Canadian Wood Fibre Centre

Who we are and what we do
2013–2014

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Working together to optimize wood fibre value – creating forest sector solutions with **FP**Innovations

Contents

Introduction

Who we are

The Canadian Wood Fibre Centre (CWFC) is a branch of the Canadian Forest Service (CFS). Its aim is to add value to the fibre supply portion of Canada's **forest value chain** while developing innovative solutions to some of the challenges faced by companies in Canada's forest sector. CWFC's values and mission are aligned with those of Natural Resources Canada (NRCan) and integrated within the research framework of FPInnovations.

What we do

CFS seeks to promote a competitive forest sector while maintaining forest sustainability. Our aim is to improve the quality of life of Canadians by helping shape the sector's important contributions to the economy, society and the environment. Our values are aligned with NRCan's corporate priorities, which are established by CFS senior management.

To carry out these objectives, CWFC conducts **upstream research** in support of industry competitiveness. In addition to being guided by NRCan's Intended Outcomes, CWFC also receives strategic direction from the National Research Advisory Committee of FPInnovations, which ensures that the research priorities set meet the needs of industry.

In 2012, while FPInnovations underwent restructuring, CWFC provided leadership both to enhance value chain capacity and to accelerate the delivery of research to better meet client and market needs. This restructuring has led to the establishment of 11 research programs. Of these, CWFC's Resource Assessment Program was the one identified to respond to selected upstream, or supply, themes.

The Resource Assessment Program complements FPInnovations' research by focusing on specific upstream research and knowledge exchange activities in three principal areas:

1. **Resource Characterization:** Involves developing forest inventory tools and techniques to more accurately quantify and assess the principal fibre attributes of Canada's forest resources.

The **forest value chain** is a concept that links forest-level management to product innovation and markets in order to maximize the value of the available fibre. CWFC looks at the portion of the forest value chain that begins with the establishment of seedlings to the harvest of mature trees.

Canadian Forest Service

CWFC

FPInnovations
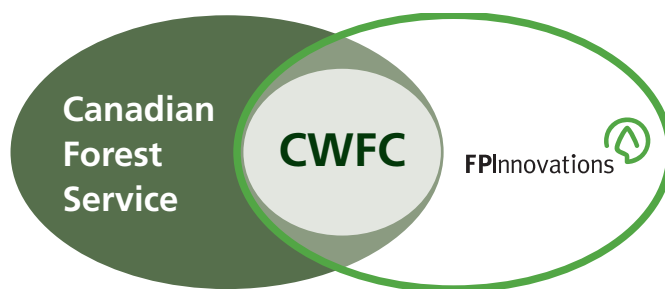
Upstream research is a term used to address forest-level research activities such as fibre characterization, quality assessment and forest inventory. Upstream research looks at fibre supply and complements *downstream research*, which addresses product development.

2. **Resource Production:** Involves developing knowledge, tools and innovative technologies to enhance future fibre supply for existing and emerging product streams, such as the development of innovative technologies for producing wood fibre with desirable attributes.

3. **Resource Optimization:** Involves developing and improving knowledge and tools to support forest management decisions that increase the sustainable net value of forest products from Canada's forest resources, such as providing decision support for enhanced forest sector competitiveness.

Together, FPInnovations and CWFC provide the intellectual capacity required to deliver a comprehensive research program that spans the entire forest value chain, from tree genomes to the final consumer product market.

CWFC's vision is to become the national authority on the assessment, characterization, production and optimization of wood fibre in Canada. Already, measurable benefits have resulted from the research conducted by CWFC. The Resource Assessment Program aims to build on this success by developing stronger alignment with FPInnovations, as well as with other units within CFS, and by continuing to collaborate with provinces, industry and academia.

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Three Main Areas of Research

Resource Characterization

Mapping fibre attributes from forest and environmental variables in Newfoundland
- **Joan Luther**

This project focuses on developing tools and methods to map fibre attributes to support the optimal management and use of fibre resources in the province. The work includes the development of models that link forest and fibre attributes at tree, plot and landscape levels and the application of emerging inventory tools to enhance mapping capabilities. Products will be integrated within operational inventory systems, and will contribute to a regional partnership to address the competitiveness of Newfoundland's forest industry.

Dynamic Temporal Inventory
- **Len Lanteigne**

The main objective of the project is to develop innovative technologies, tools and techniques for accurately assessing Canada's forests. Innovations include those for enhancing forest inventory (EFI), improving operational efficiencies and forecasting the future forests for related opportunities.

