

Effectiveness Monitoring of Fuel Treatments in SW Yukon

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**Natural Resources
Canada**

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What is an Effective Fuel Treatment (Break)?

Significantly alters fire behaviour such that fire suppression efforts can safely mitigate fire spread to values (Mooney 2010)



Photo Credit: FERIC



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Review of Fuelbreak Effectiveness (Mooney 2010)

<http://fire.feric.ca/36532008/FuelbreakEffectivenessFinalReport.pdf>

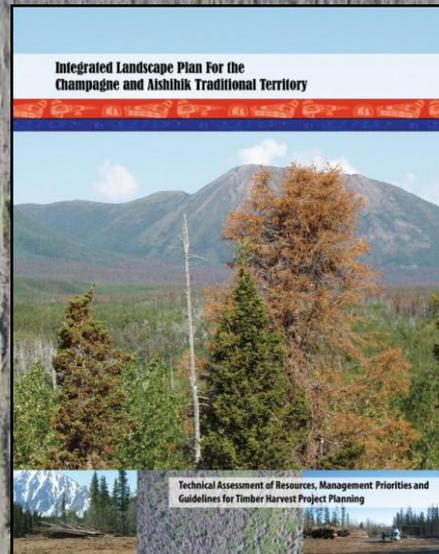
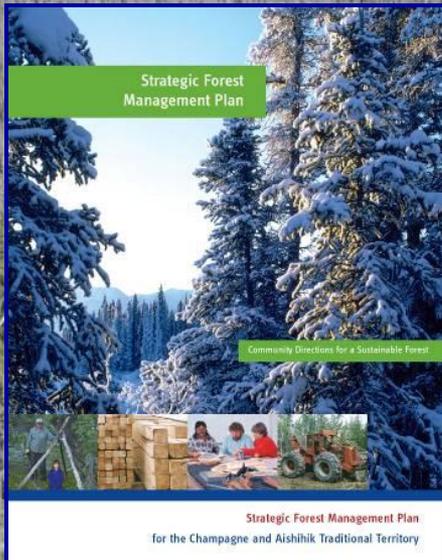
- collection of fuel treatment information is usually limited to information needed for financial due diligence and accounting purposes
- important factors to consider when designing a fuelbreak for community protection from wildfire: Fuel Type; Adjacent Fuels; Crown Fire Potential; Suppression Capabilities; Width; Distance from Community; Surface Fuel Management; Maintenance
- fuelbreak failures and successes were due to wind, fuel type and lack of timely suppression action

Southwest Yukon

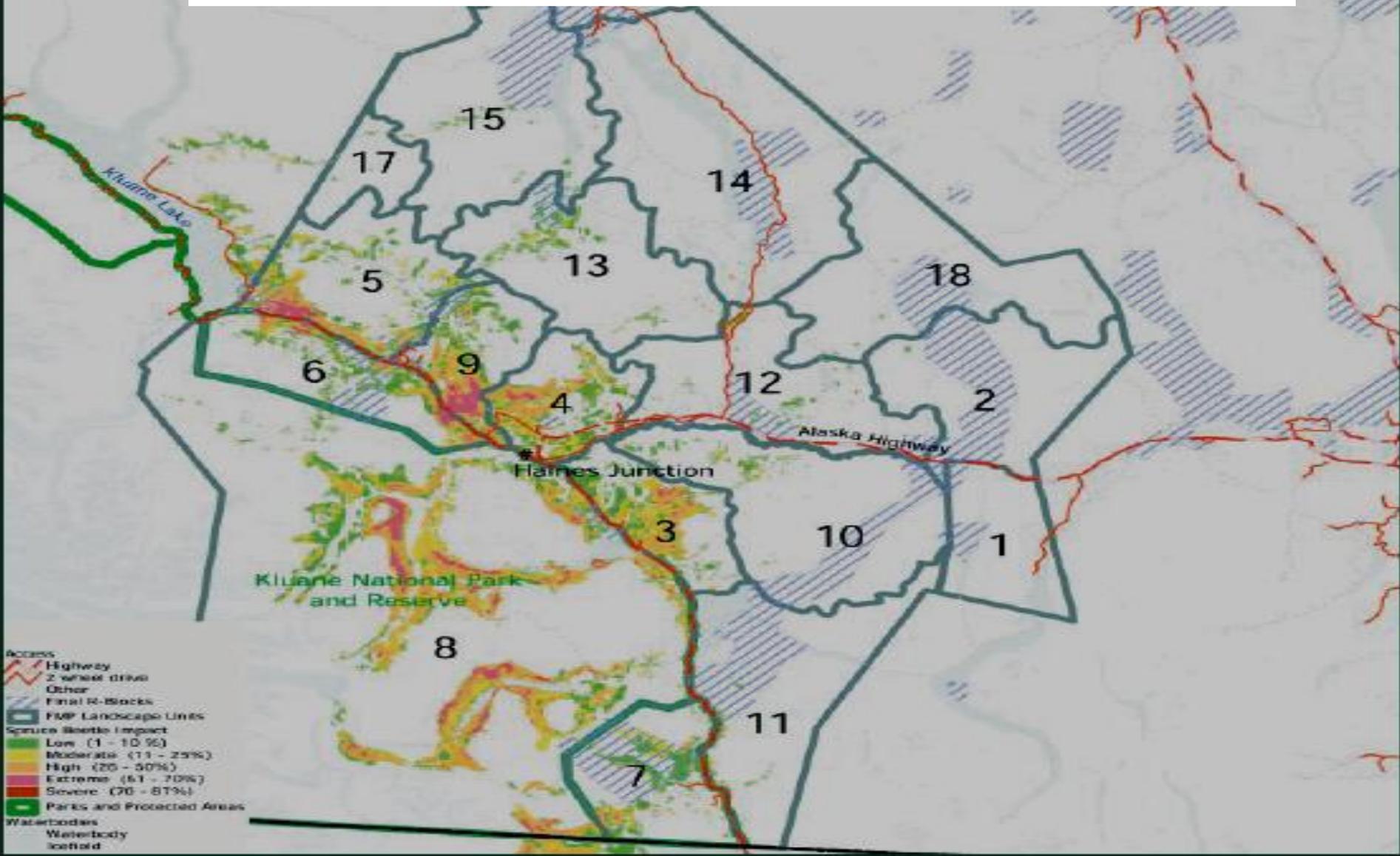
Co-Management by Champagne and Aishihik First Nations
and Yukon Territorial Government

