

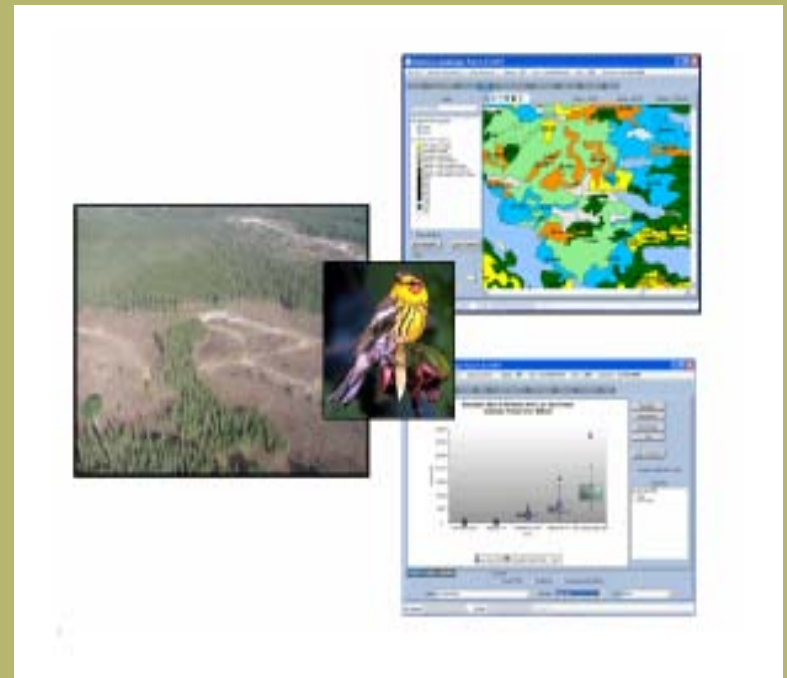
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# FOREST MANAGEMENT GUIDE FOR BOREAL FOREST LANDSCAPES

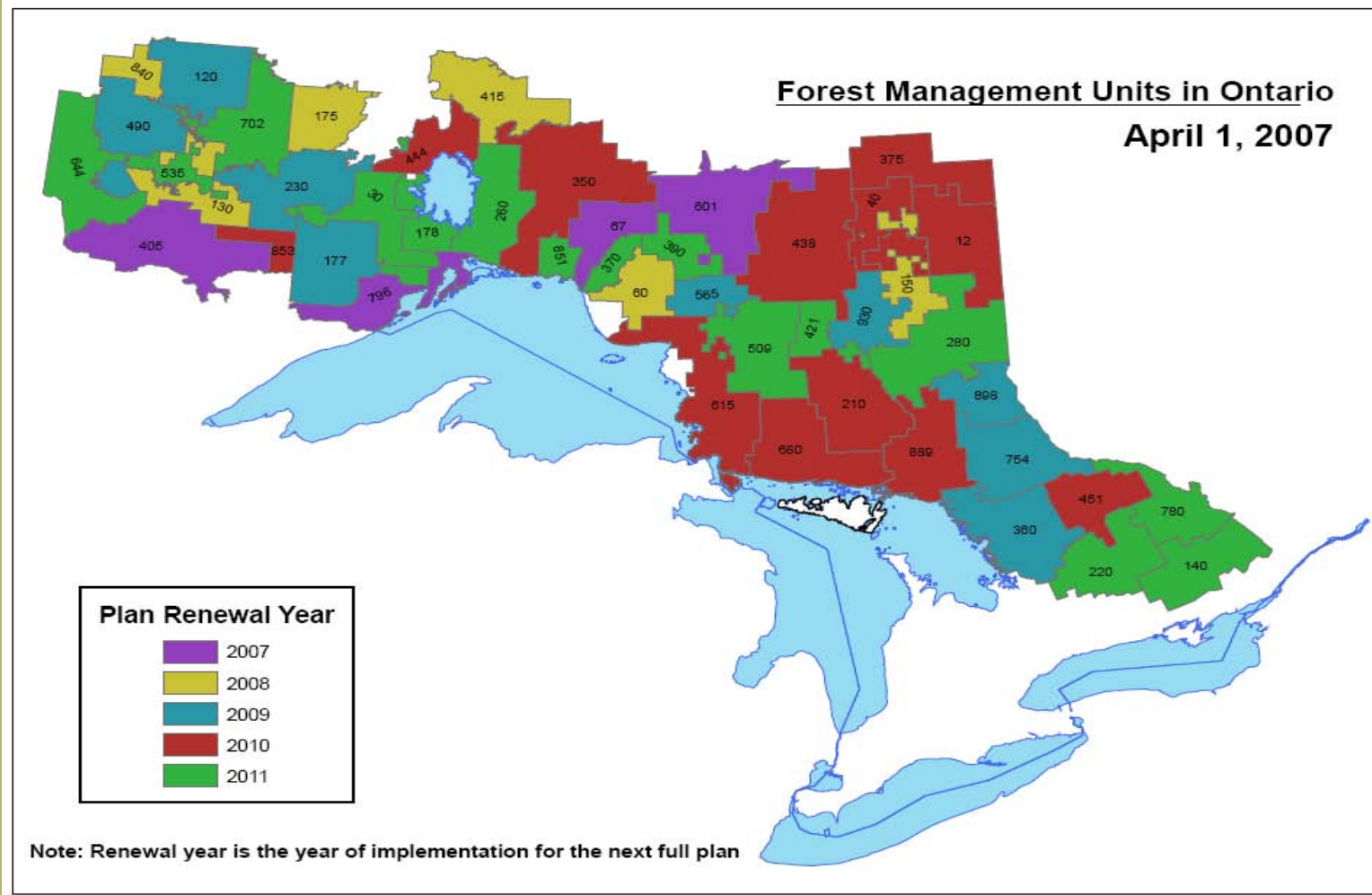
Multi-Cohort Stand Structural  
Classification Using LiDAR

University of Toronto, ON

March 26<sup>th</sup>, 2010



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- response to recommendations from a number of advisory groups and committees, the Ministry of Natural Resources (MNR) is updating its set of 36 forest management guides and replacing them with a more effective and efficient suite of only five documents
- provides direction to planning teams to help them set the broad strategic direction for their forest management plan
  - Key point: recognition of natural variation

Why?

