexity of forest ecosystems in space and time addressed in research and implementation of research through policy?

The 6th North American Forest Ecology Workshop focused on the value to practitioners of the knowing, understanding, and synthesis aspects of forest ecology research. The workshop brought together ecologists from across North America and invited speakers from other parts of the world to discuss the application of scientific and traditional ecological knowledge in the sustainable management of forest ecosystems. The workshop successfully brought together forest ecologists and foresters interested in the application of this knowledge in their work together, but also illustrated that forest ecosystem science has not yet grappled adequately with the synthesis and application aspects of the discipline.

Initiated: 07/08
Duration: 1 *year*
09/10: $0
Total: $20,520
Location: Province-wide
MFR Region: P

Y081219 Stream morphology, changes, and recovery, following the 1992 washout-flow Donna Creek Mackenzie Forest District

James W. Schwab
Ministry of Forests and Range

What are the long-term channel morphological responses to large-magnitude washout and debris flow events?

Donna Creek, in north-central BC, was severely impacted by a large landslide event in June 1992, resulting from the capture and routing of water along roads constructed for forest development. Building on detailed observations of the channel morphology changes made shortly after the event, this project documented the longer term channel response, sediment transport, and channel recovery processes along each zone of the creek downstream to its confluence with the Manson River. The effects of the washout-flow and debris flood remain evident after 15 years and are expected to last for many decades, except in very minor localized areas where faster recovery appears to have occurred.

Initiated: 07/08
Duration: 1 *year*
09/10: $0
Total: $43,200
Location: Donna Creek, Mackenzie FD
MFR Region: NI

Y082280 Studying mountain pine beetle dispersal patterns through analysis of genetic markers: investigation of population structure and examining current dispersal assumptions

Brent Murray
University of Northern British Columbia

What are the sources and patterns of dispersal for mountain pine beetle epidemics?

Mountain pine beetle population dynamics are rightly described in terms of epidemiological stages, but there is a lack of information on the genetic relationship of the current outbreaks in different parts of BC and Alberta. This limits the potential use of techniques commonly employed in human disease epidemics. This research applied microsatellite techniques to determine the population genetic structure of the MPB across the epidemic area, yielding insight into both current and historical beetle dispersal. Results provide strong evidence for a northern and southern group that have probably arisen from an interaction between post-Ice Age recolonization and differential population dynamics. Five sampling locations found to be genetically distinct from all other populations will be explored in greater detail.

Initiated: 06/07
Duration: 2 *years*
09/10: $0
Total: $35,024
Location: Province-wide
MFR Region: P

Y092186 In-situ characterization of soil microbe function in an ICH chronosequence

Melanie Jones
University of British Columbia

How long does it take for the ectomycorrhizal (ECM) fungal community to develop a full complement of nutrient cycling abilities following harvesting, such that ECM community function is typical of a mature forest soil?

In forest soils, ectomycorrhizal (ECM) fungi give roots increased access to nutrients such as nitrogen and phosphorus by releasing enzymes that break down soil organic matter; however, ECM fungal species differ from each other in this ability. This study examined in-field changes in enzyme activity in ECM communities over a successional sequence and linked them with forest management. The stem exclusion stage of stand development was found to be closely linked with tree nutrient acquisition. By monitoring when this shift in ECM function occurs in managed stands compared to naturally regenerating stands, forest managers can better assess and tailor management methods that simulate natural disturbance and enhance healthy regeneration.

Initiated: 07/08
Duration: 2 *years*
09/10: $0
Total: $93,960
Location: ICH
MFR Region: SI

Y092267 Extension - Options for the landscape-level management of dry NDT4 ecosystems in the Southern Interior Forest Region

Walt Klenner
Ministry of Forests and Range

Were frequent, low-severity fires the main disturbance agent in dry forests and grasslands, and has fire suppression led to unnatural forest conditions?

Mounting research evidence suggests that many of the dry forests in southern BC were shaped by a mixed severity fire regime, as opposed to a low-severity fire regime as is commonly assumed. This project reviewed recent literature and data on natural disturbances, forest fuel management, wildlife habitat and biodiversity, historical insect attack and fire regimes, and the effects of stand density on timber and understorey productivity to develop a peer-reviewed publication and an extension note. The analyses strongly support the notion that dry forest ecosystems in BC typically experienced mixed-severity disturbance regimes that include fire, bark beetles and defoliators. Trying to "restore" these forests with applications of frequent, low-severity fire is not an ecologically sound approach over large areas. Landscape management should focus on maintaining forest heterogeneity that would have existed historically under a mixed-severity disturbance regime.

Initiated: 07/08
Duration: 2 *years*
09/10: $0
Total: $54,508
Location: Southern interior
MFR Region: SI

Y093046 Book preparation: Ecology, conservation, and management of British Columbia's inland rainforest

Darwyn Coxson
University of Northern British Columbia

What is the best available scientific information regarding management of the cedar–hemlock stands in the wet ICH?

This project produced a book manuscript that brings together the best possible scientific information to inform management of old cedar–hemlock stands in BC's inland rainforest (wet ICH), and describes management options and likely consequences for this ecosystem. Until now, much of the emerging literature on the natural disturbance regime, ecology, and silviculture of the wet ICH is fragmented, dispersed, and often unpublished and difficult to access. The manuscript is currently under review by the Editorial Board at UBC Press (March 31, 2009). When published, the book will inform forest policy and practices in the wet ICH following completion of pine salvage programs and examine the options for future timber supply in other areas of the timber harvesting landbase.

Initiated: 06/07
Duration: 3 *years*
09/10: $0
Total: $58,260
Location: ICH zone
MFR Region: SI; NI

Y103039 Assessing soil disturbance and tree growth after stumping

Stefan Zeglen
Ministry of Forests and Range

How does the monitoring of post-harvesting disturbance planned under FRPA need to be adjusted to consider the disturbance types unique to stumping?

On blocks infected with root rot, maintaining the legislated limits to soil disturbance is circumvented by the necessity to remove infected stumps. This project will characterize levels and types of disturbance on stumped sites so that the monitoring of post-harvesting disturbance planned under FRPA can be expanded to accommodate stumped sites. The results are intended to allow the objective of soil conservation to limit soil disturbance (FPC Soil Conservation Guidebook) to be maintained regardless of the need to meet conflicting forest health objectives.

Initiated: 07/08
Duration: 3 *years*
09/10: $12,960
Total: $45,196
Location: CDF and CWH where root rot is prevalent
MFR Region: C

Y103042 Long-term Soil Productivity Study

Shannon Berch
Ministry of Forests and Range

What are the most appropriate regulations and guidelines for conserving soil productivity during harvesting and site preparation activities?

For regulation and management of the impacts of harvesting and site preparation on soil properties such as soil porosity and organic matter to be truly science-based, real data derived from long-term monitoring of forest sites is needed. To fulfill this information need, a full rotation-length research project called the long-term Soil Productivity (LTSP) study was initiated in 1990, and the present proposal requests a continuation of support for the LTSP study. The results are expected to allow both industry and government to evaluate and adjust forest practices and regulations for the conservation of soil productivity so that they achieve the desired result while minimizing the incremental cost to industry.

Initiated: 07/08

Duration: 3 *years*

09/10: $144,842

Total: $407,394

Location: Dawson Creek, Topley, Log Lake, Skulow Lake, Kamloops, Castelgar, Nelson

MFR Region: SI; NI

Y103080 Carnation Creek – Forestry impacts and watershed recovery processes in a small coastal drainage

Peter Tschaplinski
Ministry of Forests and Range

What are the long-term impacts of forestry operations in steep headwaters on downstream channel morphology and anadromous fish habitat?

The Carnation Creek project is a long-term, multi-disciplinary case study of the effects of forestry practices on a small coastal watershed. Among other things, the study provides a unique opportunity to determine and directly quantify the ultimate effects of a massive pulse of sediment and debris on the entire mainstream channel and its anadromous salmon habitats and to measure resultant impacts on fish populations. The current project will examine and document these effects by studying the alterations in morphology and habitats in the entire anadromous zone of Carnation Creek resulting from forestry-associated landslides and debris torrents that occurred over 22 years ago in three steep headwater tributaries 1 km upstream of the anadromous habitats. Results are expected to show that some forestry-caused alterations may take decades to emerge, and emphasize the importance of sound forestry management in steep headwaters where streams are closely coupled to the adjacent hillslopes.

Initiated: 07/08

Duration: 3 *years*

09/10: $157,500

Total: $506,192

Location: Carnation Creek Experimental Watershed

MFR Region: C

Y103136 Developing a new indicator of soil functioning for use in designing variable-retention harvesting

Sue Grayston
University of British Columbia

Is green-tree preservation a suitable management option for maintaining "healthy" soil, and what size and density of green-tree retention patch is required for this purpose?

The importance of soil fauna and microorganisms in nutrient cycling is well recognized, yet the structure of the belowground food web and the interactions between these organisms are poorly understood, primarily because methodologies to study them have been lacking. This project will apply new stem-injection stable-isotope labelling techniques as a tracer to determine whether retention trees "feed" the soil microbial community with C and N and if C and N are fed directly to young seedlings through common mycorrhizal networks. The results of this work will help to identify which, if any, of these species are "keystone" and essential for carrying out particular ecosystem processes and what the repercussions of a loss of any of these organisms may have on ecosystem function and resilience.

Initiated: 07/08
Duration: 3 *years*
09/10: $59,461
Total: $191,593
Location: Campbell River
MFR Region: C

Y103192 Twenty-year effects of mechanical site preparation and burning on soil properties and lodgepole pine nutrition in sub-boreal British Columbia

Jacob Boateng
Ministry of Forests and Range

Do changes in soil characteristics such as bulk density or nutrient availability observed soon after mechanical site preparation persist after 20 years?

A large project was established in the mid-1980s to study the effects of various forms of mechanical site preparation on conifer performance and on a variety of micro-environmental factors in the SBS, BWBS, and ESSF zones of the (now) Northern Interior Forest Region, and some 20-year results are substantially different from those anticipated based on early assessments. This project will collect soils data to help interpret these results, and will also provide information about the long-term effects of MSP and broadcast burning on soil physical and chemical properties. The results will demonstrate to the scientific and business communities that sustainable forest management is being practiced in BC.

Initiated: 07/08
Duration: 3 *years*
09/10: $16,286
Total: $99,535
Location: Prince George and Vanderhoof FDs
MFR Region: NI

Y103208 Managing the interacting effects of grazing and global climate change in BC Interior rangelands

Lauchlan Fraser
Thompson Rivers University

How do grassland ecosystems respond to the interacting effects of grazing and climate change?

Grasslands, a rare ecosystem in British Columbia that provides habitat for many endangered plants and animals and supports much of BC's cattle industry are threatened by tree encroachment, over-grazing, agricultural conversion, urban development, and climate change. However, the consequences of interactions between these disturbances have not been investigated. This project will explore the effect of changes in precipitation and temperature norms on grasslands using a factorial field experiment involving 12 replicated treatment combinations: 2 temperature treatments (increased by 2–3 degrees Celsius and ambient); 3 watering treatments (water addition, rainshades, and ambient); and 2 clipping treatments (clipped at 7.5 cm stubble height or not clipped). This experiment will aid managers in understanding the general response of grasslands to stress and disturbance and to incorporate climate change into their long-term management plans.

Initiated: 07/08
Duration: 3 *years*
09/10: $47,520
Total: $142,560
Location: Lac du Bois Provincial Park
MFR Region: SI

Y103214 Cotton Creek phase II: multi-scale, spatially explicit studies of mountain pine beetle impacts on watershed function

Dan Moore
University of British Columbia

What are the effects of MPB-related tree death and salvage logging on watershed processes and aquatic habitat?

MPB are beginning to establish in the Cotton Creek Experimental Watershed (CCEW) south of Cranbrook. Because extensive baseline date has already been collected during the last 3 years, CCEW provides a unique opportunity to monitor changes in watershed processes prior to and during MPB infestation and following salvage logging. The proposed work will focus on: (1) runoff dynamics and the influences of forest disturbance and management; and (2) processes governing the downstream transport and distribution of water, nutrients, heat, sediment, and woody debris. The results of this study will improve knowledge of the fundamental hydrologic processes as influenced by forest disturbance and management, particularly the propagation of impacts from hillslope to channel; contribute to the ongoing testing of spatially distributed, physically based models such as Distributed Hydrology-Soil-Vegetation Model and the Sensitive Area Mapping Model; and provide a basis for understanding and predicting the propagation of disturbance effects in the headwaters to downstream reaches.

Initiated: 07/08
Duration: 3 *years*
09/10: $102,060
Total: $321,863
Location: South of Cranbrook
MFR Region: SI

Y103245 Restoration of forest soils: long-term productivity results

Chuck Bulmer
Ministry of Forests and Range

What is the long-term recovery of growth and productivity on rehabilitated roads, trails, and landings?

Soil rehabilitation is an important strategy for enhancing timber supply where productive forest land is limited, and the benefits and costs of reclaiming roads and landings need to be documented so that managers can implement the best options for keeping roads active, deactivating them, or restoring them to establish a new forest. This project revaluated existing study plots in the BC Interior to collect longer-term measurements of the tree growth and productivity 15–20 years after rehabilitation of roads, trails and landings. Measurements have been completed on 17 rehabilitated landings and adjacent plantations in the BWBS biogeoclimatic zone of northeast BC and additional sites in the northeast, south-central and southeast interior will be visited over the next two years to provide better information for forest managers and others trying to evaluate the costs and benefits of soil rehabilitation.

Initiated: 07/08

Duration: 3 *years*

09/10: $28,499

Total: $55,999

Location: near Dawson Creek, in the Kamloops area, and in the Kootenays

MFR Region: NI

Forest Growth and Value Program

F Unclassified

Y051078 Load sharing between log stringers in gravel-decked log bridges

C. Kevin Lyons
University of British Columbia

What are the load-bearing characteristics of gravel-decked log stringer bridges?

As forestry operations move into smaller second-growth timber, load sharing between the individual logs of gravel-decked log stringer bridges becomes an important consideration. This study used an existing dataset to examine the trade-off between increased dead load and increased load-sharing for thicker gravel decks on log bridges. Stiffness and positioning of cable-lashing were found to be very important to effective load-sharing, especially for spans less than 12 metres.

Initiated: 04/05
Duration: 1 *year*
09/10: $0
Total: $21,085
Location: Province-wide
MFR Region: P

Y051178 Extension of results: in-woods chipping of trembling aspen (*Populus tremuloides* Michx.)

Timothy Conlin
Forested Ecosystems Research

How does in-woods chipping of aspen residues affect regeneration and growth?

This project is an extension of an FRBC project to study the impact of in-woods chipping of aspen stands for pulp chips on the subsequent regeneration and growth of aspen cutblocks in northeastern BC. Specifically, the current project will publish updated results from the original FRBC project, based on subsequent data collection and analysis.

Initiated: 04/05
Duration: 1 *year*
09/10: $0
Total: $1,838
Location: Northeastern BC
MFR Region: NI

Y051225 Susceptibility of weevil-resistant spruce to damage by other insect pests

René Alfaro
Natural Resources Canada

Do weevil-resistant spruce stocks have increased susceptibility to other pests and pathogens?

To protect the investment made in identifying and propagating weevil-resistant spruce, and to effectively use these genotypes in reforestation programs, it is necessary to determine the susceptibility of weevil-resistant spruce to incidence of damage by other insect pests. This study surveyed weevil-resistant stock for damage by other insect pests to provide guidelines for the selection of weevil-resistant material for inclusion in breeding programs and seed orchards. It was found that incidence of damage by insect pests other than weevil was not influenced by the trees' weevil resistance status at any of the study sites.

Initiated: 04/05
Duration: 1 *year*
09/10: $0
Total: $32,550
Location: Vancouver Island, southern interior, and Prince George
MFR Region: P

Y051244 Modeling of subalpine fir trees using industrial CT imaging and simulated X-ray scanning

Sencer Alkan
Forintek Canada Corp.

Can the application of internal log-scanning technologies be applied to the effective integration and efficient utilization of underutilized subalpine fir stems/logs into the provincial timber supply?

A 3D representation of tree stems has applications for both research purposes and for ensuring optimal utilization of the raw material in a sawmill. This report describes the design and implementation of a new surface-volume integrated tree stem model, CTSTEM, for measuring and visualizating 3D properties of subalpine fir stems from X-ray images. The most important conclusions of this project were that CT scanning is a powerful tool for the modeling and visualization of different stem properties of subalpine fir species. While the results of CTSTEM are currently not intended to be part of industrial applications, this demonstration research tool can illustrate potential benefits of modeling and simulation, based on CT scan data.

Initiated: 04/05
Duration: 1 *year*
09/10: $0
Total: $45,584
Location: Province-wide
MFR Region: P

Y073110 Evaluating the protocol for quantifying the effect of pollen contamination on the genetic worth of conifer seed orchards

Joe Webber
ProSeed Consulting

What is the accuracy of current pollen monitoring techniques, and what are the levels of contamination experienced in current seed orchard practices?

Contaminated pollen in seed orchards has a negative effect on both the orchard's estimate of the improved trait and the adaptive potential of seed orchard progeny. This project assessed the accuracy of current pollen monitoring techniques and developed new assessment techniques to improve estimates of pollen contamination from non-orchard sources of pollen. Using new protocols developed as part of this project, the authors are confident that pollen monitoring can now produce reliable estimates of contamination.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $88,315
Location: Southern Vancouver Island, and Rover Creek near Nelson
MFR Region: C; SI

Y073183 Identification and propagation of novel value-added hardwood varieties

Jim Mattsson
Simon Fraser University

How can special characteristics of hardwoods, such as figured patterns, be propagated?

With the globalization of lumber, and pulp and paper markets, the ability to produce unique and value-added products is likely to become increasingly important. The aim of this research project is to develop local expertise for propagation of potentially valuable hardwood species and also to identify and propagate novel value-added hardwood varieties, with the long-term objective of promoting the silviculture of particularly valuable hardwoods in BC. Results to date include the development of local expertise in tissue culture propagation of hybrid aspen and curly birch, and the identification of hardwood trees in BC producing potentially valuable decorative figured wood.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $101,832
Location: Province-wide
MFR Region: P

Y073290 Modeling the impact of stand management regimes on the wood characteristics of lodgepole pine

Jim Goudie
Ministry of Forests and Range

How are specific wood characteristics and tree knot populations for lodgepole pine affected by management practices?

There is concern that post-harvest pine, which is regenerated at much lower densities than fire-origin stands, will have lower wood quality because of excessively deep crowns. This project used destructive sampling of lodgepole pines ranging in age from 20 to 124 years to develop predictive equations and models of various measures of crown structure, and to test the hypothesis that lodgepole pine crown structure influences the quality of wood (density, strength, stiffness, stability, and fibre characteristics). The results support the argument that long crowns, associated with wide spacings, will lead to less mature wood than close spacings that encourage crown lift.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $422,145
Location: Central interior
MFR Region: SI

Y073364 Comandra rust screening in Bulkley Valley lodgepole pine

Jeff Gillanders
Babine Forest Products

Is there genetic variation in lodgepole pine orchard parents for resistance to Commandra rust?

There is evidence of genetic variation in lodgepole pine for resistance to Commandra rust. This project established a trial series in 2004 to identify clones in Seed Orchard 219 with resistance to Commandra rust, to provide a more precise ranking of clones established in the orchard, enabling targeted collections of resistant families for deployment in high-risk areas. Interim results indicate that Commandra infection rates are clearly under a strong degree of genetic control. However, classification of seedlots as "susceptible" and "resistant" based on prior knowledge seems to be only weakly effective; further assessments and analysis to be conducted in 2007 will result in further narrowing of confidence intervals.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $40,475
Location: Bulkley Valley
MFR Region: NI

F 1 Basic research on tree growth and stand development

F 1.0 Unclassified

Y073156 Stand Management Cooperative - growth and yield installations in BC

Louise de Montigny
Ministry of Forests and Range

What are the critical processes and dynamics of early stand establishment and growth that affect crop tree performance?

As a member of the Stand Management Co-operative (SMC), the Ministry of Forests and Range is required to maintain 22 research installations, including 9 espacement trials. This project will fund tree remeasurement at these espacement trials. The data will be used to assess both the short- and long-term effects of espacement on stand and individual tree responses, thus meeting the need for understanding critical processes and dynamics of early stand establishment and growth that affect crop tree performance.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $162,751
Location: Province-wide
MFR Region: P

Y073159 Management regimes for red alder plantations

Paul Courtin
Ministry of Forests and Range

What are the effects of spacing, thinning, and pruning on growth and wood quality in hardwoods, and the effects of phosphorous supply on long-term growth, site fertility, and water use efficiency?

As the value of red alder products has increased over the past decade, the forest industry has moved from conifer replacement to active reforestation and management of alder on short rotations. This project evaluates various management regimes for red alder plantations in coastal BC by examining the effects of spacing, thinning, and pruning on growth and wood quality, and of phosphorous supply on long-term growth, site fertility, and water use efficiency. Only halfway through, the project has already established several key facts about growing alder.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $170,531
Location: Coast
MFR Region: C

Y073210 Sulphur fertilization of lodgepole pine: a stable isotope tracer study

Rob Brockley
Ministry of Forests and Range

How does lodgepole pine respond to elemental sulphur and sulphate fertilization?

Sulphur (S) deficiencies in lodgepole pine are widespread in the BC central Interior, but there is an insufficient basis for prescribing fertilization treatments. This study compared the relative uptake of both elemental S and sulphate-S forms, their mobility and transformations in the soil, and their effects on tree growth, at operationally realistic addition rates and in combination with nitrogen fertilization. Both foliar concentrations and stable isotope data indicated that sulphate-S was more readily available than elemental S to lodgepole pine. However, addition of N (with or without added S) produced little or no improvement to radial growth, perhaps due to induced deficiencies of B and/or K.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $74,419
Location: Vanderhoof and Prince George FDs
MFR Region: NI

F 1.1 Complex stands, including partial cutting, variable retention

F 1.1.0 Unclassified

Y051131 Quantifying the dynamics of stands under selection management for mule deer winter range

Ken Day
University of British Columbia

What are the stand dynamics with uneven-aged stands of interior Douglas-fir?

This project will further our understanding of the dynamics of uneven-aged interior Douglas-fir stands by examining the relationship between stand structure and both (1) individual tree height and growth, and (2) mortality and recruitment. The study is designed to use two existing projects, comprised of 30 permanent sample plots in the UBC/Alex Fraser Research Forest. The study found that basal area and volume are insensitive to stand structure, indicating that stands can be managed for a range of structural objectives without affecting timber value.

Initiated: 04/05
Duration: 1 *year*
09/10: $0
Total: $46,565
Location: UBC/Alex Fraser Research Forest
MFR Region: SI

Y062209 **Management of complex coastal mixedwoods in BC for productivity and free-growing**

Keith Thomas
Ministry of Forests and Range

What are the competitive effects of alder on conifers in mixed alder-conifer plantings?

While red alder often overtops juvenile conifers resulting in difficulties meeting "free-growing" obligations, some research suggests low densities of red alder may enhance conifer growth. This project uses mixed alder-conifer plantings to study the competitive effects of red alder on conifers, and is now old enough to assess the 11-year "free-growing" window. Results from this study show substantial site to site variation in the response of Douglas-fir and western redcedar to gradients in red alder density, but suggest that densities of up to 400 red alder/ha may be acceptable and possibly desirable on some sites.

Initiated: 04/05
Duration: 2 *years*
09/10: $0
Total: $48,174
Location: CWH zone
MFR Region: C

Y073305 **Managing northern mixedwood stands to sustainably maximize productivity and minimize costs**

Chris Hawkins
University of Northern British Columbia

What is the optimum proportion of broadleaf stems in mixedwood stands to cost-effectively meet free-growing objectives?

It is suggested that the productivity of mixedwood stands in boreal regions is higher over the long-term than single-species or conifer-regenerated stands; however, they tend to be poorly managed due to limited understanding of their dynamic processes and a lack of predictive models. To assess the potential benefits of alternatives to the current free-to-grow guidelines, this project determined threshold deciduous levels in two ways: free-to-grow and non-free-to-grow trees (range of deciduous competitor densities) will be identified (using current MoFR definitions) and their growth monitored on operational blocks; cost–benefits will be determined from all studies based on economic inputs and yields projected from mixedwood growth models. Results to date suggest that no-treatment may be the most cost-effective scenario; they also highlight the need for reliable complex stand models to assist forest managers in the decision-making process.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $243,877
Location: Fort Nelson, Mackenzie, and Fort St John TSAs
MFR Region: NI

F 1.1.1 Species interactions

Y062304 Managing for intimate species mixtures in BC's boreal forest

Chris Hawkins
University of Northern British Columbia

What mixedwood stand management strategies and practices are most appropriate for maximizing the productivity of both aspen and spruce, while minimizing silviculture costs?

Although mixedwood stands composed mainly of aspen and white spruce comprise the top two harvested species by volume in the Peace Forest District, and research suggests that mixedwood stands have greater productive potential than single-species stands, current policy guidelines do not encourage adaptive management in these stands. Through long-term field trials, growth and yield modeling, and economic analysis, this project sought a better understanding of how to manage mixedwood stands for enhanced site productivity and harvest levels, predictable and sustainable timber production, and ecological benefits, while reducing stand management expenditures. Initial results suggest that managing for intimate species mixtures to maximize the productivity of both aspen and spruce, while minimizing silviculture costs, appears attainable; longer-term observation of the field trials and further testing of the models is necessary.

Initiated: 04/05

Duration: 2 *years*

09/10: $0

Total: $85,730

Location: Fort St John and Dawson Creek TSAs

MFR Region: NI

Y073065 Effects of young stand silviculture on conifer/broadleaf mixtures in seral ICH forests of Southern Interior BC

Suzanne Simard
University of British Columbia

What are the effects of management practices on interspecific interactions, growth and yield, stand development, and ecosystem function in conifer/broadleaf forests of the Southern Interior wet-belt?

This project involved four integrated studies on the effects of management practices on interspecific interactions, growth and yield, stand development, and ecosystem function in conifer/broadleaf forests of the southern interior wet-belt. These studies examined (1) relationships between soil properties altered by disturbance and long-term growth of different species; (2) effects of soil transfers from different forest tree species on growth and survival of planted Douglas-fir and paper birch; (3) crop-tree response to manual and chemical brushing at various radii on survival, growth, and disease or insect incidence of lodgepole pine; (4) paper birch density reduction effects on the growth, nutrition, and Armillaria infection of understorey Douglas-fir. Detailed results are presented in a series of peer-reviewed articles.

Initiated: 04/05

Duration: 3 *years*

09/10: $0

Total: $129,581

Location: ICH zone

MFR Region: SI

Y073090 **Sustainable mixedwood management in the Sub-Boreal Spruce zone of British Columbia**

Chris Hawkins
University of Northern British Columbia

What are optimal deciduous levels in mixed-species stands (spruce–birch and pine–aspen)?

Although interest in managing broadleaves and mixedwoods has increased, these stands tend to be managed poorly due to a limited understanding of their dynamic processes and a lack of predictive models. This study used growth measurements, quality assessments, and models to determine optimal deciduous levels in mixed-species stands. Findings suggest that spruce growth is promoted when growing with high densities of birch, whereas pine growth was promoted by aspen albeit at lower densities. White pine weevil attack was found to be significantly reduced by high densities of birch.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $223,291
Location: Prince George and Williams Lake TSAs
MFR Region: NI

Y081041 **Ten-year growth of white spruce underplanted beneath spaced and unspaced aspen stands in northeastern British Columbia**

Richard Kabzems
Ministry of Forests and Range

What is the effect of overstorey aspen on the survival and growth of underplanted white spruce?

Establishing white spruce under aspen 20 to 40 years before the harvest of the aspen is potentially the most cost-effective scenario for boreal mixedwood management; however, key obstacles to the operational application of this strategy are uncertainty regarding appropriate establishment conditions and stand development over time. This project assessed the change in growth rate as spruce saplings move from the understorey shrub layer into the light environment provided by the aspen canopy in spaced and unspaced aspen stands in northeastern British Columbia. Broadcast fertilization was found to have no measureable effect on tree size and growth rate at age 10; thinning of overstorey aspen to 1000 or 2000 stems per hectare did result in significant improvements in light above the shrub layer and in diameter and height growth of the underplanted seedlings, but these increases in growth of underplanted spruce may not justify the expense of thinnings.

Initiated: 07/08
Duration: 1 *year*
09/10: $0
Total: $37,077
Location: BWBS Zone (Fort Nelson and Dawson Creek)
MFR Region: NI

Y081051 **Effects of competition among trees on crown structure in spruce–fir forests**

Roberta Parish
Ministry of Forests and Range

How is the growth of individual tree crowns affected by the location, size, and species of neighbouring trees?

Understanding how trees respond to neighbours is fundamental to evaluating the possible effects of partial cut silvicultural systems. This project examined crown structure by using previously collected data to develop models that predict crown length based on tree size and amounts of crowding by neighbours. The study concluded that only fairly large trees, relative to the target tree, have a detectable effect on crown length - information that will prove useful when considering silvicultural approaches that try to maintain complex stand structures.

Initiated: 07/08
Duration: 1 *year*
09/10: $0
Total: $8,958
Location:
MFR Region: SI

Y092150 Modeling light, site quality, and crowding effects on growth of understorey subalpine fir in lodgepole pine forests

Suzanne Simard
University of British Columbia

What is the growth and survival response of juvenile trees under different potential canopy retention levels and site conditions?

To design silvicultural strategies that optimize timber production and sustain other values, forester managers must understand how seedlings and saplings grow and survive across the full range of potential canopy retention levels and site qualities. This project further developed SORTIE-ND, a resource-mediated, spatially explicit, mixed-species forest model, by designing, testing, and demonstrating a new submodel capable of making growth predictions for seedlings/saplings across a light gradient over a wide range of tree densities and site qualities. The project incorporates information about the influence of neighbour density on juvenile tree growth, a variable that has been largely overlooked in other field based studies investigating the role of different resources on juvenile tree growth. The project significantly improves the model's ability to predict juvenile tree growth in response to variation in residual canopy cover, site quality and crowding, thus providing scientific information for developing guidelines and decision support tools for the management of structurally complex, mixed-species, multi-cohort stands.

Initiated: 07/08
Duration: 2 *years*
09/10: $0
Total: $53,663
Location: Province-wide
MFR Region: P

Y103003 Competitive effects of broadleaf trees on conifer performance over a range of ecosystems

Teresa Newsome
Ministry of Forests and Range

What are the competitive effects of aspen on lodgepole pine in young stands?

The value of broadleaf trees for maintaining biodiversity and long-term ecosystem health in the Cariboo has increasingly been recognized, but competitive interactions between aspen and lodgepole pine are not well understood, and acceptable levels of aspen retention require quantification. This project, as part of an ongoing study initiated in 1992, will assess the long-term effects of different densities and spatial arrangements of aspen on pine growth in three different biogeoclimatic subzones (IDFxm, SBSdw1, SBSdw2, and SBPSxc). The intended result of this work is to provide scientifically based information to assist in the management of mixed-species stands.

Initiated: 07/08
Duration: 3 *years*
09/10: $71,014
Total: $252,256
Location: Central Cariboo FD, 100 Mile House FD, Chilcotin FD
MFR Region: SI

F 1.1.2 Microclimatic influences on tree and stand growth in multi-storied stands

Y062066 Improving predictions of juvenile tree growth in complex mixtures for sustainable forest management

Suzanne Simard
University of British Columbia

What are the growth responses of subalpine fir to variation in residual canopy cover, site quality, and crowding?

This project examines growth responses of subalpine fir to variation in residual canopy cover, site quality, and crowding. The study examines the relative strength of different factors affecting juvenile tree growth, including light, water, nutrient availability, and neighbourhood crowding. Preliminary results indicate that light and density are the key site variables influencing the growth of juvenile subalpine fir. Following additional sampling, these results will be linked to SORTIE-BC to examine how complex stands respond to a wide range of silvicultural strategies, at different spatial scales and over different time periods.

Initiated: 04/05
Duration: 2 *years*
09/10: $0
Total: $69,321
Location: ICH zone
MFR Region: SI

Y071012 Complex stand management: extension of recent research to forest managers

Kevin Kriese
Bulkley Valley Centre for Natural Resources Research and Management

How can the ecology and succession of complex stands in northern British Columbia be understood and modeled?

This project extends results of advances in knowledge about tree growth and succession in complex stands. The result was the "Complex Stands Research and Management Conference" held in February 2007.

Initiated: 06/07
Duration: 1 *year*
09/10: $0
Total: $23,100
Location: SBS and BWBS
MFR Region: SI; NI

Y071255 Regeneration recruitment and early stand growth in partially cut and burned IDFww stands

Roderick Negrave
Ministry of Forests and Range

How effective is the combined treatment of partial cutting with prescribed fire under a regime for restoration of dense Douglas-fir stands to more typical, pre-contact ecological conditions?

This study will document the occurrence of natural regeneration and investigate factors affecting its growth and the early development of stands under a combined partially cut and burned treatment regime. The study identified several relationships between site conditions and regeneration of ponderosa pine and Douglas-fir. Knowledge from this study will be used to guide policy, support decision makers, and set objectives for improved forest resources management in coast–interior transition areas.

Initiated: 06/07
Duration: 1 *year*
09/10: $0
Total: $12,010
Location: Squamish and Chilliwack FDs
MFR Region: C

Y082254 Effect of site type on competitive interactions among trees in complex-structured mixed-species sub-boreal forests

David Coates
Bulkley Valley Centre for Natural Resources Research and Management

How do individual trees respond to microclimates within complex mixedwood stands?

The most common techniques for identification and extraction of individual tree crowns from high-resolution imagery have difficulty in resolving touching and overlapping crowns, and in correctly identifying understorey vegetation in gaps as tree crowns and smaller trees lost in shadow of larger trees. This project explored the application of object-oriented feature extraction techniques to very high-resolution visible spectrum aerial images to facilitate the development of robust growth functions that can be incorporated into individual tree models. Image analysis results compared favourably with other methods, suggesting that the algorithms may be applicable for tasks that utilize aggregated stand-level data; the stem plots thus created were used in an examination of neighbourhood competitive interactions across a soil nutrient gradient. The growth response functions developed have been incorporated into the simulation model SORTIE-ND.

Initiated: 06/07
Duration: 2 *years*
09/10: $0
Total: $199,070
Location: Northern interior
MFR Region: NI

Y083028 Improving predictions of juvenile tree growth in complex mixtures for sustainable forest management

Suzanne Simard
University of British Columbia

What is the growth response of juvenile subalpine fir to variation in light availability, site quality, and crowding conditions in the understorey?

To design silvicultural strategies that optimize timber production and sustain other values, foresters and managers require an understanding of how juvenile trees (seedlings and saplings) grow and survive across the full range of potential canopy retention levels and site qualities. This study examined the growth responses of juvenile subalpine fir to variation in residual canopy cover, site quality, and crowding. Consistent with other similar studies, the results suggest that available light is one of the most important predictors of juvenile tree radial growth. The improved mechanistic understanding of juvenile growth is currently being linked to SORTIE-ND to examine how complex stands respond to a wide range of silvicultural strategies, at different spatial scales and over different time periods.

Initiated: 05/06
Duration: 3 *years*
09/10: $0
Total: $59,049
Location: Southern interior
MFR Region: SI

Y083080 **Interactions between light and nitrogen availability on juvenile tree growth in partial cut forests**

Marty Kranabetter
Ministry of Forests and Range

What is the relationship between light and nitrogen availability in development of partially cut stands?

Currently, simulations of juvenile tree growth in partially harvested stands are able to account for species-specific growth relationships with light conditions, but do not yet allow for the interactive effect of differences in nitrogen availability. This project examined the relationship between soil N supply, light availability, and the combined effects of these resources on selected tree species of northwestern British Columbia. Several published, in press, or soon to be submitted manuscripts have resulted from the work that collectively documents a number of effective tools developed to facilitate more detailed studies of stand dynamics in multi-species, uneven-aged stands.

Initiated: 05/06
Duration: 3 *years*
09/10: $0
Total: $72,932
Location: Date Creek Research Forest in the Kispiox Valley
MFR Region: NI

Y083141 **Effects of the variable retention silvicultural systems on microclimate, establishment, and growth of trees in west coast forests**

Andrew Black
University of British Columbia

What are the impacts of variable retention silvicultural systems on the microclimate, establishment, and growth of planted seedlings?

Microclimatic information on variable retention systems is needed to identify the best type and extent of tree retention for optimal seedling survival and growth. This project investigated the microclimatic influences of group VR harvesting to capture seasonal changes in seedling light, temperature, and moisture environment associated with changing solar elevation angle to determine seasonal seedling microclimates, and to use the measurement data to validate and improve the light sub-model of the FORGE forest growth model. Refinements to leaf temperature, energy balance, and water balance relationships were made, successfully validated, and incorporated into the FORGE model.

