

# Lake States Fire Science Consortium

A JFSP KNOWLEDGE EXCHANGE CONSORTIUM



2014-2015 Webinar Series  
March 19, 2015

**Fire Monitoring: Fuels, vegetation, and fire behavior  
examples from red pine and jack pine burns**

Brian Stearns

Huron-Manistee National Forests

Audio will start at top of the hour.

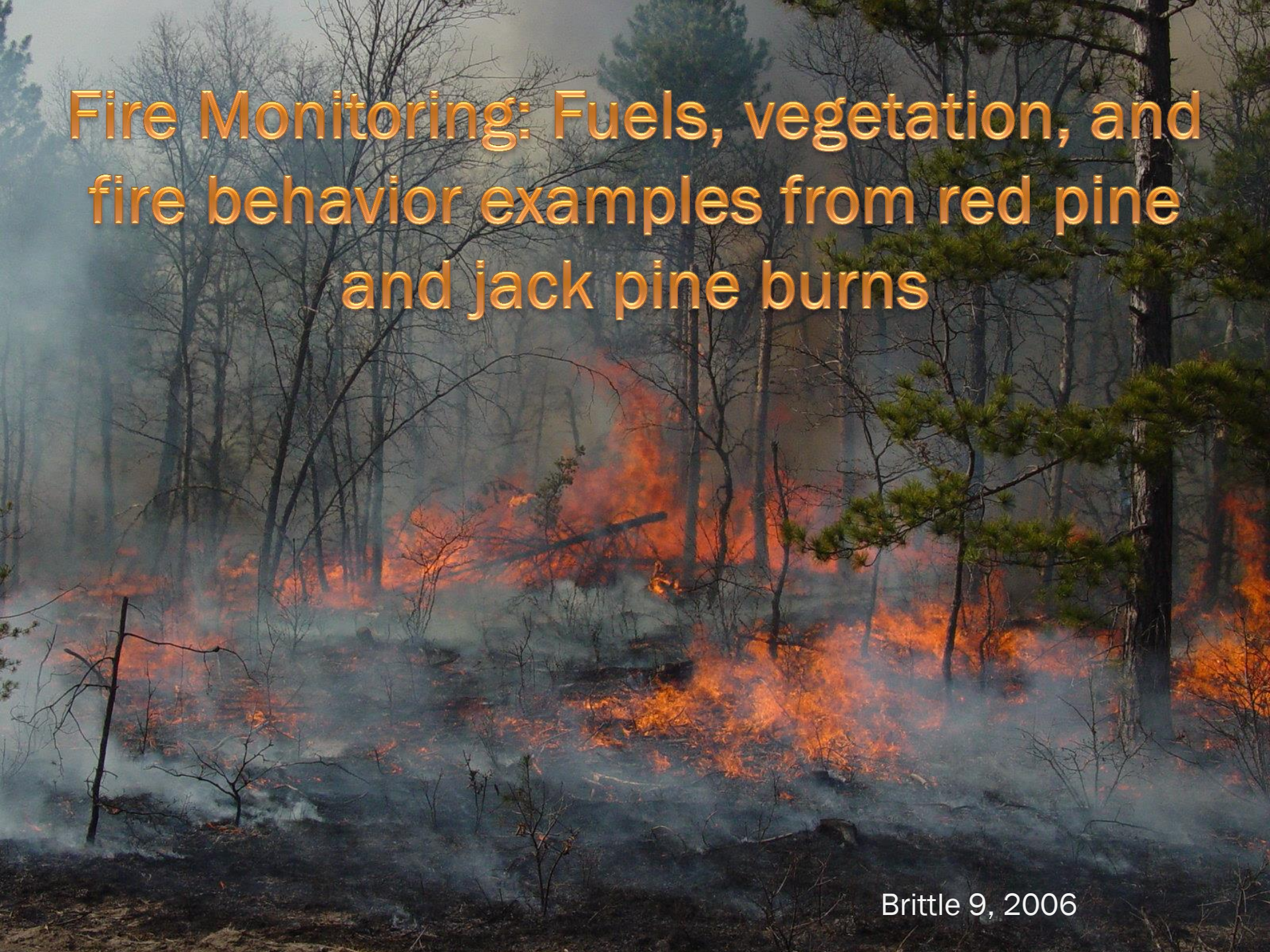
This webinar is listen only – to ask questions please use the chat box in lower right of screen.



@LSFireScience



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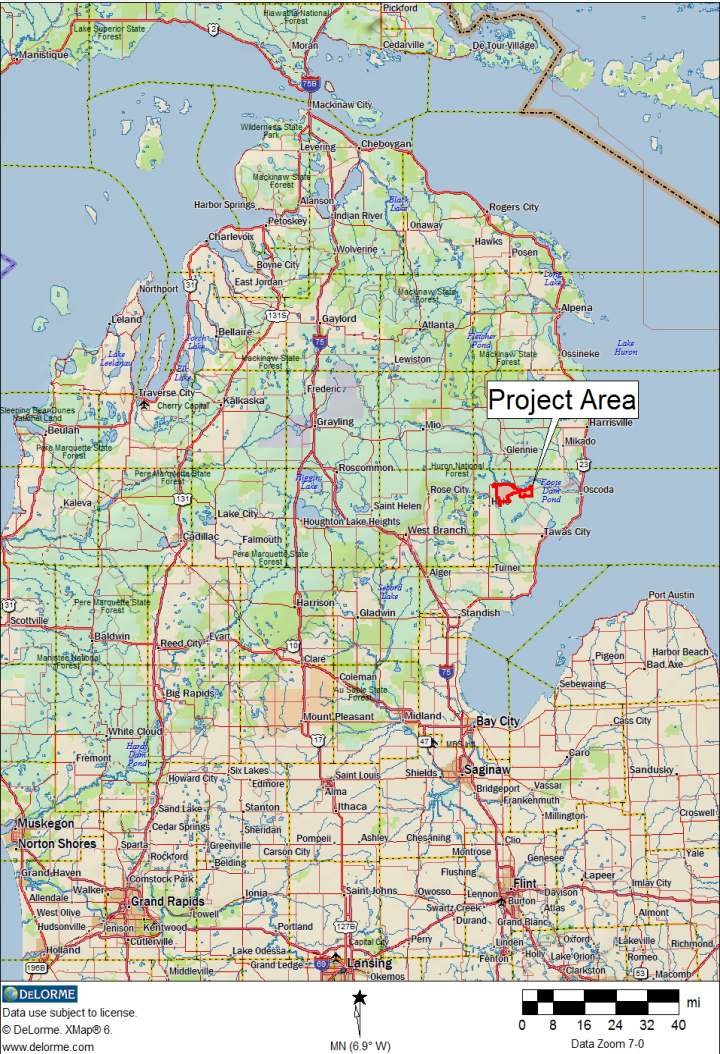


Fire Monitoring: Fuels, vegetation, and  
fire behavior examples from red pine  
and jack pine burns

Brittle 9, 2006

# Project Background

The Brittle and Memorable Projects are a landscape level reintroduction of fire to a red pine / jack pine dominated ecosystem. The goals of the projects are: Improve firefighter and public safety, reduce fuel loading, and restore fire adapted ecosystems.



