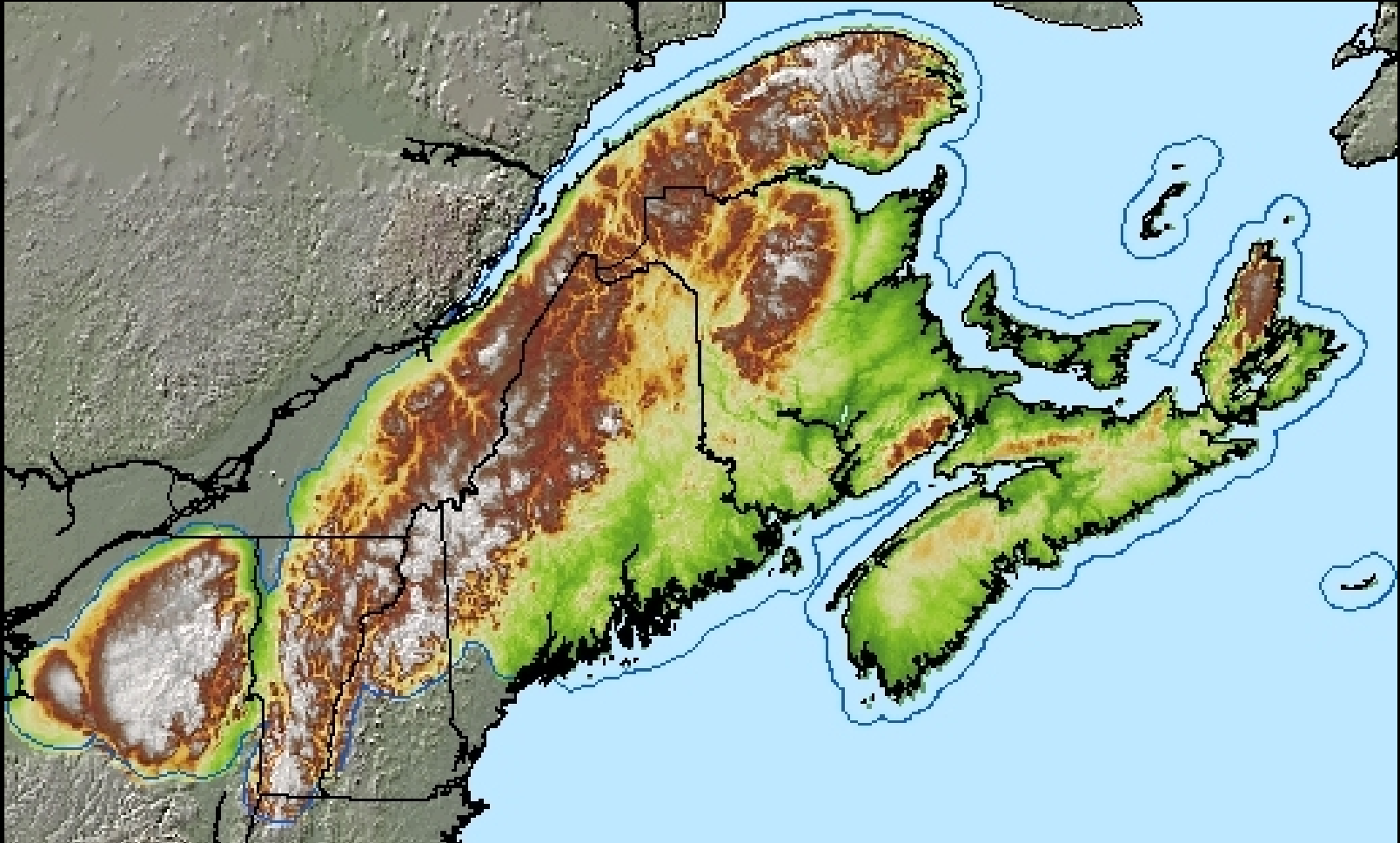


# Forest Management & Lynx Habitat Trends

Erin Simons-Legaard

Collaborators: Kasey Legaard, Dan Harrison, Mark McCollough, Aaron Weiskittel, Caitlin Andrews

# Northern Appalachian/Acadian Ecoregion



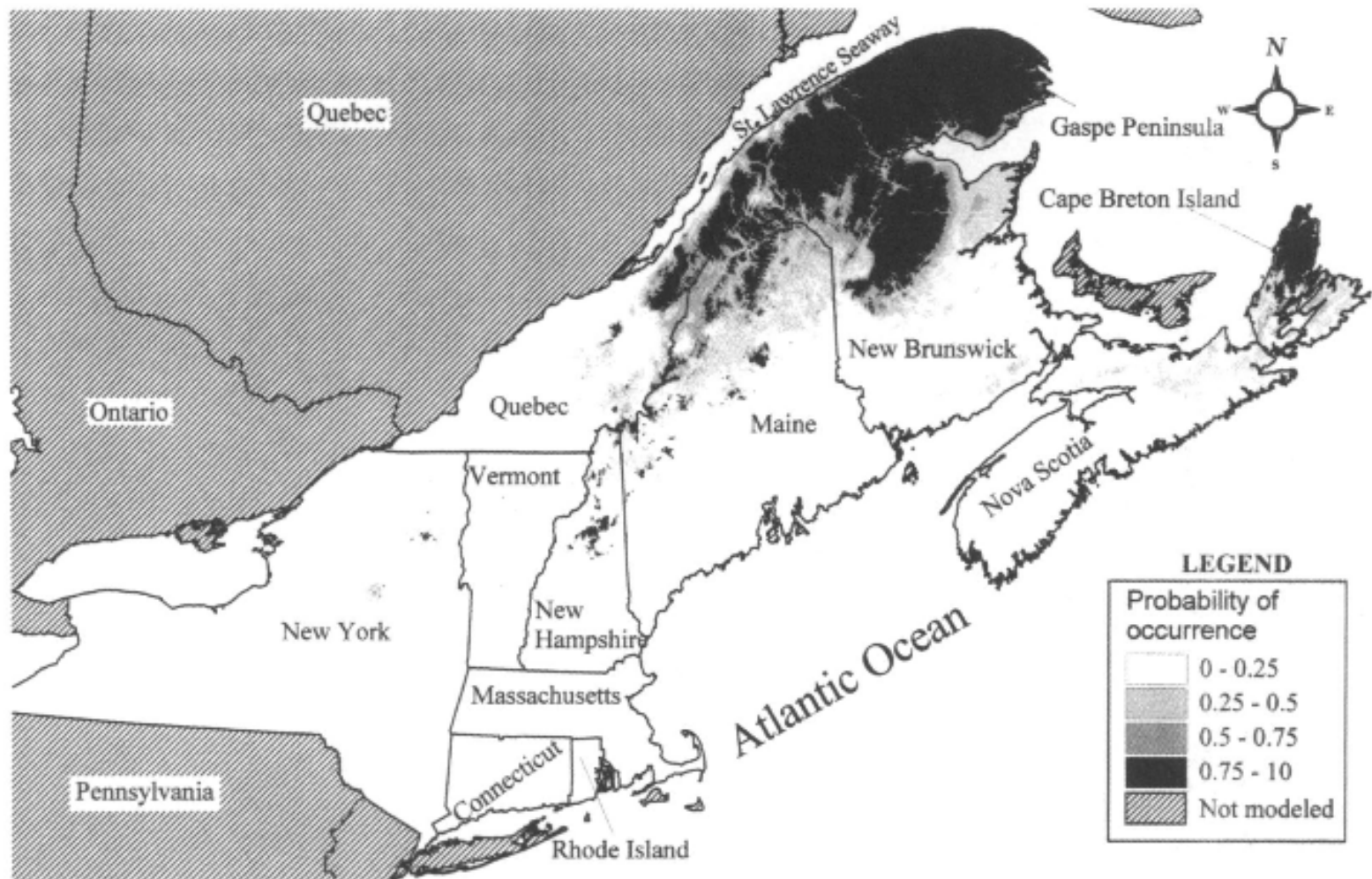


Fig. 2. Relative probability of Canada lynx occurrence based on snowfall and extent of deciduous cover throughout northeastern North America, south of the St. Lawrence Seaway, as determined from logistic regression modeling.

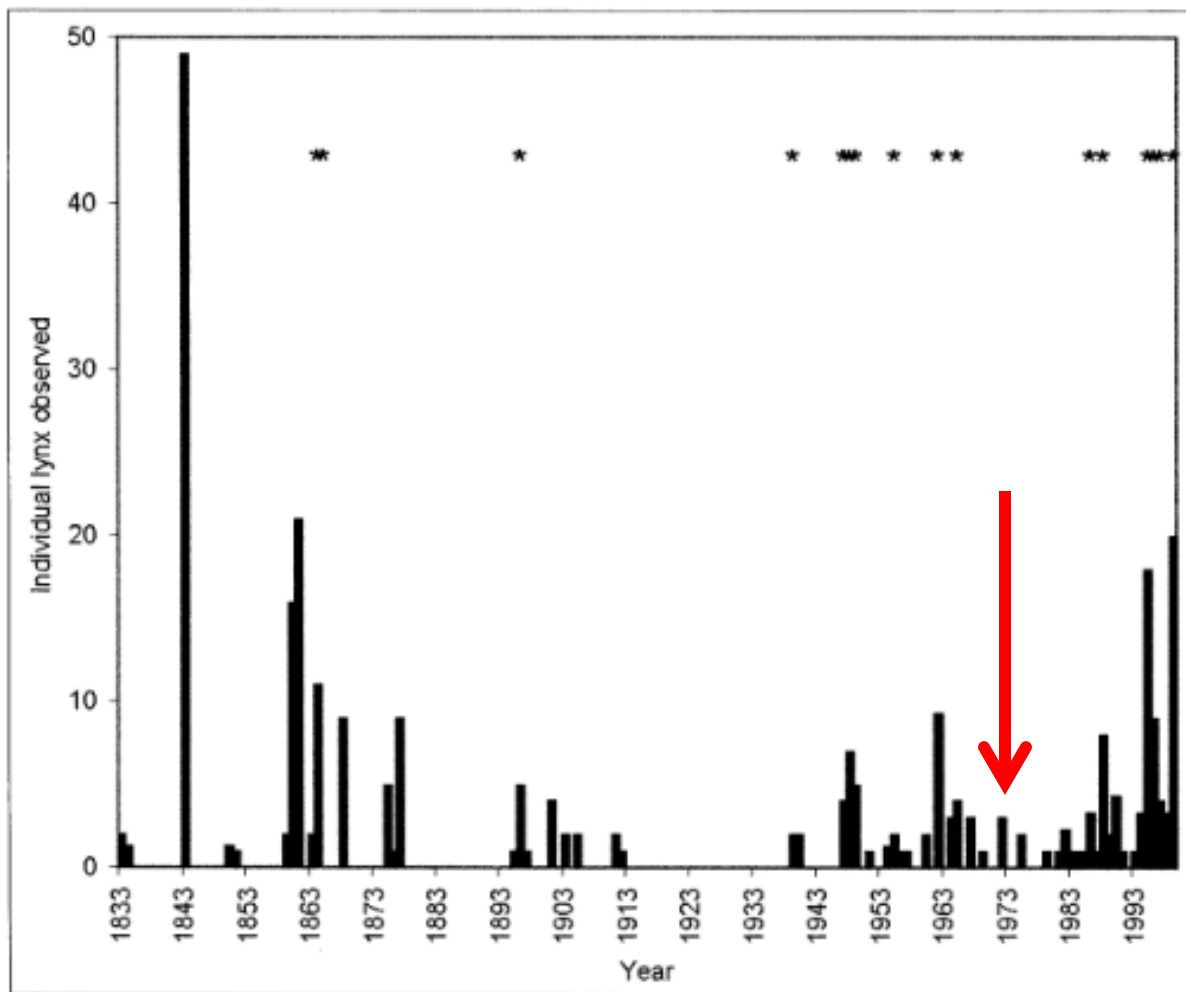
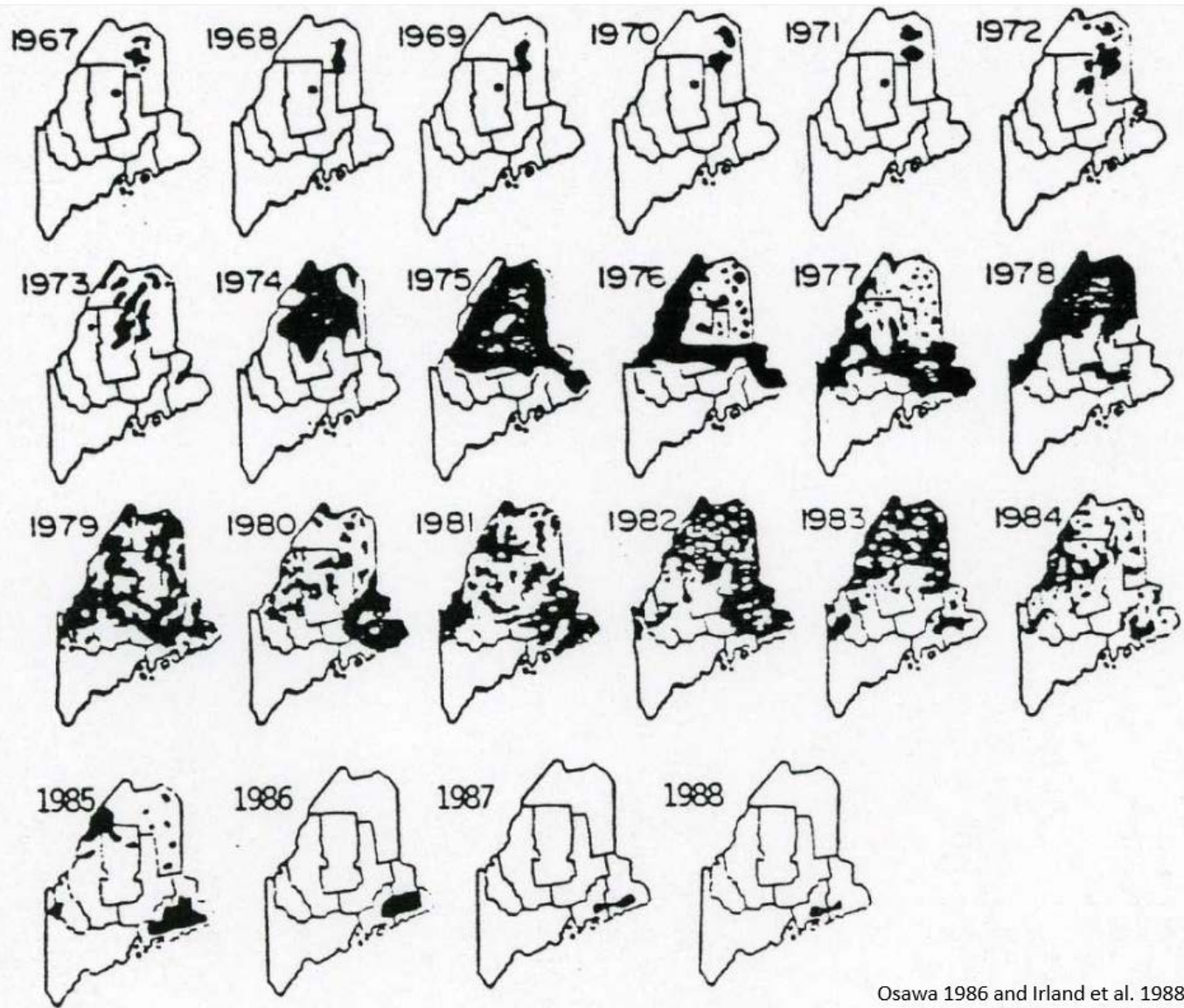


Figure 4. Canada lynx observations in Maine per year, 1833–1999, which were specific township or region. Asterisk indicate records of one or more kittens.

# Eastern spruce budworm (*Choristoneura fumiferana* Clem.)



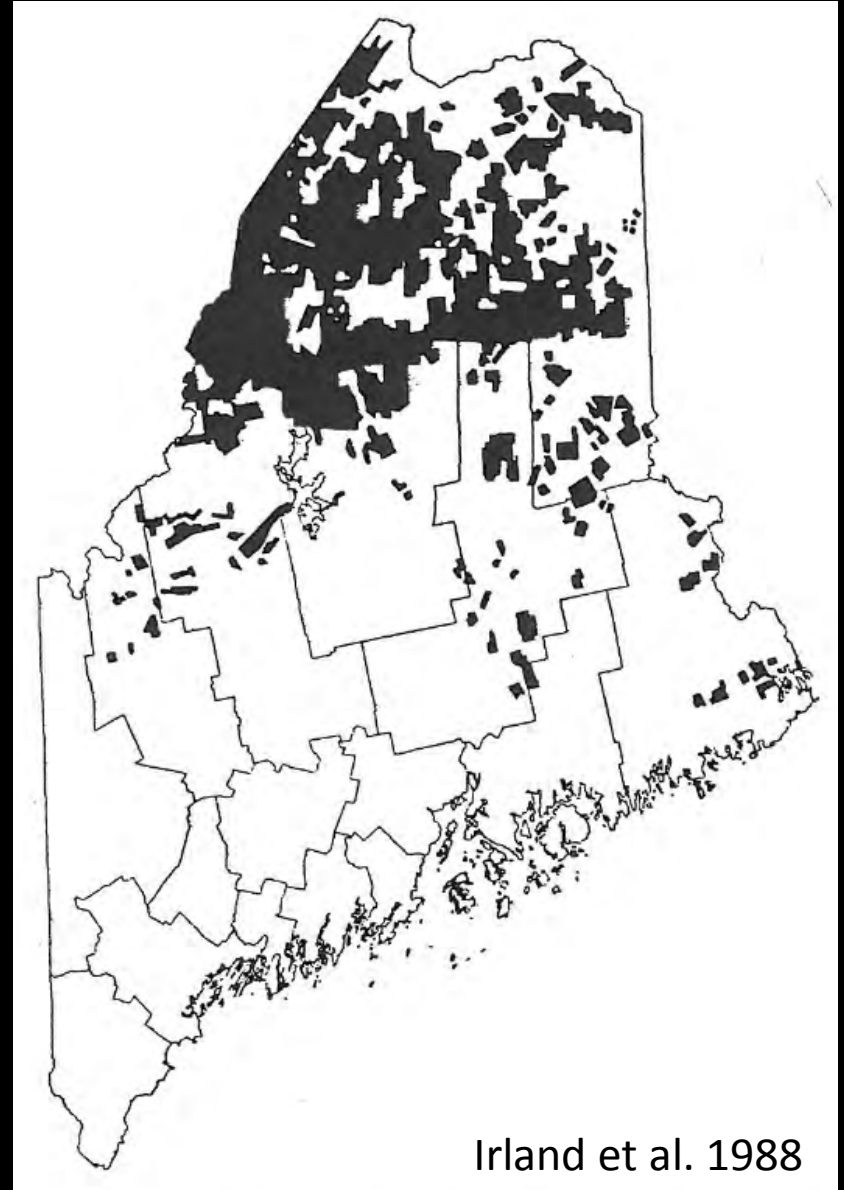


Osawa 1986 and Irland et al. 1988

State-run spray protection program,  
treating several million acres annually  
at its peak



Proposed spray blocks, 1979



Irland et al. 1988

Severe mortality

- 20-25 million cords of spruce and fir killed

Salvage logging by commercial clearcut



Approx. 1500 ac salvage harvest block





# Maine Forest Practices Act, 1989

## Forest Practices Act (FPA)

### Introduction

This rule regulates the size, arrangement, regeneration and management of clearcuts.