Initiated: 05/06
Duration: 3 *years*
09/10: $0
Total: $153,622
Location: Coast
MFR Region: C

Y091069 **Residual stand effects on light transmission and understorey conifer growth in partially cut stands in the CWHvh2, Queen Charlotte Islands**

Roderick Negrave
Ministry of Forests and Range

How does partial cutting influence residual stem growth and regeneration across a range of partial cutting methods applied on the coast?

Although partial cutting is increasingly used in managed coastal forests, its consequences for stand regeneration and growth are still poorly understood. Using a replicated partial cutting experimental site, residual stand structures, light transmission and realized growth of understorey regeneration were measured under different treatments. The results suggest that although subsequent growth of regeneration is related to residual levels of basal area left by partial cutting operations, this relationship is imprecise and will be difficult to model for timber supply purposes. Recruitment of understorey regeneration in these stands may be more closely related to post-harvest substrate conditions than to residual overstorey structure and composition.

Initiated: 08/09
Duration: 1 *year*
09/10: $0
Total: $28,099
Location: Rennell Sound, CWHvh2, Haida Gwaii
MFR Region: C

Y092022 The effect of site type and stand structure on the relationship between growth and light availability for understorey trees

Rasmus Astrup
Bulkley Valley Centre for Natural Resources Research and Management

How do light availability, site type, and canopy structure influence understorey tree growth in sub-boreal forests?

To evaluate and plan complex stand management, forest managers require additional knowledge of understorey tree growth and quantitative relationships that can be used to predictunderstoreyy tree growth. This project examined the nature of multiple resource limitations on sub-boreal tree species by investigating how light availability, nutrient availability, soil water availability, and canopy structure influencunderstoreyry tree growth and physiological traits of sub-boreal tree species. The main outcome of this project is a suite of regression models that predict juvenile tree growth as a function of site characteristics (nutrient and water availability), light availability, tree size, and competition.

Initiated: 07/08
Duration: 2 *years*
09/10: $0
Total: $124,391
Location: SBS around Smithers
MFR Region: NI

Y093038 Light as a factor in the growth and survival of four planted conifer species across forest gaps

Peter Fielder
Ministry of Forests and Range

What is the effect of the residual stand edge created under different silvicultural system treatments on the growth and development of planted seedlings?

The residual stand edge created by different silvicultural system treatments has an impact on the light environment, and hence the growth and development of planted seedlings. This study examined this impact through the collection and subsequent analysis of light and growth data across two forest gaps within the Silviculture Treatments for Ecosystem Management in the Sayward (STEMS) experiment in the Campbell River Forest District. Results that the response of seedling growth to light level varied by species with the following order of shade tolerance: hemlock > cedar > white pine > Douglas-fir. Seedling survival was generally lower under the canopy for all species, while survival in the gap was generally good. Results will be used to improve model predictions in the stand development model TASS III.

Initiated: 06/07
Duration: 3 *years*
09/10: $0
Total: $63,017
Location: Coast
MFR Region: C

Y102093 Responses of conifers and trembling aspen-dominated vegetation a decade after manual and chemical brushing in southern interior of BC: examining the role of climate, ecosystem, site, and vegetation characteristics

Jean Heineman
J. Heineman Forestry Consulting

How can management of competition for light in regenerating mixedwood stands be improved for sustaining long-term forest health and productivity?

Competitive interactions among conifers and deciduous species for light and nutrients vary across site and bioclimatic conditions, and affect both the costs of reducing this competition and predicting future stand composition under climate changes. Multivariate statistical analysis of stocking levels in mixed-species stands previously treated with alternative brushing methods will determine thresholds for management of trembling aspen in regenerating stands. Results will improve management practices in mixedwood stands for maintaining productive, diverse and healthy forest ecosystems in southern BC.

Initiated: 08/09
Duration: 2 *years*
09/10: $28,231
Total: $66,463
Location: Headwaters, Okanagan-Shuswap, Kamloops, Columbia FDs
MFR Region: SI

Y102104 Microclimate and tree growth as affected by western hemlock variable retention groups

Andrew Black
University of British Columbia

Can microclimate impacts of variable retention harvesting be used to predict survival and growth of the next crop of trees in managed coastal forests?

Variable retention (VR) levels act on residual trees and regenerating understorey in part through effects on stand microclimates. In treatment blocks of a previously established coastal variable retention experiment, intensive measurements of total photosynthetically active radiation (PAR), soil moisture, and soil temperature using fixed sensor transects together with regeneration data will be used to parameterize the FORGE forest growth model. The resulting predictions will be used to estimate effects of variable retention harvesting levels on regeneration and structure of VR stands in coastal forests.

Initiated: 08/09
Duration: 3 *years*
09/10: $54,724
Total: $112,727
Location: Vancouver I., CFR
MFR Region: C

Y102162 Crown competition, crown efficiency, tree growth, and site type: quantification with terrestrial LIDAR

Bruce C. Larson
University of British Columbia

How can efficient management of structurally complex stands be improved?

Effective management of structurally complex stands requires study of ecological variables influencing demography of individual trees. In experimental plots located across gradients of competition and below-ground resources in the SBS, fine-scaled 3D measurements of crown efficiency and crown structures will be made to create predictive growth models of individual trees in stands. Results can be used to improve spatially-explicit models (e.g., TASS 3; SORTIE-ND) of growth and stand development of complex stands.

Initiated: 08/09
Duration: 3 *years*
09/10: $61,236
Total: $129,276
Location: SBS zone near Smithers
MFR Region: NI

F 1.1.3 Partial cutting and variable retention (Retired 2006)

M065001 Regeneration and stand structure following mountain pine beetle infestation in the Sub-Boreal Spruce zone

Kirsteen Laing
Bulkley Valley Centre for Natural Resources Research and Management

What is the status of advance regeneration in pine stands before MPB attack?

This project will compile available information on the density of advance regeneration and non-commercial trees under pre-harvest conditions in pure (>80%) lodgepole pine stands of the Nechako Plateau. This work will look at all lodgepole pine stands for which data can be assembled, not just those standing today or suffering from mountain pine beetle attack.

Initiated: 05/06
Duration: 1 *year*
09/10: $0
Total: $13,999
Location: Nechako Plateau
MFR Region: NI

F 1.1.4 Natural regeneration processes in multi-storied stands

Y081114 Effects of wildfire severity and harvesting on natural regeneration potential of Douglas-fir in the dry Interior Douglas-fir forests

Suzanne Simard
University of British Columbia

What are the effects of clearcutting and fire severity on the regeneration potential of interior Douglas-fir seedlings?

BC forests are characterized by a mixed fire regime with a broad severity spectrum from low, leaving a living overstorey with uneven combustion of the forest floor, to high, with full combustion of the forest floor, death of the overstorey, and exposure of mineral soil. Forest managers attempt to emulate these conditions with a variety of silviculture systems and site preparation methods. This project examined the effects of clearcutting and fire severity on Douglas-fir regeneration potential in the Interior Douglas-fir biogeoclimatic zone across a range of disturbance severities. Overall, the treatments with the greatest disturbance severity (High Severity Burn and Screefed Clearcut) had the greatest natural regeneration potential.

Initiated: 07/08
Duration: 1 *year*
09/10: $0
Total: $29,572
Location: Near Barriere
MFR Region: SI

Y103073 Natural regeneration, mortality, and residual growth response 25 years after partial cutting on the Coast

Louise de Montigny
Ministry of Forests and Range

What is the long-term growth, regeneration, and mortality response of coastal Douglas-fir and western hemlock stands to various levels of intermediate and partial cutting?

"Experimental Project 703, Extensive Studies of Fertilizing and Thinning", initiated in 1971 to investigate the growth response of Douglas-fir and western hemlock at three levels of fertilization and three levels of thinning, is the single, largest source of data for coastal stands in BC. It has provided the most important validation and calibration data for second-growth coastal hemlock and Douglas-fir used by research organizations and consultants in BC, the Pacific Northwest, and internationally. This project will analyze and report on the 25-year response of growth, regeneration, and mortality from intermediate and partial cutting throughout the coast. The project will provide the first ever look at 25-year dynamics across the range of installations.

Initiated: 07/08
Duration: 3 *years*
09/10: $117,450
Total: $308,544
Location: Coast
MFR Region: C

Y103103 **Regeneration, growth, and potential value of bitter cherry as a component of young complex stands on Southern Vancouver Island**

Brian D'Anjou
Ministry of Forests and Range

How can better understanding of bitter cherry ecology improve management of cherry in conifer plantations?

Silvicultural interventions to remove early successional deciduous hardwoods from regenerating coastal conifer stands are expensive and may reduce both the ecological and economic value of the stand, since most of the hardwood species found in coastal BC also have substantial commercial value. This study will examine the natural regeneration, growth, and perceived value of bitter cherry, a species that has received little study, is a concern for conifer regeneration, and is also a valuable resource in its own right. The information gained will contribute to ecologically based management of cherry–conifer complexes, provide context for the regeneration studies and guidance in how to manage cherry in conifer plantations through a better understanding of the competitive effects of high densities of cherry on planted conifers.

Initiated: 07/08
Duration: 3 *years*
09/10: $14,040
Total: $75,790
Location: Southwestern Vancouver Island, Jordan River
MFR Region: C

F 1.1.5 Mortality (Retired 2006)

Y061012 **Modeling individual tree mortality for northern mixed-species stands**

Bruce C. Larson
University of British Columbia

What are the mortality functions for individual trees in mixed-species stands?

Our understanding of species competition and mortality for mixed-species stands is less developed than for even-aged, single-species stands, which can impede development of operational tools and decision support tools related to stand management. This project developed individual tree mortality models for subalpine fir, hybrid spruce, lodgepole pine, and trembling aspen for incorporation into the stand-level G&Y model SORTIE-ND. The models' predictive ability was evaluated by comparing SORTIE-ND stand-level predictions to permanent sample plot data; it was found that the mortality models provided relatively good predictions of stand density.

Initiated: 05/06
Duration: 1 *year*
09/10: $0
Total: $29,398
Location: SBS and BWBS
MFR Region: NI

Y073266 **Coastal stand management growth and yield field experiments**

Louise de Montigny
Ministry of Forests and Range

In variable retention systems, what are the causes of mortality and rate of deterioration of trees once they have died, including the decay and fall-down rates?

This project builds on data collected through the Coastal Stand Management Growth and Yield Field Experiments Program. Specifically, this study looks at the causes of mortality and rate of deterioration of trees once they have died, including the decay and fall-down rates. This information is important for understanding mortality rates in natural and managed stands and can be used to predict wildlife tree recruitment in variable retention residual patches.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $409,704
Location: Coast
MFR Region: C

Y092256 **A long-term study of the post-harvest population dynamics, development, and emergent characteristics of mature Douglas-fir leave-trees on sub-boreal sites in Central Interior BC**

Michael Jull
Aleza Lake Research Forest Society

What is the long-term fate of Douglas-fir leave-tree populations in harvested areas and resultant second-growth stands?

Heavy attrition of Douglas-fir leave-trees has been reported in Central Interior SBS forest types where post-harvest retention of dispersed mature Douglas-fir leave-trees is common. This study examined the medium- to long-term development of mature Douglas-fir leave-tree cohorts retained following timber harvesting in several sub-boreal study areas in Central Interior BC (SBSdw1, SBSmk1, SBSwk1 subzones) using direct ground-based repeated-measures observations in study populations that have been tracked and monitored since shortly after the initial harvest treatment. The results of this long-term study show good survival and vigour of these leave trees over the medium- to long-term and appear to allay or mitigate many of the initial concerns among forest managers about apparent rates of loss of Douglas-fir leave-trees after harvest on sub-boreal forest sites in the BC Central Interior.

Initiated: 07/08

Duration: 2 *years*

09/10: $0

Total: $33,492

Location: John Prince Research Forest , Aleza Lake Research Forest, Mt. Baldy Hughes and Tako Creek

MFR Region: NI

F 1.3 Old trees and stands

F 1.3.1 Stand dynamics of older stands (e.g., volume loss, decay, succession, stand break-up, mortality); includes cedar, hemlock, aspen, birch, true fir stands

Y071034 **Growth patterns prior to mortality of mature subalpine fir in the Southern Interior**

Joseph A. Antos
Consultant

Does mortality of old spruce–fir forests typically occur abruptly, or is mortality the end result of a gradual decline?

Patterns of tree ring formation prior to death could be used to infer cause of mortality, but little is known about pre-mortality growth patterns. This study examined dead subalpine trees at three different sites and measured attributes related to growth pattern and growth rate. The study concluded that trees in old spruce–fir forests tend to die gradually. This information can be used either to achieve timber objectives by identifying mortality risk of trees for removal, or to facilitate snag recruitment by retaining slow-growing trees.

Initiated: 06/07

Duration: 1 *year*

09/10: $0

Total: $9,975

Location: Sicamous Creek, Adams Lake, and Damfino Creek

MFR Region: SI; NI

Y093017 **Rates of mortality and dead tree dynamics in old coastal forest stands**

Roberta Parish
Ministry of Forests and Range

What are the dynamics of old trees and snags in remnants of old-growth forests?

This project examined rates of tree mortality and transition from standing snags to fallen logs in old growth permanent sample plots in coastal forests. Results indicated that mortality was higher in high- versus low-elevation sites, the volume of snags or recently fallen trees was more than 20% of the live volume of old growth forests, and larger snags took significantly longer to decay. Results varied by species, phase of stand development, and geographical location.

Initiated: 06/07

Duration: 3 *years*

09/10: $0

Total: $102,427

Location: Malcolm Knapp Research Forest

MFR Region: C

Y102053 **Stand dynamics over 15 years in old-growth forests in the Coast Forest Region**

Andy Mackinnon
Ministry of Forests and Range

How can ecosystem-based management policies be improved to enhance key old-growth structural functions and characteristics in managed coastal temperate forests?

The ecological dynamics and structural complexity of coastal temperate rainforests has been inferred from diverse studies, while standardized comparisons across key ecological gradients are lacking. This 2-year study will remeasure a standardized set of tree, understorey, CWD, and stand measurements from long-term plots containing tagged live, and dead and downed trees in three watersheds that cross climatic and topographic gradients. Results of this longitudinal, comparative study will refine models of coastal forest structures, demography, and ecological functioning and provide a defensible, empirical basis for management policies seeking to retain or restore old growth features in coastal BC forests.

Initiated: 08/09

Duration: 2 *years*

09/10: $69,984

Total: $126,998

Location: Kitlope R., Tahsish-Kwois R., Tofino Ck.; CFR

MFR Region: C

Y102075 **Mycorrhizal fungi: unlocking its ecology and role for the establishment and growth performance of different conifer species in coastal ecosystems**

Suzanne Simard
University of British Columbia

Can mycorrhizal colonization be used to improve regeneration rates on nutrient-poor coastal sites?

Mycorrhizal-tree root associations are crucial for seedling demographics and stand tree productivity in nutrient-limited environments such as many coastal sites. Experiments in both laboratory and field utilizing seedling bioassays and reciprocal soil transfers from western redcedar and western hemlock dominated sites will quantify seedling colonization, survivorship, growth, and nutrient uptake effects in each site type. Results will help determine if planting regimes that modify mycorrhizal inoculum could improve seedling establishment on coastal sites experiencing poor regeneration rates.

Initiated: 08/09

Duration: 3 *years*

09/10: $33,916

Total: $66,753

Location: Maritime forest ecosystems, Van. Is.; CFR

MFR Region: C

F 2 Design and analysis of silvicultural systems

F 2.0 Unclassified

Y062218 Planning methods to reduce costs and enhance value recovery in sustainably managed forests

Darrell Regimbald
Canadian Forest Products Ltd.

Can the efficiency and quality of strategic planning be improved through integrated planning of harvest, road lay-out, industrial wood allocation, and ecological constraints?

Requirements to meet sustainable forest management criteria for environmental and social values have increased the complexity of strategic and operational planning at a time when long-term increases in wood product prices are constrained by worldwide increases in wood supply. This project developed and tested planning methods, decision algorithms, and data support systems to assist managers in reducing harvest and product manufacturing costs and enhance value in managed forests. The decision support tools developed in this project allow forest managers to predict the effects of silvicultural prescriptions on production, investigate the impact of SFM scenarios on timber supply volume and log class distributions and allocations, develop production strategies that are consistent with available timber, gauge the overall impact of new product ideas and value added processing in the region while meeting SFM criteria, and analyze financial issues. However, a few system components require further research and development to overcome present deficiencies.

Initiated: 04/05
Duration: 2 *years*
09/10: $0
Total: $252,094
Location: Northern interior
MFR Region: NI

Y073021 Expert system for making site preparation and vegetation management decisions in Southern Interior BC

Donald Sachs
Consultant

How should the new expert system be applied to select appropriate site preparation and brushing treatments?

Appropriate stand treatments must be implemented to achieve full crop tree growth potential, and meet biodiversity and non-timber objectives. This project expanded and updated an existing expert system (ES) for making site preparation and vegetation management decisions in Southern Interior BC. The ES is an interactive, publicly available, Web-based tool to assist practitioners to select appropriate site preparation and brushing treatments as they develop site prescriptions.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $97,510
Location: Williams Lake
MFR Region: SI

Y073024 Long-term effects of vegetation management treatments on growth and yield and stand development

W. Jean Mather
Skyline Forestry Consultants Ltd.

What are the long-term effects of brushing on conifer growth and yield, stand dynamics, and plant community development and diversity?

PROBE (PRotocol for Operational Brushing Evaluations) sites that have already yielded 10 years of data now have the potential to provide valuable information about the long-term effects of brushing on conifer growth and yield, stand dynamics, and plant community development and diversity at relatively low cost. This project resulted in the installation of permanent measurement plots on existing PROBE sites, and remeasurement of PROBE sites with priority for sites dominated by broadleaf complexes. In total, 9 sites were remeasured and 13 new sites were established and measured.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $243,760
Location: Southern Interior
MFR Region: SI

Y073101 Effects of intensive fertilization on timber and non-timber resources

Robert Brockley
Ministry of Forests and Range

What are the effects of fertilization on growth and development of lodgepole pine and spruce stands?

This project documents the effects of various rates and frequencies of fertilization on the foliar nutrition, growth, and development of lodgepole pine and spruce managed forests, and determines the effects of repeated fertilization on above- and below-ground timber and non-timber resources. Results indicate a positive association between fertilizer input and growth responses for spruce forests. However, the response of pine forests to fertilization was small.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $277,684
Location: Central Interior
MFR Region: SI

Y073102 Stand management growth and yield field experiments in the BC Interior

Robert Brockley
Ministry of Forests and Range

What are the impacts of harvesting and stand management treatments on the growth and development of interior forests?

This project documents the impacts of a variety of harvesting and stand management treatments (partial cutting, thinning, fertilization) and regimes (planting and post-thinning density, fertilizer regimes) on the growth and development of Interior forests. Specifically, the project remeasured, analyzed, and reported on an extensive network of previously established research installations. The data will be used to calibrate/validate growth and yield models such as TASS and TIPSY.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $314,477
Location: Southern and Central Interior
MFR Region: SI

Y073190 SCHIRP: ecology and management of ericaceous shrub-dominated ecosystems in coastal BC

Cindy Prescott
University of British Columbia

How can conifer regeneration and tree growth be improved on sites dominated by ericaceous shrubs?

This project is an extension of the Salal Cedar Hemlock Integrated Research Program (SCHIRP), which uses silvicultural trials to understand poor conifer regeneration on sites dominated by ericaceous shrubs and recommends best practices for improving tree growth. Specifically, this project will remeasure several ongoing trials examining the effects of fertilization, stand density, mechanical preparation, and mycorrhizal fungi on hemlock and salal.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $238,296
Location: Coast
MFR Region: C

F 2.1 Complex stands arising from partial cutting, variable retention, and multi-species planting

F 2.1.0 Unclassified

Y051089 **An evaluation of Douglas-fir leave-tree retention practices in central British Columbia**

Chris Hawkins
University of Northern British Columbia

What are the factors affecting the survival of Douglas-fir leave-trees in variable retention harvesting?

At the northern extent of the species' range, mature Douglas-fir leave-trees display inconsistent survival within "variable retention" or "clearcut-with-reserves" silvicultural systems. This study attempts to explain this phenomenon by examining the difference in water relations between pre- and post-harvest treatments. The results indicate that water stress is greater in harvested versus unharvested stands, but there was variation in water stress among trees in unharvested stands. Assessment of pre-harvest water potential could be used to identify trees that may be unsuitable as leave-trees due to low survival probability.

Initiated: 04/05
Duration: 1 *year*
09/10: $0
Total: $68,715
Location: Dry warm variants of the SBS zone
MFR Region: NI

Y051255 **Mixed-species stands grown at high densities for the production of high-value wood**

Bruce C. Larson
University of British Columbia

Does the planting of mixed-species stands improve wood quality characteristics?

There is renewed interest in planting mixed-species stands to improve wood quality characteristics, with the underlying premise being that mixed-species stands will have some of the advantages of growing trees at higher densities, without the disadvantage of increased competitive mortality. This study undertook a literature review to identify information that would either support or weaken this assumption. It was concluded that the use of mixed-species stands established at high densities and managed through frequent thinnings will provide excellent management opportunity for the production of high-value wood.

Initiated: 04/05
Duration: 1 *year*
09/10: $0
Total: $47,524
Location: Malcolm Knapp Research Forest
MFR Region: SI

Y073299 **The ecology and management of dry Douglas-fir forests: the Opax Mountain Silvicultural Systems Study**

Andre Arsenault
Ministry of Forests and Range

What are the effects of different harvesting and site preparation treatments on selected ecological variables?

The Opax Mountain Silvicultural Systems Study was set up to monitor a number of ecological variables after the application of different harvesting and site preparation treatments. This project involved re-measurement of several ongoing experiments, completion of some studies, and integration and extension of various project elements.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $472,747
Location: N of Kamloops
MFR Region: SI

F 2.1.2 The relationship between residual stand structure and understorey recruitment and development; evaluation of the results of partial cuts and the effects on stand establishment, early growth and yield, and response to management practices

Y051161 **Growth and yield implications of alternate silvicultural strategies in mountain pine beetle–damaged stands**

David Coates
Bulkley Valley Centre for Natural Resources Research and Management

How do the snags left in unsalvaged MPB-attacked stands affect the future development of the understorey under different regeneration strategies?

Although traditional growth and yield models (e.g., TASS) can be used to predict stand growth after complete salvage and planting, they do not work well for the vast areas that will only be partially salvaged, or not salvaged at all, due to the potential structural complexity of the residual stand. This project has incorporated a robust snag-dynamics submodel into the spatially explicit, individual tree model SORTIE-ND. This will model stand development without salvage in four common stand types found in MPB-attacked forests, to predict survival and growth rates of lodgepole pine natural regeneration, and to explore the effectiveness of different underplanting prescriptions. MPB-attacked stands with a well-developed immature spruce component recover relatively well after attack, and can help mitigate mid-term timber supply shortages if protected during partial salvage or left unsalvaged. However, pine-dominated stand types will require management intervention in the form of underplanting or salvage and planting. Delaying underplanting for 5 to 15 years after initial MPB attack may result in much higher survival and growth of interior spruce or subalpine fir.

Initiated: 04/05

Duration: 1 *year*

09/10: $0

Total: $40,950

Location: Province-wide

MFR Region: P

Y061094 **Long-term Research Installation Number 042 ; EP 1151: dispersed retention in the coast-interior transition. Evaluation of a range of overstorey densities for harvesting and managing Douglas-fir dominated stands (Boston Bar)**

Brian D'Anjou
Ministry of Forests and Range

How effective is dispersed retention at improving regeneration success?

This project involves remeasurement of residual stand structure in a LTRI originally established to investigate the effects of retention of overstorey trees on establishment and growth. This monitoring provides on-going science-based information on which to assess implications of dispersed retention and broadcast burning on longer-term stand structure. Preliminary results suggest that light to moderate dispersed retention and/or aggregated retention improves regeneration success, with the optimal level and type of retention varying among study sites.

Initiated: 05/06

Duration: 1 *year*

09/10: $0

Total: $40,542

Location: Confluence of East Anderson River and Utzlius Creek

MFR Region: SI

Y071169 **The growth of natural regeneration under different partial cut silvicultural systems**

Bruce C. Larson
University of British Columbia

What is the effect of above-plot light availability on the growth of understorey trees?

The success or failure of the natural regeneration under different types of partial cutting is driven by the microsite light conditions throughout the cut area. With the objective of contributing to the design of partial cut harvests to produce the most desirable light conditions for regeneration, this project analyzed the development of natural regeneration in four types of cutting: uniform shelterwood, irregular shelterwood, strip shelterwood, and expanding group cuts. These relationships are quite complex and the derivation of simple design criteria very elusive, as clear relationships did not result from the analytical approaches proposed and used in this project.

Initiated: 06/07
Duration: 1 *year*
09/10: $0
Total: $24,968
Location: Southern Interior
MFR Region: SI

Y072079 **A study of stand growth, development, and structural biodiversity in complex and even-aged ESSF spruce–subalpine fir forests, 14 years after treatment (EP 1119.01 Lucille Mountain Project)**

Mike Jull
University of Northern British Columbia

What is the long-term response of ESSF stands under various silvicultural systems?

The Lucille Mountain ESSF Silvicultural Systems study is the oldest active ESSF silvicultural trial in BC and has resulted in numerous peer-reviewed publications. This project will support remeasurement of several stand attributes to update the time series dataset. This remeasurement and supplementary data collection will allow an opportunity to examine current post-harvest treatment response trends and silvicultural outcomes to date.

Initiated: 05/06
Duration: 2 *years*
09/10: $0
Total: $34,440
Location: Vicinity of McBride, BC; Headwaters FD
MFR Region: NI

Y073022 **Competitive effects of broadleaf trees on conifer performance over a range of ecosystems**

Teresa Newsome
Ministry of Forests and Range

What are the competitive relationships between lodgepole pine and trembling aspen in IDF and SBS subzones?

The effect of broadleaf trees on timber production in conifer–broadleaf stands is poorly understood. This project investigated the effects of trembling aspen competition on lodgepole pine growth and performance by assessing established stands, and manipulating aspen densities and spatial arrangement within young stands. Results indicate that aspen densities greater than 1000 stems/hectare have a significant impact on pine diameter and height, with the effect greater in the SBSdw1 versus the IDFdk3.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $233,872
Location: Cariboo-Chilcotin
MFR Region: SI

Y073286 **Montane Alternative Silvicultural Systems (MASS): growth limitations on regeneration**

Alan K. Mitchell
Canadian Forest Service

What are the effects on site productivity and soil nutrient cycling processes of both clearcut and alternative (retention) silvicultural systems?

Montane sites, characterized by a short growing season, winter snowpack, and slow decomposition rates, comprise 30% of the timber supply landbase in coastal British Columbia, making a better understanding of the effects of various silvicultural options on regeneration and site productivity crucial. This study compared site productivity and soil nutrient cycling processes, including characterizing the microbial communities involved, and their effects on planted and natural regeneration under clearcut (CC) and alternative (retention) silvicultural systems 12 years after harvesting on the Montane Alternative Silvicultural Systems (MASS) field trial site (est. 1992) on Vancouver Island. The study found no significant differences in foliar N, S, or decomposition at the soil surface or at 5-cm depth among silvicultural systems; supply rates of ammonium, P, Al, Fe, Mn and base cations, Ca, Mg, and K, as well as the overall composition of soil microbial communities showed distinct silvicultural system effects.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $128,966
Location: Central Vancouver Island
MFR Region: C

Y082001 **Effects of variable retention on planted and natural regeneration in coastal BC**

N.J. Smith
Western Forest Products Inc.

What are the effects of retained forest edge on the growth of regenerating trees in coastal BC?

Increased retention in openings, such as wildlife tree patches or variable retention, lead to increased edges compared to clearcuts. This study examined the effects of retained forest edge (i.e., ecotone between forest and harvested area) on the growth of regenerating trees in coastal BC by collecting growth response data from a range of variable retention experiments and by developing a new sampling system ('sector sampling') designed to sample variable retention trees. Preliminary results suggest that diameter growth was more impacted by the reduced light edge effect than height growth; sector sampling was found to be helpful in collecting tree data along environmental gradients while avoiding edge effects.

Initiated: 06/07
Duration: 2 *years*
09/10: $0
Total: $65,390
Location: Coast
MFR Region: C

Y082011 **Forest regeneration, growth, and development under seven silvicultural systems**

Louise de Montigny
Ministry of Forests and Range

How are stand growth, regeneration, and development affected by various variable retention silvicultural systems?

Data on the effects of different silvicultural systems on residual tree growth and windthrow, as well growth of planted and natural regeneration, vegetation and light availability are needed to calibrate and validate recently developed complex stand and windthrow models that will be used in guiding policy, regulations and guidelines related to partial cutting alternatives. This project determined how stand growth, regeneration and development are affected by residual stand structures and the corresponding light availability under 7 different silvicultural systems 5 years after harvesting. Interim results showed diameter increments to be greater for residual trees in treatments that removed smaller trees and left larger dominant and codominant trees; blowdown of residual trees was either minor or negligible in most treatment units except the retention systems. Data from this project is being used for the calibration and validation of complex stand model TASS 3, windthrow risk model ForestGales, and TIPSY.

Initiated: 06/07
Duration: 2 *years*
09/10: $0
Total: $113,205
Location: Coast
MFR Region: C

Y082258 **Partial cutting on steep slopes, Queen Charlotte Islands: treatment regime effects on residual stand mortality and growth; recruitment, growth, and dynamics of regeneration; and non-timber understorey composition**

Roderick Negrave
Ministry of Forests and Range

How do natural and planted regeneration perform under various levels of partial cutting?

Partial cut silvicultural systems are a recent introduction to coastal BC and we do not yet have experience over a full rotation with anything other than the clearcut system. This project completed an examination of the effects of four different silvicultural systems, and untreated control, on the performance of planted and natural regeneration 15 years after treatment. Management recommendations resulting from the project include: western redcedar appeared to be non-viable as a crop species in both the clearcut and partial-cut treatments with the methods used in this experiment; partial cut areas would likely be considered stocked for silvicultural purposes without the aid of planting, but, this stocking is dominated by western hemlock; Sitka spruce natural regeneration is incompletely understood; deliberate natural regeneration of part cutting areas may become more effective and operationally reliable with further investigation of overstorey-light-soil resource regime relations.

Initiated: 06/07
Duration: 2 *years*
09/10: $0
Total: $69,897
Location: Queen Charlotte Islands
MFR Region: C

Y082285 Pothole Creek Study Area – Interior Douglas-fir uneven-aged stand development

Catherine Bealle Statland
Ministry of Forests and Range

What are the long-term growth dynamics in an uneven-aged IDF stand?

The Pothole Creek Study Area contains a permanent sample plot that is periodically remeasured to provide data for calibration of a light model and for retrospective analysis of stand development to support spatial growth and yield modeling. This project remeasured the plot and regeneration subplots 10 years after establishment, and synthesized and documented 10 years of stand development results and retrospective analyses. Results show the degree of recovery and understorey response 30-40 years after a heavy diameter-limit harvest, the 10-year periodic stand increment, and current understorey and canopy recruitment rates. Published information and additional references are made available to forest practitioners on the Pothole Creek Study Area website and through MoFR extension note 85.

Initiated: 06/07
Duration: 2 *years*
09/10: $0
Total: $17,729
Location: Merritt
MFR Region: SI

Y091060 Regeneration in thinned and unthinned uneven-aged interior Douglas-fir stands

Peter Marshall
University of British Columbia

What silvicultural and stand management practices in uneven-aged Interior IDF forests create conditions for regenerating structurally and ecologically diverse stands?

Developing empirically-based relationships between residual stand structure, understorey recruitment and development, and evaluating the effects of partial cuts on stand establishment in the IDF zone requires additional regeneration attributes from permanent sample plots (PSPs) with different silvicultural histories. Along with remeasurements of tagged tree attributes from 30 long-term PSPs established in the late 1980s in the IDFdk3, permanent regeneration plots were used to assess average regeneration conditions and the best regeneration present in relation to present and past stand structural conditions and treatment history. Results showed that the primary determinants for the presence of germinants and seedlings in uneven-aged interior Douglas-fir stands are sufficient light and moisture on the forest floor. Since these conditions are in limited supply in the stands included in this study, regeneration was both sparse and clumped. Silvicultural activities directed at enhancing natural regeneration in such stands, especially on very dry sites, should concentrate on enhancing structural diversity within the tree layer and retaining moderate densities.

Initiated: 08/09
Duration: 1 *year*
09/10: $0
Total: $56,652
Location: Knife Ck., Alex Fraser Research Forest, Williams Lake.
MFR Region: SI

Y093262 **Effects of partial retention and common mycorrhizal networks on seedling recruitment in Douglas-fir forests across British Columbia**

Suzanne Simard
University of British Columbia

What are the factors affecting seedling recruitment in partially cut, complex Douglas-fir forests?

The purpose of this project was to conduct field and growth chamber studies examining interior Douglas-fir seedling establishment as a function of regional climate (BEC zone), proximity to residual trees, links into mycorrhizal networks with residual trees, seedling origin, and atmospheric CO2 concentrations. Results show that residual trees remaining in openings harvested with variable retention have potentially facilitative effects on seedling growth and survival via mycorrhizal networks. These residual trees do not necessarily have to be alive, but they must be standing for mycorrhizal networks to have facilitative effects on seedling recruitment.

Initiated: 06/07
Duration: 3 *years*
09/10: $0
Total: $187,350
Location: Souther interior and coast
MFR Region: SI

Y102033 **Growth and development of overstorey and regeneration following partial cutting of dry-belt Douglas-fir**

Suzanne Simard
University of British Columbia

How does selection and partial cutting retention silviculture affect growth and recruitment as well as stand structure development in dry Douglas-fir forests?

Empirical data on tree growth and yield, and stand structural responses to different single-tree selection and partial harvesting treatments are essential for improving growth and yield estimates for management of uneven-aged stands. This 2-year project will use 15-year post-treatment remeasurements of multi-way factorial partial cutting and selection harvest experimental plots. Parameters describing growth of residual trees, regeneration responses and recruitment rates in dry Douglas-fir stands will be estimated. The results will aid in validation and calibration of growth and yield and regeneration models for complex stands, and facilitate improved partial cutting practices in dry-belt forests.

Initiated: 08/09
Duration: 2 *years*
09/10: $3,000
Total: $25,494
Location: N. of Westwold,SIFR
MFR Region: SI

Y102064 **Effects of variable retention on planted and natural regeneration in coastal BC**

N.J. Smith
Western Forest Products Inc.

What effects do additional retained trees on a regenerating site have on establishment, survival, and growth of the succeeding crop of trees ?

Variable retention in coastal forests is widely viewed as a key strategy for retaining ecological values on managed sites. Using seven large-scale and three smaller scale experimental areas, the effects of different amounts and patterns of variable retention (including forest edges) on the survival and growth responses of retained and planted trees and natural regeneration will be measured, along with other indicators of ecological function. The results will assist in designing ecologically sound silvicultural prescriptions for managing and regenerating coastal forest ecosystems.

Initiated: 08/09
Duration: 3 *years*
09/10: $37,800
Total: $77,760
Location: Coast Forest Region (CFR)
MFR Region: C

Y103116 Growth of 10 tree species in relation to location and microclimatic gradients in a strip shelterwood

Phil Comeau
University of Alberta

What are the limiting factors for tree survival and growth in small openings and what are the effects of shelterwood silvicultural systems on these limiting factors?

Due to the multiple environmental factors influencing growth in the small openings created under group and patch shelterwood systems, an understanding of the seasonal dynamics and interacting effects of major environmental factors on physiology and growth of trees may lead to a better understanding of the effects of these factors. This project will build on an ongoing experiment initiated at Burton Creek in 1994 by collecting additional tree growth and microclimate data during 2007, 2008, and 2009; analyzing these data and available data from previous years; and summarizing the results in published reports that will include development of a "gap environment" classification for similar Interior Cedar–Hemlock zone stands. The work will provide more detailed data on edge effect and species performance in partial cutting situations.

Initiated: 07/08
Duration: 3 *years*
09/10: $51,840
Total: $168,240
Location: EP1191, Columbia-Shuswap variant of the ICHmw
MFR Region: SI

Y103143 St. Mary's residual basal area study in a mixed conifer stand

Michaela Waterhouse
Ministry of Forests and Range

What is the developmental and growth response of complex stands to selective removal of individual trees?

An assessment of the Saint Mary's project, a single tree selection silvicultural systems trial initiated in 1994 in the IDFdm biogeoclimatic subzone near Cranbrook, BC, was completed post-harvest in 1995, but was not remeasured due to lack of staffing. A site visit by the Southern Interior Forest Region research team in 2006 determined that with some trial maintenance, 14-year regeneration and 15-year growth and yield data could still be obtained. Therefore, this project will undertake trial and plot reconstruction in 2007; regeneration, vegetation, and understorey light assessment in 2008; and 15-year growth and yield data collection in 2009. Data on the post-logging stand structure compared with the present stand conditions will assist in making decisions regarding partially harvested stands and will provide data for modeling programs such as TASS and PrognosisBC.