Yukon Energy, Mines and Resources: Forest Management – protocol and measurements

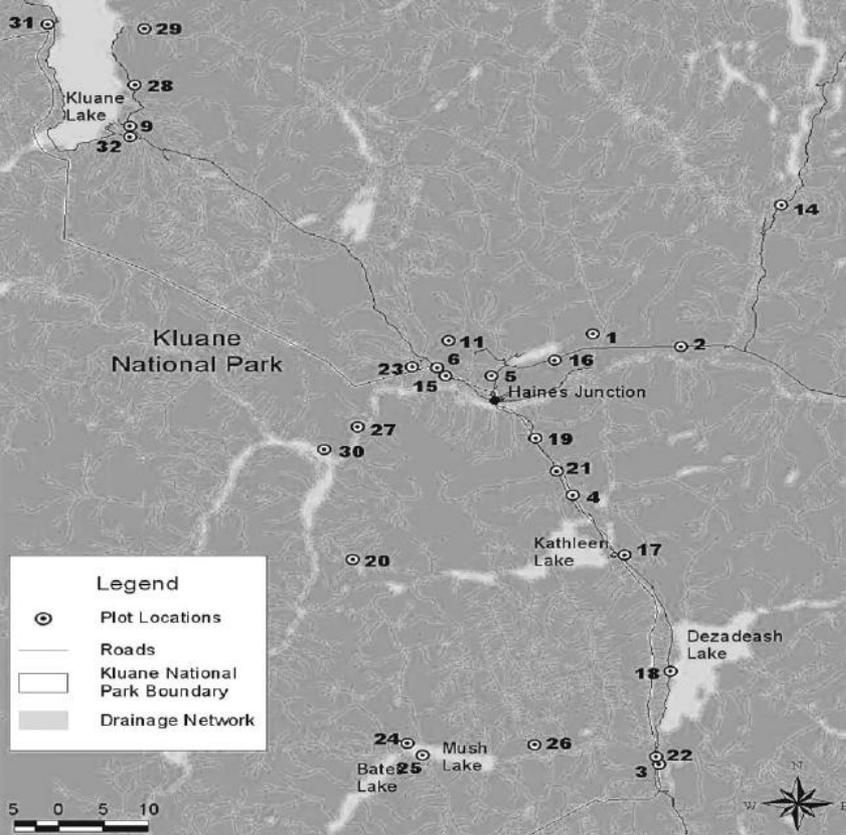
Yukon Community Services: Wildland Fire Management – Fuel Treatments to Sample



Total Area - approx 350,000 ha



Map 1 - Area of Beetle Kill Infestation



Spruce Beetle and the Forests of the Southwest Yukon

Rod Garbutt, Brad Hawkes, and Eric Allen

Natural Resources Canada • Canadian Forest Service
 Pacific Forestry Centre • Victoria, British Columbia
 Information Report • BC-X-406

Stand and Fuel Re-Measurement 2010

Plot 1		UTM		Volume (m ³ /ha)			
Name:	Marshall Creek	zone	easting	northing			
Location:	Approximately 15 km east of Haines Junction	8	372643	6748325			
Stand:	mature white spruce						
avg. age	169 years @ dbh ¹						
range -	147 - 232 years						
avg dbh -	17.9 cm						
range -	10 - 48 cm						
avg height -	19.3 m						
range -	12.8 - 26.9 m						
Stand density:		total	spruce	healthy	killed by spruce beetle	partial attack by spruce beetle	dead other causes
class 1 ² -	1575 stems/ha	368	349.5	177	101.1	44.6	22.4
class 2 ³ -	641 stems/ha						
class 3 ⁴ -	717 stems/ha						
Commonly encountered ground vegetation (percent cover)							
barren	(5)						
shrub:	prickly rose (1)						
dwarf shrub:	twinflower (11),						
herb:	commandra (5), arctic lupine (4), bluebell (2)						
grass:	Poa sp. (2)						
moss:	step moss (81)						
lichen:	Peltigera (7), Cladina sp. (2)						
Average soil temperatures (°C)							
5 cm ⁵ :	7.3						⁶ below live moss layer where applicable
10 cm:	4.8						
20 cm:	3.0						
Litter/moss depth:	4.5 cm						
f/h depth ⁶ :	5.4 cm						⁶ organic fermentation/humus layers
Surface fuels (tonnes/ha)							
coarse woody debris ⁷ :	9.8						⁷ >7 cm diameter
fine woody debris ⁸ :	3.5						⁸ ≤7cm diameter
Crown fuel characteristic ratings (all plot stems ≥10 cm dbh)							
crown base height ⁹ :	1.5						⁹ measured from ground to base of continuous crown
branch density ¹⁰ :	1.7						¹⁰ subjective estimate 1 = low
vertical continuity ¹¹ :	1.8						¹¹ subjective estimate 2 = moderate
	total	5.0					3=high
Dead tree density (stems/ha):	900						
Fire hazard rating¹²:	2 (low)						¹² on an increasing relative scale from 1-6
Spot fire potential¹³:	1 (low)						¹³ on an increasing relative scale of 1-3



Hazard Rating: 3 (low)
 Crown base height > 1 m
 Branch density low
 Vertical continuity low

= 1
 = 1
 = 1

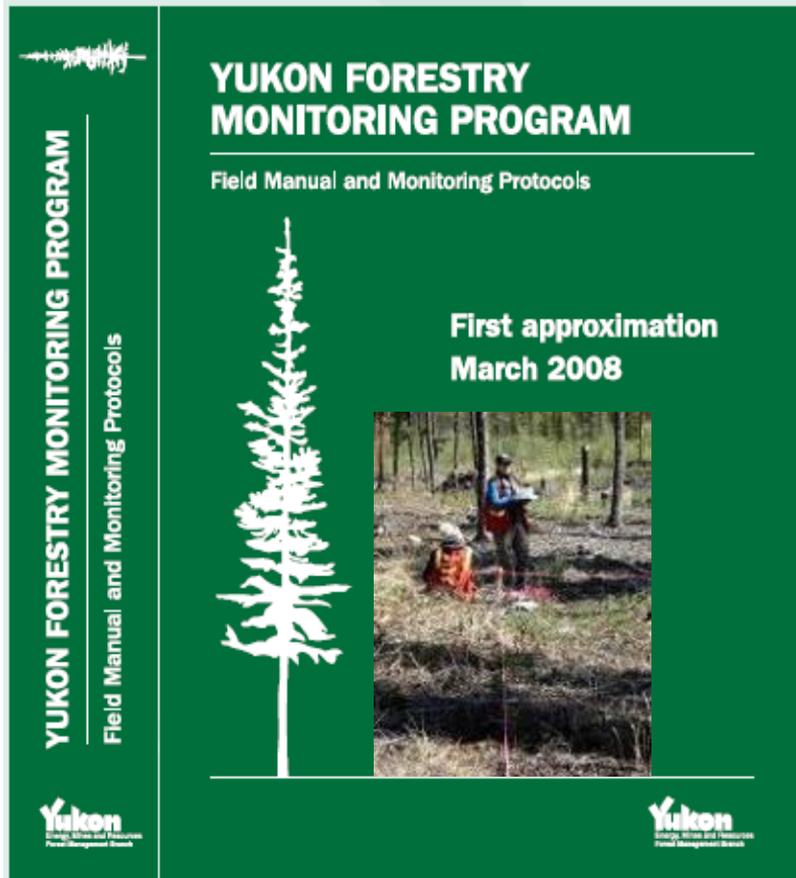


Hazard Rating: 9 (high)
 Crown base height < 0.5 m
 Branch density high
 Vertical continuity high

