Characterization of vegetation growth after harvest in forested catchments to support coupled SWAT/ALMANAC modelling.

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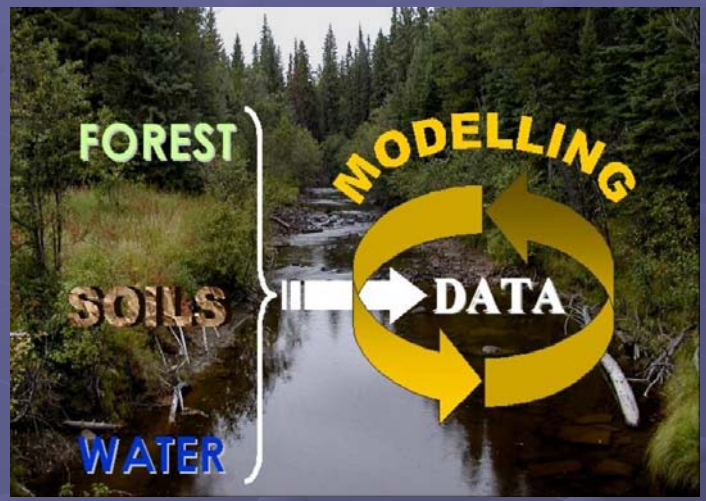
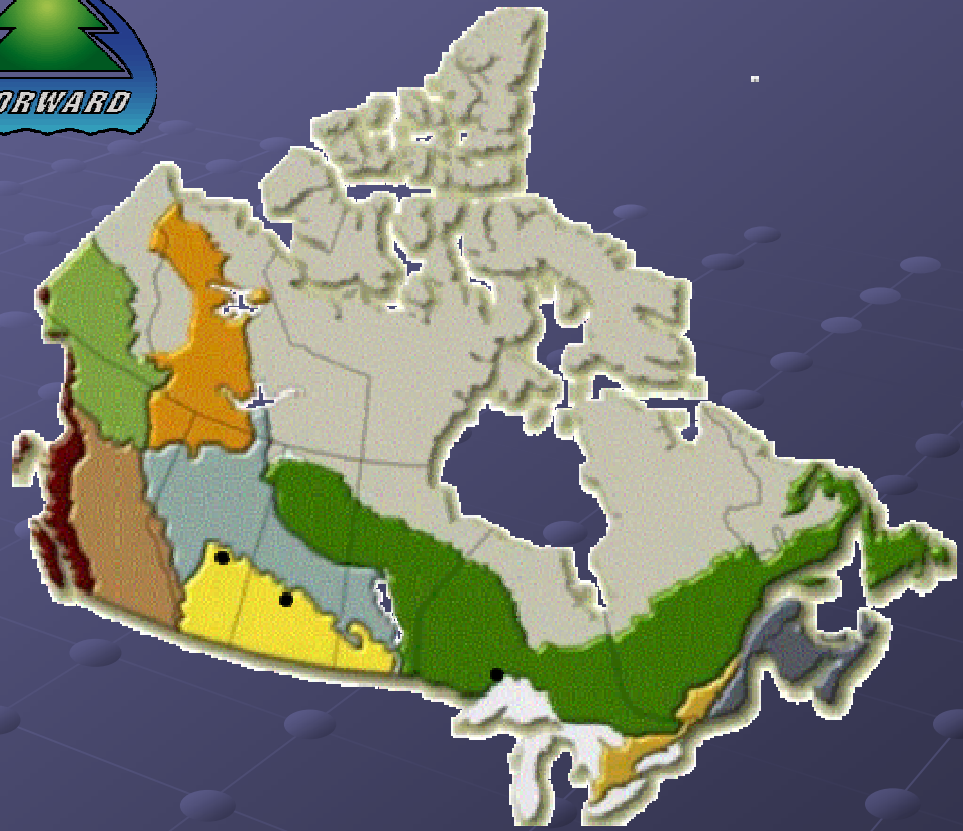
Forested Watershed and Riparian Disturbance (FORWARD) Project