Enhanced Forest Inventory
- **Chhun-Huor Ung**

This project is developing methods to facilitate the flow of information on the quantity and quality of wood from the forest to government and industry users. Its main objective is mapping wood attributes at the stand level in relation to site and stand conditions. Work to overcome two constraints is also underway: 1) how to establish a compromise between the costs and benefits of the map, and 2) how to create a link between the map and user-friendly software for operational applications.

Towards a forest inventory that can predict the properties and economic value of hardwood in eastern Canada: tree scale
- **Chhun-Huor Ung**

When tree characterization is part of the forest inventory, it will give users of hardwood trees information on the quantity and quality of timber available in a stand before trees are harvested. This information will allow better decisions based on linking wood attributes to market needs. The project's objective is to produce statistical models for estimating wood properties and wood product value using tree and stand attributes as predictors. The models will be calibrated using data from a large number of sugar maple and yellow birch trees harvested across eastern Canada.

Resource characterization
- **Isabelle Duchesne**

This project aims to assess wood fibre quality and value in unmanaged and managed stands. The quality of different wood assortments resulting from current forest management practices will be compared to determine their suitability for different end uses. Methods that consider not only volume but also internal characteristics of the wood supply will be developed to improve forest value assessment.

Advanced Forest Resource Inventory Technologies (AFRIT)
- **Doug Pitt**

Forest resource inventories represent the basic information that forest managers and planners need to improve efficiency, reduce costs and add value to the resource. The AFRIT project is a successful research and development program that focuses on developing innovative forest inventory technologies, techniques and tools to enhance the accuracy, precision and spatially explicit knowledge of the volume, value and distribution of wood fibre in Canada.

Nationally integrated testing of crown-fibre attribute relationships (CFAR)
- **Art Groot**

To diversify and add value to Canadian forest products, forest resource inventories must include information about fibre attributes. The development of relationships among fibre attributes and crown characteristics is a promising path to incorporate fibre attribute information into forest resource inventories. This project is integrating several CWFC activities that test hypotheses on relationships between fibre attributes and crown characteristics.

Tools and techniques to evaluate variation in fibre quality related to site, stand and silvicultural practice
- **Ross Koppenaal**

Tools for the non-destructive evaluation (NDE) of wood quality in standing trees and logs are being assessed in this project for their ability to rapidly and reliably characterize and segregate variation in wood quality at individual tree and stand levels. NDE uses acoustic velocity and drill resistance tools to provide surrogate measures of wood stiffness and density. The tools are being used to test for predictive relationships between wood mechanical properties and bole/crown metrics influenced by silvicultural practice and site productivity at long-term research sites.

Enhanced forest inventory for strategic and tactical planning in western Canada
■ Mike Wulder

Highly detailed data sets from airborne laser scanning (also know as LiDAR) are being used to generate stand structure information for focus sites in western Canada. The main activities are being implemented in Alberta (with a key industry partner in West Fraser - Hinton Wood Products) and in British Columbia (with a consortium of provincial and industrial partners). The information generated is being used to enhance existing forest inventories and to evaluate the relationships among LiDAR-enhanced inventory variables and wood and fibre attributes of interest. The greater objective is to combine an enhanced forest inventory with spatial planning tools to optimize and capture higher value from available fibre, as well as supporting improved forest management through access to improved information.

Resource Production

Investigating the silviculture of, and wood fibre opportunities presented by, short-rotation intensive culture willow and poplar plantations, using municipal wastewater and biosolids and using pulp mill sludge as a water and nutrient source
■ Richard Krygier

Interest in using short-rotation woody crops for phytoremediation (wastewater and sludge treatment) and the production of quality wood fibre is increasing. In this project, integrated technology is being used to create innovative new economic and social opportunities for forest communities and industry across Canada, by diversifying the wood fibre value chain through new uses for wood fibres (energy/bio-refining), while realizing value from waste and contributing to environmental sustainability.

Short-rotation fibre woody crop systems development: fibre production, management and value chain analysis
■ Derek Sidders

Short-rotation (3–20 years) woody crops under intensive management regimes are being developed as sources of quality wood fibre. This source of fibre and others recovered from forest operations, such as roadside and mill residues, will diversify the forest products supply chain and introduce new values. In this project, innovative management practices and associated costs are being included in value chain analysis. The ultimate aim is to establish practices for increasing fibre production, reducing costs and enhancing operational efficiencies.

Strategies to utilize co-generation and power-boiler ash
■ **Richard Krygier**

The forest industry generates large quantities of ash from wood biomass energy production. About 90% of the ash goes into landfills at considerable cost. FPInnovations and CWFC are working together to optimize the forest resource across the value chain by developing engineering and biological technologies and uses to address the needs and issues of governments and industry regarding ash disposal. Innovative products and enhancement of tree growth are potential outcomes of this component.

