Developing Applications to Bring Forest Research to Life

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2017-18 CIF e-Lecture Series
“Innovative Solutions to Respond to the Challenge of a Changing Climate”
Talk-show Participants

Derek Sidders
Program Manager, Technology Development
CWFC

Guy Smith
TDT Manager - CWFC

Jean-Martin Lussier
Research Scientist - CWFC

Tim Keddy
WFD Specialist - CWFC

Katalijn MacAfee
FPP Coordinator - CWFC

Brent Joss
FBG Analyst - CWFC
Developing Sustainable Fibre Solutions

Using wood products

Enhanced Forest Inventory and LiDAR

Advanced Silviculture - Growing resilient forests for a sustainable wood supply
- Genomics and genetics
- Addressing climate change
- Bioeconomy fibre supply

CWFC Mission
To provide collaborative scientific solutions supporting the forest sector as the cornerstone of an innovative, prosperous Canadian bio-economy.
Program Overview

Developing Sustainable Fibre Solutions

Tools and Techniques to Identify and Optimize use of Wood Fibre Attributes

Next Generation Enhanced Forest Inventory

Silvicultural Strategies and Tools for a Sustainable Fibre Supply and Bio-economy Opportunities

Integrated Delivery

✓ Research
✓ Collaboration
✓ Contribution funds
✓ Technology development & transfer

1) Stand Establishment Practices for Resilient Forests
2) Silvicultural Solutions to Mitigate Risks of Decreased Short-term Timber Supply
3) Sustainable Supply of Wood for Bio-economy Opportunities
Technology Development and Transfer (TDT) Team Overview

- Important part of the CWFC’s integrated delivery structure;
  - Research
  - Collaboration
  - Contribution Funding
  - Technology Development and Transfer

- TDT team members are integrated into each research theme

With a goal of creating a comfortable environment for researchers to convey their results to the appropriate end users.
Technology Development and Transfer (TDT) Team Overview

- They work with each lead researcher to:
  - Identify potential options for practitioner uptake
  - Develop technology to advance focused research
  - Develop tools to promote and enhance industry adoption

- Create, facilitate, and deliver technology transfer products to deliver relevant research information to practitioners
So How Do We Bring Research to Life?

No Secret Recipe - Our goal is to turn research into action!

5 Pronged Approach

1) Development of techniques to apply research knowledge
So How Do We Bring Research to Life?

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5 Pronged Approach

2) Development of guides to practices that incorporate research progress
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3) Demonstration of applications/practices that can operationalize research and validate forecasts
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4) Deliver field tours and other activities to bring the new knowledge into a practical context
So How Do We Bring Research to Life?

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5 Pronged Approach

5) Support all of the above with publications, presentations and digital media products
Incorporating a Changing Climate Into Forest Operations!

“Development of Innovative Practices to Recover Value, Reduce Risk and Rehabilitate MPB Impacted Forests in Northern Alberta”

Using Partial Harvests to:

1) Remove Active Attack Trees to Reduce Risk of Further Mortality,
2) Space Dense Non-impacted Lodgepole Pine to Reduce Risk, and
3) Open The Stands to Facilitate Re-establishment of Selected Crop Trees to Create Fully Stocked, Productive Stands
“Innovative Harvest Design to Rehabilitate MPB Impacted Stands”

- Parallel Machine Corridors (5m Width)
- All Equipment Limited to Machine Corridors
- Retention Strip Width Modified to Harvesting Equipment
- Easily Modified Decking Areas
- Retention Species Composition Based on Pre-determined Management Objectives
"Innovative Biomass Recovery to Increase Utilization"

- Transforms Reclamation Liability into Commercial Value
- Biomass Can be Stored in Bales Long Term Without Decomposition
- Transportation Costs Reduced
- Multiple Product Options
- Easy Handling

Chipper  Mulching Head  High Compaction Baling System  800-1000kg Bales
Innovative Silviculture Applications to Adapt to a Changing Climate

Canadian Wood Fibre Centre is actively involved in the development of innovative practices to manage forested stands impacted or susceptible to the hazards of a changing climate. The objectives of the innovative forest management systems are to transform the stands into fully stocked productive forests and healthy ecosystems capable of withstanding future threats while recovering multiple commercial values.

**Harvesting Strategy**
Innovative harvest operations designed to:
- selectively remove affected targeted trees
- reduce risk of future mortality
- protecting residual healthy, vigorous stems
- recover value from all products, including woody biomass.
- use a designated skidtrail design to provide access for future treatments

**Site Preparation Strategy**
Innovative site preparation treatments are designed to:
- create enhanced natural regeneration seedbeds
- enhance root and early seedling growth response
- minimize native competing vegetation
- protect established advanced regeneration
- enhanced survival and establishment consistency
- Reduce vegetation management costs.