Photo: Maine Forest Service

### Proper Name of the Rule

Maine Forest Service – Chapter 20

Forest Regeneration & Clearcutting Standards – Forest Practices Act

- First legal definition of a clearcut
- Regulation of clearcut size, configuration, regeneration

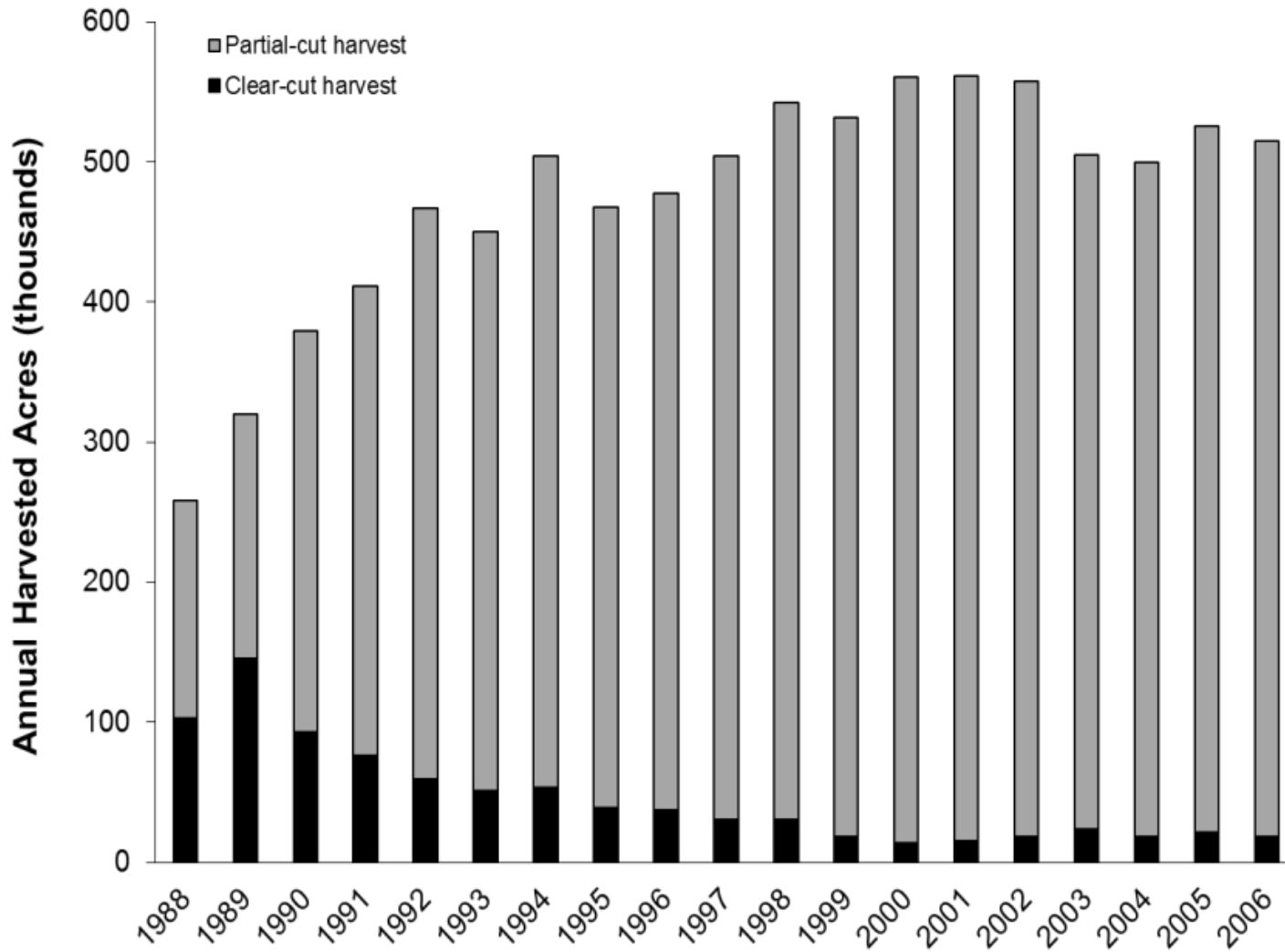
# Maine Forest Practices Act, 1989



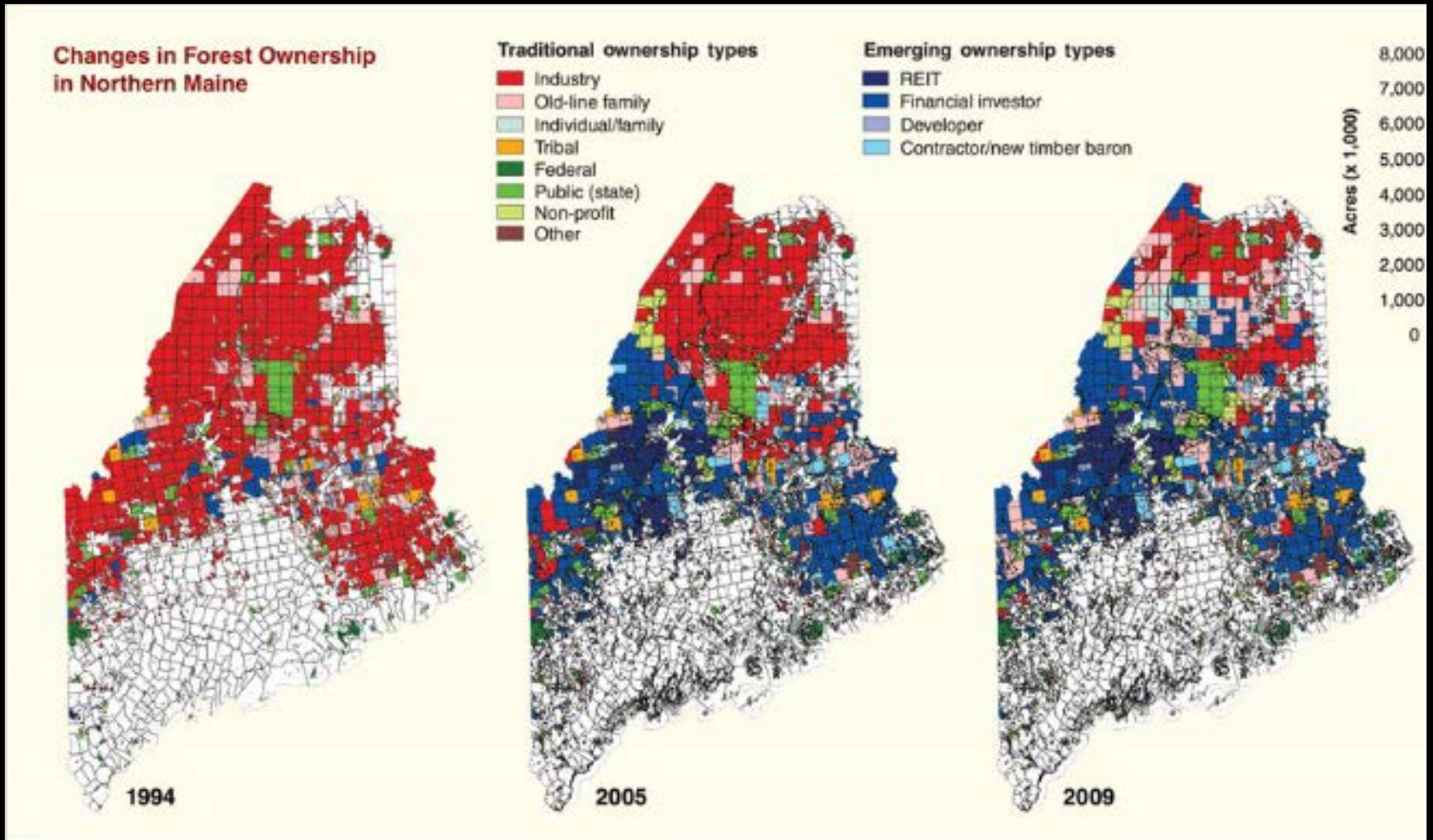
1970-80s budworm  
salvage clearcuts

Forest Practices Act  
category 1 clearcuts

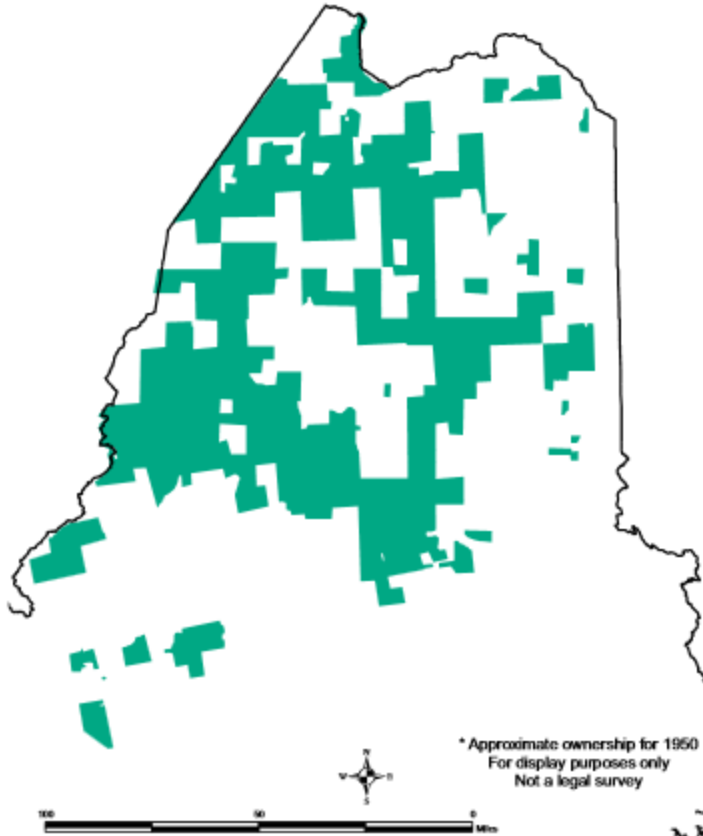
# Annual statewide harvest



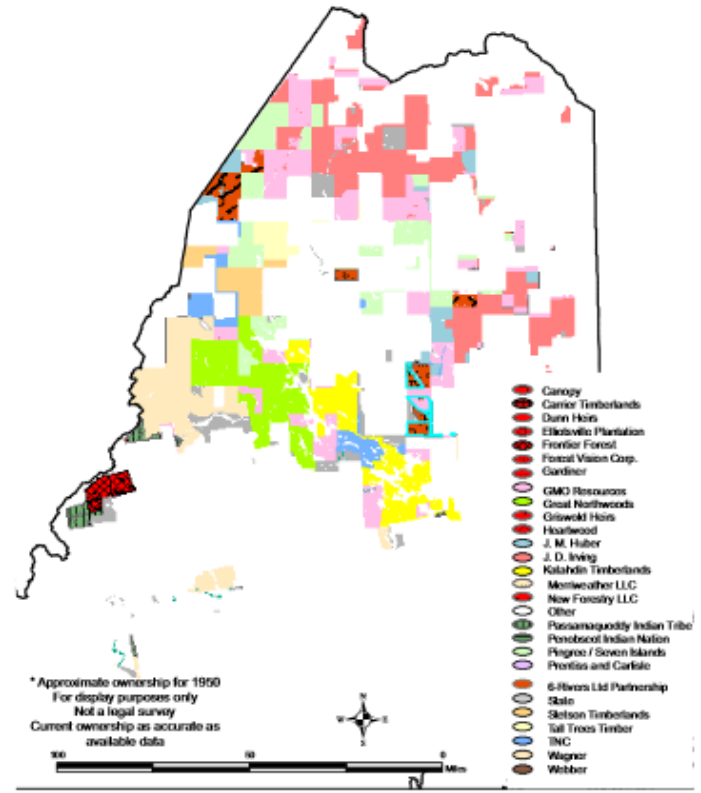
# Ownership change



# Ownership change



Great Northern Paper 1950 Land Ownership Map\*  
Figure 3 Source: Maine Forest Service, used with permission



Great Northern Paper 1950 Land Ownership Today\*  
Figure 4 Source: Maine Forest Service, used with permission