Initiated: 07/08
Duration: 3 *years*
09/10: $53,800
Total: $151,290
Location: St. Mary's River FSR about 25km NW of Cranbrook
MFR Region: SI

Y103145 Shelterwood silvicultural systems to address integrated resource management issues

Michaela Waterhouse
Ministry of Forests and Range

How can shelterwood silvicultural systems be used to meet the many objectives of integrated resource management?

Shelterwood silvicultural systems have the potential to address many issues in integrated resource management, such as planning objectives regarding wildlife, biodiversity, visual quality, recreation, and partial cutting in riparian management zones. This project will link data from two long-term shelterwood silvicultural systems trials in the Southern Interior Forest Region of BC, both of which are examining uniform shelterwood silvicultural systems, harvesting methods, and regeneration development, to evaluate management options for addressing numerous integrated resource management problems.

Initiated: 07/08
Duration: 3 *years*
09/10: $85,230
Total: $202,604
Location: Southern interior
MFR Region: SI

Y103210 **Effects of variable retention on planted and natural regeneration in coastal BC: data measurement and analysis**

N.J. Smith
Western Forest Products Inc.

What are the effects of retained forest edge on the growth of regenerating trees in coastal BC?

Increased retention of trees in openings leads to increased edges compared with clearcuts. This study will examine the effects of retained forest edge on the growth of regenerating trees in coastal BC by measuring and analyzing planted and natural regeneration and retained tree growth responses across variable retention edges, linked to light, temperature, and moisture gradients, on two permanent plot datasets established under previous funding. Results will help fuel the development of a regeneration phase of a spatially explicit microclimate-growth model called FORGE (Forest Growth Engine) previously developed.

Initiated: 07/08
Duration: 3 *years*
09/10: $44,280
Total: $132,840
Location: TFL 39 and TFL 44
MFR Region: C

Y103211 **Growth and release of understorey trees in partially cut pine stands**

Marie-Lou Lefrancois
Bulkley Valley Centre for Natural Resources Research and Management

What is the performance of underplanted trees under different levels of canopy retention, and what is the release potential of understorey trees after mountain pine beetle attacks?

The investigation of understorey release and ingress of natural regeneration after MPB attack is crucial for predicting the future growth trajectories of MPB stands, yet data on these issues remain sparse. This project will use an old experiment (EP 591) established in 1962–1963 to investigate current issues in complex stand management by (1) compiling and analyzing the existing data to characterize the effect of overstorey structures on development of planted, seeded, and naturally regenerated spruce and (2) remeasure EP 591 to access how understorey trees (spruce, subalpine fir, and aspen) release after MPB attack of varying overstorey densities. The results of this study will aid in making strategic decisions related to silvicultural and timber-supply issues in MPB-damaged stands and landscapes.

Initiated: 07/08
Duration: 3 *years*
09/10: $58,320
Total: $124,944
Location: SBS with emphasis on the SBSdk
MFR Region: NI

F 2.1.3 Experiments and analysis of various complex stand-treatment regimes

Y072075 **Natural and artificial regeneration response to opening size and site preparation in a high-elevation fir–spruce stand at Sicamous Creek**

Alan Vyse
Thompson Rivers University

Is natural regeneration a feasible option in high-elevation fir–spruce stands?

This project takes advantage of previously established and measured plots at the Sicamous Creek Silvicultural Systems Project to re-evaluate old and current silvicultural options and to design new options for future application in this forest type. Data on natural regeneration from field plots, combined with other data previously collected at the study site, will allow the proponent to forecast future stand development following alternative combinations of harvesting and site preparation. This will allow conclusions to be drawn about the feasibility of natural regeneration in high-elevation fir–spruce stands and make recommendations for the prescription of natural regeneration.

Initiated: 05/06
Duration: 2 *years*
09/10: $0
Total: $84,828
Location: South-central Interior
MFR Region: SI

Y081249 **Planted regeneration survival and growth, and natural regeneration composition and abundance, within three post-harvest stand structures in silvicultural system trials in the wet Interior Cedar–Hemlock subzones of east-central British Columbia**

Michael Jull
University of Northern British Columbia

What is the effect of various post-harvest residual stand structural types on planted and natural regeneration performance?

The main challenge to regenerating conifers in complex or multi-cohort stands is the above- and below-ground competition from both the overstorey trees and the understorey vegetation. This project compared planted and natural regeneration performance across a range of stand structure types created by harvesting in the wet ICH subzones, in a series of established long-term silvicultural systems studies that includes clearcut and partial cut systems with different size openings. Harvest treatment has not affected survival of planted seedlings 6 years after planting; natural regeneration was highly variable, as expected, because it depends on seed production, seed dispersal, predation, suitable seedbed, and growing season weather, regardless of harvest system. However, total recruitment of trees, all species combined, was greatest under group retention.

Initiated: 07/08
Duration: 1 *year*
09/10: $0
Total: $42,523
Location: Fleet Creek, East Twin Creek, Minnow Creek
MFR Region: NI

Y091149 **Growth of montane conifers 15 years after clearcutting and alternative systems at MASS**

William J. Beese
Western Forest Products Inc.

How do conifers and understorey vegetation in coastal montane forests respond to alternative silvicultural systems?

Growth of planted and naturally regenerated conifer species under clearcut, patch cut, dispersed retention, and shelterwood systems in coastal montane forests requires long-term assessment. Using the treatment plots on the MASS long-term research installation, this study quantified and compared planted and natural conifer regeneration, understorey vegetation cover and diversity after clearcutting and three alternative systems for montane coastal BC forests. Long-term plots were measured 1 year before harvesting and 1, 3, 5, 10, and 15 years post-harvesting. Forest resource managers can use these results to design silvicultural prescriptions for montane forest types throughout coastal BC to meet multiple objectives.

Initiated: 08/09
Duration: 1 *year*
09/10: $0
Total: $39,852
Location: CWHmm subzone, Vancouver I.
MFR Region: C

Y102079 **An evaluation of brushing and spacing treatments – growing space management in boreal forest mixedwoods**

George Harper
Ministry of Forests and Range

How can silviculture be used to improve stand development trajectories for sustaining long-term values in boreal mixedwoods?

Specific, measurable criteria for assessing for regenerating boreal mixedwood stands consistent with desired future forest conditions requires management practices for deliberately growing spruce-aspen mixtures in these forests. Using a replicated 6-treatment experiment involving mechanical and herbicidal removals and spacing of aspen, early stand succession trajectories of mixed spruce-aspen stands will be developed. Results will be used to develop best management practices for mixedwoods for sustaining a variety of resource values.

Initiated: 08/09
Duration: 2 *years*
09/10: $5,724
Total: $23,601
Location: BWB zone, Fort Nelson FD.
MFR Region: NI

Y103108 Does fire promote regeneration and growth of western redcedar?

Ed Korpela
Ministry of Forests and Range

Is recruitment of cedar natural regeneration promoted by fire, and is the growth of cedar natural regeneration promoted by fire?

Western redcedar is a major commercial species on the BC Coast with substantial cultural value to First Nations, yet it appears to be declining and significant questions remain about the regeneration and developmental ecology of cedar in coastal stands. This project will conduct a retrospective examination of the role of fire in cedar regeneration by sampling and comparing the occurrence and growth of western redcedar on sites subject to historical wildfires and prescribed burns and on comparable non-burned sites. The project will produce a better understanding of the basic regeneration ecology of western redcedar and of the possible effects of increased fire occurrence associated with global climate change, thus contributing to improved management of forests for the continued presence of cedar.

Initiated: 07/08

Duration: 3 *years*

09/10: $8,101

Total: $77,790

Location: Vancouver Island, Mid-Coast, North Coast

MFR Region: C

Y103279 Early survival and growth of natural regeneration and planted seedlings under seven silvicultural systems on the Coast

Louise de Montigny
Ministry of Forests and Range

What are the comparative merits of several silviculture treatment alternatives designed to create diversity in vertical and horizontal forest structure that emulates natural structural variation and promote healthy ecosystem functioning?

Silviculture Treatments for Ecosystem Management in the Sayward (STEMS) is a large-scale, multi-disciplinary experiment that compares forest productivity, economics, and public perception of seven silvicultural regimes: Extended Rotation (non-treatment control), Extended Rotation with Commercial Thinning, Uniform Dispersed Retention, Aggregate Retention, Group Selection, Modified Patch Cuts, and Clearcut with Reserves. This proposal requests funds to complete surveys of planted and natural regeneration under each of the silvicultural systems and determine the early survival, growth, mortality, health, and browsing damage four years after planting. The results of the multi-disciplinary studies within the STEMS experiment will be used to improve forest management and policies because results from many studies done on the same sites can be directly interpreted operationally due to the large-scale, replicated experimental design.

Initiated: 07/08

Duration: 3 *years*

09/10: $52,744

Total: $154,999

Location: Elk Bay

MFR Region: C

F 2.2 Even-aged stands

F 2.2.0 Unclassified

Y051025 Old-growth attributes in managed forests: integrating stand productivity with mammal diversity

Thomas Sullivan
University of British Columbia

Does pre-commercial thinning of lodgepole pine stands enhance tree growth and development of late-seral structural characteristics?

This project involved conducting analyses and preparing management guidelines and extension products based on stand structure data collected following different densities of pre-commercial thinning (PCT). These data include: (1) the diameter, height, and crown volume growth responses of lodgepole pine crop trees; (2) the responses of understorey vegetation and overall stand structure; and (3) the relative habitat use by mule deer and moose. The study generally concludes that PCT enhances productivity and structural attributes of young lodgepole pine stands, including the precocious development of late-seral structure.

Initiated: 04/05
Duration: 1 *year*
09/10: $0
Total: $39,900
Location: Southern and Central Interior
MFR Region: SI

Y062240 Optimum nutrition and nutrient loading in Douglas-fir

Barbara Hawkins
University of Victoria

What is the optimum ratio of ammonium to nitrate for providing a nitrogen source to Douglas-fir seedlings, and what are the implications of exponential nutrient loading (versus conventional fertilization) for growth and nutrient dynamics?

Regeneration of Douglas-fir following harvesting has proven difficult on many sites in British Columbia. This project explored both the optimum ratio between two inorganic sources of N , and the implications of exponential nutrient loading (exponentially increasing fertilization rate) versus conventional fertilization (constant fertilization rate) on seedling growth and nutrient allocation. Seedlings grown in solutions containing abundant and relatively equal portions of NH4+ and NO3- had the greatest relative growth rates, greatest biomass, and stable internal nitrogen concentrations; there were no significant differences in height, root collar diameter, or total dry mass between the nursery fertilizer regimes 2 years after planting.

Initiated: 04/05
Duration: 2 *years*
09/10: $0
Total: $42,599
Location: Kamloops FD
MFR Region: SI

F 2.2.1 Assessment and analysis of fertilization experiments or trials for cedar, interior Douglas-fir, spruce, pine, and true fir. New research projects are limited to mid to late rotation cedar

Y081189 Analysis and reporting of the Shawnigan Lake Fertilizer and Thinning Experiment

A Yenemurwon Omule
Agro Forestry Limited

What is the 32-year growth response of a coastal Doulas-fir stand to thinning (partial cutting)?

The Shawnigan Lake Fertilizer and Thinning Experiment Project, established in 1970 to study the mechanisms of response to thinning and fertilization, is one of the few well designed experiments in coastal British Columbia that can provide valuable growth response information over a relatively long period of observation. This project analyzed and documented the 32-year growth response of coastal Douglas-fir to various levels of thinning and nitrogen (N) fertilization as well as additional fertilization with phosphorus (P) and sulphur (S), and disseminating the results. The 32-year results, too numerous to cite here, are comparable to the trends reported in the 24-year response report (McWilliams and Therien, 1996), and are also consistent with those found in other studies.

Initiated: 07/08
Duration: 1 *year*
09/10: $0
Total: $35,122
Location: Coast
MFR Region: C

Y103055 SCHIRP: ecology and management of ericaceous shrub-dominated ecosystems in coastal BC

Annette van Niejenhuis
Western Forest Products Inc.

How can the poor conifer growth observed on CH (cedar–hemlock) and HA (hemlock–amabilis fir) sites dominated by ericaceous shrubs on northern Vancouver Island be improved?

Long-term research trials established on northern Vancouver Island in the 1980s to study poor conifer growth on CH (cedar–hemlock) and HA (hemlock–amabilis fir) sites have led researchers to hypothesize that high soil moisture causes low nutrient supply on CH cutovers, and that this may be the cause of the lower productivity observed on the CH sites. This project will investigate this hypothesis using a combination of field measurements, lab incubations, a field trial, and ecosystem modeling. This ongoing research is anticipated to contribute to the development of tools to improve conifer growth on these sites.

Initiated: 07/08
Duration: 3 *years*
09/10: $89,157
Total: $287,208
Location: Between Port McNeill and Port Hardy, and out to Holberg
MFR Region: C

Y103127 Growth responses of red alder to fertilization: remeasurements of existing single-tree and multi-tree plot experiments on Vancouver Island and the Sunshine Coast

Roderick Negrave
Ministry of Forests and Range

How long do the effects of P fertilization on red alder growth persist?

Recent studies have shown that growth of young red alder in coastal British Columbia, a subject of increasing commercial interest, may be limited by deficiencies of phosphorus (P) even in soils classified as rich to very rich, and trials have indicated the potential for fertilization at planting to reduce the time required to reach free-to-grow status. This project will remeasure stem growth from three sets of alder fertilization experiments on Vancouver Island over the next 3 years to assess the long-term effects of P additions on red alder growth. The results of this work will contribute to improved management of red alder as a species of commercial value.

Initiated: 07/08
Duration: 3 *years*
09/10: $24,948
Total: $77,123
Location: Eastern Vancouver Island (Bowser to Sayward); Powell River
MFR Region: C

F 3 Stand dynamics modelling

F 3.0 Unclassified

Y051325 New models of regenerated forest stands

Peter Forsythe
Northern Interior Vegetation Management Association

How can stands regenerated under various operational conditions be linked to realistic long-term growth and yield predictions?

In spite of its importance, the stand initiation stage has not been modelled seriously for operationally established commercial forest stands. This project uses transition matrices to simulate stand dynamics during the stand initiation stage, producing stand structures that can be used to initialize stand conditions for long-term stand models like TIPSY and PROGNOSIS. The outcome of the project is the NIVMA model, a powerful tool for modeling the stand initiation stage of forest development.

Initiated: 04/05
Duration: 1 *year*
09/10: $0
Total: $64,158
Location: Province-wide
MFR Region: P

Y051355 Implementing a PrognosisBC regeneration submodel for the complex stands of southeastern and central British Columbia

Abdel-Azim Zumrawi
Ministry of Forests and Range

How can stands regenerated under various operational conditions be linked to realistic long-term growth and yield predictions?

In the past, the ability of the PrognosisBC stand development model to make long-term projections in partially cut stands has been limited by the lack of a natural regeneration component. This project assessed predictions of a regeneration component currently under development for PrognosisBC against long-term regeneration data from MPB-affected stands, and studied how the model responds to different partial cutting regimes. It is recommended that the existing PrognosisBC regeneration model be modified to include key variables for MPB-affected stands, such as initial and subsequent mortality along with snag dynamics, before being added to the MPB stand dynamic component to better estimate regeneration in MPB-affected stands. For partial cutting regimes, the PrognosisBC regeneration model was found to be more sensitive to time since disturbance, stand basal area, and crown competition factor, and is less sensitive to the total number of stems per hectare.

Initiated: 04/05
Duration: 1 *year*
09/10: $0
Total: $73,227
Location: Southeastern and Central Interior
MFR Region: SI

F 3.1 Complex stands, including partial cutting, variable retention

F 3.1.0 Unclassified

Y061168 Incorporating variable retention harvesting functionality into the Forest Service Spatial Analysis Model (FSSAM)

C. Mario Di Lucca
Ministry of Forests and Range

How can variable retention be reflected in forest growth models?

The lack of long-term research on the response of stands to variable retention (VR) harvesting makes it difficult to predict growth and yield implications. This project used the Tree and Stand Simulator (TASS) model to incorporate variable retention harvesting functionality into FSSAM. The adjustments to FSSAM improved the model's ability to predict the impact of variable retention harvesting at the forest level for provincial timber supply analysis applications.

Initiated: 05/06
Duration: 1 *year*
09/10: $0
Total: $26,647
Location: Province-wide
MFR Region: P

Y073071 SIBEC site index estimates

Shirley Mah
Ministry of Forests and Range

How can SIBEC estimates be improved for selected BEC subzones and variants?

SIBEC estimates of site index are based on relationships between site index and environmental factors such as soil moisture and nutrient regimes. This project collected additional data for 18 BEC subzones and variants and used the data to specify second-generation estimates that report mean site index and standard error.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $259,230
Location: Province-wide
MFR Region: P

F 3.1.2 Boreal mixedwood (spruce–pine–aspen) (Retired 2008)

Y051256 Evaluation of the simulation model SORTIE for prediction of growth and yield in mixed aspen–spruce stands

Bruce C. Larson
University of British Columbia

Is the spatially explicit individual tree model SORTIE an appropriate tool for predicting growth and stand dynamics in mixed boreal and sub-boreal stands?

There is currently no widely used operational model that is fully suited to deal with the spatially complex mixed-species silvicultural systems being considered as alternatives to single-species clearcutting in boreal and subboreal forests. This project evaluated the suitability of the SORTIE growth and yield model as a predictive tool for growth and stand dynamics in these complex, mixed-species stands. The model was found to produce biologically believable predictions of stand development patterns for both single-species and mixed-species stands of aspen and spruce.

Initiated: 04/05
Duration: 1 *year*
09/10: $0
Total: $34,650
Location: Northern Interior
MFR Region: NI

Y081165 Improving the prediction of species composition of managed aspen and white spruce stands within boreal mixedwoods

Craig DeLong
Ministry of Forests and Range

How can the ability to predict the effect of management activities on the amount, type, and spatial distribution of mixedwood stands across the boreal landscape be improved?

The ability to predict how management activities affect the amount, type and spatial distribution of stands across the landscape is a prerequisite to implementing silviculture strategies that effectively achieve boreal mixedwood management objectives. This project developed predictive empirical models of compositional changes in managed aspen and white spruce stands as a function of management interventions, pre-treatment stand composition, and spatial context. The equations developed, while statistically significant, had a low predictive ability as a result of stochastic events and loss of identifiable predictive variables over time, such as post-harvest seedbed conditions. This project will assess the utility of statistically based Markov models as an alternative to process modeling by quantifying changes in tree species composition as state transition probabilities from pre-treatment to current forest types. This work will help improve the prediction of species compositions in managed aspen and white spruce stands within boreal mixedwoods.

Initiated: 07/08
Duration: 1 *year*
09/10: $0
Total: $24,488
Location: Boreal forest
MFR Region: NI

Y083051 Modeling boreal mixedwoods (spruce–aspen–pine) with TASS

George Harper
Ministry of Forests and Range

How can biologically defensible growth and yield estimates for boreal mixedwoods and complex stands be incorporated into TASS?

There is growing demand for the ability to simulate growth of mixedwood and complex stands with the Tree and Stand Simulator (TASS), the most widely used source of managed stand-yield information in British Columbia. This project undertook to: incorporate TASS aspen yield information into the TIPSY database; summarize the best available information on the growth patterns of spruce and pine in relation to understorey light within boreal mixedwood stands; support the development of biologically defensible growth and yield estimates for boreal mixedwoods and complex stands; and increase awareness and knowledge of boreal mixedwood stand dynamics. Project outcomes to date include data acquisition, knowledge compilation, the building of advanced technical tools, and the development of several extension materials and publications; development of the TASS III model for complex stands and mixedwoods continues to be an ongoing high priority project.

Initiated: 05/06
Duration: 3 *years*
09/10: $0
Total: $110,551
Location: Research Branch, Victoria, BC
MFR Region: C

Y083088 TASS III: Simulating the management, growth, and yield of complex stands

James Goudie
Ministry of Forests and Range

How can TASS be improved to broaden its application to include uneven-aged, multi-storied stands?

Currently, the potential of TASS II and TIPSY to address complex stands is limited to certain applications (e.g., variable retention in even-aged stands). This project integrated new and revised modules into TASS to provide support for the complex structures found in uneven-aged and mixed-species stands, and the complex treatments now being designed and implemented in BC. A new version of the model, TASS III, has been produced in which the desired improvements have initially focused on a select number of high-priority tree species and stand types.

Initiated: 05/06
Duration: 3 *years*
09/10: $0
Total: $365,666
Location: Victoria, Kamloops
MFR Region: P

Y093286 Defining boreal mixedwoods and exploring their response to management and natural disturbance (fire, MPB) through spatially explicit ecosystem management modeling

Hamish Kimmins
University of British Columbia

Should management of mixedwood mosaics attempt to achieve maximum spatial and temporal complexity or targeted forest conditions?

Management of multi-species stands is complicated by their diversity, complex temporal dynamics, large spatial scales, and long time frames. This project uses a spatial modeling approach (FORCEE) to explore at what spatial scale various biological, ecological, economic and management costs and benefits of mixedwoods are achieved. The completed model is useful for exploring policies and management options for mixedwood and complex stands, and for communicating the possible long-term consequences of alternative mixedwood management practices.

Initiated: 06/07
Duration: 3 *years*
09/10: $0
Total: $202,051
Location: Interior
MFR Region: SI; NI

Y103243 Managing northern mixedwood stands to sustainably maximize productivity and minimize costs

Chris Hawkins
University of Northern British Columbia

What are the impacts of reduced vegetation control on growth and yield and future timber supply in complex mixed-wood stands?

The cost of carrying out some brushing treatments in parts of the province may be unwarranted; however, the impacts of reduced vegetation control on growth and yield and future timber supply are not well understood. This project will continue work initiated in 2004 to examine the growth responses of young spruce and pine stands to varying densities of residual birch or aspen by expanding the database to include effects of broadleaf density (basal area) on conifer growth; establishing controlled density plots in each TSA; comparing model outputs to temporal data; determining the utility of SORTIE for modeling these complex stands; describing treatment cost–benefit; defining the density-species-age-height relationship; and meeting with policy makers to discuss the implications and implementation of early findings. The results of this work will allow for a more strategic allocation of brushing activities to areas where vegetation control is necessary and avoiding treatment of areas where broadleaf densities will not impact conifer growth or where a mixedwood complex stand is an appropriate and desirable condition future forest condition.

Initiated: 07/08
Duration: 3 *years*
09/10: $57,785
Total: $186,439
Location: Fort Nelson, Fort St John, and Mackenzie TSAs
MFR Region: NI

F 3.1.3 Interior BEC zones SIR (IDF, MS, ICH) (Retired 2008)

Y061132 Development of the PrognosisBC growth and yield simulator in southern and central BC: model validation

Abdel-Azim Zumrawi
Ministry of Forests and Range

Is the IDF version of Prognosis ready for release?

The IDF version of the stand simulation model PrognosisBC 3.0 needed to be validated prior to release. This project consists of a full validation of the simulator using various sources of independent data. The project completed and documented the 10-year model development work on PrognosisBC, and concluded that PrognosisBC can be confidently used for predicting growth and yield in the IDF.

Initiated: 05/06
Duration: 1 *year*
09/10: $0
Total: $82,131
Location: IDF, ICH, MS, SBS, and SBPS
MFR Region: SI

Y073067 Predicting development and productivity of southern interior mixed-species stands through calibration and modeling with SORTIE-BC

Suzanne Simard
University of British Columbia

How does the species composition of mixed-species stands affect growth response to light conditions, juvenile tree mortality, and competition interactions?

Mixed-species forest models can examine how complex stands respond to a wide range of silvicultural strategies, at different spatial scales and over different time periods, which is an impossible undertaking for traditional field-based research. This study quantified the growth response of several tree species growing under a range of light environments, characterized the probability of juvenile tree mortality, and investigated the effects of competition on the growth and survival of adult trees. Results were used to calibrate the SORTIE-ND model for stand dynamics in Southern Interior mixed stands.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $158,173
Location: Southern interior
MFR Region: SI

Y073092 Light and tree growth in complex forest stands

David G. Simpson
Ministry of Forests and Range

What are the relationships between tree height increment and light levels in interior Douglas-fir partially cut stands?

The objective of this project is to aid the development of the TASS-III tree and stand model by determining relationships between tree height increment and light levels, and evaluating model estimates of light and tree growth in stands harvested using variable retention (VR). Specifically, the project sampled young saplings growing at varying distances from stand edges to obtain growth measurement and collected light data, from an interior Douglas-fir partially cut stand. The diameter and height of Douglas-fir and western hemlock increased linearly with increasing light levels, with Douglas-fir reaching a maximum height at lower light levels than western hemlock.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $200,346
Location: Southern Interior and South Coast
MFR Region: C; SI

F 3.1.6 Coastal BEC zones (MH, CDF, CWH) (Retired 2008)

Y081038 SIBEC site index estimates for complex stands in the northern CWH and ICH biogeoclimatic zones

Shirley Mah
Ministry of Forests and Range

What are the second approximation estimates of site index mean and standard error for CWHvm1, CWHws1, CWHws2, and ICHmc2 subzone/variants in the Kalum area of the Northern Interior Forest Region?

The SIBEC model is increasingly used to provide site index estimates to support Timber Supply Review and strategic silviculture strategies in cases where conventional methods are not reliable, however a large proportion of the SIBEC model is still based on first approximation estimates. This project continued development of the SIBEC model by completing the sampling matrix for site series in the CWHvm1, CWHws1, CWHws2, and ICHmc2 subzone/variants of the Kalum Forest District. New site index estimates resulting from the analysis are included in the report, "Site index estimates by site series: report by biogeoclimatic unit (2008 approximation)" and are available on the SIBEC website.

Initiated: 07/08
Duration: 1 *year*
09/10: $0
Total: $52,895
Location: CWH and ICH biogeoclimatic zones in the Kalum FD
MFR Region: NI

Y091083 Incorporating the effects of tree-to-tree variability and upwind windfield conditions on mechanistic windthrow models and growth and yield models

Steve Mitchell
University of British Columbia

Can predictive growth and yield models better account for windthrow losses in variable retention stands?

Minimizing effects of windthrow losses is important when designing partial harvesting prescriptions. This project modified the UK Forestry Commission windthrow risk model ForestGALES and integrated it with TASS-III to represent windthrow losses in uniform stands in various harvest scenarios. The resulting Windfirm/ForestGALES_BC code has been prepared in a format for direct inclusion in the TASS III growth and yield model. The improved windthrow risk models will enable managers to test various cutblock design alternatives and quantify potential windthrow losses.

Initiated: 08/09
Duration: 1 *year*
09/10: $0
Total: $49,248
Location: CFR (Van. Is.); NIFR
MFR Region: C

Y102049 Validation of the SIBEC model for estimating site index in complex stands

Gordon Nigh
Ministry of Forests and Range

How important is site-series variability for estimating site index values using the SIBEC model?

Anecdotal information indicates that productivity can vary within a site series based on elevation, north-south gradients, and other biophysical factors. However, the SIBEC model is predicated on the assumption that site series are homogeneous ecosystems. This project tested that assumption for one site series, focusing on the 01 site series in the CWHxm2 zone. Specifically, it used ecosystem classification coupled with stem analyses of trees sampled in 50 plots to estimate a site index value. Results will be used to refine the SIBEC model, enabling more accurate growth and yield estimations for timber supply projections and silvicultural planning.

Initiated: 08/09
Duration: 2 *years*
09/10: $0
Total: $77,659
Location: CWHxm2 zone
MFR Region: C

Y102066 Site index models for amabilis fir

Gordon Nigh
Ministry of Forests and Range

What is the site index of different amabilis fir stands across its geographic range?

Current efforts to manage coastal forests for long-term economic and ecological sustainability requires accurate growth and yield information for key commercial species across their geographic range. This 2-year study of amabilis fir used stem analysis measurements taken from 100 plots stratified across the range of site productivity and BEC zones covered by this species to generate updated site index values. Results will be used to improve the site index estimates generated by the SIBEC models for formulating improved silviculture prescriptions and more accurate timber supply analyses.

Initiated: 08/09
Duration: 2 *years*
09/10: $0
Total: $154,692
Location: CWH zone
MFR Region: C

Y103264 Modeling the development of coastal BC stands: an individual tree model linked to a variable retention microclimate model

N.J. Smith
Island Timberlands Limited Partnership

How can growth and yield models be improved to better represent regeneration processes and the impacts of variable retention systems in coastal BC forests?

Currently, no validated individual tree-distance independent (ITDI) growth and yield model exists for the BC Coast, and existing G&Y models have weak regeneration components with only rudimentary abilities for modeling the impacts of variable retention on stand development. This project will develop a calibrated and validated ITDI model applicable to coastal BC forests that incorporates a regeneration component enabling the model to begin at bare ground, and incorporates a mechanism for modeling the impacts of variable retention on height growth, diameter growth, mortality, and regeneration. The resulting model will assist in addressing management questions concerning levels of silvicultural investment, harvesting plans, and short-term tree and log profiles.

Initiated: 07/08
Duration: 3 *years*
09/10: $57,348
Total: $184,788
Location: Vancouver I., Queen Charlotte Is., Powell River
MFR Region: C

F 3.1.7 Interior BEC zones NIR (ESSF, MH, SBS, ICH) (Retired 2008)

Y051055 Quantifying growth of spruce saplings in spruce–birch stands under different environmental conditions in the SBS zone

Scott Green
University of Northern British Columbia

What are the relationships between deciduous tree density, growth of conifer crop trees, and key environmental gradients?

This project examines dynamics between deciduous and coniferous trees in mixed-species stands across a range of different environmental conditions. The goal is to identify relationships between deciduous-tree density, growth of conifer crop trees, and key environmental gradients. Results indicate that environmental conditions associated with aspect are key to understanding competitive relationships. Study results will be directed toward developing a general model to predict site-specific conifer performance in mixed stands in the SBS zone.

Initiated: 04/05
Duration: 1 *year*
09/10: $0
Total: $31,192
Location: Sinclair Mills
MFR Region: NI

Y051356 Calibrating PrognosisBC in the Sub-Boreal Spruce and the Sub-Boreal Pine–Spruce biogeoclimatic zones

Abdel-Azim Zumrawi
Ministry of Forests and Range

How will new silvicultural systems affect both growth and yield and tree species composition in SBS and SBPS stands?

PrognosisBC is a very versatile growth and yield model that is able to simulate almost any form of harvesting, but it has not been calibrated for use in many parts of the province. This project calibrates the main components of PrognosisBC to extend the model to the SBS and SBPS BEC zones. Despite data limitations, biologically sound and statistically robust radial increment models for large trees (larger than 7.5 cm dbh), height growth models for small trees (less than 7.5 cm dbh), and tabular mortality models were developed for the major coniferous species in the SBS BEC zone, and incorporated in the PrognosisBC growth and yield simulator. These models will subsequently be tested and validated collectively through yield projections and management scenarios.

Initiated: 04/05
Duration: 1 *year*
09/10: $0
Total: $63,986
Location: Cariboo FD
MFR Region: SI

Y061033 Evaluation of an ecosystem-based approach to mixedwood modeling

Brad Seely
University of British Columbia

How effective is FORECAST in simulating mixedwood stand dynamics?

The majority of models used in BC to predict stand growth and yield contain little or no representation of the fundamental ecological processes and thus cannot effectively incorporate newly acquired knowledge of forest growth dynamics in mixedwood stands. This study evaluated the ability of the ecosystem management model FORECAST (which includes an explicit representation of the key ecosystem processes regulating growth dynamics and competition for limited resources) to project patterns of stand growth and dynamics in mixedwood forests by comparing model output against data from long-term field trials in different mixedwood stand types in both the SBS and ICH BEC zones. The model was able to reproduce patterns of growth response in both mixedwood forest types with reasonable accuracy, and was able to capture the essence of the competitive interactions between the conifers and hardwoods as well as the impact of the various management interventions on these dynamics; validation and model development are ongoing.

Initiated: 05/06

Duration: 1 *year*

09/10: $0

Total: $46,504

Location: BWBS, SBS, and ICH zones

MFR Region: P

Y092260 Development of a spatially explicit crown allometry model

Rasmus Astrup
Bulkley Valley Centre for Natural Resources Research and Management

How can the crown allometry functions used in SORTIE-ND be modified to improve the model's ability to predict understorey tree growth and mortality?

This project used an individual-based, spatially explicit "neighbourhood" analysis to develop new models of crown radius and crown length for subalpine fir, lodgepole pine, and interior spruce. Models were parameterized using spatially explicit crown measurement data from ~2400 trees collected in the sub-boreal spruce forest near Smithers, in north-central BC. Results showed that In the absence of competition, spruce and fir showed similar patterns of increasing crown radius and length with tree DBH and height respectively. Compared to fir and spruce, pines growing in the absence of competition were associated with wider, shallower crowns. All three species showed significant effects of competition on crown dimensions. Results were incorporated into a new, individual-based, distance-dependent crown model for the stand simulation model SORTIE-ND. Including a competition-dependent canopy model in SORTIE-ND is likely to improve the model's accuracy in predicting dynamics of mixed-species stands, understorey light availability, and sapling and subcanopy tree dynamics.

Initiated: 07/08

Duration: 2 *years*

09/10: $0

Total: $118,421

Location: SBS around Smithers

MFR Region: NI

Y103187 **Evaluation of the complex stand simulation model SORTIE-ND for timber supply review in sub-boreal forests of northern BC**

David Coates
Bulkley Valley Centre for Natural Resources Research and Management

What are the capabilities and shortcomings of SORTIE-ND for growth predictions of mixedwood sub-boreal forests for use in the provincial Timber Supply Review?

A prerequisite for practicing sustainable forest management is the availability of growth models that can project future growth of stand types, including complex structured stands, but the models must first be subjected to evaluation, validation, and calibration procedures that are appropriate to the model design and the intended application. This project will evaluate the overall performance of the SORTIE-ND spatially explicit model of stand dynamics, and determine if calibration is desirable from the perspective of supporting timber supply analysis. The result of this project will be a better understanding of the strengths, weaknesses, and potential scope of valid application for this model.

Initiated: 07/08

Duration: 3 *years*

09/10: $32,400

Total: $182,331

Location: SBS with emphasis on the SBSmc2 and SBSdk

MFR Region: NI

F 3.2 Wood quality

F 3.2.1 Incorporating effects of silvicultural regimes on wood quality in stand models

Y103078 **Modeling the impacts of silvicultural treatments on the wood quality of interior spruce**

James Goudie
Ministry of Forests and Range

Which silviculture regimes will generate the best interior spruce wood quality at the lowest cost, with the least negative impact on non-timber values?

The catastrophic effects of the current mountain pine beetle outbreak will no doubt result in an expansion of the areas managed for spruce to help diversify interior forests and stabilize timber supplies. However, there is concern that the wood quality from these post-harvest/post-beetle stands could be substantially lower than historical levels if the management of second-growth stands is not conducted with up-to-date information. This project proposes to develop models to predict wood quantity and quality of managed interior spruce under different silvicultural strategies by: (1) collecting new information on tree growth, yield, wood quality, and value; (2) fitting relationships to predict the quantity and quality of wood that can be used in computer models; and (3) building on the TASS modeling framework developed by the MOFR by specifically adding data on interior spruce. The results of this research will help to identify which silviculture regimes will generate the best wood at the lowest cost, while allowing the impacts of those regimes on non-timber values such as wildlife habitat to be predicted.

Initiated: 07/08

Duration: 3 *years*

09/10: $124,020

Total: $458,919

Location: North of Kamloops where spruce is to be managed

MFR Region: SI; NI

F 4 Response of trees and stands to disturbance

F 4.0 Unclassified

Y073184 **New egg survey method for population assessments of the western hemlock looper (*Lambdina fiscellaria lugubrosa*) (Lepidoptera: Geometridae)**

Art Stock
Ministry of Forests and Range

How effective is new sampling technology for predicting the location and severity of western hemlock looper outbreaks?

Although the western hemlock looper (WHL) is seriously disrupting normal economic and operational planning in parts of BC, current methods of estimating population trends are expensive, which limits the ability of managers to respond with appropriate interventions. This project tested the effectiveness of a new sampling technology for predicting the location and severity of WHL outbreaks against current sampling technologies for WHL. It was concluded that the new sampling method shows excellent potential for monitoring western hemlock looper population levels and trends in British Columbia, and will be confirmed and calibrated through ongoing sampling.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $77,188
Location: ICH zone
MFR Region: SI

F 4.1 Stand and forest dynamics following the mountain pine beetle epidemic

F 4.1.0 Unclassified

Y073138 **Vole population and seedling damage monitoring with diversionary feeding methods**

Thomas Sullivan
University of British Columbia

What is the efficacy of diversionary food supplies in decreasing mortality of plantation trees from winter vole damage?

Feeding damage by voles may limit regeneration of some tree species in certain forest ecosystems, increasing reforestation costs and decreasing net productive forested area. This project has monitored vole populations for 3 years, and is testing the efficacy of diversionary food supplies in decreasing mortality of plantation trees from winter vole damage. Interim results indicate that populations of voles are quite low (< 10/ha) in the first year after harvest. Numbers in the second post-harvest year usually range from 13 to 20, and occasionally higher (45/ha), and to 70–80 voles/ha in year 3, if vegetation cover is suitable. To date, diversionary food has protected newly planted trees compared with control trees.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $144,894
Location: Glenogle Creek east of Golden
MFR Region: SI

F 4.1.1 Growth, development, and health of residual stands of all ages following MPB attack, including research on the timber supply implications of losses

M065002 Success rate of MPB attack in young stands

Chris Hawkins
University of Northern British Columbia

What is the impact of MPB in younger stands?