**Regeneration Strategy**
Innovative plantation establishment systems of softwoods and mixedwoods are designed to:
- diversify values and minimize risk to a changing climate
- utilize partially harvested overstories or fast growing pioneer species to:
  - enhance site fertility
  - to provide shelter for new seedlings
  - to buffer climate variables impacting the establishing conifer seedlings
Adapting Afforestation Scenarios to Address a Changing Climate

Canadian Wood Fibre Centre is actively involved in the operational research of innovative practices to establish, manage and utilize various afforestation scenarios. Establishing a “National Network of Sites” demonstrates the benefits of innovative afforestation systems to grow wood fibre and woody biomass at rates 8-10 times the growth of “native forests” on previously non-forested lands to create significant carbon sinks and produce feedstock for an evolving green or renewable energy industry, contributing to a low-carbon economy.

<table>
<thead>
<tr>
<th>High Yield Afforestation</th>
<th>Concentrated Biomass</th>
<th>Mixedwood Afforestation</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Grid style plantations</td>
<td>• Hedge style plantations</td>
<td>• 11-1600 st ha(^{-1}) Hybrid poplar or aspen</td>
</tr>
<tr>
<td>• Consisting of hybrid poplar or aspen</td>
<td>• Consisting of hybrid poplar or willow</td>
<td>• 8-1200 st ha(^{-1}) White spruce</td>
</tr>
<tr>
<td>• 11-1600 stems ha(^{-1})</td>
<td>• 13-16,000 stems ha(^{-1})</td>
<td>• Flexible design and management</td>
</tr>
<tr>
<td>• 1 x 16-20 yr rotation</td>
<td>• 7 x 3 yr rotations</td>
<td>• Long term carbon sequestration option</td>
</tr>
<tr>
<td>• 13.6-20 m(^{3}) ha(^{-1}) yr(^{-1})</td>
<td>• 6-12 ODT ha(^{-1}) yr(^{-1})</td>
<td>• Fast growing overstory harvested at year 20</td>
</tr>
<tr>
<td>• 25cm+ DBH at harvest</td>
<td>• Small diameter (&lt;10cm)</td>
<td>• 644 – 820 t CO(_2) e ha(^{-1}) potentially sequestered over 20 + 50 yr rotation</td>
</tr>
<tr>
<td>• 20m+ HT at harvest</td>
<td>• High bark to white wood ratio</td>
<td></td>
</tr>
</tbody>
</table>
## Revegetation of Phospho-Gypsum Stacks

### Objectives
- To improve the long term sustainability, ecosystem diversity, and aesthetic values,
- reducing long term maintenance costs of the site,
- provide biomass that could be used for energy production, sequestering carbon,
- utilize excess nutrients/water resulting in improved groundwater quality.

### Methods
- Use SRWC as a revegetation/site rehabilitation option,
- establishing concentrated biomass beds of willow and hybrid poplar on reclaimed storage pond site,
- establishing high yield afforestation plantations of hybrid poplar on re-engineered phosphor-gypsum stacks,
- establish tolerant conifer (white spruce) in high yield afforestation plantations once sites close canopy.
“Silviculture Toolkit”

**Need:**
- Improve reclamation success
- Increase return to forest cover
- Obtaining reclamation certificates

**CFS can offer:**
- Years of Silviculture Research
- Solid knowledge base

Typical lowland OSE site
“Silviculture Toolkit”

Extension project: to inform oil and gas sector, reclamation workers and decision makers on applying silviculture tools

- **Four silviculture themes:**
  - Site Assessment
  - Site Preparation Techniques
  - Regeneration Techniques
  - Vegetation Management Techniques

- **Collaborative approach:**
  - Funding by COSIA
  - Industry Partners
  - Reclamation experts
  - Forestry Experts
“Silviculture Toolkit”

- Technology Transfer products:
  - Guidebooks
  - Factsheets
  - Videos
  - Online Decision Making tool
“Adaptation Methodology and Actions”

- Bringing R+D agencies, government and private industry together to:
  - Develop strategies
  - Host Information sessions and workshops
  - Coordinate field tours
  - Create active partial harvest demonstrations

With a goal of incorporating partial harvest systems into their planning
“Addressing the Challenge of a Changing Climate”

- Mid-term Timber Supply Gaps
- Risk Reduction
  - Wildfire
  - Insect and Disease
- Wildlife Habitat
  - Woodland Caribou
  - Overwintering Areas
- Visual Quality of Landscape
Silvicultural Services of Partial Cuttings

- Commercial Thinning
- Shelterwood regeneration & final cuttings
- Selection Cutting
- Partial Harvest
“Adaptation Methodology”