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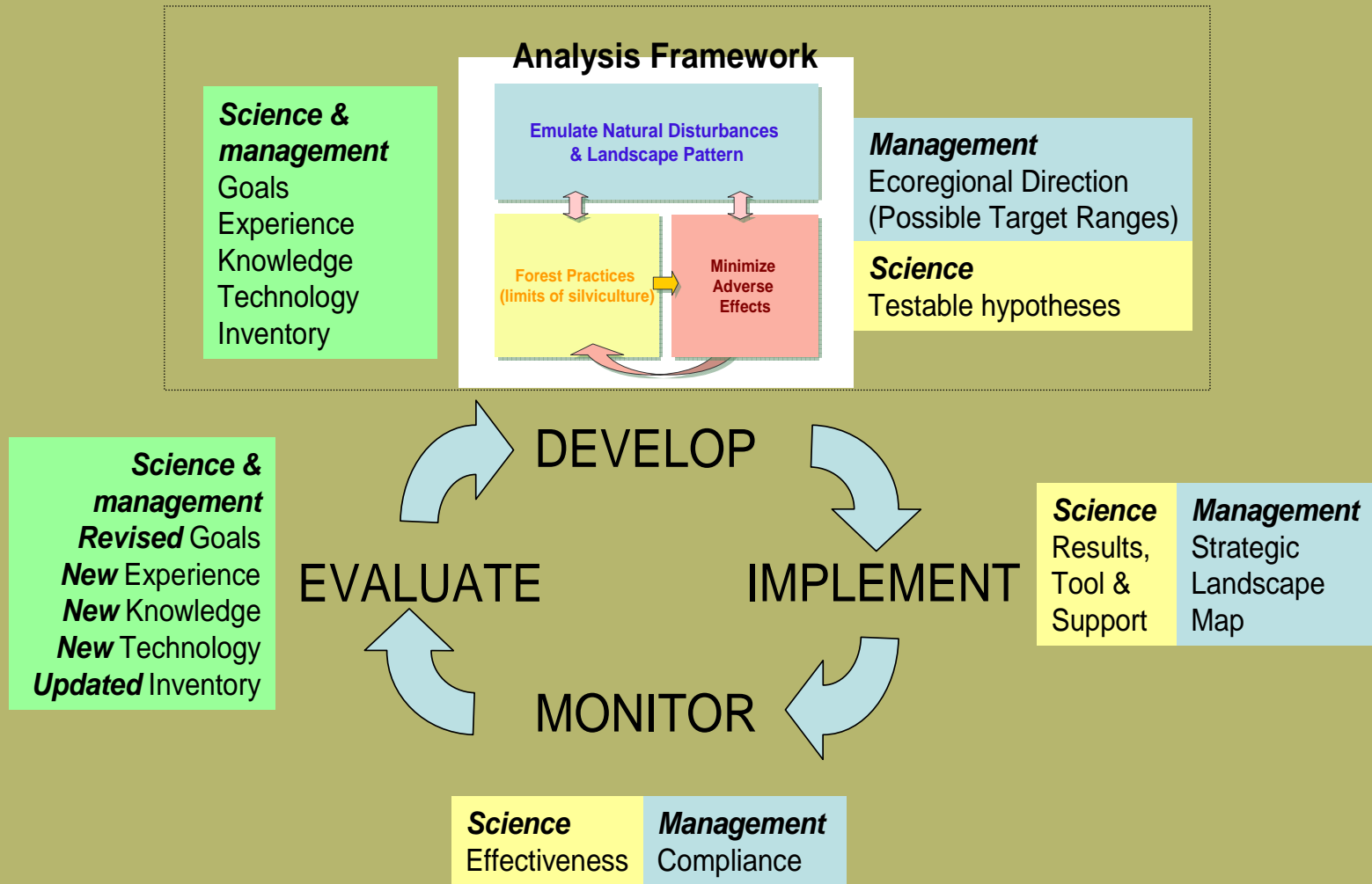
## Replacing Current “Landscape Guides”

- NDPEG
  - Disturbance template
- Old Growth
  - Amount and distribution
- Marten
  - Habitat provision
- Caribou
  - Habitat provision
- Deer
  - Habitat provision
- Moose
  - Habitat provision
- Coarse filter
  - Move/maintain landscape towards/within SRNV
    - Composition
    - Pattern
- Fine filter
  - Amount, arrangement and location of caribou habitat

How?

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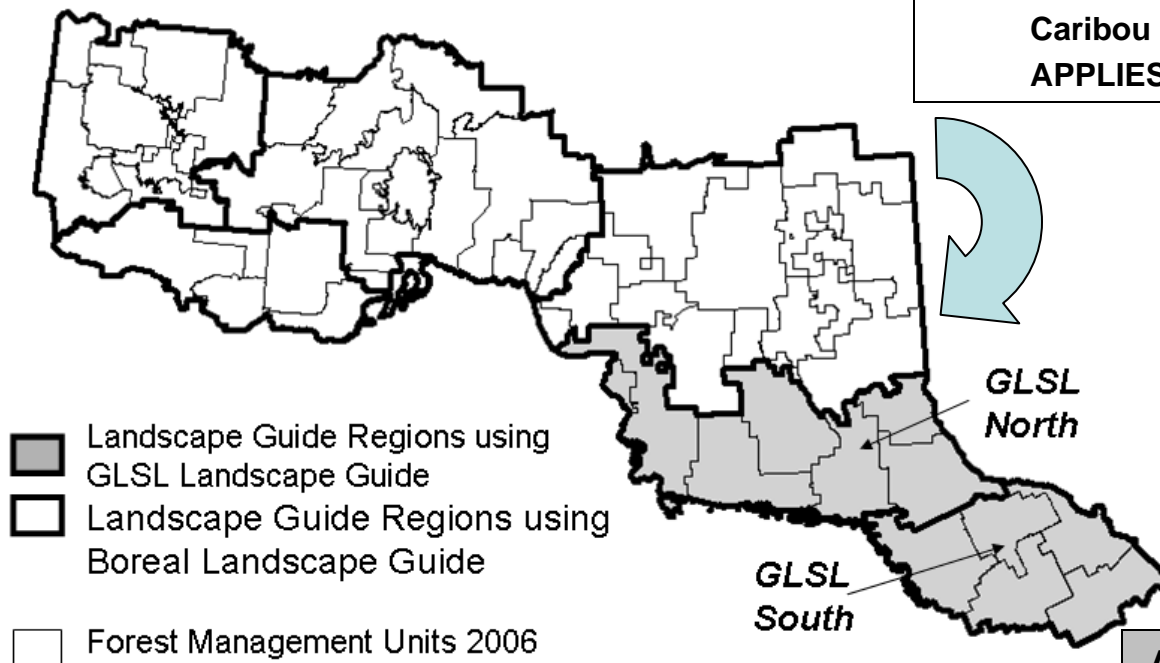
Context



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# Two Versions of the Landscape Guide

Landscape Guide for Boreal  
Will be in line with:  
Caribou habitat regulation  
Caribou Conservation Plan  
APPLIES TO 2012 FMPS



Applying GLSL Landscape Guide –  
starts with 2011 FMPS

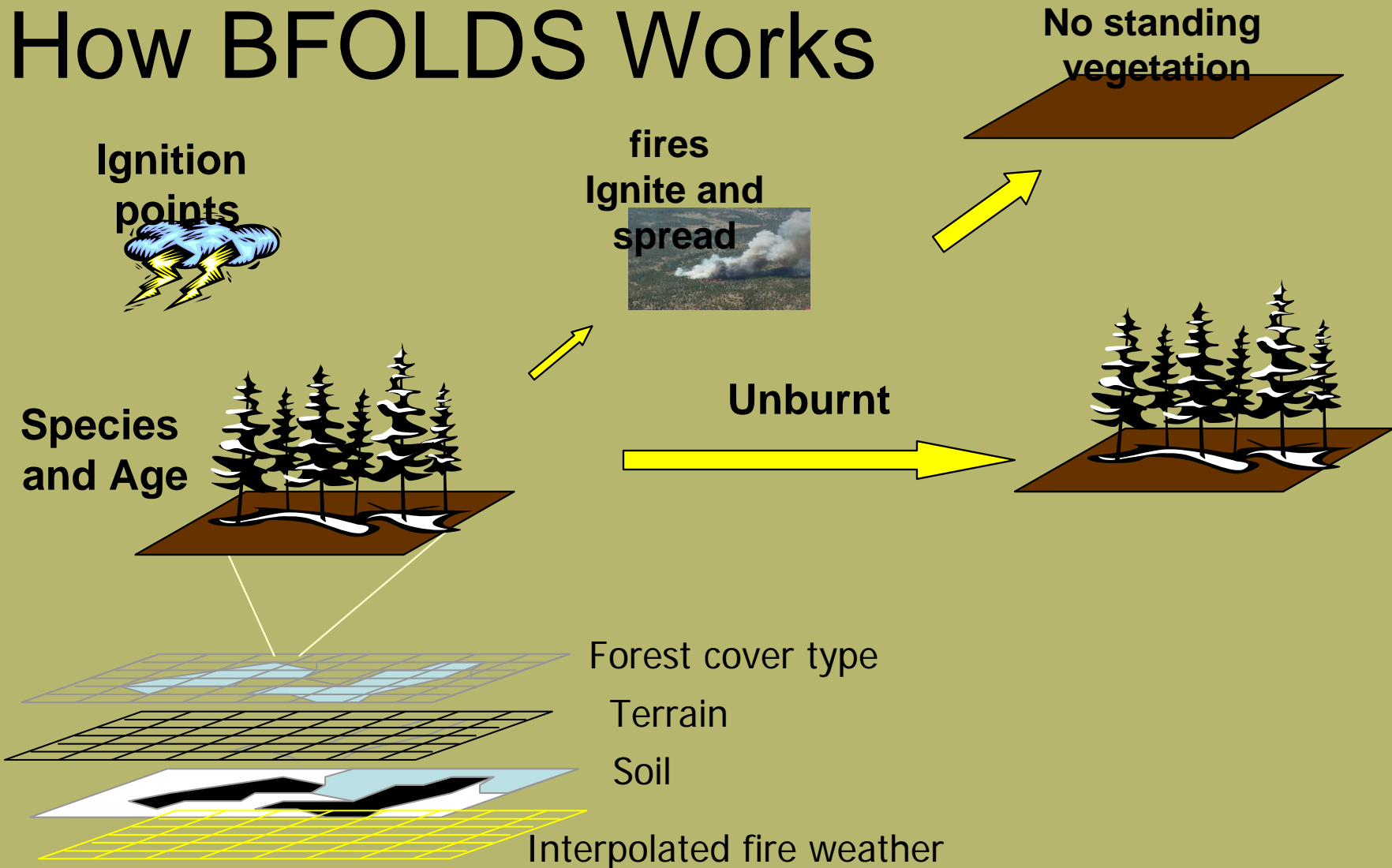
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## Boreal Forest Landscape Dynamics Simulator