The high level of MPB attack observed in young stands could have a significant effect on mid-term timber supply. This project sampled young stands (age class 1–3) for information on MPB attack and mortality, as well as regeneration. The outcome of the project provides data that may allow managers to choose harvest and silviculture strategies for young stands to try and reduce the MPB impact on timber supply.

Initiated: 05/06
Duration: 1 *year*
09/10: $0
Total: $32,499
Location: Prince George and Vanderhoof FDs
MFR Region: NI

M085169 Mountain pine beetle impacts and risk projections in young lodgepole pine stands

Lorraine Maclauchlan
Ministry of Forests and Range

What is the risk of MPB attack in young lodgepole pine stands throughout the breadth of the MPB outbreak area?

Normally, lodgepole pine less than 40 years old is not considered at risk to MPB, however, many young stands in these low susceptible age- and size-classes are currently being killed by MPB. This project was initiated to determine the extent and severity of mortality in young lodgepole pine stands from mountain pine beetle and associated insects, and to predict the duration and magnitude of risk to young pine. In summarizing their conclusions the authors note that areas within the central and southern core areas of the outbreak are likely to see the highest level of mountain pine beetle mortality in young stands, with increased mortality in the far south until the outbreak declines in surrounding mature pine forests.

Initiated: 07/08
Duration: 1 *year*
09/10: $0
Total: $78,895
Location: Throughout core MPB outbreak area
MFR Region: NI

M085196 Evaluation of regeneration delay, release of advance regeneration, future growth rates, and stand dynamics after a 40- to 50-year-old MPB attack in sub-boreal forests around Takla Lake

David Coates
Bulkley Valley Centre for Natural Resources Research and Management

What is the extent of mortality, regeneration delay, release of advance regeneration and other surviving residual trees in post-MPB attack stands?,

To ensure sustainable forest management in the large areas of MPB-attacked forests that will remain unsalvaged, a better understanding of post-beetle-attack stand dynamics is required. This project undertook a retrospective study of mortality, regeneration delay, release of advance regeneration, and other surviving residual trees and post-beetle stand growth in an old MPB-attacked forest. Results include mortality ranging from 42 to 100% of pre-attack basal area, dramatic release of surviving lodgepole pine trees, and 5-10 year delays in recruitment of new regeneration.

Initiated: 07/08
Duration: 1 *year*
09/10: $0
Total: $69,238
Location: SBS of north-central BC
MFR Region: NI

M086020 Predicting development and productivity of Southern Interior mixed-species stands following mountain pine beetle attack

Suzanne Simard
University of British Columbia

What are the dynamics of stand recovery following MPB attack in the Southern Interior MS zone, and what is the ideal timing of underplanting in MPB affected stands?

The SORTIE-BC stand dynamics model is inadequately parameterized for mixed stands in the Montane Spruce zone, limiting the model's ability to accurately predict stand growth in MPB affected areas in this zone. This project collected empirical data to quantify growth and survival rates for juvenile and adult lodgepole pine, subalpine fir, and interior spruce trees, and used this data to parameterize SORTIE-ND for Southern Interior MS mixtures. The updated model has been used to conduct simulations aimed at understanding and quantifying how stands will develop following MPB attack.

Initiated: 06/07
Duration: 2 *years*
09/10: $0
Total: $140,483
Location: MS zone
MFR Region: SI; NI

M086024 Mountain pine beetle impacts on young age-class, pine-leading stands in the SBS biogeoclimatic zone

Chris Hawkins
University of Northern British Columbia

What is the impact of MPB attack on residual stand development, stand and forest dynamics, and mid- and long-term timber supply in the SBS zone within the Prince George TSA?

The temporal dynamics of MPB attack, as well as the release of advanced regeneration under the dying canopy, are poorly understood but have significant influence on mid- and long-term timber supply and on restoration strategies. This project combined analysis of newly and previously collected empirical data with SORTIE-ND simulations to investigate spatio-temporal dynamics of MPB attack and subsequent regeneration, and to develop improved post-attack growth and yield estimates, harvest scheduling projections, and restoration strategies. The results provided more realistic estimates of age-class–specific attack rates for use in AAC projections, and indicate that allowing the residual tree layer and secondary stand structure to develop unaided may be the most cost-effective and environmentally sound management/restoration strategy.

Initiated: 06/07
Duration: 2 *years*
09/10: $0
Total: $101,426
Location: Central Interior
MFR Region: NI

M086044 Stand dynamics following mountain pine beetle outbreaks in central British Columbia

René Alfaro
Natural Resources Canada

What is the effect of MPB infestation on subsequent stand dynamics in even-aged and uneven-aged lodgepole pine stands?

Current knowledge of stand dynamics following MPB infestation in uneven-aged lodgepole pine forests is insufficient to reliably apply decision support tools in these forests. This study examined the dynamics of both even-aged and uneven-aged stands to determine the roles MPB and fire have played in the ecological processes of lodgepole pine, and used the resulting data to drive TASS model simulations to characterize the impacts of various MPB outbreak scenarios on stem density and total volume. Conceptual models of the relative influence of MPB and fire disturbances on stand dynamics in lodgepole pine stands were produced, and it was concluded that stands with significant secondary structure could be significant contributors toward mid-term timber supply.

Initiated: 06/07
Duration: 2 *years*
09/10: $0
Total: $130,950
Location: Extent of MPB infestation
MFR Region: SI; NI

M086046 **Stand and forest dynamics following MPB: how spatial patterns of salvage harvesting affect Warren root collar weevil pressure in regenerating stands**

Brian Aukema
University of Northern British Columbia

How do the spatial patterns of salvage logging affect the potential risk to recruitment and success of regenerating stands from Warren root collar weevil?

Salvage logging following mountain pine beetle (MPB) infestation increases the susceptibility of regenerating stands to infestation by Warren root collar weevil. The focus of this research was to quantify relationships between the spatial arrangement of MPB-killed stands and the spatial patterns of weevil-induced mortality in nearby regenerating stands. Results to date are consistent with the hypothesis that Warren root collar weevils are migrating out of stands killed by mountain pine beetle into regenerating cutblocks.

Initiated: 06/07
Duration: 2 *years*
09/10: $0
Total: $93,739
Location: Extent of MPB infestation
MFR Region: NI

Y061021 **Stand- to landscape-level effects of the mountain pine beetle (MPB) outbreak in central British Columbia**

Chris Hawkins
University of Northern British Columbia

What are the changes in stand characteristics, and the potential stand development dynamics without management intervention, following MPB infestation?

Maintaining MPB-attacked but stocked, older stands on the landscape may assist in minimizing the creation of large areas of young pine stands across the landscape, and may also be more effective at meeting mid-term timber supply needs than starting from bare ground. This study documented MPB attack levels and changes in stand characteristics by age class (1 through 8), BEC subzone, and site series to assess the potential stand development following MPB attack in the absence of management intervention. The data collected will allow managers to direct their harvesting to stands that are poorly stocked and leave those with adequate stocking to help address the mid-term timber supply problem.

Initiated: 05/06
Duration: 1 *year*
09/10: $0
Total: $36,543
Location: Lakes, Morice, and Prince George TSAs
MFR Region: NI

Y061134 **Regeneration and stand structure in stands in the east Ootsa and Entiako areas after infestation by the mountain pine beetle**

Deborah Cichowski
Bulkley Valley Centre for Natural Resources Research and Management

How does stand structure respond following MPB infestation?

At the beginning of the current mountain pine beetle (MPB) epidemic, research plots were established to measure and monitor vegetation responses to the outbreak. The purpose of this project was to remeasure these research plots within MPB stands and to address knowledge gaps relating to advanced regeneration, ingress, stand structure, and coarse woody debris. Several significant impacts were identified in MPB stands, and results were incorporated into related FSP projects examining forest productivity, and improving forest growth models.

Initiated: 05/06
Duration: 1 *year*
09/10: $0
Total: $52,489
Location: East Ootsa area, and Entiako Park and Protected Area
MFR Region: NI

Y061151 **Improving juvenile tree growth prediction for complex mountain pine beetle damaged stands**

David Coates
Bulkley Valley Centre for Natural Resources Research and Management

How do juvenile trees grow under a range of management conditions in MPB-damaged stands?

Forest managers require robust, unbiased predictive equations of juvenile tree growth under a range of management conditions in MPB-damaged stands. This project developed and tested new juvenile tree growth equations for use in parameterizing the SORTIE-ND model. Understanding the response of individual juvenile trees to variation in light is fundamental to predicting future growth under a range of management options.

Initiated: 05/06
Duration: 1 *year*
09/10: $0
Total: $33,997
Location: SBS of north-central and northwestern BC
MFR Region: NI

Y071328 **Effects of a mountain pine beetle epidemic on forest floor vegetation dynamics and regeneration in the Itcha-Ilgachuz caribou winter range in the Quesnel TSA**

Deborah Cichowski
Bulkley Valley Centre for Natural Resources Research and Management

What is the impact of the current mountain pine beetle epidemic on terrestrial forage lichen abundance?

The recent mountain pine beetle outbreak has affected a large part of the Itcha-Ilgachuz caribou low-elevation winter range, where caribou select mature lodgepole pine forests and forage primarily by cratering through the snow to obtain terrestrial lichens. The objective of this project is to establish permanent sampling sites in the Modified Harvest portion of the Itcha-Ilgachuz caribou winter range in the Quesnel TSA to monitor changes in terrestrial forage lichen abundance in response to the current mountain pine beetle epidemic. Recommendations for managing terrestrial lichens in the study area are deferred until data measurements are repeated and changes in terrestrial lichen abundance and competing vegetation are documented.

Initiated: 06/07
Duration: 1 *year*
09/10: $0
Total: $32,142
Location: Itcha-Ilgachuz caribou winter range in the Quesnel TSA
MFR Region: SI

Y072003 **Determining susceptibility of young pine plantations to the mountain pine beetle, *Dendroctonus ponderosae*, and manipulating future stands to mitigate losses**

Lorraine Maclauchlan
Ministry of Forests and Range

How susceptible are young pine stands to MPB attack, and what are the future risks to these stands?

The recently observed infestation of young pine stands by MPB threatens both previous investments in these stands and future harvests. This project used controlled, replicated experiments in pine plantations to: (1) quantify current levels of mortality in 20- to 55-year-old lodgepole pine stands in the core outbreak areas of BC; (2) determine key attributes of susceptibility, risk, and hazard in young pine stands; (3) determine MPB brood potential in young pine; and (4) test methods of reducing losses from MPB in young pine stands. Very young, small diameter pine were found to be less vulnerable than stands over 30 years old, although moderate levels of mortality were still recorded throughout the outbreak area; the numbers of beetles successfully emerging from attacked trees in young stands is relatively low and the resultant attack from these "resident" beetles is low.

Initiated: 05/06
Duration: 2 *years*
09/10: $0
Total: $147,483
Location: Southern interior
MFR Region: SI

Y072148 Regeneration and stand structure following mountain pine beetle infestation in the Sub-Boreal Spruce zone

David Coates
Bulkley Valley Centre for Natural Resources Research and Management

How will different management choices affect regeneration in MPB-infected stands?

Current modeling tools available to assist managers with decisions on how to manage MPB-infested stands are limited by incomplete data on regeneration following mountain pine beetle attack, especially in complex stands. This project collected data on stand regeneration in field sample plots across the full range of stands affected by MPB. Regeneration was found to be very patchy, with basal area and overstorey composition best explaining this variability. Study results were incorporated into a computer program that creates realistic spatial patterns for initializing tree growth in models such as SORTIE-ND.

Initiated: 05/06
Duration: 2 *years*
09/10: $0
Total: $141,466
Location: SBS zone
MFR Region: NI

Y073043 Shelterwood silvicultural systems to address integrated resource management issues

Michaela Waterhouse
Ministry of Forests and Range

What are the stocking levels after MPB salvage, and how does root disease affect the productivity, regeneration, and future health of forests?

By linking the results of two long-term, shelterwood silvicultural systems trials in BC in the SBS and ICH zones, this project aims to address management questions about stocking levels after MPB salvage, and the productivity, regeneration, and future health of forests affected by root disease. Relationships between residual stand structure, understorey development, and non-timber values were determined by evaluating various levels of basal area retention and different harvesting systems.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $186,877
Location: Southern Interior
MFR Region: SI

Y083072 A framework for documenting the effects of the mountain pine beetle outbreak in sub-boreal forests of northern BC

Craig DeLong
Ministry of Forests and Range

What ecological changes result from the MPB and wildfire disturbances in the sub-boreal forest landscape?

Long-term monitoring of stands is the most precise method of describing structural and compositional changes over time in unsalvaged stands following MPB and wildfire disturbance. This project has established a system of randomly located permanent sample plots as a multi-purpose monitoring framework to improve understanding of: (1) ecological changes and value of unique stand features (e.g., wildlife trees) of unsalvaged and burned unsalvaged MPB stands; (2) forest regeneration and non-crop vegetation dynamics of unmanaged and burned MPB stands; (3) timber supply (regeneration delay, growth and yield) and biodiversity implications of unharvested MPB stands; (4) relative ecological and economic (timber supply) benefits of burning unharvested MPB stands; (5) windthrow and decomposition dynamics of pine trees killed by MPB; and (6) changes in lichen abundance and rate of tree fall, as they affect caribou habitat quality. The numerous and ongoing reported results will provide data for improved modeling of live understorey and a better general understanding of ecological changes associated with MPB and MPB followed by fire.

Initiated: 05/06
Duration: 3 *years*
09/10: $0
Total: $108,484
Location: Nadina, Vanderhoof, and Prince George FDs
MFR Region: NI

Y083184 Predicting advanced regeneration density in lodgepole pine stands in the Northern Interior of British Columbia

Philip Burton
University of Northern British Columbia

How can forest planners better select and prioritize stands for salvage in the wake of the mountain pine beetle outbreak?

Pine stands with vigorous understories can be left unharvested to recover on their own, contributing to mid-term timber supply and non-timber forest values, but forest cover and vegetation maps do not provide information on subcanopy trees and the abundance of advance regeneration in the understorey. This project sought to: quantify the relative influence of various site, stand, and landscape factors on the density and stocking of conifer seedlings in the understorey; implement statistical relationships (derived from the above analysis) in a spatial model, predicting the density and stocking levels of conifer seedlings; and extend results to forest planners and managers in a manner useful to forest development and land use planning. Final results have not yet been reported.

Initiated: 05/06
Duration: 3 *years*
09/10: $0
Total: $130,755
Location: Nadina, Vanderhoof, and Prince George FDs
MFR Region: NI

Y093313 Analysis of insect, disease, and abiotic factors affecting post-free-growing lodgepole pine in Southern Interior British Columbia

Suzanne Simard
University of British Columbia

What is the post-free-growing health status of planted lodgepole pine in the Southern Interior Forest Region?

Lodgepole pine has been extensively planted across the Southern Interior of BC due to its good initial survival, rapid early growth, timely achievement of free-growing standards, wide ecological amplitude, tolerance of adverse conditions, and cost-effective production by nurseries. However, there is increasing evidence that on many sites the species is not continuing to perform well as it ages beyond free-growing. This study augments information gained in past site- and problem-specific surveys with a systematic survey and analysis of post-free-growing lodgepole pine condition across the southern Interior. Results showed that damage is common in 15-30 year-old post-free-growing lodgepole pine plantations, preventing about one-third of these stands from being free-growing. Policy makers need to reconsider the practice of planting lodgepole pine across a broad range of sites and decide whether monitoring should be extended beyond the free-growing window.

Initiated: 06/07
Duration: 3 *years*
09/10: $0
Total: $205,404
Location: Invermere and Cranbrook TSAs and TFL 14
MFR Region: SI

Y102087 Future productivity of lodgepole pine stands following mountain pine beetle outbreaks

René Alfaro
Canadian Forest Service

Improving complex stand succession trajectories from pre- to post-MPB disturbance measurements will aid in forecasting future stand productivity in SBPS and IDF stand types.

Even- and uneven-aged mixed stands in the SBPS and IDF zones are subject to repeated large-scale disturbances by fire and insects. Remeasurements of stem plots established in stands affected by MPB outbreaks in the 1980s and currently, historical and current changes in stand structure, and regeneration success, will be used to model future stand structure and species composition in these stand types. Resulting predictive models will be used to estimate future growth and yield and future development trajectories in stands with complex disturbance histories.

Initiated: 08/09
Duration: 2 *years*
09/10: $60,750
Total: $139,050
Location: Cariboo-Chilcotin Plateau, SIFR
MFR Region: SI

Y102095 Predicting development and productivity of southern interior mixed species stands following mountain pine beetle attack

Suzanne Simard
University of British Columbia

Can estimates of in-stand structure, composition, and recruitments in post-MPB affected stands enable future estimation of timber supply across affected areas?

SORTIE-ND is widely used as a predictive stand composition and dynamics model for projecting successional and structural characteristics of post-disturbance regenerating stands. Sampling and measurement of growth, survival, and recruitment responses of juvenile Douglas-fir and aspen trees in lodgepole pine stands affected by MPB mortality will enable parameterization of this model to enable projections of stand conditions in post-MPB killed stand types. Projections with the parameterized model will enable estimates of timber growth implications on residual trees and regenerated stands in the understorey and in clearcut openings in MPB-affected stands.

Initiated: 08/09
Duration: 2 *years*
09/10: $54,140
Total: $119,750
Location: MSpruce zone, SIFR
MFR Region: SI

F 4.1.3 Growth, development, and health of residual stands (overstorey and understorey) across a wide range of post-attack stand types and conditions (i.e., mixed species - salvaged; mixed species - unsalvaged; pine dominant - unsalvaged) in different BEC zones. Includes mitigating losses and determining the extent and intensity of MPB impacts on younger stands (e.g., 25–30-year-old plantations)
(Retired 2008)

M065004 Current/critical research on species-specific responses to climate/microenvironment change, making specific applications for MPB stands under different scenarios: literature review

Scott Green
University of Northern British Columbia

What are the controlling factors and management implications of using advance regeneration as a stand regeneration process in unsalvaged mountain pine beetle-killed stands?

Stands developing from advance regeneration may restock quickly and provide short- to mid-term harvest opportunities, but high variability in release and growth responses in these stands will create numerous management challenges. This project conducted a literature review and synthesis to suggest some important differences in stand dynamics and growth between reforestation from advance regeneration and conventional reforestation in unsalvaged MPB-killed stands. It was concluded that development and yields of stands originating from advance regeneration following MPB attack will be highly variable, potentially resulting in complex uneven-sized structures, and difficulties in making accurate growth and yield predictions. A better understanding of the stand-level conditions and processes involved is therefore required.

Initiated: 05/06
Duration: 1 *year*
09/10: $0
Total: $21,889
Location: Province-wide
MFR Region: P

M085111 The effects of salvage logging on the net ecosystem productivity of MPB-attacked lodgepole pine forests of the northern BC Interior

Andrew Black
University of British Columbia

What is the impact of MPB attack and subsequent salvage harvesting on the carbon balance of forest stands?

Despite the huge area affected by the MPB, little is known about how insects impact the C balance of attacked stands. This study measured net ecosystem productivity (NEP) in MPB-attacked stands with and without significant secondary structure, and also explored the effect of salvage harvesting on growing-season NEP. Results of the NEP measurements found that both study sites were small C sinks, in spite of differences in secondary structure, but also demonstrated that salvage harvesting can result in a stand being a large C source 2 years following harvesting.

Initiated: 07/08
Duration: 1 *year*
09/10: $0
Total: $56,159
Location: Kennedy Siding, southeast of Mackenzie
MFR Region: SI

M086001 Density and distribution of advance regeneration in the MS biogeoclimatic zone in relation to site moisture and overstorey density

Gordon Nigh
Ministry of Forests and Range

Which MPB-damaged stands do we treat (and how do we treat them), and which stands can be left to regenerate on their own?

Due to the wide extent of the current MPB infestation, managers need to determine which stands need treatment to ensure adequate regeneration, and which stands can be left alone to regenerate by advance regeneration. This project involved collection of field data and subsequent development of equations to predict the abundance and spatial distribution of advance regeneration from canopy characteristics and site moisture. These equations can be used to determine the potential for successful development of a particular stand following the MPB outbreak.

Initiated: 06/07
Duration: 2 *years*
09/10: $0
Total: $60,074
Location: Merritt TSA
MFR Region: SI

M086010 Development of residual trees and regeneration following MPB attack in thinned lodgepole pine stands

Rob Brockley
Ministry of Forests and Range

What are the effects of post-thinning stand densities on the susceptibility of lodgepole pine to attack and mortality from the MPB, and on the growth and development of surviving residual trees, existing advance regeneration, and natural regeneration ingress following attack?

Development of mixed-species stands post-MPB infection has been poorly documented. This study sought to determine, in unthinned stands and across a range of post-thinning stand densities: (1) the pattern and progression of MPB attack and tree mortality; (2) the growth and development of surviving residual trees; and (3) the amount and type of regeneration present at the time of attack, and the post-attack ingress and development of regeneration. Results indicate that the effects of post-thinning density on susceptibility of lodgepole pine to MPB attack vary with beetle population levels, and the assessment has provided a comprehensive baseline dataset describing the overstorey, regeneration and understorey conditions at the "green-to-red" post-beetle attack stage in typical thinned pine stands.

Initiated: 06/07
Duration: 2 *years*
09/10: $0
Total: $43,684
Location: Southern Interior
MFR Region: SI

M086015 Modeling natural regeneration in mountain pine beetle impacted stands

Peter Marshall
University of British Columbia

How can uncertainties in the prediction of natural regeneration following MPB attack in non-salvaged stands be reduced?

Since not all MPB-infected stands will be salvage-logged and planted, accurate projection of future timber production in MPB-affected stands will depend on our ability to estimate natural regeneration following MPB disturbances. This study collected overstorey and understorey tree data to estimate of the amount of natural regeneration in MPB-attacked lodgepole pine stands, and to develop regeneration prediction methods for these stands for use in PrognosisBC. Averages of regeneration-level predictions were quite close to observed data by size class and species group for each BEC zone assessed, however predictions were quite variable at the plot level.

Initiated: 06/07
Duration: 2 *years*
09/10: $0
Total: $124,649
Location: Southern and Central Interior
MFR Region: SI

M086045 Balancing disturbances in forest management

V.G. Nealis
Natural Resources Canada

Do forest management practices aimed at mitigating one pest disturbance result in a change in risk of another pest disturbance?

Selective removal of lodgepole pine in mixed stands may significantly increase susceptibility to western spruce budworm in residual Douglas-fir. This project examined the response of western spruce budworm populations on Douglas-fir in mixed stands to selective removal of associated lodgepole pine. Results showed relatively small differences in defoliation associated with modification of stand structure due to compensatory population effects between early-stage larvae dispersal and later stage larvae mortality; however, it was also found that a much greater portion of interior Douglas-fir forests is at risk of budworm damage than was apparent from historical surveys.

Initiated: 06/07
Duration: 2 *years*
09/10: $0
Total: $93,429
Location: Southern Interior
MFR Region: SI

Y102188 The release of secondary stand structure in immature and mature pine stands following MPB attack

Chris Hawkins
University of Northern British Columbia

Which attributes of post-MPB attacked stands determine their selection and scheduling for alternative silviculture activities?

Identifying the key characteristics of post-MPB stands suitable for alternative fates (e.g., salvage harvest, restoration, or retention) may be important for efficient harvest scheduling to maintain mid- and long-term timber supply. Using data from 525 stands sampled since 2004, MPB attack and stand structure, and regeneration status and stand structure will be correlated for use in stand-level growth and yield (G&Y) models. Results will help to improve harvest scheduling and guide stand activities that positively affect the growth and quality of secondary stand structure.

Initiated: 08/09
Duration: 2 *years*
09/10: $29,527
Total: $72,770
Location: SBS subzones, Prince George FD; SBS subzones, Vanderhoof FD
MFR Region: NI

F 4.2 Estimating and/or mitigating stand-level losses

F 4.2.0 Unclassified

Y051207 **Predicted impacts of hard pine rusts in lodgepole pine–dominated juvenile stands in central BC**

Alex Woods
Bulkley Valley Centre for Natural Resources Research and Management

Are the basic assumptions used to predict rotation-age volume losses from hard pine rusts in central BC lodgepole pine leading stands correct?

A previous study (Woods et al. 2000) made three essential assumptions to predict hard pine rust impacts on rotation-age stand volumes. This study re-examined the validity of those assumptions 7 years later by reassessing all trees within the 30 sample plots used in the first study. It was concluded that the assumptions were valid and that the impact of hard pine rusts in juvenile lodgepole pine–dominated stands in central British Columbia is approximately 7.2%

Initiated: 04/05
Duration: 1 *year*
09/10: $0
Total: $23,090
Location: Lakes TSA
MFR Region: NI

Y061188 **Conifer defoliating insects of British Columbia: an identification and information guide**

Robert Duncan
Natural Resources Canada

How can defoliating insects be identified?

Estimating timber losses caused by defoliating insects depends on accurate identification of the causal agent, yet forest practitioners currently lack the necessary tools to accurately identify this important group of insects. This project developed a comprehensive full-colour identification guide and information source for the conifer feeding defoliators of BC.

Initiated: 05/06
Duration: 1 *year*
09/10: $0
Total: $50,400
Location: Province-wide
MFR Region: P

F 4.2.1 Windthrow

Y051298 **Predicting wind damage in mixed-species complex-structured stands**

David Coates
Ministry of Forests and Range

How does harvest intensity (% basal area removal) and the proximity to a logging-created edge affect the risk of wind damage in complex-structured mixed-species forests?

Foresters have long believed that partial cutting increases the risk of windthrow. This study used a model selection approach to test competing hypotheses on wind damage risk in complex structured mixed-species forests. There were clear species and tree-size differences in susceptibility to windthrow. However, no evidence was found to indicate that harvest intensity, as measured by the level of basal area removal, increased the risk of windthrow for any tree species, clearly refuting the presumption that risk of windthrow increases as you open up the stand.

Initiated: 04/05
Duration: 1 *year*
09/10: $0
Total: $20,925
Location: Northwestern BC
MFR Region: NI

Y062276 Numerical modeling of wind flow in retention system openings

Steve Mitchell
University of British Columbia

What are the windthrow risks in complex stands created by partial cutting scenarios?

Given BC's windy climate and the susceptibility of partially harvested stands to windthrow, forest managers need tools to design harvesting regimes that reduce windthrow risk to acceptable levels. Using a simulation model, this study characterizes wind behaviour in harvested openings of various shapes and sizes, with and without residual trees, in simple and in complex terrain. Results indicate that, for cutblock edges, geographic/topographic exposure to wind is the most important predictor of windthrow susceptibility, followed by harvest design. As retention levels increase, geographic / topographic exposure to wind becomes much less important; stand and soil factors are less important than previously thought, particularly in high-retention partial cuts; and tree-slenderness and live crown ratio are good tree-level predictors.

Initiated: 04/05
Duration: 2 *years*
09/10: $0
Total: $134,101
Location: Vancouver Island
MFR Region: C

Y081107 Improvement of a mechanistic risk model for estimating windthrow losses

Steve Mitchell
University of British Columbia

How can the mechanistic windthrow risk model ForestGALES be adapted to better reflect the complex stands and topography in BC forests?

Previous work by UBC researchers, the BCMOF Decision Support group, and the UK Forestry Commission to integrate the UK Forestry Commission's mechanistic windthrow risk model ForestGALES with the growth and yield model TASS/TIPSY have identified a number of limitations in the application of ForestGALES to BC conditions. This project enhanced ForestGALES to account for the propagation of damage through stands, the effect of complex harvest patterns on windflow within canopy gaps, and the directionality and speed of local winds. The result is an updated version (ForestGALES_BC) of greater versatility that better reflects conditions in BC stands and takes advantage of new data sources; model validation indicates that it is sensitive to harvesting patterns and produces reasonable levels of wind damage; however, further refinement is necessary to fully capture tree-tree interactions.

Initiated: 07/08
Duration: 1 *year*
09/10: $0
Total: $30,672
Location: Province-wide
MFR Region: P

Y081247 Extension: IUFRO Wind and Trees Conference

Steve Mitchell
University of British Columbia

What is the current state of knowledge and research in the fields of wind and tree interaction, damage prediction, and damage mitigation?

The International Union of Forest Research Organizations (IUFRO), Wind and Trees group meets every 4–5 years to provide an opportunity for an international and multidisciplinary group of aerodynamicists, physicists, physiologists, ecologists, foresters, engineers, and arborists to present their work and discuss new developments, approaches, and methodologies in the fields of wind and tree interaction, damage prediction, and damage mitigation. This project supported the delivery of a workshop on windthrow risk modeling and management strategies at the 2007 conference, hosted by the UBC Department of Forest Sciences, FERIC, and the BCMOF in Vancouver on August 5–9, 2007. Both the conference and the workshop were successful in bringing together 120 participants from 22 countries, and several manuscripts resulting from conference presentations were published in a special 'Wind and Trees ' issue of the Journal of Forestry in 2008.

Initiated: 07/08

Duration: 1 *year*

09/10: $0

Total: $15,120

Location: Coast and Interior BC and world

MFR Region: P

Y083169 Incorporating the effects of windthrow after variable retention harvesting into TASS and TIPSY

C. Mario Di Lucca
Ministry of Forests and Range

How can the ability to predict the combined impact of losses due to windthrow after variable retention harvesting be incorporated into the TIPSY and TASS growth and yield models?

Windthrow losses in variable retention (VR) harvesting systems affect both growth and yield projections for overstorey trees and success and growth of understorey regeneration, but are currently not accounted for in the TASS and TIPSY growth and yield models. This project has incorporated empirical windthrow models into TIPSY / BatchTIPSY for Douglas-fir, western hemlock, lodgepole pine, and white spruce after variable retention harvesting, and has linked the mechanistic wind risk assessment model ForestGALES to TASS. The incorporation of windthrow models into TIPSY provides non-spatial stand-level volume adjustment factors to account for windthrow losses, while the linking of ForestGALES and TASS III provides a more spatial windthrow assessment at either the stand or individual tree level, enabling users to test and compare alternative cutblock design scenarios at the individual tree level.

Initiated: 05/06

Duration: 3 *years*

09/10: $0

Total: $159,016

Location: Province-wide

MFR Region: P

F 4.2.3 Spruce bark beetle

Y071173 Spruce beetle risk modeling in a changing climate

Stephen Taylor
Natural Resources Canada

What are the risks of spruce beetle attack in the face of climate change?

This project examines the relationship between climate, windthrow, and spruce beetle populations and tree mortality at the stand-level, and develops landscape-level models of spruce beetle occurrence risk based on host, climate, and windthrow variables within the context of a changing climate. The resulting models provide indications of how the spruce beetle may respond to changing climate, and highlights where outbreak risk will increase. However, the authors discuss specific components of the model that need further work prior to further analyses. Field research indicates that windthrow within mature stands can be a significant resource for and reservoir of spruce beetle.

Initiated: 06/07
Duration: 1 *year*
09/10: $0
Total: $79,798
Location: Northern and Southern Interior
MFR Region: SI; NI

F 4.2.4 Root disease (*Armillaria*, *Phellinus*)

Y062041 Reducing the impact of Armillaria root disease via mixed-species plantations including western redcedar

Bart van der Kamp
University of British Columbia

Is western redcedar more resistant to root rot than other conifers, and does it convey protection to other trees in the stand?

Previous studies suggest that in the ICH, western redcedar is more resistant to Armillaria root disease than other common conifers, including western hemlock and Douglas-fir. This project examined differential resistance to Armillaria root disease among 20- to 30-year-old western redcedar, western hemlock, and Douglas-fir trees. Results support previous work showing higher resistance in western redcedar, and pointed toward a series of physiological mechanisms. The authors suggest that planting higher densities of redcedar on infested sites may reduce the overall impact of Armillaria root disease.

Initiated: 04/05
Duration: 2 *years*
09/10: $0
Total: $101,203
Location: Southern interior
MFR Region: SI

Y062143 Evaluation of Hypholoma trials

Bill Chapman
Ministry of Forests and Range

How effective is Hypholoma fasciculare as a cultural control agent for Armillaria root disease?

Many trials to assess the efficacy of *Hypholoma fasciculare* as a cultural control agent for Armillaria root disease have been installed over the Southern Interior of BC, and must be monitored to determine the longer-term efficacy of the treatment. The basic methodology for assessing the trials simply involves determining each tree that has died from Armillaria inside each plot, excluding a 10-m buffer around each plot. The treatment is viewed as an effective treatment for Armillaria root disease with worldwide application in forestry and in agriculture wherever woody species are grown, and will be eligible for operational use in BC once it is registered.

Initiated: 04/05
Duration: 2 *years*
09/10: $0
Total: $54,190
Location: Southern interior
MFR Region: SI

Y062223 **Impacts of Armillaria root disease on stand productivity in the Southern Interior of BC**

Mike Cruickshank
Natural Resources Canada

What is the growth loss attributable to sublethal Armillaria infection in Douglas-fir plantations in the ICH?

Armillaria root disease (generally non-lethal) is present in most lower elevation conifer stands in the Southern Interior, with incidence of diseased trees in mature stands as high as 80%. This project collected field data to quantify the growth loss attributable to sublethal Armillaria infection in Douglas-fir plantations in the ICH. The results of this study clearly identified that Armillaria root disease exerts a strong effect on Douglas-fir stand development, and has improved representation of the effects of Armillaria for the TASS/TIPSY suite of growth and yield models.

Initiated: 04/05
Duration: 2 *years*
09/10: $0
Total: $224,377
Location: Headwaters FD
MFR Region: SI

Y103130 **Distribution and impacts of Phellinus root disease in the Southern Interior of British Columbia**

Michelle Cleary
Ministry of Forests and Range

What is the incidence of Phellinus root disease, and the magnitude of timber losses caused by it, in the Southern Interior of BC?

Phellinus root disease poses a long-term threat to the productivity of managed stands in BC's Southern Interior. However, current inadequacies in its detection have serious implications for the accuracy of future yield predictions for managed stands and timber supply analyses. This study will (1) determine the occurrence and/or incidence of Phellinus root disease using a matrix of inventory type groups, age classes, and BEC zones, and (2) estimate losses due to Phellinus root disease in Douglas-fir obtained from a network of growth and yield permanent sample plots (PSPs) in the Southern Interior. Results of this study will permit the development of an interim OAF2 factor specific to Phellinus root disease.

Initiated: 07/08
Duration: 3 *years*
09/10: $36,504
Total: $142,340
Location: Kamloops and Okanagan Shuswap FDs
MFR Region: SI

F 4.2.5 Rusts (*Dothistroma*, *Commandra*, western gall)

Y073203 **Genetic variation in the foliar pathogen *Dothistroma septospora* and relationship to toxin production**

Kathy J. Lewis
University of Northern British Columbia

What is the level of genetic diversity of Dothistroma in BC at the tree-, stand-, and BEC subzone-level in the NW, and is there a relationship between genotype and production of the toxin dothistromin?

To avoid future epidemics of Dothistroma, and to develop comprehensive strategies for management of lodgepole pine, such as genetic resistance, it is critical that the biology of the fungus and the factors leading to outbreaks are understood. This project will examine the genetic makeup of Dothistroma in BC, and determine if there is a relationship between genotype and production of the toxin dothistromin. The finding of genetic variation (and sexual reproduction) in the populations of *D. Septosporum in northwest*ern BC implies a higher evolutionary potential, which could lead to strains with increased virulence or strains that are able to overcome resistance in host populations.

Initiated: 04/05
Duration: 3 *years*
09/10: $0
Total: $70,100
Location: Northwestern BC
MFR Region: NI

Y073204 **Relationships between climate, forest practices, and incidence of *Dothistroma septospora***

Kathy J. Lewis
University of Northern British Columbia

What are the influences of weather patterns and forest management-caused changes in host abundance on the extent and nature of current and historical severity of Dothistroma?

Two principal factors appear to have played a role in the increased size and severity of the current Dothistroma needle blight epidemic: (1) increased host abundance on the landscape, and (2) a shift toward weather patterns that are more conducive for disease spread. This study sets up and monitors spore traps and simple weather stations to ascertain current conditions, uses historical records and dendrochronological analyses to reconstruct past conditions, and conducts stand surveys to assess microclimate factors. Ten regional Dothistroma needle blight outbreak periods in northwestern BC extending back to A.D. 1831 were identified; the correspondence of outbreaks with periods of wet and warm conditions in the study area suggests that regional climate is becoming more favourable for Dothistroma needle blight, resulting in widespread, synchronous outbreaks.

