Field Assessment of Fuel Consumption and Fire Severity on Wildfires

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**Canadian Forest Service
Canada Centre for Remote Sensing**

Linkages to the overall CWFIS project

- **Provides actual data for validation of the fire effects model (Borefire), which is necessary for subsequent estimates of emissions**

- **Tests the reliability of national burn severity mapping products in Canadian fuel types**

- **Provides critical ground validation of remotely sensed burn images**

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Objectives

1) **To improve estimates of forest floor fuel consumption on large wildfires**

2) **Validate detection of burned areas through fire severity assessment**

3) **To explore methods of using EO to refine carbon emission estimates directly**

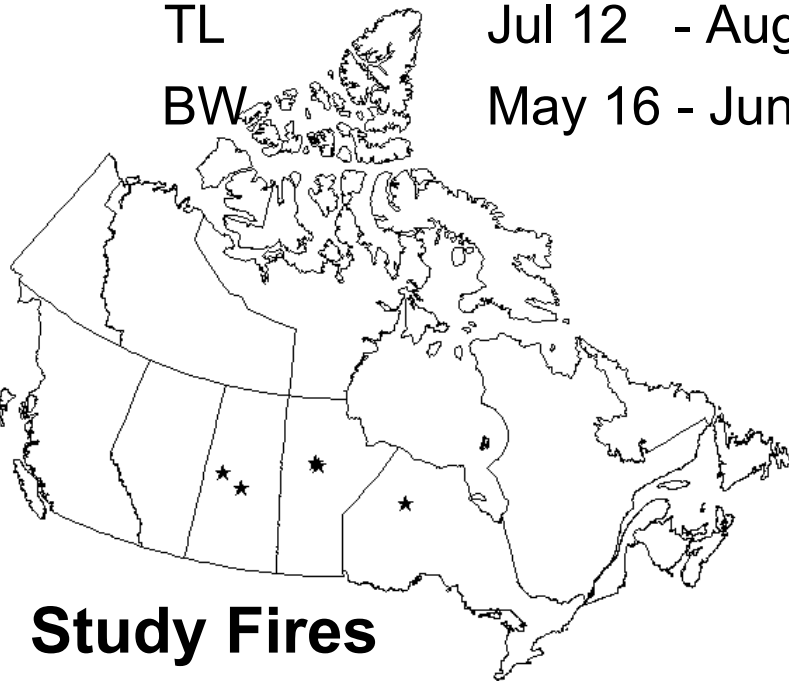**Carl Key – burn severity mapping**

CBI – field estimate of average
burn condition

NBR = (TM4 – TM7)/(TM4 + TM7)
•Compute ΔNBR as difference in
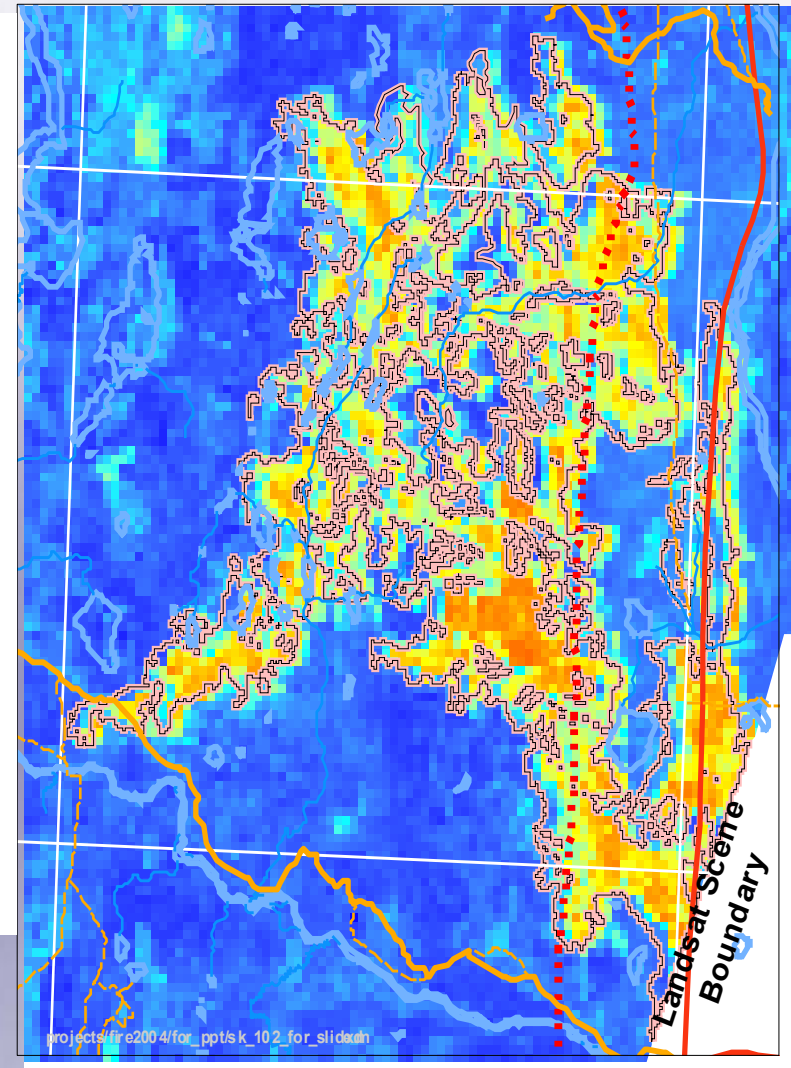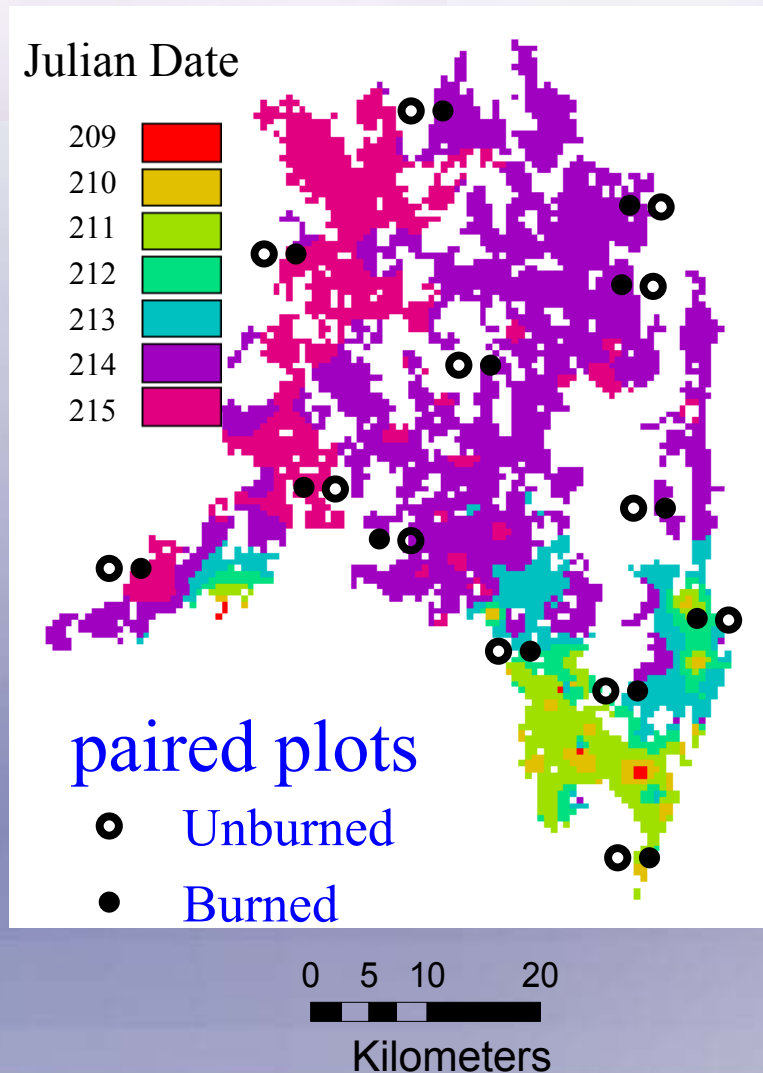**Pre- and Post-fire image**
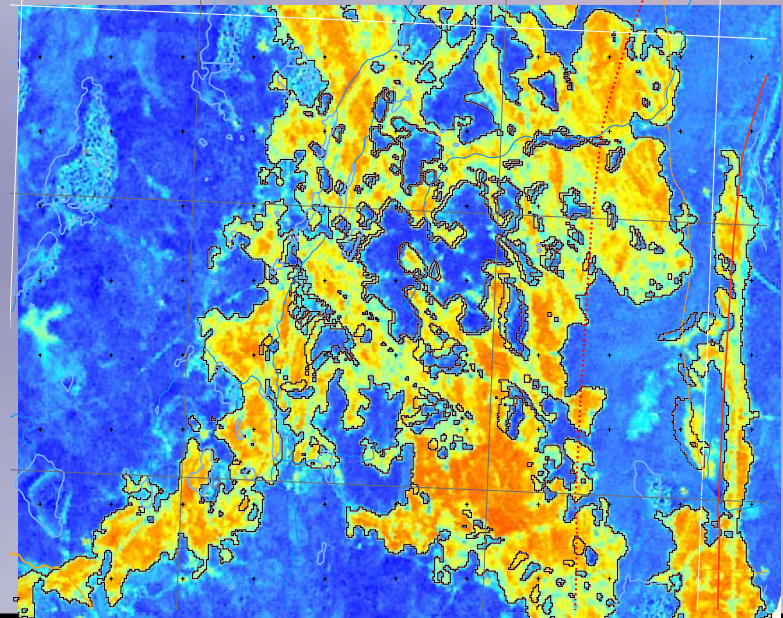
Characteristics of Study Fires