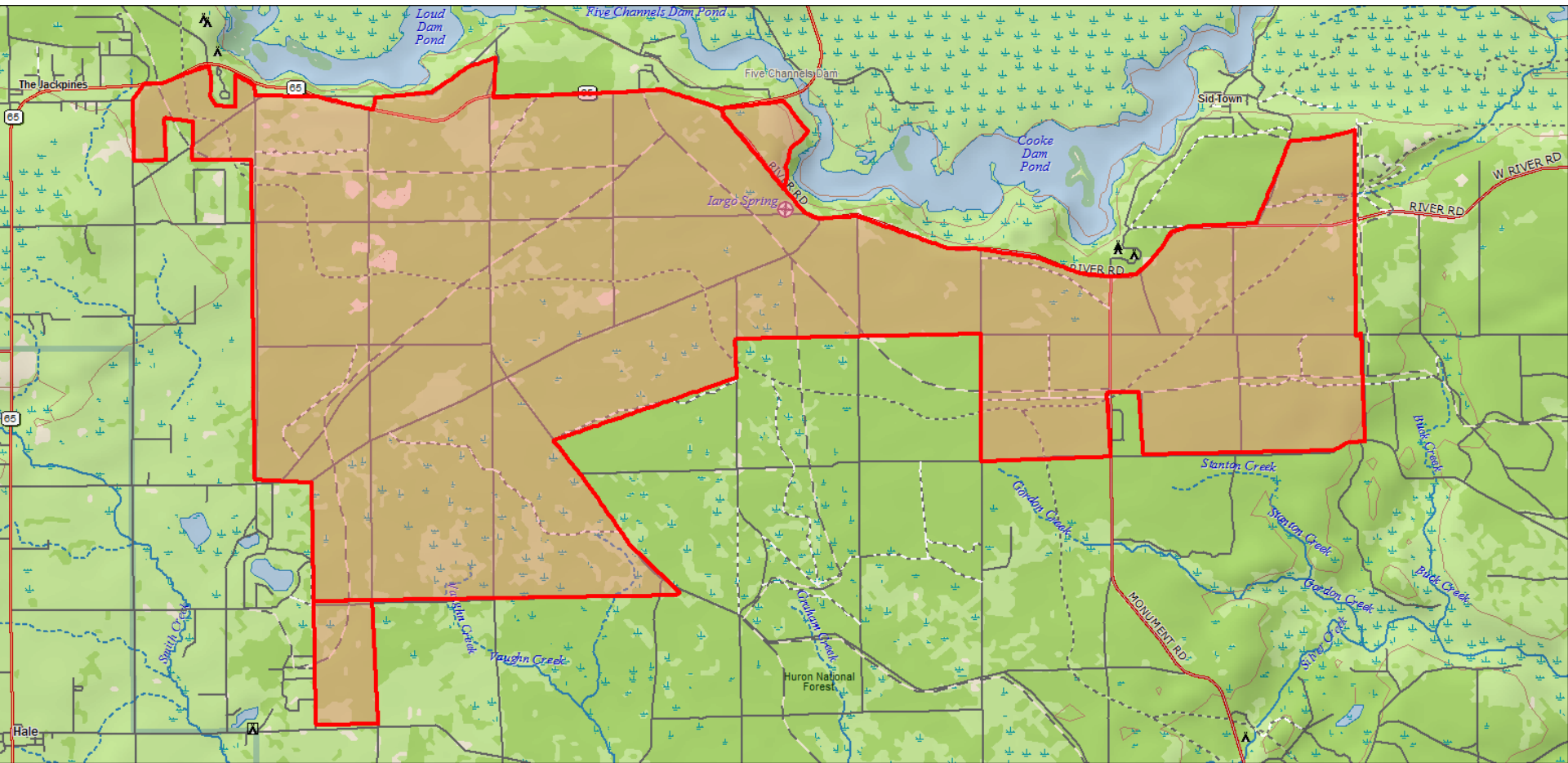
# Brittle and Memorable Landscape Prescribed Burn Projects

14,500+ Acres

Xeric Soils

Annual Precipitation is around 28-29"

Surface fuels are primal sedges, cool season grass, and blueberry





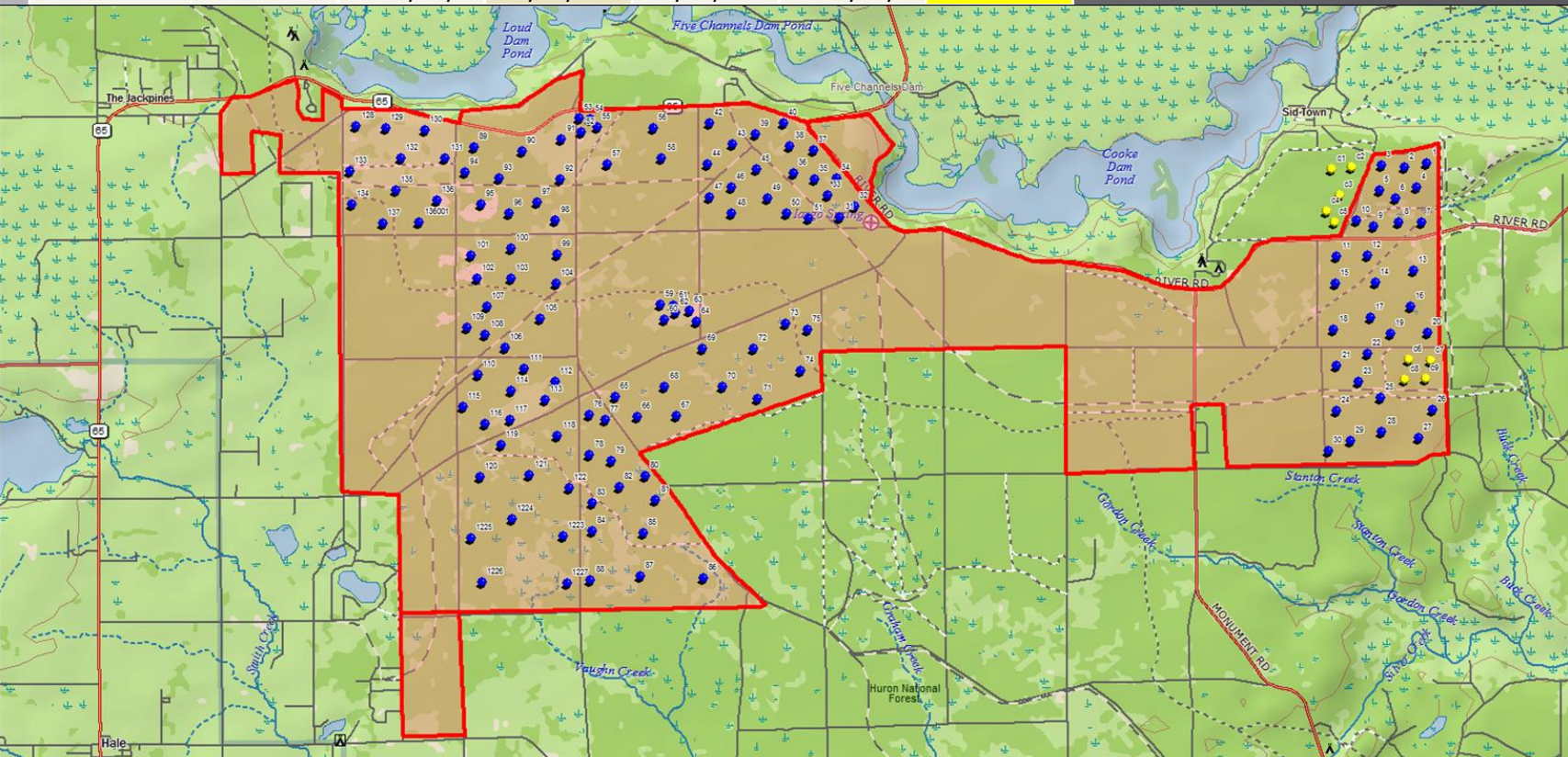
## Measurements

- Fuel loading
- **Duff / litter**
- Fire severity
- **Surface fire behavior potential**
- Photo series
- **Mortality / snag creation**
- Crown scorch
- **Bole char / char depth**
- Crown bulk density
- **Soils / carbon content**
- Vegetation mapping
- **Fire behavior**
- Smoke
- Needle Density

