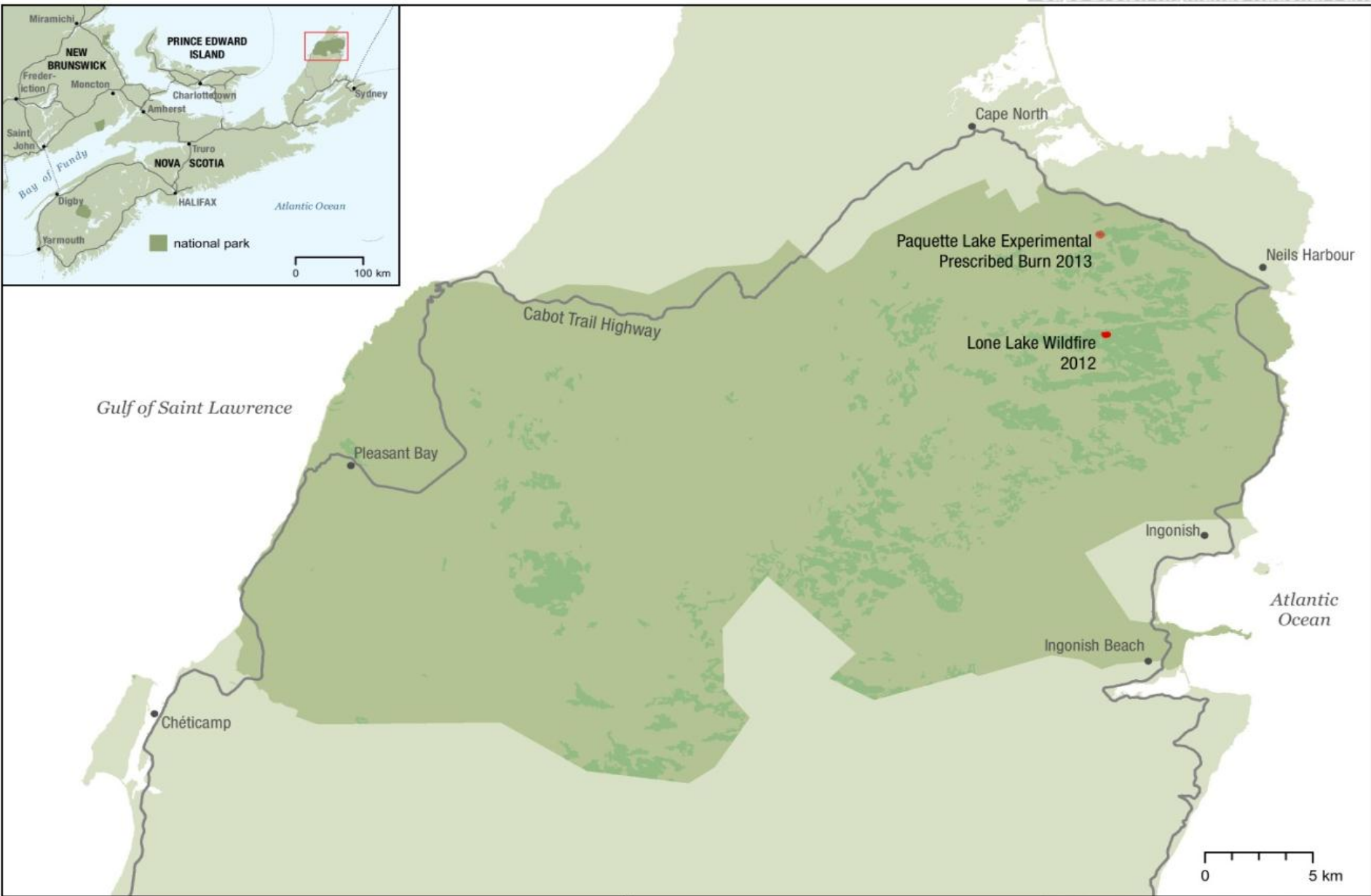




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 **NOVA SCOTIA** CANADA

# Nova Scotia Special Fuel Type Fire Behaviour Study



● community    ● burn location    ■ NS-1 barrens    ■ Cape Breton Highlands National Park