= 3
 = 3
 = 3

Yukon Forestry Monitoring Program

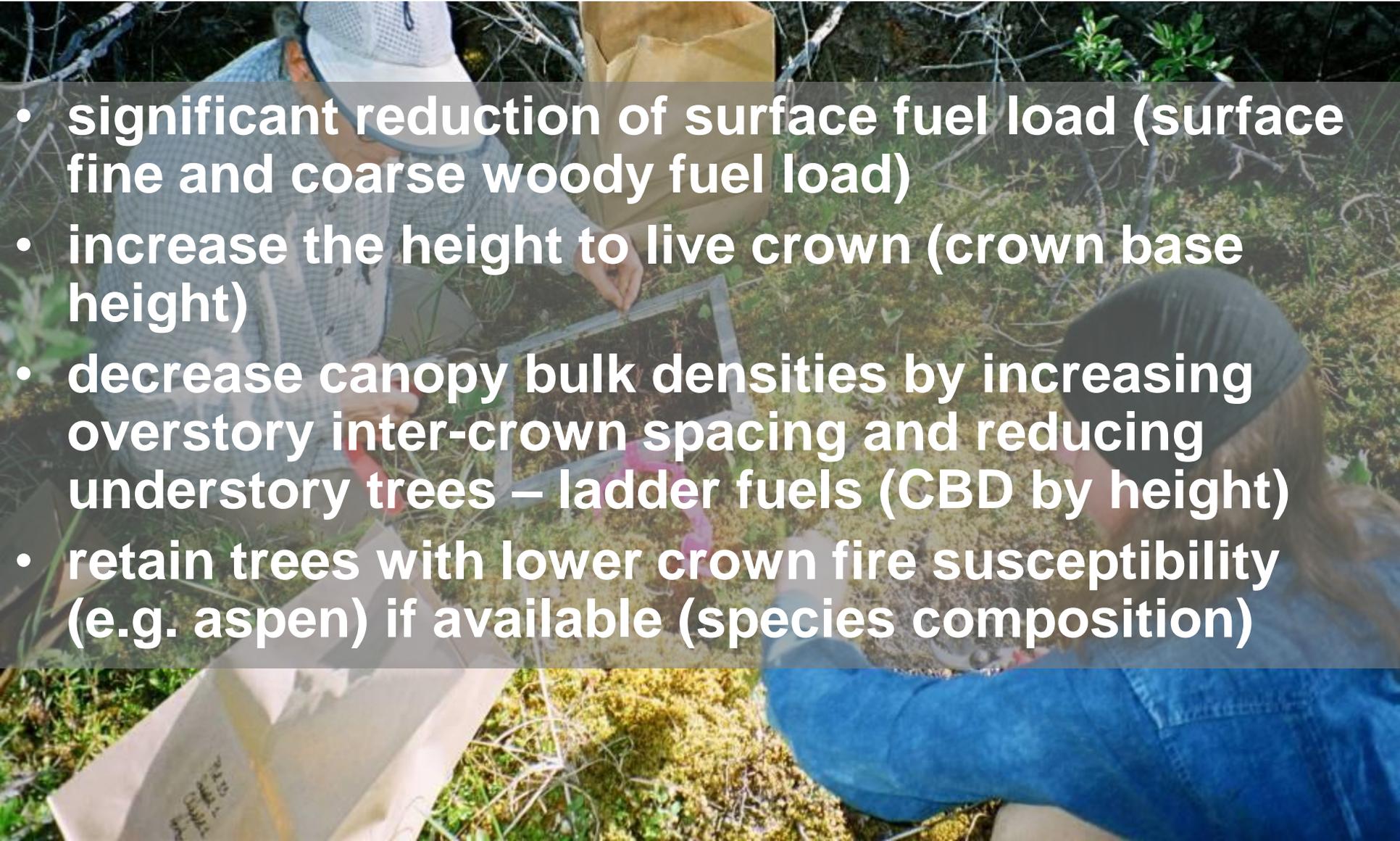
Field Manual and Monitoring Protocols



Examples of projects using monitoring protocols

- Criteria and Indicators
- Post wildfire salvage
- Adaptive mgt trials – harvesting - Site prep understory retention – summer/winter harvest
- Lichen retention in Caribou range – lodgepole pine harvesting

Fuel Treatment Objectives: Attributes to Monitor

- 
- significant reduction of surface fuel load (surface fine and coarse woody fuel load)
 - increase the height to live crown (crown base height)
 - decrease canopy bulk densities by increasing overstory inter-crown spacing and reducing understory trees – ladder fuels (CBD by height)
 - retain trees with lower crown fire susceptibility (e.g. aspen) if available (species composition)

YUKON APPROVED!



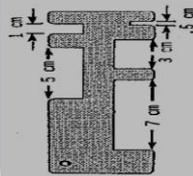
2008
EDITION

Fuel Treatment Monitoring “Lite” Protocol for White Spruce forests in SW Yukon

**“COUNTING STICKS’
MADE FUN & EASY!**

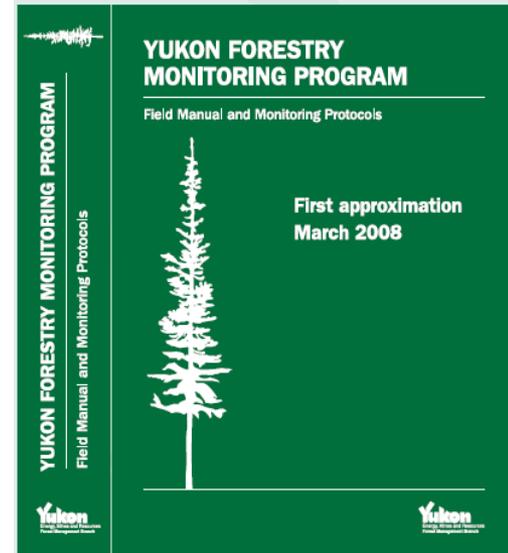
**EXCEL SPREADSHEET
CALCULATOR FOR
CANOPY BULK
DENSITY!**

**FREE GO-NO-GO GAUGE
FRIDGE MAGNET INSIDE**



Fuel Treatment Monitoring Protocol: sections used in Yukon Forestry Monitoring Program Field Manual