# Plot Measurement Schedule and Frequency

Burn Name	Primary Fuel Type	Pre-Burn Date	Last Burn Date	Mortality Study Date	Post-Burn Date	Next Measurement
Brittle Block 01	Red Pine Aspen	9/25/2008	4/28/2009	9/12/2010 6/06/2014	9/12/2010 6/06/2014	Year 2017
Brittle Block 09	Red Pine / Jack pine	5/7/2005	4/17/2008	06/24/09	6/24/2009	Year 20114
Brittle Block 10	Red Pine/ Jack pine	4/13/2014	4/28/2014	5/8/2014	5/8/2014	Year 2017
Brittle Block 12	Red Pine	09/28/06	4/24/2007	8/20/2009	08/20/09	Year 2015

Pre-Burn (1 year before)  
 Post- Burn (within 1 year)  
 Post- Burn 3-5 years



# PROTOCOLS

## Fire Monitoring Handbook. USDI National Park Service. 2003

After arriving at plot center, record the coordinates in either lat/long or UTM with the GPS. Also note the stand and compartment information (Figure 1). Fill in the header.

If wearing an analog watch, the azimuth of the 1<sup>st</sup> transect is chosen by the direction of the minute hand. A random azimuth for the 1<sup>st</sup> transect can be selected by choosing a number between 0 and 360. The other 3 transects are laid out clockwise at 90° angles from the previous transect: 1<sup>st</sup> transect = 161°, 2<sup>nd</sup> = 251°, 3<sup>rd</sup> = 341°, 4<sup>th</sup> = 71° (Figures 2 and 3). A random number generator has been provided (Table 1).

Place a permanent marker (stake, wire flag) at plot center. Measuring tapes should be laid out to 50' from plot center.

Record the length of transects for time lag fuels.

Transect lengths	Diameter of debris		
	0-1 in	1-3 in	>3 in
Downed material	6'	10-12'	35-50'
Nonslash (naturally fallen material)	6'	10-12'	35-50'
Discontinuous light slash	6'	10-12'	35-50'
Continuous heavy slash	3'	6'	15-25'

Record the azimuth and slope for each transect.

Record the number of intercepts for each time lag fuel class.

For the 1000+ fuels, a diameter and species is recorded for each intercept. The 1000+ fuels are also classified as "sound" or "rotten" and recorded in the appropriate column. If a species cannot be identified, note pine or hardwood.

Tally rules for fuel classes:

- Only **downed, dead woody material** from trees and shrubs on the litter layer are recorded. Do not record: *Leaves cones bark flakes needles grass forbs undisturbed stumps dead stems or branches still attached to standing trees or shrubs*
- Only record the 1-, 10-, and 100-hr fuels along the prescribed length of the transect (1-hr from 0-6').
- If a piece intersects the tape measure more than once, count all intercepts.
- If the end of a piece intersects the taper, only record it if the central axis is crossed.
- Estimate the diameter of rotten logs that fallen apart by visualizing a cylinder to contain the material.
- Downed material can be sample up to any height, so be sure to look up from the ground. An upper cutoff of 6' can be used; adjust as necessary in heavy slash.
- Record diameters of 1000+ fuels to the nearest whole inch.

Plot ID: _____	B/C (Circle One) _____	Date: ____/____/____							
Coordinates: _____	Recorders: _____								
Burn Unit: _____	Burn Status: Circle one and indicate number of times treated, e.g., 01-yr01, 02-yr01								
00-PRE _____	Post -yr01 -yr02 -yr05 -yr10 -yr20 Other: -yr; -mo								
Transect lengths, in feet: 0-.025" 0.25-1" 1-3" 3+s 3+r									
Transect 1 Azimuth °	# of intercepts	Diameter (in)	Litter and Duff Depths (in)						
Slope %	0-.25" (1-hr)	.25-1" (10hr)	1-3" (100hr)	3+s	3+r	L	D	L	D
			(1000hr)						
						1		25	
						5		30	
						10		35	
						15		40	
						20		45	

Litter and duff are also recorded at set intervals along the length of each transect (Figure 4).

The first measurement is taken 1 foot from the plot center and the next at the 5' mark. After that measurements are taken every 5 feet, ending at the 45' mark.

Tally rules for litter and duff:

- Record duff and litter measurements after fuel intercepts have been tallied.
- Record litter to the nearest whole inch.
- Measure duff to the nearest 0.1 inch or .25 inch (depending on ruler used).
- Litter is still recognizable as its former self before death (it still looks like a needle).
- Duff is the decomposed litter (it is no longer recognizable as a needle).
- When stumps, logs and trees occur at the points of measurement, offset 1' perpendicularly to the right.
- Measure through rotten logs whose central axis is in the duff layer.



# Data Collection



Brown's Fuel Transect Fuel Load Calculator			Brittle Block 10 Averages of plots				
	PostBurn		5/29/2014				
Note: Transect lengths are in feet; 1000 hr fuel diameters, duff and litter depths are in inches							
Required Field	Optional Defaults	Products					
Slope %***	0						
	Length ft	n=Count	d2 *	s**	Tons/Acre	Kg/m2	
1 hr	16	2.25	0.031	0.61	0.032	0.007	
10 hr	80	1.875	0.242	0.53	0.036	0.008	
100 hr	80	0.5	2.518	0.49	0.092	0.021	
	Sum d <sup>2</sup> (Below)						
1000 hr Solid	240	3	53.25	0.30	0.775	0.174	
1000 hr Rotten	240	5	73.00	0.46	1.629	0.365	
	Bulk Density (lb/ft3)						
Litter loading	2.50				1.418	0.318	
Duff loading	4.30				8.414	1.886	Inches cm
Litter depth	0.31						0.313 0.794
Duff depth	1.08						1.078 2.738
Total Fine					0.159	0.036	
Total Heavy					2.403	0.539	
Total Litter/Duff					9.832	2.204	
Grand Total					12.394	2.778	