- a grid-based, spatially explicit model
- contains a simulation module for crown-fire regimes (FSM) and a vegetation transition module (VTM)
- simulates the fire regime and fire induced forest cover dynamics at broad spatial and temporal scales (>10 million ha and >300 yr)
- uses a relatively fine spatial scale for some processes (1- ha spatial resolution)
- BFOLDS developed specifically for modeling stand initiating fire, succession and post fire transitions in the Boreal Forest Region of Ontario.

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# How BFOLDS Works

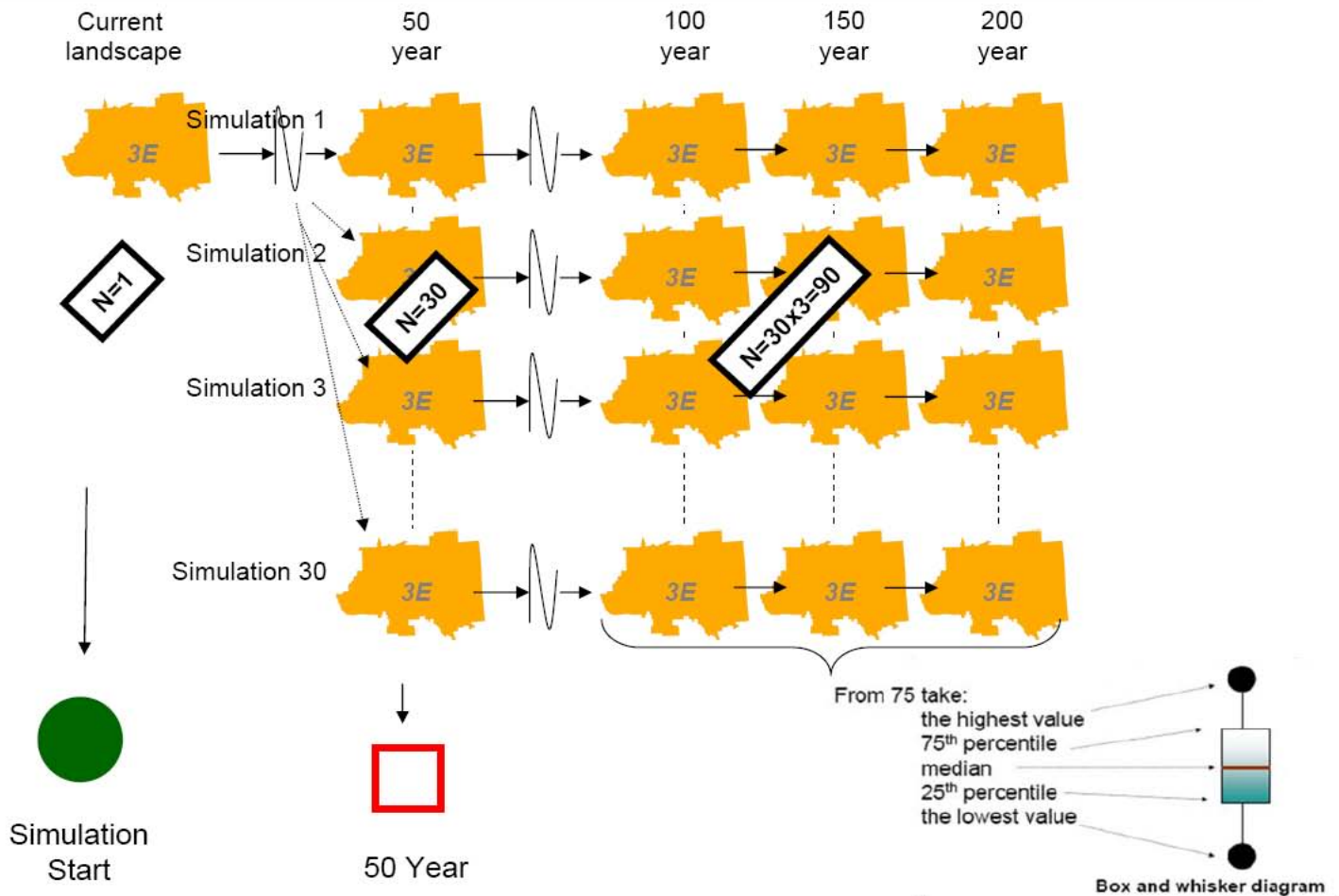


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Forest Management Guide for Landscapes - Simulation Example Information Sheet

Simulation Example

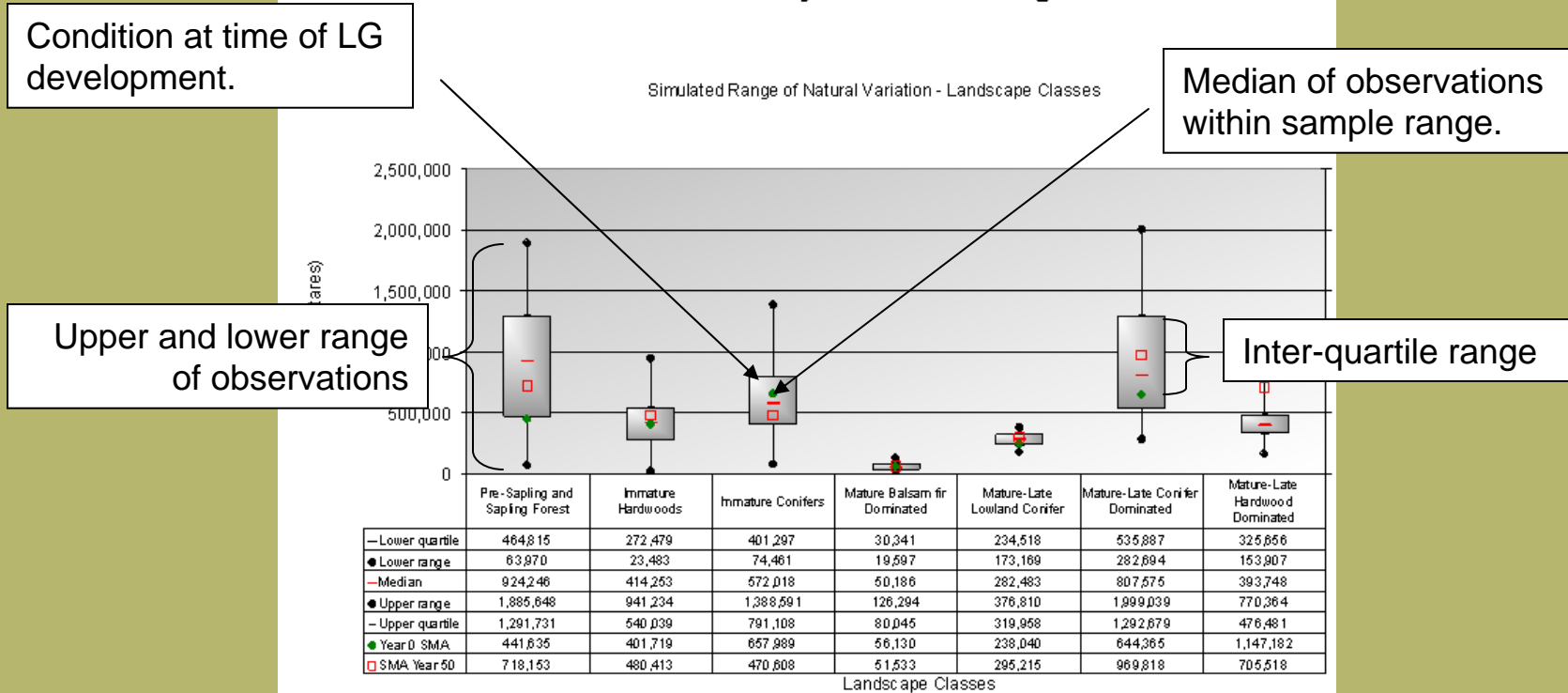
Boreal Forest Region East



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# Simulated Range of Natural Variation (SRNV)