Initiated: 04/05

Duration: 3 *years*

09/10: $0

Total: $93,999

Location: ICH zone, northwestern BC

MFR Region: NI

F 4.3 Mitigating losses (other than MPB) (Retired 2007)

F 4.3.1 Browse (Retired 2007)

Y103081 **Influence of forest harvesting and succession on vole populations and feeding damage to plantations**

Thomas Sullivan
University of British Columbia

What is the influence of silvicultural system on vole habitat, population dynamics, and feeding damage to seedlings?

Voles (of the genera *Microtus* and *Clethrionomys*) are known to inflict severe feeding damage on planted seedlings in large (> 100 ha) contiguous openings created by harvesting or wildfire in the Southern Interior. However, the population fluctuations of *Microtus* are generally unknown in these areas, and comparisons of vole populations in clearcut and variable retention harvested sites have not been done. This project, a continuation of FSP project Y073138 initiated in 2004, will continue monitoring vole populations on 3 sites near Golden for an additional three years, and will compare vole populations in clearcut versus variable retention harvested sites. The results of this work will help determine the influence of silvicultural system on habitat and population dynamics of voles, and feeding damage to seedlings.

Initiated: 07/08

Duration: 3 *years*

09/10: $49,680

Total: $149,040

Location: Glenogle and Roth Creeks, east of Golden, BC

MFR Region: SI

Y103092 Development of molecular markers to aid in the identification of western redcedar populations that are resistant to deer browsing and heartwood rot fungi

Jim Mattsson
Simon Fraser University

Can markers be developed that allow for rapid, reliable selection of durable, rot-resistant, and browse-resistant western redcedar trees for reforestation?

Western redcedar (WRC) ranks as the fifth most important species in BC by total logs harvested, yet reforestation with WRC is expensive and inefficient due to extensive herbivory by ungulates, and second-growth WRC heartwood succumbing to early rot, especially in the Interior Cedar–Hemlock biogeoclimatic zone. This project seeks to assist BC MoF efforts to breed for resistance to both threats by developing markers to be used to select for deer- and heartwood rot-resistant offspring in crosses from WRC breeding programs. The intended use of these markers is to substantially shorten the time and cost for each breeding cycle with respect to browsing resistance and enable efficient breeding for rot resistance in WRC, potentially leading to considerable short-term benefits for reforestation with WRC and invaluable long-term benefits with regard to the quality and reputation of WRC heartwood from BC.

Initiated: 07/08
Duration: 3 *years*
09/10: $48,600
Total: $145,800
Location: Coast
MFR Region: C

F 4.3.3 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 (Retired 2006)

M086004 Enhancing early stand growth through the use of vegetation management – 15-year post-treatment results

George Harper
Ministry of Forests and Range

What are the impacts of vegetation management treatments on the growth & survival of Engelmann spruce?

Vegetation management practices are important tools for accelerating growth, achieving high yields and maintaining certain types of forest structures; however, there is substantial variation in the efficacy of these practices. This project collected 15th year post-treatment data from a study initiated in 1992 to compare the effectiveness of repeated cutting treatments relative to single cutting or glyphosate herbicide treatments, with the objective of supporting cost-effective stand establishment vegetation management practices that may help to mitigate MPB losses. While treatments resulted in significant improvements in diameter and height of planted spruce from 2 to 7 years post-treatment, these differences were found no longer significant at year 15; all treatments significantly increased survival to year 15, but were found to have little lasting effect on non-crop vegetation.

Initiated: 06/07
Duration: 2 *years*
09/10: $0
Total: $11,957
Location: Columbia FD
MFR Region: SI

M086009 Identification of young pine stands at high risk to mountain pine beetle through an integration of GIS analysis and field evaluation techniques

Lorraine Maclauchlan
Ministry of Forests and Range

How can forest managers estimate the potential MPB infestation risk in young (less than 45 year) pine stands so as to prioritize activities intended to minimize the risk to these stands?

Concern for MPB impacts on younger pine stands is rising as the beetle depletes its preferred host resource, mature pine. This project combines recent stand-specific data on beetle incidence and severity and GIS analytical techniques in an attempt to improve the performance of previously developed susceptibility and risk-rating systems in young pine stands. An early (2006) version of the model was somewhat reliable at predicting presence or absence of MPB in young lodgepole pine stands in 2007. However, the revised version, although potentially more representative of 'normal' conditions, may not be well-suited for the southern districts.

Initiated: 06/07
Duration: 2 *years*
09/10: $0
Total: $80,655
Location: Range of MPB infestation
MFR Region: SI; NI

M086012 Treatment of repressed lodgepole pine stands

Teresa Newsome
Ministry of Forests and Range

Do thinning and fertilization effectively release suppressed lodgepole pine?

The future timber falldown as a result of accelerated harvest due to MPB, the need to return height-repressed lodgepole pine stands to their full productivity potential is critical. The goals of this project were to find cost-effective treatment regimes for height-repressed lodgepole pine stands, leading to a merchantable product within a reasonable time frame through the establishment and evaluation of field trials. The results to date indicate that a combination of thinning and fertilization can overcome lodgepole pine repression, effectively increasing the value of stands not currently considered part of the productive land base.

Initiated: 06/07
Duration: 2 *years*
09/10: $0
Total: $125,590
Location: Chilcotin Plateau in the SBPS zone
MFR Region: SI

M086018 Evaluation of the impact of N fertilization on mountain pine beetle success in mature lodgepole pine stands at the leading edge of an infestation

John McLean
University of British Columbia

Can nitrogen fertilization be used to increase mature lodgepole pine trees' natural defences against the MPB?

Numerous studies have shown that nitrogen is the most limiting nutrient in lodgepole pine forests in the interior of British Columbia. This project sought to evaluate the effectiveness of nitrogen fertilization in increasing mature lodgepole pine trees' natural defences against MPB attack through the establishment and monitoring of experimental plot trials. Results to date indicate no significant impact on blue stain fungus and local beetle microflora, but differences in MPB attack success among nitrogen treatments have not yet been reported.

Initiated: 06/07
Duration: 2 *years*
09/10: $0
Total: $112,988
Location: Southern Interior
MFR Region: SI

F 4.3.4 Growth and yield implications of stand management at the urban interface for fire hazard protection (Retired 2007)

Y092230 Reducing wildfire hazards in the wildland–urban interface: impacts on timber yields and the best practices for stand management

Tom Hobby
Royal Roads University

What are the appropriate evaluation tools, strategies, and institutional incentives for assessing and reducing wildfire risk within wildland–urban interface areas?

Developing tools and guides lines to assess and mitigate risk of wildfire in the wildland–urban interface areas of the Rocky Mountain Trench could reduce potential losses of timber production, ecosystem health, and personal property worth millions of dollars. This project assessed fuels risk and determined the economic costs for fuels treatments on 760 hectares near Cranbrook using current assessment tools and software. It also evaluated both stumpage appraisal and tenure systems and recommended changes to both that provide appropriate incentives for industry to co-operate in fuels reduction programs. The methods and models tested through the research have led to improved methods for assessing fuels hazards and increased understanding of the differences between "fire hazard" and "fire risk". The policy reports developed through this work should foster innovative stumpage and tenure solutions for fuels treatment projects and support for increased fuels treatment viability in the future.

Initiated: 07/08

Duration: 2 *years*

09/10: $0

Total: $157,439

Location: Rocky Mountain Trench of the East Kootenay region of British Columbia

MFR Region: SI

F 4.4 Site productivity impacts

F 4.4.1 Impacts of changes to site hydrology due to major disturbance (e.g., MPB mortality/salvage, fires) on productivity and growing conditions

Y102045 Measurement and modeling of disturbance impacts on site hydrology and productivity in British Columbia's southern interior

Darryl Carlyle-Moses
Thompson Rivers University

How are site- and stand-scale hydrological, nutrient cycling, and regeneration functions of stands altered by MPB and other large-scale disturbance, and can future management of these forests minimize these impacts?

Water and energy balances from the canopy to the rooting zone in forests become altered as a result of large-scale tree mortality events, and these in turn affect recovery of forest productivity. Results of field studies (examining factors that influence soil moisture and temperature regimes under different disturbance and stand regeneration conditions, and their consequences for productivity) will be linked to selected hydrological models to determine hydrological and ecological recovery times for post-disturbance forests. Project results will guide development of policy regarding harvesting operational practices to minimize hydrological, soil, and environmental effects of silviculture activities in disturbed forests.

Initiated: 08/09

Duration: 2 *years*

09/10: $47,684

Total: $99,456

Location: Mayson Lk, Kamloops FD, SIFR

MFR Region: SI

Y102163 **Predicting changes in early growing-season water availability contributed as snowmelt following mountain pine beetle attack**

Trevor Blenner-Hassett
Forestec Forestry Consulting

How can productivity in post-MPB stands be sustained if changes in early-season hydrology has a negative effect?

Changes in early-season hydrology in post-MPB attacked stands is of management concern for sustaining stand productivity. Measured changes in stand attributes of 3 post-MPB–MS zone stands (20 yrs-thinned, 80, 140 yrs) will be related to changes in early growing-season water availability contributed by snowmelt and combined with similar data to determine tree radial increments. Results will be used in combination with stand dynamics models (e.g. SORTIE-ND) to forecast the ongoing effects of MPB on infilling and regrowth for these stands.

Initiated: 08/09
Duration: 2 *years*
09/10: $20,736
Total: $47,466
Location: MS zone; SIFR
MFR Region: SI

F 5 Analytical techniques and models for strategic analysis

F 5.1 Development of novel methods to integrate data and models across scales

F 5.1.1 Techniques for integrating various data sources for strategic analyses (e.g., forest inventory, remote sensing, GY, and non-conventional data layers such as traditional plant communities and tourism)

Y081155 **Enhancing conventional forest inventory in the Sunshine TSA with individual tree crown (ITC) analysis of hyperspectral and LiDAR remotely sensed data**

Brian Calder
Timberline Natural Resource Group Ltd.

Can supplemental species and height samples derived from LiDAR and hyperspectral data improve the accuracy and consistency of the VRI?

Advances in remote sensing techniques for acquiring forest attribute information have led to a significant gap between these new techniques and the standard inventory methods employed by industry and government, which have remained essentially the same since their inception. This project evaluated the impact of supplementary LiDAR-derived metrics (canopy height, stem density, rugosity, and gap fraction) and hyperspectral data provided to photointerpreters on the accuracy and consistency of stand-level visual interpretation. Results showed that variation associated with visual interpretation was not reduced by providing additional forest information (LiDAR and hyperspectral metrics) in the form of raster classifications.

Initiated: 07/08
Duration: 1 *year*
09/10: $0
Total: $39,304
Location: Sooke
MFR Region: C

Y092213 Integrating historical airphoto data for cedar analyses

Marguerite Forest
Haida Mapping

What changes in the distribution, abundance, and quality of redcedar and yellow-cedar on Haida Gwaii have occurred between 1937 and 2000, and can modern 3D digital stereo viewing be used effectively with historical air photos?

First Nations in coastal BC make extensive use of large, high-quality cedars. However, evidence suggests that on Haida Gwaii there are very few western redcedar and yellow-cedar in second-growth stands, cedar regeneration is impeded in part due to severe over-browsing by introduced deer, and remaining cedars are of lower quality. This research will help determine changes in the distribution, abundance, and quality of western redcedar and yellow-cedar on Haida Gwaii between 1937 and 2007, as well as the best sites for future growth of high-quality cedar, by comparing newly acquired imagery with air photos flown in 1937. Project results will be used to develop a registry of monumental cedar for Haida cultural use and to establish a series of age-graded sites for long-term regeneration of high-quality cedar.

Initiated: 07/08
Duration: 2 *years*
09/10: $0
Total: $134,979
Location: Haida Gwaii
MFR Region: C

Y092234 An evaluation and comparison of LiDAR remote sensing technology and large-scale digital photography for landscape-level forest management applications in complex multi-aged coniferous forests

Melanie Karjala
Aleza Lake Research Forest Society

How can LiDAR (Light Detection And Ranging system) and large-scale digital aerial photography be used to assess high-priority forest values in managed and unmanaged spruce/subalpine fir forest types in the SBSwk1 ?

LiDAR (Light Detection And Ranging system) has the potential to assess forest condition efficiently by providing accurate and detailed information describing topography and forest structure, and large-scale digital aerial photography combines the advantages of very high spatial resolution with digital stereo viewing for tree height measures and capture of fine topographic detail. This study evaluated the use of recently acquired LiDAR data and large-scale digital photography in the context of measuring three forest values: understorey conifer vegetation, timber volume, and carbon stocks. The LiDAR data produced very good results for high biomass areas as well as for describing understorey vegetation, in both open and closed canopy conditions. This and other research increasingly suggests that the high cost of LiDAR could be offset by the range of forest values that can be accurately inventoried and modeled from the LiDAR data.

Initiated: 07/08
Duration: 2 *years*
09/10: $0
Total: $46,280
Location: Aleza Lake Research Forest
MFR Region: NI

F 5.2 Development of novel methods to link GY models to process, climate, hydrology, wildlife, and other models

F 5.2.1 Hybrid, empirical, and process GY modelling

Y092048 **Estimating natural regeneration and yield in pine-dominated stands following mountain pine beetle attack using SORTIE-ND and PrognosisBC in a hybrid modeling approach**

Valerie LeMay
University of British Columbia

Can a hybrid combination of process-based regeneration and empirically based growth and yield models be used to improve growth and yield projections in MPB-affected stands?

Because much of the BC's mid- to long-term timber supply will originate from MPB-affected stands that are never salvaged, there is a need to develop quantitative growth and yield models that capture the natural dynamics of these stands, beginning with the estimation of regeneration following attack. This project developed a hybrid modeling approach that links SORTIE-ND and PrognosisBC, bringing together empirical and process-based modeling approaches. The resulting model was evaluated by comparing projections of stand density, diameter distribution, and species composition against actual measurements from stands that were attacked by MPB roughly 25 years ago. Overall, prediction accuracy for the hybrid model was better than simulations run using SORTIE-ND and PrognosisBC independently.

Initiated: 07/08

Duration: 2 *years*

09/10: $0

Total: $61,253

Location: MPB-attacked stands around Quesnel/Williams Lake and Kamloops

MFR Region: SI; NI

F 5.3 Techniques for scheduling harvesting after MPB attack (Retired 2006)

F 5.3.0 Unclassified

M075040 **Moving toward a desirable future: developing and evaluating alternative MPB salvage strategies in the Prince George Forest District**

Kerry Deschamps
Canadian Forest Products Ltd.

How do different goal-oriented, stand-level salvage and establishment strategies influence landscape-scale management objectives and outcomes? What types of strategies will allow managers to balance short-term benefits of MPB salvage with long-term resource stability and risk factors?

To explore the consequences and developmental implications of alternative salvage and post-salvage harvesting strategies, managers require decision-support systems that allow them to examine the potential short and long-term consequences of MPB management on both economic and ecological indicators of sustainable forest management. The primary objective of the project is to provide insight into designing optimal MPB salvage strategies by building upon the foundation of well-established decision-support tools (integrated application of both FORECAST and FSOS models) and Canfor's ongoing investment in the application of these tools toward the development of comprehensive SFM plans. The results illustrate the value of the use of ecological, economic, and risk indicators within a target-oriented planning tool to evaluate alternative stand management and harvest scheduling options with respect to desirable future forest conditions.

Initiated: 06/07

Duration: 1 *year*

09/10: $0

Total: $68,670

Location: Prince George FDs

MFR Region: NI

F 5.3.1 Allocation of post-attack live volumes to harvesting schedules (Retired 2006)

M086025 A strategic analysis framework for managing forests under the mountain pine beetle outbreak

Don Morgan
Ministry of Forests and Range

What is the efficacy of various management options for mitigating the effects of MPB outbreaks on a stand's loss of resilience to absorb further perturbation, and reduced capacity to provide key ecological services, such as wildlife habitat, mid- to long-term timber supply, and jobs?

Events as large as the current MPB outbreak can cause forests to lose some resilience to absorb further perturbation and reduce their capacity to provide key ecosystem services, such as wildlife habitat, mid- to long-term timber supply, and jobs, thus requiring innovative and forward-looking approaches to landscape-level planning. This project exploited the information available from a historical MPB-outbreak event during the 1970s in the East Kootenays to evaluate the consequences of historical responses to alternative management approaches through the development and application of a set of stochastic, landscape-based simulation models. The project developed an analysis framework suitable for evaluating resource values and trade-offs in the context of uncertainty, used the framework to create scenarios of alternative retrospective landscape conditions under different management strategies for comparison to historicalorical record from the 1970s outbreak, and also developed estimates of possible MPB-related future conditions and management responses.

Initiated: 06/07
Duration: 2 *years*
09/10: $0
Total: $134,160
Location: East Kootenays
MFR Region: SI

F 5.3.2 Design of retention and salvage harvesting at scales ranging from individual cutblocks through landscape units to entire management units (Retired 2006)

M075023 Rating options for post-attack cutting on affected stands

Bruce C. Larson
University of British Columbia

How can better decisions be made regarding what to do after MPB attack, especially in mixed-species stands?

Choosing the best management option after MPB attack at the stand-level is a difficult task, involving choices of what metric or combination of metrics to use and evaluation of the impact on long-term fibre production. This project developed a probabilistic decision-support tool that allows managers to look at the results of stand management decisions from a probabilistic approach rather than the stand deterministic approach that is used in optimization modeling. The resulting model allows forest managers to quickly and easily generate indicators of the consequences of different management decisions.

Initiated: 06/07
Duration: 1 *year*
09/10: $0
Total: $43,174
Location: Alex Fraser Research Forest
MFR Region: SI

F 6 Marketable resources other than timber (Retired 2008)

F 6.2 Non-timber forest products (NTFPs) (Retired 2008)

F 6.2.0 Unclassified

Y071045 Incremental silviculture of lodgepole pine and non-timber forest products (NTFPs)

Thomas Sullivan
University of British Columbia

How can incremental silviculture treatments in lodgepole pine stands be designed to optimize wood fibre and NTFP benefits?

Thinning and fertilization are tools that could dramatically alter stand structure and the rate and direction of ecological succession. Hence, diversification of thinning prescriptions could have profound implications for wood fibre and NTFPs (berry crops, medicinal plants, herbs, and mushrooms). This project used data from existing field trials to compare the incidence and utility of NTFPs relative to stand productivity, in managed versus old-growth stands. Study results indicate that stand treatments can have a significant, positive effect for cultivation of some NTFP species.

Initiated: 06/07
Duration: 1 *year*
09/10: $0
Total: $31,500
Location: Summerland, Kelowna, Cariboo
MFR Region: SI

F 6.2.1 Development and assessment of techniques for producing other resources in conjunction with timber production under various silvicultural systems (Retired 2007)

Y082310 Developing molecular tools to help determine the effect of natural disturbance on pine mushroom (NTFP) distribution and sustainability

Bill Chapman
Ministry of Forests and Range

What is the utility of molecular tools for easily and accurately determining pine mushroom persistence and presence?

The MPB epidemic and associated salvage harvesting threatens the sustainability of the developing pine mushroom industry, resulting in the need to quickly and accurately determine the presence of pine mushroom in MPB-affected stands with a proportion of MPB escape trees. This project developed and tested a pine mushroom detection method based on double-stranded DNA and species-specific oligonucleotide primers. Two primers were identified that were repeatedly and confidently identified on roots from known pine mushroom producing areas; however, results were less reliable and efficient when sampling stands of uncertain pine mushroom-producing capability and further development is planned.

Initiated: 06/07
Duration: 2 *years*
09/10: $0
Total: $137,225
Location: Queen Charlotte Islands
MFR Region: P

Y093021 Timber/NTFP compatible management extension

Wendy Cocksedge
Royal Roads University

How can forests be managed for compatible production of timber and non-timber forest products?

The need and demand for compatible management of all forest resources continues to increase as the value of NTFPs becomes more apparent as communities explore additional and/or alternative strategies for generating income. This three-year project developed professional development modules, a comprehensive compatible management resource website, and "how-to" guides using compatible management case studies. These extension products provide resource managers with tools to incorporate understorey species into forest management plans.

Initiated: 06/07
Duration: 3 *years*
09/10: $0
Total: $138,542
Location: Southern interior
MFR Region: P

F 6.2.5 Ecological research (autecology, synecology, NTFP harvest effects) on key NTFPs or suites of NTFP species. Research proposals are particularly invited on heavily utilized and impacted NTFP species, and those affected by MPB (Retired 2008)

Y093163 Chanterelle mushroom habitat modeling and inventory

Tyson Ehlers
Tysig Ecological Research

What are the most productive sites for chanterelles and how can their potential be realized?

This project produced a chanterelle habitat supply model for coastal forest ecosystems needed for valuing the resource and incorporating chanterelle production into sustainable forest management plans. The most productive chanterelle habitat is associated with 40-80 year-old Douglas-fir and western hemlock stands, on zonal or slightly richer sites (site series 01 and 05) in the CWHmm1 and CWHxm2. Many highly productive sites have evidence of past spacing or thinning (20-30 years ago). A 4-class rating scheme was used to assign productivity ratings classes to chanterelle habitat, using the assumption that the best sites in this area are the most highly productive in BC.

Initiated: 06/07

Duration: 3 *years*

09/10: $0

Total: $76,851

Location: Northern Vancouver Island

MFR Region: C

Y093318 Understanding the spatial and quality attributes of culturally important non-timber forest product species in mountain pine beetle-affected areas of the Cariboo-Chilcotin

Wendy Cocksedge
Royal Roads University

What are the effects of mountain pine beetle on selected understorey plant and fungal species of high cultural importance and priority to the T'exelc and Xats'ull First Nations?

Despite the dramatic expansion of the non-timber forest products (NTFPs) in recent decades and the associated benefits to many individuals and Aboriginal communities, there is currently no accepted methodology for incorporating NTFPs into conventional vegetation inventories, making it difficult to ensure sustainability of this sector, especially in light of the impact of the recent mountain pine beetle (MPB) epidemic on traditional NTFP harvest areas. Over 3 years, the project gathered and collated existing traditional and western knowledge about the non-timber forest species and harvest areas of interest to the T'exelc and Xats'ull communities, and applied the Ministry of Forests and Range's vegetation inventory methodology to the selected species and study areas. Through site visits and input from a range of knowledge holders including elders, active harvesters, and ecologists, rating criteria were developed for key species which denote specific requirements and conditions for categorizing their quality. These criteria can be used by ecologists and foresters to assign quality ratings for the selected species when conducting conventional inventories. Some preliminary projections of MPB impacts were made, showing that the effects of the beetle will vary by species and by biogeoclimatic zone.

Initiated: 06/07

Duration: 3 *years*

09/10: $0

Total: $160,722

Location: SBSdk, SBSmc, SBSdw, and SBPSmc

MFR Region: SI; NI

F 6.2.6 Understanding the effects of existing forest and range practices (e.g., harvesting, silviculture) on traditionally-used plant communities and other NTFPs. Priority will be given to NTFP species located in areas with accelerated timber harvesting or endangered ecosystems (Retired 2008)

Y102158 Impact of accelerated timber harvesting on NTFPs in Burns Lake Community Forest

Wendy Cocksedge
Royal Roads University

How can conditions for sustaining culturally relevant NTFP be maintained through silviculture in post-MPB harvest treatments?

Accelerated harvests in MPB-affected stands may affect the quality and quantity of both economically and culturally important forest species. Using a combination of community consultation, GIS analysis, inventories, and intensive field sampling protocols, this 3-year project will develop predictive habitat quality models for culturally relevant NTFP species based on sites and stand variables. The results will be used to design harvest and silviculture strategies that maximize co-production of timber and non-timber values in regenerating post-MBP stands.

Initiated: 08/09

Duration: 3 *years*

09/10: $39,960

Total: $85,320

Location: Burns Lk. Community Forest, Nadina FD; NIFR

MFR Region: NI

Y102160 Quantifying the effects of silvicultural techniques, wildfire, and forest stand attributes on black huckleberry abundance and productivity

Michael Keefer
Keefer Ecological Services

How can productivity of culturally and economically important berries be sustained in managed forests through management and silviculture?

Declines in some non-timber forest products (NTFP), including huckleberries are focusing attention on defining forest and land-management practices will sustain supplies of these products. In two Southern Interior areas, measurements of huckleberry growth and fruit production on sample plots stratified by disturbance age and type (harvested, unharvested, burned) forest stands and burns will define models describing shrub occurrence, abundance, and fruit productivity. Results will provide forest management guidance for forest, wildlife managers, and First Nations peoples in parts of the province where this resource has cultural, economical, and ecological importance.

Initiated: 08/09

Duration: 3 *years*

09/10: $33,480

Total: $76,086

Location: Flathead R., Lamb Ck., Rocky Mtn FD; SIFR

MFR Region: SI

F 7 Climate change (Retired 2008)

F 7.0 Unclassified

Y062149 Spatial climate data and assessment of climate-change impacts on forest ecosystems

David Spittlehouse
Ministry of Forests and Range

What is the expected response of species and ecosystems in BC to climate change?

Applying climate data in resource management requires matching the spatial scale of the climate and resource databases. This project developed a methodology for generating scale-free, biologically and hydrologically relevant climate data, and demonstrated the application of these data for assessing climatic impacts on vegetation and ecosystem processes. A stand-alone MS Windows® application (ClimateBC) was developed to perform all calculations and to integrate predictions of future climate from various global circulation models.

Initiated: 04/05

Duration: 2 *years*

09/10: $0

Total: $47,234

Location: Province-wide

MFR Region: P

F 7.1 Predicting effects of climate change on forest health and condition (e.g., insects, disease, fire) (Retired 2008)

F 7.1.0 Unclassified

Y071030 **Determining forest health impacts of root disease, fuels, and fires for use by the CBM-CFS3 carbon accounting model**

David Spittlehouse
Ministry of Forests and Range

How can carbon accounting models (such as the CBM-CFS3) be improved to incorporate effects of root disease, fuels, and fires?

The Carbon Budget Model used by the Canadian Forest Service (CBM-CFS3) may overestimate tree growth and underestimate mortality in some regions due to exclusion from the model of root disease and other pathogens. This project used PrognosisBC to simulate tree-level stand dynamics and quantify the impact of root diseases and pine beetles on stand dynamics, and examined how to incorporate these results into the CBM-CFS3 model. Study results indicated significant differences in patterns of mortality between PrognosisBC and CBM-CFS3, and highlighted expected difficulties in simulating diseases and pathogens in CBM-CFS3.

Initiated: 06/07

Duration: 1 *year*

09/10: $0

Total: $15,000

Location: Southern and Central Interior

MFR Region: SI; NI

F 7.1.2 Methods for forecasting the effects of climate change on forest productivity, susceptibility to pests and pathogen outbreaks, and plantation health (Retired 2008)

Y091028 **Modeling phenology and outbreaks of the western spruce budworm**

V.G. Nealis
Canadian Forest Service

Can forecasting loss risk from western spruce budworm in interior Douglas-fir forests aid future monitoring and protection decisions, for example, under climate change?

Predicting future climate-related depletion hazards to Douglas-fir forests by the western spruce budworm is essential for making strategic-level policy and silvicultural decisions as well as for tactical-level planning. This project analysed original experimental and field data on western spruce budworm in BC to produce phenology models of stage-specific, temperature-dependent development of this insect. This work formed the basis for an individual-based model with realistic variability in development rates. A preliminary version of the model was incorporated into a BioSIM phenology model interface and output derived for comparison with field information. Real-time and simulated temperature records can improve operational predictions related to the timing of control programs and mapping areas of greatest risk in the near future.

Initiated: 08/09

Duration: 1 *year*

09/10: $0

Total: $54,432

Location: BC range of interior Fd

MFR Region: SI; NI

F 7.2 Predicting effects of climate change on growth and productivity (Retired 2008)

F 7.2.0 Unclassified

Y071321 Development and analysis of forest health climate-change databases for BC: western spruce budworm and Douglas-fir

Harry Swain
University of Victoria

What are the appropriate datasets and methodologies for assessing the potential impacts of future climate-change scenarios on forest health?

Assessing the future of BC's forests under the forcing of climate change is a complex task because of the pest-host interactions involved in forest health, the uncertainty and scale of results from climate models, and the lack of knowledge of climate requirements of both hosts and pests. This project will focus on compiling and developing appropriate climate data and output from climate models for investigating the future of forest health and testing the data with a single host–pest system. The results will provide standard spatial databases of climate and climate-change projections compatible with the scale of recently developed natural disturbance databases and data on host distribution from forest inventory records. This data can be used to develop and test methods to predict the impacts of climate change on forest pests, using the western spruce budworm Douglas-fir system as a test case.

Initiated: 06/07

Duration: 1 *year*

09/10: $0

Total: $49,193

Location: Columbia Valley between Arrow Lakes and Mica Dam

MFR Region: C

F 7.2.1 Predicting the effects of climate change on the management and growth and yield of current and future stands (Retired 2008)

Y082316 Climate and outbreaks of western hemlock looper in coastal forests of British Columbia

Lori Daniels
University of British Columbia

What are the causal factors that influence the timing and frequency of western hemlock looper outbreaks, and the impacts of those outbreaks on the composition and structure of coastal BC forests?

Climate has been identified as a trigger for outbreaks of many insects; therefore, future climate change will impact forest health through changes to the length, frequency, and severity of insect outbreaks. This research investigated the causal factors that influence the timing of outbreaks of western hemlock looper, the impacts the resultant defoliation has on forest structure and composition, and the spatio-temporal dimensions of this biological disturbance agent. Detailed results presented in the study author's PhD thesis include: high moisture stress appears to trigger outbreak levels of visible defoliation events; the degree of canopy openness increased with disturbance severity; the frequency of defoliations has not changed significantly over the past 200 years.

Initiated: 06/07

Duration: 2 *years*

09/10: $0

Total: $36,349

Location: Coquitlam River watershed in the CWH

MFR Region: C

Y091179 **Examining interactions between long-term climatic fluctuations and Douglas-fir productivity in the BC Interior**

Scott Green
University of Northern British Columbia

Can potential climate-induced productivity changes in interior Douglas-fir stands be used to identify alternative silvicultural options under climate change?

Productivity of many commercial tree species in BC may be adversely affected by climate change. An extended analysis of previously collected tree-ring data from 34 mature Douglas-fir populations was used to quantify low-frequency temporal patterns in climate-growth relationships to determine how climate-growth relationships are changing for Douglas-fir and if climate thresholds exist that may represent significant and dramatic changes in forest productivity. Significant results from the project include: 1) at the population level, Douglas-fir growth responses to climate vary over large climatic and geographic gradients and appear to be linked with local conditions; and 2) changes in precipitation and soil moisture availability could be the dominant influence on future Douglas-fir productivity across a large spatial scale in the BC Interior. These and other results should help forest managers and policy-makers determine appropriate management approaches for retaining Douglas-fir populations as climates change.

Initiated: 08/09

Duration: 1 *year*

09/10: $0

Total: $19,761

Location: Range of interior Fd: ICH, SBS, ESSF, PP, IDF, SBPS, & BG zones; NIFR, SIFR

MFR Region: SI; NI

Y093061 **Development and analysis of forest health databases, models, and economic impacts for BC: spruce bark beetle and spruce; western spruce budworm and Douglas fir**

Harry Swain
University of Victoria

What is the magnitude of stand-level losses due to the spruce bark beetle and western spruce budworm across BC under current and potential future climatic regimes?

The impact of projected climate change on spruce and Douglas-fir forests in BC was assessed using bioclimatic envelope models and impacts of climate change on spruce bark beetle (SBB) and western spruce budworm (WSBW) were modeled. The results of all climate change projections used in this study indicate a shift in suitability for both spruce and Douglas-fir to elevations and latitudes higher than their current range. The study further indicates increasing risks for both SSB and WSBW in central and northwestern BC under two climate change projections.

Initiated: 06/07

Duration: 3 *years*

09/10: $0

Total: $193,431

Location: Province-wide

MFR Region: P

F 7.2.2 Predicting effects of climate-change on key NTFP species (Retired 2008)

Y081188 Climate variables and Dothistroma development: tools for future risk assessment

Kathy J. Lewis
University of Northern British Columbia

What are the climatic and site conditions contributing to the development of Dothistroma needle blight with respect to the severe outbreak happening in northwestern BC?

Recently a severe outbreak of Dothistroma needle blight, recognized worldwide as a problematic pathogen, has developed in the Skeena Stikine Forest Region in northwestern BC resulting in a considerable economic impact on the cost of re-stocking severely damaged pine plantations, and the future costs of managing these stands back to free-growing standards. This project monitored the variation in disease expression, identified the ranges of temperature and humidity conducive to disease development, and identified the role of site factors such as elevation, slope, and proximity to water in disease severity. Data analysis is ongoing, but results to date indicate that asexual reproduction is the dominant means of reproduction, which suggests long-distance dispersal of ascospores occurs only over a short period of time, and is relatively rare compared to shorter-distance dispersal during periods of high humidity.

Initiated: 07/08

Duration: 1 *year*

09/10: $0

Total: $56,894

Location: Bulkley, Kispiox, Skeena watersheds

MFR Region: NI

Y103277 Bark beetle response to climate change: a landscape-level risk model for British Columbia

Brian Aukema
University of Northern British Columbia

How can the impact of climate change on MPB population dynamics and spread be most effectively represented in spatially explicit models?

The impacts of insects and diseases on BC forests are being exacerbated by climate change. However, the current process-based landscape-level models being used to examine MPB dynamics and spread can be problematic when constructing models to investigate climate change. This project proposes to construct a spatiotemporal statistical climate-change model for mountain pine beetle to complement existing process models. The results of this work will be absolute estimates of outbreak probability on annual bases, with standard errors, at clearly defined scales.

Initiated: 07/08

Duration: 3 *years*

09/10: $59,400

Total: $155,926

Location: Central and Northern BC

MFR Region: P

F 7.3 Responding to ecosystem shifts (Retired 2008)

F 7.3.0 Unclassified

Y103215 **Tree species growth rates and susceptibility to insects and diseases in the southern ICH under current and possible future climatic conditions**

Alan Vyse
Thompson Rivers University

What are the growth rates and susceptibility to insects and diseases of tree species in the Southern Interior ICH under current and potential future climatic conditions?

There are currently no mechanisms for evaluating tree species choice for planting activities in the light of climate change, and the factors limiting current species ranges are not well understood. This project will study species growth and health, at several long-term multi-species trials established in the Southern Interior in the mid-1980s, to assess likely factors limiting ranges such as abiotic stresses (e.g., frost or drought) during seedling establishment, insects, diseases, ability to reproduce, or interspecific competition. The resulting information will inform efforts to move species north in anticipation of climate change.

Initiated: 07/08
Duration: 3 *years*
09/10: $15,120
Total: $113,769
Location: Southern Interior
MFR Region: SI

Y103220 **Assessing ecosystem vulnerability to climate change from the tree- to stand- to landscape-level**

Craig Nitschke
Bulkley Valley Centre for Natural Resources Research and Management

How might climate change influence forest health and condition and growth and yield from the stand to the landscape-level?

Understanding how climate change may influence ecosystem resilience is an essential foundation for determining how climate change will influence forest health and condition and growth and yield from the stand to the landscape-level. This project will address this important principle by: (1) applying a tree and climate assessment model (TACA) to assess species and ecosystem resilience to climate change in the Sub-Boreal Spruce zone near Smithers, BC; (2) apply TACA to assess how climate change will impact a site's moisture regime (site type); (3) link the results of TACA to a stand-level forest dynamics model, SORTIE-ND, to predict how changes in site type and species resilience will affect stand-level competition, development, and growth and yield under climate change; and (4) use the results from TACA and SORTIE-ND to investigate the impact of climate change and disturbances (e.g., mountain pine beetle, Dothistroma fungus, root rot fungus and fire) at the landscape-level. The results of this work will contribute to determining where and what adaptation strategies are to be incorporated into long-term forest planning and to providing guidance on how to manage for the risks associated with climatic change.

Initiated: 07/08
Duration: 3 *years*
09/10: $71,928
Total: $231,646
Location: SBS around Smithers
MFR Region: NI

F 7.3.1 Determine how the management of timber species can incorporate effective responses to changing climate and associated ecological changes (Retired 2008)

Y081091 Growth phenology and cold hardiness of 32 coastal Douglas-fir full-sib families

Barbara Hawkins
University of Victoria

Are certain fitness traits in Douglas-fir orchard seedling stock jeopardized by selecting solely for growth potential, thereby reducing potential adaptations to changing climatic conditions?

Nearly 100% of the coastal Douglas-fir seedlings planted each year are grown from improved seed produced in seed orchards, yet little is known about the phenology, growth rhythm, and other physiological traits of potential selections, how these factors will be affected by a changing climate, or if certain fitness traits will be jeopardized by selecting solely for height growth potential. This study examined and characterized full-sib families in the coastal Douglas-fir breeding program for a variety of fitness and growth traits relevant to their long-term performance. Significant family differences existed in almost all phenological, growth and cold hardiness traits examined, demonstrating that variation exists that can be exploited in the selection of families for the Douglas-fir breeding program.

