
CIF E-Lecture, February 5, 2020

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Who Are We?

Combined 75 Years of Forest/Afforestation Operations Experience

Combined 60 Years of Innovative Silviculture/Afforestation Systems Practices Development

Derek Sidders

Tim Keddy

Canadian Forest Service and CWFC have a long history of establishing applied field trials, tests and studies that incorporate ecological and technical development objectives addressing a major forest management issue.

What are Forest Practices Legacy Sites

Develop Applied Practices that are ISSUE DRIVEN with Realistic short and long-term Objectives (Operational Adoption)

Partner/Stakeholder Driven and Protected

Controlled Infrastructure to Track Response and Present Evidence and Attract Additional Research

Long-Term Technology Development and Transfer Venues

Technology Development Legacy Sites

“Stand the Test of Time”

Leave an Imprint on the Forest Landscape

Present Evidence Related to the Response of a Practice

Demonstrate a Technical Application or Several

Answer Issue Oriented Questions Using Practical Actions
Examples: 1985-2000 Silviculture Operations
Development focused on Backlog Reforestation
Evaluating a Wide Range of Site Preparation Treatments

Large Scale → Small

Heavy Footprint → Light
Resulting in the Development of Innovative Site Preparation Techniques/Equipment

Modifying Existing Implements

Developing New Technologies

To Prepare Sites for Regeneration Systems
THE GRIZZ
High-Powered
Elevated Bed Mixer
THE GRIZZ

The GRIZZ Mixer is a twin-driven, hydraulically powered site preparation implement which creates continuous, elevated beds of mixed mineral soil and organics over an undisturbed section of forest floor.

The GRIZZ was initially developed in response to a need for a heavy-duty, variable configuration that would agitate and aggressively mix the forest surface and organic layers with the upper mineral soil. The concept prototype was designed and built by the Canadian Forest Service. It was first field tested in 1993. The Canadian Forest Service has leased the GRIZZ to Forest Leasing Inc. of Edmonton to support operational needs in Alberta and B.C.

The GRIZZ will penetrate to approx. 30 cm and will create beds up to 35 cm in height depending on the disc size and angle (flexible angle), the soil condition (density and moisture), and surface ground impediments. The bed width will be approx. 60 cm in width, and a vertical disturbance of approx. 110 cm.

Individual GRIZZ beds are comprised of two 1-metre-wide or 1.3-metre-wide discs of 76 cm in thickness. Each disc has 11 claw-shaped teeth (25 cm in length). Four hydraulic high-torque radial piston motors drive the discs in either a forward or reverse direction, powered by an auxiliary power pack driven by a variable displacement hydraulic pump. All discs are independently controlled using directional control valves which can redirect or free flow the discs instantly from the

Users, Contractors, Distributors and Manufacturers call...

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Canada

Canada

Phone: (403) 435-7355
Fax: (403) 435-7356

Technology Development Unit,
Northern Forest Centre, Edmonton.
26 Years Post Planting, Edson, Alberta

12-18 cm DBH
9-11 m height
High Speed Horizontal Bed Mixer

1.4 m wide X 1.4 m long, 15-20 cm depth
Meri Crusher Mix,
15 Year-Old White Spruce in mature Aspen Understory
EMEND, Alberta
# A2 FORESTER MACHINE SPECIFICATIONS

## PHYSICAL SPECIFICATIONS
- **Height:** 9'0"  
  2.75 m
- **Width:** 13'6"  
  4.11 m
- **Length:** 32"  
  9.75 m
- **Weight:** 33,000 lb  
  14,969 kg

## POWER UNIT
- **8V-92T Detroit Diesel Silver**
- **480 HP @ 2000 RPM**

## ELECTRICAL SYSTEM
- **24 Volt Alternator**

## AIR CLEANER
- **Donaldson Dry Type Heavy Duty**

## COOLING SYSTEM
- **Radiator:** 28 Imperial Gallons (127.29 Litres)
- **2 Torque Converter Coolers:** 12 Imperial Gallons (54.55 Litre)