Plot	Date	Tree #	Tree Sp	DBH	Tree Height	CBH	Crown Ratio %	Crown Class	Crwn Scorch (% Live)	Total Bole Char	Min. Bole Char	char depth 10th "	Live / Dead	Insect Activity	Decay	Cavity	Remarks
BR10-1	5/29/2014	1	RP	15.2	28	18	60	CO	100	4	1	0.12	L	N	N	N	
		2	OAK	15	27	N/A	0	CO	N/A	4	1	0.08	D	N	N	N	
BR10-10	5/29/2014	1	RP	9	30	4	90	CO	90	6	0.5	0.16	L	N	N	N	MECH. SCAR
		2	RP	11	30	20	50	CO	100	6	0.5	0.12	L	N	N	N	MECH. SCAR



# Burn Day Data



Fire behavior from aerial ignition Slash Model 2 (SB2). Flame Length 7'

DATE	Burn Name	Time of Burn	Day of Last Rain	Rain (in)	Temp (F)	Rh %	Wind Spd	Wind Dir	F.L. (ft)	R.O.S (ft/min)	Notes	Acres	Est. Mortality
4/19/2014	Brittle Block 20	16:30-19:30	4/14/2014	0.7	44-51	40-57	0-8	SE & E	1 to 6'	1 to 2	Strip head fire w/ Heli, lake wind	1017	<1%
4/19/2014	Brittle Block 18	16:30-19:30	"	"	44-51	40-57	0-8	SE & E	1 to 6'	1 to 2	Strip head fire w/ Heli	356	<1%
4/19/2014	Brittle Block 10	16:30-19:30	"	"	44-51	40-57	0-8	SE & E	1 to 6'	1 to 2	Strip head fire w/ Heli	637	<1%
4/27/2014	Brittle Block 3	13:45-17:54	4/25/2014	0.1	48-52	31-48	0-10	S to NE	1 to 5'	.5-1.5	Strip head fire w/ Heli, lake wind	648	<1%
4/27/2014	Brittle Block 4	13:45-17:54	"	"	48-52	31-48	0-10	S to NE	1 to 5'	.5-1.5	Strip head fire w/ Heli	553	<1%
4/27/2014	Brittle Block 5	13:45-17:54	"	"	48-52	31-48	0-10	S to NE	1 to 5'	.5-1.5	Strip head fire w/ Heli	579	<1%
5/5/2014	SBWH Block 2	11:27-1345	2 days	0.44"	48-52	39-51	3 to 10	Se-E	0.5-3'	0.5-1.5	ATV torch, lake wind	195	1%
5/5/2014	SBWH Block 3	15:00-17:35	2 days	0.44"	48-52	39-51	3 to 10	Se-E	0.5-3'	0.5-1.5	ATV torch	80	2%

# Photo Plots

MEMORABLE UNIT 1

PLOT 3 05/12/2005

TRANSECT 2

POST BURN (2wks)

FIRST VISIT 07/16/2004 BURN 4/30/2005



Pre Burn

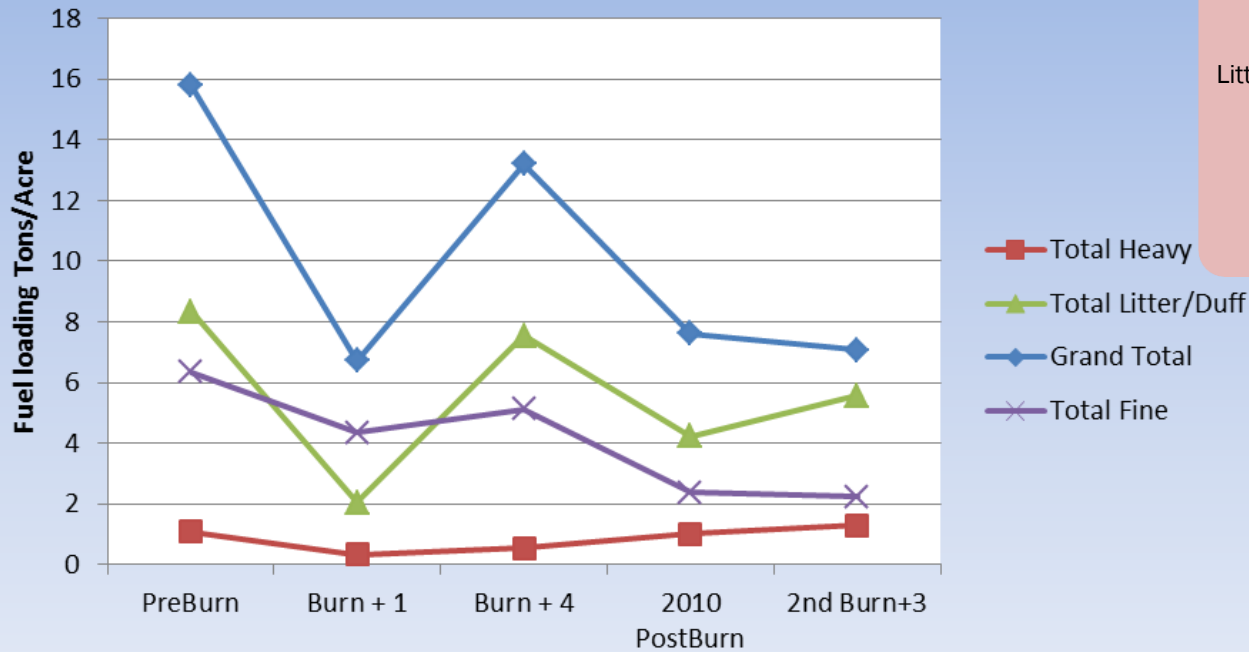


Post Burn

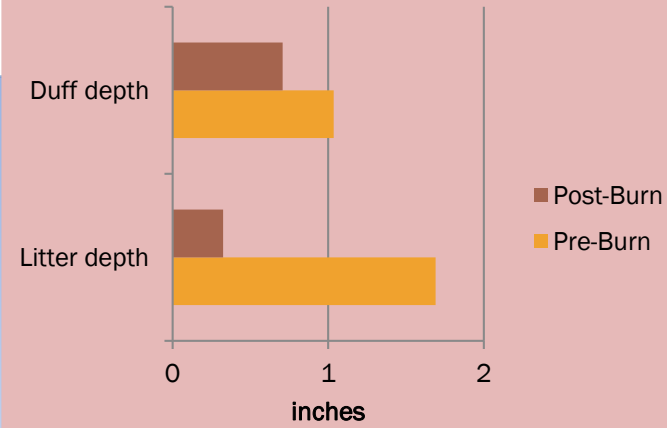


# Results

## Memorable North Fuel Loading



## Project Litter / Duff Depth



	Pre-Burn		
	Blk 4	Blk 10	Ave
Litter loading	7.297	9.035	8.166
Duff loading	6.882	11.426	9.154
	Post-Burn		
Litter loading	1.992	1.485	1.739
Duff loading	4.206	8.475	6.341