100 – 200 year simulation ranges\*



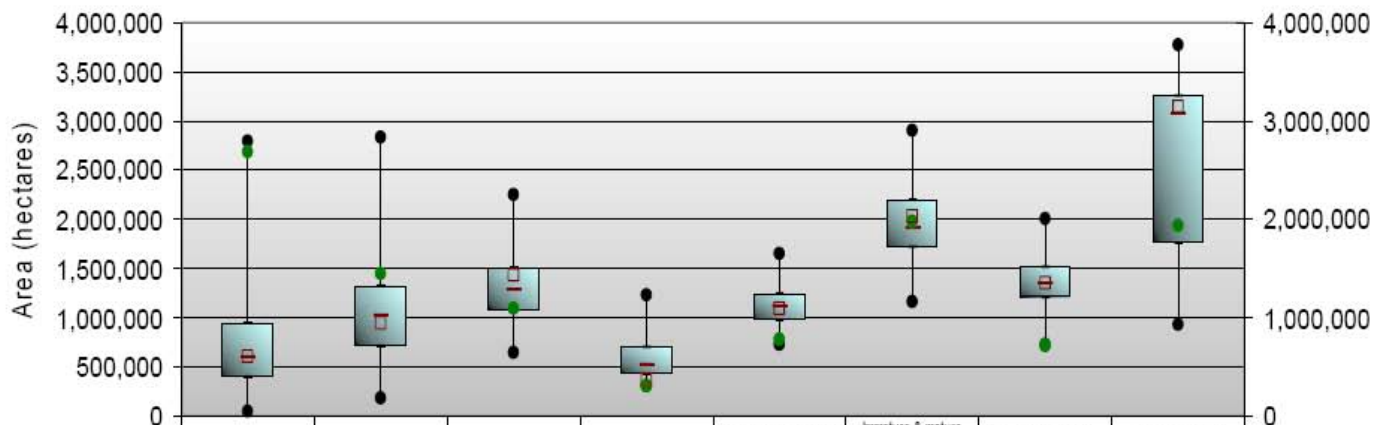
# Forest Management Guide for Landscapes - Landscape Class Information Sheet

3E - Landscape Classes SRNV

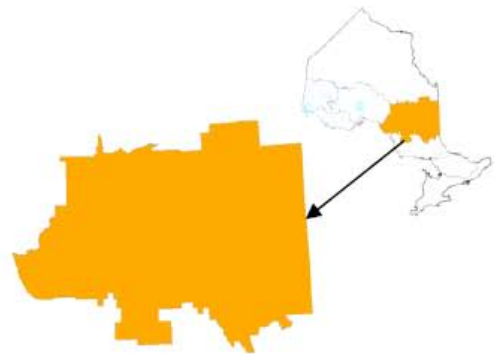
Boreal East Forest Region

## 100 – 200 year simulation ranges\*

Estimated range of natural variation - "Landscape Classes"



**Landscape Guide Region 3E**  
12,835,126 hectares



Lower Quartile	398,147	705,602	1,087,126	424,857	967,198	1,708,885	1,196,412	1,756,399
Lower Range	37,169	173,987	638,510	298,238	719,385	1,155,681	717,260	923,216
Median	584,895	1,021,015	1,278,437	512,903	1,111,803	1,910,385	1,348,291	3,070,724
Upper Range	2,787,954	2,627,426	2,250,098	1,222,963	1,643,562	2,896,581	2,003,697	3,775,374
Upper Quartile	932,586	1,313,064	1,602,088	690,118	1,234,486	2,196,651	1,607,339	3,251,351
Year 0	2,682,967	1,437,560	1,089,216	299,011	780,626	1,969,016	708,981	1,932,152
50 year median	698,583	937,143	1,434,833	373,865	1,083,537	2,033,091	1,348,439	3,137,253

\* Simulated ranges of natural variation based on 30-200year simulation replications with measurements taken at simulation years 100,150 and 200. (n=30\*3).

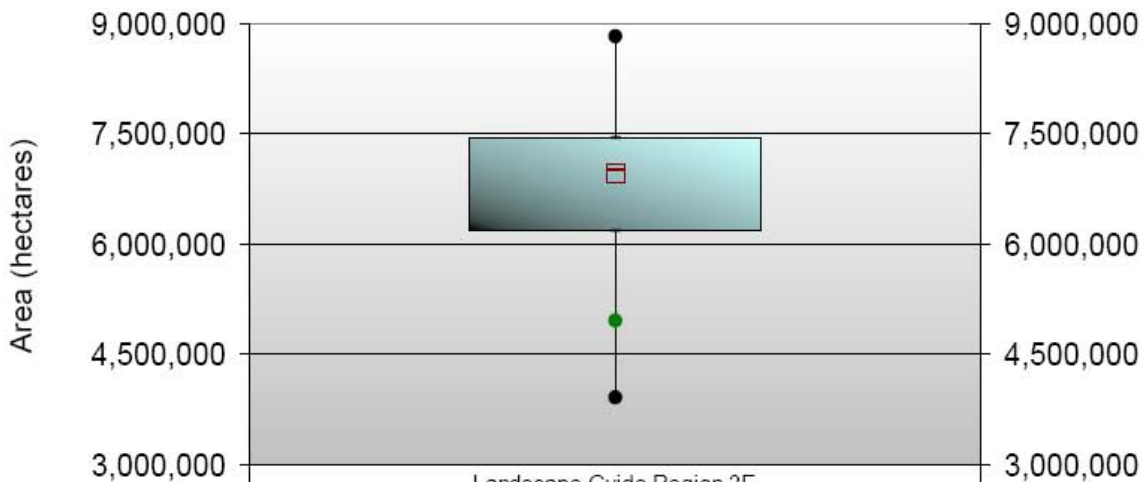
# Forest Management Guide for Landscapes - Mature and Old Information Sheet

3E – Mature and Old SRNV

Boreal East Forest Region Mature and Old

## 100 – 200 year simulation ranges\*

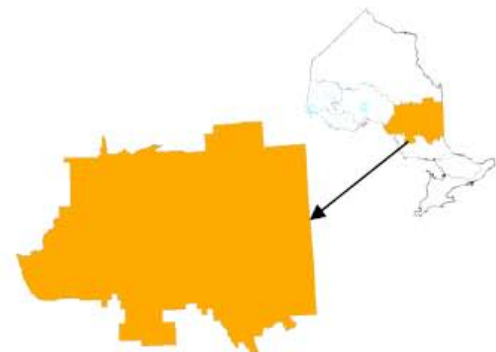
Estimated range of natural variation - "Mature and Old"



Landscape Guide Region 3E	
- Lower Quartile	6,179,109
● Lower Range	3,917,528
- Median	7,012,699
● Upper Range	8,816,065
- Upper Quartile	7,436,120
● Simulation Start	4,957,782
□ 50 year median	6,955,285



**Landscape Guide Region 3E**  
12,835,126 hectares



\* Simulated ranges of natural variation based on 30-200 year simulation replications with measurements taken at simulation years 100,150 and 200. (n=30\*3).