## DRIVE SYSTEM
- **Hydrostatic:** Hagglund Dennison Pump
- **Pump:** Gold cup Series P24P Model C
- **Sundstrand SMA Motors**
- **Top Axle:** 15 Tooth high carbon steel double sprocket
- **Stub Axle:** 14 Tooth high carbon steel double sprocket
- **Chain:** 140 Double high quality

## ROTOR
- **Width:** 10' 3.08 m
- **Cutting:** 3' 0.9 m on each end
- **Diameter including teeth:** 31" 79 cm
- **Teeth:** 44 self sharpening knock out replacement
- **Pockets:** 44 Taper wedge
- **Drum:** 20" 50.8 cm 812 WT
- **Depth of cut:** 0" (0 cm) to 9" (22.8 cm)
- **Rotor speed:** 380 rpm

## TIRES
- **73-4400-32 H16 Logger (185.4 x 11176-8128 cm)**

## FUEL TANK
- **245 Imperial gallons 1113.7 Litres**

## HYDRAULIC TANKS
- **220 Imperial gallons 1000.12 Litres**
Mechanical Strip Thinning

Front Mounted Seppi-M Mulcher on a Tractor

Sites: 15-25 Year-old Fire Origin Jack and Lodgepole Pine

Also developed for releasing White Spruce from Aspen when under 1.2 m in height (Sw)
1994 Mechanical Strip Thinning in 1974 Fire Origin Lodgepole Pine (Alberta) and 1972 Jack Pine (Sask.)
1994 Treatment
Average Height: 3.2 M
Average DBH: 2.85 cm
Density: 16,150 Stems/ha
Swan Hills, Alberta
20 Years Post Treatment (2013)

Average Height: 13.6 m
Average DBH: 14.2 cm
Density: 3150 Stems/ha
Other Tools Developed and Tested
OVERVIEW: Designs created to meet the “Management Objectives of the forest industry Partners”

1) Mixedwood Variable Retention to Emulate Natural Disturbance: Full Tree Design (CANFOR and Daishowa-Marubeni)

2) Commercial Thinning in Mature Pure White Spruce: Cut-To-Length Design (Vanderwell Contractors)

3) Adaptive Mixedwood to Protect Immature Softwood: Full Tree Design (Ainsworth, Tolko, Al-Pac, Weyerhaeuser and Footner Forest Products)

4) MPB Stand Rehabilitation Study: Recovery Value, Reducing Risk and Re-establishing a Productive Forest: Full Tree Design (CANFOR, Spectrum)
1 Hotchkiss River Mixedwood Management Demonstration Area: 1993
2 Ecosystem Management Emulating Natural Distribance (EMEND): 1999
3 Adaptive Mixedwood, Understory Protection Project: 2005/06
4 Candle Lake Understory White Spruce Release in Mixedwoods: 1951-53
5 Calling Lake White Spruce Commercial Thinning: 2002
6 Drayton Valley White Spruce Understory Protection: 1989
7 Muskeg River Forest Demonstration Area: 1994/95
8 Alcott Creek Silviculture Demonstration Area: 1994
9 White Spruce Under-planting of Aspen: 1962
10 Black River Understory Protection Demonstration: 1996
11 Riding Mountain Mixedwood Partial Harvest Study: 1953-55

Created by Derek Sidders, Tim Keddy and Brent Joss, CWFC, Edmonton
Established 1998/99

“Ecosystem Management Emulating Natural Disturbance”

Management Objective:

To emulate natural disturbance using a variable recovery harvest system that retains individual tree and patch retention in 4 stages of aspen/white spruce mixedwoods. To evaluate the ecosystem impacts, species diversity and sustainability.
### EMEND PROJECT