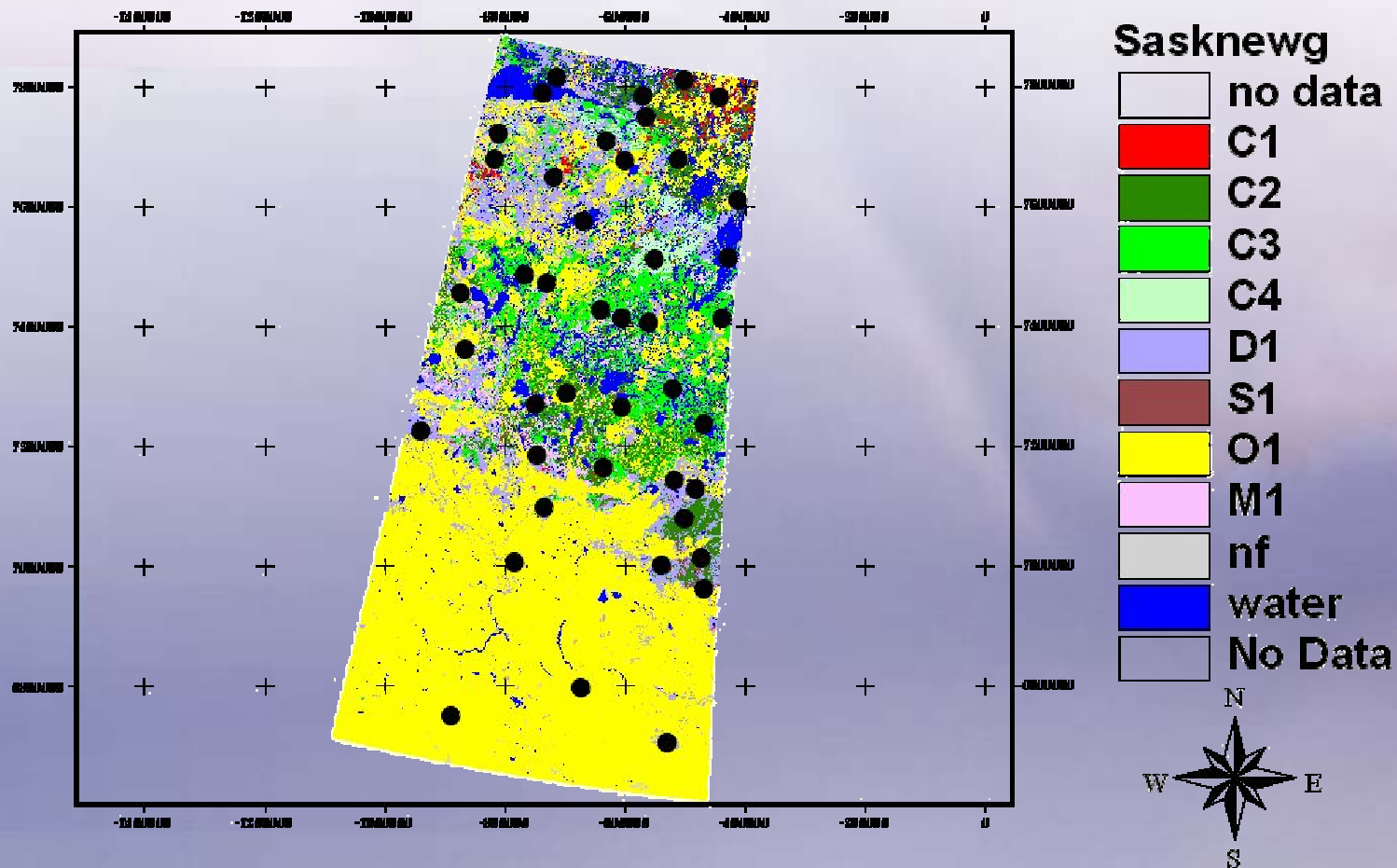| Location	Start Date	Initial FWI	Initial BUI	FWI range
ML - rawhide	May 28 - Jun 5	30.3	96.5	0.2 - 34.9
ML - pasture	Jun 18 - Jun27	30.1	64.6	0.0 - 37.8
ML - spruce	Jul 15 - Jul 28	16.4	32.8	1.0 - 20.2
GL	Jul 28 - Aug 10	30.8	86.5	0.0 - 37.7
TL	Jul 12 - Aug 20	31.4	41.7	0.0 - 43.1
BW	May 16 - Jun 18	58.0	59.0	0.1 – 58.0

Study Fires

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Accounting for Fire Severity in Sampling