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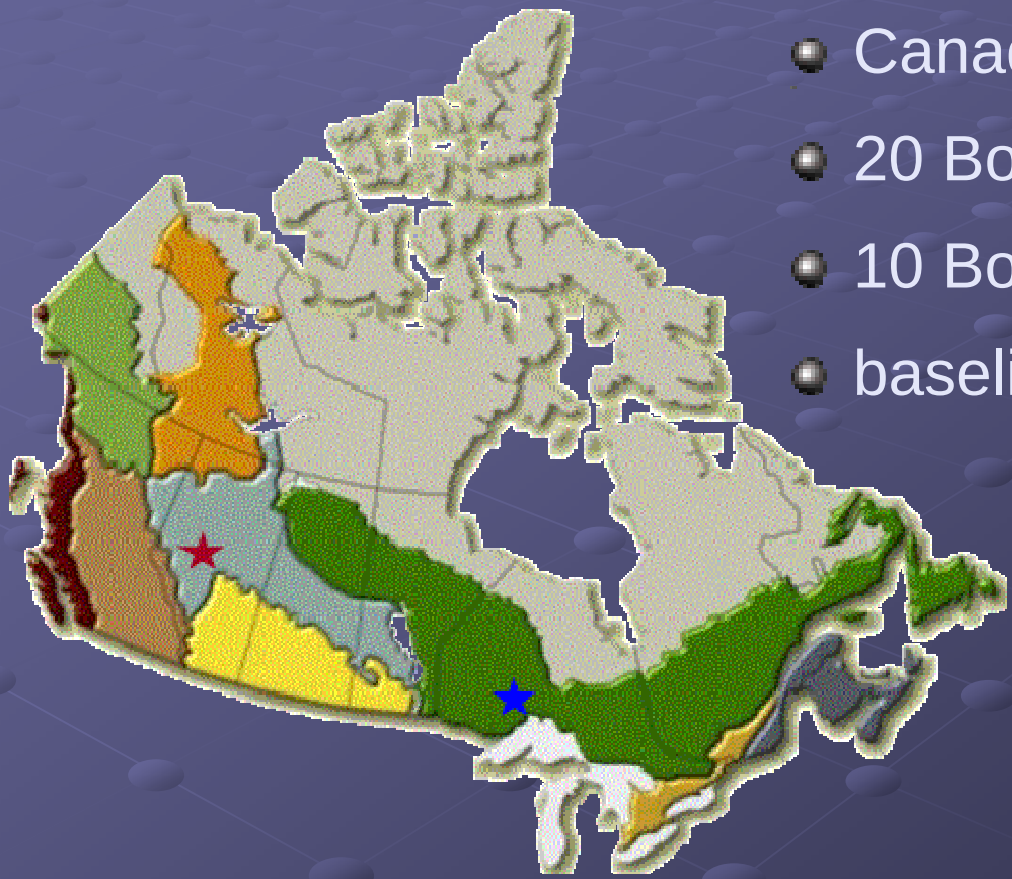
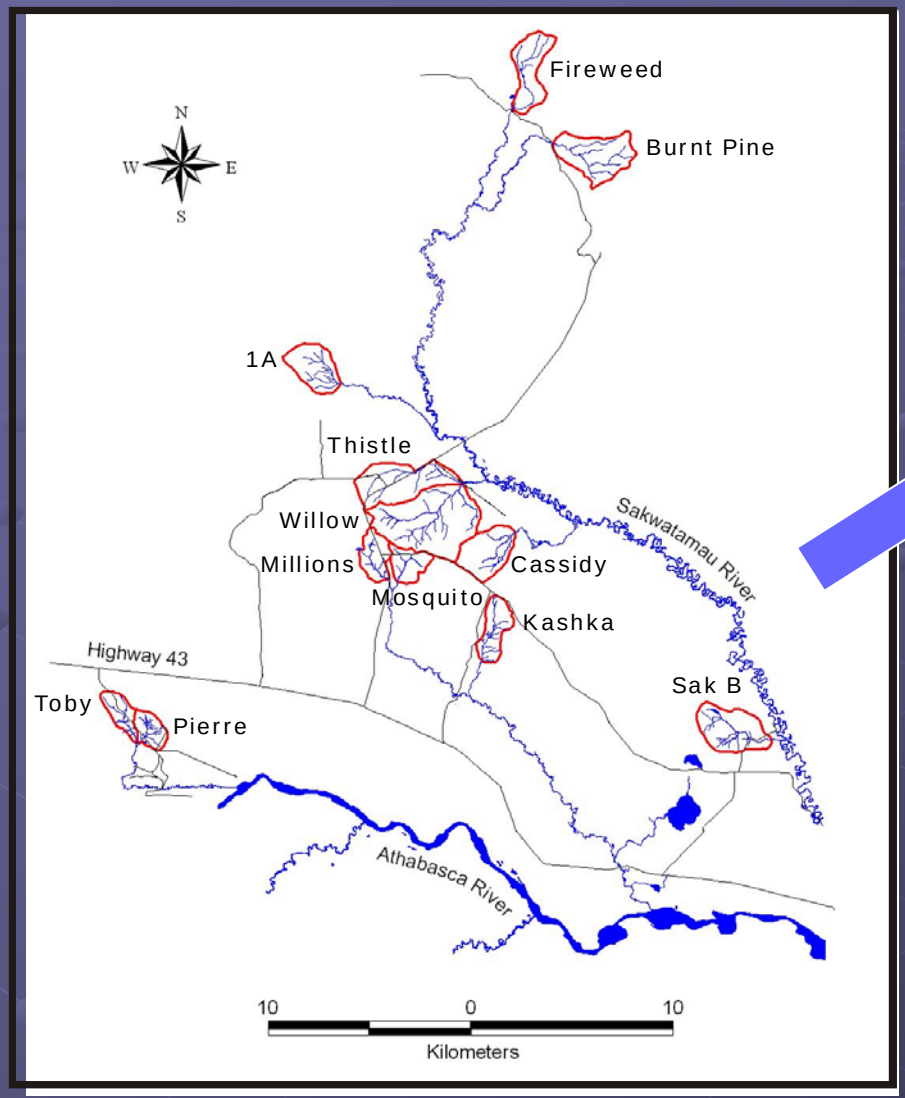
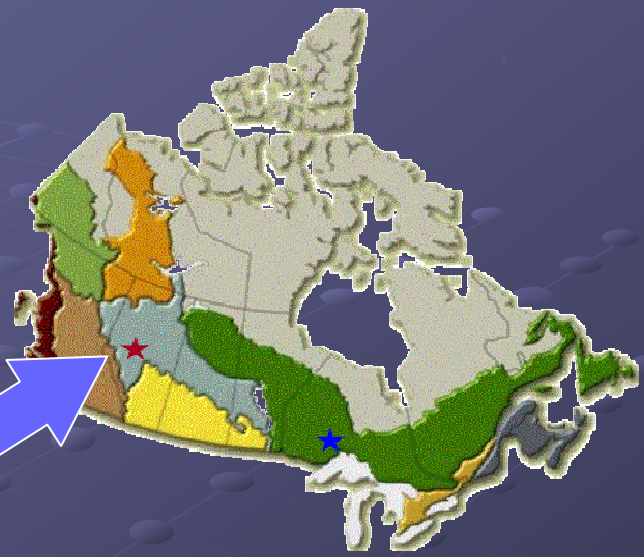
FORWARD: Study Areas



- Canadian Boreal forest
- 20 Boreal Plain watersheds
- 10 Boreal Shield watersheds
- baseline & disturbed conditions

FORWARD: Boreal Plain Small Watersheds





- reference and harvested small watersheds (3 to 16 km^2)
- Winter 2003/2004 harvest
  - Toby (2.6 km^2, 57%)
  - Pierre (2.6 km^2, 87%)
  - Millions (3.4 km^2, 58%)
  - Kashka (4.0 km^2, 59%)