# Ownership change

Maine's newest big-time landowner is also the nation's largest landowner

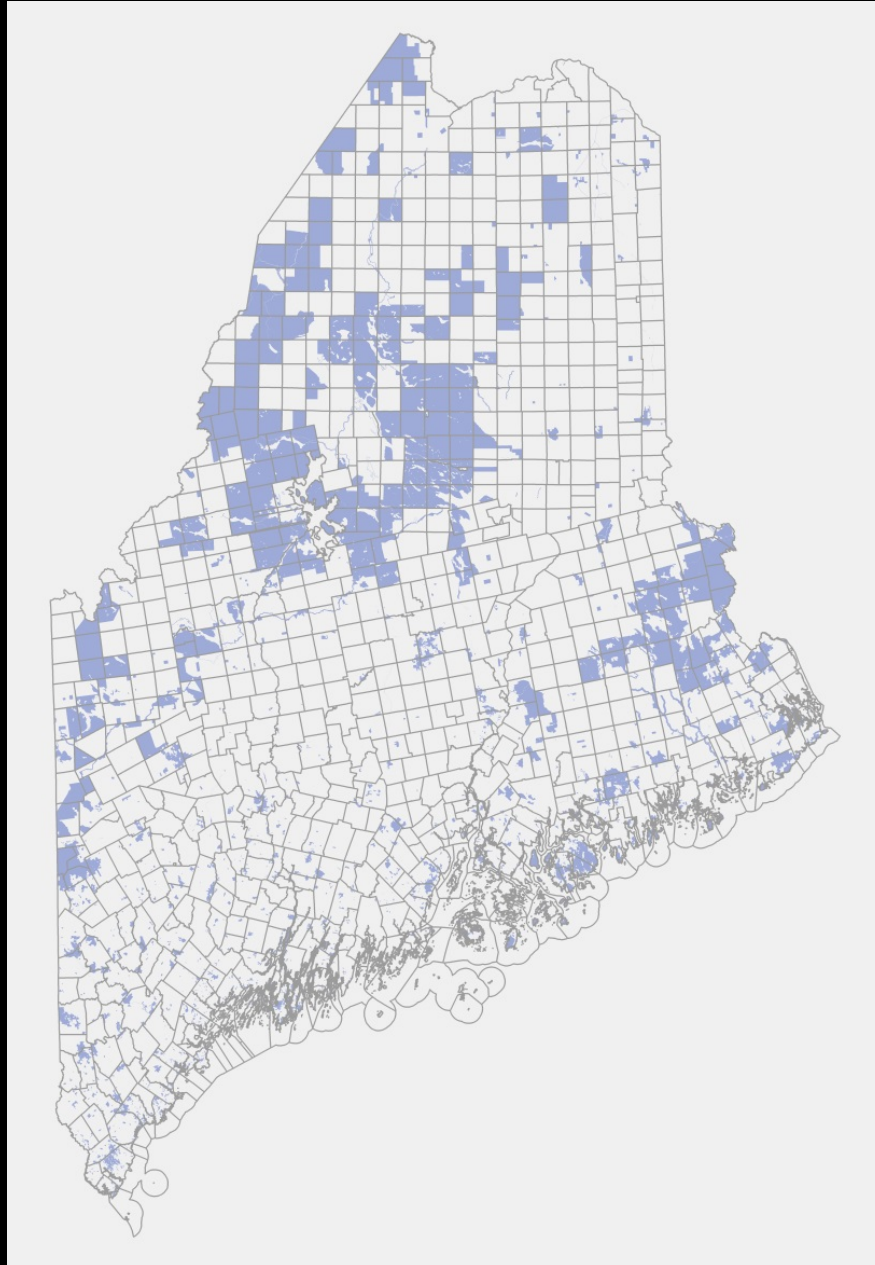
Next 1 of 2







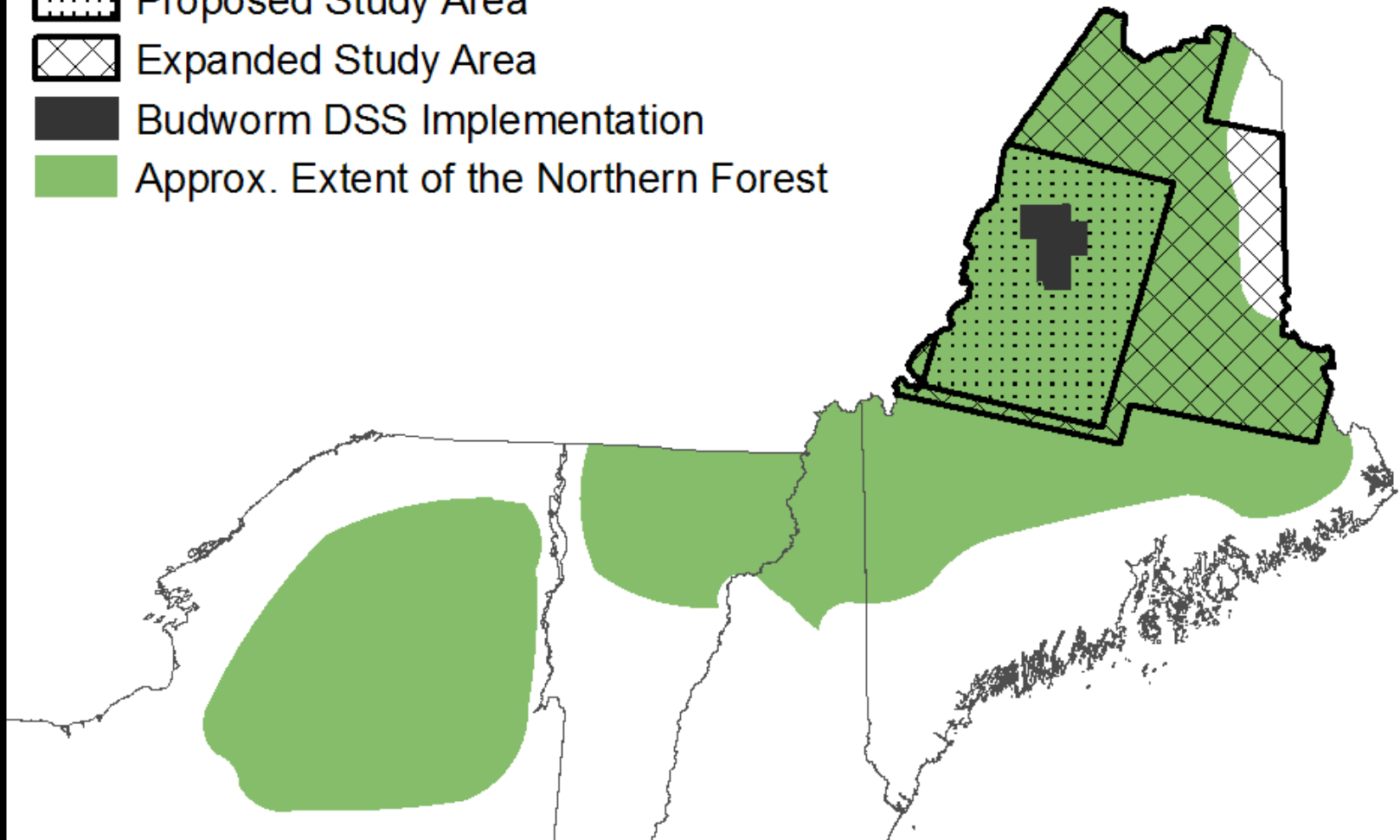
Karl Gehring | Denver Post

John Malone (center) is now the United States' largest landowner

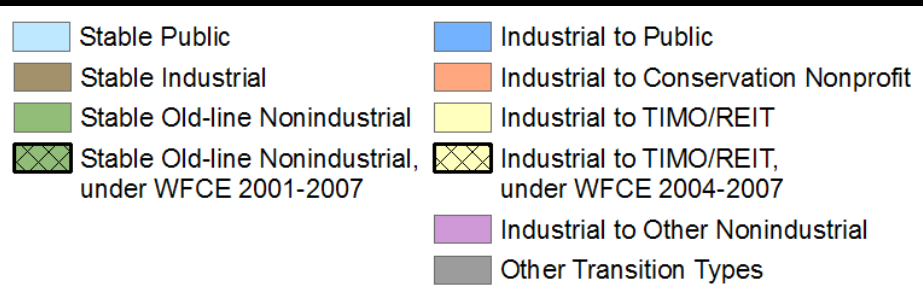
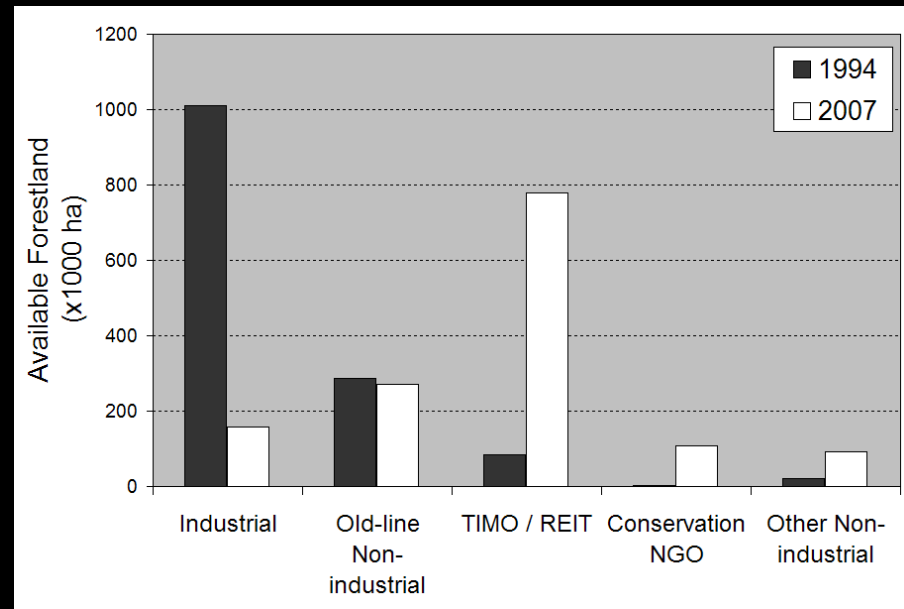
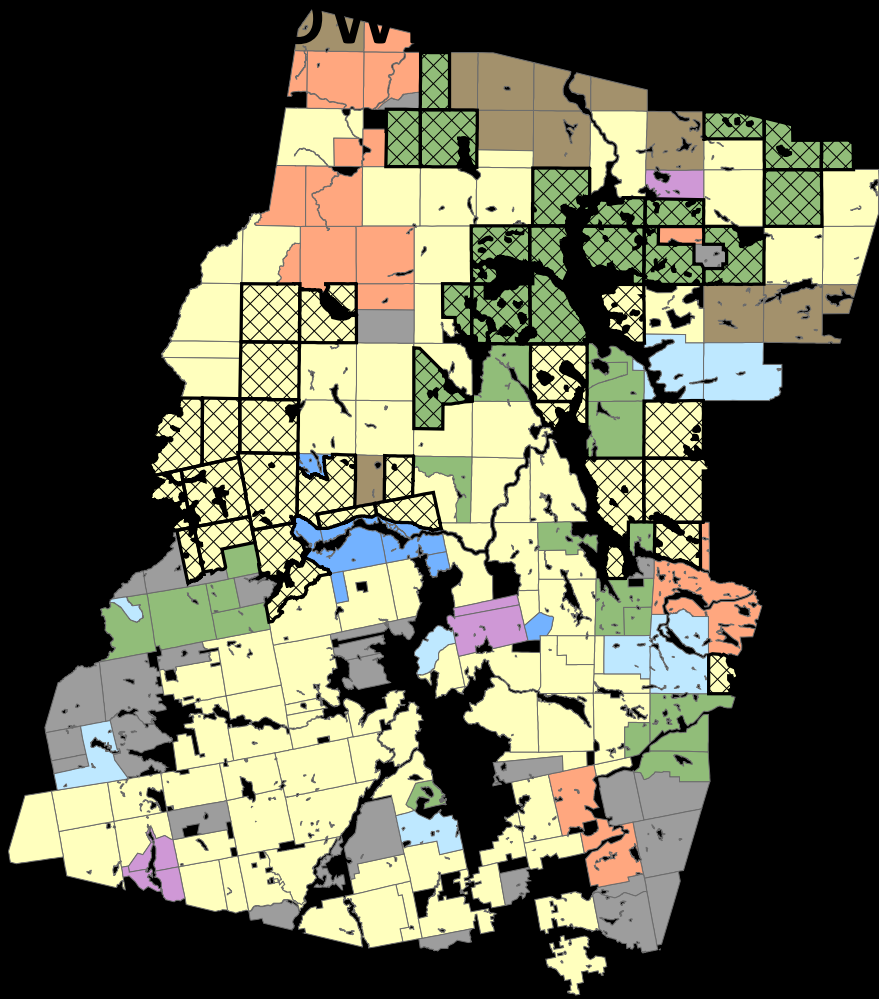
# Conservation easements



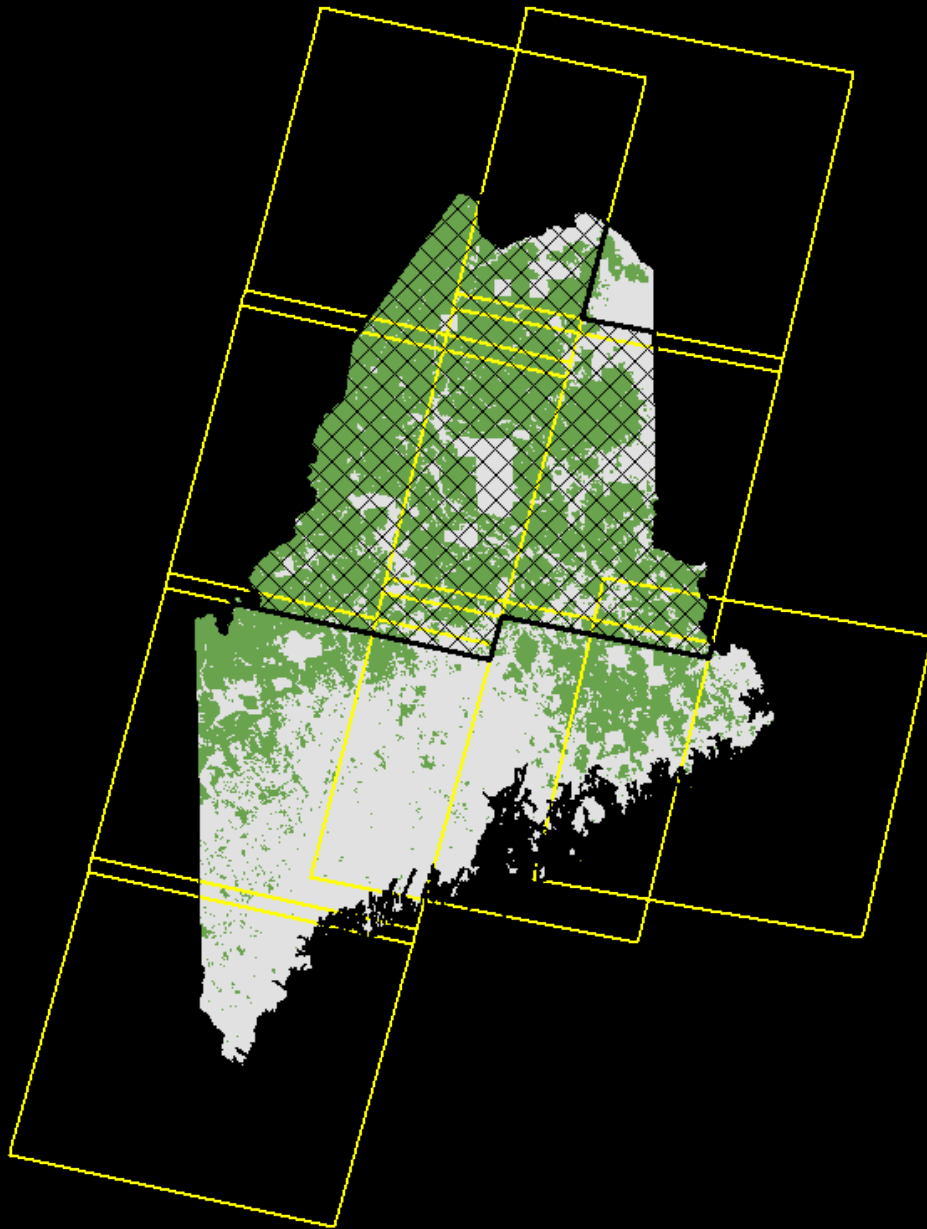
-  Proposed Study Area
-  Expanded Study Area
-  Budworm DSS Implementation
-  Approx. Extent of the Northern Forest







# Forest disturbance, age, composition mapping



## Landsat Thematic Mapper:

2010  
2007  
2004  
2001  
1998  
1995  
1993  
1991  
1988  
1985

2-3 year intervals  
- stand-replacing and  
partial canopy disturbance  
- disturbance intensity  
(% basal area removed)

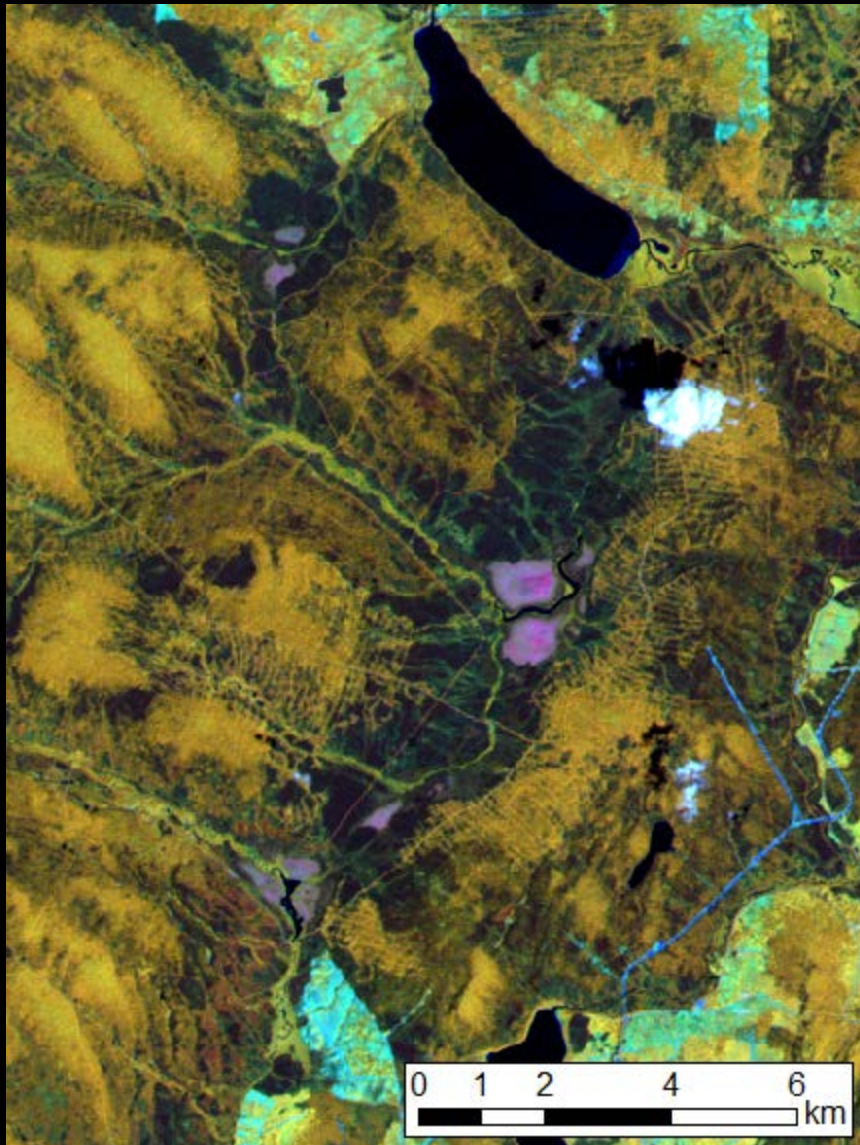
## Landsat Multispectral Scanner:

1985  
1982  
1978  
1975  
1973

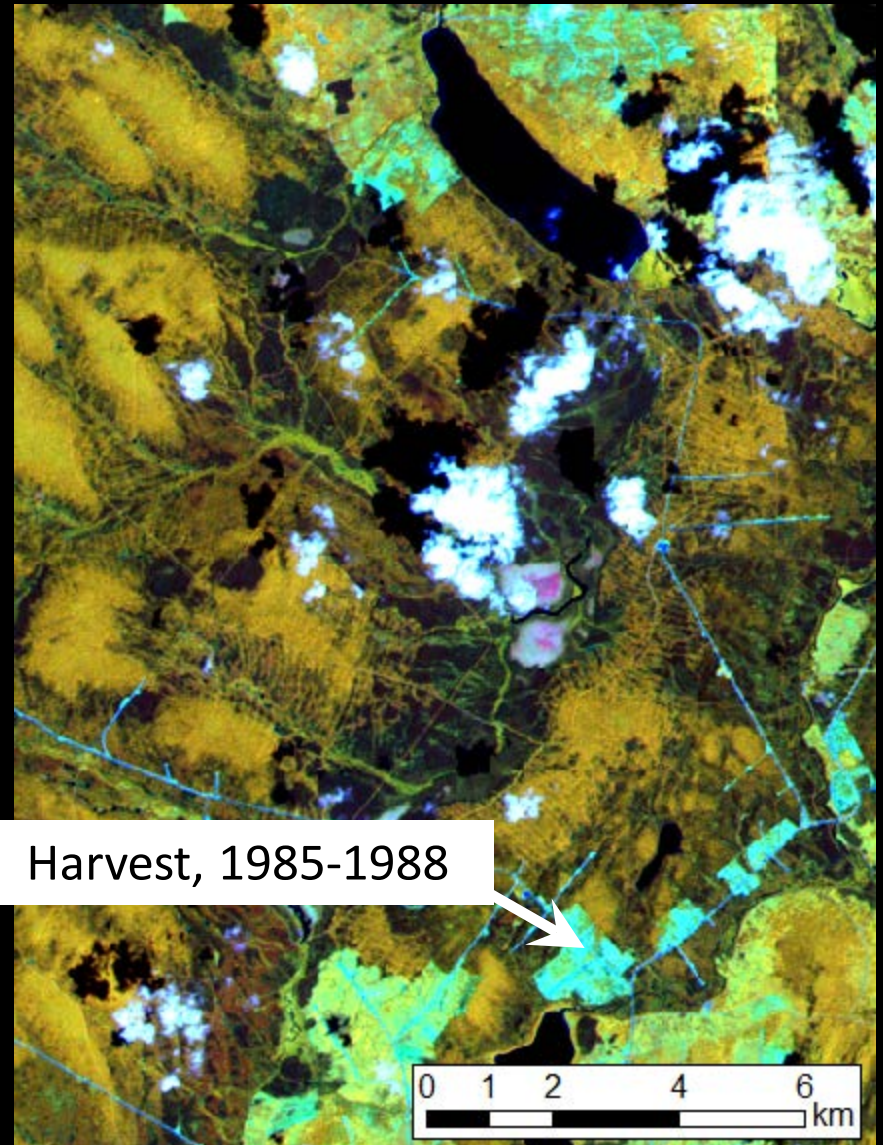
2-4 year intervals  
- stand-replacing  
disturbance