- 1) Monitoring site establishment
- 2) Site description
- 3) Forest mensuration
- 4) Understory vegetation
- 5) Coarse woody debris
- 6) Fine woody debris
- 7) Tree fuels assessment (fire hazard rating and spot fire potential)
- 8) Fuel treatment prescription compliance and effectiveness monitoring
- 9) Soil description



Pilot Project - Description

- **Monitoring protocols were developed with assistance from the Canadian Forest Service including data analysis methods for stand reconstruction and canopy bulk density**
- **13 monitoring sites installed in 8 treatments in Haines Junction, Canyon, Mendenhall, and MacIntosh**



Monitoring Sites

Figure #3 - FRATWG - Haines Junction Map

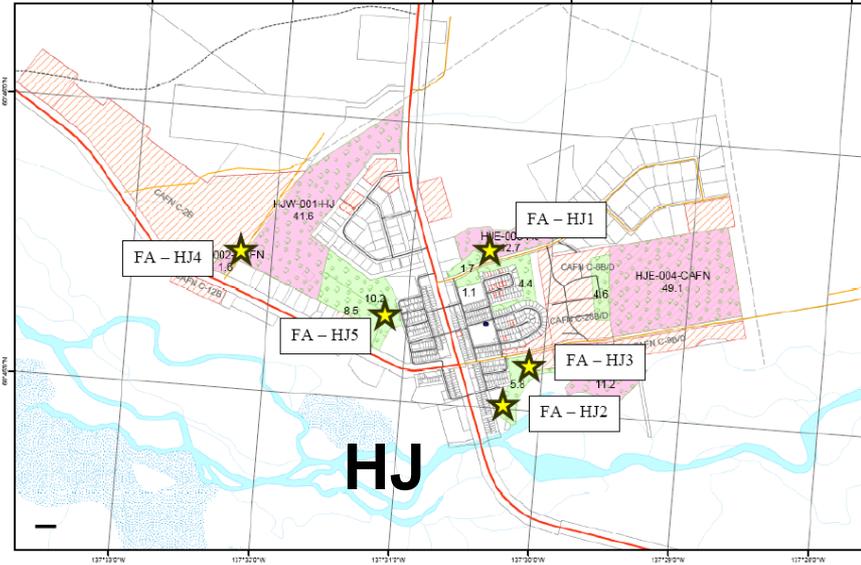


Figure #2 - FRATWG - Canyon Map