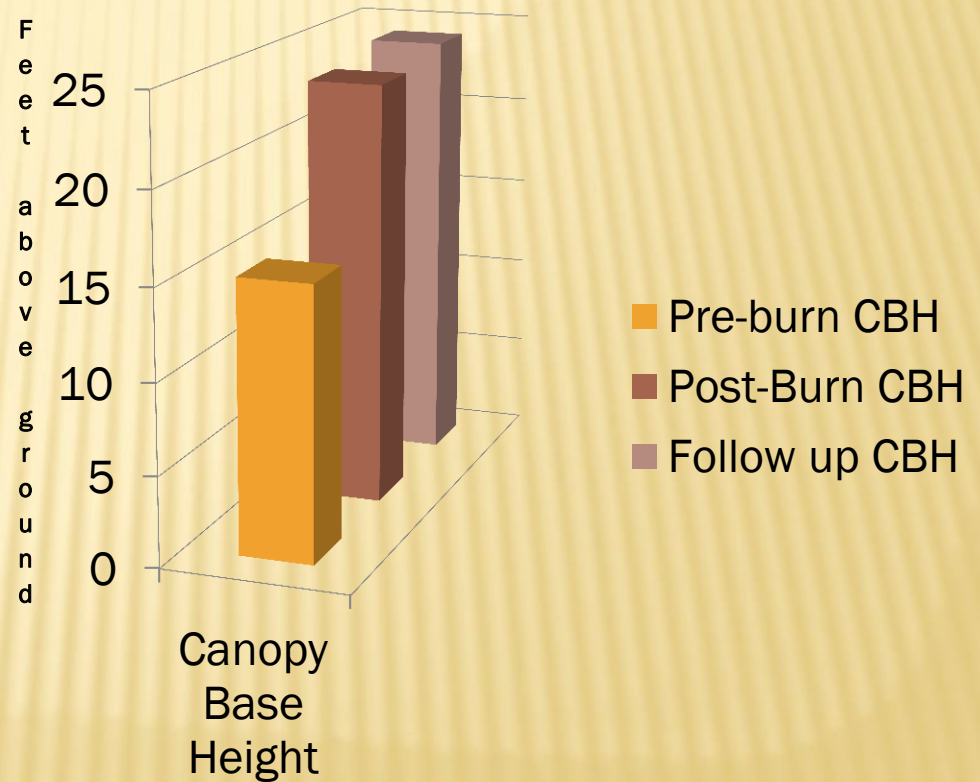
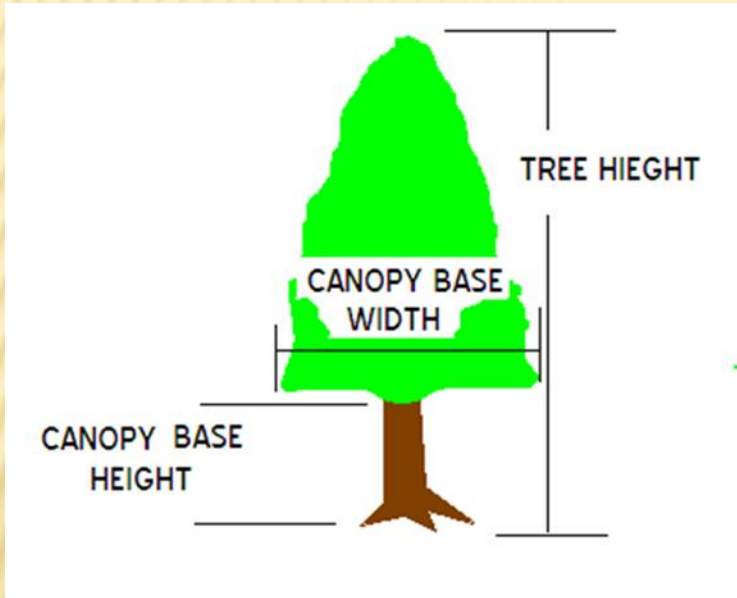


Jack pine =1,403.95 acres (largest stand is 246.1 acres)

White pine =26.4 acres

Aspen (Quaking and trembling) = 252.5 acres (largest stand is 52.2 acres)

Oak (Black or Northern Pin) = 301.0 acres (largest stand is 120.1 acres)