- Partial Harvests are the forester’s Swiss Army Knife
- We have good assumptions about stand growth reactions, but further work is needed
- We can potentially improve timber supply with innovative partial cutting strategies
“Revisiting Present Actions”

- Bringing R+D agencies, government and private industry together to:
  - Develop strategies
  - Host Information sessions and workshops
  - Coordinate field tours
  - Create active partial harvest demonstrations

With a goal of incorporating partial harvest systems into their planning
“Petawawa Research Forest”

- Established in 1918
- Great Lakes – St. Lawrence forest region
- Can’t buy time
“Petawawa Research Forest”

- Vulnerability Assessment – using inventory data
- Using genetics data for climate change studies
“Petawawa Research Forest”

- **Knowledge Exchange and Technology Development and Transfer:**
  - Close proximity of sites
  - Data, lots of data!
  - Availability of researchers
  - Staff on-site
“Petawawa Research Forest”

100 years!!

- Forestry Capital of Canada
- Special Events
- Special Publications
"Spatial Wood Biomass Residue Inventory"
“Spatial Wood Biomass Residue Inventory”

BIMAT
# Optimization of Biomass Supply Chain

## Woody Biomass Compaction and Long Term Storage Capability!

### February 2015 Moisture Content

<table>
<thead>
<tr>
<th>Type</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shavings</td>
<td>14.40%</td>
<td>20.50%</td>
<td>16.90%</td>
</tr>
<tr>
<td>Seasoned Chips</td>
<td>35.30%</td>
<td>41.20%</td>
<td>38.25%</td>
</tr>
<tr>
<td>Unhugged Bark</td>
<td>60.90%</td>
<td>62.90%</td>
<td>62.00%</td>
</tr>
<tr>
<td>MPB Harvest Residue</td>
<td>45.00%</td>
<td>50.40%</td>
<td>46.44%</td>
</tr>
</tbody>
</table>

### 20+ Month Open Storage Moisture Content

<table>
<thead>
<tr>
<th>Type</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shavings</td>
<td>9.07%</td>
<td>34.80%</td>
<td>17.83%</td>
</tr>
<tr>
<td>Seasoned Chips</td>
<td>16.47%</td>
<td>38.67%</td>
<td>25.60%</td>
</tr>
<tr>
<td>Unhugged Bark</td>
<td>22.69%</td>
<td>67.29%</td>
<td>46.97%</td>
</tr>
<tr>
<td>MPB Harvest Residue</td>
<td>15.20%</td>
<td>28.83%</td>
<td>21.70%</td>
</tr>
</tbody>
</table>

### Parameter Comparison

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Shavings</th>
<th>Unhugged Bark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Moisture Content</td>
<td>16.90%</td>
<td>62.00%</td>
</tr>
<tr>
<td>53&quot; Loaded Weight (Unbaled)</td>
<td>8,000 kg</td>
<td>33,010 kg</td>
</tr>
<tr>
<td>53&quot; Loaded Weight (Baled)</td>
<td>18,424 kg</td>
<td>46,544 kg</td>
</tr>
<tr>
<td>Payload Change</td>
<td>130.3% Increase</td>
<td>41% Increase</td>
</tr>
</tbody>
</table>

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[Additional images and content related to optimization and storage solutions for biomass supply chain.]

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[Images of biomass processing equipment and forested areas.]
Biomass Value Simulator

Objective
Create and maintain an internet-based fibre valuation system as part of the Canadian Wood Fibre Centre's "Short Rotation Woody Crops (SRWC) and Opportunity Woody Biomass" project. The valuation system provides users with a decision support tool to determine the economical feasibility of growing and/or accessing woody biomass feedstocks for bioenergy/bioproduct development.

Future Development
Information pertaining to fibre characteristics, accessibility, availability, value-chain cost/value components and economics of purpose grown and opportunity woody biomass will be progressively added and integrated into the system to facilitate the development/refinement of the decision support tool and the optimization of the models that comprise it.

Partners
Canadian Biomass Innovation Network, EcoEnergy Technology Initiative, Canadian Forest Service (GLFC and LFC), CANMET Energy Technology Centre, Agriculture and Agri-Food Canada, FPInnovations - FERIC, FPInnovations - Paprican, University of Guelph, University of Saskatchewan, University of British Columbia and Manitoba Conservation.