Projection / Grid / Datum : UTM Zone 20 / 30m / NAD83



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# GOALS

- Lead to **safer and more effective** fire control in a non standardized fuel type
- Better understand the role of fire in the taiga and establish thresholds for prescribed fire operations aimed at **restoring ecosystems**
- Contribute to the Canadian FBP system



# Description

12% of CBHNP  
6% of NS



# Description (height, composition)

Species	Frquency (% plots with species)	Mean % cover class	Mean stem height (cm)	Max stem height (cm)
<b>Picea mariana</b>	100	3	<b>55</b>	74
<b>Rhododendron canadense</b>	100	3	<b>52</b>	75
<b>Kalmia angustifolia</b>	100	2	<b>46</b>	68
Vaccinium angustifolium	83	1	31	50
<b>Picea Mariana dead</b>	67	2	64	88
<b>Cladonia sp.</b>	67	2	3	3
Cornus canadensis	50	1	4	6
Gaultheria procumbens	50	1	4	9
Bare ground	33	3	0	0
Sphagnum	50	2	2	2
Amelanchier Bartramiana	33	2	45	50
Nemopanthus mucronatus	33	2	38	47
Viburnum cassidoides	33	1	45	48



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\* Determined using only plots where the species was present, so does not represent overall percent cover. Using Braun-Blanquet cover classes r = rare; + = few; 1=<5%;2=5-25%;3=26-50%;4=51-75%;5=76+%



# Description (fuel load (kg/m<sup>2</sup>))

Sample Type	Lone Lake					Paquette Lake						
	10P	2P	8P	4P	Average	Pre-A	Pre-B	Pre-C	Pre-D	Pre-E	Pre-F	Average
Dead Foliage											0.02	0.02
Dead Stems 0.5-1 cm	0.00	0.00	0.00		0.00	0.02	0.26	0.13	0.05	0.07	0.09	0.10
Dead Stems 0-0.5 cm	0.07	0.07	0.09		0.08	0.17	0.24	0.33	0.15	0.12	0.19	0.20
Dead Stems 1-7 cm	0.00	0.00	0.00		0.00	0.23	0.59	0.27	0.49	0.04	1.26	0.48
Litter	0.96	0.86	0.72		0.85	0.67	0.87	0.71	1.03	0.82	0.94	0.84
Duff	12.60	6.07	4.01	8.66	<b>7.99</b>	8.07	10.62	7.47	13.84	na	na	<b>10.0</b>
Live Foliage	0.17	0.26	0.33		0.25	0.10	0.23	0.51	0.58	0.28	0.25	0.30
Live Stems 0.5-1 cm	0.00	0.00	0.00		0.00	0.13	0.15	0.41	0.35	0.19	0.23	0.24
Live Stems 0-0.5 cm	0.44	0.38	0.72		0.51	0.58	0.40	0.69	0.68	0.56	0.70	0.60
Live Stems 1-7 cm	0.00	0.87	0.00		0.29	0.16	0.13	0.72	0.45	0.35	1.32	0.52
Grand Total	1.64	2.44	1.86		<b>1.98</b>	2.07	2.87	3.77	3.77	2.43	4.98	<b>3.28</b>



# Pepin (2010) model assumptions

- Live woody moisture assumption

LWMC	Pepin 2010
Before budbreak	60%
During	140%
Summer	100%

Time of year	LWMC %
May 21 2013	85
June 23 2013	134
Aug 4 2013	94
Aug 11 2013	106
Sept 24 2013	96
Oct 16 2013	77
June 10-12 2014	106



# Pepin (2010) model assumptions

- Based on US SH-6 fuel type load

	1hr	10hr	100hr	live herb	live woody	Total load
SH6 (Scott 2007)	0.725	0.3625	0	0	0.35	1.44
NS-1 Lone Lake	0.93	0	0	0	1.05	1.98
NS-1 Paquette Lake	1.14	0.48	0	0	1.66	3.28

- Standard low heat of combustion (18000 KJ/kg)

Group	Average low heat of combustion (MJ/kg)
Kalmia new foliage	21.43
Duff	18.26
Kalmia winter	22.63
Rhodara	21.85
Stems	21.79
Spruce	20.54
Overall	21.43