Initiated: 07/08

Duration: 1 *year*

09/10: $0

Total: $15,997

Location: University of Victoria farm field site, and the Cowichan Lk Research Station

MFR Region: C

F 7.4 Physiological and adaptive responses of species and seedlots (Retired 2008)

F 7.4.1 Quantifying plant-climate relationships and estimating the future range and deployment of BC tree species and genotypes, including bio-climatic modelling and opportunities for facilitated migration to match genotypes with future environments (Retired 2008)

Y091054 Drought tolerance of sub-maritime Douglas-fir progeny

Barbara Hawkins
University of Victoria

Can drought-tolerant Douglas-fir progeny be identified and planted in sub-maritime zone forests subject to future decreases in annual rainfall?

Drought-induced seedling mortality of planted Douglas-fir is currently a major problem in the sub-maritime ecosystems and this situation may worsen as the climate changes. The purpose of this project was to quantify the water use efficiency of 45 families of sub-maritime Douglas-fir from first-generation seed orchards planted in progeny tests and to test the drought tolerance of a subset of these families. Knowing the range of drought tolerance in progeny from seed orchards producing seed for the sub-maritime zone allows breeders to select parents which will produce drought-tolerant progeny. Results from this work will have direct application to Douglas-fir family selection in the BCMoFR Forest Genetics Program, allowing breeders to select families which will continue to perform well in the face of decreasing annual rainfall.

Initiated: 08/09

Duration: 1 *year*

09/10: $0

Total: $18,792

Location: Coast/Interior (submaritime) transition; Whistler-Lillooet

MFR Region: C

Y091062 **Underlying biological processes: the role of ectomycorrhizal fungal communities in early growth and relocation success of whitebark pine under climate change**

Hugues B. Massicotte
University of Northern British Columbia

Can declining high-elevation whitebark pine populations be conserved through relocation or regeneration strategies?

Whitebark pine (WBP) is a long-lived, low-dispersal, subalpine conifer now in dramatic decline due to white pine blister rust and mountain pine beetle impacts. Using greenhouse bioassays of soils from multiple sites with and without WPB, effects of root-soil interactions involving symbiotic root-fungal communities on seedling growth were studied. Significant differences in growth rates were observed between the five populations studied. Early results suggest that both location and population are impacting growth in this study and that these factors may influence seedling response to natural or assisted relocation. This has implications with respect to the suitability of prospective sites, the choice of seedlot populations, and the capacity of WBP to respond to these variables and to relocation.

Initiated: 08/09

Duration: 1 *year*

09/10: $0

Total: $19,386

Location: Range of southern and northern interior whitebark Pine

MFR Region: NI

F 8 Forest harvesting and engineering studies (Retired 2008)

F 8.1 Salvaging MPB-killed timber (Retired 2008)

F 8.1.1 Forest engineering studies relating to designing efficient, cost-effective, and environmentally appropriate methods of harvesting and hauling MPB-killed trees (i.e., as logs, chips, etc.) (Retired 2008)

M065003 **Maximizing log truck efficiency when transporting logs from mountain pine beetle killed stands**

Rob Jokai
Forest Engineering Research Institute of Canada

Are logging trucks loaded with MPB salvage carrying less than economically optimal weight?

Previous studies in the Quesnel TSA indicate that short-axle logging trucks are unable to reach their maximum load when hauling dry MPB-killed wood, which leads to high hauling costs. This project collected detailed loaded vehicle weights, axle-group weights, and load measurements for trucks coming into Quesnel mills. These data were used to estimate the additional load-carrying volume required for trucks to reach maximum axle weight ratings for 100% dry loads, to assess the economic impact of underweight loads to both mills and hauling contractors, and to recommend options for increasing the load-carrying capacity of existing trucks.

Initiated: 05/06

Duration: 1 *year*

09/10: $0

Total: $50,853

Location: Quesnel TSA

MFR Region: SI

M065005 Monitoring soil disturbance on MPB-harvested areas

Shannon Berch
Ministry of Forests and Range

Can remotely-sensed data be used to assess the extent of soil disturbance following salvage harvesting using the imagery analysis method developed for FREP?

There is concern that the accelerated timber harvest in the MPB epidemic area could compromise long-term forest productivity if soils are unduly disturbed. This project assessed the suitability of a variety of remotely sensed imagery products and resolutions for detecting the extent of soil disturbance in the MPB salvage area using the imagery analysis method developed for the Soil Resource Stewardship Monitoring component of the FRPA Resource Evaluation Program. Low-resolution satellite images are sufficient for detecting and measuring the extent of roads and landings; images with spatial resolution greater then 2.5 m are suitable for detecting areas occupied by landslides, erosion, drainage diversion, inordinate disturbance, or roadside work areas; aerial photographs are best suited to describe and accurately assess less evident harvesting-related soil disturbances.

Initiated: 05/06
Duration: 1 *year*
09/10: $0
Total: $25,993
Location: Central interior
MFR Region: SI; NI

M075019 Evaluating forest road construction techniques to improve access to stands affected by mountain pine beetle

Doug Bennett
Forest Engineering Research Institute of Canada

How can road construction methods be made more efficient and timely for access development in stands affected by mountain pine beetle?

Given the pressing nature of the MPB infestation, forest managers must build roads to allow for immediate use by crews and equipment, which has proved challenging. This project deals with issues faced by managers when accessing MPB-infected stands, including maximizing efficiency, organizing equipment throughout the operation, and deciding what type of equipment to use at various road construction stages.

Initiated: 06/07
Duration: 1 *year*
09/10: $0
Total: $74,026
Location: Extent of MPB infestation
MFR Region: SI; NI

M085120 Harvesting beetle-killed lodgepole pine while protecting advanced regeneration and non-pine species

Ernst Stjernberg
FP Innovations - FERIC Division

What selective harvesting techniques afford the best protection to existing secondary structure, while allowing for the cost-effective removal of the pine overstorey?

In MPB-attacked stands containing significant healthy secondary structure, selectively harvesting the pine while protecting the secondary structure would allow the post-harvest stand to achieve fully stocked free-growing status more quickly, with the potential to contribute harvestable timber early enough to coincide with the mid-term time period. This project examines the productivity and harvesting cost breakdown of two completed partial retention trials (Trials A and B) and the level of secondary structure protection that was achieved. The results indicate that protecting secondary structure is operationally feasible while harvesting MPB-killed pine, and proposes several factors that must be considered in order to ensure a desirable post-harvest stand that will contribute to the mid-term timber supply is retained in a cost-effective manner.

Initiated: 07/08
Duration: 1 *year*
09/10: $0
Total: $150,723
Location: Prince George, Vanderhoof, Quesnel and/or Williams Lake
MFR Region: SI

M085197 Extending the logging season in mountain pine beetle-damaged stands by using ground wood to surface in-block roads

C. Kevin Lyons
University of British Columbia

Can mulched woody slash be used as an all-weather road surface for in-block roads, thereby reducing both construction costs and environmental impact?

Warmer winters and the need to harvest mountain pine beetle-killed timber has resulted in the need to extend the operating season; however, water tables have risen due to the mortality of lodgepole pine stands and inexpensive gravel is unavailable for surfacing in-block roads. This project assessed whether mulching windrows of slash can produce enough material to provide an all-weather road surface for in-block roads. Results indicate that roads with a mulched wood surface outperform soil roads when the subgrade consists of a saturated fine grained soil, and that failure of the mulched wood roads could be efficiently repaired by hand or with a skidder blade under operational conditions.

Initiated: 07/08
Duration: 1 *year*
09/10: $0
Total: $57,029
Location: UBC Alex Fraser Research Forest
MFR Region: NI

M086016 Mountain pine beetle red attack shelf-life discriminations

Arthur Roberts
Simon Fraser University

Can multispectral imagery be used to identify and separate MPB-killed trees by year of mortality?

Although considerable funds have been spent investigating the utility of remote sensing for forestry health applications over the past two decades, no prior studies have been able to reliably detect year of mortality in MPB-attacked lodgepole pine stands. The goal of this project was to develop a cost-effective aerial mapping procedure to identify and separate MPB-killed trees by year of mortality. The study consistently provided reliable separation between current attack and the first 3 years following mortality, demonstrating the technical feasibility of shelf-life discriminations to improve harvest scheduling, maximize timber utilization, and increase value recovery from MPB-killed pine.

Initiated: 06/07
Duration: 2 *years*
09/10: $0
Total: $146,970
Location: W and SW of Prince George
MFR Region: NI

M086032 Developing new techniques, systems, and equipment for harvesting post-mountain pine beetle stands

Tony Sauder
FP Innovations - FERIC Division

To what extent do current harvesting equipment and techniques need to be modified in order to maximize fibre utilization, maintain log quality, and provide acceptable delivered wood costs when harvesting MPB-killed stands?

The current focus on harvesting in MPB-infested stands may require changes to current harvesting equipment and techniques. This project compared harvesting equipment productivity and recovered volume between infested and green blocks, and investigated the effectiveness of new skidding techniques. The most notable result from this project was how small the impact of the MPB on harvesting operations has been, as productivity differences between MPB-attacked and green blocks for most harvest phases were not statistically different; however, modified skidding techniques resulted in some productivity increase and reduced breakage.

Initiated: 06/07
Duration: 2 *years*
09/10: $0
Total: $228,160
Location: Extent of MPB infestation
MFR Region: SI; NI

F Other strategic projects

Y061034 Synthesis and extension of research on the nutritional sustainability of variable retention harvesting

Cindy Prescott
University of British Columbia

How do different harvesting methods (clearcut, variable retention) affect N cycling processes and site productivity in different ecosystems?

In BC, it is usually assumed that loss of N (the primary factor limiting the productivity of most temperate and boreal forests) following clearcutting would be mitigated by using variable-retention harvesting. This study synthesized long-term results from silvicultural systems trials to determine, at a provincial level, the effect of different harvesting methods on nitrogen cycling processes. While it was found that single-tree selection causes smaller changes in N cycling than clearcutting or group-selection harvesting, there was significant variability in the response of forests to harvesting. This result indicates that there is not a universal answer to whether partial-cutting represents a better option than clearcutting in respect to N availability and N losses.

Initiated: 05/06
Duration: 1 *year*
09/10: $0
Total: $29,400
Location: Province-wide
MFR Region: P

Y061065 Critical information for policy development and management of non-timber forest products in British Columbia: baseline studies on economic value and compatible management

Darcy A. Mitchell
Royal Roads University

How can forests be managed to maximize total forest value from both timber and non-timber forest products?

The purpose of this research is to assist forest managers to increase total forest value by establishing a better understanding of the economic value of the non-timber forest product (NTFP) sector and the potential for compatible management of BC forests for both timber and NTFP values. Literature reviews and survey questionnaires were used to compile and synthesize information on the economic valuation and compatible management of NTFPs and timber throughout BC. The study uncovered a wide range of knowledge and experience surrounding compatible management, as well as estimates of the economic value of a range of NTFPs, and recommended the development of provincial strategy to support the incorporation of NTFPs into sustainable forest management.

Initiated: 05/06
Duration: 1 *year*
09/10: $0
Total: $64,732
Location: Province-wide
MFR Region: P

Y071330 Evaluating the potential to store beetle-killed logs under an insulated snowpack to mitigate volume and value losses after mountain pine beetle attack

Roger Whitehead
Canadian Forest Service

Is storage of beetle-killed logs under an insulated snowpack an effective way to reduce deterioration and limit spread of the infestation?

The large volume of trees killed by mountain pine beetle has disrupted orderly harvesting plans and log inventory management in affected forest regions. Storage of logs under an insulated snowpack can prevent deterioration of log value, reduce volume loss, and mitigate future falldown. This project assesses the strategic potential to store beetle-killed logs under an insulated snowpack, examines requirements and implications of applying this technique, and assesses the potential to limit spread of the infestation by storing logs at temperatures too low to allow development and emergence of adult beetles.

Initiated: 06/07
Duration: 1 *year*
09/10: $0
Total: $77,870
Location: BC, Ontario, international
MFR Region: P

Y072107 **Predicting the growth responses to climate change among co-occurring, major tree species in BC**

Scott Green
University of Northern British Columbia

How will regenerating forests respond to climate change?

There is considerable uncertainty about how regeneration and growth from both improved and wild seedlots may respond to future climate change in BC. This study examined tree growth responses to climate change by sampling mature populations of major co-occurring, ecologically distinct tree species across a climate gradient. Results indicate that climate–growth relationships are species-specific, suggesting that climate response models should also be species-specific.

Initiated: 05/06
Duration: 2 *years*
09/10: $0
Total: $33,785
Location: Central Interior
MFR Region: SI

Y081237 **Timber Growth and Value Program Synthesis Conference**

Rick Budhwa
Bulkley Valley Centre for Natural Resources Research and Management

How can the advancements in knowledge resulting from the Timber Growth and Value Program be extended to a broader audience?

The FIA-FSP Timber Growth and Value Program focuses on research to improve: prediction of tree and stand growth, and wood properties and values under various management regimes and for different stand types; forecasting of timber losses and stand development following natural disturbances; evaluation and development of management regimes for co-production of timber and non-timber values; and effectiveness of mandated policies and practices. This project organized and hosted a two-day conference based on the FIA-FSP Timber Growth and Value Program Themes that included speakers from all over Canada. The result was a unique web-accessible comprehensive conference proceedings package including audio files, speaker histories and presentations, providing an opportunity for anyone to experience the conference in a meaningful manner.

Initiated: 07/08
Duration: 1 *year*
09/10: $0
Total: $22,032
Location: Province-wide
MFR Region: P

Y081269 **Linking *Dothistroma septospora* to climate variability through establishment of regional paleoclimate baseline: Skeena Stikine Climate Network**

Rick Budhwa
Bulkley Valley Centre for Natural Resources Research and Management

What is the long-term historical relationship between climate variability and Dothistroma outbreaks in the Skeena Stikine Forest District?

Recent studies on Dothistroma needle blight have suggested that climate change may be responsible for unprecedented levels of Dothistroma outbreaks in northwest British Columbia. This project combined dendroclimatological techniques and statistical analysis of present and past meteorological data to reconstruct paleoclimate for the Kispiox Valley, link climate-forcing mechanisms to theoretical Dothistroma outbreak conditions (warm-wet events with a duration of three days or more), from the meteorological record, and thereby establish statistical linkages between climate-forcing mechanisms and Dothistroma outbreaks. Results suggest that the recent, and unprecedented, Dothistroma outbreaks in the Kispiox Valley are a result of a coupled ecosystem-atmosphere teleconnection whereby Dothistroma outbreaks respond to the state of the north Pacific, specifically, increasingly intense positive Pacific Decadal Oscillation and El Niño events are suggested to result in increasingly larger Dothistroma outbreaks.

Initiated: 07/08

Duration: 1 *year*

09/10: $0

Total: $79,315

Location: First Nation Traditional Territory: Office of the Wet'suwet'en

MFR Region: NI

Y082270 **Predicting the responses of interior Douglas-fir to climate change in BC**

Scott Green
University of Northern British Columbia

How does the growth of Douglas-fir vary with climatic conditions across its ecological range in the interior of British Columbia?

Characterizing changes in tree-population sensitivities to climate across the range of conditions where Douglas-fir occurs in BC will provide a biological foundation to predict their future competitive abilities, productivities, local abundances and transfer potentials. This study examined spatial and ecological patterns of interior Douglas-fir growth variation across its ecological range in the interior of British Columbia, identified climate variables that influence growth variation, and examined how climate-growth relationships differ among populations growing in ecologically unique sites. Results suggest that Douglas-fir is sensitive to precipitation over most of its range, including northern populations, and that forest managers should consider potentially widespread productivity shifts when adapting practices and policies to future conditions.

Initiated: 06/07

Duration: 2 *years*

09/10: $0

Total: $41,012

Location: Range of Douglas-fir

MFR Region: SI; NI

Y092075 The ecological resilience of lodgepole pine seed orchard crops

Joe Webber
ProSeed Consulting

What factors and stages in the production of lodgepole pine orchard seedlings contribute to the loss of genetic diversity?

Reduction in genetic diversity is associated with losses in ecological resilience of plantations, an important trait for mitigating uncertainties associated with climate-change. This project evaluated the impacts of orchard production and nursery culture (thinning and culling) on lodgepole pine genetic diversity, using standard orchard statistics and molecular DNA paternity analysis. The study found that maternal effects are strong up to germination but paternal effects begin to have an influence at thinning and have a very strong influence at culling. As advance generation orchards using fewer clones are planned for the future, it will become increasingly important for orchard managers to proactively manage genetic diversity by recognizing the disproportionate contribution of seed cone and pollen cone parents to genetic diversity.

Initiated: 07/08
Duration: 2 *years*
09/10: $0
Total: $53,530
Location: North Okanagan
MFR Region: SI; NI

Y103054 Effects of intensive fertilization on timber and non-timber resources

Rob Brockley
Ministry of Forests and Range

To what extent can repeated fertilization potentially mitigate looming timber supply shortfalls, and what are the potential long-term ecological consequences of adding large quantities of nutrients to BC Interior forests?

A large-scale operational fertilization program has recently been implemented in interior TSAs that are heavily impacted by the MPB as a means of accelerating the development of immature stands. This will make them harvestable sooner, thereby helping to mitigate some of the serious future timber supply challenges for the forestry sector in the BC Interior. This project, a continuation of the long-term "maximum productivity" research project, seeks to document the potential growth and yield benefits from fertilization, the effects of rapid growth on wood quality and value, and the effects of repeated fertilization on above-ground timber and non-timber forest resources. The results of this project will provide reliable, scientifically based estimates of productivity and sustainability impacts of high input silviculture to ensure that appropriate stand management treatments are used to achieve specific timber and non-timber yield and product objectives.

Initiated: 07/08
Duration: 3 *years*
09/10: $37,700
Total: $82,404
Location: Central BC Interior
MFR Region: SI; NI

Y103070 The effect of contamination on performance of progeny from coastal Douglas-fir seed orchards

Joe Webber
ProSeed Consulting

What is the impact of pollen contamination on the growth potential and environmental range of coastal Douglas-fir seed orchard stock?

In spite of recent improvements in pollen monitoring techniques for reliably estimating the level of contamination by non-orchard pollen in coastal Douglas-fir seed orchards, neither the extent to which contaminate pollen will reduce progeny growth from high breeding value (BV) maritime orchard parents nor the suitability of the progeny for the full range of conditions in the Douglas-fir maritime seed planning zone is understood. This project will address this knowledge gap by creating a series of progeny sired by southern Vancouver Island pollen sources (contamination) on high BV maritime Douglas-fir seed-cone parents and comparing their performance to progeny from high BV pollen parents (within orchard) on the same high BV seed-cone parents. The results of this work will help to quantify the impact of pollen contamination on the genetic worth and future wood production potential of the seedlot stock.

Initiated: 07/08
Duration: 3 *years*
09/10: $26,784
Total: $94,088
Location: Saanich Peninsula
MFR Region: C

Y103258 Stand management and forest productivity

Louise de Montigny
Ministry of Forests and Range

What are the effects of various silvicultural treatments and management regimes on wood properties and value?

Although there have been numerous studies on the effects of initial spacing, pre-commercial thinning, and commercial thinning on stand growth and yield in coastal forests, these rarely include examination of the effects of silvicultural treatment regimes on wood properties and value. To address this information gap, the "Stand Management Co-operative" (SMC) will (1) determine the relationships between the average stiffness of lumber or veneer in a log, stiffness of the log, and stiffness of the parent tree and to what extent these relationships are influenced by stand, tree, log, or environmental variables, including thinning and fertilizing; and (2) determine if there is a relationship between the largest limb average diameter and the diameter of the largest branch in the breast height region of the parent tree. This work will support the design of stand management regimes that produce high yields of wood with desirable properties.

Initiated: 07/08
Duration: 3 *years*
09/10: $72,539
Total: $155,370
Location: Province-wide
MFR Region: C

Future Forest Ecosystems Collaborative Research Initiative

FFE Unclassified

F090116 Increasing the spatial range of ClimateBC

David Spittlehouse
Ministry of Forests and Range

Can impacts of projected climate change on species and ecosystems be projected better by expanding ClimateBC to encompass western North America?

To investigate the climatic tolerance of a species throughout its range, resource managers and researchers require monthly temperature and precipitation data, projected using various climate change scenarios, for areas outside of BC. This project expanded the range of the ClimateBC, a free computer model, to include the Prairie Provinces (ClimatePP), Northwest Territories and the western United States including Alaska. It also evaluated the accuracy of predictions over the whole area. The result is a climate change projection program that covers western North America, allowing resource managers and researchers to generate more thorough analyses of climate change impacts on forest and range resources.

Initiated: 08/09
Duration: 1 *year*
09/10: $0
Total: $64,677
Location: Province-wide
MFR Region: P

F100212 Preliminary assessments of climate change impacts on the carbon balance of BC's forest ecosystems

David Spittlehouse
Ministry of Forests and Range

Are projected increases in tree productivity from climate change offset by increases in disturbance and decay rates?

Climate change could alter the future carbon balance of BC's forests by increasing growth and decomposition rates as well as increasing the frequency and severity of disturbances. This project examined the concurrent impacts of changes in productivity, decomposition, and disturbance rates using the Carbon Budget Model of the Canadian Forest Service, and forest inventory and growth data from the province of BC. The results show that with current rates of growth and disturbance BC's forests will be a net carbon sink after 2030. However, increases in fire and decay rates increase the likelihood that BC's forests will be a cumulative carbon source by 2080, even when these increases are offset by productivity increases.

Initiated: 08/09
Duration: 3 *years*
09/10: $63,180
Total: $133,380
Location: Province-wide
MFR Region: P

F100215 Improving access to high spatial-resolution climate data for climate change studies

David Spittlehouse
Ministry of Forests and Range

How can current precipitation and temperature projections generated through ClimateBC be standardized for easy application in resource management scenarios?

Resource managers and researchers require standardized data regarding future precipitation and temperature scenarios in BC, with spatial scales that correspond to resource databases. This project produced gridded temperature and precipitation data for use in geographic information systems using data generated through ClimateBC, a computer model that uses historical data to project monthly temperature and precipitation data under various climate change scenarios.

Initiated: 08/09
Duration: 3 *years*
09/10: $58,500
Total: $131,660
Location: Province-wide
MFR Region: P

F100238 Assisted migration adaptation trial

Greg ONeill
Ministry of Forests and Range

How can seedlots be managed to maxmize the productivity of plantations, given the expected effects of climate change?

Planting seedlots adapted to future climates is recognized as an effective, pro-active, and inexpensive strategy to mitigate climate change impacts. This project will test 40 Class A seedlots at 48 field sites. Productivity of each seedlot will be described as a function of site climate, and results will be used to develop a facilitated migration seed deployment system to help maximize productivity of plantations.

Initiated: 08/09
Duration: 3 *years*
09/10: $175,252
Total: $252,040
Location: Province-wide
MFR Region: P

F100240 Towards a framework for the operational assessment of ecological resilience in temperate and boreal ecosystems

Elizabeth Campbell
Ministry of Forests and Range

Can ecological resilience theory be incorporated into existing frameworks for managing forests and range in BC to promote management that increases ecosystem resilience?

Ecological resilience theory offers valuable insight into how ecosystems respond to stressors and changes (such as climate change) but it is difficult to operationalize. This project developed a framework for assessing ecological resilience of ecosystems across BC and initiated scenario testing for three focal ecosystems (boreal, lodgepole pine-dominated landscapes of the Nechako Plateau, Ponderosa Pine and Interior Douglas-fir forest complex of the Rocky Mountain Trench; Coastal Douglas-fir to very dry Coastal Western Hemlock transition of southern Vancouver Island). The scenarios included identification of variables that may be effective operational indicators of resilience, and design of studies of operational implications of management, including restoration, for resilience in the context of climate change.

Initiated: 08/09
Duration: 3 *years*
09/10: $67,500
Total: $139,264
Location: Province-wide
MFR Region: P

Growth and Yield Modeling Collaborative Research Initiative

F 3 Stand dynamics modelling

F 3.1 Complex stands, including partial cutting, variable retention

F 3.1.2 Boreal mixedwood (spruce–pine–aspen) (Retired 2008)

G106074 Development of the PrognosisBC model for the complex stands in Southern and Central Interior of BC

Abdel-Azim Zumrawi
Ministry of Forests and Range

How to improve PrognosisBC to ensure sustainable management of a wide range of forest values?

PrognosisBC requires further development to inform decision support tools applicable to managing complex stands. Further development of PrognosisBC under this project will include a review of growth and mortality components, and development of a snag and coarse woody debris component to generate carbon reports that will facilitate future linkages to fuel and fire models. The possibility ofincorporating climate change effects into the model's predictions will also be investigated.

Initiated: 08/09
Duration: 3 *years*
09/10: $95,256
Total: $194,145
Location: Interior
MFR Region: SI; NI

F 3.1.6 Coastal BEC zones (MH, CDF, CWH) (Retired 2008)

G106003 Expansion of the Tree and Stand Simulator for complex stands

James Goudie
Ministry of Forests and Range

How can the Tree and Stand Simulator be improved to better accomodate complex stands and treatements?

The Tree and Stand Simulator (TASS II) is being upgraded to better accommodate complex stands and treatments. Uprades will include changes to the model structure, modification of existing modules, development of new modules, addition of new species, and recalibration.This project will will allow TASS to directly model the growth and yield of complex stands and wood quality attributes.

Initiated: 08/09
Duration: 3 *years*
09/10: $284,580
Total: $444,746
Location: Province-wide
MFR Region: P

F 4 Response of trees and stands to disturbance

F 4.1 Stand and forest dynamics following the mountain pine beetle epidemic

F 4.1.1 Growth, development, and health of residual stands of all ages following MPB attack, including research on the timber supply implications of losses

G106048 Regeneration and growth following MPB-attack: synthesis of knowledge; a GYMP project

Chris Hawkins
University of Northern British Columbia

Extension project

Estimates of the amount of regeneration and rates of growth in stands following MPB attack are critical for future management of the stands and for forecasting the impacts of the infestation on hydrology, habitat, and vegetation types. This project consists of a workshop and meeting to: (1) allow growth and yield research to shared by the forestry community; (2) provide a synthesis of the knowledge acquired through these research projects; (3) promote the use of this information; (4) help to identify knowledge gaps; and (5) encourage collaborative research.

Initiated: 08/09
Duration: 2 *years*
09/10: $22,464
Total: $50,544
Location: Interior
MFR Region: SI; NI

F 7 Climate change (Retired 2008)

F 7.2 Predicting effects of climate change on growth and productivity (Retired 2008)

F 7.2.1 Predicting the effects of climate change on the management and growth and yield of current and future stands (Retired 2008)

G106109 Representation of climate change impacts on forest growth in FORECAST

Brad Seely
University of British Columbia

How can the forest management model FORECAST better represent the potential impacts of climate change on forest growth and development?

Modeling tools are required to predict possible effects of climate change on timber supply and other forest values. To be effective, such tools must represent the current understanding of how specific climate variables affect forest growth. This project will improve the mechanistic forest management model FORECAST by adding the capability to explicitly represent potential impacts of climate change on forest growth and development. Specifically, the project will simulate the effects of different temperature and moisture regimes on organic matter decomposition and growth rates of three key interior tree species: lodgepole pine, white spruce, and interior Douglas-fir.

Initiated: 08/09
Duration: 3 *years*
09/10: $69,012
Total: $145,143
Location: Interior
MFR Region: SI; NI

Appendix I. Classification Hierarchies for Research Strategies

Sustainability Program

S 1 Basic research to support sustainable forest management

S 1.1 Riparian and aquatic ecology and management

S 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

S 1.1.2 Riparian biodiversity of small streams and wetlands, especially in dry interior ecosystems (Retired 2008)

S 1.1.3 Effects of small stream characteristics on levels of material and energy contributed to downstream reaches

S 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

S 1.1.5 Sensitivity of wetland ecosystems to alternative riparian management strategies including livestock use (Retired 2007)

S 1.1.6 Biodiversity value of wetland riparian zones, especially in dry Interior ecosystems (Retired 2007)

S 1.1.7 Effects of restoration techniques on riparian values of small streams

S 1.2 Soil biology, ecology, and productivity

S 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

S 1.2.2 Effects of forest management (e.g., coarse woody debris retention, green tree retention, soil disturbance allowances, salvage of MPB-killed stands) on soil ecology and site productivity. Research needs are particularly focused on biological, chemical, and physical attributes (Retired 2008)

S 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

S 1.2.4 Evaluating effects of changes in site hydrology on soil biology, ecology, and productivity (Retired 2007)

S 1.2.5 Improving the scientific basis for determining the sensitivity of soil as defined in the forest planning and practices regulations (Retired 2008)

S 1.2.6 Effects of grassland vegetation succession (e.g., forest in-growth and encroachment) on soil productivity

S 1.2.7 Effects of soil rehabilitation techniques in re-establishing soil productivity

S 1.3 Landscape ecology and management

S 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

S 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

S 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

S 1.3.4 Are there species or groups of species that can be used to infer habitat condition for a variety of other species – if so, which ones? (Retired 2007)

S 1.3.5 How effective is habitat management for key species in meeting the needs of other species and maintaining biodiversity? (Retired 2005)

S 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

S 1.4 Stand-level ecology and management

S 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

S 1.4.2 Effectiveness of management strategies in creating site-level structures and in the maintenance of site-level biodiversity, non-timber forest products, and rangeland habitat (Retired 2008)

S 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)

S 1.4.4 How effective are such derived structures in maintaining stand-level biodiversity? Effects of management practices on some NTFPs are also of interest in this context (Retired 2006)

S 1.4.5 Effectiveness of riparian buffers and their design in maintaining site-level wildlife habitat and biodiversity. Research needs are particularly focused on upland, riparian, and aquatic habitats (Retired 2008)

S 1.4.6 Because of increasing interest in the boreal forest and relative historical focus of research in non-boreal ecosystems, there is particular interest in improving the scientific basis for boreal forest management. In the Boreal White and Black Spruce biogeoclimatic zone, what is the response of wildlife to various levels and configurations of overstorey retention? How do stand management alternatives affect wildlife habitats? (Retired 2005)

S 1.4.7 What are appropriate targets and configurations of stand-level structures in dry forest and open range (grassland, shrubland) needed to maintain biodiversity? (Retired 2007)

S 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

S 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

S 1.4.10 Effects of climate change on biological communities and ecological processes at site levels

S 1.5 Disturbance ecology and management (fire, wind, pests, disease, pollutants, and invasives)

S 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

S 1.5.2 Effectiveness of emulating patterns of natural disturbance in managing for biodiversity

S 1.5.3 Effects of natural disturbance processes on soil productivity, forest regeneration, forest succession, and wildlife habitat at both landscape and site levels

S 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

S 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

S 1.5.6 Contribution of large areas of dead trees (e.g., killed by insects, disease, drought, or windthrow) to resource management objectives

S 1.5.7 Effects of windthrow in the design of stand-level biodiversity retention

S 1.5.8 Effects of grassland vegetation succession (e.g., forest in-growth and encroachment) on soil productivity and forage production for livestock and wildlife habitat at both landscape and site levels (Retired 2008)

S 1.6 Watershed function and management

S 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

S 1.6.2 Effects of road construction and layout on watershed processes (e.g., stream flow)

S 1.6.3 Developing methods for landslide risk assessment and landslide avoidance (Retired 2008)

S 1.6.4 Effects of patterns, levels, and methods of tree removal (e.g., variable retention, cable logging, helicopter-grapple logging) on slope stability

S 1.6.5 Evaluating the physical, biological and cumulative effects of forest management (including salvage harvesting), natural disturbance (e.g., fire, mass wasting, MPB mortality), 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) (Retired 2008)

S 1.6.6 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 (Retired 2006)

S 1.6.7 Effects of large woody debris recruitment on stream channel type and state

S 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

S 1.7 Invasive species (plants, animals, pathogens) (Retired 2008)

S 1.7.1 Impacts of exotic (alien invasive) plants on diversity, productivity, and resilience of grassland and forest ecosystems (Retired 2008)

S 1.7.2 Characterizing population growth and range expansion of invasive species (including potentially harmful pests and pathogens), with an emphasis on early detection, prediction and control, and responses to forest and range practices (Retired 2008)

S 1.7.3 Problem analysis of the impacts of invading species on species at risk (Retired 2007)

S 1.7.4 Detection and identification of invasive pathways and their ecological mechanisms, particularly as these are affected by forest and range practices (Retired 2008)

S 1.7.5 Characterizing the mechanism of interaction (e.g., predation and competition) between invasive species and species at risk (Retired 2008)

S 1.8 Ecological restoration (Retired 2008)

S 1.8.1 Evaluating the effectiveness of restoration techniques on mitigating forest encroachment and in-growth in NDT4 ecosystems (Retired 2008)

S 1.8.2 Evaluating the effectiveness of diversity enhancing techniques, such as introducing snags and gaps, as a means of restoring biodiversity in stands or landscapes dominated by homogeneous second-growth forests (Retired 2008)

S 1.8.3 Evaluating the effectiveness of methods for controlling the populations or impacts of invasive species (Retired 2008)

S 1.8.4 Evaluating the effectiveness of in-stream aquatic habitat restoration techniques (Retired 2008)

S 1.8.5 Evaluating the effectiveness of riparian habitat restoration techniques (Retired 2008)

S 1.8.6 Evaluating the effectiveness of soil rehabilitation techniques in re-establishing soil productivity (Retired 2008)

S 1.8.7 Utilizing traditional knowledge to understand the pre-harvest values of the land to define rehabilitation practices that result in desired future landscapes and promote important species associations at different stages of regeneration (Retired 2008)

S 1.9 Climate change (Retired 2008)

S 1.9.1 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 (Retired 2008)

S 1.9.2 Understanding how biological communities and ecological processes, at both the stand and landscape levels, might respond to projected changes in climate (Retired 2008)

S 1.9.3 The influence of climate change on the interactions among wildland fire and wildland fire behaviour, the appropriate management responses, and the ultimate impacts of wildland fire on other resources (Retired 2008)

S 1.9.4 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) (Retired 2008)

S 1.10 Range ecology and management

S 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

S 1.10.2 Effects of exotic (alien invasive) species on diversity, productivity and resilience of grassland and forest ecosystems

S 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

S 1.11 Cultural heritage resources

S 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

S 1.12 Fish and wildlife ecology and management

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

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

S 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

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

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

S 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

S 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

S 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/re-introduction of fire) on the ecology of species-at-risk

S 1.13 Visual quality and recreation

S 1.13.1 Effects of ATV and snowmobile use on biological communities, wildlife, and wildlife habitat

S 1.13.2 Effects of forest access, and access management, on human use of non-timber resources (e.g. fish, wildlife, recreation)

S 1.14 Social, cultural, and economic dimensions of SFM

S 1.14.1 Effects of all-terrain vehicles (ATV) and snowmobile use on biological communities, wildlife, and wildlife habitat

S 1.14.2 Effects of forest access and access management on human use of non-timber resources (e.g., fish, wildlife, recreation)

S 2 Decision support tools for sustainable forest management

S 2.1 modeling resource availability, dynamics, and sensitivity to management and disturbance

S 2.1.1 Development of spatially-explicit models related to Theme 1.0 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

S 2.1.2 Development of methods to evaluate the effectiveness of habitat capability models in identifying high-value habitat

S 2.1.3 Development of tools to explore the spatial and temporal dynamics of habitat values in both natural and managed forest stands at both stand and landscape levels. Tools focused within stands may include multi-species irregular stand structures and/or patterns resulting from variable-retention harvesting. Needs are particularly focused on the development of new, or the adaptation of existing, tools that use or improve the utility of existing inventory and other readily available data and that are responsive to external variables (e.g., stands killed by Mountain Pine Beetle, projections of climate change) (Retired 2008)

S 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

S 2.1.5 Development of remote sensing, information systems, and innovative technology for use in assessing landscape- and stand-level forest resource characteristics

S 2.2 Population viability and spatially explicit population models (Retired 2008)

S 2.2.1 Developing spatially explicit habitat supply models for population viability analysis (PVA) applied to species at risk as outlined in topic 4.1 (Species at risk-recovery) (Retired 2008)

S 2.3 Watershed response (Retired 2008)

S 2.3.1 Developing, refining and validating spatially explicit watershed models. Research needs are particularly focused on: the effects of forest disturbances including mortality and salvage of stands killed by Mountain Pine Beetle, on peak flow, timing of flow, volume of flow, effect on critical aquatic habitat, and effect on ground water, and water quality (Retired 2008)

S 2.4 Developing or refining ecological classification systems

S 2.4.1 Updating, reconciling, and refining BEC or its components

S 2.4.2 Development of methods for identifying rare ecosystems

S 2.4.3 Development of classification systems for aquatic ecosystems

S 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

S 2.5 Watershed stewardship tools (Retired 2008)

S 2.5.1 Predicting stream temperature regimes to support designation of temperature-sensitive streams (Retired 2008)

S 2.6 Developing or refining ecological risk assessment tools

S 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

S 2.6.2 Developing integrated risk assessment frameworks for evaluating outcomes from trade-off analysis

S 2.6.3 Development of methods for assessing risk of landslides and landslide avoidance

S 2.7 Assessment of cumulative effects

S 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

S 2.7.2 What are the implications for social-cultural values of multiple resource uses (e.g., forest management, oil and gas exploration and development, access, recreation) (Retired 2008)

S 2.7.3 Tools for strategic planning that integrate time/space/scales for assessing cumulative effects of multiple resource uses (Retired 2008)

S 3 Indicators, thresholds, monitoring systems

S 3.1 Development of indicators and monitoring systems

S 3.1.1 Assessment of the Forest Resource Evaluation Program (FREP) indicators and monitoring systems

S 3.1.2 Riparian function (Retired 2005)

S 3.1.3 Watershed function (Retired 2005)

S 3.1.4 Ecological representation (Retired 2005)

S 3.1.5 Habitat quality (Retired 2005)

S 3.1.6 Range health (upland and riparian) (Retired 2006)

S 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

S 3.1.8 Developing and evaluating uses of remote sensing, information systems, and innovative technology to assess landscape- and stand-level characteristics (Retired 2008)

S 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

S 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

S 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

S 3.2 Ecological sustainability

S 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

S 3.2.2 Determining the likely range of natural variability (biological and biophysical) of coarse-through fine-filter indicators to aid in the determination of management thresholds (Retired 2008)

S 3.2.3 Defining biophysical or indigenous knowledge-based 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? (Retired 2008)

S 3.2.4 Development of indicator targets and management thresholds for sensitive species and ecological communities, especially those species and communities designated under the Forest and Range Practices Act and regulations as "at risk", "regionally significant", or "specified ungulates". (Also see Topic 2.1 – Resource modeling, and Topic 4.1 – Species at risk recovery research)

S 3.2.5 Clarification/refinement of thresholds for indicators of change in watershed functioning (e.g., road density, equivalent clear-cut area)

S 3.3 Social, cultural, and economic sustainability

S 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

S 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

S 3.3.3 Development of methods to aggregate social and economic data for inclusion in forest and range land-use planning processes

S 3.3.4 Development of approaches to quantify impacts on, and determine compensation processes for, parties affected by forest and range management activities

S 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

S 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

S 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

S 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

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

S 3.4.1 Process and criteria for setting thresholds, establishing targets, and balancing ecological, economic, and social indicators (Retired 2008)

S 3.4.2 Implications and management of changing access patterns on non-timber resource use (e.g., fish, wildlife, recreation) (Retired 2008)

S 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

S 3.4.4 Developing methods for the inclusion of First Nations-specific values into planning processes (Retired 2008)

S 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

S 3.5 Socio-cultural sustainability (Retired 2008)

S 3.5.1 Development of indicators for assessing the well-being and resiliency of human communities affected by forest and range management and the respective tenure agreements (Retired 2008)

S 3.5.2 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 (Retired 2008)

S 3.5.3 Assessment of the use of social and cultural indicators in policy, planning, and operations associated with sustainable forest management (Retired 2008)

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

S 4.1 Species at risk recovery

S 4.1.1 Determination of critical habitat requirements for species at risk where results will support development of recovery plans by recovery teams

S 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

S 4.1.3 Effects of management practices (e.g., forest road development, salvage and rehabilitation of stands killed by Mountain Pine Beetle, livestock use, exclusion/re-introduction of fire) on the ecology of species at risk (Retired 2008)

S 4.1.4 Determination of how specific threats to habitat may be mitigated or how recovery mechanisms could be developed to assist recovery of species at risk (Retired 2008)

S 4.2 Impact of forest policies and practices on First Nations and rural community resiliency

S 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

S 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)

S 4.2.3 Development of knowledge, process, and tools to improve consideration of the resiliency of First Nations and rural communities in AAC determination

S 4.2.4 Consequences of policies, regulations, and science on community resilience (Retired 2008)

S 4.2.5 Evaluation of effectiveness of policy, regulations, and practices in achieving socio-economic objectives

S 4.3 Ecosystem-based management

S 4.3.1 Compare and contrast effectiveness of EBM with other current forest and range management approaches

S 4.3.2 Assess the relative contribution of protected and inoperable areas to the maintenance of viable species populations and representative ecosystems

S 4.3.3 Assess the relative contribution of second-growth forests to the maintenance of viable species populations and representative native ecosystems

S 4.4 Management and regulation of non-timber forest resources

S 4.4.1 Development of information to enable policy, regulations, and practices addressing the sustainable management of non-timber forest resources

S 4.4.2 Determination of habitat requirements for non-timber forest products (e.g., salal, pine mushrooms, huckleberry) defined at the appropriate scale

S 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/re-introduction of fire) on the sustainability of non-timber forest products

S 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.