# Forest disturbance, age, composition mapping

1985 Landsat:

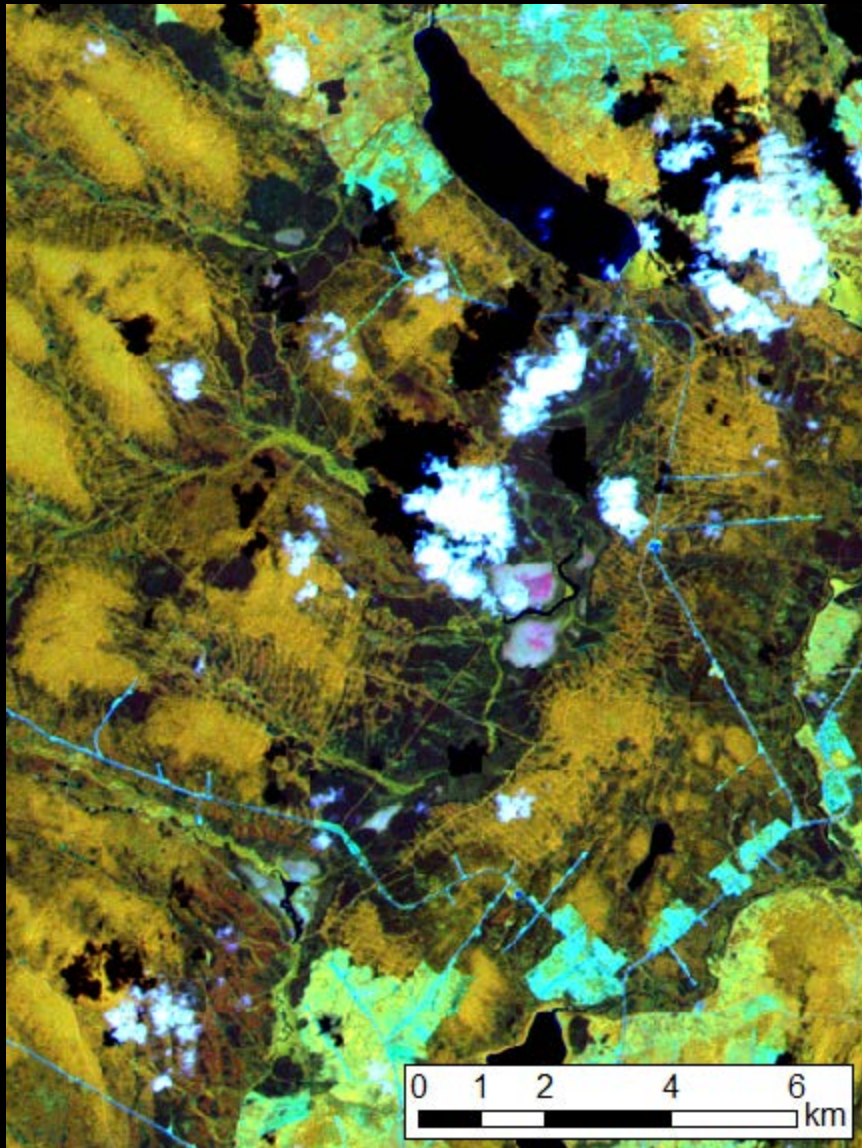


1988 Landsat:

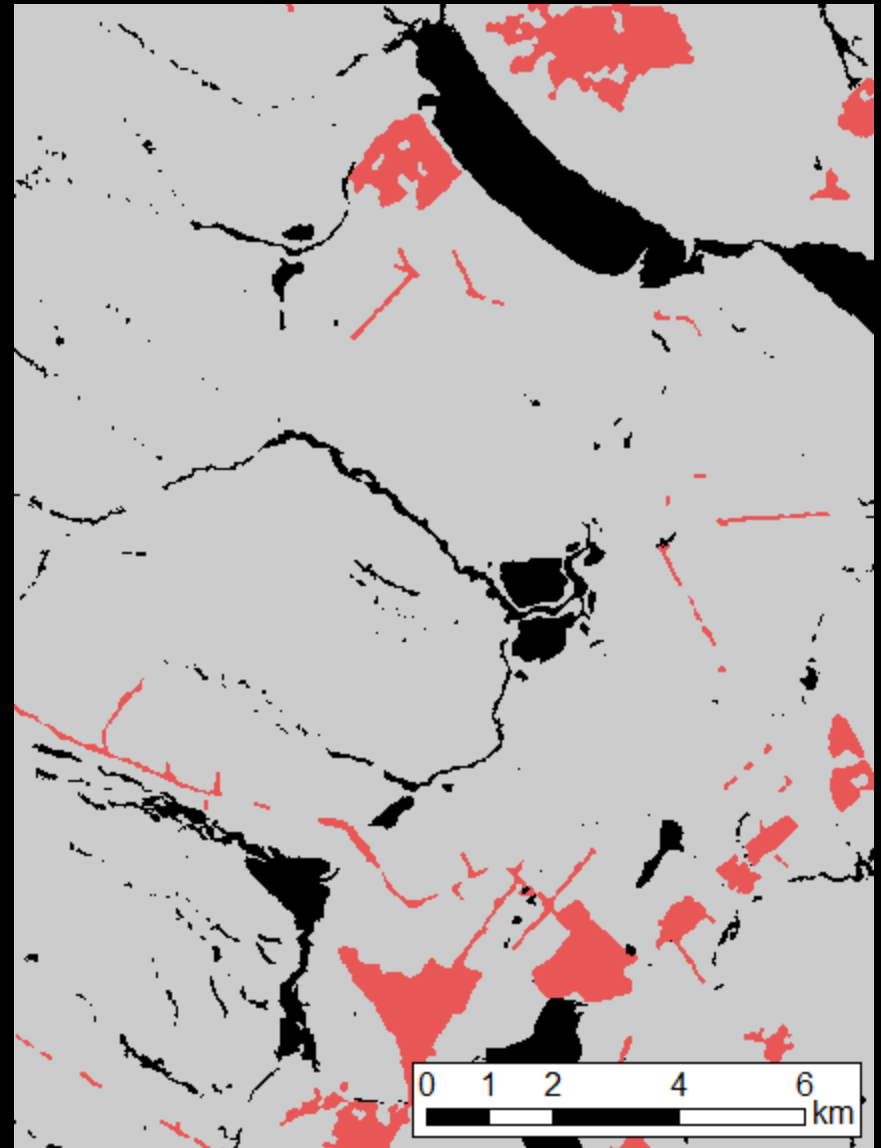


# Forest disturbance, age, composition mapping

1988 Landsat:

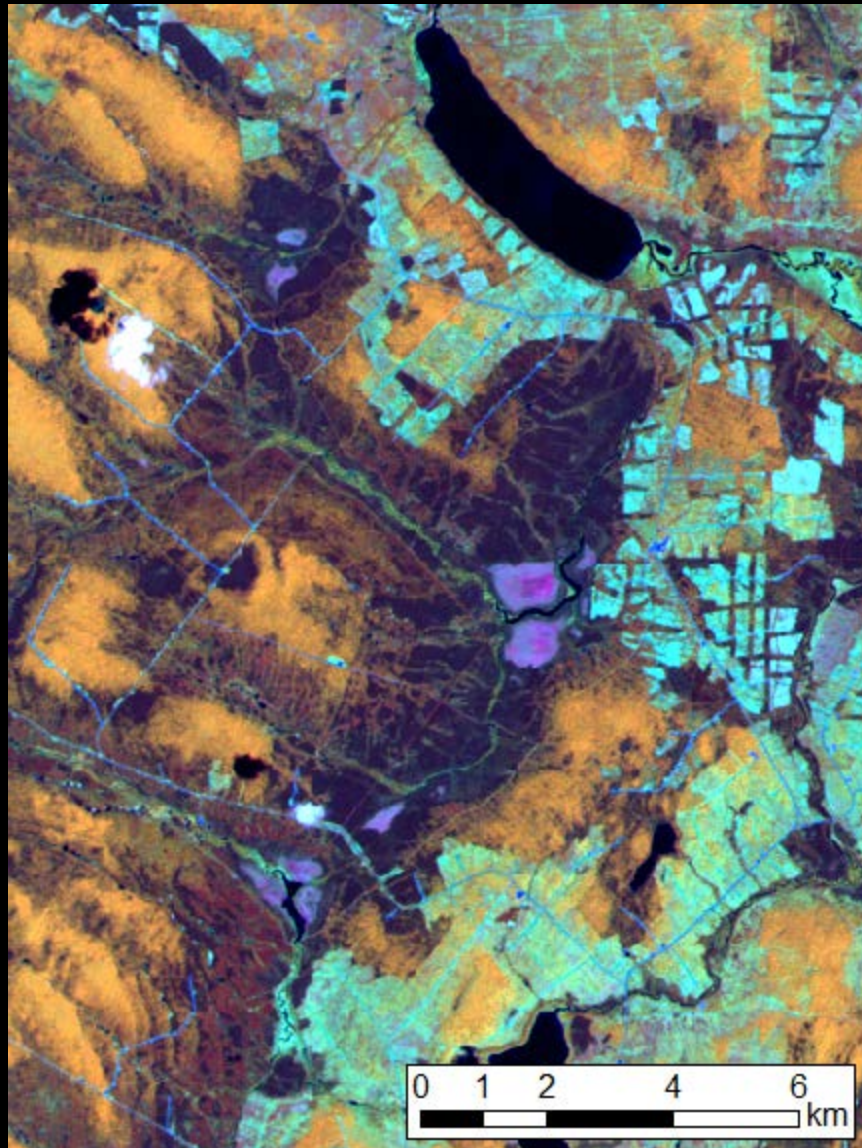


1985-1988 forest disturbance:

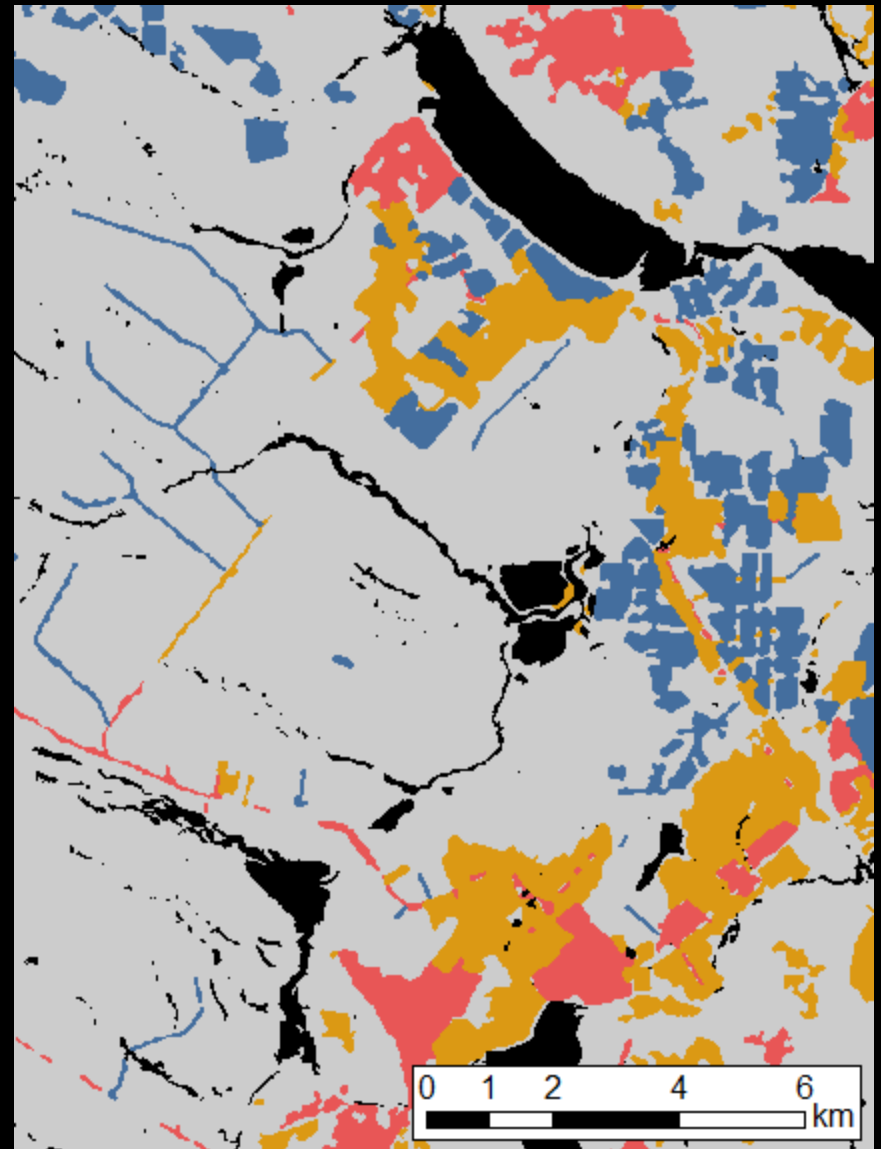


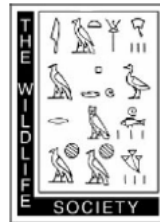
# Forest disturbance, age, composition mapping

1993 Landsat:



1985-1993 forest disturbance:





Management and Conservation

# Canada Lynx Occurrence and Forest Management in the Acadian Forest

ERIN M. SIMONS-LEGAARD,<sup>1,2</sup> *Department of Wildlife Ecology, University of Maine, 5755 Nutting Hall, Orono, ME 04469, USA*

DANIEL J. HARRISON, *Department of Wildlife Ecology, University of Maine, 5755 Nutting Hall, Orono, ME 04469, USA*

WILLIAM B. KROHN, *Department of Wildlife Ecology, University of Maine, 5755 Nutting Hall, Orono, ME 04469, USA*

JENNIFER H. VASHON, *Maine Department of Inland Fisheries and Wildlife, 650 State Street, Bangor, ME 04401, USA*

**Table 1.** Forest classes mapped using a time series of Landsat satellite images, class areas circa 2004 (km<sup>2</sup>), stand-scale snowshoe hare densities, and references for hare densities used to predict occurrence of Canada lynx across our 16,530-km<sup>2</sup> study area in the Acadian Forest of Maine, USA, 2003–2006.

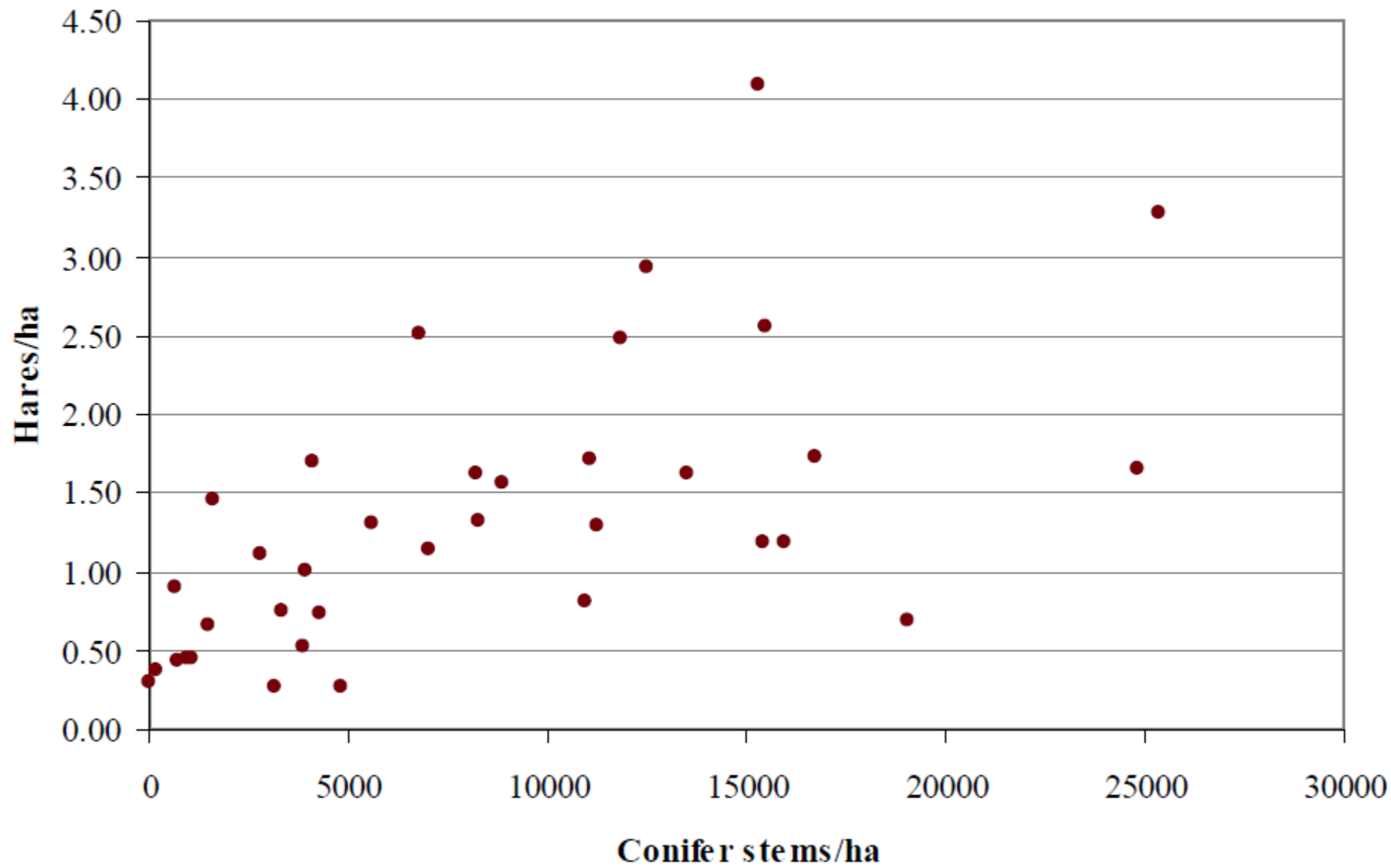
Class	Years post-harvest	Area	Hares/ha	Refs.
Mature forest	>35	7,213	0.24	Fuller and Harrison (2005)
Partially harvested forest <sup>a</sup>				
Recent	1–10	2,151	0.80	Robinson (2006)
Established	11–16	743	0.80	Robinson (2006)
Regenerating forest <sup>b</sup>				
Recent clearcut	1–9	1,053	0	de Bellefeuille et al. (2001)
Coniferous or mixed	10–17	748	0.2–1.6 <sup>c</sup>	
Coniferous or mixed	18–35	1,393	1.8	Robinson (2006) and Homyack et al. (2007)
Deciduous	10–35	1,296	0.4	Litvaitis et al. (1985)
Non-forestland <sup>d</sup>		1,933		

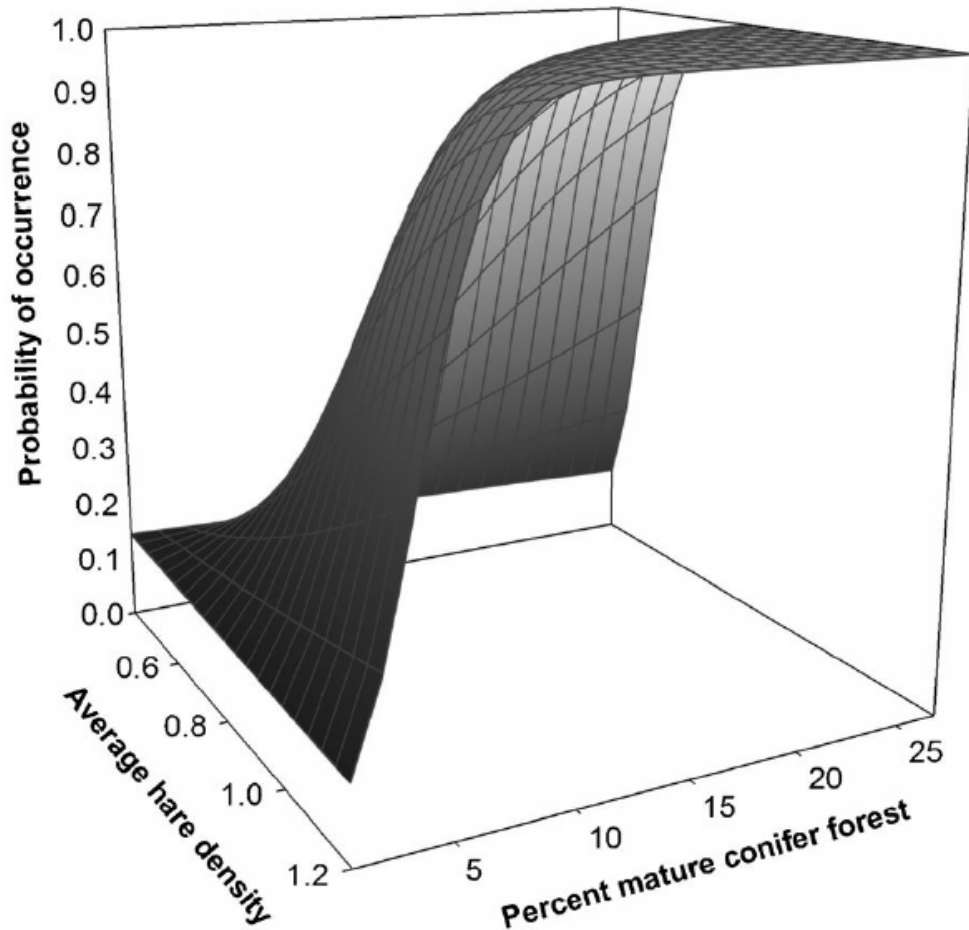
<sup>a</sup> Recent and established partially harvested forest defined based on Fuller et al. (2007).

<sup>b</sup> Regenerating forest identified by heavy canopy disturbances detected 1970–2004 using Landsat satellite imagery. Evidence of intensive management in regenerating forest (e.g., precommercial thinning) detected during harvest mapping reduced respective density estimates by 50% based on Homyack et al. (2007).

<sup>c</sup> We assumed a linear relationship between stand age and hare density 10–18 years post-harvest, resulting in an estimated increase of 0.2 hares/ha/year.

<sup>d</sup> Non-forestland included water and non-forested wetland classes.