Boreal Plain Forest

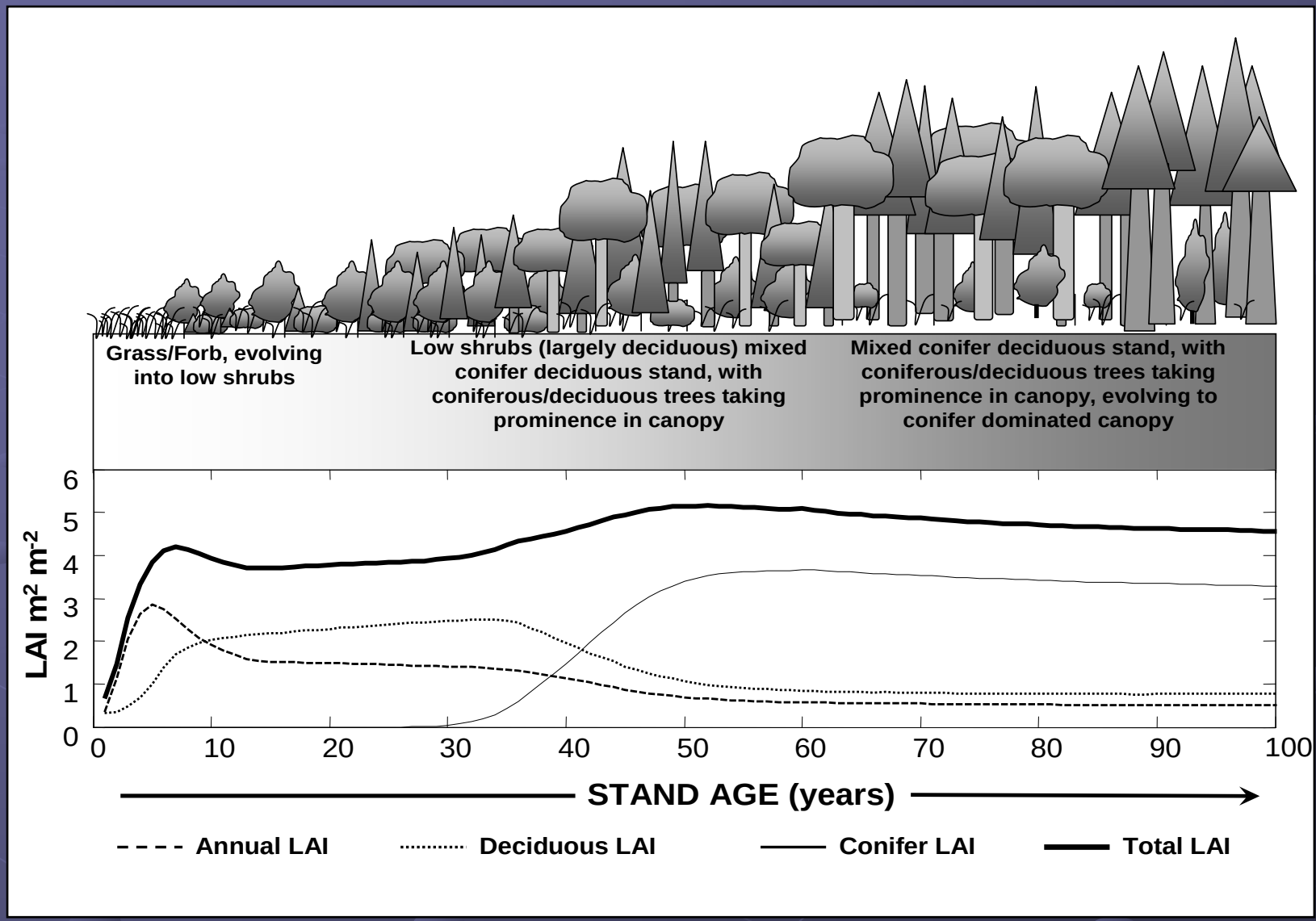
- Upland dominated by lodgepole pine, trembling aspen, white spruce and balsam poplar
- Lowlands dominated by black spruce and tamarack

- 325 to 625 mm ppt annually
- 1/4 as snow, spring melt runoff
- Sporadic storm events May to Sept
- Predominantly deep clay till soils (luvisols)
- Wetlands and organic soils in low areas (histosols)

Background - FORWARD Modelling

- SWAT and ANN modelling
- SWAT-C
  - Boreal forest litter layer
  - Wetlands
  - Soil temperature and spring thaw
- Applied to small reference watersheds
- Vegetation growth model problems for representing forest conditions

Vegetation succession after disturbance



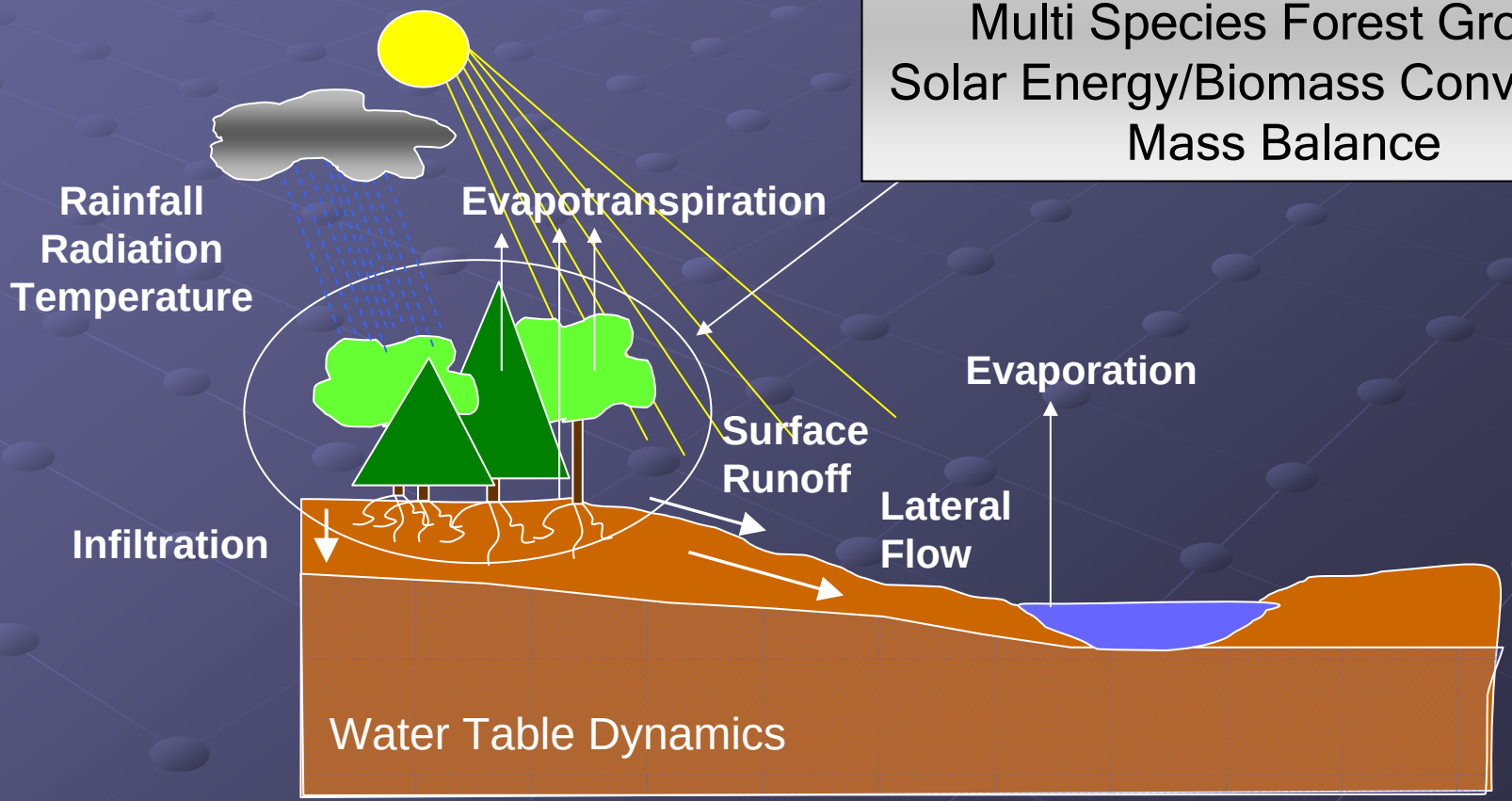
SWAT-C

Represents typical Boreal forest hydrological processes on a single homogeneous soil & vegetation unit (HRU) from meteorological input