S 4.4.5 Evaluation of the effects of increased timber harvest levels and road access on availability of wildlife for subsistence

S 4.4.6 Evaluation of climatic trends (e.g., milder winters) for effects on wildlife and its availability for subsistence

S 4.5 Biomass for bioenergy (Retired 2008)

S 4.5.1 Environmental consequences of utilization of harvesting debris and/or increased removals of biomass (normally left on-site) from harvesting or silviculture sites for the purposes of bioenergy (Retired 2008)

S 4.6 Wildlife habitat management in response to forest and range management and climate change (Retired 2008)

S 4.6.1 Development and evaluation of knowledge to support forest and range policy, regulations, and practices that promote availability of and access to wildlife for subsistence purposes (Retired 2008)

S 4.6.2 Evaluation of the effects of increased timber harvest levels and road access on availability of wildlife for subsistence (Retired 2008)

S 4.6.3 Evaluation of climatic trends (e.g., milder winters) for effects on wildlife and its availability for subsistence (Retired 2008)

Forest Growth and Value Program

F 1 Basic research on tree growth and stand development

F 1.1 Complex stands, including partial cutting, variable retention

F 1.1.1 Species interactions

F 1.1.2 Microclimatic influences on tree and stand growth in multi-storied stands

F 1.1.3 Partial cutting and variable retention (Retired 2006)

F 1.1.4 Natural regeneration processes in multi-storied stands

F 1.1.5 Mortality (Retired 2006)

F 1.1.6 Mortality in seedling, sapling, and pole stages

F 1.2 Early stand growth

F 1.2.1 Subalpine fir (*Abies lasiocarpa*)

F 1.2.2 Western redcedar (*Thuja plicata*)

F 1.2.3 Yellow-cedar (*Chamaecyparis nootkatensis*)

F 1.3 Old trees and stands

F 1.3.1 Stand dynamics of older stands (e.g., volume loss, decay, succession, stand break-up, mortality); includes cedar, hemlock, aspen, birch, true fir stands

F 1.3.2 Mortality (Retired 2008)

F 1.3.3 Succession and stand dynamics (Retired 2008)

F 1.4 Ecological responses of trees to climate change

F 1.4.1 Quantifying plant-climate relationships and estimating the future range and deployment of BC tree species and genotypes, including bio-climatic modelling and opportunities for facilitated migration to match genotypes with future environments

F 1.4.2 Quantifying the adaptation and productivity of select seed from BC and neighbouring jurisdictions when grown in current and forecast future climates

F 1.4.3 Understanding the physiological stress response of trees and genotypes to changing environments, with linkages to species and seed zone ranges

F 1.4.4 Assessing effects of climate change on traditionally used plant communities

F 1.5 Factors influencing the supply of forest products and services other than timber

F 1.5.1 Ecological research (autecology, synecology) on NTFPs singly or in combination. Research proposals are particularly invited on heavily utilized and impacted NTFP species, including those affected by the mountain pine beetle epidemic

F 2 Design and analysis of silvicultural systems

F 2.1 Complex stands arising from partial cutting, variable retention, and multi-species planting

F 2.1.1 Maintenance of complex stand conditions for the co-production of timber and specific non-timber values such as wildlife habitat and NTFPs (Retired 2005)

F 2.1.2 The relationship between residual stand structure and understorey recruitment and development; evaluation of the results of partial cuts and the effects on stand establishment, early growth and yield, and response to management practices

F 2.1.3 Experiments and analysis of various complex stand-treatment regimes

F 2.1.4 The impact of complex stand management on stand genetics, genetic worth, and stand productivity

F 2.1.5 Use of fire and other silvicultural treatments to create resilient stands in dry forests (e.g., the Ponderosa Pine zone and parts of the Interior Douglas-fir zone)

F 2.1.6 Silvicultural systems and treatments for biomass (co)production, including, but not limited to, planning to integrate with FN traditional management and salvage practices (Retired 2008)

F 2.2 Even-aged stands

F 2.2.1 Assessment and analysis of fertilization experiments or trials for cedar, interior Douglas-fir, spruce, pine, and true fir. New research projects are limited to mid to late rotation cedar

F 2.2.2 High density stands (Retired 2005)

F 2.2.3 Field experiments studying the area-based impact of selected seed on timber growth across various stand densities and site qualities (referred to as genetic-realized-gain trials). Linkage to existing breeding programs is critical and use of the Forest Productivity Council approved design is preferred

F 2.2.4 Repressed stands. Investigations of joint production opportunities are encouraged

F 2.2.5 Espacement trials. New trials are not eligible but investigations of joint production opportunities are encouraged

F 2.2.6 Interactions among silvicultural treatments (e.g., fertilization, stand density, genetics). New trials are not eligible but investigations of joint production opportunities are encouraged

F 2.3 Compatible management of forest products and services

F 2.3.1 Understanding the effects of existing forest and range practices on traditionally used plant communities. Research proposals, including new trials, investigating plant communities and species located in areas with accelerated timber harvesting or endangered ecosystems are encouraged

F 2.3.2 Investigating effects of increased utilization levels of logging residues for wood and energy products on other forest products and services, including traditionally used plant communities, with particular emphasis on salvage operations in MPB-attacked stands

F 3 Stand dynamics modelling

F 3.1 Complex stands, including partial cutting, variable retention

F 3.1.1 Partial cutting and variable retention (Retired 2005)

F 3.1.2 Boreal mixedwood (spruce–pine–aspen) (Retired 2008)

F 3.1.3 Interior BEC zones SIR (IDF, MS, ICH) (Retired 2008)

F 3.1.4 Fire-maintained stands (Retired 2007)

F 3.1.5 High elevation stands (MH, ESSF) (Retired 2005)

F 3.1.6 Coastal BEC zones (MH, CDF, CWH) (Retired 2008)

F 3.1.7 Interior BEC zones NIR (ESSF, MH, SBS, ICH) (Retired 2008)

F 3.1.8 Incorporating production of biomass for bio-energy in stand modelling

F 3.1.9 Stand models designed to assist forest managers in the following BEC zones: interior (ESSF, IDF, MS, ICH, SBS, SBPS, BWBS, PP) and coastal (MH, CDF, CWH)

F 3.2 Wood quality

F 3.2.1 Incorporating effects of silvicultural regimes on wood quality in stand models

F 3.4 Predicting effects of climate change on growth and productivity

F 3.4.1 Predicting the effects of climate change on tree and stand growth and incorporating these effects in stand models

F 4 Response of trees and stands to disturbance

F 4.1 Stand and forest dynamics following the mountain pine beetle epidemic

F 4.1.1 Growth, development, and health of residual stands of all ages following MPB attack, including research on the timber supply implications of losses

F 4.1.2 Evaluating and estimating timber growth implications on residual trees and regenerated stands, in the understorey, and in clearcut openings. Includes species interactions related to the scale and pattern of harvesting (Retired 2005)

F 4.1.3 Growth, development, and health of residual stands (overstorey and understorey) across a wide range of post-attack stand types and conditions (i.e., mixed species - salvaged; mixed species - unsalvaged; pine dominant - unsalvaged) in different BEC zones. Includes mitigating losses and determining the extent and intensity of MPB impacts on younger stands (e.g., 25–30-year-old plantations) (Retired 2008)

F 4.1.4 Mitigating MPB losses. Research proposals are particularly invited on silvilcultural treatments and regimes (e.g., fertilization of non-lodgepole pine stands, treatment of repressed lodgepole pine stands, mixedwood management, broadleaved species management, and underplanting of attacked stands to accelerate stand development

F 4.2 Estimating and/or mitigating stand-level losses

F 4.2.1 Windthrow

F 4.2.2 Ips beetles

F 4.2.3 Spruce bark beetle

F 4.2.4 Root disease (*Armillaria*, *Phellinus*)

F 4.2.5 Rusts (*Dothistroma*, *Commandra*, western gall)

F 4.2.6 Spruce leader weevil

F 4.2.7 Spruce budworm

F 4.2.8 Dwarf mistletoe. New research projects are limited to studying infection processes and rates in the understory of MPB-affected stands

F 4.2.9 Wildlife and grazing impacts

F 4.2.10 Growth and yield implications of stand management at the urban interface for fire hazard management

F 4.2.11 Root collar weevil

F 4.3 *Mitigating losses (other than MPB) (Retired 2007)*

F 4.3.1 Browse (Retired 2007)

F 4.3.2 Fire (Retired 2006)

F 4.3.3 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 (Retired 2006)

F 4.3.4 Growth and yield implications of stand management at the urban interface for fire hazard protection (Retired 2007)

F 4.3.5 Spruce budworm (Retired 2007)

F 4.3.6 Dothistroma (e.g., applications of copper sulphate) (Retired 2007)

F 4.4 Site productivity impacts

F 4.4.1 Impacts of changes to site hydrology due to major disturbance (e.g., MPB mortality/salvage, fires) on productivity and growing conditions

F 4.5 Influence of genetic factors on stand response to insect and disease attacks

F 4.5.1 Mountain pine beetle (Lodgepole pine)

F 4.5.2 Leader weevils (spruces)

F 4.5.3 Rusts (lodgepole pine)

F 4.6 Effects of climate change on forest health and condition

F 4.6.1 Determining how insects and disease (as biotic agents of change) will respond to climate change, and the controlling variables in the response

F 4.6.2 Methods for forecasting the effects of climate change on forest productivity, susceptibility to pests and pathogen outbreaks, and plantation health

F 4.6.3 Effects of climate change on fire risk and behaviour

F 4.6.4 Methods for assessing and managing the risk and uncertainty associated with climate change

F 4.7 Salvaging MPB-killed timber

F 4.7.1 Forest engineering studies relating to designing efficient, cost-effective, and environmentally appropriate methods of harvesting and hauling and sorting MPB-killed trees (e.g., as logs, chips, bio-energy)

F 4.7.2 Studies to quantify the rates and amount of deterioration of MPB-killed timber for forest product use in relation to timber supply, harvest scheduling, and salvage operations

F 4.8 Management responses to climate-induced ecosystem shifts

F 4.8.1 Determine how the regeneration of disturbed stands can incorporate effective responses to changing climate and associated ecological changes

F 4.8.2 Mitigating timber supply losses due to climate-change effects

F 4.8.3 Determining timber supply and environmental implications of introducing exotic tree species

F 5 Analytical techniques and models for strategic analysis

F 5.1 Development of novel methods to integrate data and models across scales

F 5.1.1 Techniques for integrating various data sources for strategic analyses (e.g., forest inventory, remote sensing, GY, and non-conventional data layers such as traditional plant communities and tourism)

F 5.2 Development of novel methods to link GY models to process, climate, hydrology, wildlife, and other models

F 5.2.1 Hybrid, empirical, and process GY modelling

F 5.2.2 Linking GY models with other resource models (e.g., climate, hydrology, wildlife habitat supply, NTFPs, and other models)

F 5.3 *Techniques for scheduling harvesting after MPB attack (Retired 2006)*

F 5.3.1 Allocation of post-attack live volumes to harvesting schedules (Retired 2006)

F 5.3.2 Design of retention and salvage harvesting at scales ranging from individual cutblocks through landscape units to entire management units (Retired 2006)

F 6 Marketable resources other than timber (Retired 2008)

F 6.1 *Collect, synthesize, and assess existing knowledge; and identify critical knowledge gaps (Retired 2006)*

F 6.1.1 Non-timber forest products (NTFPs) (Retired 2006)

F 6.1.2 Bio-products (biofuels, nutraceuticals) (Retired 2006)

F 6.2 *Non-timber forest products (NTFPs) (Retired 2008)*

F 6.2.1 Development and assessment of techniques for producing other resources in conjunction with timber production under various silvicultural systems (Retired 2007)

F 6.2.2 Developing innovative methods to inventory and value NTFPs, using multi-media and multi-scale approaches (Retired 2007)

F 6.2.3 Defining relationships between high value NTFPs, forest site conditions, and stand dynamics (Retired 2007)

F 6.2.4 Assessing impacts of environmental factors on marketable non-timber resources (Retired 2007)

F 6.2.5 Ecological research (autecology, synecology, NTFP harvest effects) on key NTFPs or suites of NTFP species. Research proposals are particularly invited on heavily utilized and impacted NTFP species, and those affected by MPB (Retired 2008)

F 6.2.6 Understanding the effects of existing forest and range practices (e.g., harvesting, silviculture) on traditionally-used plant communities and other NTFPs. Priority will be given to NTFP species located in areas with accelerated timber harvesting or endangered ecosystems (Retired 2008)

F 6.2.7 Initiate new trials to assess impacts of integrated forest management on NTFPs (Retired 2008)

F 6.2.8 Explore the potential of species not currently used as NTFPs (Retired 2008)

F 6.3 *Biofuels (Retired 2007)*

F 6.3.1 Silvicultural treatments for managing for production of biofuels, in conjunction with timber production (Retired 2007)

F 7 Climate change (Retired 2008)

F 7.1 *Predicting effects of climate change on forest health and condition (e.g., insects, disease, fire) (Retired 2008)*

F 7.1.1 Determining how insects and disease (as biotic agents of change) will respond to climate change, and the controlling variables in the response (Retired 2008)

F 7.1.2 Methods for forecasting the effects of climate change on forest productivity, susceptibility to pests and pathogen outbreaks, and plantation health (Retired 2008)

F 7.1.3 Effects of climate change on fire risk and behaviour (Retired 2008)

F 7.1.4 Methods for assessing and managing the risk and uncertainty associated with climate change (Retired 2008)

F 7.2 *Predicting effects of climate change on growth and productivity (Retired*

F 7.2.1 Predicting the effects of climate change on the management and growth and yield of current and future stands (Retired 2008)

F 7.2.2 Predicting effects of climate-change on key NTFP species (Retired 2008)

F 7.3 *Responding to ecosystem shifts (Retired 2008)*

F 7.3.1 Determine how the management of timber species can incorporate effective responses to changing climate and associated ecological changes (Retired 2008)

F 7.3.2 Mitigating timber supply losses due to climate-change effects (Retired 2008)

F 7.3.3 Timber supply and environmental implications of introducing exotic tree species (Retired 2008)

F 7.4 *Physiological and adaptive responses of species and seedlots (Retired 2008)*

F 7.4.1 Quantifying plant-climate relationships and estimating the future range and deployment of BC tree species and genotypes, including bio-climatic modelling and opportunities for facilitated migration to match genotypes with future environments (Retired 2008)

F 7.4.2 Quantifying the adaptation and productivity of select seed from BC and neighbouring jurisdictions when grown in current and forecast future BC climates (Retired 2008)

F 7.4.3 Tracking vegetation changes due to climate change through the evaluation of older vegetation survey plots (Retired 2008)

F 7.4.4 Understanding the physiological stress response of trees to changing environments, with linkages to species and seed zone ranges (Retired 2008)

F 8 Forest harvesting and engineering studies (Retired 2008)

F 8.1 *Salvaging MPB-killed timber (Retired 2008)*

F 8.1.1 Forest engineering studies relating to designing efficient, cost-effective, and environmentally appropriate methods of harvesting and hauling MPB-killed trees (i.e., as logs, chips, etc.) (Retired 2008)

F 8.1.2 Studies to quantify the rates and amount of deterioration of MPB-killed timber for forest product use in relation to timber supply, harvest scheduling, and salvage operations (Retired 2008)

F 8.2 *Harvesting systems for biomass (co)production in conjunction with timber (Retired 2008)*

F 8.2.1 Harvesting systems for biomass (co)production in conjunction with timber (Retired 2008)

F 9 Enhancing forest values

F 9.1 Designing and evaluating novel systems for producing biomass for bioenergy

F 9.1.1 Harvesting systems for biomass production in conjunction with timber

F 9.2 Market and non-market valuation of forest products and services other than timber

F 9.2.1 Exploring the potential of species not currently used as NTFPs

Appendix II. Funded Projects by Organization and Contact Name

Organization (white) and Contact Name	Project #	Title
Agro Forestry Limited		
A Yenemurwon Omule	Y081189	Analysis and reporting of the Shawnigan Lake Fertilizer and Thinning Experiment
Aleza Lake Research Forest Society		
Melanie Karjala	Y092234	An evaluation and comparison of LiDAR remote sensing technology and large-scale digital photography for landscape-level forest management applications in complex multi-aged coniferous forests
Michael Jull	Y092256	A long-term study of the post-harvest population dynamics, development, and emergent characteristics of mature Douglas-fir leave-trees on sub-boreal sites in Central Interior BC
Artemis Wildlife Consultants		
Richard Weir	Y082019	Identification of critical habitat requirements for interior Western Screech-Owls
Babine Forest Products		
Jeff Gillanders	Y073364	Comandra rust screening in Bulkley Valley lodgepole pine
Bulkley Valley Centre for Natural Resources Research and Management		
Alex Woods	Y051207	Predicted impacts of hard pine rusts in lodgepole pine–dominated juvenile stands in central BC
Craig Nitschke	Y103220	Assessing ecosystem vulnerability to climate change from the tree- to stand- to landscape-level
David Coates	M085196	Evaluation of regeneration delay, release of advance regeneration, future growth rates, and stand dynamics after a 40- to 50-year-old MPB attack in sub-boreal forests around Takla Lake
David Coates	Y051161	Growth and yield implications of alternate silvicultural strategies in mountain pine beetle–damaged stands
David Coates	Y061151	Improving juvenile tree growth prediction for complex mountain pine beetle damaged stands
David Coates	Y072148	Regeneration and stand structure following mountain pine beetle infestation in the Sub-Boreal Spruce zone
David Coates	Y082254	Effect of site type on competitive interactions among trees in complex-structured mixed-species sub-boreal forests
David Coates	Y103187	Evaluation of the complex stand simulation model SORTIE-ND for timber supply review in sub-boreal forests of northern BC
Deborah Cichowski	M085226	The response of caribou terrestrial forage lichens to forest harvesting and mountain pine beetles in the East Ootsa and Entiako areas
Deborah Cichowski	M086047	Effects of a mountain pine beetle epidemic on northern caribou habitat use, migration, and population status
Deborah Cichowski	Y061134	Regeneration and stand structure in stands in the east Ootsa and Entiako areas after infestation by the mountain pine beetle

Deborah Cichowski	Y071328	Effects of a mountain pine beetle epidemic on forest floor vegetation dynamics and regeneration in the Itcha-Ilgachuz caribou winter range in the Quesnel TSA
Deborah Cichowski	Y102159	Effects of a mountain pine beetle epidemic on northern caribou habitat use, migration, and population status
Don Morgan	Y092259	Enhancing the resiliency of the Tweedsmuir-Entiako caribou to the current mountain pine beetle outbreak
Douglas Steventon	M086006	Landscape strategies for mountain pine beetle management: some stewardship implications
Douglas Steventon	Y062053	Implications of landscape composition and pattern in managed sub-boreal forests
Kevin Kriese	Y071012	Complex stand management: extension of recent research to forest managers
Kirsteen Laing	M065001	Regeneration and stand structure following mountain pine beetle infestation in the Sub-Boreal Spruce zone
Marie-Lou Lefrancois	Y103211	Growth and release of understorey trees in partially cut pine stands
Marty Kranabetter	Y093010	Developing indicators of soil productivity, function, and biodiversity through soil biotic communities
Rasmus Astrup	Y092022	The effect of site type and stand structure on the relationship between growth and light availability for understorey trees
Rasmus Astrup	Y092260	Development of a spatially explicit crown allometry model
Rick Budhwa	Y081237	Timber Growth and Value Program Synthesis Conference
Rick Budhwa	Y081269	Linking *Dothistroma septospora* to climate variability through establishment of regional paleoclimate baseline: Skeena Stikine Climate Network
Ruth Lloyd	Y071158	Structural recruitment: factors affecting survival and growth of residual immature trees after clearcut overstorey harvesting
Ruth Lloyd	Y071269	Range of natural variation in structural attributes of young stands: refining current indicators
Sybille Haeussler	Y071075	Stand-level vegetation indicators for boreal mixedwood forests
Todd Mahon	Y092251	Effects of habitat composition on the fitness of a mature forest indicator; do thresholds exist?
Canadian Forest Products Ltd.		
Darrell Regimbald	Y062218	Planning methods to reduce costs and enhance value recovery in sustainably managed forests
Kerry Deschamps	M075040	Moving toward a desirable future: developing and evaluating alternative MPB salvage strategies in the Prince George Forest District
Steven Day	Y061143	Deriving and measuring the soil-based thresholds required for maintaining ecosystem productivity under a Sustainable Forest Management Plan
Steven Day	Y071160	The implications of management practices for mitigating mountain pine beetle on soil-based indicators of SFM
Alan K. Mitchell	Y073286	Montane Alternative Silvicultural Systems (MASS): growth limitations on regeneration
J.A. Tony Trofymow	Y092173	Integration of information on ectomycorrhizal fungal species for use as indicators of sustainable forestry in British Columbia
René Alfaro	Y102087	Future productivity of lodgepole pine stands following mountain pine beetle outbreaks

Richard Winder	Y093322	Can the important microbial diversity and nutrient cycling characteristics of old-growth Douglas-fir forests be maintained in managed second-growth forests?
Roger Whitehead	Y071330	Evaluating the potential to store beetle-killed logs under an insulated snowpack to mitigate volume and value losses after mountain pine beetle attack
Stephen Taylor	Y102111	Wildfire risk in a changing climate
V.G. Nealis	Y091028	Modeling phenology and outbreaks of the western spruce budworm
Consultant		
David Huggard	Y072044	Ecologically based connectivity indices for landscape monitoring
Donald Sachs	Y073021	Expert system for making site preparation and vegetation management decisions in Southern Interior BC
Joseph A. Antos	Y071034	Growth patterns prior to mortality of mature subalpine fir in the Southern Interior
Davis Environmental Ltd.		
Larry Davis	Y092290	Fisher (*Martes pennanti*) habitat ecology in pine-dominated habitats of the Chilcotin
Ecologia		
Audrey Pearson	Y092147	Structural recovery in second-growth forests on Lyell Island, Haida Gwaii
Enlichened Consulting Ltd.		
Trevor Goward	Y051034	Distributional ecology of alectorioid lichens in the ICH
Environment Canada		
Krista De Groot	Y081218	Evaluation of the use of avian focal species to maintain diversity in forested landscapes
Max L. Bothwell	Y073151	Does logging elevate ultraviolet radiation exposure of streams impact juvenile coho?
Foresol Consulting Ltd.		
Mary-Jane Douglas	Y093284	Soil disturbance effects of hoe-forwarding on tree growth and site productivity
Doug Bennett	M075019	Evaluating forest road construction techniques to improve access to stands affected by mountain pine beetle
Rob Jokai	M065003	Maximizing log truck efficiency when transporting logs from mountain pine beetle killed stands
Trevor Blenner-Hassett	Y102163	Predicting changes in early growing-season water availability contributed as snowmelt following mountain pine beetle attack
Forested Ecosystems Research		
Timothy Conlin	Y051178	Extension of results: in-woods chipping of trembling aspen (Populus tremuloides Michx.)
Forintek Canada Corp.		
Sencer Alkan	Y051244	Modeling of subalpine fir trees using industrial CT imaging and simulated X-ray scanning

FP Innovations - FERIC Division		
Ernst Stjernberg	M085120	Harvesting beetle-killed lodgepole pine while protecting advanced regeneration and non-pine species
Tony Sauder	M086032	Developing new techniques, systems, and equipment for harvesting post-mountain pine beetle stands
Haida Mapping		
Marguerite Forest	Y092213	Integrating historical airphoto data for cedar analyses
International Forest Products Ltd.		
Warren Warttig	Y091153	Analysis of riparian restoration techniques on biodiversity: use of invertebrate indicator species to determine appropriate restoration options for ecological recovery of riparian stands
Warren Warttig	Y091155	Design of riparian zones: temporal response of secondary productivity to stream geomorphology and classification
Island Timberlands Limited Partnership		
N.J. Smith	Y103264	Modeling the development of coastal BC stands: an individual tree model linked to a variable retention microclimate model
J. Heineman Forestry Consulting		
Jean Heineman	Y102093	Responses of conifers and trembling aspen-dominated vegetation a decade after manual and chemical brushing in southern interior of BC: examining the role of climate, ecosystem, site, and vegetation characteristics
Keefer Ecological Services		
Michael Keefer	Y093329	Measuring success in managing for saskatoon berries and other traditionally important plants
Michael Keefer	Y102160	Quantifying the effects of silvicultural techniques, wildfire, and forest stand attributes on black huckleberry abundance and productivity
McGregor Model Forest Association		
Scott McNay	Y072136	Establishing a science basis for recovery of woodland caribou in north-central British Columbia
Scott McNay	Y073348	An ecosystem approach to planning for sustainable management of mountain goat resource values and timber supply
Scott McNay	Y071064	Extension of habitat supply tools: the caribou habitat assessment and supply estimator
Ministry of Environment		
Douglas Heard	Y102050	Determining the causes and magnitude of caribou mortality during a moose population decline
Eric Lofroth	Y093268	Fisher habitat ecology in the Peace River region
Ian Sharpe	Y073128	Benthic macroinvertebrate sustainability indicator development for SFMP and LRMP applications

John Youds	Y091176	Effects of a mountain pine beetle epidemic on forest floor vegetation dynamics and lichen regeneration in the Itcha Ilgachuz caribou winter range in the Quesnel TSA
Jordan Rosenfeld	Y073113	Development of indicators of stream condition, function, and capacity for juvenile salmon
Jordan Rosenfeld	Y092209	Assessing critical habitat and threats to endangered stickleback species pairs on the forested land base
Laura Friis	Y103135	Identification of long-eared myotis bat species in British Columbia: an essential tool for developing management recommendations for bat species at risk
Marc Nelitz	Y082057	Developing a science-based framework to identify and designate "temperature sensitive streams" for sustainable riparian forest management in the BC Interior
Marc Porter	Y081231	Developing fish habitat models for broad-scale forest planning in the BC southern Interior
Tom Johnston	Y092289	Source distances and delivery processes for large woody debris recruitment to small streams from riparian forests
Ministry of Forests and Range		
Abdel-Azim Zumrawi	G106074	GYMP: Development of the PrognosisBC model for the complex stands in Southern and Central Interior of BC
Abdel-Azim Zumrawi	Y051355	Implementing a PrognosisBC regeneration submodel for the complex stands of southeastern and central British Columbia
Abdel-Azim Zumrawi	Y051356	Calibrating PrognosisBC in the Sub-Boreal Spruce and the Sub-Boreal Pine–Spruce biogeoclimatic zones
Abdel-Azim Zumrawi	Y061132	Development of the PrognosisBC growth and yield simulator in southern and central BC: model validation
Andre Arsenault	M085281	Mountain pine beetle as an agent of enhanced hair lichen biomass, with implications for the winter ecology of mountain caribou
Andre Arsenault	Y073299	The ecology and management of dry Douglas-fir forests: the Opax Mountain Silvicultural Systems Study
Andre Arsenault	Y103280	The ecology and management of dry Douglas-fir forests: the Opax Mountain Silvicultural Study
Andy Mackinnon	Y102053	Stand dynamics over 15 years in old-growth forests in the Coast Forest Region
Art Stock	Y073184	New egg survey method for population assessments of the western hemlock looper (*Lambdina fiscellaria lugubrosa*) (Lepidoptera: Geometridae)
Bill Chapman	Y062143	Evaluation of Hypholoma trials
Bill Chapman	Y082310	Developing molecular tools to help determine the effect of natural disturbance on pine mushroom (NTFP) distribution and sustainability
Brian D'Anjou	Y061094	Long-term Research Installation Number 042 ; EP 1151: dispersed retention in the coast-interior transition. Evaluation of a range of overstorey densities for harvesting and managing Douglas-fir dominated stands (Boston Bar)
Brian D'Anjou	Y103103	Regeneration, growth, and potential value of bitter cherry as a component of young complex stands on Southern Vancouver Island
Bruce McLellan	M086037	Implications for grizzly bears and moose of forest management in response to the 1970s mountain pine beetle infestations in the Flathead Drainage

Bruce McLellan	Y073086	Quantifying forest stand and landscape attributes that influence mountain caribou habitat fragmentation and predation rates
Bruce McLellan	Y083042	Evaluating and refining guidelines for forested buffers for grizzly bear habitat management
Bruce McLellan	Y103201	Quantifying forest stand and landscape attributes that influence mountain caribou habitat fragmentation and predation rates
C. Mario Di Lucca	Y061168	Incorporating variable retention harvesting functionality into the Forest Service Spatial Analysis Model (FSSAM)
C. Mario Di Lucca	Y083169	Incorporating the effects of windthrow after variable retention harvesting into TASS and TIPSY
Catherine Bealle Statland	Y082285	Pothole Creek Study Area – Interior Douglas-fir uneven-aged stand development
Chuck Bulmer	Y073250	Soil conditions and tree growth in BC's forests: factors affecting ecosystem response to forest practices
Chuck Bulmer	Y103245	Restoration of forest soils: long-term productivity results
Craig DeLong	M085007	Can wildlife tree patches conserve sensitive species in MPB impacted landscapes?
Craig DeLong	Y051073	Understanding and predicting snag and CWD dynamics in Sub-boreal Spruce and Engelmann Spruce–Subalpine Fir forests
Craig DeLong	Y081165	Improving the prediction of species composition of managed aspen and white spruce stands within boreal mixedwoods
Craig DeLong	Y083072	A framework for documenting the effects of the mountain pine beetle outbreak in sub-boreal forests of northern BC
Dale Seip	M086049	Response of woodland caribou to partial retention logging of winter ranges attacked by mountain pine beetle
Dale Seip	Y062035	Ecological relationships between threatened caribou herds and their habitat in the central Rocky Mountains Ecoregion
Dale Seip	Y102010	Response of woodland caribou to partial retention logging of winter ranges attacked by mountain pine beetle
Dan Hogan	Y062170	Functional large woody debris in small streams: what is it?
David Coates	Y051298	Predicting wind damage in mixed-species complex-structured stands
David G. Simpson	Y073092	Light and tree growth in complex forest stands
David John Wilford	Y051077	Forest management on alluvial and colluvial fans
David Maloney	M065007	Compendium of fish/forestry reports
David Maloney	Y073027	The effects of riparian harvesting on fish habitat and ecology of small headwater streams
David Spittlehouse	F090116	Increasing the spatial range of ClimateBC
David Spittlehouse	F100212	Preliminary assessments of climate change impacts on the carbon balance of BC's forest ecosystems
David Spittlehouse	F100215	Improving access to high spatial-resolution climate data for climate change studies
David Spittlehouse	Y062149	Spatial climate data and assessment of climate-change impacts on forest ecosystems

David Spittlehouse	Y071030	Determining forest health impacts of root disease, fuels, and fires for use by the CBM-CFS3 carbon accounting model
David Wilford	Y061091	Small streams on fans: recognition of hydrogeomorphic hazards
Denis Collins	Y104005	Using stereoscopic high-resolution satellite imagery to assess landscape and stand-level characteristics
Dennis Lloyd	Y061116	Refinement of the BEC classification for selected subzones of the former Nelson Forest Region
Dennis Lloyd	Y061118	Spatial and temporal response of bryophytes to silvicultural and site preparation treatments in high-elevation forests at Sicamous Creek
Don Morgan	M086025	A strategic analysis framework for managing forests under the mountain pine beetle outbreak
Douglas Steventon	Y093256	Retention patches: windthrow and recruitment of habitat structure
Ed Korpela	Y103108	Does fire promote regeneration and growth of western redcedar?
Elizabeth Campbell	F100240	Towards a framework for the operational assessment of ecological resilience in temperate and boreal ecosystems
Elizabeth Campbell	M086048	Assessing the threat of mountain pine beetle outbreaks to whitebark pine in British Columbia
Evelyn Hamilton	Y103033	Ecosystem recovery after disturbance: thresholds for biodiversity and resiliency indicators
F. Louise Waterhouse	Y061171	Assessment of data requirements and development of multi-scale habitat classification methods for refining strategic habitat
F. Louise Waterhouse	Y062074	Landscape analysis of habitat supply and effects on populations of the northern spotted owl in BC
F. Louise Waterhouse	Y082026	Evaluating the potential threat of barred owls on northern spotted owl population recovery and habitat management strategies
F. Louise Waterhouse	Y082028	Landscape analysis of habitat supply and effects on populations of the northern spotted owl in BC: extension of results
Fred Hovey	Y073365	Development of analytic and decision models for assessing grizzly bear needs from forest management objectives
George Harper	M086004	Enhancing early stand growth through the use of vegetation management – 15-year post-treatment results
George Harper	Y083051	Modeling boreal mixedwoods (spruce–aspen–pine) with TASS
George Harper	Y102079	An evaluation of brushing and spacing treatments – growing space management in boreal forest mixedwoods
Gordon Nigh	M086001	Density and distribution of advance regeneration in the MS biogeoclimatic zone in relation to site moisture and overstorey density
Gordon Nigh	Y102049	Validation of the SIBEC model for estimating site index in complex stands
Gordon Nigh	Y102066	Site index models for amabilis fir
Graeme Hope	Y072093	Recovery of soil carbon and nitrogen ten years after harvesting and site preparation at Sicamous Creek
Greg ONeill	F100238	Assisted migration adaptation trial