Julian Date
209
210
211
212
213
214
215

paired plots
○ Unburned
● Burned

0 5 10 20
Kilometers

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Saskatchewan Forest Fuels Map

Sasknewg

- no data
- C1
- C2
- C3
- C4
- D1
- S1
- O1
- M1
- nf
- water
- No Data

Source: A. Frank

Site selection

- species composition
- Topography, moisture regime
- fire behavior

Plots for an Unburned /Burned Area that was homogenous pre-fire

Burned area

Unburned area

Duff depth
- do every 5 m
- also record litter depth

-Basal area
-**Duff core**
-Do every 20 m

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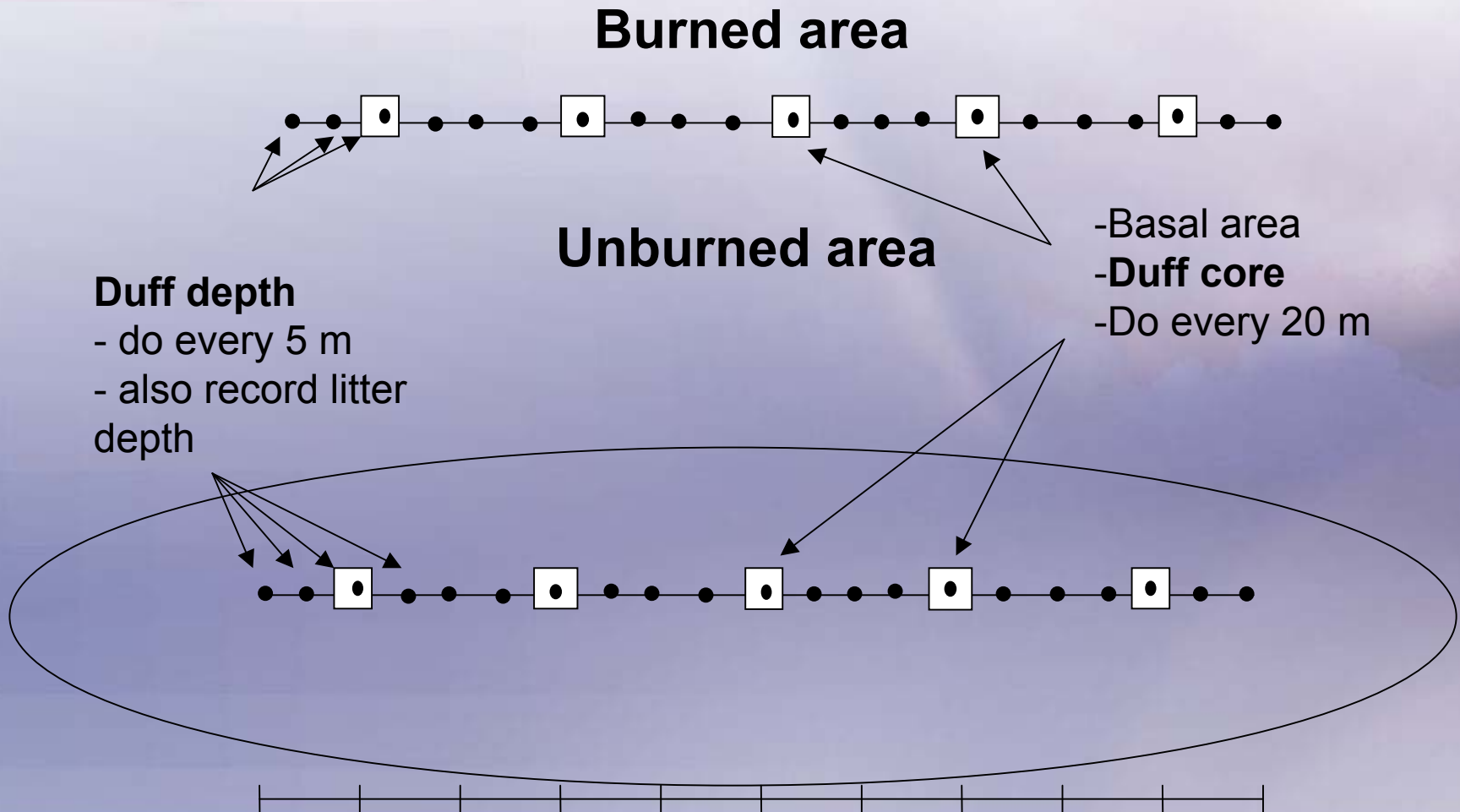
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Duff thickness in burned stands versus unburned stands