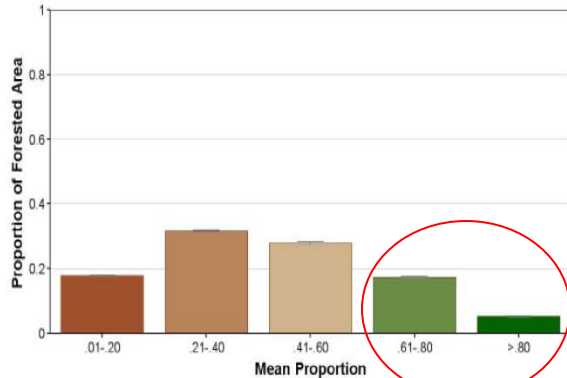
## Forest Management Guide for Landscapes - Mature and Old Pattern Information Sheet

3E Year 0-500 (ha) HISTOGRAM

Boreal Forest Region Northeast – Mature and Old

### 427 Mature and Old Forest - Ecoregion 3E: Year 0

Proportion of Mature and Old Forest (500ha)



	Case	Bar	Case
	Ecoregion 3E: Year 0		Ecoregion 3E: Year 0
#Offsets	9 of 9	<	4.33
Replicate#	1	.01-.20	.178
N	28613	.21-.40	.316
Mean	.421	.41-.60	.280
		.61-.80	.174
		>.80	.074

13 of 112

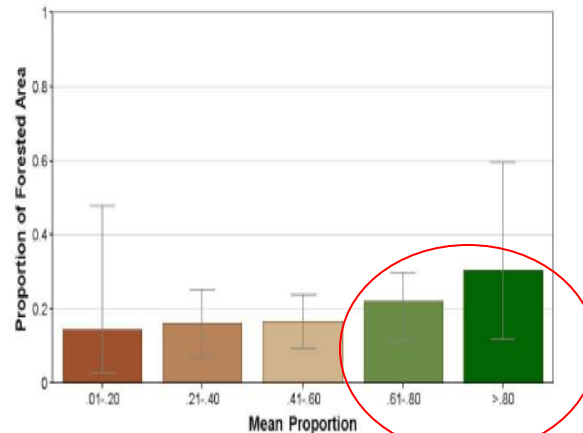
## Forest Management Guide for Landscapes - Mature and Old Pattern Information Sheet

3E Simulation 500 (ha) HISTOGRAM

Boreal Forest Region Northeast – Mature and Old

### 427 Mature and Old Forest - Ecoregion 3E: Years 100-150-200

Proportion of Mature and Old Forest (500ha)



Landscape Guide Region 3E  
12,835,126 hectares



	Case	Bar	Case
	Ecoregion 3E: Years 100-150-200		Ecoregion 3E: Years 100-150-200
#Offsets	9 of 9	<	5.56
#Replicates	90 of 90	.01-.20	.145
N	28608	.21-.40	.163
Mean	.573	.41-.60	.166
		.61-.80	.166
		>.80	.155

15 of 112

## Forest Management Guide for Landscapes - Mature and Old Pattern Information Sheet

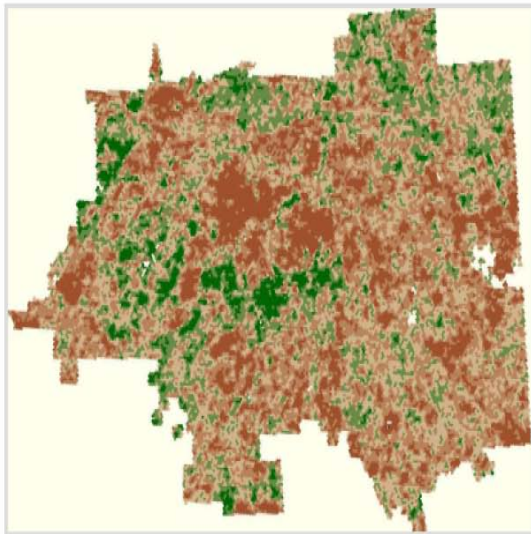
3E Year 0-500 (ha) MAP

Boreal Forest Region Northeast – Mature and Old

### 427 Mature and Old Forest - Ecoregion 3E: Year 0

Proportion of Mature and Old Forest (500 ha)

r1



## Forest Management Guide for Landscapes - Mature and Old Pattern Information Sheet

3E Simulation 500 (ha) MAPS (a)

Boreal Forest Region Northeast – Mature and Old

### 427 Mature+Old Forest - Ecoregion 3E: Year 100 Fire Intensity 200

Proportion of Mature and Old Forest (500 ha)



Landscape Guide Region 3E  
12,835,126 hectares



# The way BFOLDS Handles Age and the 3E calibration

Table 7. Age ranges associated with the five development stages for each standardized forest unit in the revised Boreal East habitat suitability model.

Standardized forest unit	Development Stage				
	P	S	I	M	O
PR1	0-14	15-39	40-79	80-129	130+
PW1	0-14	15-39	40-79	80-129	130+
PRW	0-14	15-39	40-79	80-129	130+
LH1	0-9	10-29	30-69	70-99	100+
TH1	0-9	10-29	30-69	70-99	100+
SBOG	0-34	35-69	70-109	110-149	150+
SB1	0-19	20-39	40-79	80-119	120+
LC1	0-19	20-39	40-79	80-119	120+
SF1	0-14	15-39	40-79	80-109	110+
SP1	0-14	15-39	40-79	80-109	110+
PJ1	0-9	10-29	30-69	70-109	110+
PJ2	0-9	10-29	30-69	70-99	100+
PO1	0-9	10-29	30-59	60-89	90+
BW1	0-9	10-29	30-59	60-89	90+
MW1	0-9	10-29	30-69	70-99	100+
MW2	0-9	10-29	30-69	70-99	100+

+

SFU	Maximum age	After succession
BW1	140	40
LC1	300	60
LH1	143	80
MW1	140	60
MW2	160	65
PJ1	130	40
PJ2	160	55
PO1	120	60
PR	250	60
PRW	300	77
PW1	300	77
SB1	150	55
SF1	130	55
SP1	160	40
TH1	250	70

## Keypoint:

Without fire, BFOLDS cycles the forest from old growth to immature to mature. This can be considered a multi-aged condition (uneven or all-aged)

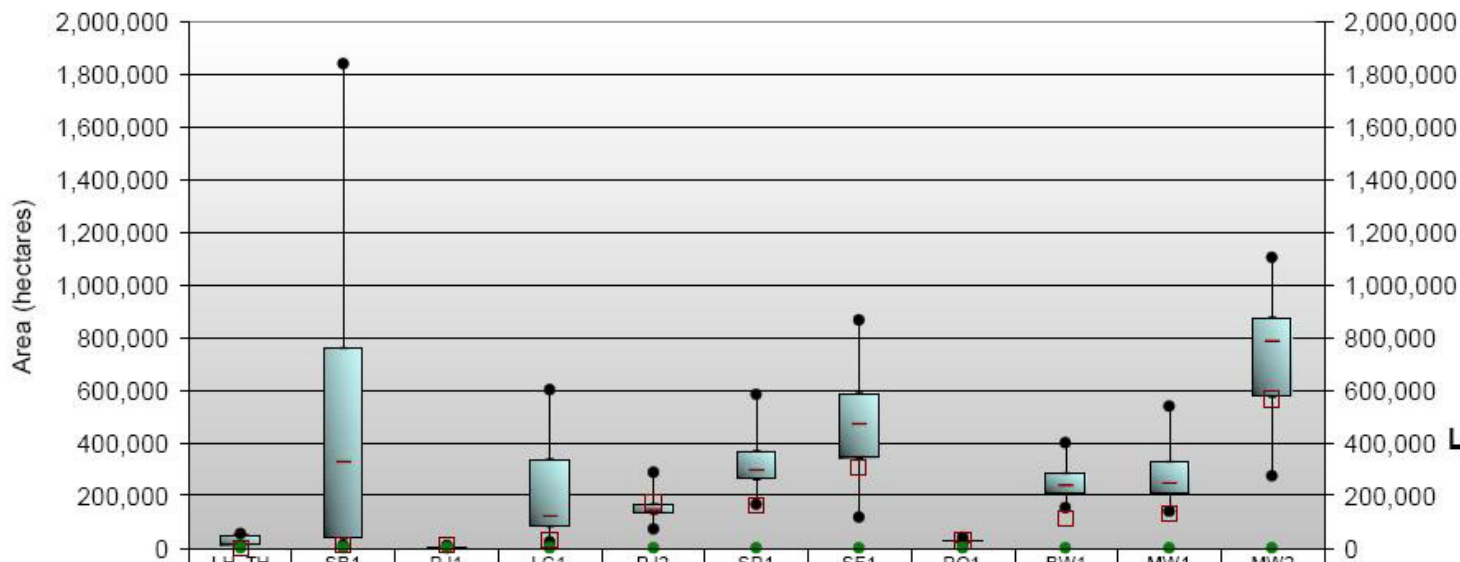
# Forest Management Guide for Landscapes - Uneven age site Information Sheet