**working project design**

All Treatment Blocks Approx. 10 Ha. In Size

<table>
<thead>
<tr>
<th>&gt;70%</th>
<th>aspen over</th>
<th>mixed</th>
<th>&gt;70%</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;70% aspen</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>no harvest</td>
<td>no harvest</td>
<td>no harvest</td>
<td>no harvest</td>
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<tr>
<td>10% residual</td>
<td>10% residual</td>
<td>10% residual</td>
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<tr>
<td>20% residual</td>
<td>20% residual</td>
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<td>50% residual</td>
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<tr>
<td>75% residual</td>
<td>75% residual</td>
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</tr>
<tr>
<td>clear cut</td>
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All treatments replicated 3 times within each stand type.
**EMEND Harvest Pattern**

Candidate Stand ~ 10 Hectares

- 2 Retained Patches: 0.20 (40X60m) and 0.46 ha (60X90) - elliptical
- 10, 20, and 50% retention - evenly distributed
- 20 m interval between machine corridors (centre to centre) 5 metre wide corridors
- 25% removal within machine corridors
- Retention strips removal = 1 of 3 (50%), 3 of 4 (20%), and 7 of 8 (10%)

Machine Corridor

Retention Strip

No Cut Patch

Landing

Haul Road

All skidding from the landing backing down the machine corridors.


EMEND AERIAL VIEW

Uniform Shelterwood Harvesting
Systematic Individual Tree Retention with Parallel Machine
Corridors at 20 m Centres, Spacing: 1 Merchantable Aspen Left
Every 4 Trees (Cut 3, Leave 1) Resulting Retention Level = 20%.

Pre-Harvest

Post-Harvest

**Leave Trees are Systematically Located in the Strips Between the Machine Corridors Based on Regular Buncher Harvest Pattern (Cut 3, Leave 1)**
## Retention Prescription Table

<table>
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<tr>
<th>Retention Level</th>
<th>Machine Corridor % of Net Area</th>
<th>Individual Stem Removal Ratio</th>
<th>Retention Strip (% Net Area*)</th>
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<tbody>
<tr>
<td>75%</td>
<td>25%</td>
<td>No Individual Tree Removal</td>
<td>75%</td>
</tr>
<tr>
<td>50%</td>
<td>25%</td>
<td>1 removed of 3</td>
<td>75%</td>
</tr>
<tr>
<td>20%</td>
<td>25%</td>
<td>3 removed of 4</td>
<td>75%</td>
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<tr>
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## Harvesting Treatment Profiles Post-Harvest

- **Block 917 10% Conifer Dom.**
- **Block 890 75% Conifer Dom.**
- **Block 853 50% Deciduous Dom.**
- **Block 910 20% Mixed**
- **Block 914 Clearcut Mixed**
Silviculture Plot Installation

Silviculture Plot Layout

Site Preparation: High-Speed, Horizontal Bed Mixing

Silviculture Plot in Block 850: Clear Cut - Site

Site Preparation - Scalp

Planting in Mixed Microsite - July 1999

Planted to 415B White Spruce, July 1999, 100 per Treatment
Seeded with Local White Spruce Seed

Scalp Mound Mix No Site Preparation
2002 White Spruce Commercial Thinning, Calling Lake, Alberta
Thinning equally from Above and Below (by BA) Resulted in Greater Stem Size Consistency and Stand Health.

Objectives:
This study was established in 2000 to investigate the effectiveness of 30%, 50%, and 70% basal area removal commercial thinning options for natural white spruce stands.

To assess prescription effectiveness and cost, increase volume growth and availability, and regeneration response.