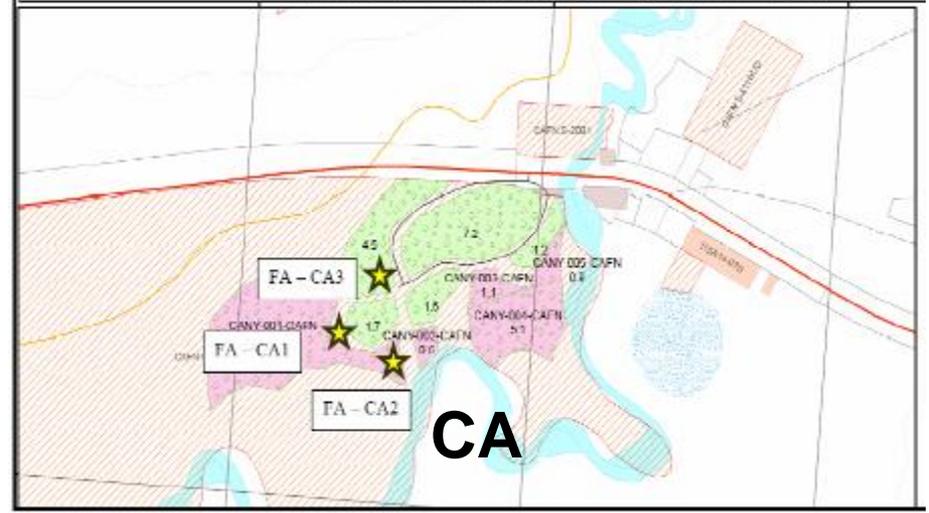


Figure 5 - FRATWG Mendenhall Map

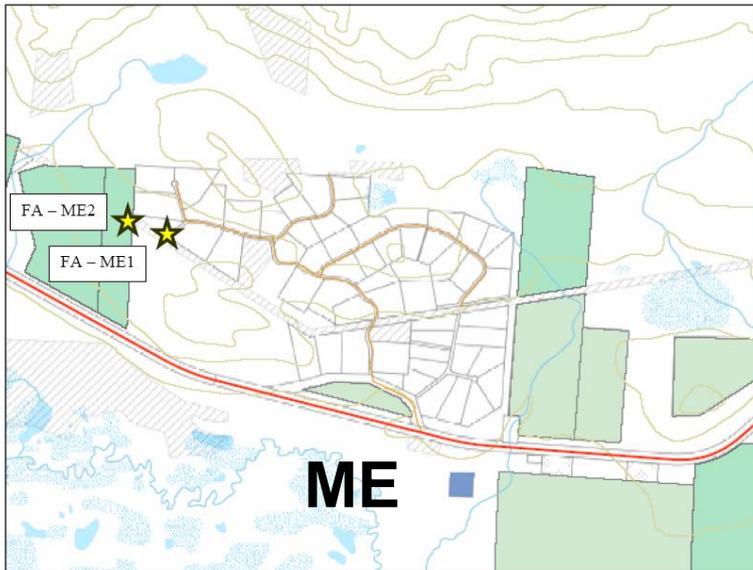


Figure 4 - FRATWG MacIntosh Map

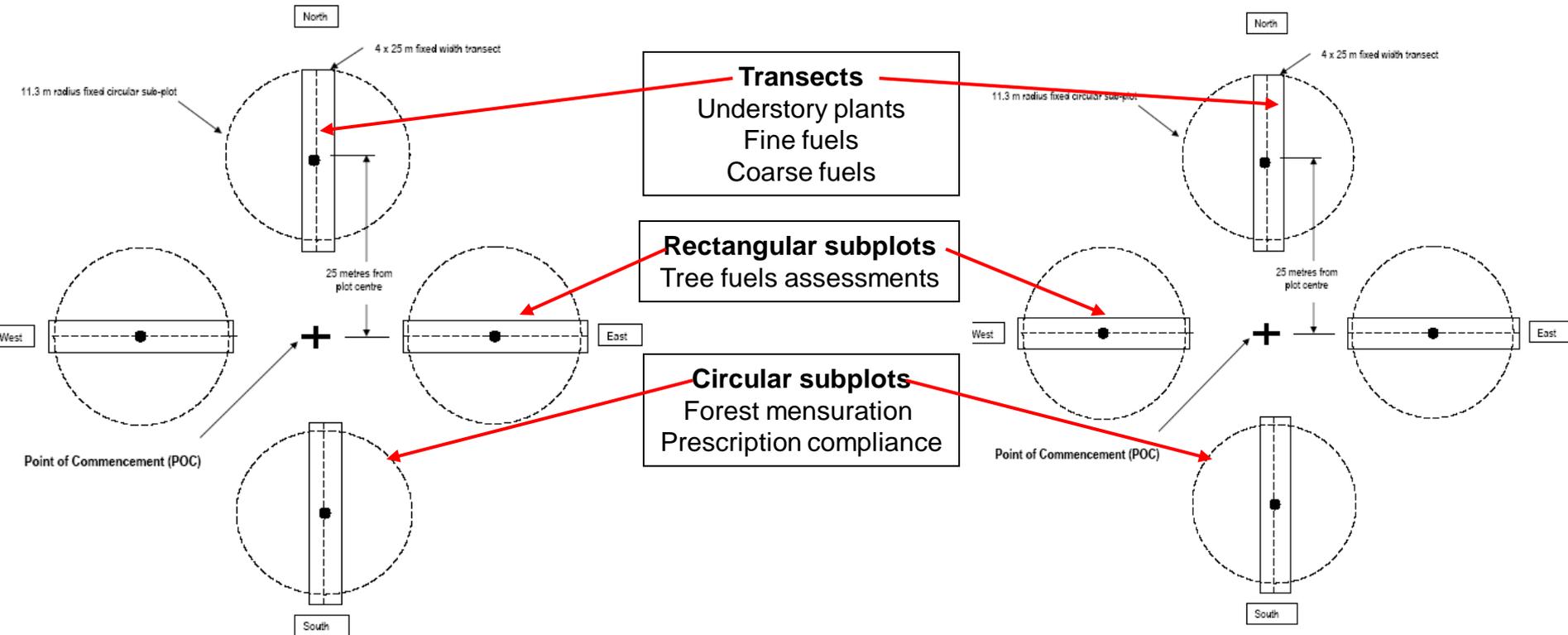


Monitoring Protocol: Monitoring Site Establishment



Figure 1: Monitoring Site Layout.

Figure 1: Monitoring Site Layout.



Stand Reconstruction

- Generate DBH and height of a tree from cut stumps
- Stump data sorted into size class, species, and live/dead (when cut)
- DBH calculated from stump diameter (DS) and stump height (SH)
 - $DBH = DS + b \cdot DS \cdot \text{Log}(10) \cdot [(SH+1)/2.3]$
- Tree height calculated using regression analysis of tree mensuration data from stand

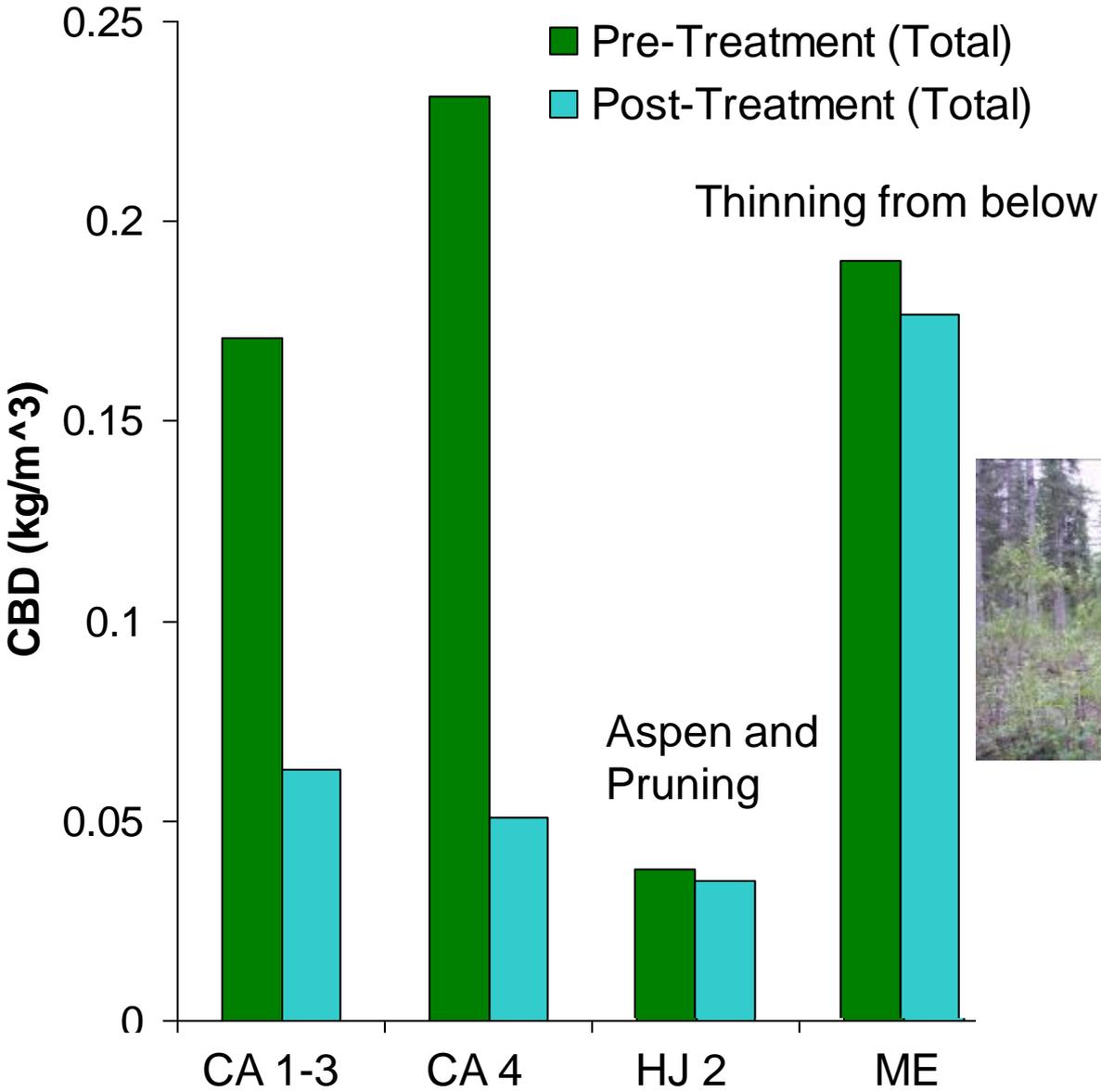


Canopy Bulk Density (CBD)