3E – Uneven age Site SRNV

Boreal East Forest Region - Uneven age site

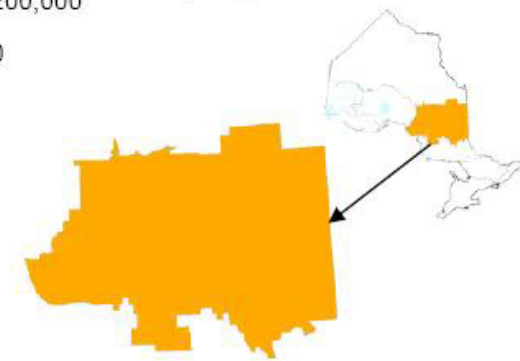
## 100 – 200 year simulation ranges\*

Estimated range of natural variation - "Uneven aged site (all development stages)"



	LH_TH	SB1	PJ1	LC1	PJ2	SP1	SF1	PO1	BW1	MW1	MW2
- Lower Quartile	11,055	34,776	132	80,840	128,608	258,942	340,757	20,212	206,682	206,700	574,715
● Lower Range	10,503	7,325	19	20,823	70,720	165,283	116,318	13,014	152,934	139,175	275,609
- Median	47,437	329,386	353	122,786	147,349	294,643	469,111	24,077	238,320	245,089	786,691
● Upper Range	54,501	1,838,338	9,324	603,139	288,976	582,517	865,575	40,294	397,426	538,820	1,103,228
- Upper Quartile	50,954	755,950	2,168	335,242	167,985	368,689	588,189	27,389	283,195	328,355	875,798
● Year 0	0	0	0	0	0	0	0	0	0	0	0
□ 50 year median	988	9,670	8,520	30,225	170,134	160,303	305,753	28,085	110,941	128,323	563,993

**Landscape Guide Region 3E**  
12,835,126 hectares



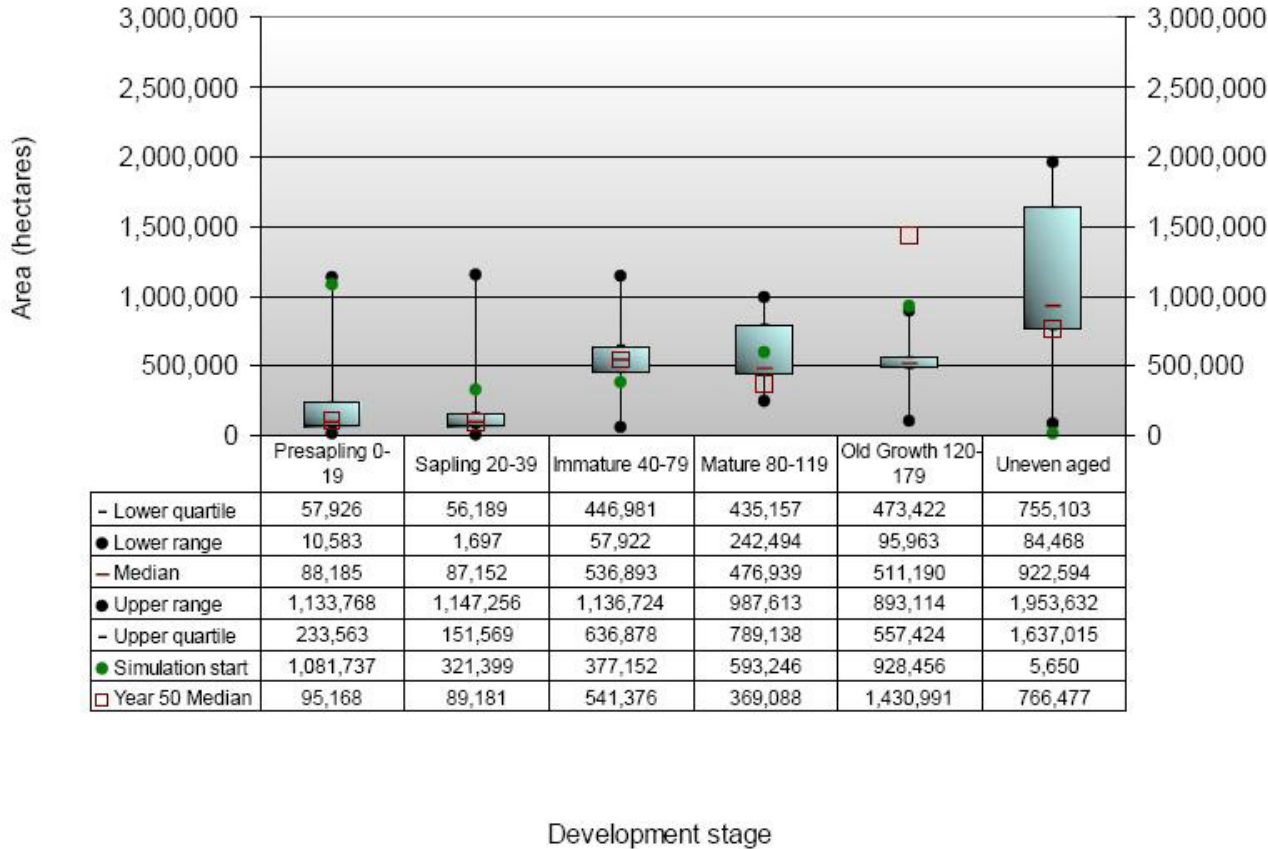
\* Simulated ranges of natural variation based on 30-200year simulation replications with measurements taken at simulation years 100,150 and 200. (n=30\*3).

\*\* 2006 areas based on the 2006 inventory, 30-50 year simulation ranges based on 30 runs with measurement taken at year 50 (n=30).

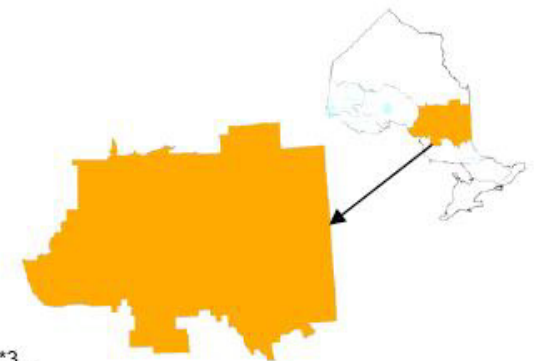
Tools used – Boreal Forest Landscape Dynamics Simulator (BFOLDS) and Landscape Scripting language (LSL) .

**100 – 200 year simulation ranges\***

Estimated range of natural variation - "SB1"