Refinement of somatic embryogenesis (SE) of conifers and development of industrial multi-varietal forestry (MVF) to optimize fibre value chain
■ **Yill-Sung Park**

Built on the framework of the National Network of Somatic Embryogenesis Laboratories, multi-varietal forestry (MVF), using the SE system, can produce wood and fibre with desirable attributes and uniform quality at easily accessible locations. This reduces the cost of sorting, harvesting and transportation. Although MVF is already commercially implemented, this project is working to further refine the process— for example, through automated embryo transplanting and greenhouse culture systems—to make it more cost-effective.

DNA-marker systems for selection of desirable fibre attributes in spruces
■ **Jean Beaulieu**

To maximize plantation yield and value and to shorten harvest cycles, spruce breeding programs have been set up in most of Canada's provinces. Growth and adaptive traits have been the priority so far, largely because they are easily evaluated at a young age. Wood properties are yet to be fully incorporated into breeding programs, mostly because of the high cost of phenotypic determinations and because these properties can be assessed only at a late stage. This project aims to develop selection tools based on molecular markers that will help speed up breeding programs and create varieties with desirable attributes— both of which will provide the industry with a competitive advantage.

Genomics Research and Development Initiative (GRDI): tree functional genomics
■ **Armand Séguin**

This research is focusing on the identification of the genetic blueprints that determine features such as forest productivity and wood quality traits, resistance to forest insect pests, and adaptation to climate change. The implementation of these tools will allow the early identification of tree genotypes for further use in tree plantations, thus maximizing yield (better growth, protection and product quality).

Innovative methods for propagating mature conifer trees using somatic embryogenesis (SE)

- **Krystyna Klimaszewska**

Clonal propagation of adult trees with superior characteristics has the potential to achieve rapid gains by circumventing the genetic limitations of seed-based propagation. Founded on the success in initiating SE from buds of adult white spruce, the focus of this project is on improving this technology for application to a wide range of conifer genotypes and species. Another objective is to improve the efficiency and quality of somatic embryo production.

Genomics Research and Development Initiative (GRDI): towards molecular breeding for growth and adaptation in spruces

- **Nathalie Isabel**

This project is focusing on the development of molecular breeding using DNA gene-based markers that are predictive of phenotypic performance for early selection in spruces. Discovering the genes that control growth and adaptive traits (budburst, bud formation, frost tolerance) is both challenging and complex, because of their oligogenic nature and the interactions between loci and environmental factors. Various strategies are being examined, such as QTL (quantitative trait loci) in pedigrees, association of candidate genes in natural populations and sequencing of region-enriched genes.

Bioproducts: production of valued attributes

- **Mamdouh Abou-Zaid**

This research is evaluating the biochemical makeup of bio-oil derived from lignin and other underutilized components of forest biomass. The work identifies compounds and their potential end use in value-added products that currently rely on petroleum-based platform chemicals. This project brings a biochemical approach to forest feedstock evaluation that links end-products of bio-refinery to forest attributes including tree species.

Impact reduction of pest and wood quality using genetic control and predictive models

- **Mike Cruickshank**

This project is aimed at reducing landscape-level pest impacts on conifers through resistance/tolerance traits. Douglas-fir is serving as a multi-trait selection model for trees that survive several pest and abiotic stresses and suffer minimal impact on wood quality and quantity. These traits are very poorly known but offer substantial value gains. Root disease impact is being assessed through a computer simulator, TASS/ROTSIM (Tree and Stand Simulator/Root Rot Simulator), to determine options for mitigating pest risk and increasing value through genetics, silviculture and planning.

Resource Optimization

Development of fibre yield curves as economic indicators for potential product recovery to optimize stand prescriptions and management strategies for increased value in northern hardwood stands
- Edwin Swift

This project is examining relationships between stem form, tree grade projections, fibre attributes and potential product recovery from northern hardwood trees in New Brunswick. Such relationships/algorithms are required to improve the accuracy in existing management techniques and to promote increased value in existing and future hardwood stands in eastern Canada.

Examining wood fibre quality and productivity variation in a range-wide spruce provenance experiment: testing the effect of long-term temperature change
- John Major

This project is examining a 30-year-old range-wide white spruce provenance experiment to directly test whether wood production and fibre quality improve when the temperature warms or cools and whether assisted migration can be beneficial for wood production and fibre quality. The experiments are well replicated and are providing timely strategic information on the effect of climate change on wood fibre quality, and on productivity to partners.

Examining wood fibre quality and productivity variations in one of the oldest multi-generational black spruce genetic experiments
- John Major

This project is evaluating the heritability of wood fibre quality and how it relates to productivity. It is also quantifying: how fibre quality traits are affected by moisture stress; and the wood quality traits of drought tolerant genotypes. This information will lead to marker-assisted selection mapping and breeding and cloning trees with desirable traits.