•Lab analyses of bulk density and Loss on ignition are necessary for fuel consumption estimates
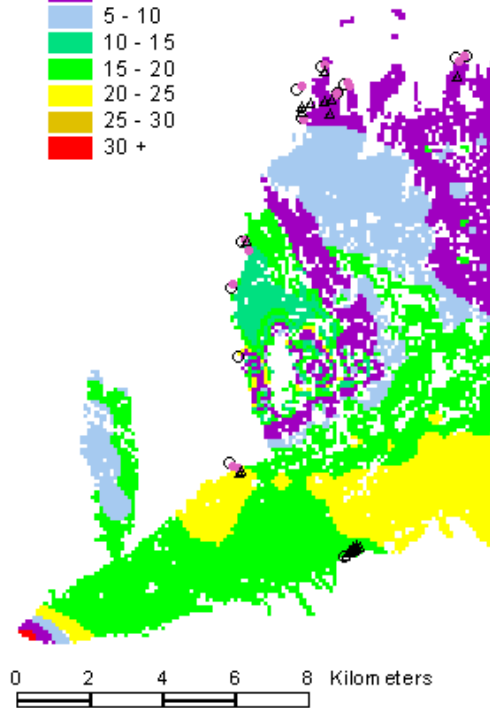
Modeling fuel consumption

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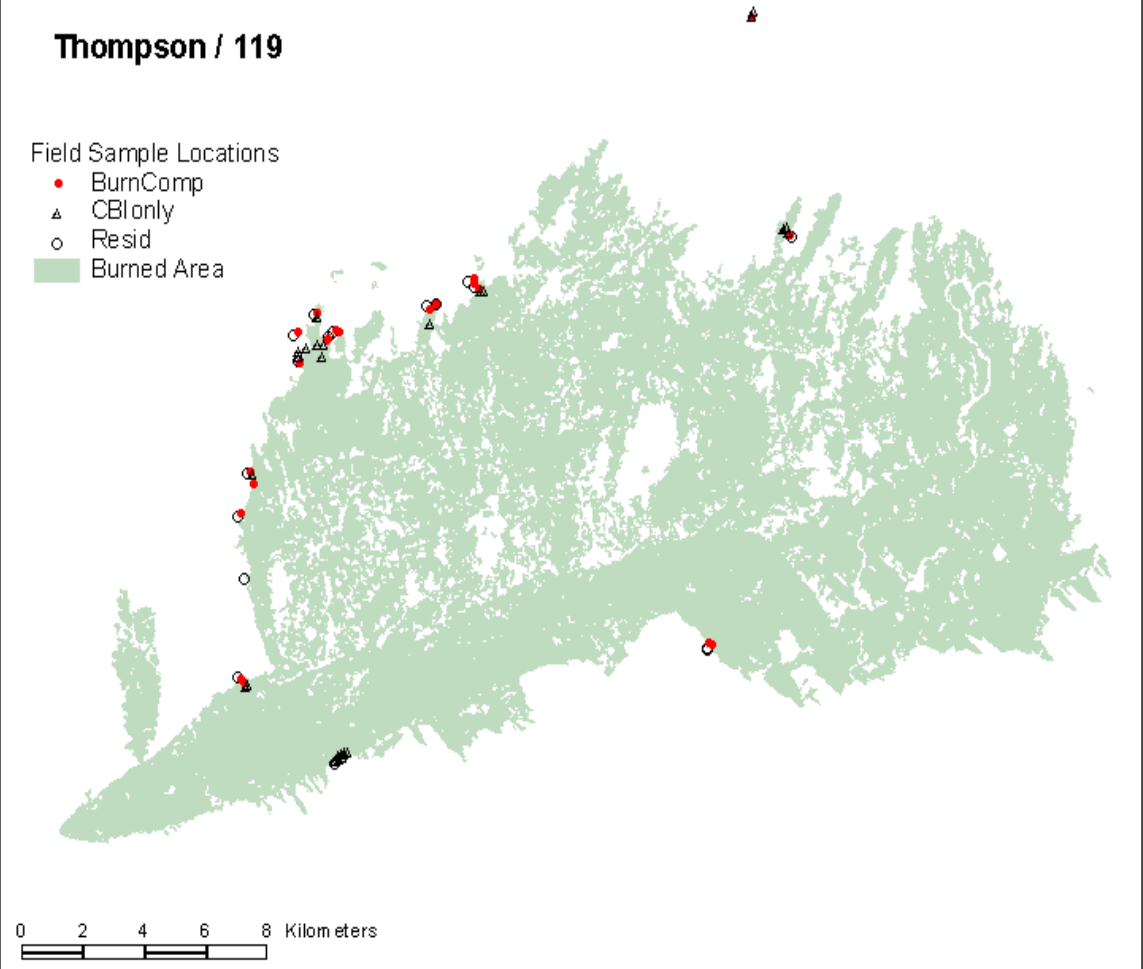
Data Analysis