Water Balance

ALMANAC$_{BF}$

Multi Species Forest Growth
Solar Energy/Biomass Conversions
Mass Balance



SWAT-C / ALMANAC$_{BF}$ Model Integration

- Simulates successional forest regrowth
  - Multi-layer canopies
- Simplified strategy of simulating generic species types
  - annual species (grasses and forbs), generic shrubs and crop tree species.
- Requires generic vegetation parameters quantification
  - Field study in summer 2006

Objectives of 2006 field study

- Characterize the vegetation communities at several post harvest sites
- Investigate sites with different pre-harvest vegetation communities.
- At each site:
  - Document complete species distribution
    - Estimate percent cover for each species
  - Measure
    - LAI
    - Biomass
    - Light interception
- Estimate RUE based upon model fit
- Examine vegetation differences with respect to landscape features (high and low spots).

Experimental Harvest - Winter 2003/2004

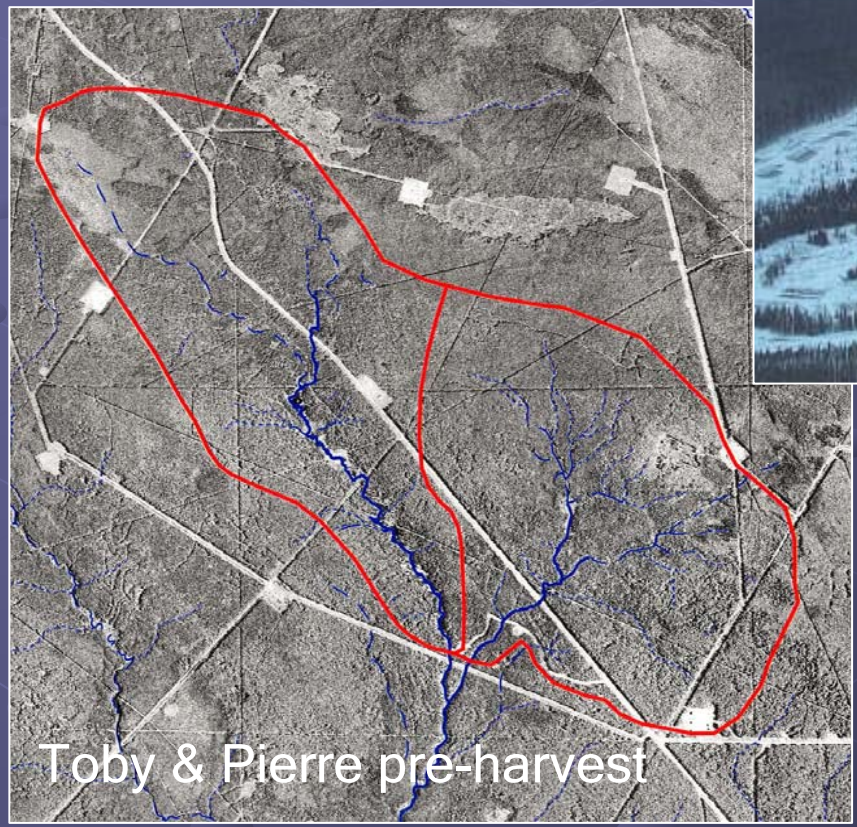


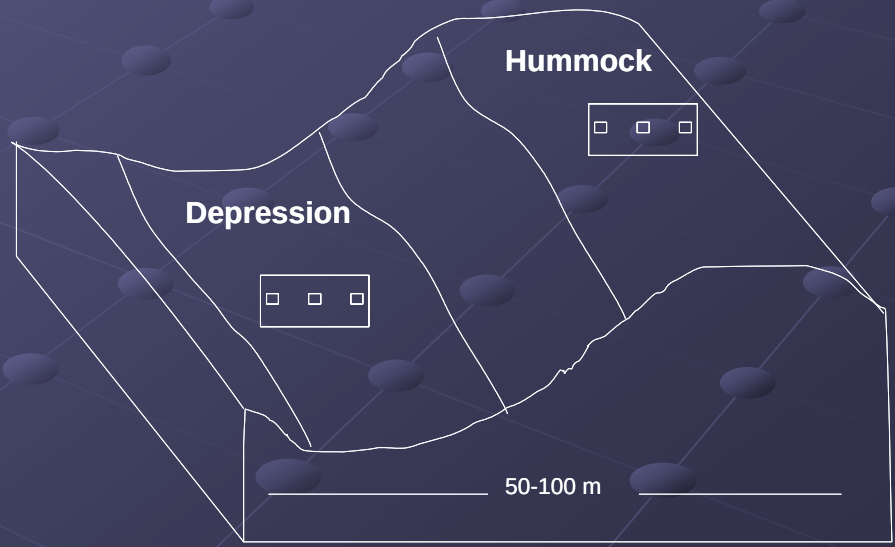
Photo credit: Tom Plouffe

Experimental Harvest - Spring 2004

Examples of vegetation 3rd summer post harvest

Sampling Plan

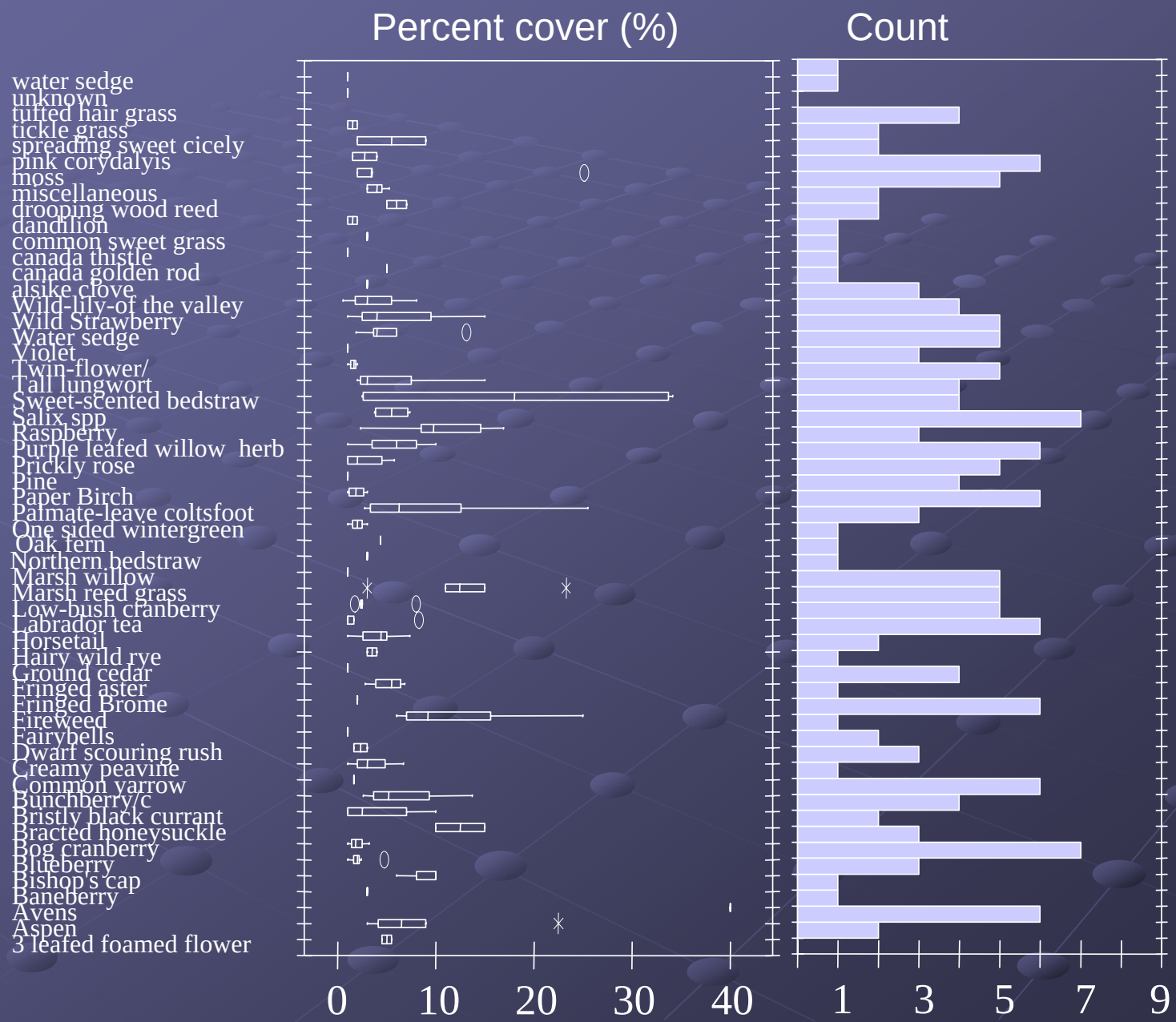
- 3 typical harvest sites
- 3 sample locations per site