Impact of crown development on stem quality, fibre attributes and potential products in mixed young hardwood stands
- Edwin Swift

This project is examining the influences of crown development in young hardwoods on wood properties, growth, stem quality and thus final value of the stand in terms of potential product recovery and restoration of stand structure. A better understanding of these relationships will allow the development of fibre attribute yield curves and algorithms that incorporate more accurate potential product recovery distributions. Such information is required to optimize stand prescriptions and management strategies for industry.

Boreal Plains Mixedwood Fibre Initiative
■ Derek Sidders

This initiative is integrating a developing information system of mixedwood stand and tree bole/crown characteristics with internal fibre attributes of trees originating from managed and natural stands. The result will be a value chain assessment simulation model for querying potential product options and values related to a produced tree/stand inventory. CWFC research outputs are being developed by exploring managed versus natural systems as presented in numerous industry-relevant long-term research sites located across the Prairie Provinces, northeastern British Columbia and the Northwest Territories.

Linking tree and stand characteristics to wood quality and fibre attributes in lodgepole pine
■ Jim Stewart

Building on a comprehensive industry study from West Fraser Hinton Wood Products, and on data from a network of long-term CFS silviculture field installations, this project is developing models to: predict wood and fibre quality attributes from ground-based variables; and capture the pattern of juvenile and mature wood production in tree stems. The influence of competition, crown lift and climate on wood and fibre attributes is also being evaluated. This project is being undertaken in partnership with Foothills Growth & Yield Association.

Impact of intensive silviculture on wood productivity and quality traits for fibre and timber products in jack pine stands
■ Edwin Swift

In the mid-1970s, an operational commercial thinning was conducted in a 40-year-old natural jack pine stand in Tracadie, New Brunswick, mimicking current mechanized harvesting operations. This project is examining the effect on tree growth, fibre and lumber attributes, and crown relationships for development of new forest inventories because mechanized commercial thinning is becoming a more prevalent silvicultural prescription in naturally regenerated forests and plantations of eastern Canada.

Impact of timing and intensity of pre-commercial thinning on stand dynamics and on tree grade quality for northern hardwoods of the Acadian Forest Region
■ Edwin Swift

This project is examining relationships in stand dynamics, tree grade projections, fibre attributes, and product potential under different timing and intensity of pre-commercial thinning in hardwoods of eastern Canada. Such interrelated information, aimed at making better use of, and improving, the northern hardwood resources, is required to support the development of models (of crown development) and integration of the results into regional inventories and manufacturing facilities.

Optimization of partial harvest strategies and practices: application to uneven-aged hardwood management

■ Jean-Martin Lussier

The first objective of the project is to improve and evaluate Biolley II, a stand-level decision-support model to optimize selection-cutting prescriptions in tolerant hardwood forests. The second objective is to develop Biolley III, a forest-level decision-support system to optimize management plans for uneven-aged stands by considering market demands and ecosystem protection policies. The last objective is to develop innovative partial cutting silviculture practices in collaboration with FPInnovations.

Decision-support systems for optimal density management and associated growth and wood quality model derivatives for boreal conifers

■ Peter Newton

The purpose of this project is to develop enhanced structural stand-density management models and an associated decision-support software suite for Ontario's natural and managed boreal stand types (black spruce, jack pine, red pine). Both the models and software will be used in determining the optimal density management regime for a given volumetric, end-product, economic or ecological stand-level management objective. The models will employ functional yield-density and empirical density-dependent relationships that are consistent with ecological and forest production theoretical constructs. A participatory advisory team—consisting of provincial regulators, scientists, tech-transfer specialists, policy experts and industrial end-users—will be used to provide real-time operational advice during model development. The biological realism, empirical precision and internal consistency of the model's predictions will be assessed using sensitivity analysis and error validation metrics.

Increasing the value of future wood fibre through production optimization
■ Michael Hoepting

Capitalizing on existing research installations, this project will introduce forest industry and forest managers to forest production approaches that will increase up- and downstream value by lowering costs and increasing the volume and quality of raw material produced sustainably on a reduced footprint. The work will generate quantitative knowledge to aid and optimize decision-making in forest management, and will contribute to model, yield curve and policy developments, as well as to economic analyses.

IVY-FIBRE: an integrated decision-support system for predicting tree growth and fibre attributes

■ Art Groot

Development of an integrated decision-support system called IVY-FIBRE is continuing. IVY-FIBRE combines prediction of tree growth, fibre attributes and product recovery for major Canadian boreal tree species for stand structures ranging from simple to complex. A beta-version of the system software has been completed, and feedback from the user community will be used to increase the system's functionality and uptake.