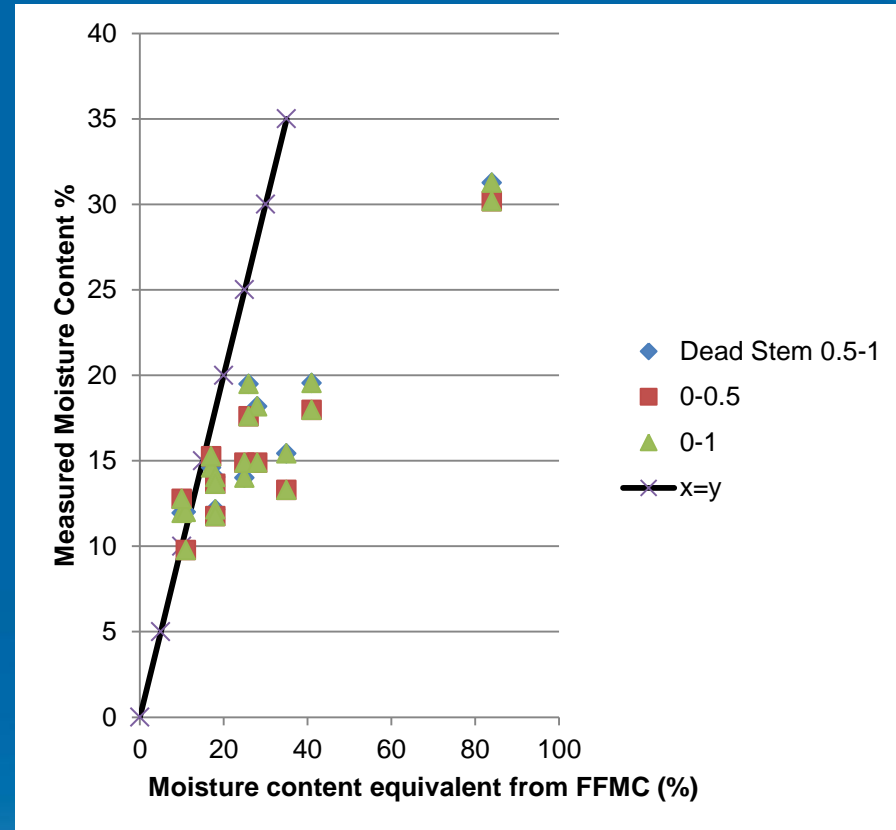
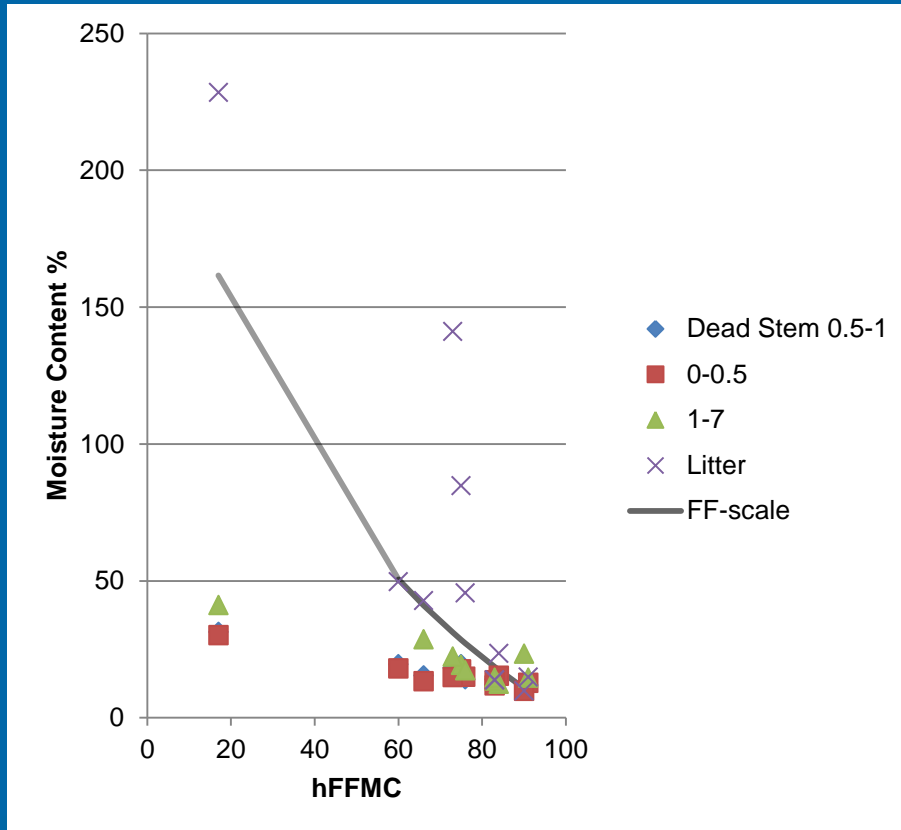