**Landscape Guide Region 3E**  
12,835,126 hectares



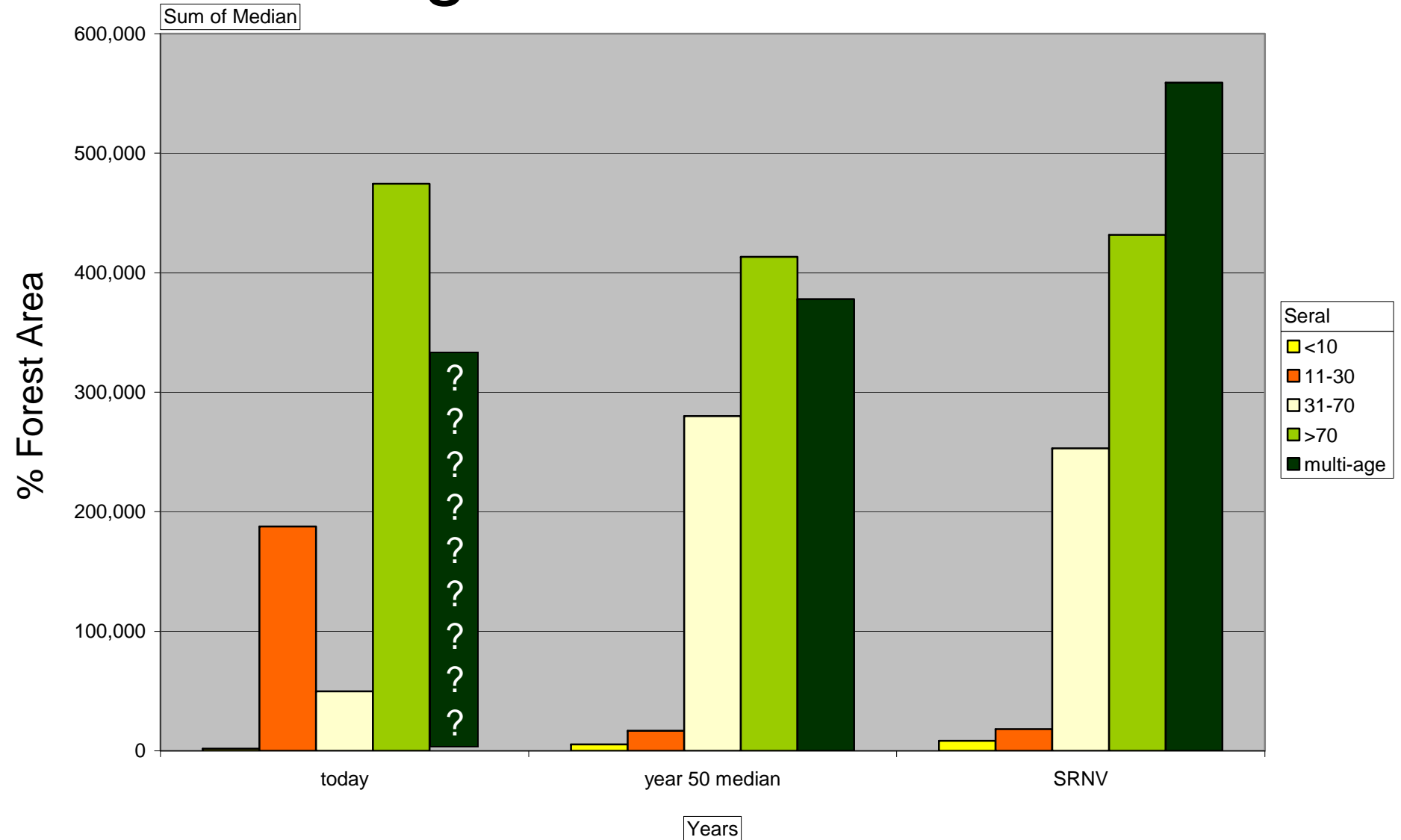
\* Estimated natural ranges based on 30 - 200 year simulation replications with measurements taken at years 100,150 and 200 (n=30\*3).

\*\* 2006 areas based on the 2006 inventory, 50 year simulation ranges based on 30 runs with measurement taken at year 50 (n=30).

Tools used – Boreal Forest Landscape Dynamics Simulator (BFOLDS).

# Sb1 Age Class Structure

e.g. Gordon Cosens Forest



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Questions to answer:

How do we identify Multi-Cohort stands today?

LiDAR?

Age? Structure? Modelling? Habitat?  
Growth & Yield?

Is spatial configuration important?

Do “immature” multi-cohort stands count as old growth?

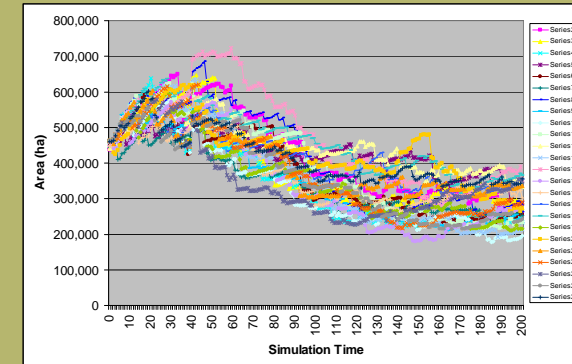
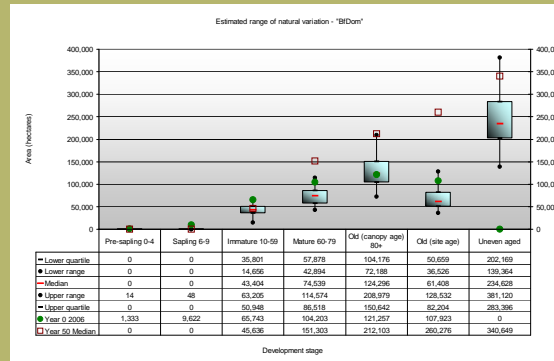
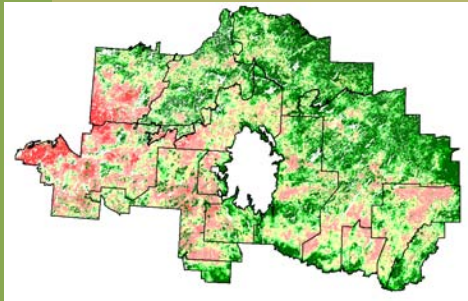
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Questions?

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# Science & Information Packages

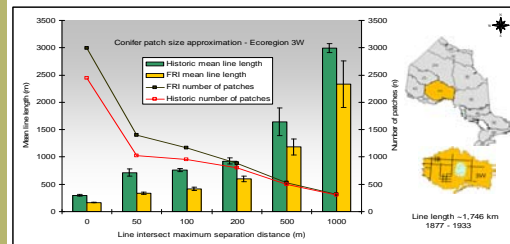
- Contains all inputs, assumptions, data sources and rationale used to develop SRNV



NWR Forest Unit	Development Stage				
	Presapling	Sapling	Immature	Mature	Late
BfDom	0	5	10	60	80
BwDom	0	5	10	50	110
ConMx	0	10	30	70	110
HrdMw	0	5	10	60	110
HrDom	0	5	10	60	100
OcLow	0	10	30	70	120
OthHd	0	5	10	60	100
PjDee	0	10	30	70	100
PmMx1	0	10	30	70	100
PoDee	0	5	10	60	130
PnwMx	0	10	20	80	120
SsDee	0	10	30	70	120
SsLow	0	10	30	70	110
SsMx1	0	10	30	70	100

Pattern Class Legend	
[Yellow]	Pre-sapling & sapling
[Light Green]	Immature conifer
[Light Blue]	Immature hardwood
[Light Orange]	Mature & late Bf
[Orange]	Mature & late lowland conifer
[Dark Orange]	Mature & late hardwood & mixed
[Dark Green]	Mature & late upland conifer & mixed

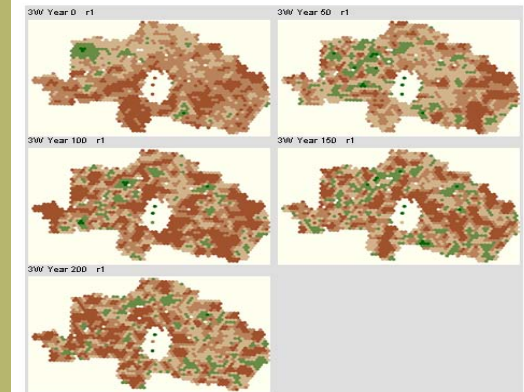
## Results fragmentation: historic survey lines