Assessment and Monitoring Protocol

Commercial Thinning Options to Maximize Volume Recovery, Growth and Sustainability in Pure White Spruce Stands
Completed by the Canadian Forest Service, Forest Engineering Research Institute of Canada and Vanderwell Contractors (1971) Ltd.
Established: Summer 2002
Derek Sidders and Tim Keddy, Canadian Wood Fibre Centre, Canadian Forest Service

Results (to end of 2006)

Technology Transfer

Summer harvest and at-the-stump processing and forwarding= Natural Sw on machine disturbed sites.
Commercial Thinning: Systematic Removal, Variable Levels of Removal
Stand Condition: Inconsistent or Consistent

30% 50% 70%

Remove Trees with Diameters above and below Prescription Range

Remove Trees with Diameters above and below Prescription Range

30% 50% 70%
Resulting Treatment Profiles

30% Removal

50% Removal

70% Removal

30% Removal

50% Removal

70% Removal
### Pre-Harvest Stand Summary

| Block # | White Spruce |  |  | Balsam Poplar |  |  | Trembling Aspen |  |  | Balsam Fir |  |  |
|---------|--------------|---------------------------------|---------------|--------------|---------------------------------|---------------|--------------|----------------|---------------|--------------|----------------|---------------|--------------|
|         | Stems/ha | BA/ha (m²) | Vol/ha (m³) | Stems/ha | BA/ha (m²) | Vol/ha (m³) | Stems/ha | BA/ha (m²) | Vol/ha (m³) | Stems/ha | BA/ha (m²) | Vol/ha (m³) |
| 100     | 1064       | 42.97 | 434.05 | 173       | 10.93 | 120.82 | 27          | 2.21 | 28.25 | 0           | 0.00 | 0.00 |
| 130     | 1182       | 46.94 | 475.32 | 77        | 5.22  | 56.55  | 23          | 1.28 | 15.22 | 0           | 0.00 | 0.00 |
| 150     | 1433       | 49.62 | 458.83 | 171       | 16.91 | 181.23 | 0           | 0.00 | 0.00  | 0           | 0.00 | 0.00 |
| 170     | 968        | 35.25 | 341.25 | 36        | 2.59  | 29.15  | 186         | 14.04 | 160.70 | 0           | 0.00 | 0.00 |
| 200     | 1217       | 46.60 | 435.92 | 11        | 0.71  | 7.36   | 0           | 0.00 | 0.00  | 0           | 0.00 | 0.00 |
| 230     | 1125       | 51.03 | 506.28 | 60        | 3.88  | 39.44  | 40          | 4.79 | 53.93 | 30          | 0.64 | 5.24 |
| 250     | 1259       | 42.96 | 393.99 | 176       | 5.15  | 42.59  | 18          | 0.50 | 4.76   | 0           | 0.00 | 0.00 |
| 270     | 1163       | 48.06 | 459.13 | 63        | 3.80  | 37.57  | 8           | 0.49 | 5.73   | 0           | 0.00 | 0.00 |
| 300     | 958        | 36.02 | 354.91 | 53        | 4.16  | 47.39  | 132         | 9.18 | 108.63 | 0           | 0.00 | 0.00 |
| 330     | 1105       | 43.54 | 418.69 | 42        | 3.80  | 40.61  | 42          | 2.80 | 30.16  | 0           | 0.00 | 0.00 |
| 350     | 1205       | 39.48 | 363.97 | 74        | 4.39  | 45.97  | 111         | 6.55 | 70.26  | 0           | 0.00 | 0.00 |
| 370     | 705        | 34.44 | 367.90 | 50        | 3.85  | 43.96  | 160         | 12.70 | 158.91 | 0           | 0.00 | 0.00 |

### Averages by Treatment

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| 30% Removal | 1137   | 47.17      | 466.76      | 60       | 4.30       | 45.53       | 35       | 2.96       | 33.10       |
| 50% Removal | 1299  | 44.02      | 405.60      | 141      | 8.82       | 89.93       | 43       | 2.35       | 25.00       |
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Even Distribution of Retained Overstory Hardwood Stems Creates a Healthier and More Productive Stand

Adaptive Management of Mixedwoods to Maximize Fibre Recovery and Retained Stem Volume Growth and Ecosystem Sustainability

Established in the winter of 2006 by the Canadian Forest Service and the University of Alberta in cooperation with Alnaworth Engineering Canada LP, Alberta-Pacific Forest Industries Inc., Fostner Forest Products Limited, Weyerhaeuser Company, Tolko Industries Limited, and the Mixedwood Management Association of Alberta, with funding support from FRIAA.