# FM vs FFMC

Drier than Van Wagner relationship

$$MC\% = 147,2 (101 - FFMC) / (59,5 + FFMC)$$



# Study design

15 blocs 20m x 20m  
8 done June 10-12 2014



# Method

- Fire intensity :
  - 1) Flame length estimates and
  - 2) Fuel consumption x ROS x heat of combustion
- Fire depth
- Rate of Spread
- Fuel Moisture
- Heat of combustion





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Temp – 19.4

RH – 50

WS – 16

Rn – 0

hFFMC – 88.1

DMC – 19

DC – 71

hISI – 7.4

BUI – 23

Frontal ROS (m/min) – 8.4

Head Fire Intensity (kw/m)- 8339

Flank ROS (m/min) – 3.4

Flank Fire Intensity (kw/m) – 3440

June 10, 1500 (Bloc 7)





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Temp – 18.4

RH – 54

WS – 13

Rn – 0

hFFMC – 88.1

DMC – 19

DC – 71

hISI – 6.4

BUI – 23

Frontal ROS (m/min) – 12.5

Head Fire Intensity (kw/m)- 12469

Flank ROS (m/min) – 3.6

Flank Fire Intensity (kw/m) – 3563

June 10, 1600 (Bloc 12)





## June 10, 1900 (Bloc 8)

Temp – 12.3

RH – 72

WS – 11

Rn – 0

hFFMC – 87.6

DMC – 19

DC – 71

hISI – 5.2

BUI – 23

Frontal ROS (m/min) – 5.7

Head Fire Intensity (kw/m)- 6913

Flank ROS (m/min) – 1.3

Flank Fire Intensity (kw/m) – 950





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## June 10, 1940 (Bloc 9)