-Examine between fire versus within fire variability in fuel consumption

- Examine fuel consumption relative to fuel type

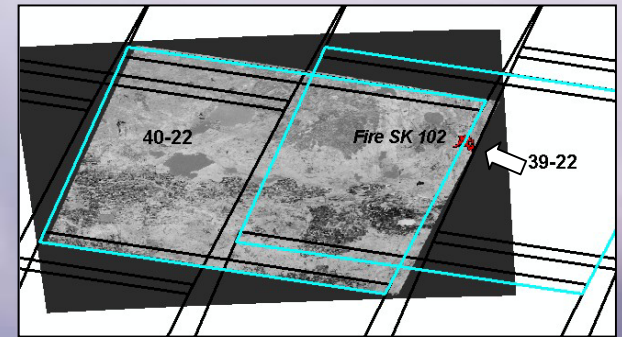-Develop predictive models of fuel consumption

Pre-burn Image Search

**Need to find pre-burn images for each site. The images
should be:**

Image Search Criteria:

- Seasonal: one month window
- Recent: within 3 years of the burn
- Landsat 5 TM when possible
- Little cloud cover

Resources:

- CCRS image database
- USGS image database
- RSI client services

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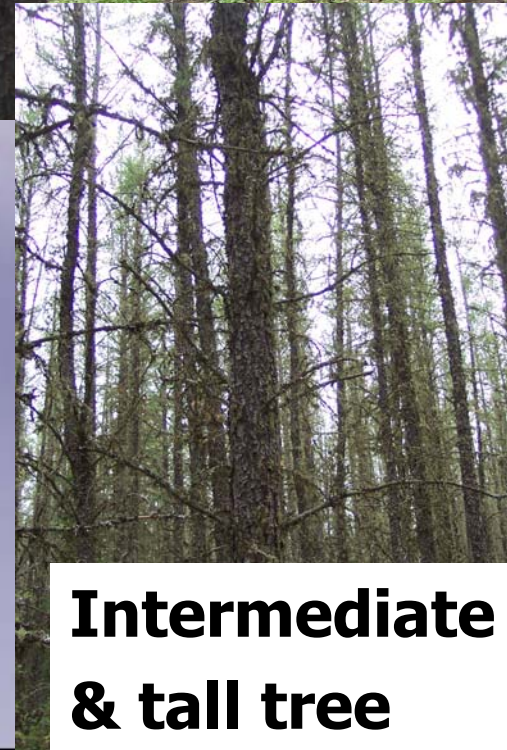
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Vegetation strata assessed for the CBI:

substrate

herb

Shrub and sapling

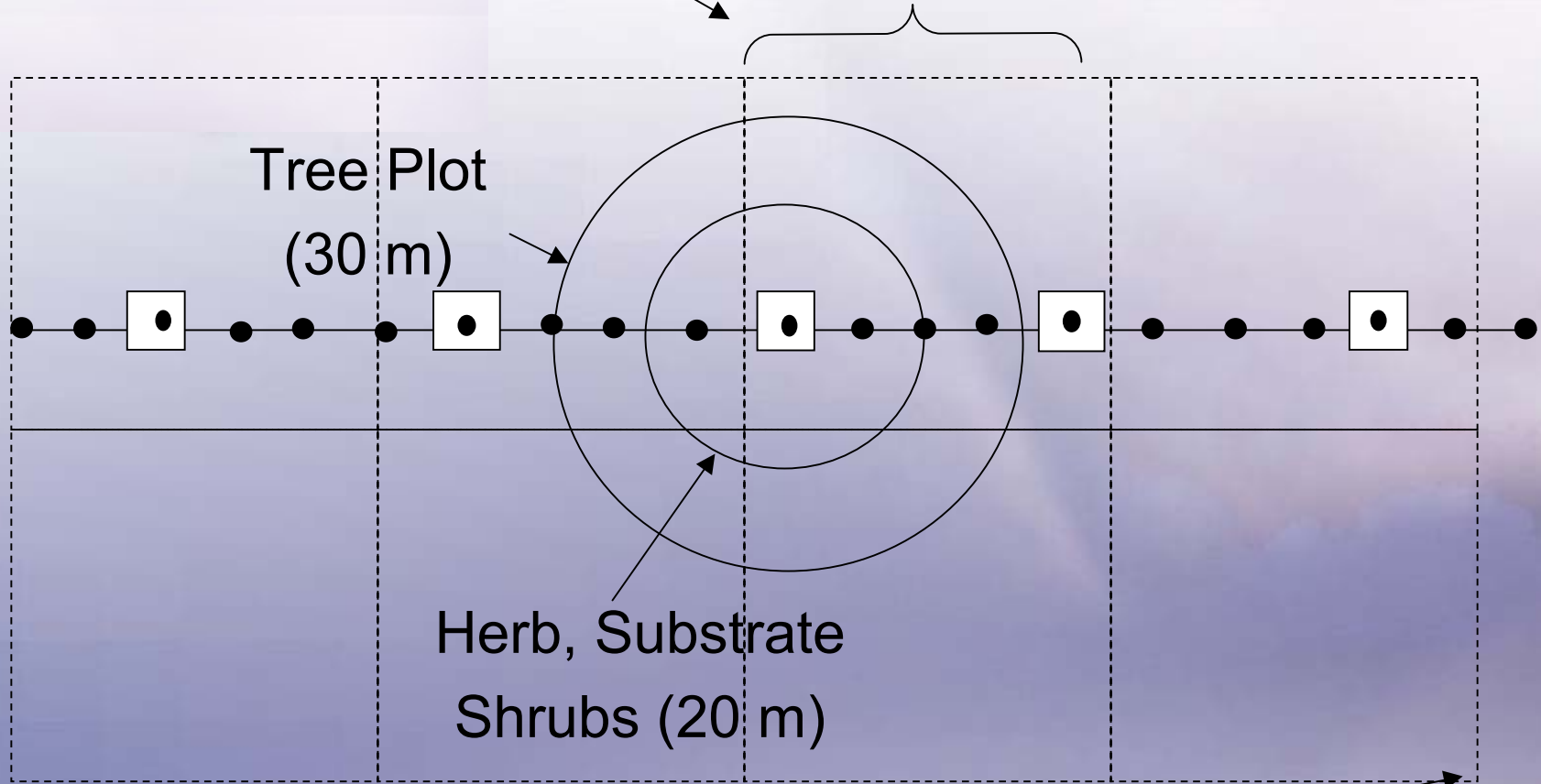Mortality
Regeneration
Charring
Species change
Fuel consumption