Average Crown Scorch	Average DBH	Average Tree Height
11.40%	11.06	39.4

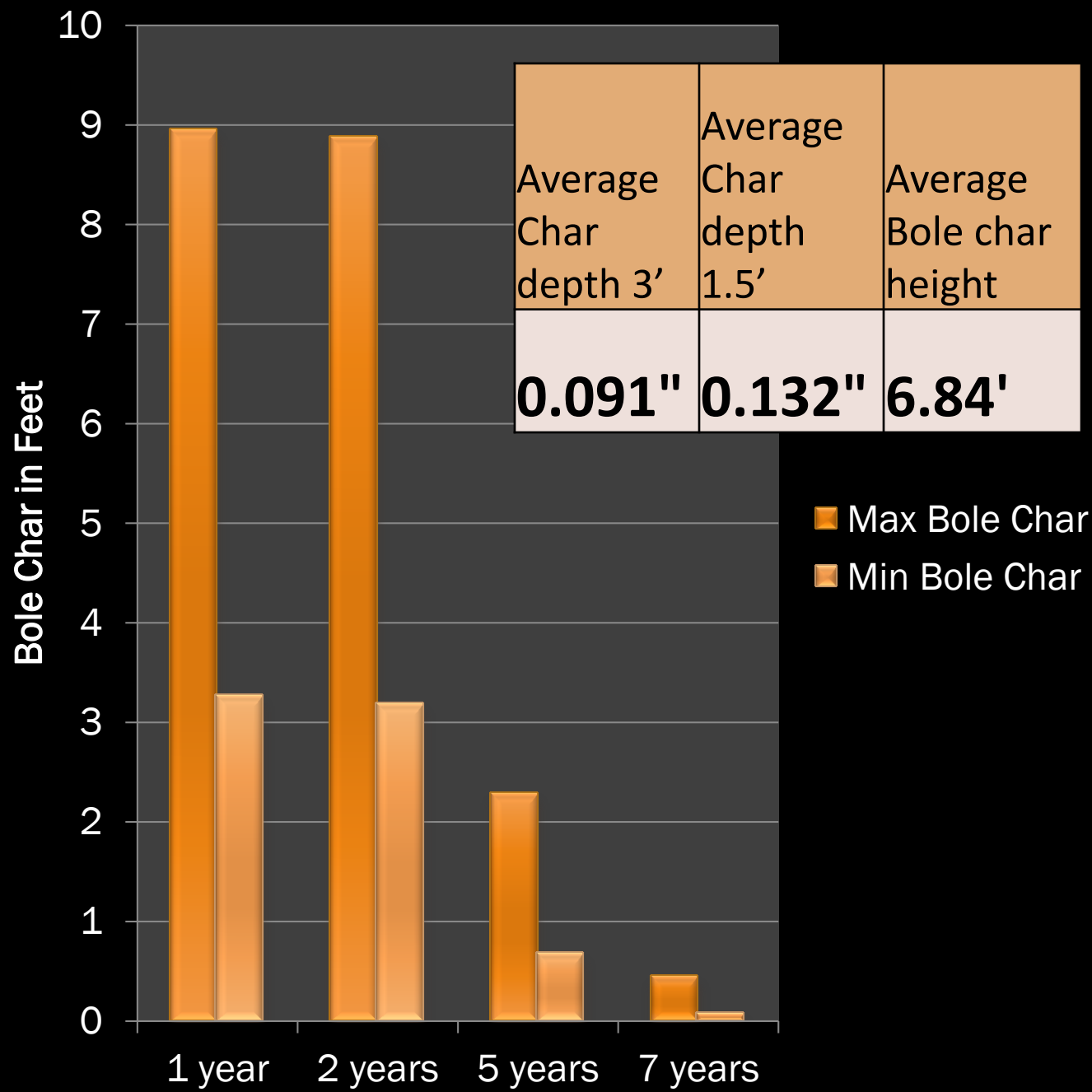


1 year Post-Burn



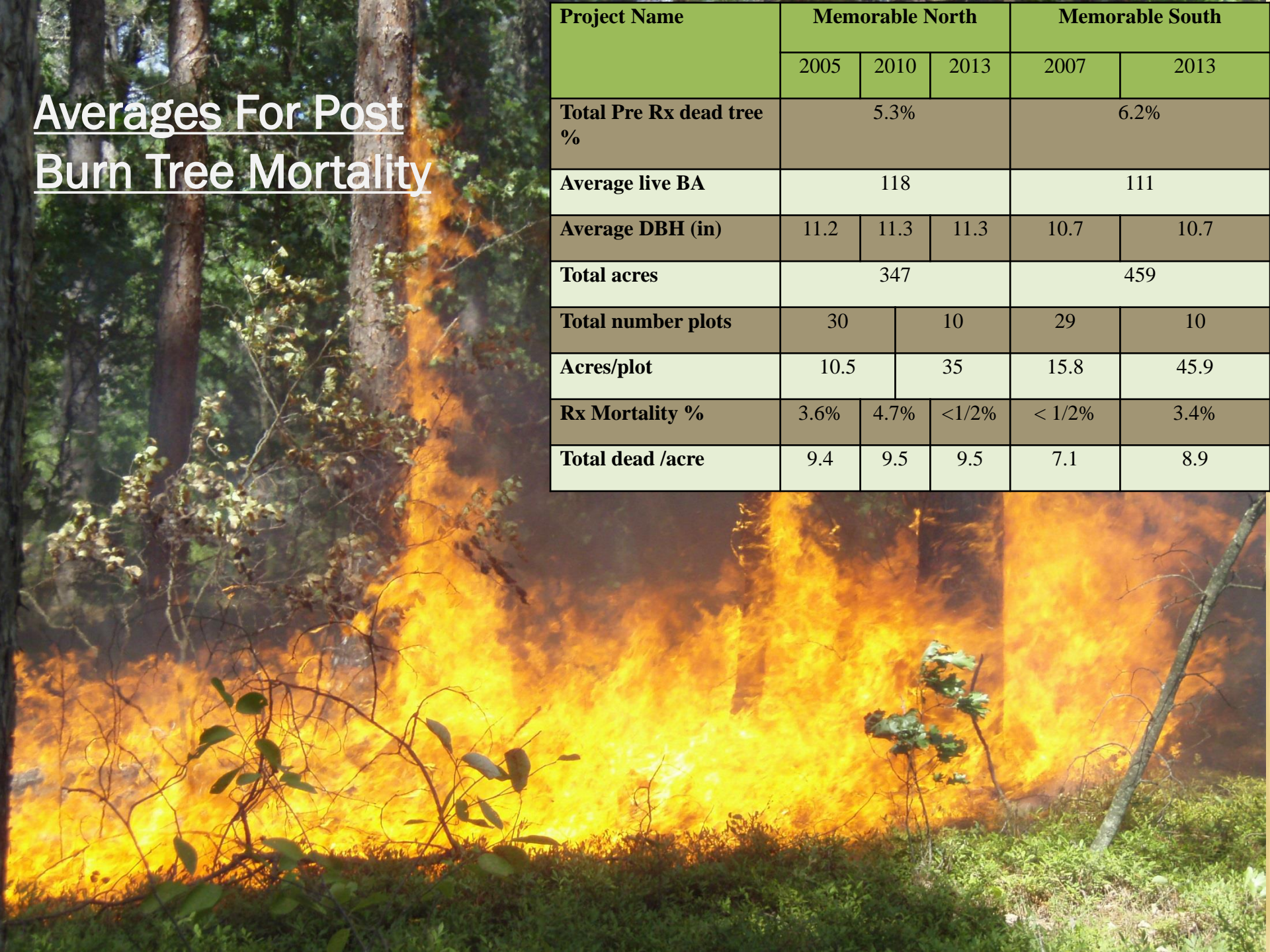
7 years Post- Burn

# Bole Char in Red Pine



# Averages For Post Burn Tree Mortality

Project Name	Memorable North			Memorable South	
	2005	2010	2013	2007	2013
<b>Total Pre Rx dead tree %</b>	5.3%			6.2%	
<b>Average live BA</b>	118			111	
<b>Average DBH (in)</b>	11.2	11.3	11.3	10.7	10.7
<b>Total acres</b>	347			459	
<b>Total number plots</b>	30		10	29	10
<b>Acres/plot</b>	10.5		35	15.8	45.9
<b>Rx Mortality %</b>	3.6%	4.7%	<1/2%	< 1/2%	3.4%
<b>Total dead /acre</b>	9.4	9.5	9.5	7.1	8.9





### Canopy stratum - Trees: Live trees

#### Total Canopy Cover

	Mode	Min	Max
Total percent cover ( % )	40.0	5.0	80.0

not present

#### Overstory

	Mode	Min	Max
Percent cover ( % )	40.0	5.0	80.0
Height ( ft )	40.0	25.0	70.0
Height to live crown ( ft )	15.0	10.0	40.0
Density ( #/acre )	35.0	5.0	100.0
Diameter at breast height ( in )	10.0	5.0	15.0

Scientific Name	Rel Cover
<i>Quercus ellipsoidalis</i>	45
<i>Quercus velutina</i>	25
<i>Pinus banksiana</i>	5
<i>Quercus alba</i>	25

Total relative cover ( % ) 100

100% required for Relative Cover

not present

#### Understory

	Mode	Min	Max
Percent cover ( % )	not pres...	0.0	0.0
Height ( ft )	not pres...	0.0	0.0
Height to live crown ( ft )	not pres...	0.0	0.0
Density ( #/acre )	not pres...	0.0	0.0
Diameter at breast height ( in )	not pres...	0.0	0.0

Scientific Name	Rel Cover

Total relative cover ( % ) 0

#### Midstory

	Mode	Min	Max
Percent cover ( % )	not pres...	0.0	0.0
Height ( ft )	not pres...	0.0	0.0
Height to live crown ( ft )	not pres...	0.0	0.0
Density ( #/acre )	not pres...	0.0	0.0
Diameter at breast height ( in )	not pres...	0.0	0.0