Operational biomass trial in the Great Lakes–St. Lawrence Forest

■ **Jeff Fera**

Large tracts of forests within the Great Lakes–St. Lawrence forest consist of low-quality mixedwoods. Using knowledge gained from decades of experimentation with white pine ecosystems at the Petawawa Research Forest, combined with information on the current demand for biomass to sustain the bioeconomy, this study will look at the economic and environmental feasibility of using biomass harvests as a driver to restore these degraded sites back to higher value species such as white pine.

Characterization and assessment of quality of woody biomass residues

■ **Suzanne Wetzel**

Woody residues from both the mill and the forest are a major source of feedstock for the bioeconomy. Characterization and classification of this low-value biomass will enable matching of the feedstock to appropriate conversion technologies, maximizing value added. Development of specifications and standards of residues for various industrial pathways, taking into consideration the entire supply chain, will lead to the development of integrative measures of sustainability.

Responses of boreal conifers to density manipulation: growth, biomass wood properties and end-products

■ **Peter Newton**

This study is assessing the effects of density manipulation on the structural yields, growth, allometry, biomass partitioning, fibre attributes, and quality and value of commercially relevant end-products for boreal conifers. This assessment is being done directly through controlled field experimentation involving destructive sampling and Silviscan analyses, and indirectly through literature-based meta-analytical reviews. This study will provide forest managers with response models, validation data sets, and quantitative metrics to support density management decision-making.

Coastal second-growth forests: assessment of resource quality, value and product potential

■ **Cosmin Filipescu**

Second-growth forests are becoming increasingly important for the coastal British Columbia industry. Current research and knowledge of fibre attributes in relation to forest management in coastal second-growth is relatively fragmented. The aim of this project is to develop an integrated approach to address the linkages. The main goal is to deliver a range of optimization tools to aid in the decision-making process.

Silviculture for wood quality and desired fibre attributes in western spruce-pine-fir (SPF) forests
■ Roger Whitehead

This project is evaluating the effects of site preparation, brushing, pre-commercial thinning, commercial thinning and /or fertilization on growth, yield, rotation length, products and value of western interior softwoods. It is using long-term research installation (LTRI) data, growth and yield models and the decision-support tool SYLVER to project and compare potential products and the quality and value of future forests under various management regimes; and to explore optimum rotation lengths for maximizing site value and return on silvicultural investments. When possible, it is validating cost and product yield projections through harvest, handling and mill outturn trials in collaboration with FPInnovations.

Decision support to optimize silvicultural investments
■ Roger Whitehead

Over the past four years, CWFC has contributed updates of the decision-support system SYLVER. SYLVER, a tool created by BC Ministry of Forests, Lands and Natural Resource Operation, allows forest planners and timber supply analysts in western Canada to predict product yields, value and economic return from different silvicultural regimes. This project is aimed at: improving user access to recent updates; investigating the potential for the system's use in the rest of Canada; and using fibre attribute prediction models developed by the Crown-Fibre Attributes Relationships (CFAR) to improve product value prediction.

CWFC Employee List

■ **George Bruemmer –** Executive Director
George is responsible for the overall direction of the CWFC. In this role, he serves on the senior leadership teams of Natural Resources Canada's Canadian Forest Service (CFS) and FPInnovations.

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■ **Mike Adams –** Silviculture Technician
Mike provides support in the field and laboratory for silvicultural research in the boreal forest and the development of models used to forecast stand development.

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■ **Joseph Anawati –** Manager, Business Development
Joseph's responsibilities include setting up business processes such as those required for finance and human resources and for partnering activities. He brings his background in forest engineering, heavy equipment sales, pulp and paper, intellectual property and business development to assist Canadian industry maximize their benefit from Canadian Forest Service research.

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■ **Peter Arbour –** Operations Manager, Petawawa Research Forest
Peter is responsible for day-to-day operations of the 10 000-hectare research forest, including management activities and assisting researchers in accessing and using the forest for experiments and demonstrations.

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■ **Jean Beaulieu –** Research Scientist, Forest Genomics; Regional Coordinator
Jean specializes in population and quantitative genetics and forest genomics.

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■ **Jason Bernard –** Specialized Field Technician, Petawawa Research Forest
Jason supervises harvesting operations and reforestation and assists scientific users of the research forest.

■ **Martin Blank –** Nutrient Cycling Technician
Martin is a wood fibre and bioremediation technician. He is involved with the research and use of municipal sewage and industrial wastes on short rotation woody crops to increase biomass and act as an alternative to traditional waste management systems.