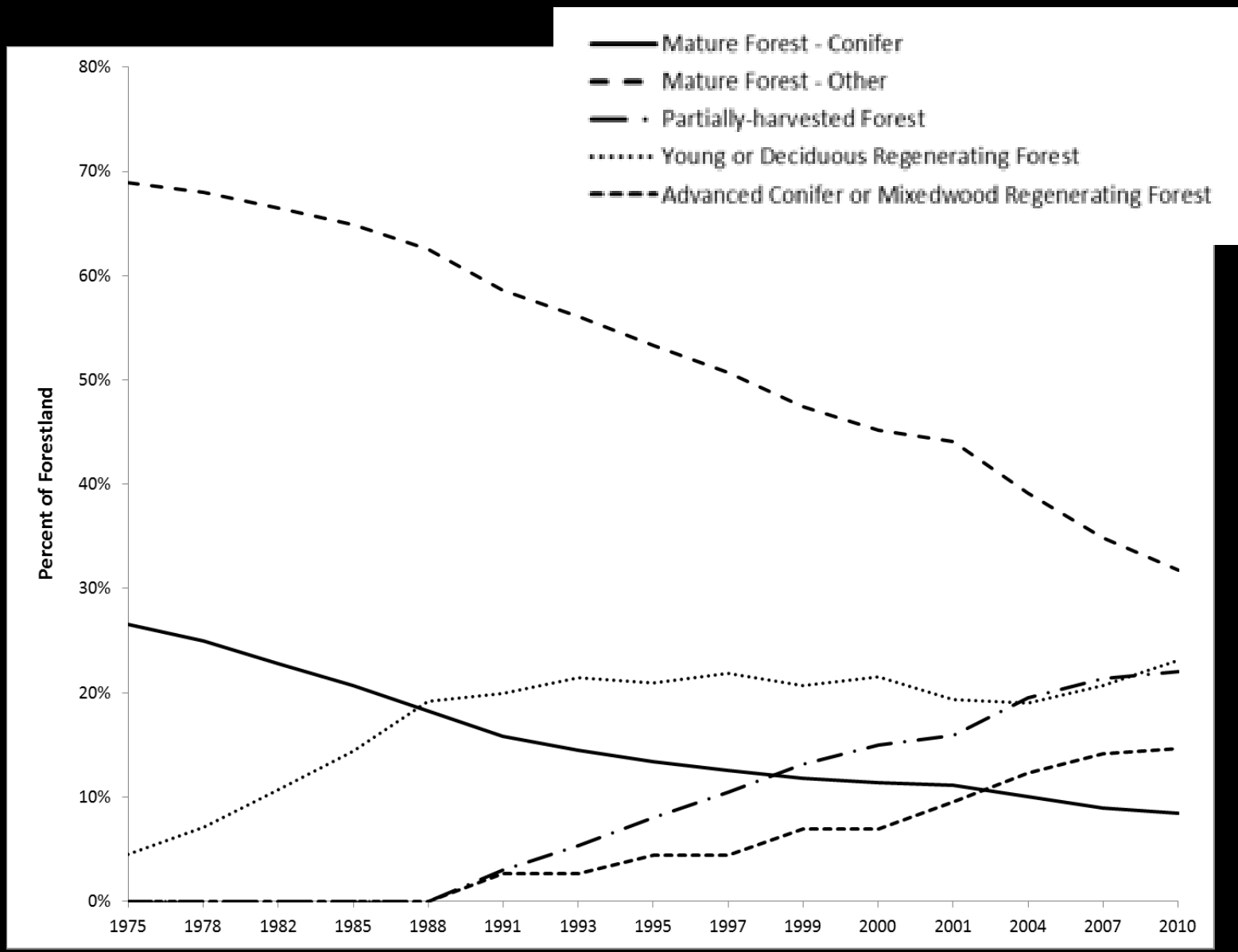
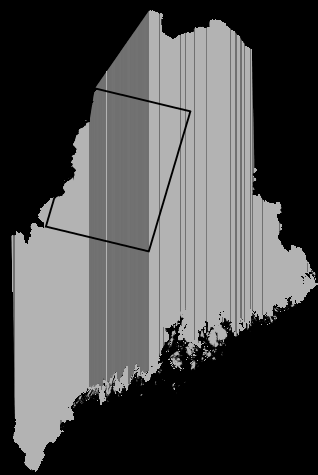


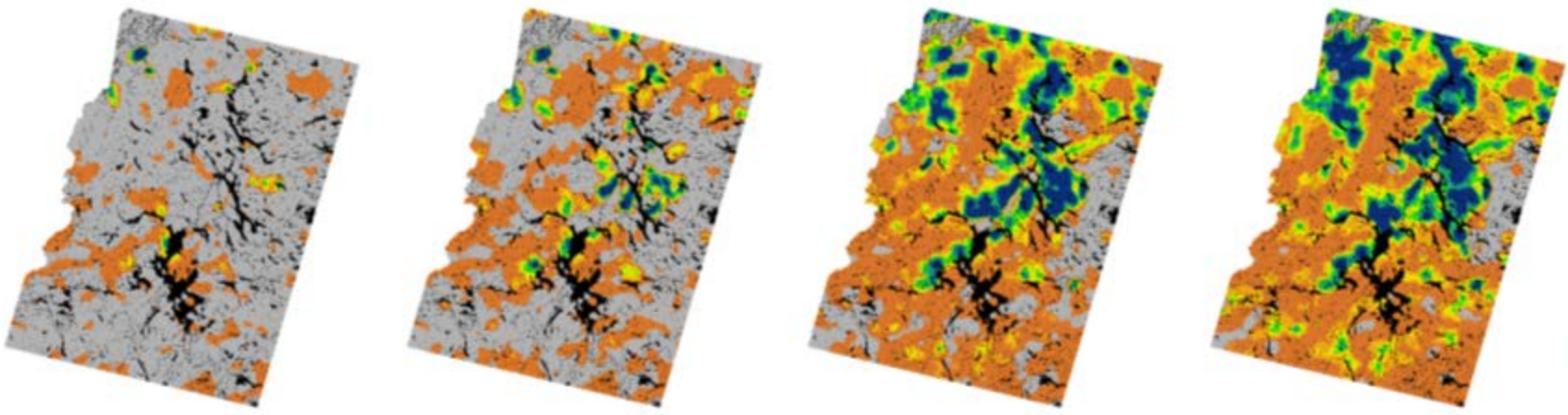
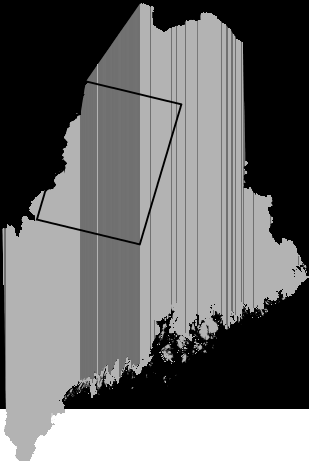


**Figure 2.** Predicted probability of occurrence of adult Canada lynx modeled at the landscape scale as a function of percent mature conifer and average density of snowshoe hare (hares/ha) using binary logistic regression, 2003–2006, Maine, USA.

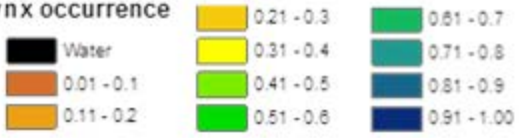








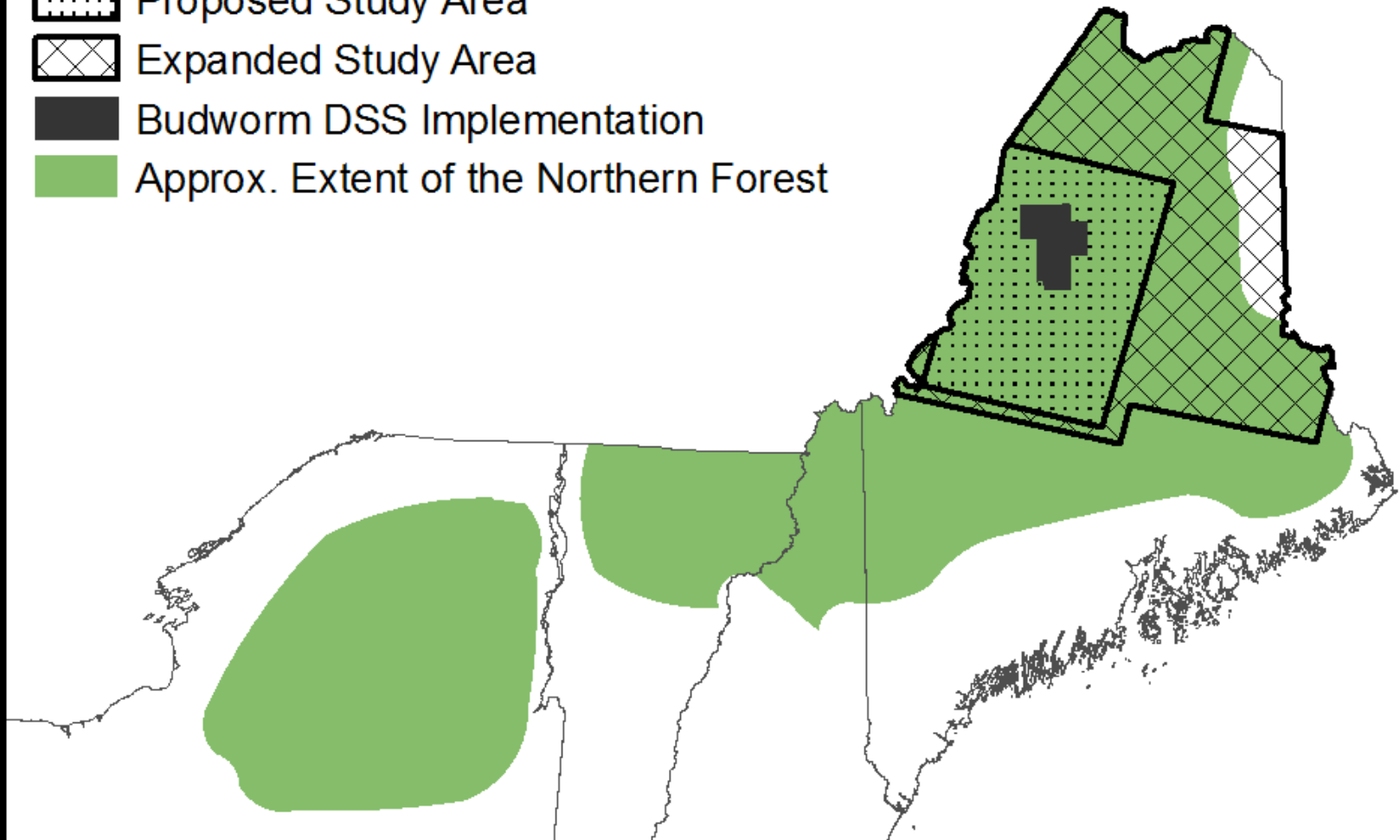




Probability of lynx occurrence



-  Proposed Study Area
-  Expanded Study Area
-  Budworm DSS Implementation
-  Approx. Extent of the Northern Forest



# LANDIS-II

sponsored by

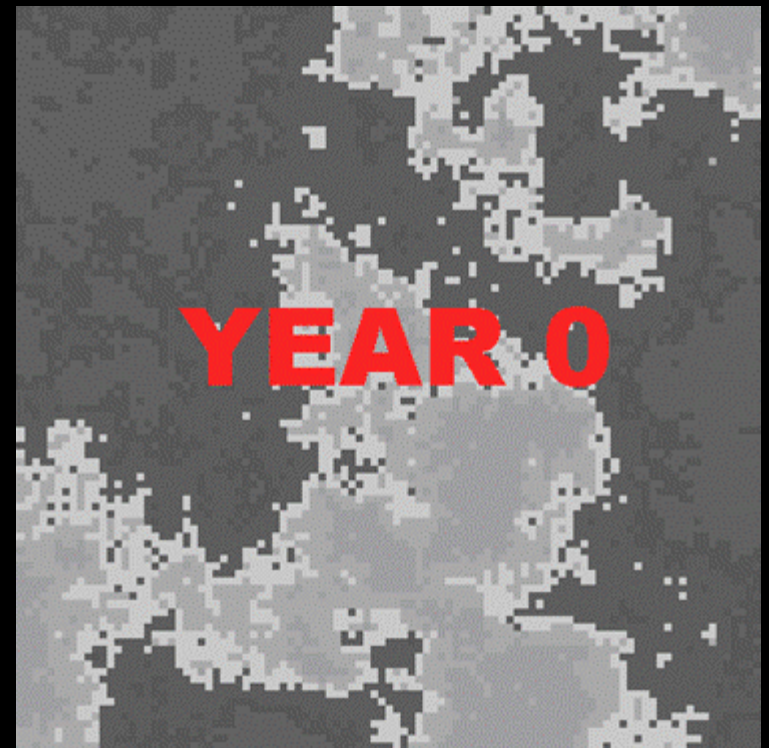
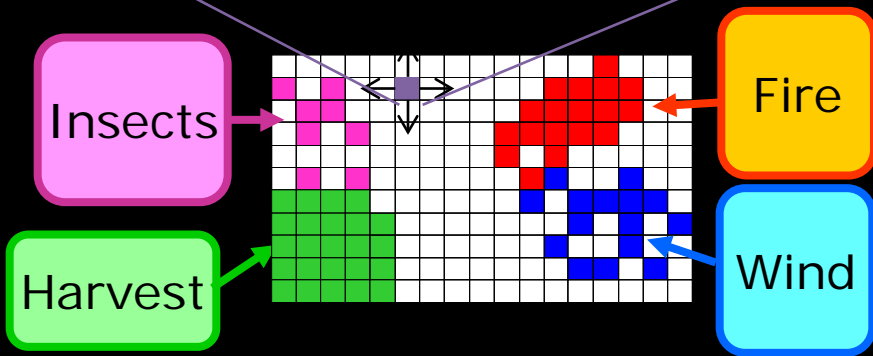
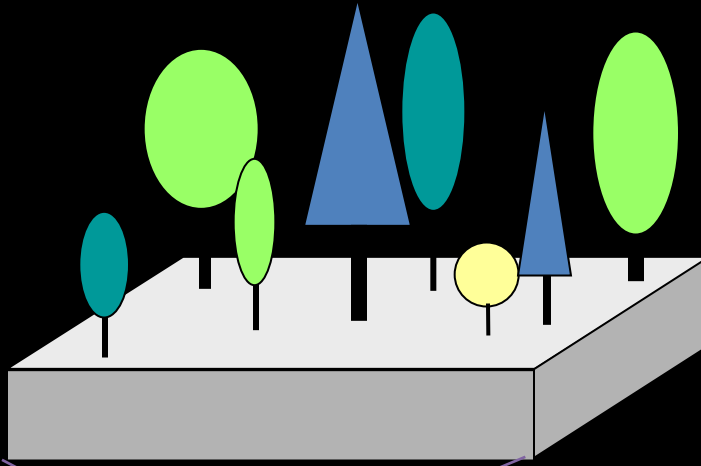


Portland State  
UNIVERSITY

Fire

Wind

Biomass



# LANDIS-II

sponsored by

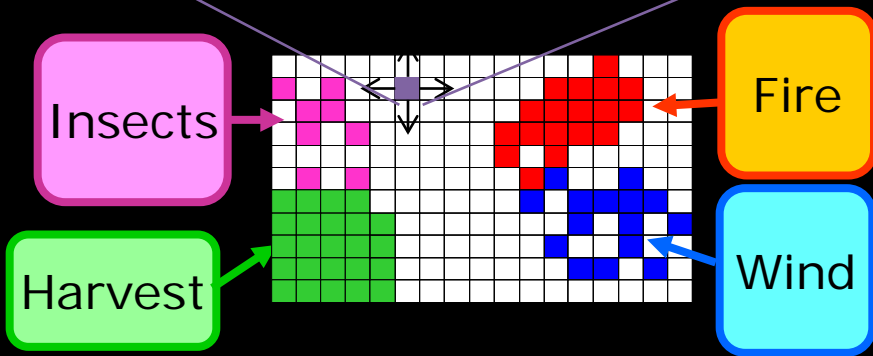
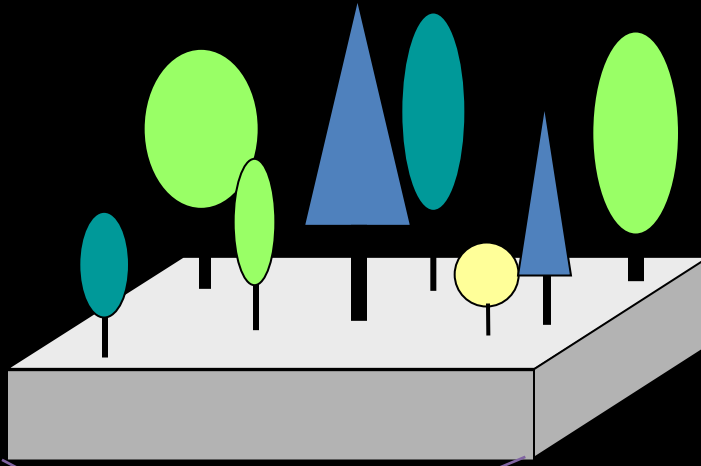