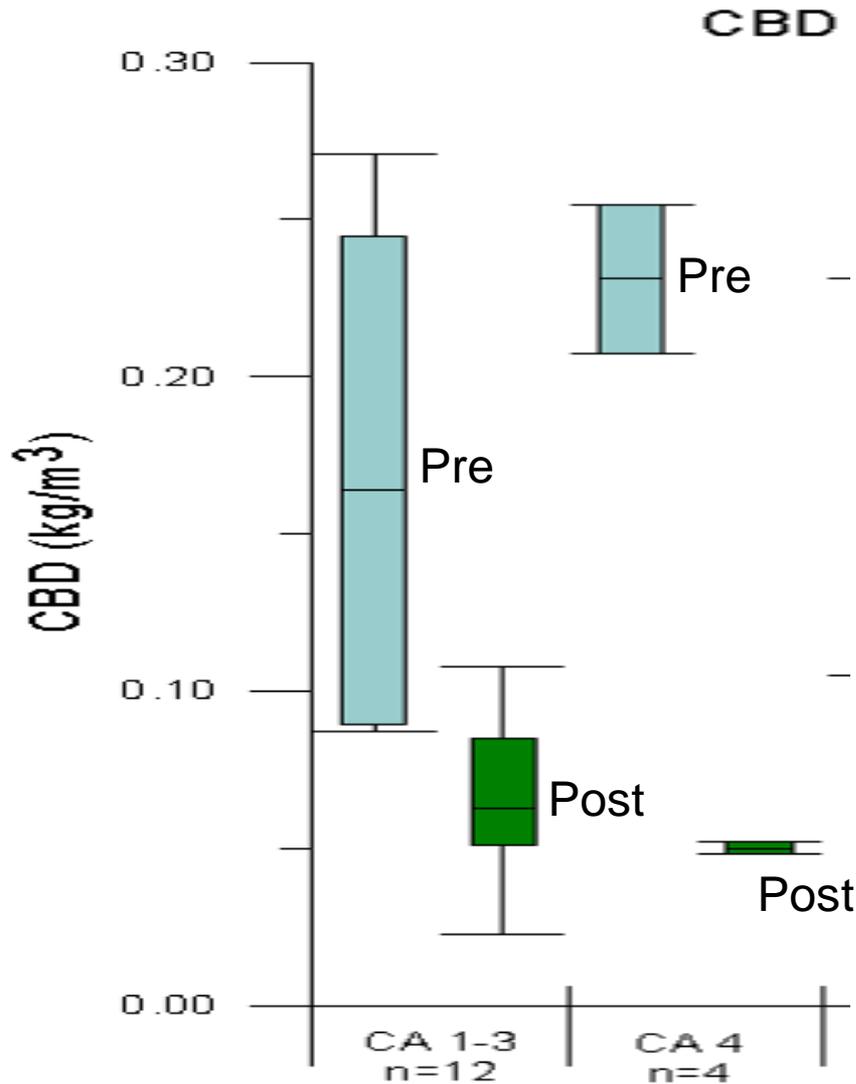
- $CBD = \text{Crown Mass} / \text{Plot Volume} \text{ (kg/m}^3\text{)}$
- Crown Mass (needles + <0.5cm branches + dead branches) = $a + bD^2H$
 - $D = \text{DBH}; H = \text{Height}$
 - $a, b = \text{constants obtained from Manning } et. al. 1984$
- $\text{Plot Volume} = \text{Plot Area} * \text{Canopy Length}$



Pre and Post CBD for Selected Treatment Areas



Variability in Pre and Post Canopy Bulk Density for Canyon 1-3 and 4



Crown Fuel Ignition Model - CFIM (Cruz et al 2006 IJWF)

Crown Fire Initiation and Spread CFIS software

(Alexander et al 2006, 5th International Conf. on Forest Fire Research)

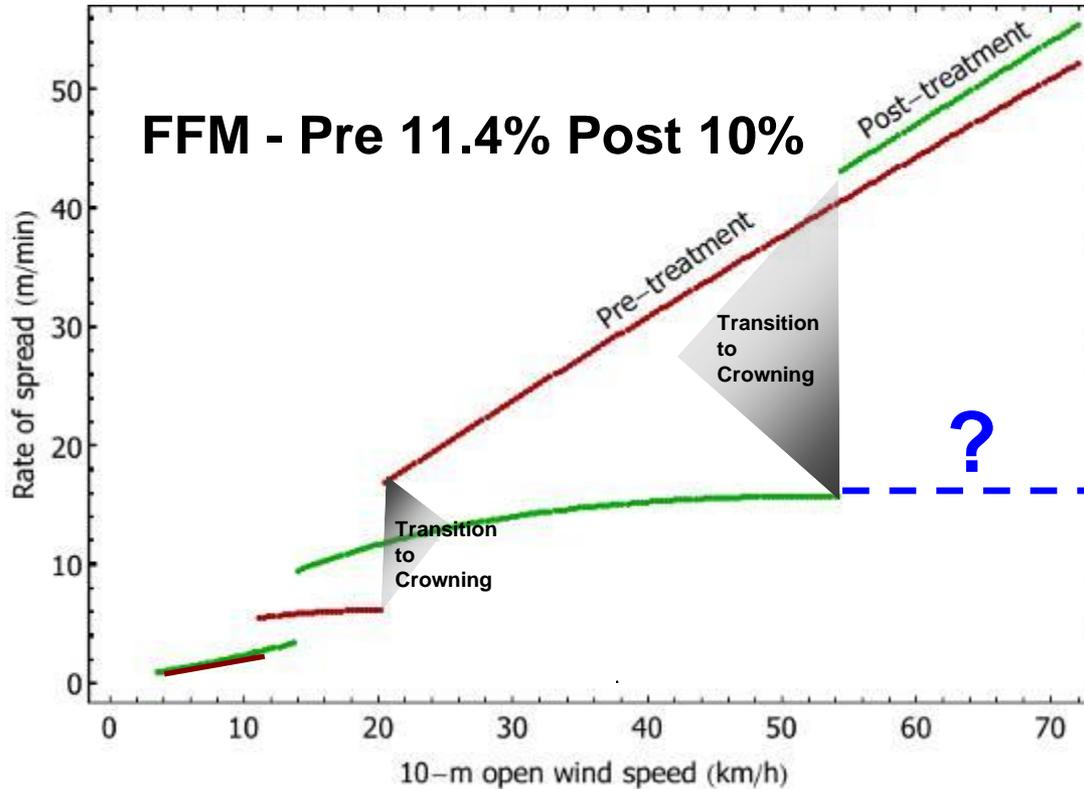


CFIS Main outputs:

- Likelihood of crown fire initiation and occurrence
- Type of crown fire (active vs. passive) and its rate-of-spread
- Minimum spotting distance required to increase a fire's overall forward rate-of-spread



Canyon 1-4 using CFIM



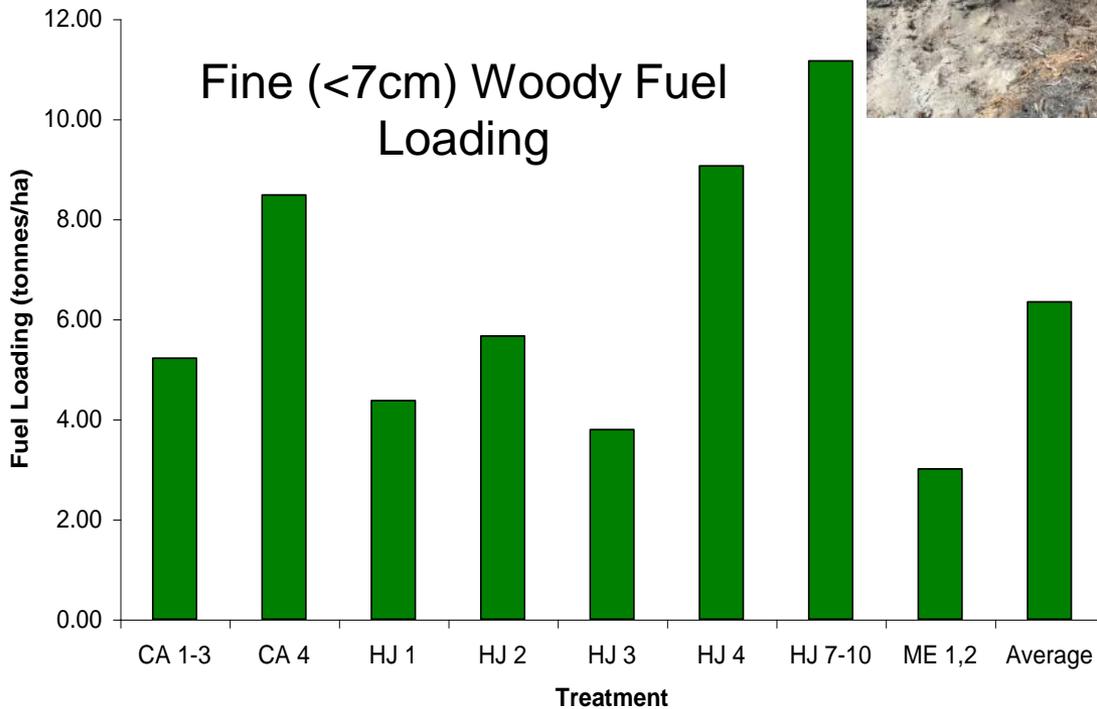
Threshold?

CBD that only passive crown fire or surface fire will be predicted?
0.05 kg/m³?

	Pre-Treatment	Post-Treatment	
Density (stems/ha) (Spruce)	1291	391	
Mean crown spacing (m)	Not Available	3.5	
LCBH (m)	0.80	3.0	
CBD (kg/m ³)	0.18	0.07	
Woody (kg/m ²) ≤7 cm	0.60 (post used)	0.60	

Ignition Probability

- In SW Yukon, hand piling slash and burning important to reduce surface fine fuel loading. Potential for tree fine root damage.



WFORG
 MOF
 CFS

Lodgepole Pine



Spotting and Fuel Treatments

Fuelbreak width in Canada 150-200m (Mooney 2010)

800 metre spotting on 1997 wildfire near Haines Junction – beetle killed trees and moderate fire danger



Maintenance and Monitoring



- **Frequency of re-assessment versus re-measurement? Depends on** ground disturbance, moisture regime and crown closure (shaded fuel breaks). Experience in SW Yukon is changes are relatively slow so 5 yr mark a good place to start.
- **What to measure? Priorities** **First:** surface flammable vegetation response (grass) and cured states. **Second:** windthrow, insect, and pile burning induced mortality. **Third:** potential disease problems from tree bole damage during pruning and harvesting operations. **Fourth:** Tree regeneration – ladder fuels

Two Case Studies of Jack Pine FireSmart Treatments in Canada's Northwest Territories