Purpose Grown and Opportunity Biomass Value Chain

WOODY BIOMASS

HARVEST / COLLECT

PRE-PROCESS

LOAD

TRANSPORT

PRE-PROCESS

CONVERSION

2° PRODUCT

PRIMAR Y PRODUCT

2° PRODUCT

STORAGE
Biomass Value Simulator

Afforestation
- Yield: 114 million m³
- Net: $23/ODt

Harvest
- Feller Buncher: $25/ODt
- Skidding & Loading: $15/ODt

Handling
- Feller Buncher: $25/ODt
- Skidding & Loading: $15/ODt
- Transport: $30/ODt

Conversion
- Chipping & Combustion: $75/ODt
- Heat: $168/ODt
- Pellets (as heat equivalent): $40/ODt
- Power & Carbon: $50/ODt
- Pulp: $315/ODt

Transport
- Logging Truck: $30/ODt

Preparation
- Chipping & Storage: $18/ODt
- Chemical Pulping: $148/ODt

First Conversion
- Preparing & Gasification: $50/ODt
- Power & Carbon: $34/ODt

Canadian Wood Fibre Centre
Creating sustainable forest solutions

Developing Applications to Bring Forest Research to Life
CIF e-Lecture

Natural Resources Canada
Ressources naturelles Canada
Developing Applications to Bring Forest Research to Life
CIF e-Lecture

National Network of Sites

Short Rotation Woody Crops
- Purpose-grown woody crops of willow and poplar established as a means of rapidly producing lignocellulosic fiber for use in the wood products industry and for energy.
- Require appropriate site selection and preparation, suitable clonal planting stock and intensive site management to achieve high-yields (8x native yields) over short rotations (3-20 years).
- The 3 most common types of SRWC plantations are: High Yield Afforestation, Concentrated Woody Biomass and Mixedwood Afforestation.

High Yield Afforestation
- Stand oriented design (1,100 - 1,600 stems/ha).
- Designed to meet yields of 13.6 - 20.0 gross cubic metres (M3) or 7.3 - 10.8 GDT/ha yr of woody biomass.
- Uses biogeographically suitable hybrid poplar cultivars and superior aspen clones under intensive management regimes.
- Established on moderate to high quality agriculture land.
- 15 - 20 year rotations.
- Values: energy, forest products, carbon credits.

Concentrated Woody Biomass
- Short rotation (3-5 yr), high-yield biomass plantations that use high density designs (15,000 to 20,000 stems per hectare).
- Designed to meet yields of 6.0-12.0 GDT/ha yr of biomass.
- High intensity, coppice management regime with 5-7 generations from one root system.
- Established to develop feedstock for energy conversion and carbon credits (offsets).
- Various cultivars of hybrid willow and hybrid poplar are used.

Mixedwood Afforestation
- Designed to mimic the dynamics that exist within mixedwood forests in Western Canada - the hardwood (hybrid poplar) provides the protection required by the spruce understory.
- Hybrid poplar (1,600 stems/ha) are inter-plantied with white spruce (1,200 stems/ha) to meet yields of 13.6-20.0 m³/ha yr and 4.0-5.0 m³/ha yr respectively.
- A dual-crop strategy that maximizes the biomass, fibre and carbon values available from a given land base.
Developing Applications to Bring Forest Research to Life
CIF e-Lecture

“Ellerslie Virtual Tour”

8 Stops with 60 informative vignettes

MIXEDWOOD AFFORESTATION
Green Giant hybrid poplar (Populus deltoides x Populus petrowskyana) and white spruce (Picea glauca)

MIXEDWOOD AFFORESTATION
Walker hybrid poplar (open pollinated Populus deltoides) and white spruce (Picea glauca)

HIGH YIELD AFFORESTATION
Northwest hybrid poplar (Populus deltoides x Populus balsamifera)

HIGH YIELD AFFORESTATION
Hill hybrid poplar (Populus deltoides x Populus Petrowskyana)

HIGH YIELD AFFORESTATION
Assiniboine hybrid poplar (open-pollinated Walker seedling, P x Walker x deltoides)

HIGH YIELD AFFORESTATION
Walker hybrid poplar (open pollinated Populus deltoides) and white spruce (Picea glauca)

CONCENTRATED WOODY BIOMASS
Various willow (Salix spp.) and hybrid poplar (Populus spp.)

CONCENTRATED WOODY BIOMASS
Various willow (Salix spp.) and hybrid poplar (Populus spp.)
“Ellerslie Virtual Tour”
Mixedwood Afforestation Aerial View

This mixedwood afforestation crop is comprised of Walker hybrid poplar (Populus spp.) and white spruce (Picea glauca). From above, the narrow crown of Walker can be observed. The semi-upright form (i.e. branch angle less than 45 degrees) and shyness of Green Giant prevents it from achieving complete crown closure. As a result, the inter-planted white spruce are visible from above.

From a crop management perspective, complete crown closure is desire because it minimizes site competition and reduces vegetation management costs. However, it can also impede understory growth. Consequently, incomplete crown closure can be beneficial to mixedwood afforestation crops.

Photography: acquired with UAV (Unmanned Aerial Vehicle)
Developing Applications to Bring Forest Research to Life

Thank You!

Questions!

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