Derek Sidders and Tim Keddy, Canadian Wood Fibre Centre, Canadian Forest Service, Edmonton 780-435-2710

Objectives:
To test promising practices for the management of mature aspen stands with understory spruce;
To establish a network of sites that tests, demonstrates and validates new harvesting designs;
To establish permanent monitoring plots to determine the effects of the treatments;
To evaluate the cost effectiveness of the operational aspect of the new practices.

Treatment Designs
5m Concentrated Wind Buffers at 36m spacing with full aspen removal between buffers.
Evenly distributed aspen retention at 25% coverage within retention strip, all other aspen removed.

Network of Demonstration Sites

Sample pre and post harvest of one of 5 sites.

Concentrated Wind Buffers
Early Distribution
Understory

Operations Results: All Sites Combined

Number of Harvest
1.5m Average
1.7m Average
2.2m Average
3.2m Average

Natural Resources Canada
Ressources naturelles Canada
Adaptive Mixedwood Harvesting With Concentrated Wind Buffers
Feller Buncher and Grapple Skidder, Full Tree with designated machine corridors at 18 m, Centre to Centre and a 5 m Wind Buffer every 36 metres

Adaptive Mixedwood Harvesting With Evenly Distributed Overstory Feller Buncher and Grapple Skidder, Full Tree with designated machine corridors at 18 m Intervals, Center to Center

Haulroad
Protection Strip
Landing
36 m Wide, 30 m Deep

Wind Buffer
Protection Strip
Machine Corridor
Machine Corridor
Machine Corridor
Machine Corridor
Machine Corridor
Machine Corridor
Machine Corridor

Wind Buffer
Protection Strip
Machine Corridor
Machine Corridor
Machine Corridor
Machine Corridor
Machine Corridor
Machine Corridor

Landing
32 m Wide, 30 m Deep

Full-Tree Harvesting System
Innovative Stand Enhancement and Regeneration Systems to Rehabilitate Mountain Pine Beetle Affected Stands on Boreal Sites

Established 2014/15, Grande Prairie, Alberta
1) Remove Active Attack Trees to Reduce Risk of Further Mortality

2) Space Dense Non-impacted Lodgepole Pine to Reduce Risk and Susceptibility

3) Reduce Fire Hazard by Removing Commercial Dead Stems and Dropping Hanging Stems

4) Open The Stands to Facilitate Re-establishment of Selected Crop Trees to Create Fully Stocked, Productive Stands

5) Protect understory juvenile softwoods and codominant hardwoods
1) Parallel Machine Corridors (5m Width)
2) All Equipment Limited to Machine Corridors
3) Retention Strip Width Modified to Harvesting Equipment
4) Easily Modified Decking Areas
5) Retention Species Composition Based on Pre-determined Management Objectives
15 metre retention and selection strip

5 metre machine corridor

Log deck
Logging Operations

CFS and CWFC have a 20 year history of establishing applied field trials, tests and studies that incorporate ecological and technical development objectives addressing a major issue on non-forested lands. “New Source of Fibre, Carbon Sink and Bioenergy”
Short-Rotation Woody Crop Systems Development

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 (above native yields) over short rotations (3-20 years).
- The 3 most common types of SFRWC plantations are: High Yield Afforestation, Concentrated Woody Biomass and Mixedwood Afforestation.