- Hummock and depression sample plot (60 m^2) at each location
- 3 x1m^2 subplots within each plot



Sampling Site Pre-harvest Characteristics

- Site 1 – Pierre Watershed
  - Conifer Dominant
    - Lodgepole Pine 69%, Black Spruce 27%, White Birch 2%
    - Bracted honeysuckle, fern
    - Mesic-medium
- Site 2 – Pierre Watershed
  - Conifer Deciduous mixture
    - Lodgepole Pine 65%, Trembling Aspen 22%, Black Spruce 13%
    - Green alder, feather moss
    - Mesic
- Site 3 – Millions Watershed
  - Deciduous dominant
    - Trembling Aspen 100%
    - Green alder
    - Mesic medium

Species distribution and percent cover



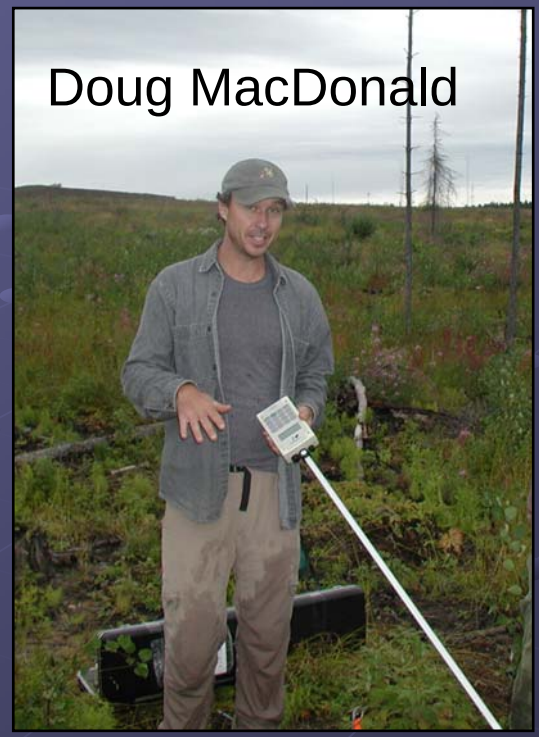
Leaf Area Index and Dry Biomass

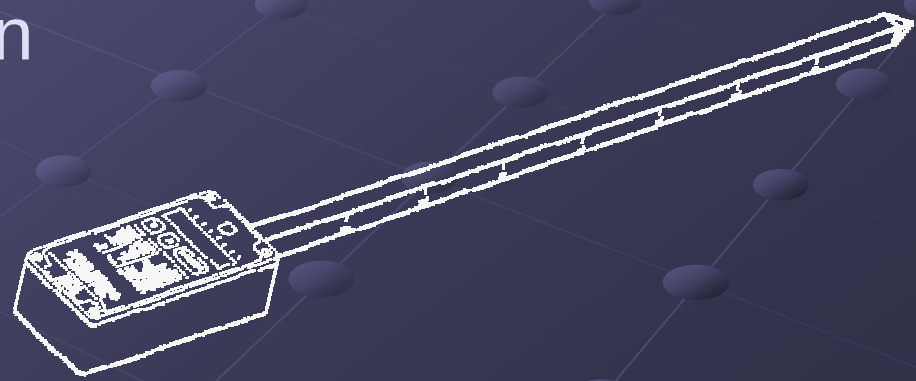
- Leaf area/plant of each species observed in plots determined by digital image analysis
- Leaf area vs. moist weight relationships developed
- Subplots destructively sampled
  - Species count and moist weight
  - estimate LAI
- Samples dried to determine dry biomass

e.g. Palmate leafed coltsfoot

Light Measurements

- 0.8 m Sunflect Ceptometer
  - at ground and above canopy
- 1 m^2 subplots
  - 10 measurements each at 10 cm intervals
- 60 m^2 plots
  - 10 random measurements
- k calculated based upon measurements and LAI