Jacob Boateng	Y103192	Twenty-year effects of mechanical site preparation and burning on soil properties and lodgepole pine nutrition in sub-boreal British Columbia
James Goudie	G106003	GYMP: expansion of the Tree and Stand Simulator for complex stands
James Goudie	Y083088	TASS III: Simulating the management, growth, and yield of complex stands
James Goudie	Y103078	Modeling the impacts of silvicultural treatments on the wood quality of interior spruce
James W. Schwab	Y051047	Debris flow occurrence and major storm cycles, Kalum Forest District
James W. Schwab	Y081219	Stream morphology, changes, and recovery, following the 1992 washout-flow Donna Creek Mackenzie Forest District
Jeff Stone	Y081212	Addressing information exchange needs around analysis and decision processes that use forest estate models and their inherent linkages to habitat supply models and sustainability indicators
Jim Goudie	Y073290	Modeling the impact of stand management regimes on the wood characteristics of lodgepole pine
Keith Thomas	Y062209	Management of complex coastal mixedwoods in BC for productivity and free-growing
Lorraine Maclauchlan	M085169	Mountain pine beetle impacts and risk projections in young lodgepole pine stands
Lorraine Maclauchlan	M086009	Identification of young pine stands at high risk to mountain pine beetle through an integration of GIS analysis and field evaluation techniques
Lorraine Maclauchlan	Y072003	Determining susceptibility of young pine plantations to the mountain pine beetle, *Dendroctonus ponderosae*, and manipulating future stands to mitigate losses
Louise de Montigny	Y073156	Stand Management Cooperative - growth and yield installations in BC
Louise de Montigny	Y073266	Coastal stand management growth and yield field experiments
Louise de Montigny	Y082011	Forest regeneration, growth, and development under seven silvicultural systems
Louise de Montigny	Y103073	Natural regeneration, mortality, and residual growth response 25 years after partial cutting on the Coast
Louise de Montigny	Y103258	Stand management and forest productivity
Louise de Montigny	Y103279	Early survival and growth of natural regeneration and planted seedlings under seven silvicultural systems on the Coast
Marty Kranabetter	Y083080	Interactions between light and nitrogen availability on juvenile tree growth in partial cut forests
Michaela Waterhouse	Y073006	Group selection systems to maintain caribou habitat in high-elevation forests (ESSFwc3) in central BC
Michaela Waterhouse	Y073007	Silvicultural systems to maintain northern caribou habitat in lodgepole pine forests in central BC
Michaela Waterhouse	Y073043	Shelterwood silvicultural systems to address integrated resource management issues
Michaela Waterhouse	Y103008	Group selection silvicultural systems to maintain caribou habitat in high-elevation forests (ESSFwc3) in central BC
Michaela Waterhouse	Y103133	Silvicultural systems to maintain northern caribou habitat in lodgepole pine forests in central BC
Michaela Waterhouse	Y103143	St. Mary's residual basal area study in a mixed conifer stand
Michaela Waterhouse	Y103145	Shelterwood silvicultural systems to address integrated resource management issues

Michelle Cleary	Y103130	Distribution and impacts of Phellinus root disease in the Southern Interior of British Columbia
Paul Courtin	Y073159	Management regimes for red alder plantations
Peter Fielder	Y093038	Light as a factor in the growth and survival of four planted conifer species across forest gaps
Peter Tschaplinski	Y061074	Development and testing of extensive-level field indicators and methods to determine whether current forestry practices are sustainably managing riparian, aquatic ecosystem, and fish habitat values
Peter Tschaplinski	Y073222	Carnation Creek: forestry impacts and watershed recovery processes in a small coastal drainage
Peter Tschaplinski	Y103080	Carnation Creek – Forestry impacts and watershed recovery processes in a small coastal drainage
Reg Newman	Y071154	Linking range health assessment methodology with science
Reg Newman	Y073069	Understorey succession following ecosystem restoration of ingrown dry forests
Reg Newman	Y081045	Development of cost-effective health indicators for fescue grasslands of British Columbia
Richard Kabzems	Y081041	Ten-year growth of white spruce underplanted beneath spaced and unspaced aspen stands in northeastern British Columbia
Rita Winkler	Y073115	Snow, road, soil moisture, and harvest distribution effects on streamflow at Upper Penticton Creek
Rob Brockley	M086010	Development of residual trees and regeneration following MPB attack in thinned lodgepole pine stands
Rob Brockley	Y073210	Sulphur fertilization of lodgepole pine: a stable isotope tracer study
Rob Brockley	Y103054	Effects of intensive fertilization on timber and non-timber resources
Robert Brockley	Y073101	Effects of intensive fertilization on timber and non-timber resources
Robert Brockley	Y073102	Stand management growth and yield field experiments in the BC Interior
Roberta Parish	Y081051	Effects of competition among trees on crown structure in spruce–fir forests
Roberta Parish	Y093017	Rates of mortality and dead tree dynamics in old coastal forest stands
Rod Hudson	Y073273	Tsitika River sediment budget project
Roderick Negrave	Y071255	Regeneration recruitment and early stand growth in partially cut and burned IDFww stands
Roderick Negrave	Y082258	Partial cutting on steep slopes, Queen Charlotte Islands: treatment regime effects on residual stand mortality and growth; recruitment, growth, and dynamics of regeneration; and non-timber understorey composition
Roderick Negrave	Y091069	Residual stand effects on light transmission and understorey conifer growth in partially cut stands in the CWHvh2, Queen Charlotte Islands
Roderick Negrave	Y103127	Growth responses of red alder to fertilization: remeasurements of existing single-tree and multi-tree plot experiments on Vancouver Island and the Sunshine Coast
Sari Saunders	Y091090	Developing old-growth benchmarks for evaluating multiscale structure-recruitment relationships in harvested coastal temperate forests
Shannon Berch	M065005	Monitoring soil disturbance on MPB-harvested areas
Shannon Berch	Y061085	Impact of retaining woody debris and forest floor habitats on stand-level diversity of soil collembola

Shannon Berch	Y061173	Replacement of fire-damaged LTSP plots: Rover Creek ICH installation
Shannon Berch	Y062093	Ten-year soil fauna responses to soil compaction and organic matter removal at Sub-Boreal Spruce LTSP
Shannon Berch	Y073084	Long-term Soil Productivity study
Shannon Berch	Y103042	Long-term Soil Productivity Study
Shirley Mah	Y073071	SIBEC site index estimates
Shirley Mah	Y081038	SIBEC site index estimates for complex stands in the northern CWH and ICH biogeoclimatic zones
Stefan Zeglen	Y103039	Assessing soil disturbance and tree growth after stumping
Teresa Newsome	M086012	Treatment of repressed lodgepole pine stands
Teresa Newsome	Y073022	Competitive effects of broadleaf trees on conifer performance over a range of ecosystems
Teresa Newsome	Y103003	Competitive effects of broadleaf trees on conifer performance over a range of ecosystems
Tom Millard	Y062324	Coastal fan destabilization and forest management
Walt Klenner	M085266	Developing retention strategies to maintain landscape-level wildlife habitat and biodiversity during the salvage harvesting of mountain pine beetle attack areas in the Southern Interior Forest Region
Walt Klenner	Y073220	Harvesting and site preparation treatments to develop and maintain open canopy conditions in dry-belt Douglas-fir forests: the Isobel Project
Walt Klenner	Y081268	Harvesting and site preparation treatments to develop and maintain open canopy conditions in dry-belt Douglas-fir forests: the Isobel Project
Walt Klenner	Y082273	Developing stand management prescriptions to maintain suitable habitat for mountain caribou
Walt Klenner	Y092267	Extension - Options for the landscape-level management of dry NDT4 ecosystems in the Southern Interior Forest Region
Walt Klenner	Y093324	Abundance of critical wildlife habitat attributes in relation to forest management practices
Walt Klenner	Y102164	Harvesting and site preparation treatments to develop and maintain open canopy conditions in dry Douglas-fir forests: the Isobel Project
Walt Klenner	Y103282	Landscape habitat-supply modeling to develop and test management scenarios that balance ecological and socio-economic indicators
Ministry of Water, Land, and Air Protection		
Jordan Rosenfeld	Y051112	Development of sustainability indicators for turbidity impacts on stream ecosystems
Jordan Rosenfeld	Y062114	Implications of static riparian reserve zones for long-term function of naturally migrating river channels
Natural Resources Canada		
J.A. Tony Trofymow	Y083183	Assessment of the effectiveness of green-tree retention in maintaining the diversity of and promoting the recolonization by ectomycorrhizal fungal species into harvested areas of coastal forest

Mike Cruickshank	Y062223	Impacts of Armillaria root disease on stand productivity in the Southern Interior of BC
René Alfaro	M086044	Stand dynamics following mountain pine beetle outbreaks in central British Columbia
René Alfaro	Y051225	Susceptibility of weevil-resistant spruce to damage by other insect pests
Richard Winder	Y082172	Development of a microbial indicator database for validating measures of sustainable forest soils
Robert Duncan	Y061188	Conifer defoliating insects of British Columbia: an identification and information guide
Stephen Taylor	Y062233	Development and analysis of a British Columbia natural disturbance database
Stephen Taylor	Y071173	Spruce beetle risk modeling in a changing climate
V.G. Nealis	M086045	Balancing disturbances in forest management
Northern Interior Vegetation Management Association		
Peter Forsythe	Y051325	New models of regenerated forest stands
Okanagan University College		
Adam Wei	Y051107	Simulation of large woody debris recruitment and dynamics associated with wildfire disturbance and harvesting in headwater streams of the BC Interior
Adam Wei	Y051108	In-stream LWD as a sustainability indicator at spatial and temporal scales for headwater streams of the BC Interior
ProSeed Consulting		
Joe Webber	Y073110	Evaluating the protocol for quantifying the effect of pollen contamination on the genetic worth of conifer seed orchards
Joe Webber	Y092075	The ecological resilience of lodgepole pine seed orchard crops
Joe Webber	Y103070	The effect of contamination on performance of progeny from coastal Douglas-fir seed orchards
Resources North Association		
Scott McNay	M085236	Implications of salvage scale: mountain pine beetle and integrity of woodland caribou winter ranges
Scott McNay	Y093065	Use of adaptive management to mitigate risk of predation for woodland caribou in north-central British Columbia
Scott McNay	Y102186	Identifying factors affecting the succession of terrestrial lichen communities in the Omineca Region of north-central British Columbia
Royal Roads University		
Darcy A. Mitchell	Y061065	Critical information for policy development and management of non-timber forest products in British Columbia: baseline studies on economic value and compatible management
Tom Hobby	Y092230	Reducing wildfire hazards in the wildland–urban interface: impacts on timber yields and the best practices for stand management

Wendy Cocksedge	Y093021	Timber/NTFP compatible management extension
Wendy Cocksedge	Y093318	Understanding the spatial and quality attributes of culturally important non-timber forest product species in mountain pine beetle-affected areas of the Cariboo-Chilcotin
Wendy Cocksedge	Y102158	Impact of accelerated timber harvesting on NTFPs in Burns Lake Community Forest
Selkirk Geospatial Research Centre		
Bill Chapman	Y081286	Development of a Rapid Moisture and Soil Erosion Evaluation Protocol (RM-SEEP) for mountain pine beetle deforestation and associated logging
Robert Magai	Y071072	Optimal sampling strategy for effective evaluation of the soils value at the cutblock level under FRPA
Robert Magai	Y071166	Application of remote sensing to detect changes in vegetation structure from differing land treatment levels in the Kootenay region of British Columbia
Simon Fraser University		
Arthur Roberts	M086016	Mountain pine beetle red attack shelf-life discriminations
D.B. Lank	Y071051	Integration and extension of Marbled Murrelet habitat data collected at different scales
David Green	Y103119	Determining thresholds of habitat quality for breeding birds in rangeland ecosystems in the Cariboo region
David Lank	Y102067	Testing relationships between habitat quality indices, forest configuration, and marbled murrelet local population size
Evelyn Pinkerton	Y103271	Evaluating the ecological, economic, and social trade-offs of managing for valued plants and other non-timber forest products
Jim Mattsson	Y073183	Identification and propagation of novel value-added hardwood varieties
Jim Mattsson	Y103092	Development of molecular markers to aid in the identification of western redcedar populations that are resistant to deer browsing and heartwood rot fungi
Kelly Squires	Y103167	Quantifying the responses of songbirds and woodpeckers to changes in habitat at the stand and landscape scales – does intensive monitoring result in different response curves?
Ronald Ydenberg	Y062309	Identification of critical habitat of breeding marbled murrelets
Ronald Ydenberg	Y073342	Experiments on edge effects in marbled murrelets: incorporating reproductive performance into habitat quality
Wolfgang Haider	Y092250	Valuing low-elevation old-growth forests of the southwestern British Columbia mainland: an application of the contingent choice and production function techniques
Simpcw Development Corporation		
Robert Serrouya	Y071312	The suitability of stand-level retention to mountain caribou foraging and movement requirements
Skeetchestn Indian Band		
Chris Ortner	M085112	Stand-level harvesting in mountain pine beetle affected stands and impact on riparian-based cultural resource management zones

Skyline Forestry Consultants Ltd.		
W. Jean Mather	Y073024	Long-term effects of vegetation management treatments on growth and yield and stand development
Thompson Rivers University		
Alan Vyse	Y072071	Forecasting forest vegetation response to management activities aimed at reducing ungulate browse in mountain caribou winter range
Alan Vyse	Y072075	Natural and artificial regeneration response to opening size and site preparation in a high-elevation fir–spruce stand at Sicamous Creek
Alan Vyse	Y103215	Tree species growth rates and susceptibility to insects and diseases in the southern ICH under current and possible future climatic conditions
Alan Vyse	Y103240	Sustainable management of the ponderosa pine parkland ecosystems in the Thompson River watershed after the mountain pine beetle epidemic
Brian Heise	Y073367	Effects of logging on export of organic matter from headwater streams
Brian Heise	Y081087	Extension of the effects of logging on export of organic matter from headwater streams in the BC Interior
Darryl Carlyle-Moses	M086035	Measurement and modeling of mountain pine beetle impacts on the annual forest water balance
Darryl Carlyle-Moses	Y102045	Measurement and modeling of disturbance impacts on site hydrology and productivity in British Columbia's southern interior
Donald Thompson	Y102122	Contrasting spring and fall grazing regimes for effects on grassland biota
Karl Larsen	Y073177	Dispersal and habitat selection by juvenile Northern Goshawks in a managed forest landscape
Karl Larsen	Y082020	Indicators of biodiversity within aspen stands of the Interior Douglas-fir zone
Karl Larsen	Y091088	Badger habitat use and movements in forested ecosystems
Karl Larsen	Y102041	Early-seral forest stands and their relationship to wildlife populations and ecosystem stability
Lauchlan Fraser	Y091081	How will climate change affect the distribution and competitive performance of *Centaurea maculosa* and *Linaria vulgaris* in south interior grasslands?
Lauchlan Fraser	Y103208	Managing the interacting effects of grazing and global climate change in BC Interior rangelands
Lauchlan Fraser	Y103232	Effects of livestock grazing in southern Interior wetlands: interactions with amphibians, benthic macroinvertebrates, vegetation, and breeding waterfowl
Lyn Baldwin	Y103157	Structure and functional values of riparian buffer strips for sustaining floristic diversity in interior forested landscapes
Robert Higgins	Y102172	Dietary dependence of Williamson's Sapsucker on coarse woody debris-associated ants
William Harrower	Y102102	Are northern goshawks and forest harvesting compatible? An examination of the effects of different harvest practices on northern goshawk nest productivity

Timberline Natural Resource Group Ltd.		
Brian Calder	Y081155	Enhancing conventional forest inventory in the Sunshine TSA with individual tree crown (ITC) analysis of hyperspectral and LiDAR remotely sensed data
Tysig Ecological Research		
Tyson Ehlers	Y093163	Chanterelle mushroom habitat modeling and inventory
University of Alberta		
Phil Comeau	Y103116	Growth of 10 tree species in relation to location and microclimatic gradients in a strip shelterwood
University of British Columbia		
Adam Wei	M075036	Using GIS and time series analysis to evaluate impacts of large-scale salvage logging on hydrology in the BC Interior
Adam Wei	Y073127	An experimental approach to evaluating impacts of the recent Okanagan Mountain Park Fire and other disturbances on large woody debris recruitment and transportation processes
Adam Wei	Y093282	Using GIS and multivariate statistical analysis to assess the relations between aquatic habitat indicators and forest harvesting at both stream reach and watershed scales
Adam Wei	Y102136	Relations between riparian disturbance and habitat attributes in the Southern Interior of BC
Andrew Black	M085111	The effects of salvage logging on the net ecosystem productivity of MPB-attacked lodgepole pine forests of the northern BC Interior
Andrew Black	Y083141	Effects of the variable retention silvicultural systems on microclimate, establishment, and growth of trees in west coast forests
Andrew Black	Y102104	Microclimate and tree growth as affected by western hemlock variable retention groups
Ann Chan-McLeod	Y073026	Effects of climate change on avian communities and implications for sustainable forest management
Ann Chan-McLeod	Y103156	An experimental study of variable-retention harvest methods on forest birds
Bart van der Kamp	Y062041	Reducing the impact of Armillaria root disease via mixed-species plantations including western redcedar
Brad Seely	G106109	GYMP: Representation of climate change impacts on forest growth in FORECAST
Brad Seely	Y061033	Evaluation of an ecosystem-based approach to mixedwood modeling
Brad Seely	Y092095	Forest ecosystem recovery following disturbance: a retrospective analysis of historical disturbances on the southern BC coast
Brad Seely	Y092160	The application and evaluation of an ecosystem model to project the recovery of old-growth attributes in second-growth stands
Brett Eaton	Y082031	Hydrogeomorphic response to forest disturbance: Fishtrap Creek
Bruce C. Larson	M075023	Rating options for post-attack cutting on affected stands

Bruce C. Larson	Y051255	Mixed-species stands grown at high densities for the production of high-value wood
Bruce C. Larson	Y051256	Evaluation of the simulation model SORTIE for prediction of growth and yield in mixed aspen–spruce stands
Bruce C. Larson	Y061012	Modeling individual tree mortality for northern mixed-species stands
Bruce C. Larson	Y071169	The growth of natural regeneration under different partial cut silvicultural systems
Bruce C. Larson	Y102162	Crown competition, crown efficiency, tree growth, and site type: quantification with terrestrial LIDAR
C. Kevin Lyons	M085197	Extending the logging season in mountain pine beetle-damaged stands by using ground wood to surface in-block roads
C. Kevin Lyons	Y051078	Load sharing between log stringers in gravel-decked log bridges
Charles Menzies	Y092001	Sustainable forestry, traditional economies, and community well-being: a collaborative project with Gitxaala Nation and Nuxalk Nation
Cindy Prescott	Y061034	Synthesis and extension of research on the nutritional sustainability of variable retention harvesting
Cindy Prescott	Y073190	SCHIRP: ecology and management of ericaceous shrub-dominated ecosystems in coastal BC
Dan Moore	Y061049	Headwater stream temperature response to alternative riparian management strategies: an experimental and modeling approach
Dan Moore	Y103214	Cotton Creek phase II: multi-scale, spatially explicit studies of mountain pine beetle impacts on watershed function
Daniel Durall	Y103185	Food web dynamics of flying squirrels, red squirrels, and voles along a 100-year gradient of stand age following clearcut logging and wildfire
David Findlay Scott	Y073327	Evaluation of fire site rehabilitation methods in terms of controlling erosion and sedimentation
David Findlay Scott	Y073328	Testing the H60 concept in the Interior Watershed Assessment Procedure by process hydrology studies
Edward J. Quilty	Y051116	EpHects - a cumulative effects analysis method using automated continuous pH measurements in streams
Fred Bunnell	Y051023	Refining conservation priorities in British Columbia
Fred Bunnell	Y062031	Linking multiple indicators of biological diversity to forest management decisions
Fred Bunnell	Y073005	Evaluating large-scale forest zoning to improve the efficiency of timber production and biodiversity objectives
Fred Bunnell	Y073045	A species accounting system to integrate indicators of biological diversity
Fred Bunnell	Y082015	Developing thresholds for within-stand biodiversity indicators
Fred Bunnell	Y093014	Evaluating effectiveness of forest management practices at sustaining biological diversity in northeastern British Columbia
Fred Bunnell	Y102120	Future vegetation structure and vertebrate distributions based on changes in moisture balance and temperature
Fred Bunnell	Y103131	Using few species to assess the sustainability of many species
Fred Bunnell	Y103137	Developing and validating habitat-based management models for species at risk in northeastern BC

Geoffrey G.E. Scudder	Y073001	Beetle families of British Columbia
George Hoberg	Y081059	Institutional mechanisms for the spatial and inter-temporal transfer of fiscal capacity in rural British Columbia
Hamish Kimmins	Y081132	North American Forest Ecology Workshop: From Science to Stewardship - knowing, understanding, applying
Hamish Kimmins	Y082027	Incorporation of wildlife habitat capability into the multi-value, spatially explicit, complex cutblock ecosystem management model LLEMS
Hamish Kimmins	Y093286	Defining boreal mixedwoods and exploring their response to management and natural disturbance (fire, MPB) through spatially explicit ecosystem management modeling
Harry Nelson	Y102110	Assessing alternative forest management strategies under climate change
John Innes	M085166	Assessing the effectiveness of management strategies in creating and maintaining stand-level biodiversity on large-scale mountain pine beetle cutblocks in the Arrow Boundary Forest District
John Innes	Y093307	Improvement of social, economic, and other indicators of sustainable forest management and tools for their integration
John Innes	Y103077	Development of appropriate economic and social indicators of sustainable forest management
John Kominoski	Y103068	Ecosystem functioning in small streams and their riparian areas in response to partial harvest riparian management
John McLean	M086018	Evaluation of the impact of N fertilization on mountain pine beetle success in mature lodgepole pine stands at the leading edge of an infestation
John Richardson	Y061025	Effects of forest practices on the native signal crayfish, *Pacifastacus leniusculus*, in BC
John Richardson	Y073017	Ecology and management of riparian–stream ecosystems: a large-scale experiment using alternative streamside management techniques
John Richardson	Y093040	Alternative indicators of the integrity of stream function as an assessment of sustainable forest management
John Richardson	Y093300	Downed wood in riparian areas and its contribution to stand-level biodiversity
John Richardson	Y093301	Long-term trends in amphibians in riparian reserves: are riparian reserves effective for their conservation?
John Richardson	Y102082	Conservation genetics and ecology of the threatened coastal giant salamander in managed forests of British Columbia: setting priorities for an integrative species recovery plan
John Richardson	Y103097	Recovery processes of small streams and their riparian areas from clearcutting and partial harvest riparian management
Kathy Martin	M085126	Predicting biodiversity maintenance after bark beetles and MPB management
Ken Day	Y051131	Quantifying the dynamics of stands under selection management for mule deer winter range
Lori Daniels	Y073363	VR emulating canopy gaps in coastal forests: an operational trial and experiment
Lori Daniels	Y082316	Climate and outbreaks of western hemlock looper in coastal forests of British Columbia
Lori Daniels	Y093167	Coarse woody debris in the East Kootenays: understanding sources and dynamics to guide targets for sustainable forest management

Maja Krzic	Y092066	Cost-effective indicators of soil physical condition: natural variation in the relative bulk density and associated tree growth as measures of forest productivity and ecosystem resilience
Markus Weiler	Y092171	Equivalent clear cut area thresholds in large-scale disturbed forests
Marwan Hassan	Y093074	Hydrologic indicators for watershed sensitivity to peak flow changes in small upland watersheds
Melanie Jones	Y092186	In-situ characterization of soil microbe function in an ICH chronosequence
Melanie Jones	Y093052	Does retention of downed wood help maintain stand-level functional biodiversity of mycorrhizal fungi in EESF clearcuts?
Michael Meitner	Y071006	Developing a cumulative effects model of forest aesthetics at the landscape-level: automating the spatial design and planning of variable retention
Nicholas Coops	Y082024	Sustainable forestry indicators derived from airborne LIDAR data and high spatial resolution satellite imagery
Peter Arcese	Y092238	Reconstructing historical diets and population dynamics of the Marbled Murrelet
Peter Jordan	Y103004	Thresholds for post-wildfire flood, erosion, and mass wasting processes
Peter Marshall	M086015	Modeling natural regeneration in mountain pine beetle impacted stands
Peter Marshall	Y091060	Regeneration in thinned and unthinned uneven-aged interior Douglas-fir stands
Ralph Wells	Y082069	Effective landscape-level planning approaches to sustain biodiversity in the managed forests of southeastern British Columbia
Ronald Trosper	Y093002	Common knowledge, values and perceptions of sustainable forest management held by First Nations communities
Sarah Gergel	Y082305	Quickbird high-resolution satellite imagery for riparian TEM classification
Scott G. Hinch	Y051038	Stream habitat and rainbow trout responses to clearcut logging in north-central British Columbia
Scott G. Hinch	Y071039	A broad-scale investigation of the effects of streamside clearcut timber harvesting on small stream ecosystems in British Columbia: analyses of large-scale databases to forecast impacts on physical and thermal habitats and their salmonid populations
Scott Hinch	Y061038	Rainbow trout bioenergetic and stream dissolved oxygen responses to clearcut logging in north-central British Columbia
Scott Hinch	Y081216	Long-term stream habitat and rainbow trout responses to alternative riparian management in north-central British Columbia
Scott Hinch	Y091046	Stream habitat and bull trout (*Salvelinus confluentus*) responses to MPB riparian salvage harvesting in north-central British Columbia.
Stephen R.J. Sheppard	Y071036	A synthesis of BC public perception survey results and techniques for quantifying social indicators in forest planning
Steve Mitchell	Y062276	Numerical modeling of wind flow in retention system openings
Steve Mitchell	Y081107	Improvement of a mechanistic risk model for estimating windthrow losses

Steve Mitchell	Y081247	Extension: IUFRO Wind and Trees Conference
Steve Mitchell	Y082276	Effect of stand structure and riparian buffer design on wind damage susceptibility and large woody debris recruitment
Steve Mitchell	Y091083	Incorporating the effects of tree-to-tree variability and upwind windfield conditions on mechanistic windthrow models and growth and yield models
Sue Grayston	Y073049	green-tree retention: a tool to maintain ecosystem health and function
Sue Grayston	Y103136	Developing a new indicator of soil functioning for use in designing variable-retention harvesting
Sumeet Gulati	Y071311	Open access, common pool resources, and non-timber values: a model for government intervention
Suzanne Simard	M086020	Predicting development and productivity of Southern Interior mixed-species stands following mountain pine beetle attack
Suzanne Simard	Y062066	Improving predictions of juvenile tree growth in complex mixtures for sustainable forest management
Suzanne Simard	Y073064	Ectomycorrhizae and networks: their role in facilitating Douglas-fir regeneration under water, site, and climatic stresses
Suzanne Simard	Y073065	Effects of young stand silviculture on conifer/broadleaf mixtures in seral ICH forests of Southern Interior BC
Suzanne Simard	Y073067	Predicting development and productivity of southern interior mixed-species stands through calibration and modeling with SORTIE-BC
Suzanne Simard	Y081114	Effects of wildfire severity and harvesting on natural regeneration potential of Douglas-fir in the dry Interior Douglas-fir forests
Suzanne Simard	Y083028	Improving predictions of juvenile tree growth in complex mixtures for sustainable forest management
Suzanne Simard	Y092150	Modeling light, site quality, and crowding effects on growth of understorey subalpine fir in lodgepole pine forests
Suzanne Simard	Y093262	Effects of partial retention and common mycorrhizal networks on seedling recruitment in Douglas-fir forests across British Columbia
Suzanne Simard	Y093313	Analysis of insect, disease, and abiotic factors affecting post-free-growing lodgepole pine in Southern Interior British Columbia
Suzanne Simard	Y093314	Determining stand-level structures in dry Douglas-fir forests that maintain appropriate levels of ectomycorrhizal genetic diversity to facilitate Douglas-fir regeneration
Suzanne Simard	Y102033	Growth and development of overstorey and regeneration following partial cutting of dry-belt Douglas-fir
Suzanne Simard	Y102075	Mycorrhizal fungi: unlocking its ecology and role for the establishment and growth performance of different conifer species in coastal ecosystems
Suzanne Simard	Y102076	Effects of climate change on high-elevation plant communities and their ecological processes
Suzanne Simard	Y102095	Predicting development and productivity of southern interior mixed species stands following mountain pine beetle attack
Sybille Haeussler	M085168	Effects of cumulative disturbances on an endangered whitebark pine–cladina lichen ecosystem

Takashi Sakamaki	Y103261	Biogeochemical indicator and threshold for assessing ecological impacts of riparian forest management on downstream ecosystems
Thomas Sullivan	Y051025	Old-growth attributes in managed forests: integrating stand productivity with mammal diversity
Thomas Sullivan	Y071045	Incremental silviculture of lodgepole pine and non-timber forest products (NTFPs)
Thomas Sullivan	Y071047	Impact of cattle foraging on understorey plant biodiversity (range health) using long-term exclosures
Thomas Sullivan	Y073138	Vole population and seedling damage monitoring with diversionary feeding methods
Thomas Sullivan	Y083008	Stand structure and maintenance of biodiversity in green-tree retention stands at 30 years after harvest: a vision into the future
Thomas Sullivan	Y093302	Dry forests and grasslands: stand structures, habitat, and small mammals as indicators of biodiversity
Thomas Sullivan	Y103081	Influence of forest harvesting and succession on vole populations and feeding damage to plantations
Thomas Sullivan	Y103244	Creation of habitat for small mammal prey and their predators on clearcuts: coarse woody debris in piles and windrows
Trent Hoover	Y103241	Assessing the sensitivity of streams to riparian changes: Does channel geomorphology determine how tightly forests and small streams are linked to downstream reaches?
Valerie LeMay	Y092048	Estimating natural regeneration and yield in pine-dominated stands following mountain pine beetle attack using SORTIE-ND and PrognosisBC in a hybrid modeling approach
Yixin Zhang	Y073062	Cumulative watershed effects of forestry practices on stream ecosystems
Younes Alila	M085276	Peak flow and water yield responses to mountain pine beetle infested and salvage logged watersheds in the Kootenays
Younes Alila	M086039	Peak flow and water yield responses to mountain pine beetle infested and salvage logged watersheds
Younes Alila	Y051293	Hydrologic decision-making tools for sustainable forest management in rain-dominated coastal BC watersheds
Younes Alila	Y061046	Developing thresholds for a key hydrologic indicator of watershed function: equivalent cut area
Younes Alila	Y073294	Forest management in interior British Columbia: moving beyond equivalent cut area (ECA)
University of Northern British Columbia		
Brent Murray	Y082280	Studying mountain pine beetle dispersal patterns through analysis of genetic markers: investigation of population structure and examining current dispersal assumptions
Brian Aukema	M086046	Stand and forest dynamics following MPB: how spatial patterns of salvage harvesting affect Warren root collar weevil pressure in regenerating stands
Brian Aukema	Y103277	Bark beetle response to climate change: a landscape-level risk model for British Columbia
Chris Hawkins	G106048	Regeneration and growth following MPB-attack: synthesis of knowledge; a GYMP project
Chris Hawkins	M065002	Success rate of MPB attack in young stands
Chris Hawkins	M086024	Mountain pine beetle impacts on young age-class, pine-leading stands in the SBS biogeoclimatic zone

Chris Hawkins	Y051089	An evaluation of Douglas-fir leave-tree retention practices in central British Columbia
Chris Hawkins	Y061021	Stand- to landscape-level effects of the mountain pine beetle (MPB) outbreak in central British Columbia
Chris Hawkins	Y062304	Managing for intimate species mixtures in BC's boreal forest
Chris Hawkins	Y073090	Sustainable mixedwood management in the Sub-Boreal Spruce zone of British Columbia
Chris Hawkins	Y073305	Managing northern mixedwood stands to sustainably maximize productivity and minimize costs
Chris Hawkins	Y102188	The release of secondary stand structure in immature and mature pine stands following MPB attack
Chris Hawkins	Y103243	Managing northern mixedwood stands to sustainably maximize productivity and minimize costs
Darwyn Coxson	Y083062	Coarse-filter approaches for the conservation biology of canopy lichens in wet cedar–hemlock and Sub-Boreal Spruce forests of central-interior BC
Darwyn Coxson	Y091154	Reassessment of arboreal lichen biomass at the Pinkerton Mountain Silvicultural Systems Site 10 years after partial cutting
Darwyn Coxson	Y092094	Lichen biodiversity in deciduous wetland swales
Darwyn Coxson	Y093046	Book preparation: Ecology, conservation, and management of British Columbia's inland rainforest
Hugues B. Massicotte	Y091062	Underlying biological processes: the role of ectomycorrhizal fungal communities in early growth and relocation success of whitebark pine under climate change
Kathy J. Lewis	Y051202	Quantification of disturbance processes along a temperature and moisture gradient in sub-boreal forests
Kathy J. Lewis	Y073203	Genetic variation in the foliar pathogen *Dothistroma septospora* and relationship to toxin production
Kathy J. Lewis	Y073204	Relationships between climate, forest practices, and incidence of *Dothistroma septospora*
Kathy J. Lewis	Y081188	Climate variables and Dothistroma development: tools for future risk assessment
Michael Gillingham	Y051058	Evaluating a structural basis for monitoring biodiversity
Michael Jull	Y081249	Planted regeneration survival and growth, and natural regeneration composition and abundance, within three post-harvest stand structures in silvicultural system trials in the wet Interior Cedar–Hemlock subzones of east-central British Columbia
Mike Jull	Y072079	A study of stand growth, development, and structural biodiversity in complex and even-aged ESSF spruce–subalpine fir forests, 14 years after treatment (EP 1119.01 Lucille Mountain Project)
Philip Burton	Y083184	Predicting advanced regeneration density in lodgepole pine stands in the Northern Interior of British Columbia
Sarah Boon	M065006	Determining the impact of MPB-killed forest and elevated harvesting on snow accumulation, and the projected impacts on melt and peak flow
Scott Green	M065004	Current/critical research on species-specific responses to climate/microenvironment change, making specific applications for MPB stands under different scenarios: literature review
Scott Green	Y051055	Quantifying growth of spruce saplings in spruce–birch stands under different environmental conditions in the SBS zone
Scott Green	Y072107	Predicting the growth responses to climate change among co-occurring, major tree species in BC

Scott Green	Y082270	Predicting the responses of interior Douglas-fir to climate change in BC
Scott Green	Y091179	Examining interactions between long-term climatic fluctuations and Douglas-fir productivity in the BC Interior
Staffan Lindgren	Y071033	Direct and indirect effects of harvesting on carabid beetle community composition in regenerating sub-boreal spruce stands – refining their indicator potential through understanding of biotic interactions
University of Victoria		
Alan Burger	Y073061	Habitat use by marbled murrelets on southwestern Vancouver Island and implications for forest management
Alan Burger	Y092158	Nest-site re-use and management of nest habitat attributes of marbled murrelets in coastal forests
Barbara Hawkins	Y062240	Optimum nutrition and nutrient loading in Douglas-fir
Barbara Hawkins	Y081091	Growth phenology and cold hardiness of 32 coastal Douglas-fir full-sib families
Barbara Hawkins	Y091054	Drought tolerance of sub-maritime Douglas-fir progeny
Harry Swain	Y071321	Development and analysis of forest health climate-change databases for BC: western spruce budworm and Douglas-fir
Harry Swain	Y093061	Development and analysis of forest health databases, models, and economic impacts for BC: spruce bark beetle and spruce; western spruce budworm and Douglas fir
Olaf Niemann	Y093062	Integration of airborne LiDAR and hyperspectral remote sensing data to support the Vegetation Resources Inventory and sustainable forest management
Western Forest Products Inc.		
Annette van Niejenhuis	Y103055	SCHIRP: ecology and management of ericaceous shrub-dominated ecosystems in coastal BC
N.J. Smith	Y082001	Effects of variable retention on planted and natural regeneration in coastal BC
N.J. Smith	Y102064	Effects of variable retention on planted and natural regeneration in coastal BC
N.J. Smith	Y103210	Effects of variable retention on planted and natural regeneration in coastal BC: data measurement and analysis
William J. Beese	Y072029	Utility of carabid beetles as indicator species for monitoring biodiversity effects from variable retention harvesting practices
William J. Beese	Y083027	Amphibians as indicators of wetland habitat conservation under variable retention harvesting
William J. Beese	Y083030	Terrestrial gastropods as indicator species for monitoring biodiversity effects from variable retention harvesting practices
William J. Beese	Y091149	Growth of montane conifers 15 years after clearcutting and alternative systems at MASS
William J. Beese	Y102065	Effect of stand-level retention on carabid beetles in coastal BC