Scientific Name	Rel Cover

Total relative cover ( % ) 0

100% required for Relative Cover

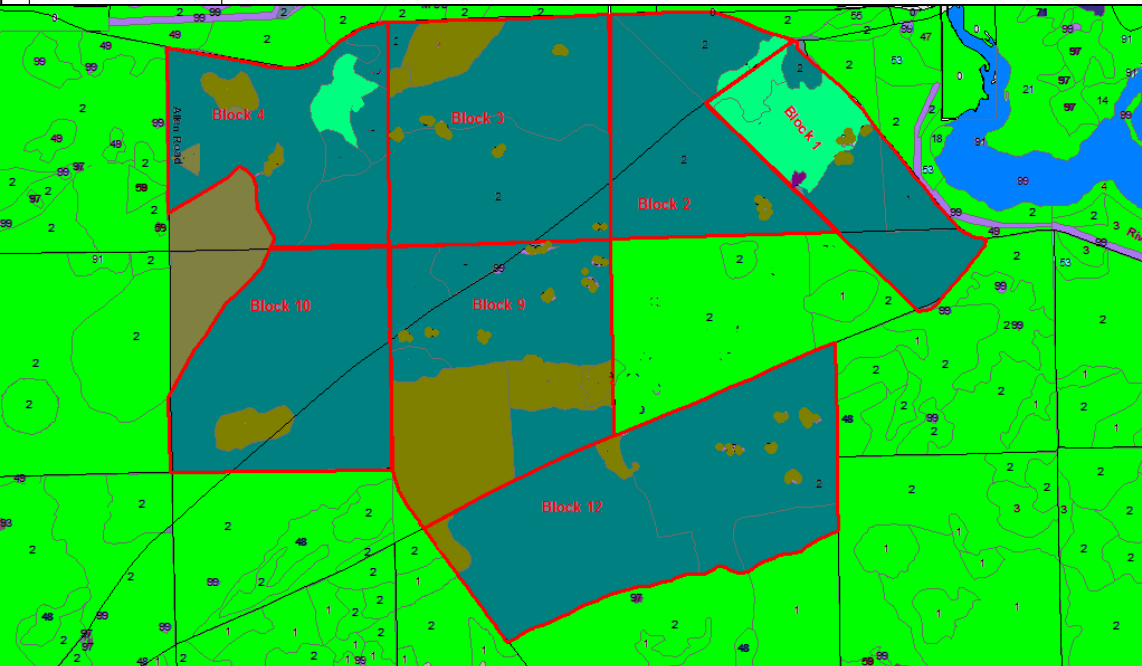
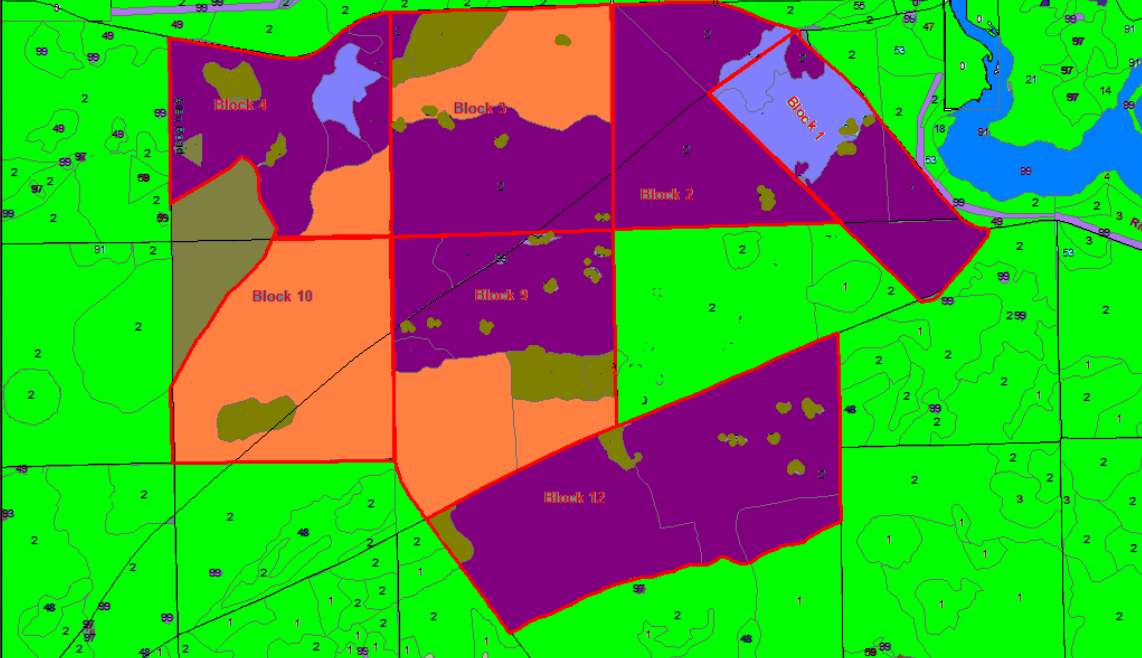
not present

- Fire Potential
- Surface Fire Behavior
- General
- Strata & Categories
- Carbon



# FUELS MAPPING

- ✘ Fire behavior modeling
- ✘ Tracking changes in fuel models



**Author:** Brian Stearns

**Date:** Jan 28 2011 - 12:51 AM

**Fuelbed Name:** Red pine – pin oak Brittle with Slash

**Fuelbed Number:** N/A

**File Name:** C:\FCCS\conf\fuelbeds\user\_fuelbeds\Brittle\_slash.xml

**Data quality ranking:**

**Original FBPS fuel model (13)\*:** 9

**Standard fuel model (40)\*:** TU2

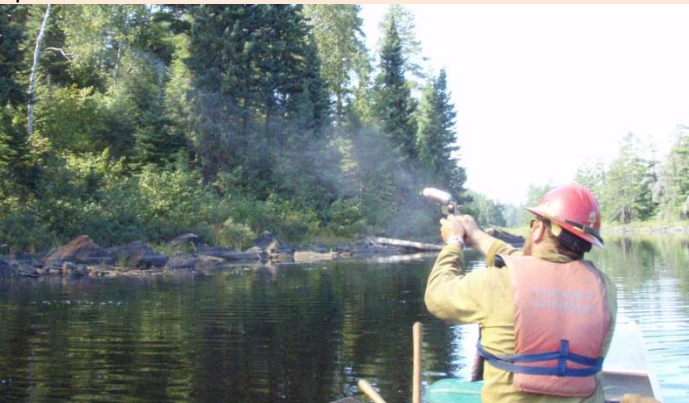
**Description:** Red pine plantation that were typically planted in the 1930's & 40's. Dense stands on poor sandy soils.

<b>Surface Fire Behavior Potential</b>	<b>6</b>	Summary surface fire behavior potential, calculated as the maximum of spread potential and flame length potential scaled to an index between 0-9.
Reaction Potential	4.9	Approximates the potential reaction intensity (energy released per unit area and time).
Spread Potential	5.6	Proportional to the no-wind rate of spread in surface fuel (distance per unit time).
Flame Length Potential	3.8	Proportional to fireline intensity or flame length.
<b>Crown Fire Potential</b>	<b>5</b>	Weighted average of crown fire subpotentials.
Crown fire initiation potential	4.3	Potential for fire to reach canopy layer.
Crown-to-crown transmissivity potential	8.8	Potential for fire to carry through a canopy.
Crown fire spreading potential	3.3	Relative index of crown fire rate of spread.
<b>Available Fuel Potential</b>	<b>3</b>	Sum of fuel loadings in all combustion phases scaled to an index between 0-9.
Flame available fuel potential	1.9	Sum of fuel loadings available for the flaming phase of combustion (in units of 10 tons/acre).
Smoldering available fuel potential	1.2	Sum of fuel loadings available for the smoldering phase of combustion (in units of 10 tons/acre).
Residual Available Fuel	0.2	Sum of fuel loadings available for the residual smoldering phase of combustion (in units of 10 tons/acre).
<b>FCCS Fire Potential Code</b>	<b>653</b>	Three-digit code representing the surface fire behavior, crown fire, and available fuel potentials.