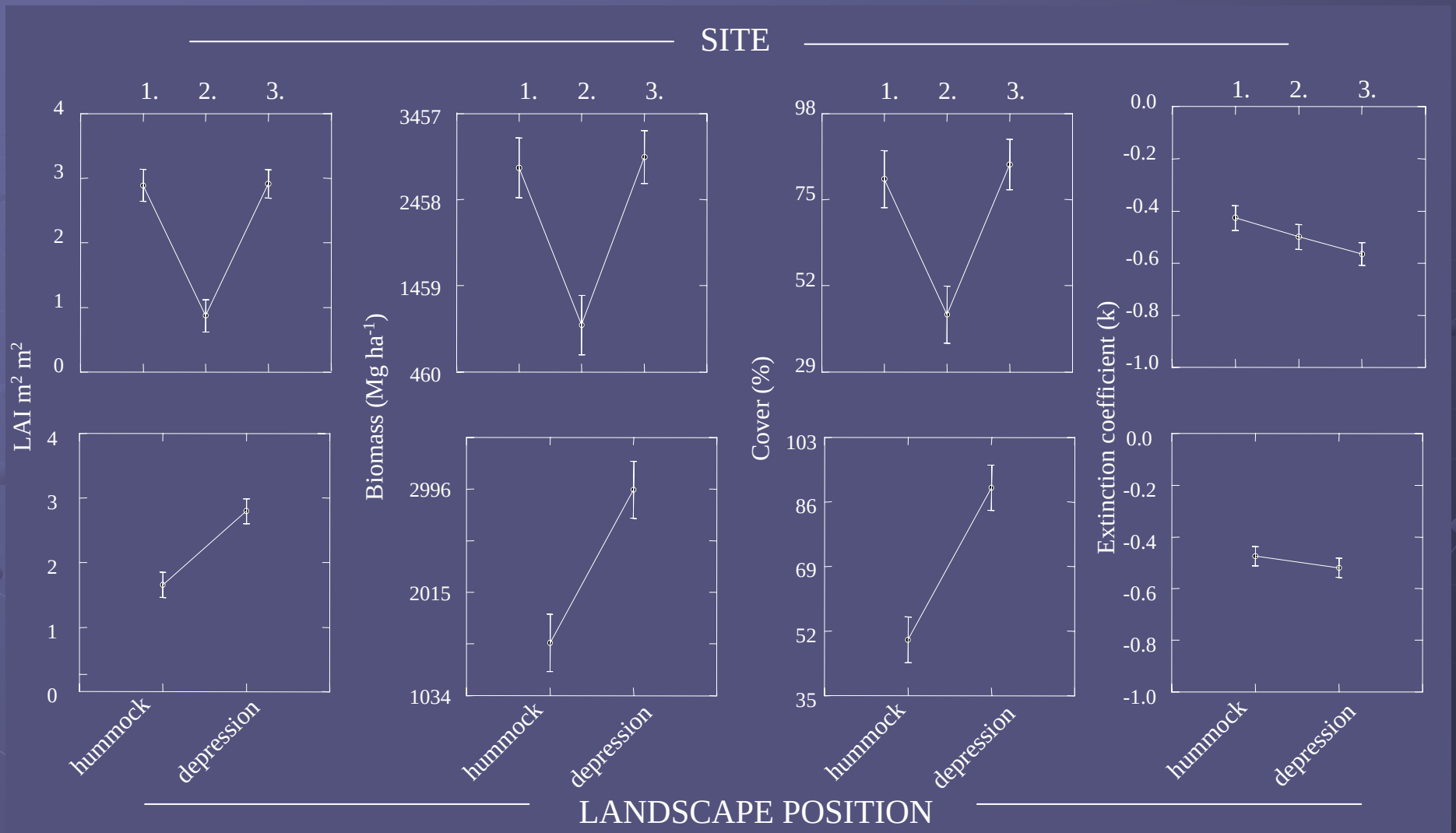


Study Results (LAI, % cover, Biomass)

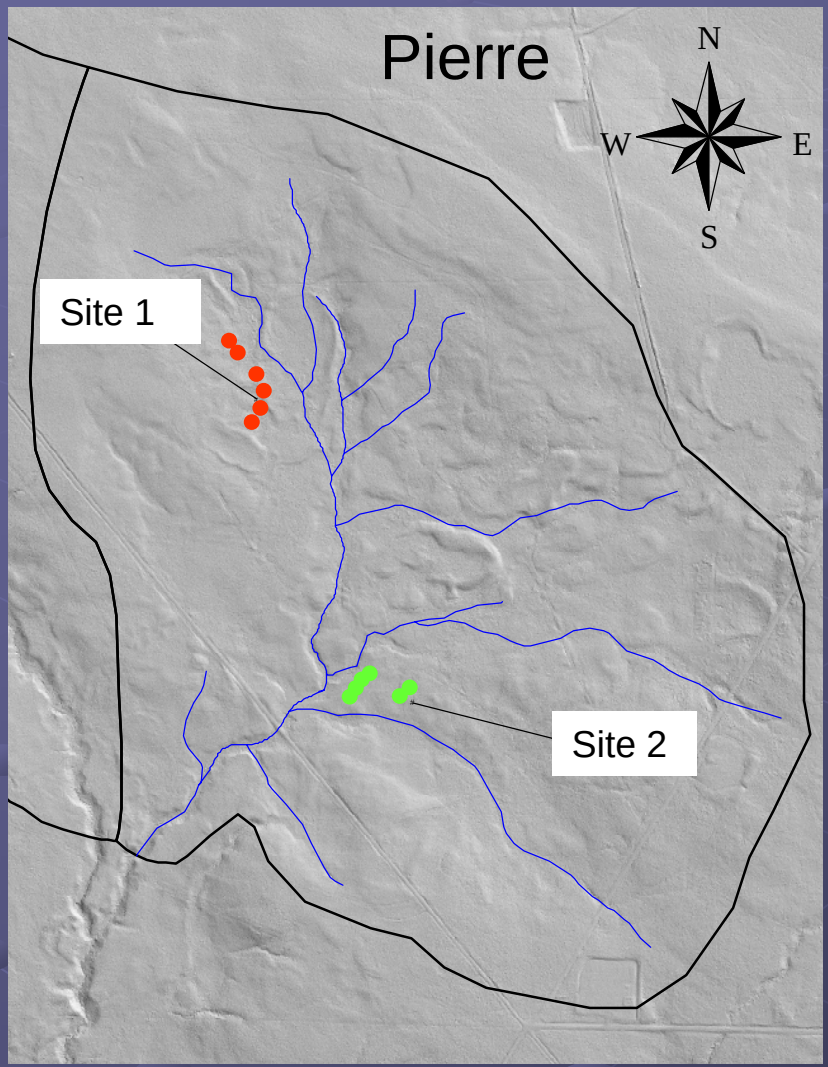
Table 3. Summary of vegetation characteristics among sites and landscape positions.