High Yield Afforestation
- Stands oriented design (1,100 - 1,800 stems/ha).
- Designed to meet yields of 13.6 - 20.0 ODT/ha yr of woody biomass.
- Uses biologically suited 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 ODT/ha yr of biomass.
- High intensity, coppice management regime with 5-7 generations from one root system.
- Established to develop feedstocks 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 (1,500 stems/ha) are inter-planted with white spruce (1,200 stems/ha) to meet yields of 13.6-20.0 ODT/ha yr and 4.0-6.0 m3/ha yr respectively.
- A dual-crop strategy that maximizes the biomass, fibre and carbon values available from a given land base.

National Network of Sites

St. Albert, Alberta
- Type: Concentrated Woody Biomass
- Established: 2007
- Species: Hybrid Poplar
- Hectares: 35
- Density: 2,100 stems/ha
- Management: High Intensity

Cynthia, Alberta
- Type: Mixedwood Afforestation
- Established: 2007
- Species: Hybrid Poplar, Hybrid Aspen, White Spruce
- Hectares: 50
- Density: 1,400 stems/ha
- Management: Low Intensity

Kemptville, Ontario
- Type: Concentrated Woody Biomass
- Established: 2007
- Species: Hybrid Poplar & Willow
- Hectares: 6.3
- Density: 5,270/ha
- Management: High Intensity

Legend:
- Afforestation Plantations
- Concentrated Woody Biomass Plantations
- Mixedwood Afforestation
- Major Countries
- Afforestation Site Suitability

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Natural Resources Canada
Ressources naturelles Canada
Canada
Develop and Optimize Effective Practices to Establish, Manage and Recover Woody Fibre/Biomass
High-yield Afforestation

Species: hybrid poplar, aspen
Densities: 1,100-1,600 stems/ha
Spacing: 3 X 3 or 2.5 X 2.5 metres
Rotation Age: 12-20 yrs
Stem Yields: 13.6-20 m3/ha/yr
Biomass Yields: (7-10.3 ODT/ha/yr),
Establishment Investment Costs: 3.4-4K/ha

2.5 - 3 metre spacing
Middle of First Season
2 year-old

3 year-old

14 year-old
6 Year-Old Hybrid Poplar: Edmonton South
12 year-old

NOW THAT IS IMPRESSIVE!

high-yield
afforestation
mix
Afforestation/Biomass Hybrid Design

Species: hybrid poplar, aspen
Densities: 4,400-6,400 stems/ha
Spacing: 1.25 X 1.25 or 1.5 X 1.5 metres
Rotation Age: 12-16 yrs,
2 Harvests: 1st at Year 4-6, 2nd at Year 12-16
Yields: 1st Harvest: 30 ODT, 2nd 13.6-20 m³/ha/yr
Biomass Yields: (8.5-12.8 ODT/ha/yr),
Establishment Investment Costs: 4.5-5.5K/ha

Year 1 (4400/ha)

Yellow Harvested Year 4-6)

2 Years after 1st harvest (1100/ha)

3 metre x 3 metre spacing
Mixedwood Afforestation

Species: hybrid poplar/aspen & spruce
Densities: 1,100-1,600 stems/ha/species
Spacing: 3 x 3 or 2.5 x 2.5 metre/species
Rotation Age: 12-20 / 60-80 yrs (spruce)
Stem Yields: 13.6-20.0 m³/ha/yr
  4.0-5.0 m³/ha/yr
Biomass Yields: 7.3-10.8 ODT/ha/yr
  1.9-2.3 ODT/ha/yr
Establishment Costs: $4.4-5.2k/ha

Spruce planted between hardwoods

2.5 - 3 metre spacing
10 Year-Old Hybrid Poplar/White Spruce Mix: Edmonton South
13 Year-Old Hybrid Poplar/White Spruce Mix
Edmonton, Alberta
3-row Bed Concentrated Woody Biomass Plantation

Species: willow and hybrid poplar  
Density: 15,625 stems/ha  
Spacing: 60cm X 60cm between Trees and rows and 2 metres between beds  
Rotation Age: 3-4 yrs, 4-6 cycles  
Biomass Yields: 6-10 ODT/ha/yr  
Establishment Investment Cost: 7-10K/ha
Species: willow and hybrid poplar
Density: 14,380 stems/ha
Spacing: 61cm X 76cm between Trees and rows and 1.52 metres between beds
Rotation Age: 3-4 yrs, 4-6 cycles
Biomass Yields: 6-10 ODT/ha/yr
Establishment Investment Cost: 7-10K/ha
3 Hybrid Poplar Clones
Established in 2004 Under
Forest 2020:
Harvested in 2018

246 m³/ha
274 m³/ha
292 m³/ha
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.