Intermediate & tall tree

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Sampling for the CBI / ⊿NBR

NBR resolution 25 m

Tree Plot
(30 m)

Herb, Substrate
Shrubs (20 m)

Homogeneity of fire effects (100 m)
Facilitates spatial analyses

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Data Collected at the Plot

- **Documents the site**
  - I.e. GPS position, transect, fire ID, plot #, etc, topographic position, moisture class

- **Describes the fire & fuels:**
  - Fire type, CBI, fuel type, scorch height, fuel consumption (duff depth)

- **Describes other confounding factors so we understand why fire severity (CBI) values differ from ΔNBR values**
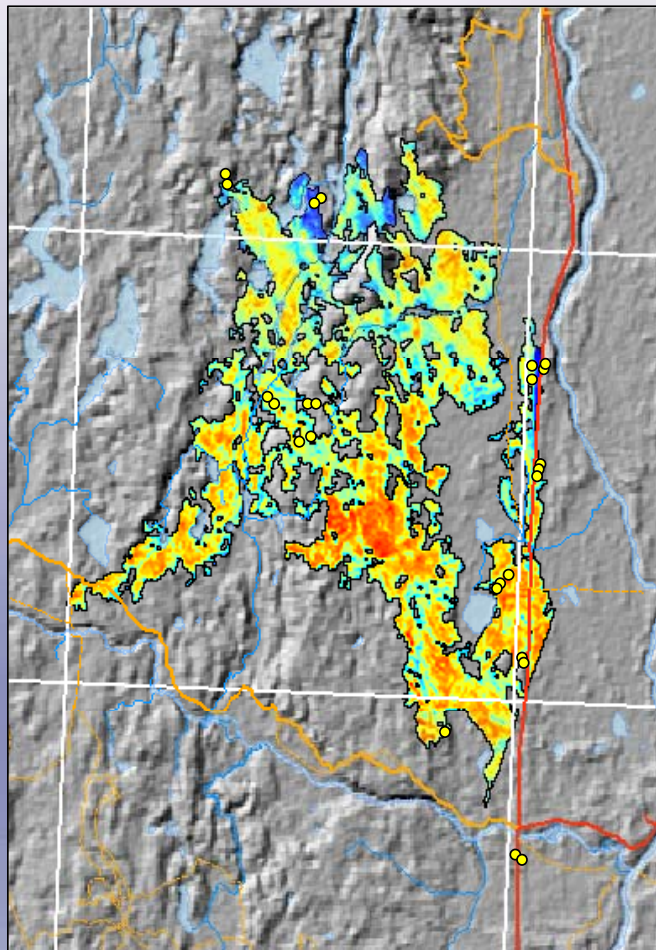 - stem density, basal area, % mineral soil, substrate type