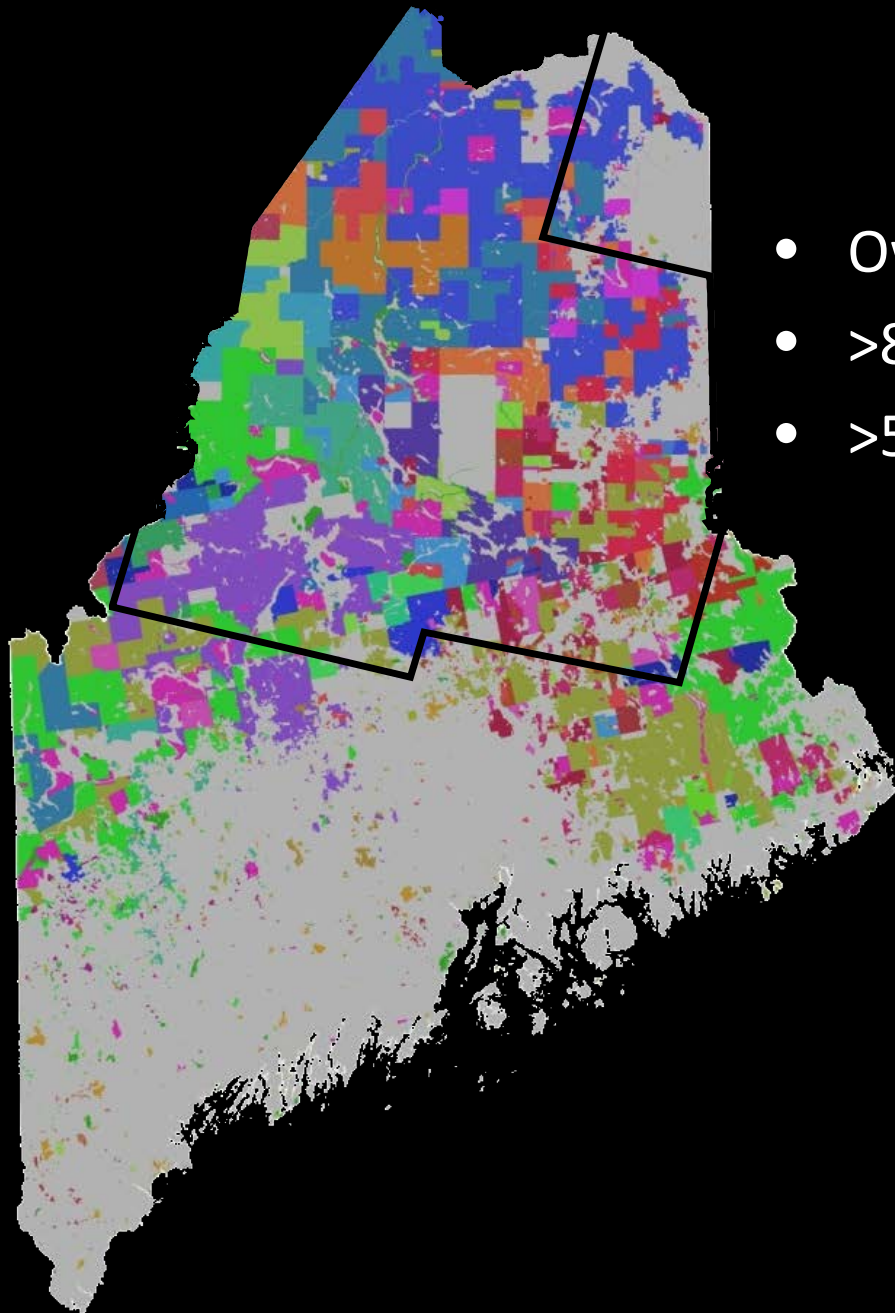
Portland State  
UNIVERSITY

Fire

Wind

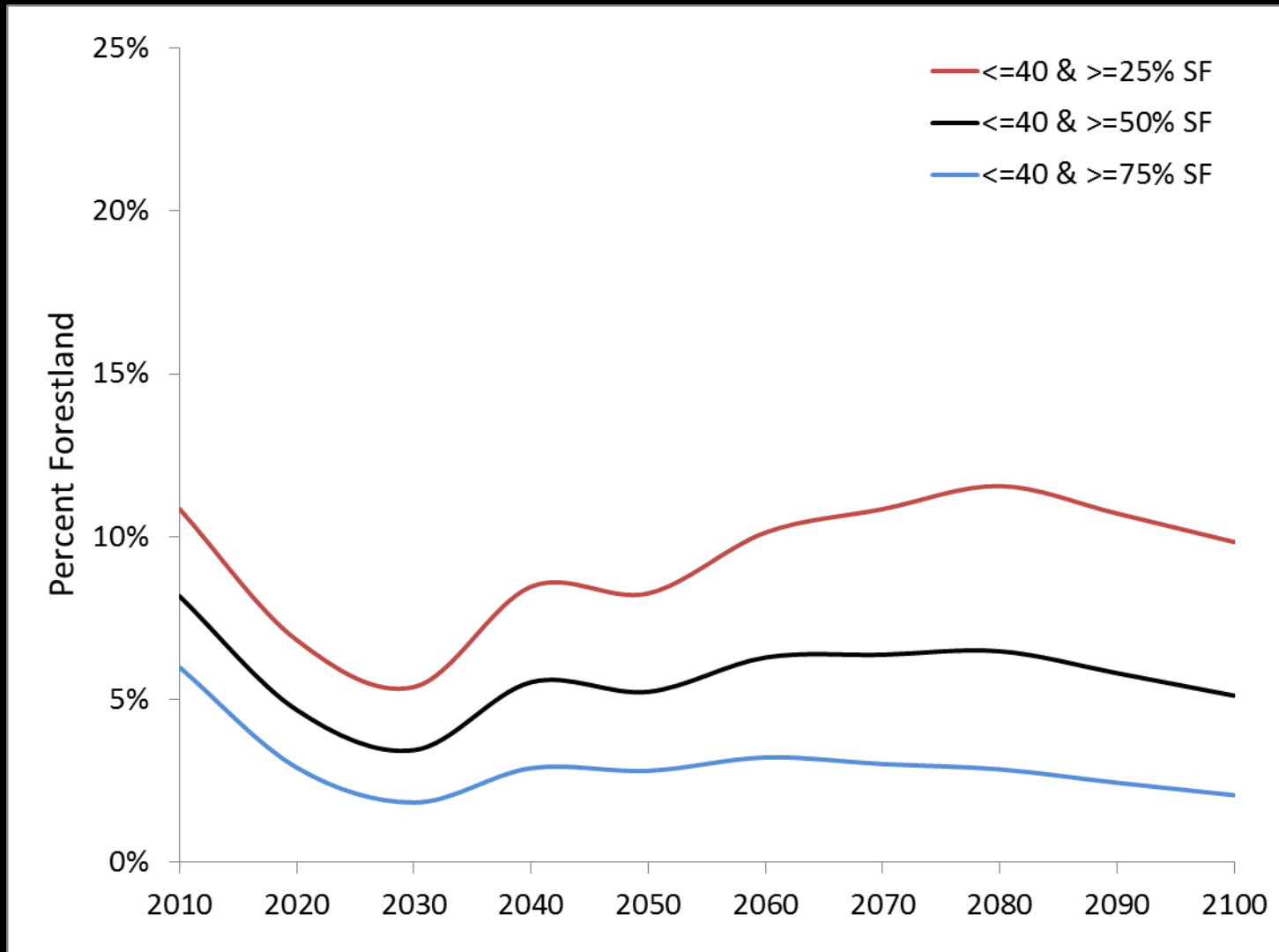
Biomass



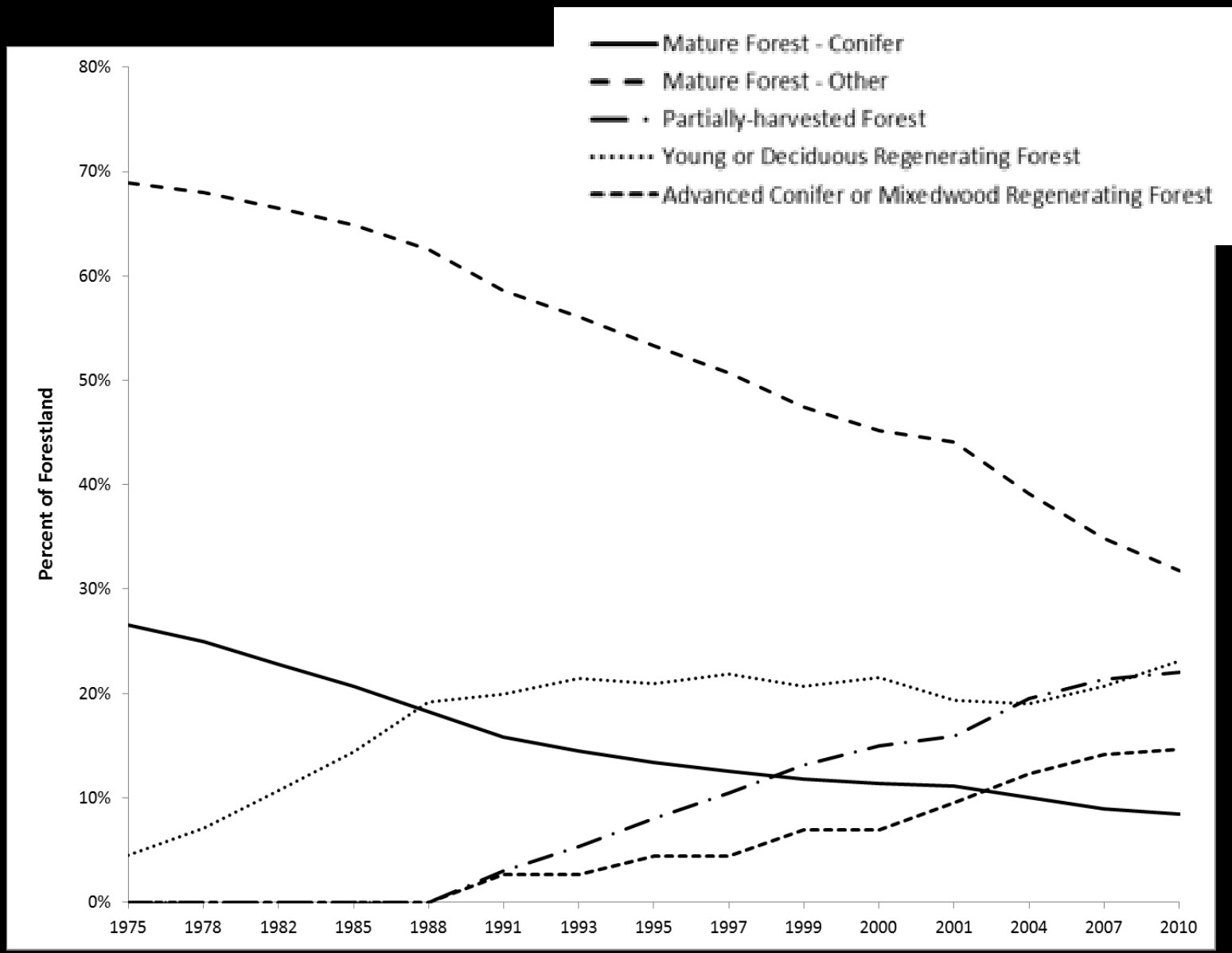
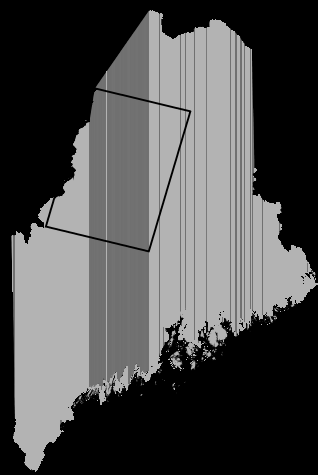


- Ownership ca. 2010
- >80 owners
- >500 parcels

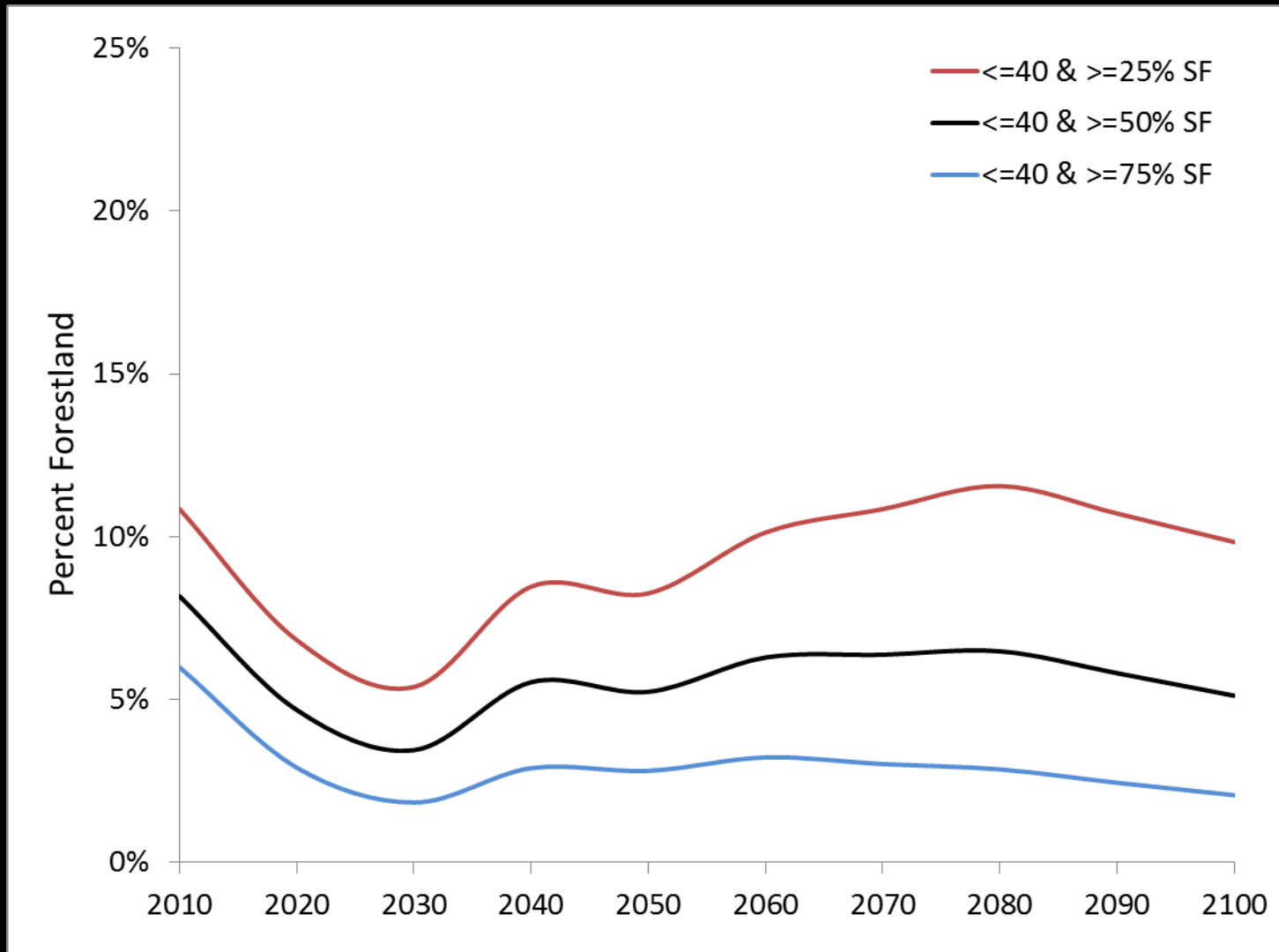
# Snowshoe hare/Lynx foraging habitat



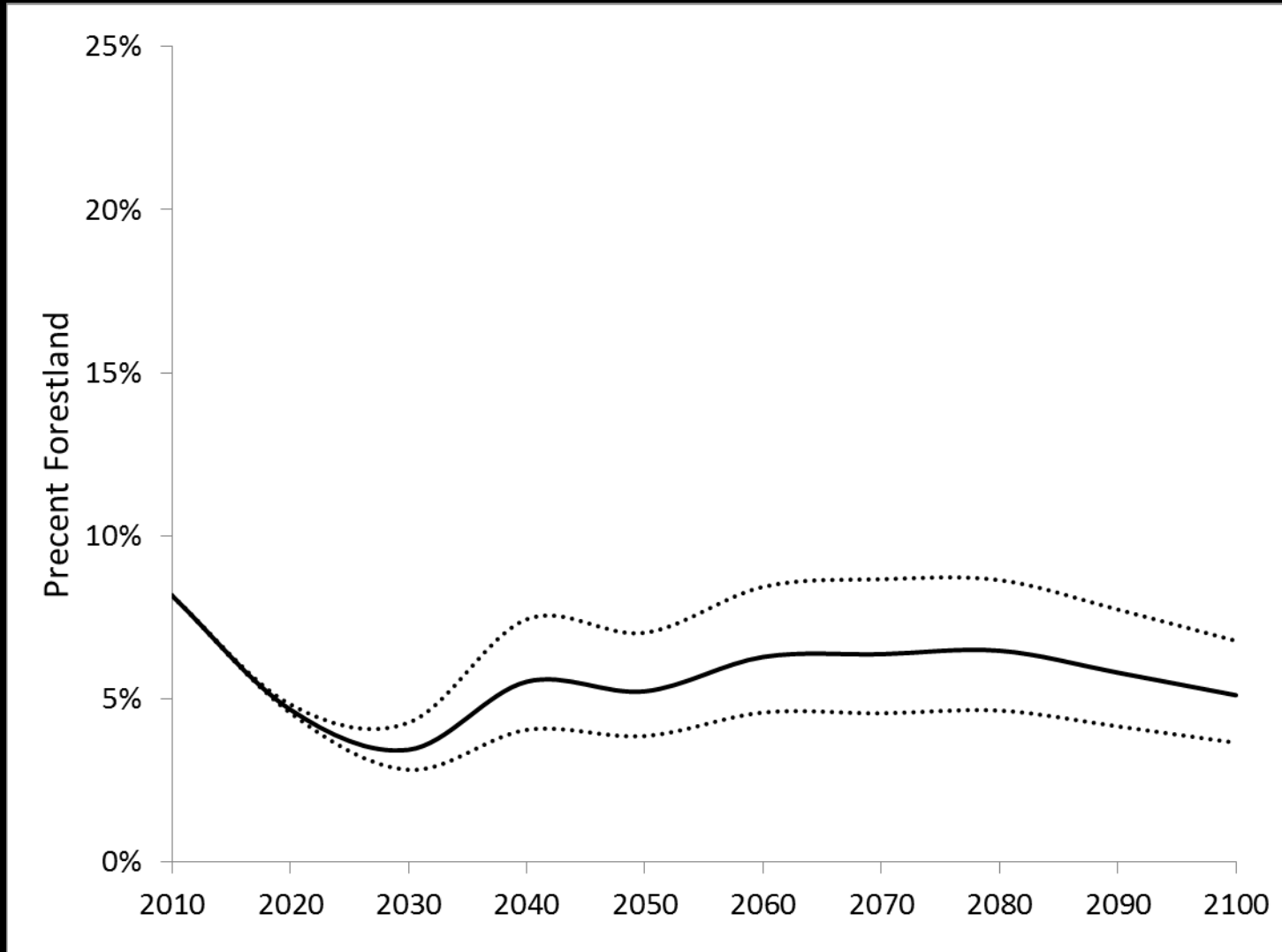


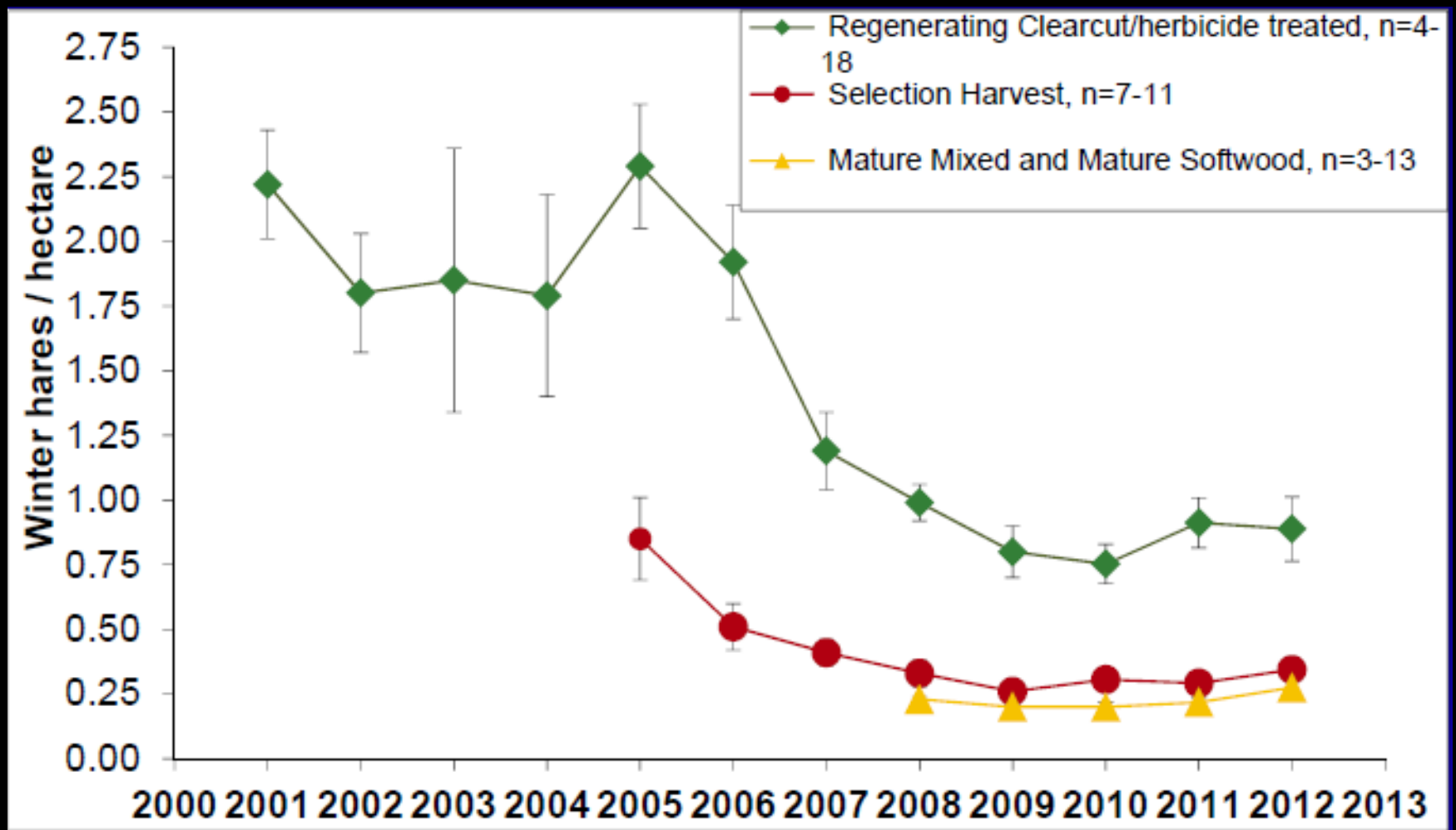


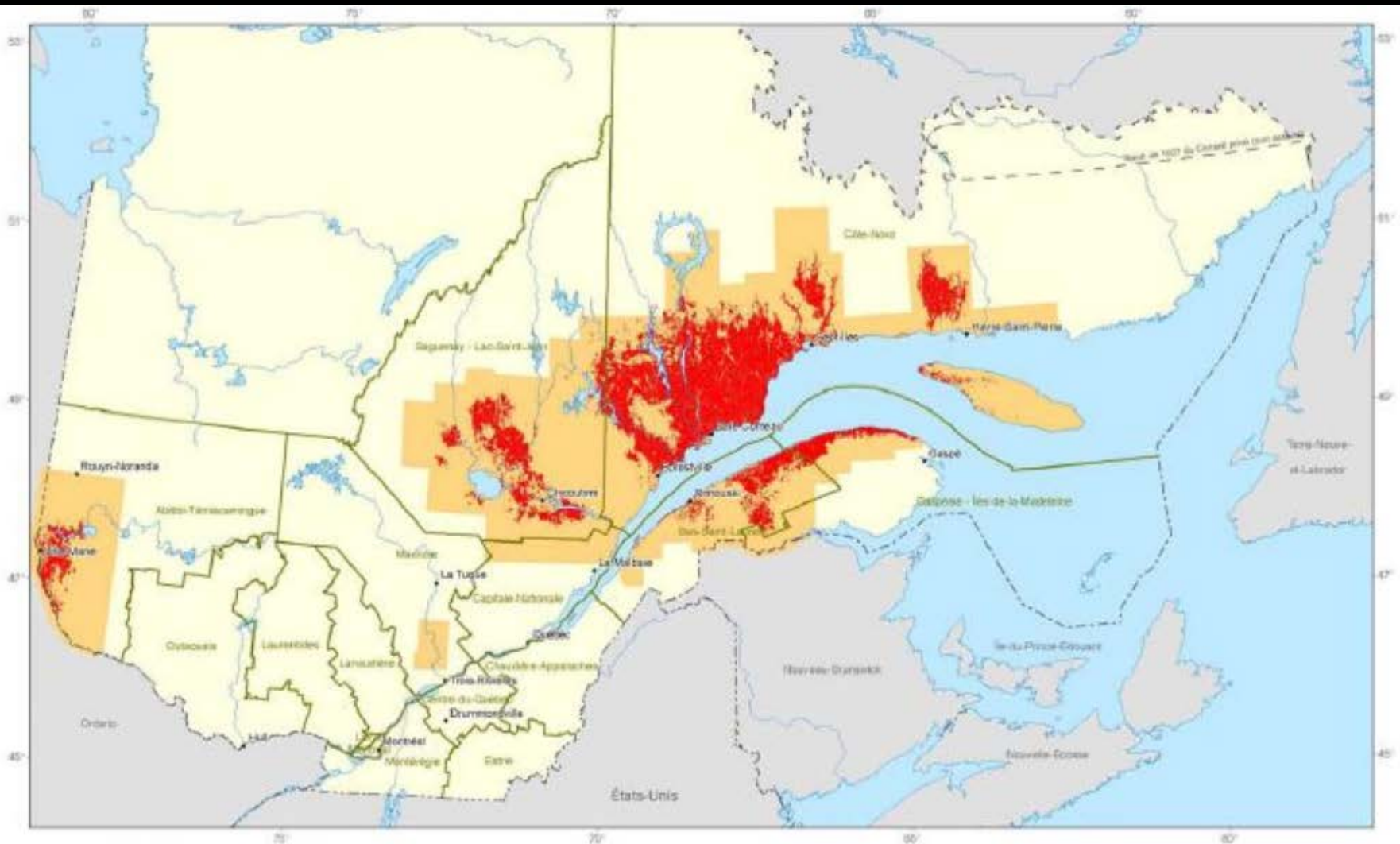
# Snowshoe hare/Lynx foraging habitat



# Snowshoe hare/Lynx foraging habitat







## Québec méridional

Relevé aérien des dommages causés par la tordeuse des bourgeons de l'épinette  
Territoire survolé