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■ **Tom Bown –** Forest Ecophysiology Technician
Tom mostly researches the fibre attributes of coastal British Columbia trees with a focus on non-destructive evaluation and the influence of silviculture and environment. He also led the component to develop the Long-Term Research Installation Catalogue (LTRIC), a national searchable database for long-term sites. Tom continues to collaborate with FPInnovations, the CFS and the National Forest Information System (NFIS) to enter and update LTRIC records on sites and studies related to fibre attributes.

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■ **Laura Chittick –** Wood Fibre Development Technician
Laura is involved with the data collection and analysis of ongoing research studies related to white spruce understory protection and partial harvest systems within the boreal mixedwood forest.

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■ **Sébastien Clément –** Biologist and Forest Genomics Database Administrator
Sébastien studies the spruce genes involved in wood formation by comparing the genetic profile (natural genetic variations) and phenotype (MFA, density, etc.) in thousands of trees. To this end, he develops databases capable of storing millions of lines of data, along with programs to analyze this data and establish statistical relationships between the genes and phenotypes.

Jean-François Côté – Research Scientist, Forest Inventory

Jean-François uses emerging remote-sensing technologies such as LiDAR and architectural modelling of forest canopies to measure new structural variables associated with wood fibre qualities.

Joanne Côté-Pilon – Administration and Finance Officer

Joanne provides administrative and financial advice and support to the CWFC, including coordination of meetings and other events.

Mike Cruickshank – Research Scientist, Root Diseases

Mike is a forest pathologist with a specialty in the epidemiology, control and impact of Armillaria root disease. In British Columbia, he works with provincial colleagues to develop models that help incorporate risk assessment into forest-planning strategies.

Bernard Daigle – Knowledge Exchange Specialist

Bernard supports knowledge exchange activities for the CFS, the CWFC and other key stakeholders such as FPInnovations and the Canadian Woodlands Forum.

Steve D'Eon – Knowledge Exchange Specialist

Steve supports the Knowledge Exchange team with key collaborators and stakeholders and is responsible for knowledge exchange in western Canada. He also links the CWFC with the Ontario Ministry of Natural Resources on forest management and silvicultural strategies for the Great Lakes-St. Lawrence Forest including added value to tolerant hardwood research and red and white pine silviculture.

Marie Deslauriers – Biologist, Forest Genomics

Marie uses bioinformatics and statistical tools to identify and characterize candidate genes for wood quality that will be used for marker-assisted selection. She manages the molecular genetics laboratory and works closely with members of the SMarTForests (Laval University) project for the development of chips for genotyping genetic markers.

Isabelle Duchesne – Research Scientist, Resource Characterization

Isabelle specializes in the effects of silvicultural practices on wood product quality and value. She links external tree characteristics with internal wood attributes to better predict product volume, quality and value recoveries for softwoods and hardwoods.

Geneviève Dumas – Communications Assistant

Geneviève assists with knowledge exchange activities between scientists and partners. She also supports internal communications and staff involvement through the publication and distribution of CWFC's internal newsletter.

James Farrell – Tree Growth Impact Advisor

James coordinates and carries out field activities and acts as a technical advisor to project leaders of research projects on silviculture, pest management and forest inventories. He also maintains the Stem Analysis Laboratory at the Atlantic Forestry Centre.

Jeff Fera – Forest Research Officer

Jeff co-leads the Operational Biofibre Harvest Trial within the Great Lakes St-Lawrence Forest, located at the Petawawa Research Forest. He also provides professional support for forest research that serves the CWFC's value chain objectives.

Cosmin Filipescu – Research Scientist

Cosmin studies the influence of management practices and ecophysiological factors on wood properties and potential value of forest products. He leads an integrated approach currently focused on the resource assessment of coastal British Columbia second-growth forests.

Roger Gagné – Forest Research Technician

Roger supports silvicultural research and the development of partial-cutting techniques, as well as operational and innovation development.

Jason Garcia – Policy Analyst

Jason provides policy support for CWFC administrative and research activities. His current work includes the evaluation of CWFC's research portfolio, managing information, and sharing innovative practices within CFS.

Caroline Gosselin – Knowledge Exchange Specialist

Caroline is responsible for knowledge exchange between the CWFC and FPInnovations and other key stakeholders. She is a member of the FPInnovations Knowledge Exchange Group and provides leadership in the use of collaborative tools.

Art Groot – Research Scientist, Ecophysiology

Art's research focuses on three areas: incorporating fibre attributes into enhanced forest inventories, modelling the tree growth and fibre attributes with the IVY individual tree growth model, and developing silvicultural treatments for black spruce and boreal mixedwoods.