Temp – 11.5

RH – 76

WS – 8.5

Rn – 0

hFFMC – 87.3

DMC – 19

DC – 71

hISI – 4.5

BUI – 23

hFWI – 7

Frontal ROS (m/min) – 4.4

Head Fire Intensity (kw/m)-4340

Flank ROS (m/min) – 0.5

Flank Fire Intensity (kw/m) – 528







## June 12, 1130 (Bloc 32)

Temp – 12.5

RH – 70

WS – 14

Rn – 0.2

hFFMC – 79

DMC – 21

DC – 77

hISI – 2.2

BUI – 25

Frontal ROS (m/min) – 3.5

Head Fire Intensity (kw/m)- 3517

Flank ROS (m/min) – 0.7

Flank Fire Intensity (kw/m) –735





Temp – 14.2

RH – 61.5

WS – 7.9

Rn – 0.2

hFFMC – 80

DMC – 22

DC – 82

hISI – 1.7

BUI – 27

Frontal ROS (m/min) – 2

Head Fire Intensity (kw/m)- 1995

Flank ROS (m/min) – 1.4

Flank Fire Intensity (kw/m) – 1385

## June 12, 1330 (Bloc 27)



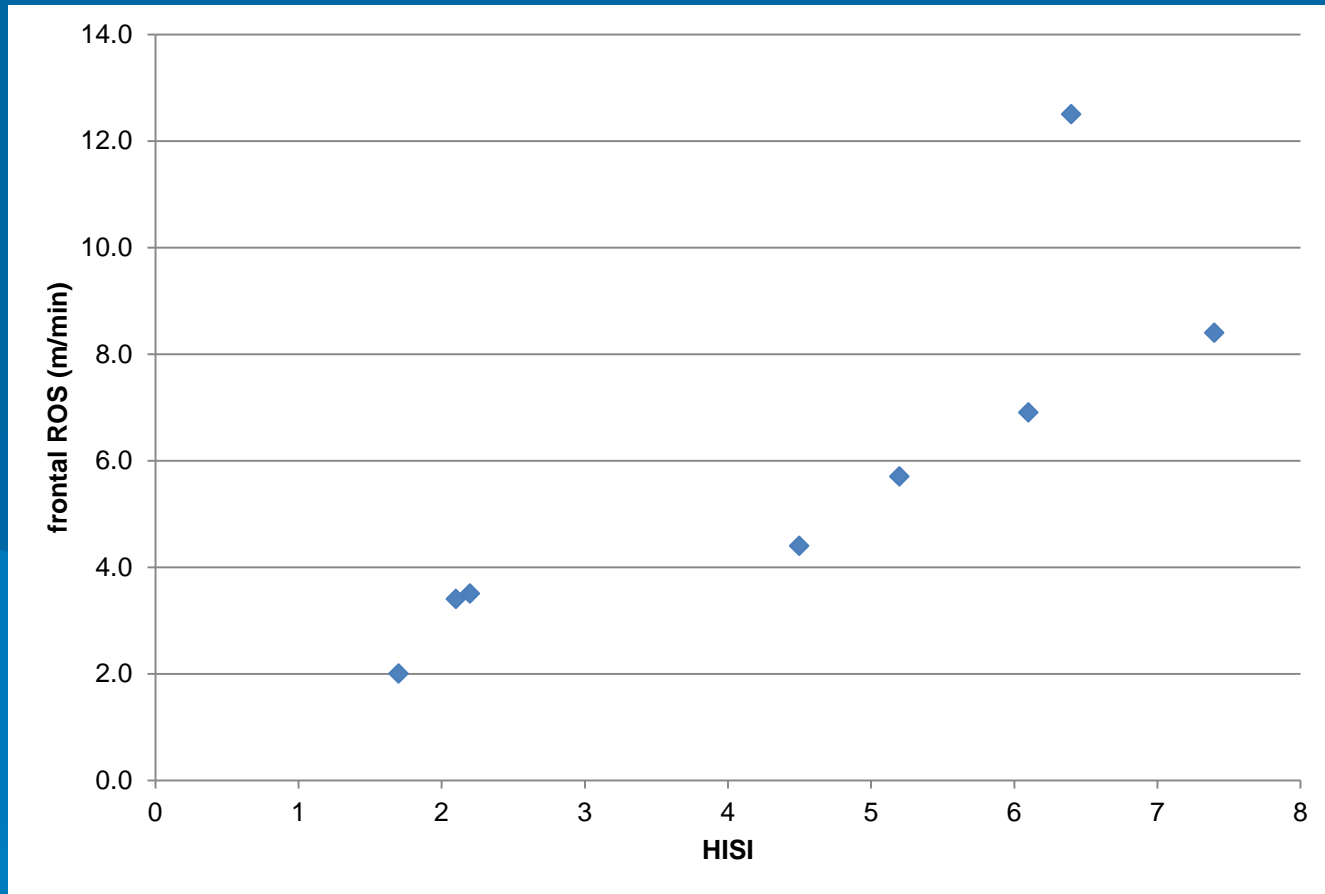


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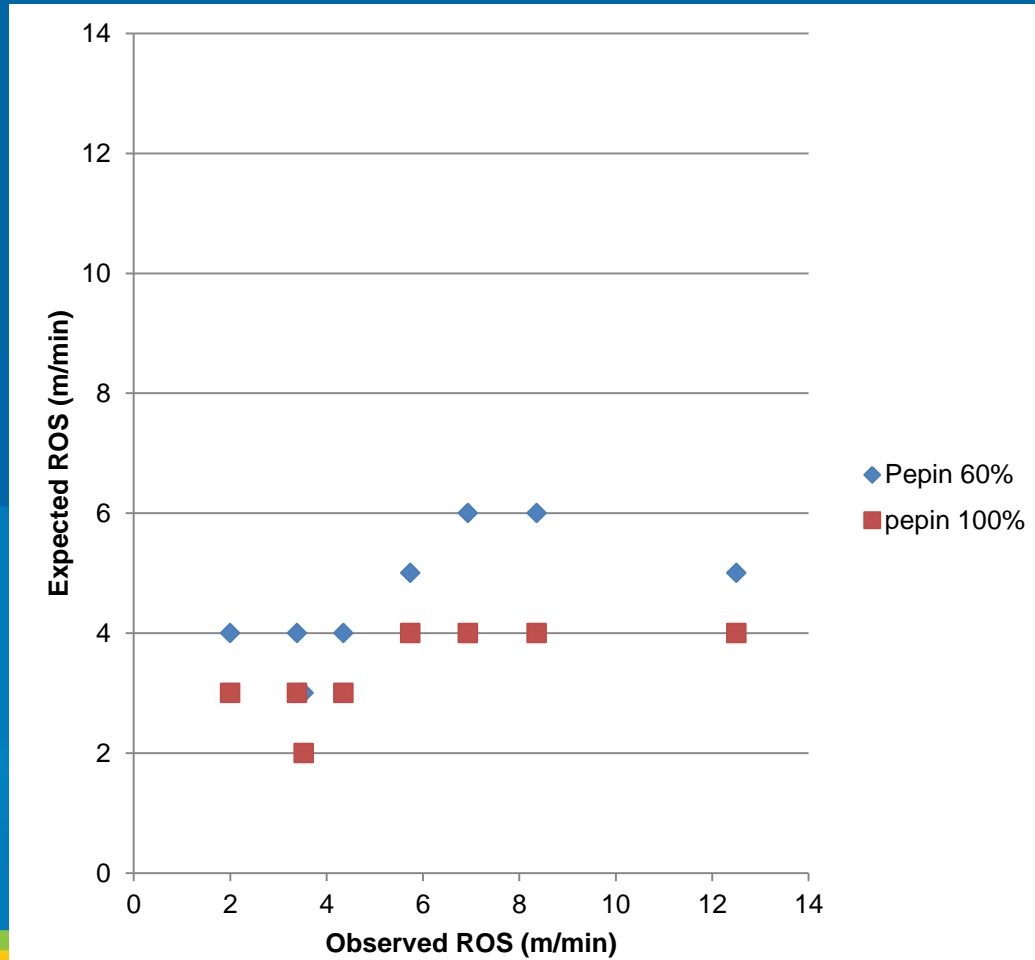