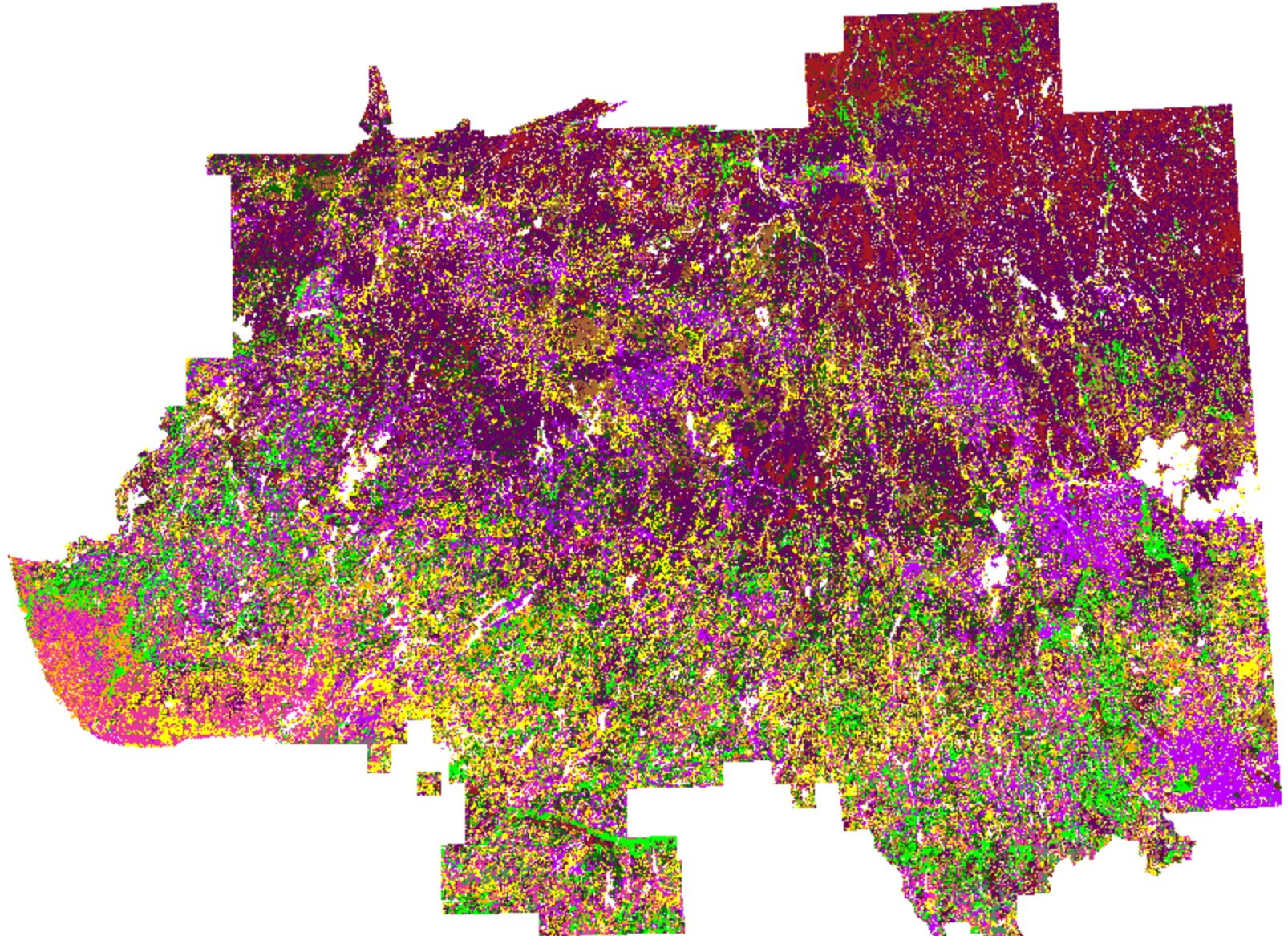
Patch size estimation and isolation for conifer in Ecoregion 3W including historic mean line length with 95% confidence intervals, FRI mean line length with 95% confidence intervals, and number of historic and FRI patches using varying separation distances.

## Landscape Indicators

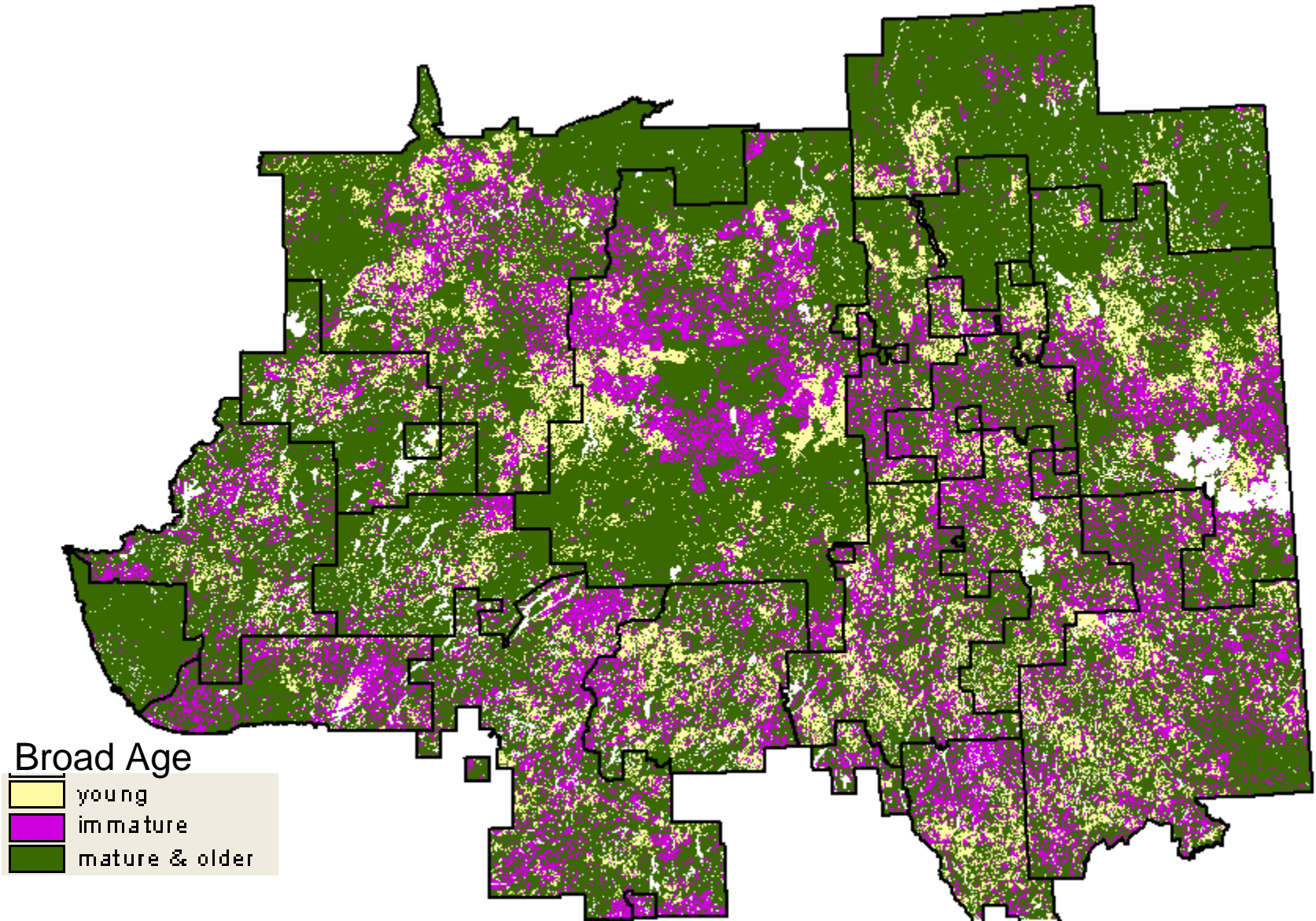
Proportion of Mature and Late Conifer Mixedwood at 5000ha



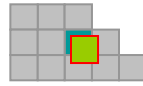
# Today's Landscape Composition



# Today's Landscape Age



Species composition



Stand age



$$\text{Fire ignition} = P_f \left[ \begin{array}{l} \text{Lightning} \\ \text{Daily weather dynamics} \\ \text{Duff Moisture} \\ \text{Fuel type} \end{array} \right]$$

$$\text{Fire spread} = P_f \left[ \begin{array}{l} \text{Topography (slope and aspect)} \\ \text{Daily forest fire weather indices} \\ \text{Daily wind direction} \\ \text{Daily wind speed} \\ \text{Fuel type} \end{array} \right]$$

$$\text{Fire extinguishment} = P_f \left[ \begin{array}{l} \text{Daily weather} \\ \text{Fuel type} \\ \text{Duff Moisture} \end{array} \right]$$

$$\text{Forest cover transitions} = P_f \left[ \begin{array}{l} \text{Geo-climatic zone} \\ \text{Soil moisture} \\ \text{Soil nutrient status} \\ \text{Species composition} \\ \text{Time since last disturbance} \\ \text{Time since last transition} \end{array} \right]$$

Spatial Bias

$D_r$  (edaphic, terrain)

Cell burn (yes/no)