Source : Direction de la protection des forêts

Projection cartographique : Conique conforme de Lambert  
avec deux parallèles d'échelle constante (46° et 50°)

Limite de survol

Défoliation 2014

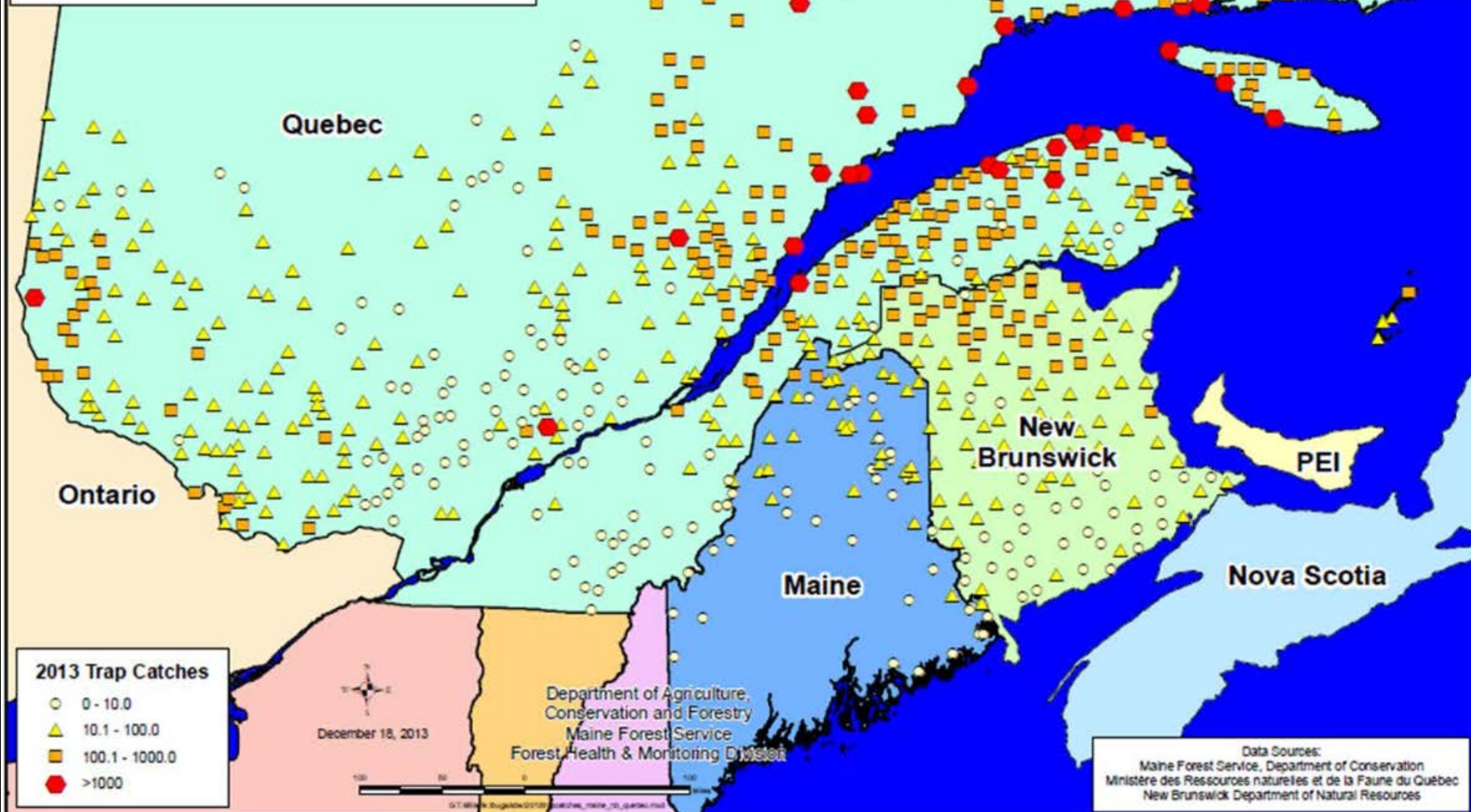
Limite de région administrative

Forêts, Faune  
et Parcs

Québec



2013 Spruce Budworm  
Pheromone Trap Catches  
Maine - New Brunswick - Quebec



**2013 Trap Catches**

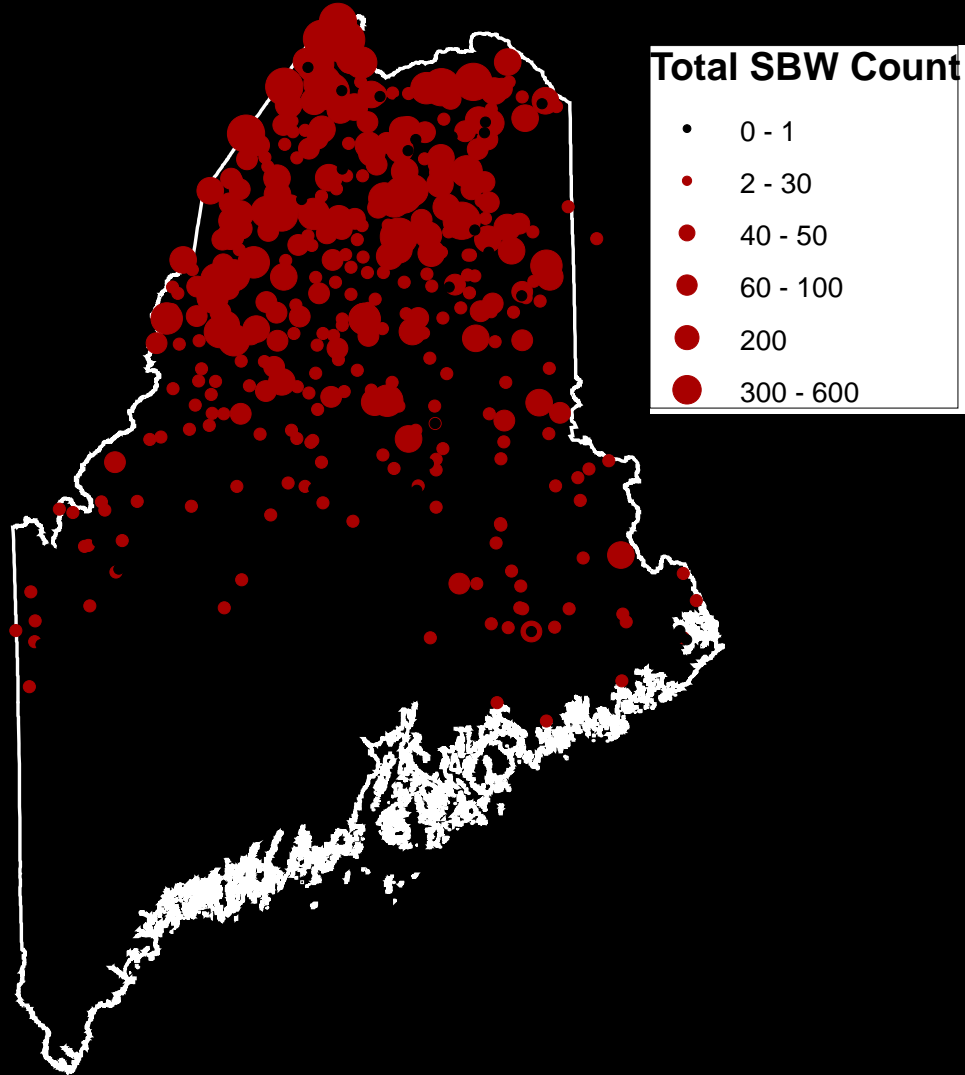
- 0 - 10.0
- ▲ 10.1 - 100.0
- 100.1 - 1000.0
- >1000

December 18, 2013

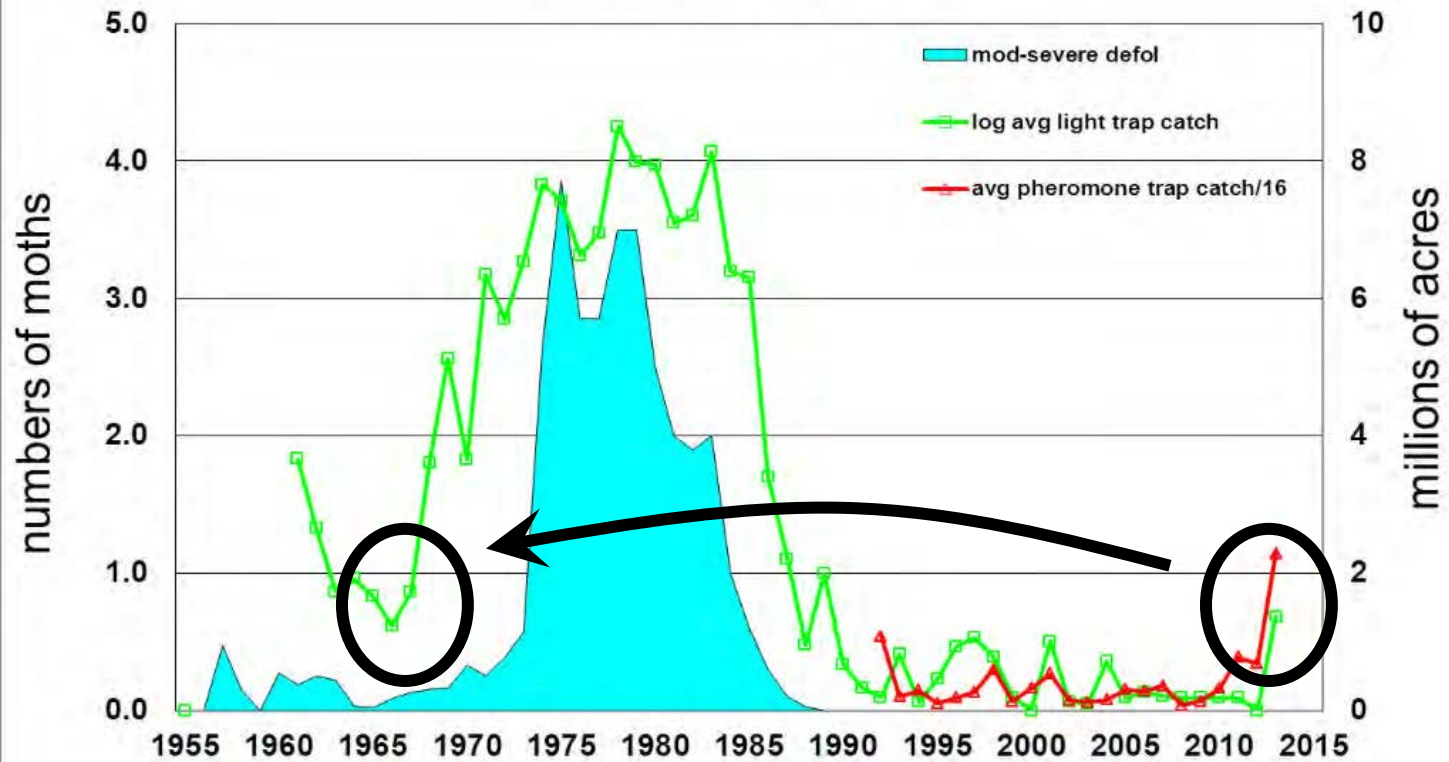
Department of Agriculture,  
Conservation and Forestry  
Maine Forest Service  
Forest Health & Monitoring Division

Data Sources:  
Maine Forest Service, Department of Conservation  
Ministère des Ressources naturelles et de la Faune du Québec  
New Brunswick Department of Natural Resources

# 2014 trap counts

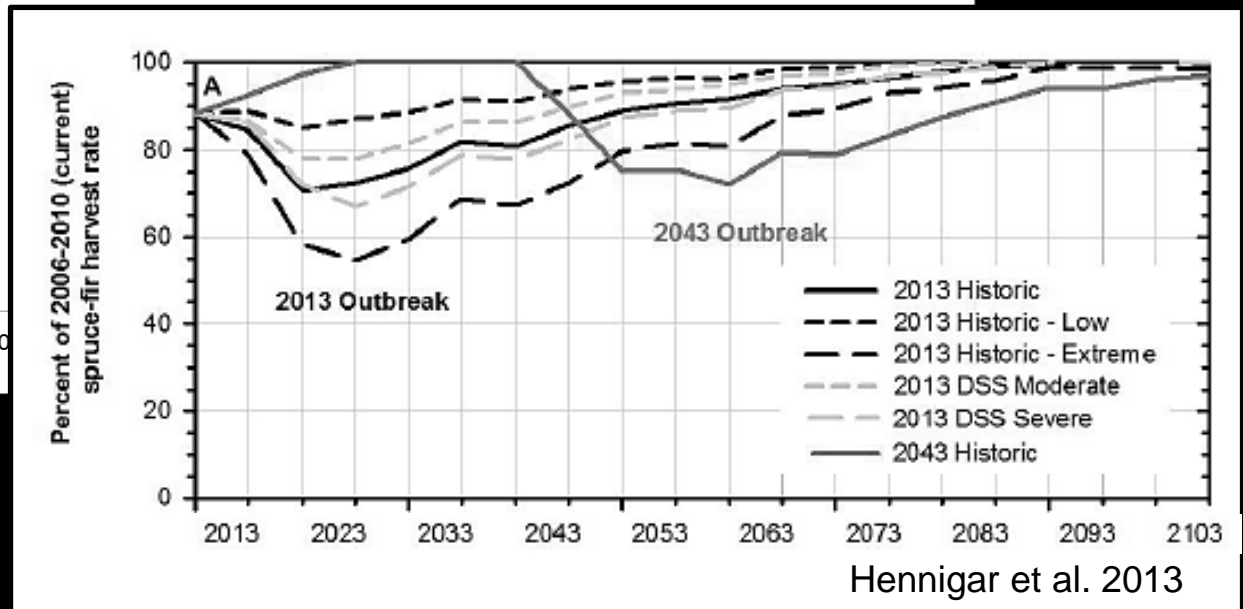
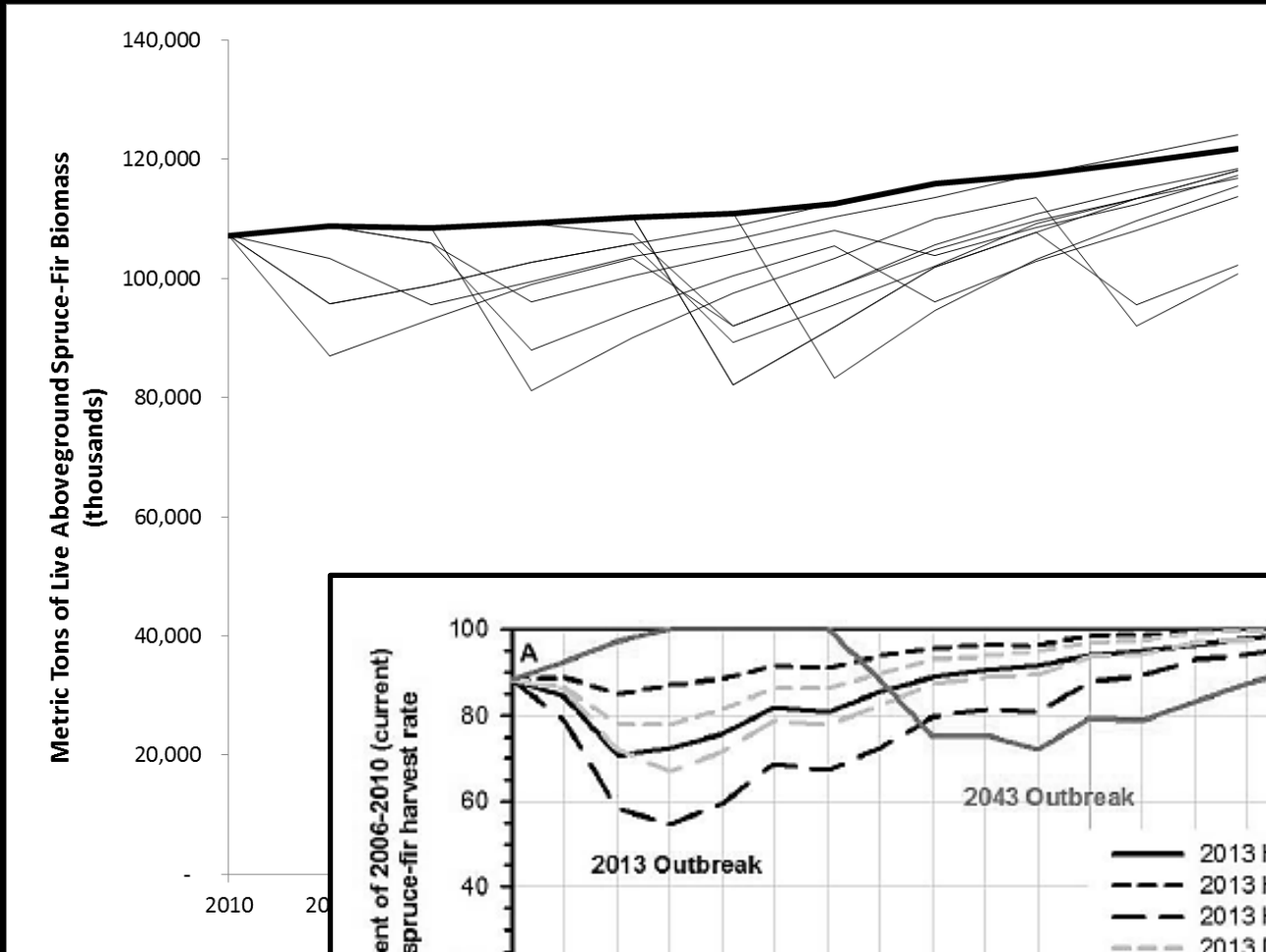