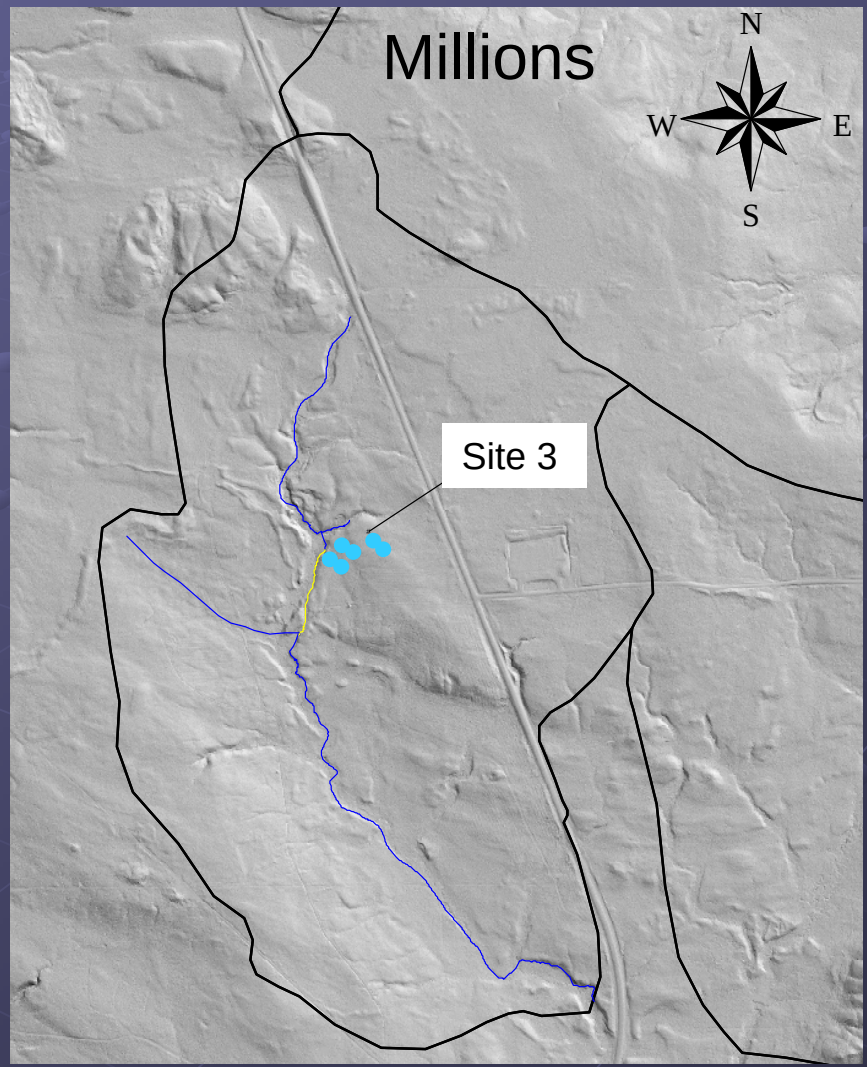
Site	Plot	Position	LAI m^2 m^{-2}			Percent Cover			Biomass Mg ha^{-1}		
			Annual	Shrub	Tree	Annual	Shrub	Tree	Annual	Shrub	Tree
Site 1	1	Hummock	1.2	0.0	0.0	36.0	2.0	1.0	1052.8	25.4	6.5
		Depression	2.0	0.4	0.0	52.8	7.0	1.0	2194.8	280.8	13.0
	2	Hummock	1.1	0.3	0.2	29.5	6.5	4.3	848.3	193.3	333.1
		Depression	1.7	0.5	0.9	57.3	15.3	22.5	1198.7	1222.6	2746.0
	3	Hummock	0.6	0.2	0.0	17.8	8.7	1.0	386.2	128.1	14.2
		Depression	1.3	0.4	0.1	30.8	6.5	7.0	1065.7	241.0	30.3
Site 2	1	Hummock	0.2	0.1	0.2	9.0	5.3	9.0	66.2	156.8	500.1
		Depression	0.6	0.1	0.1	24.2	2.7	4.0	558.9	149.5	132.5
	2	Hummock	0.1	0.0	0.1	5.2	3.0	2.3	88.2	69.8	133.7
		Depression	0.2	0.8	0.1	9.8	26.0	1.0	199.9	1162.6	40.9
	3	Hummock	0.3	0.0	0.0	11.3	2.3	0.0	247.8	37.9	0.0
		Depression	0.7	0.3	0.3	27.6	13.0	15.0	864.8	473.5	605.4
Site 3	1	Hummock	1.2	0.4	0.2	37.7	13.6	3.0	1199.1	302.7	140.2
		Depression	1.8	0.7	0.1	44.6	18.3	2.0	2165.8	554.8	123.4
	2	Hummock	1.2	0.1	0.0	50.8	5.3	1.0	1259.5	114.5	26.7
		Depression	1.2	0.4	0.1	40.2	16.8	1.8	1106.7	299.3	116.7
	3	Hummock	1.2	0.3	0.2	27.6	10.3	2.5	1280.2	320.7	299.3
		Depression	1.1	0.5	0.2	30.0	11.3	5.0	1044.2	345.0	283.7