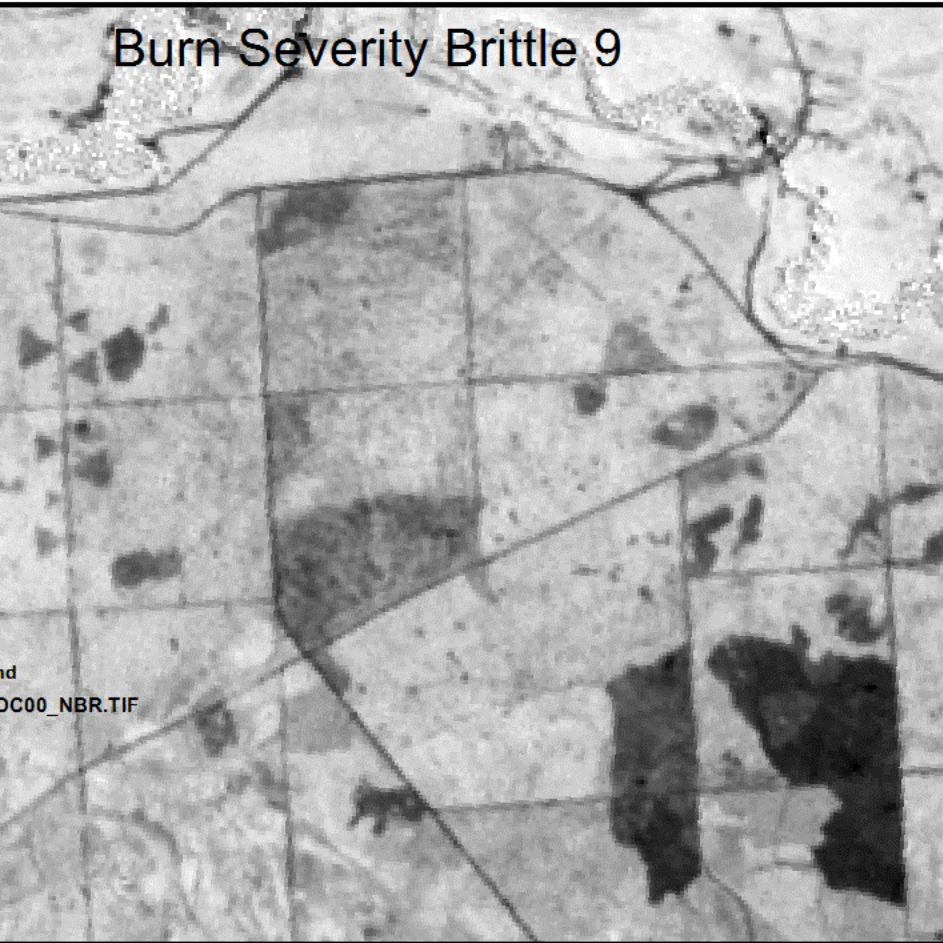
\*Based on dry fuel conditions (D2L2 moisture scenario) FCCS v 2.1

# Fuel Potential for Brittle (Pre and Post-Burn)

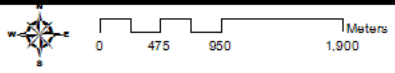
Fuel bed	Fuel Model	Surface Fire Potential (1-9)	Crown Fire Initiation Potential (1-9)	Available Fuel Potential (1-9)	FCCS Fire Potential Code
Opening in Brittle Pre-burn	<b>TU2</b>	<b>5</b>	<b>6</b>	<b>4</b>	<b>564</b>
Opening in Brittle Post-burn	<b>TU2</b>	<b>6</b>	<b>4</b>	<b>2</b>	<b>642</b>
Red Pine-Oak Brittle pre-burn	<b>TL9</b>	<b>6</b>	<b>5</b>	<b>3</b>	<b>653</b>
Red Pine-Oak Brittle post-burn	<b>TL8</b>	<b>5</b>	<b>4</b>	<b>2</b>	<b>542</b>
Red Pine with slash pre-burn	<b>SB2</b>	<b>6</b>	<b>7</b>	<b>3</b>	<b>673</b>
Red Pine with slash post-burn	<b>TL8</b>	<b>5</b>	<b>4</b>	<b>2</b>	<b>542</b>
Red Pine with Aspen pre-burn	<b>TL6</b>	<b>4</b>	<b>5</b>	<b>3</b>	<b>453</b>
Red Pine with Aspen post-burn	<b>TL5</b>	<b>4</b>	<b>4</b>	<b>2</b>	<b>442</b>



Burn Severity Brittle 9

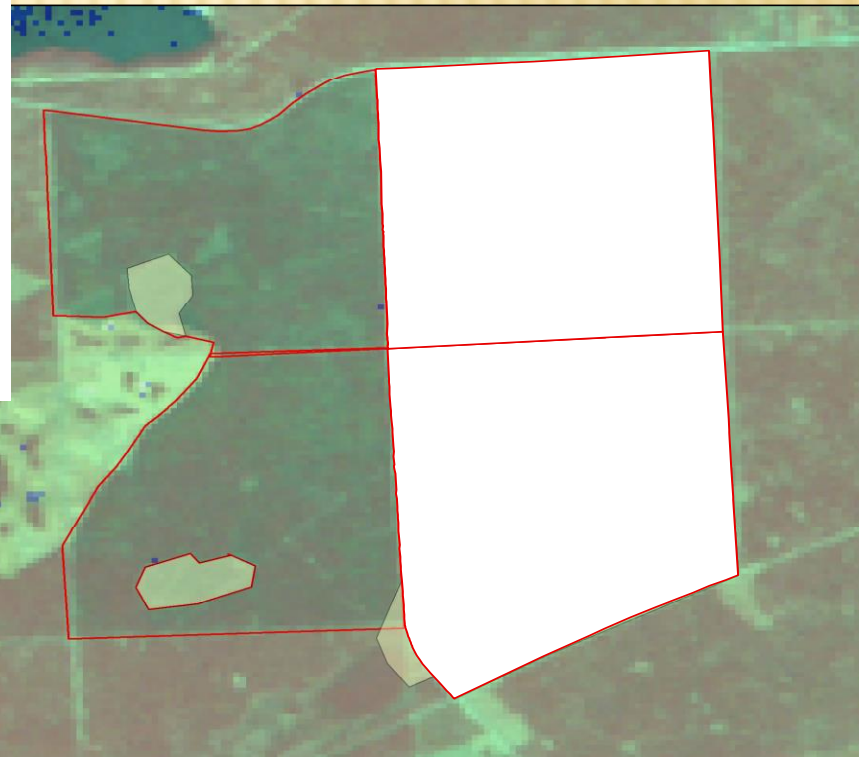


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# Burn Severity Mapping

Brittle Block Burn Intensity Map



# Questions?



# Lake States Fire Science Consortium

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## Next Webinar:

April 16, 2015 at 2:00 PM Eastern (1:00 PM Central)

## Easy-to-Use Smoke Tools

Trent Wickman

Air Resource Management

Great Lakes National Forests - Eastern Region



@LSFireScience



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