### High Yield Afforestation
- Grid style plantations
- Consisting of hybrid poplar or aspen
- 11-1600 stems ha\(^{-1}\)
- 1 x 16-20 yr rotation
- 13.6-20 m\(^3\) ha\(^{-1}\) yr\(^{-1}\)
- 25cm+ DBH at harvest
- 20m+ HT at harvest
- 19-29 t CO\(_2\) e ha\(^{-1}\) yr\(^{-1}\)

### Concentrated Biomass
- Hedge style plantations
- Consisting of hybrid poplar or willow
- 13-16,000 stems ha\(^{-1}\)
- 7 x 3 yr rotations
- 6-12 ODT ha\(^{-1}\) yr\(^{-1}\)
- Small diameter (<10cm)
- High bark to white wood ratio
- 14-28 t CO\(_2\) e ha\(^{-1}\) yr\(^{-1}\)

### Mixedwood Afforestation
- 11-1600 st ha\(^{-1}\) Hybrid poplar or aspen
- 8-1200 st ha\(^{-1}\) White spruce
- Flexible design and management
- Long-term carbon sequestration option
- Fast growing overstory harvested at year 20
- 644 – 820 t CO\(_2\) e ha potentially sequestered over 20 + 50 yr rotation

For more information, please contact: Tim Keddy, Wood Fibre Development Specialist, CWFC and/or Derek Sidders, Regional Coordinator and Program Manager, CWFC
Woody Biomass Recovery, Handling and Product Conversion Development Sites and Cases

Canadian Wood Fibre Centre

Edmonton, AB

Canadian Forest Products Ltd
University of Alberta
University of British Columbia
Hedgeco
Canadian Forest Service
Alberta-Pacific Forest Industries
University of Saskatchewan
Manitoba Conservation
Canadian Forest Service
Millson Forestry
Port Hawkesbury Power
Canadian Forest Service
Ferguson Forest Centre
University of Guelph
Gyro-Trac Corporation
Cape Breton University
Ongoing Supply-chain Development and Cost Analysis

ACTIVE DEVELOPMENT STUDY: Edmonton, Alberta: $250 k
Legacy Knowledge Transfer Examples

STOP 7
Oil Well Site Rehabilitation
Planted to White Spruce:
1971 Hand Weeded in 1988
Thinned and Pruned 1999

1997 2-pass White Spruce Understory Protection
1983 White Spruce Planted on Bracke, Ground Vision @ 3L/ha 1985
1983 Summer White Spruce Planting on Marttini Plow
1983 White Spruce Planted on Bracke, Gyromower or Brushsaw 1988, Basal Bark Release 2002
2002 White Spruce Commercial Thinning to 30/50/70% Retention
1995 White Spruce Planted on Meri-crusher Mixed Strips under Mature Aspen
1997/3 White Spruce Planted on Bare Bladed Strips
1995 White Spruce Planted on Meri-crusher Mixed Strips under Mature Aspen

Tour Guides: Derek Sidders and Tim Keddy
Canadian Wood Fibre Centre and Gitte Grover, Alberta-Pacific Forest Industries

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International Boreal Forest Research Association

2013 PRE-CONFERENCE TOUR

Field Guide

Boreal Mixedwoods 2012- Post Conference Tour: June 20-22

Calling Lake, Alberta

1999

2013

1999

International Boreal Forest Research Association

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Thank You!