Harinderjit Hans – Artificial Intelligence Application Specialist

Harinderjit provides computer programming support to develop decision support systems (DSS), databases and models for forest management. His current work with CWFC includes computer programming for the Wood Fibre Value Simulation Model and models for forest landscape dynamics.

Terry Hatton – Director

Terry is a Director for the Canadian Wood Fibre Centre and is responsible for advancing research integration of the CWFC with CFS, FPInnovations and other partner organizations to deliver on new forest upstream research that is aligned with the needs of FPInnovations and industry.

Michael Hoepting – Silviculture Research Forester

Michael's role is to provide professional leadership by coordinating field activities, conducting analyses, and reporting for a portfolio of studies that through managing species composition, competition control, or density regulation all aim to optimize forest production.

Ann Marie Hussar-Lucas – Planning and Project Officer

Ann Marie supports the CWFC management regarding the planning, reporting and direction of its research. She is also the Secretariat for the FPInnovations' Resource Assessment Program Advisory Committee and assists FPInnovations with its reporting and performance management.

Brent Joss – Fibre Bio-Geoinformatics Analyst

Brent specializes in spatial science, spatial information management and Unmanned Aerial Vehicle (UAV) based remote sensing. He is responsible for the design, development and management of a variety of Geographic Information Systems (GIS), spatial models, decision support tools, web-based mapping applications and UAV systems.

Tim Keddy – Wood Fibre Development Specialist

Tim develops and coordinates field activities associated with evaluating wood fibre characteristics and the production of desirable fibre attributes through establishing, managing, and monitoring forest silviculture, afforestation and bioenergy research trials.

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Ross Koppenaal – Research Biologist

Ross conducts research for the evaluation and application of acoustic velocity and other non-destructive technology to characterize variation in fibre quality in standing and harvested trees in relation to silvicultural practice, site influences and species differences.

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Richard Krygier – Intensive Fibre Management Specialist

Incorporating municipal wastewater and biosolids treatment, Richard conducts research into the production of biomass from short rotation woody crops like willows and poplars. He also investigates the potential of using willow for reclamation and phytoremediation of forest landscapes disturbed by industrial activity.

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Antoine Lalumière – Forest Pathology Technician

Antoine provides research assistance, from field to data management and analysis, on several research projects in the CWFC, including those on acoustic velocity and wood quality, growth and yield and CFAR, and Armillaria root disease.

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Len Lanteigne – Reforestation Officer

Len focuses on research and knowledge exchange activities related to forest management topics such as resource characterization (forest inventory), silviculture and integrated forest vegetation management.

Mike Laporte – Forest Research Technologist

Mike plans and carries out the technical portions of scientific research projects within CWFC and allied research from CFS providing advice to research scientists and managers.

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Dominique Lejour – Forestry Pathology Technician

Dominique provides technical support for silvicultural studies related mostly to the Lodgepole Pine Partnership and the North Central Interior Initiative and actively participates in committees contributing to the health and success of the organization.

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Chao Li – Landscape Dynamics Research Scientist

Chao works on both stand and forest level forecast of wood fibre supply and valuation under uncertainties induced by various disturbance regimes, the optimal use of Canadian wood fibre and forest value chain integration through systems modeling.

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Jean-Martin Lussier – Research Scientist, Silviculture and Forest

Jean-Martin develops silvicultural systems adapted to mixed and resinous forest stands and the response of those stands to partial cutting. In particular, his research aims to optimize silviculture thinning and selection prescriptions taking into consideration stand performance, intervention costs and product value.

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Joan E. Luther – Research Scientist, Remote Sensing

Joan develops remote sensing and geospatial approaches and methods to enhanced forest inventories with new information on wood quantity and quality attributes. She also develops indicators of land cover and forest change to support ecosystem-based management and sustainability reporting.

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- **Katalijn MacAfee –** Knowledge Exchange Specialist
  Katalijn provides knowledge exchange support to all CWFC employees. Based in Ottawa, she works closely with FPInnovations and CWFC communications staff, as well as external organizations. She also supports Canada's National Research Forests, especially the Petawawa Research Forest, both at an operational and management level.

- **Ian MacEacheron –** Forest Genetics Technician
  Ian assists with research that focuses on somatic embryogenesis methodology development in pine and spruce.

- **Dan MacIsaac –** Regional Group Leader
  Dan specializes in the dynamics of stands of boreal mixedwoods and supports research into relationships of crown-fibre attributes.

- **Wendy Mills –** Nursery Grower
  Wendy conducts and manages greenhouse trials that include the propagation, management, handling and storage of various deciduous species.

- **Peter Newton –** Research Scientist, Productivity Assessment and Modeling
  Dr. Newton develops innovative products for boreal conifers (jack pine, black spruce and red pine). His current focus is on the development of density management decision-support systems and models, and quantifying volumetric yield, product and fibre attribute responses to intensive forest management treatments (e.g., initial espacement, thinning, vegetation management and tree improvement).