# BUI 23-27; LWMC 106%)



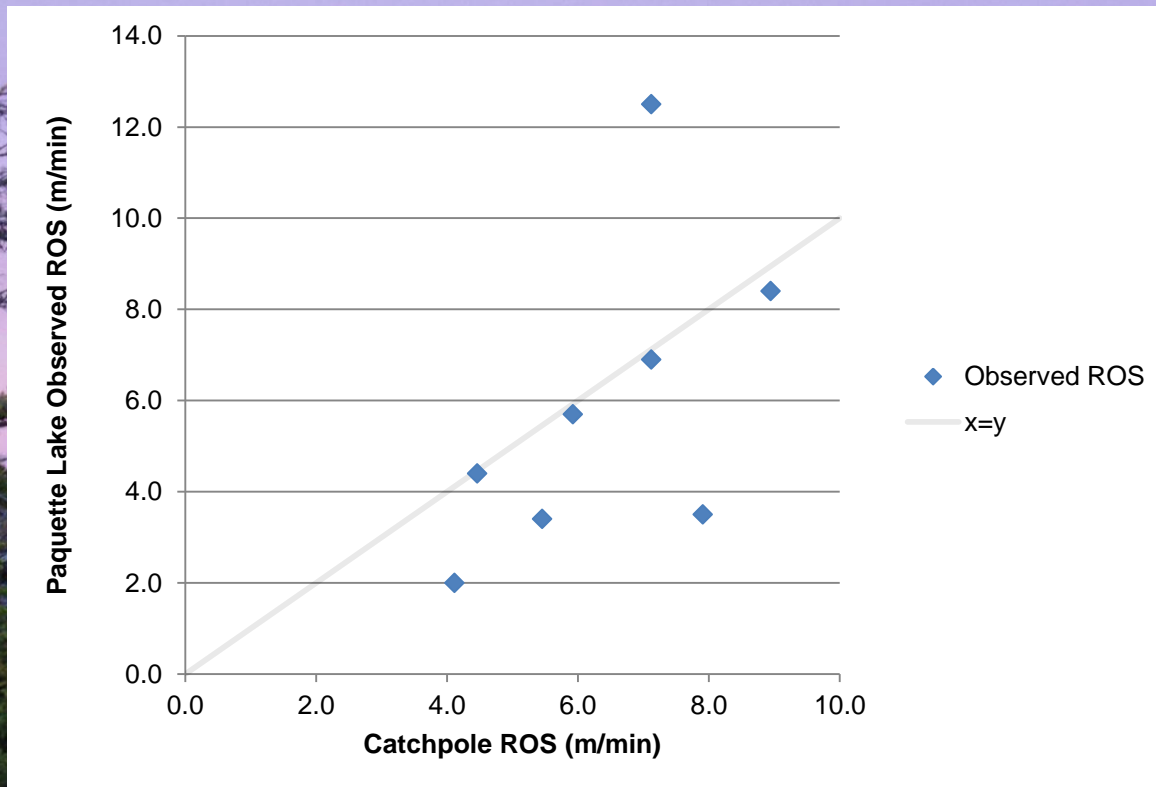


# Comparison Pepin 2010



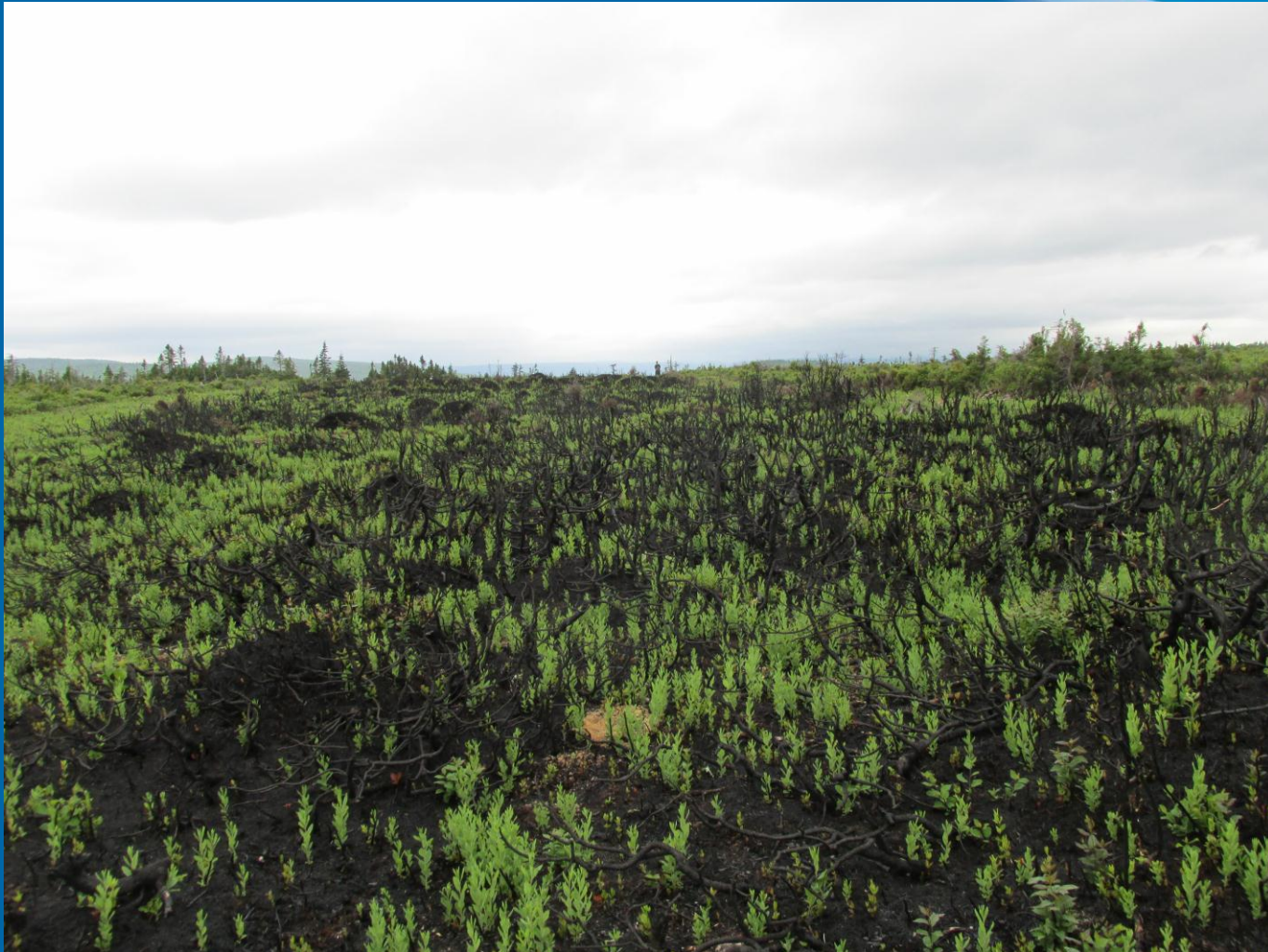
# Comparison with different fuel models (Catchpole 1999)