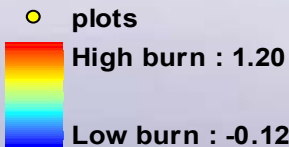# Exploratory CBI vs ΔNBR analysis

Green Lake CBI vs ΔNBR

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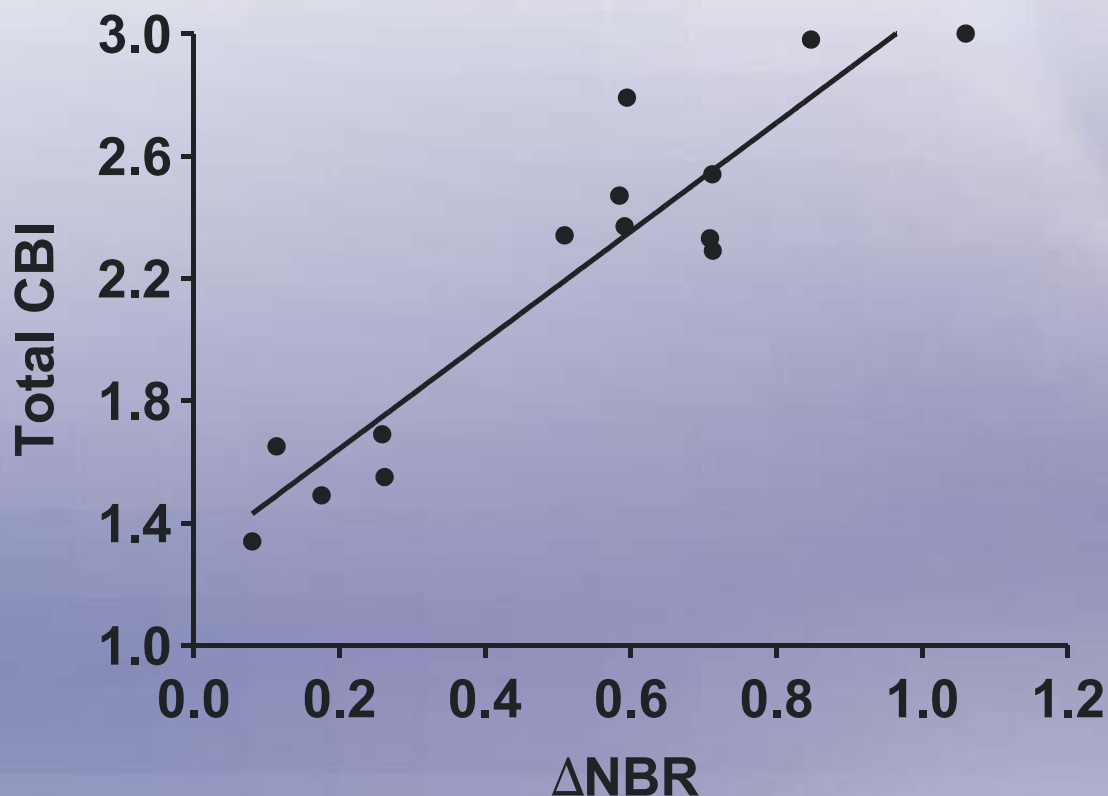
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Green Lake ΔNBR

Landsat TM5 Imagery: orthorectified, TOAR

ΔNBR

○ plots

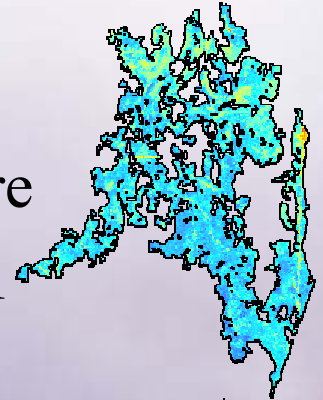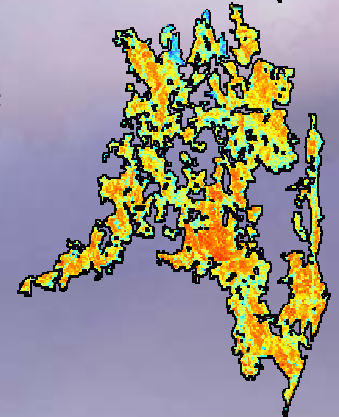High burn : 1.20

Low burn : -0.12

0   1   2   4

Kilometers

NBR pre-fire
Aug 2, 2001

NBR post-fire
Aug 15, 2003

$$NBR = \frac{(R_4 - R_7)}{(R_4 + R_7)}$$

$$\Delta NBR = NBR_{prefire} - NBR_{postfire}$$

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Future Analyses

- **Develop statistical relationships between CBI and ΔNBR**
  - **Stratify by fuel type and land cover**
  - **Explore variability between fires**

- **Validate detection of burned areas through fire severity assessment**

- **Explore fuel consumption vs. CBI**
  - **Develop statistical relationships**
  - **Explore sensitivity of CBI (excluding several parameters)**

Summary of Sampling Considerations

Fuel Consumption

1) **Between Fire Variability – FWI**
2) **Within Fire Variability**
   a) **FWI, date of burn**
   b) **Fuel Types**

Remote Sensing

1) **Pre- and post-burn imagery**
2) **Variability in spectral response**
3) **Performance of indices relative to:**
   a) **Fuel type**
   b) **Fire type**