<http://fire.feric.ca/36162002/FireBehaviourInThinnedJackPine.pdf>



FOREST MANAGEMENT DIVISION
Environment and Natural Resources



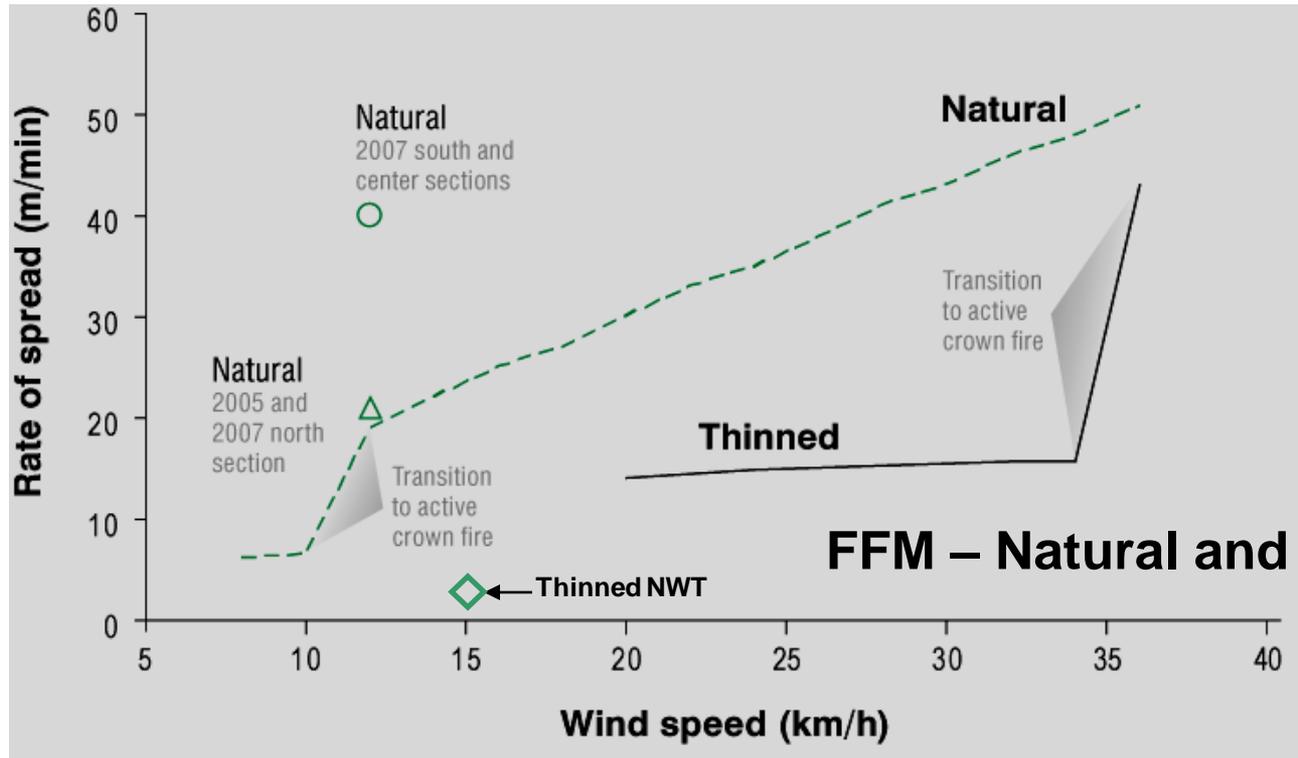
FPInnovations



Wildland Fire Operations Research Group

WFORG

Case Studies using CFIS software

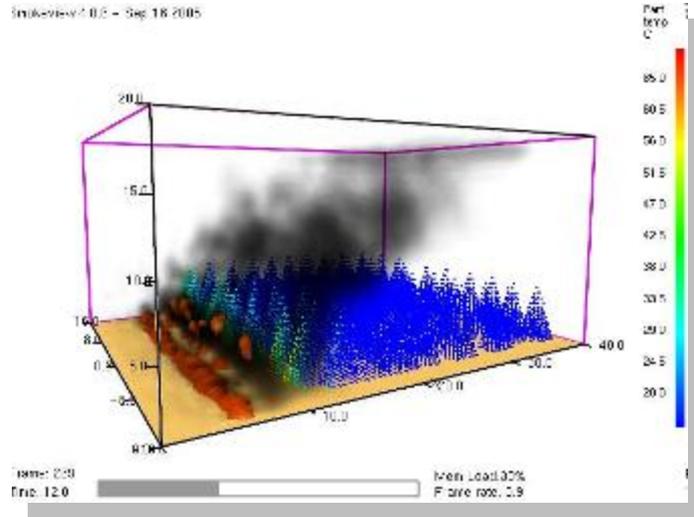


FFM – Natural and Thinned 8%

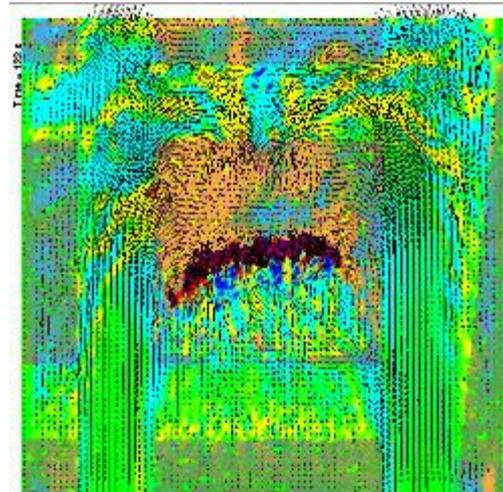
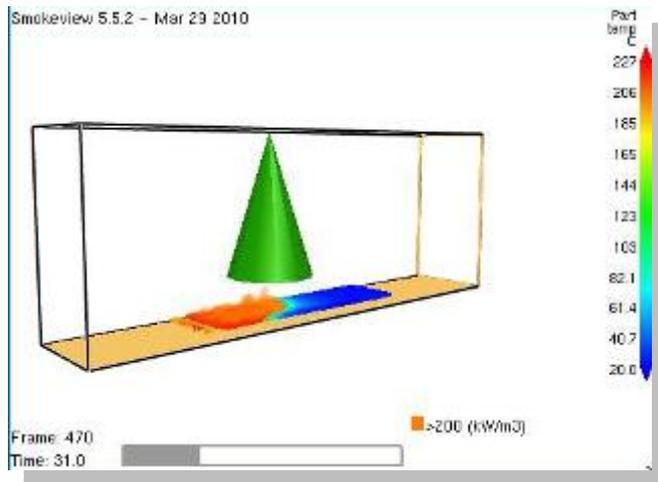
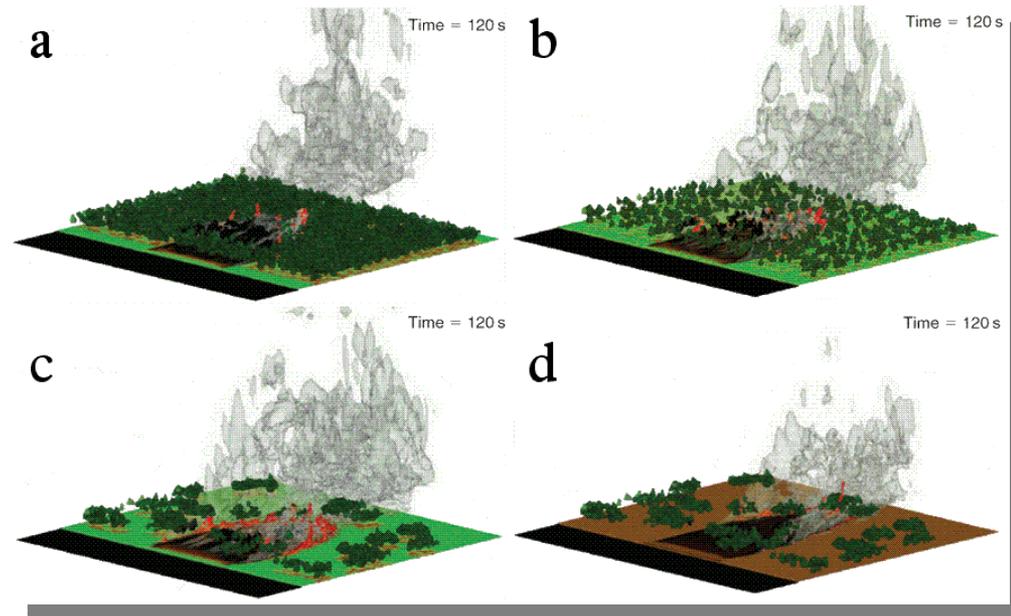
	Natural	Thinned
Density (stems/ha) (Jack Pine)	2340 to 5000	500
Mean crown spacing (m)	Not Available	3.6
LCBH (m)	0.80	9.8
CBD (kg/m ³)	0.16	0.07
Woody (kg/m ²) ≤7 cm	0.76	1.52

Other Models? Kerry Anderson CFS Edmonton AB

Wildland Fire Dynamics Simulator (NIST)



FIRETEC (LANL)



Questions?