- $ROS = 0.801 W_{sp2m}^{1.10} H^{0.49}$



# Ecosystem Restoration

Spring burn 2014, post regen July 2014



# Thresholds for PB operations

## Upper

- 4000 kw/m<sup>2</sup> is reach at ISI 4
- Wind driven,
  - max 20 km/hr = FFMC 83
  - 10 km/hr = FFMC 86

## Lower

- ROS 2 m/min and 2000 kw/m<sup>2</sup> was reached at ISI 1.7 (FFMC 80, wind 8km/hr)





# Result summary

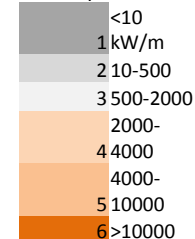
Hourly	Hour	Temp	RH	Precip	WS	WD	HFFMC	HISI	BUI	Bloc	Time	ROS	Intensity *
06/10/2014	15	19.4	50	0	16	293	88.1	7.4	23	7	1500	8.4	3440
06/10/2014	16	18.4	54	0	13	294	88.1	6.4	23	12	1545	12.5	12469
06/10/2014	17	15.9	59	0	13	307	88	6.1	23	17	1627	6.9	6913
06/10/2014	19	12.3	72	0	11	311	87.6	5.2	23	8	1857	5.7	5719
06/10/2014	1930	11.5	76	0	8.5	303	87.3	4.5	23	9	1935	4.4	4340
06/10/2014	20	10.8	80	0	6	296	87	3.7	23				
06/12/2014	11	12.4	71	0	12	329	79.1	1.9	25				
06/12/2014	1130	12.5	70.5	0	14.3	360	79.3	2.2	25	32	1127	3.5	3517
06/12/2014	12	12.6	70	0	12	333	79.5	1.9	25				
06/12/2014	13	14	63	0	9	346	79.9	1.8	27				
06/12/2014	1330	14.2	61.5	0	7.9	86	80.2	1.7	27	27	1328	2.0	1995
06/12/2014	14	14.4	60	0	9	352	80.4	1.8	27				
06/12/2014	15	14.7	55	0	8	5	81	1.9	27				
06/12/2014	1515	14.7	55	0	10.2	19	81	2.1	27	22	1514	3.4	3376

Equilibrium rate of spread (m/min)

and fire intensity class

NSS-100 Nova Scotia Special, 100% live woody moisture content

Intensity class



BUI

ISI	0-20	21-30	31-40	41-60	61-80	81-120	121-160	161-200
1			2					
2			3					
3			4					
4			5					
5			6					
6			7					
7			10					
8								
9								
10								
11								
12								



# Working with others

- Parks Canada
- NSDNR, Dustin Oikle
- Natural Resources Canada, Dan Thompson and Mike Wotton



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Natural Resources Canada