- **Yill-Sung Park –** Research Scientist, Forest Genetics
  Yill-Sung specializes in quantitative genetics, tree breeding, and conifer somatic embryogenesis. His current research focuses on the synthesis of tree breeding, biotechnology, and quantitative genetics into the development and implementation of Multi-Varietal Forestry, a new paradigm in tree breeding and plantation forestry.

- **Doug Pitt –** Research Scientist, Quantitative Silviculture
  Doug leads a variety of silviculture and forest inventory research projects across Canada. His efforts explore innovative approaches to growing and quantifying forests, with the goal of enhancing forest sector competitiveness through increased efficiency and value creation.

- **Jared Salvail –** Wood Fibre Development Technician
  Jared provides technical support for data acquisition, quality control and analysis. He is also responsible for field logistics, plot maintenance and preparing knowledge exchange inventories, silviculture and afforestation research.

- **Derek Sidders –** Program Manager and Regional Coordinator
  Regional Coordinator at Northern Forestry Centre, Derek is responsible for research and development focused on innovative forest management and afforestation applications, system designs, ecological and economic analysis, and the application of research to operatonal systems. He focuses primarily in the production of fibre with desirable attributes and optimization of the supply-chain from developing woody feedstock production systems to final product value/s.

- **Guy Smith –** Manager, Knowledge Exchange; Regional Coordinator
  Guy provides leadership to the CWFC Knowledge Exchange (KE) team and collaborates with FPInnovations management in coordinating KE activities. He provides research direction as Regional Coordinator at Great Lakes Forestry Centre and supports CWFC's strategic planning as a member of the Management Team.

■ **Jim Stewart –** Research Scientist, Silviculture and Fibre Production

Jim conducts research on the quantity and quality of wood fibre produced in natural forests as well as the effects of thinning and fertilization in managed stands, develops fibre quality models, and assesses the value of silviculture treatments.

■ **Edwin Swift –** Forest Research Officer

Edwin's research involves various regeneration, silvicultural and ecology studies that examine the impact of forest management on fibre attributes. His work further supports advanced inventory projects and the characterizing of wood fibre attributes. He is currently developing silvicultural systems to improve wood properties in northern hardwood stands.

■ **Dean Toole –** Project Manager and Regional Coordinator

Dean is the Regional Coordinator at Atlantic Forestry Centre (AFC) for the Canadian Wood Fibre Centre and the manager for Canada's two National Research Forests. He also leads Knowledge Exchange activities at AFC for both the CWFC and CFS.

■ **Dan Turcotte –** Forestry Technician, Petawawa Research Forest

Dan is responsible for road maintenance, timber harvesting and forest fire protection. He also helps with daily operational activities and assists researchers in accessing the Research Forest.

■ **Chhun-Huor Ung –** Research Scientist

The first objective of Ung's research studies consists of improving the information flow regarding wood resources along the forest value chain by adapting forest information and planning systems to utilize improved information from LiDAR image-aided inventories. His second objective is to develop non-destructive methods for assessing wood properties and qualities.

■ **John Vallentgoed –** Silviculture Technician

John focuses on field work on forest insects and diseases, silvicultural research and mountain pine beetle research.

■ **Olivier R. van Lier –** Geospatial Research Assistant

Olivier specializes in geospatial analysis and data management. He provides professional support through data acquisition, management, interpretation and delivery; statistical model implementation, the development of semi-automated processing tools and the coordination of field activities. His current research focus is on assessing the effects of different scales of remotely sensed data for classifying and mapping forest types.

■ **Sen Wang –** Resource Valuation Specialist

Sen researches Canada's competitiveness in the national and international forest products market. He specializes in forest economics and policy.

■ **Suzanne Wetzel –** Research Scientist

Suzanne's research focuses on the opportunities for forestry within the bioeconomy. She examines biomass harvesting in the Great Lakes-St. Lawrence Forest and characterizes this biomass to determine its most efficient utilization within new and emerging industries.

■ **Roger Whitehead –** Research Silviculturist and Regional Coordinator

Roger studies impacts of silviculture on growth, yield, rotation length, wood quality, fibre attributes, potential final products and net value of western interior softwoods to improve decision support systems for forest managers. He is also the Regional Coordinator at the Pacific Forestry Centre.

■ **Raoul Wiart –** Director, Research Integration

Raoul is responsible for managing the regional staff and core science of the centre and research relations with FPInnovations and Industry. Raoul contributes to the development of long-term research strategies as well as the implementation and evolution of CWFC's development plan.