Influence of Site and Position on Vegetation Characteristics

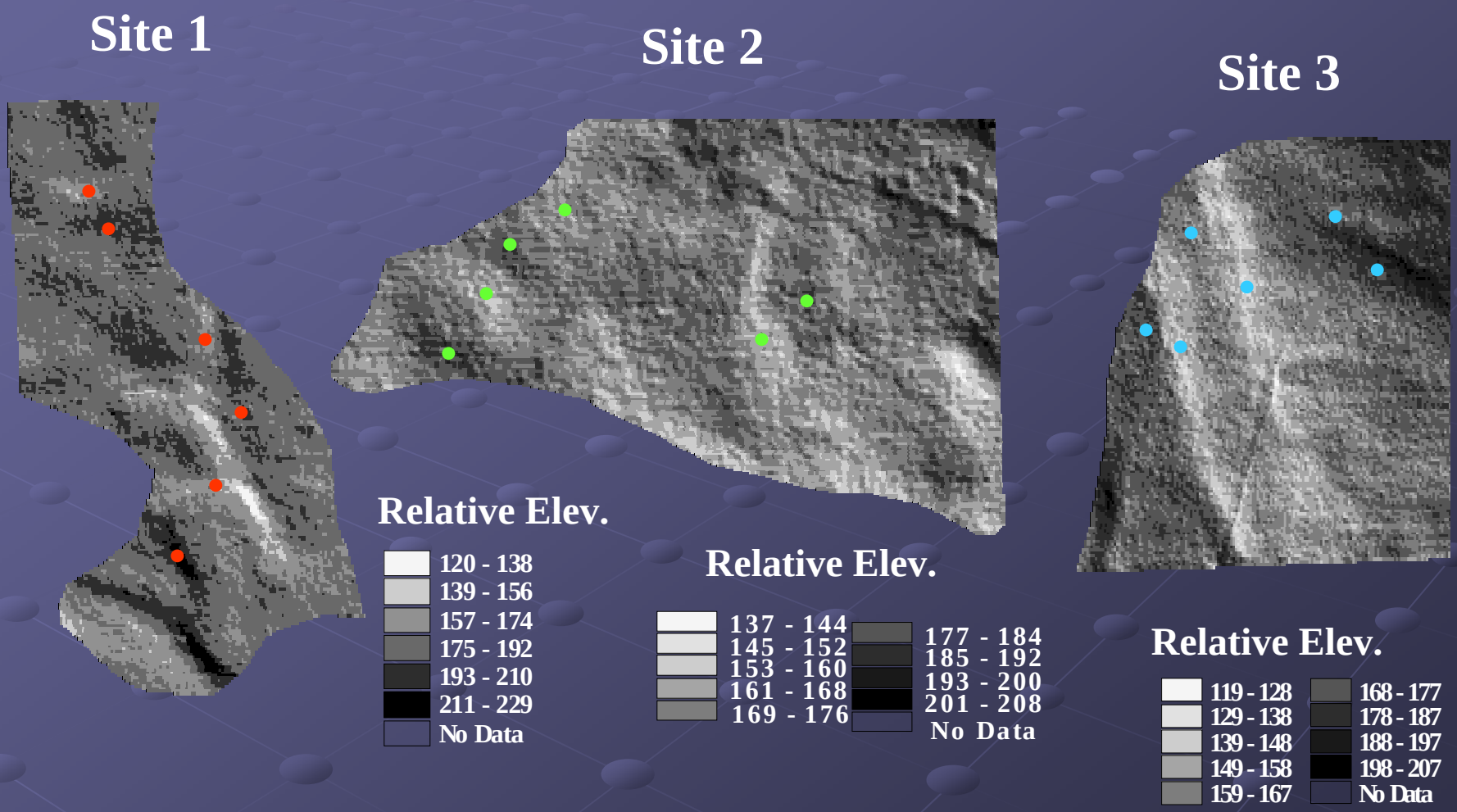


Watershed LIDAR Images and Site Locations





Delineation of sites into depression and hummock using LIDAR imaging



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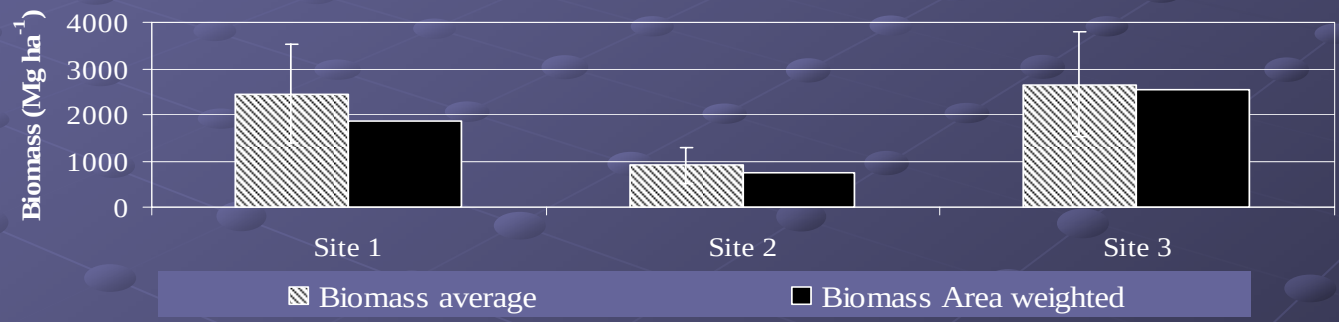

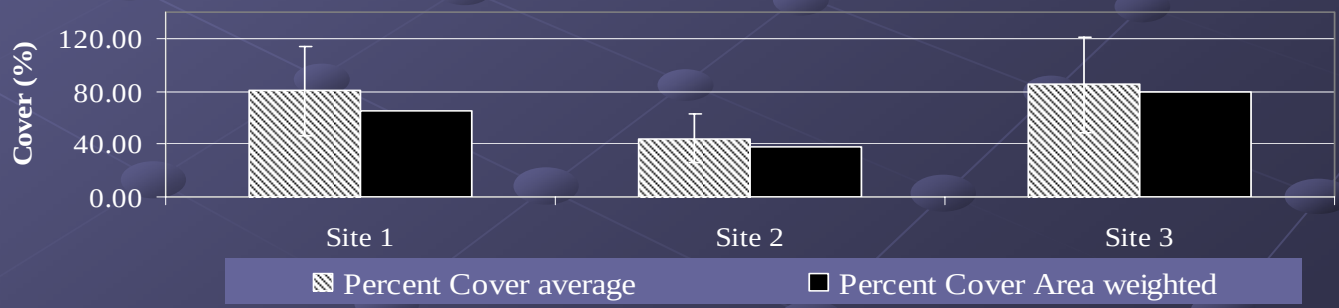

Radiation Use Efficiency

- Estimated using multiple model runs using FORWARD data for sites
  - Meteorology, Soils, DEM
- Best fit to LAI and biomass at sample plots
  - Grasses, forbs: 4.9 ± 1.7 Kg/ha per MJ/m^2
  - Shrubs: 3.3 ± 2.0 Kg/ha per MJ/m^2
- Species observations rarely below 10
  - Model underestimates?
  - Understory species adaptation?
    - LAI vs. biomass

Conclusions

- Vegetation cover 3 years post harvest has important observed differences
  - site to site
    - initial forest, nutrient – moisture regime
  - hummocky to depression
    - Influenced by moisture conditions
- variability must be considered for sampling and hydrologic modelling
- Limited data set – additional work required

Forest Watershed & Riparian Disturbance Project

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linking research & industry to improve forest management planning & policy in Canada

Welcome to the website of the Forest Watershed and Riparian Disturbance (FORWARD) research project, which was initiated in 2001. FORWARD is based on the western Canadian Boreal Plain. Our companion project, the Legacy Forest Small Streams (LFSS) project, is based on the central Canadian Boreal Shield.

FORWARD is a partnership between researchers, students, forest-related companies, First Nations communities, and Provincial and Federal Governments. We collect soil, water, and vegetation data from reference, burned and experimentally harvested watersheds to develop hydrologic models. These can be linked directly to the management plans of our Industry Partners.

The models we develop will predict how watershed disturbance influences the movement of water and nutrients from forests to streams. Experimental work tests hypotheses relating to watershed processes that influence boreal forest soils, biodiversity, streamflow and water quality.

Feedback to: janicemarion@yahoo.com

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http://forward.lakeheadu.ca

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