# Spruce Budworm Population Indicators Maine - 1955-2013



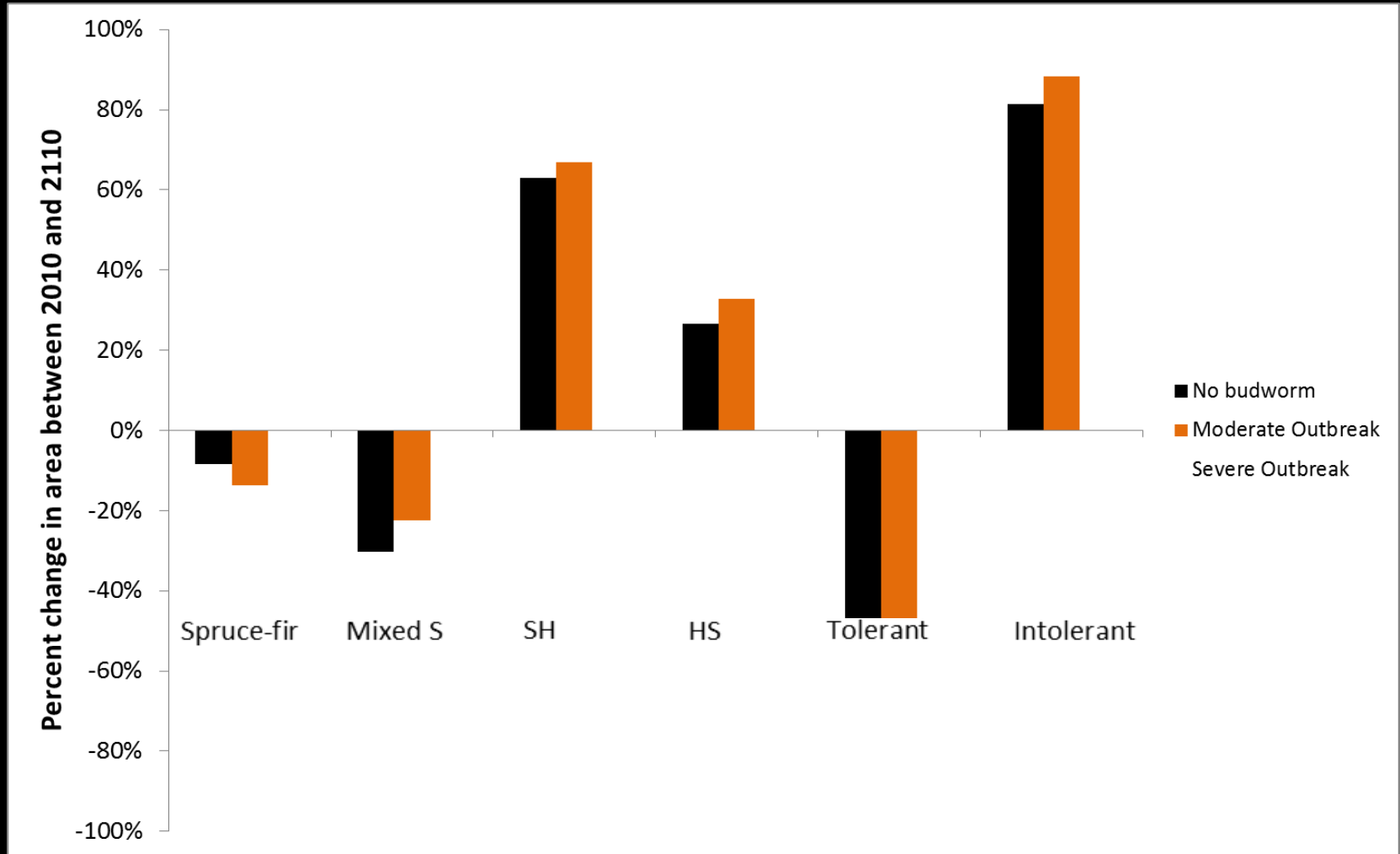


# Spruce-fir Live Biomass

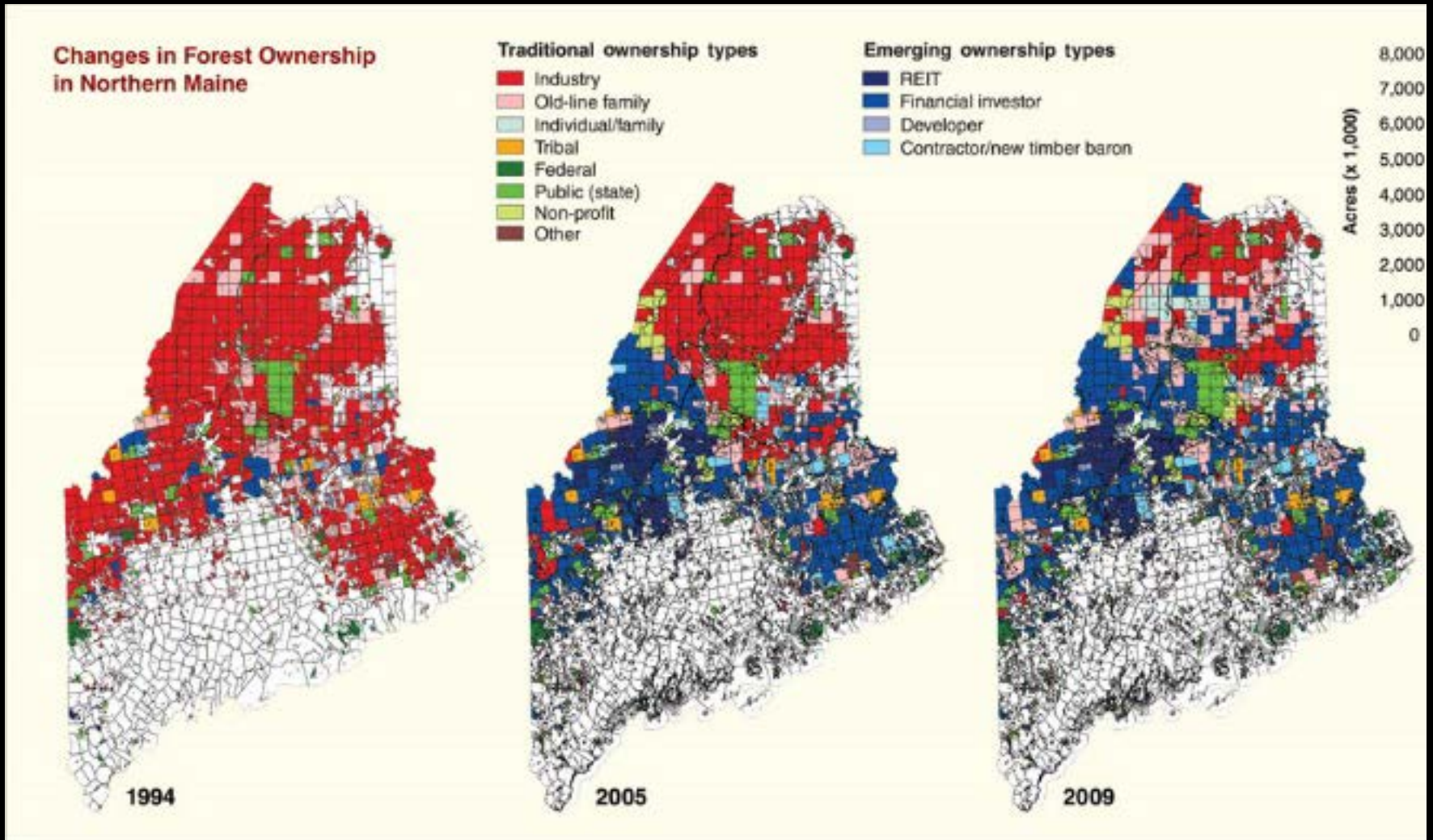


Hennigar et al. 2013

# Percent change in forest area (2010-2110)



# Ownership change

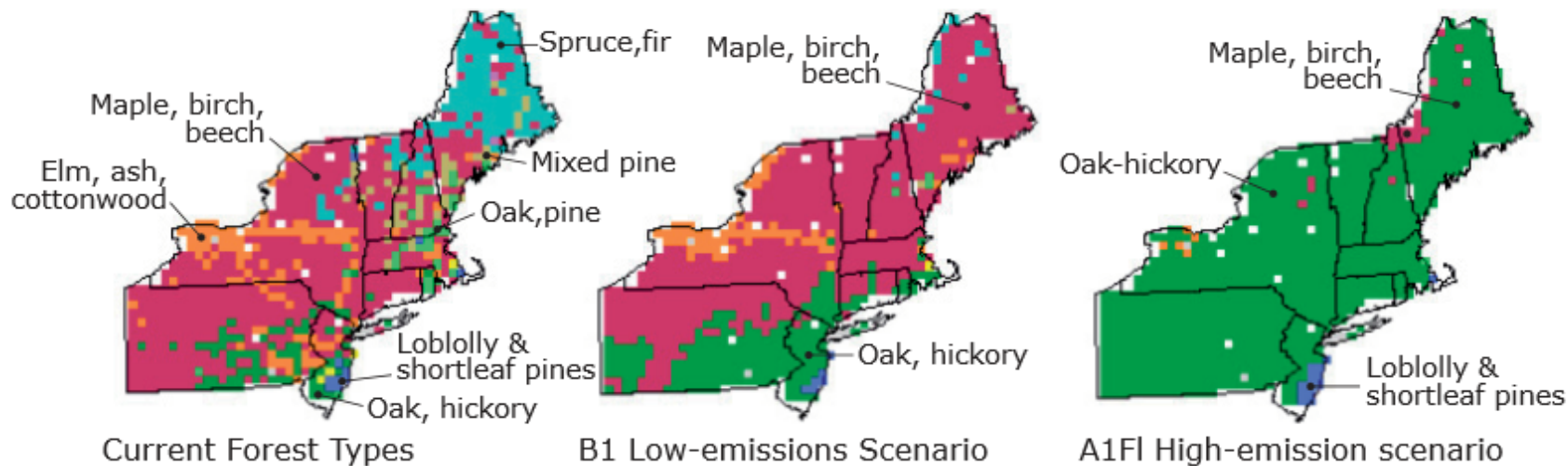


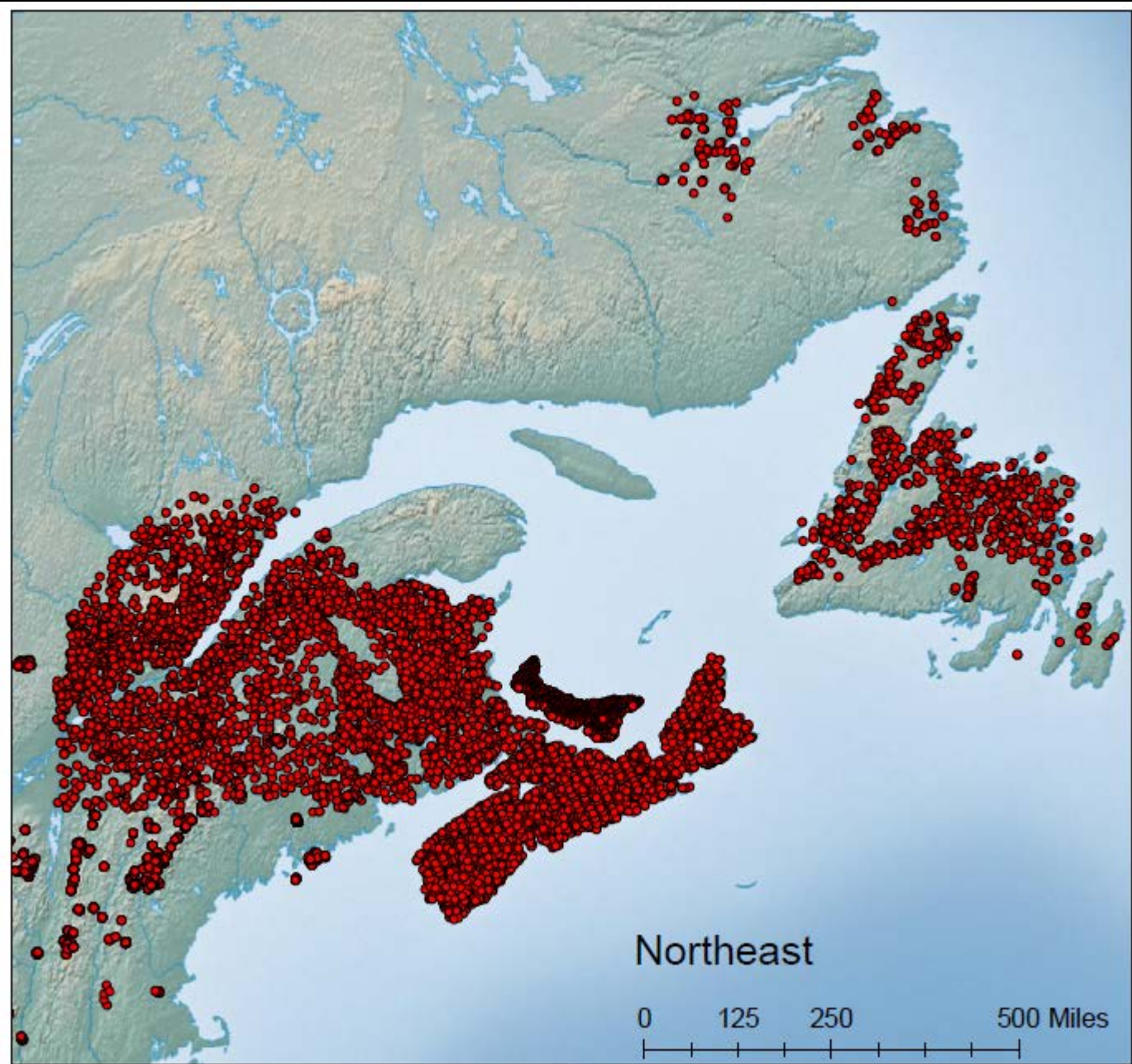
# Freed from state clear-cut restrictions, Maine's largest landowner says it's doing better forestry



Gabor Degre | BDN

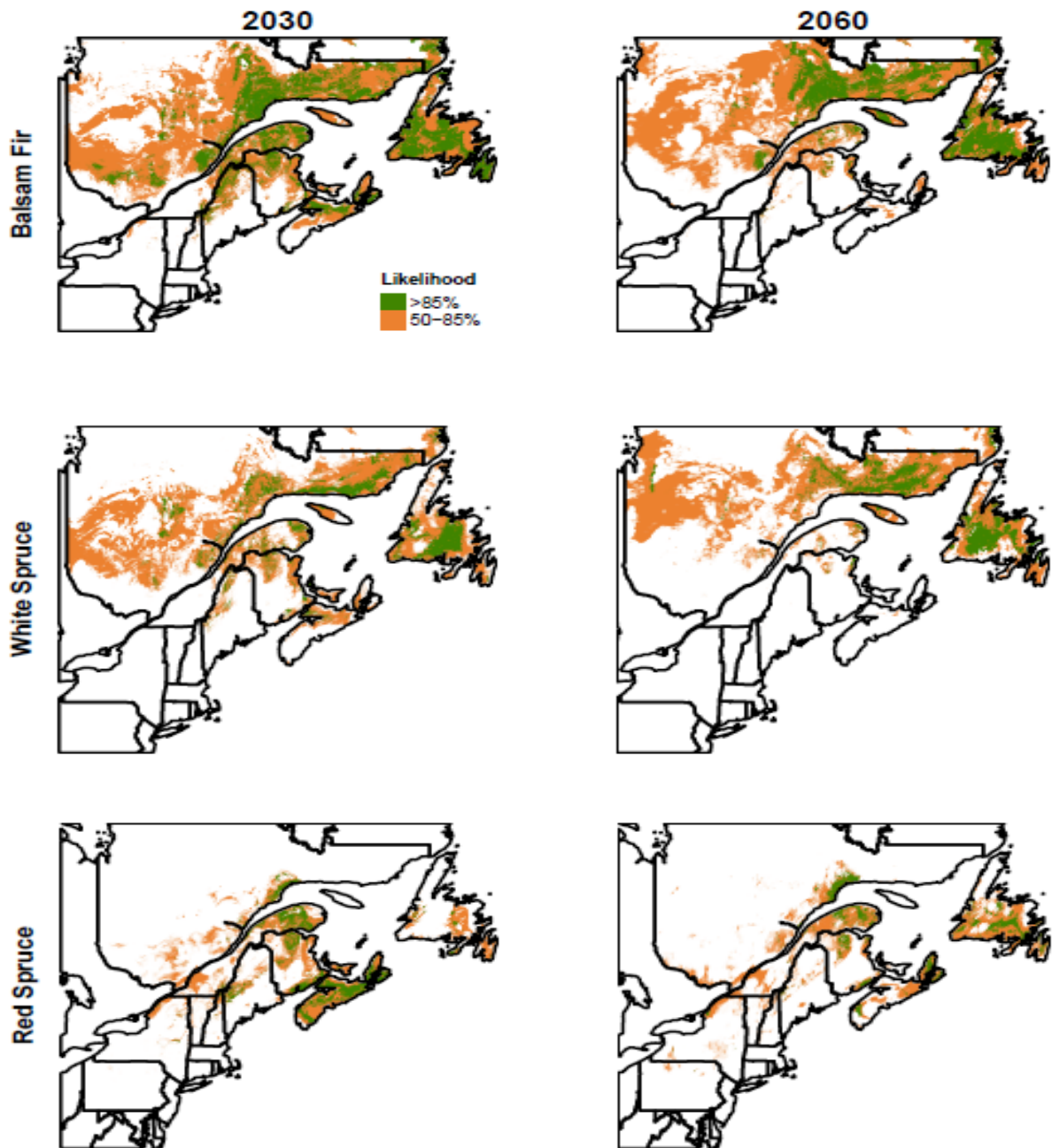
Recently harvested hardwood logs are piled up before being trucked from a J.D. Irving Ltd. logging





# Suitable habitat for S-F forest

- Number of days  $>5^{\circ}\text{C}$
- Mean temp in the coldest month
- Mean annual precipitation
- Growing season precipitation
- Associated with areas that are colder and snowier



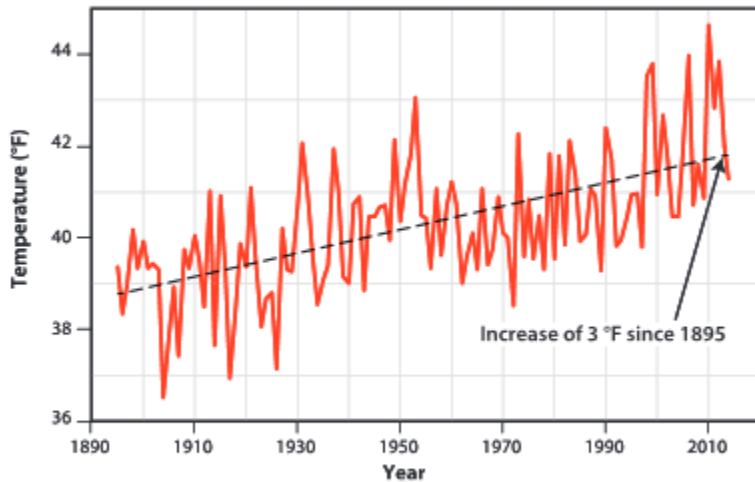


# MAINE'S CLIMATE FUTURE

ENJOBE  
CLIMATE  
MAINE, 2

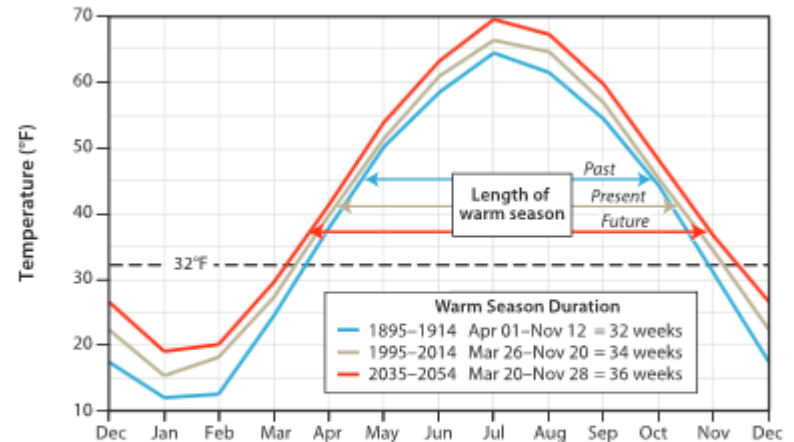
**2015**  
**UPDATE**

## Maine's Average Annual Temperature



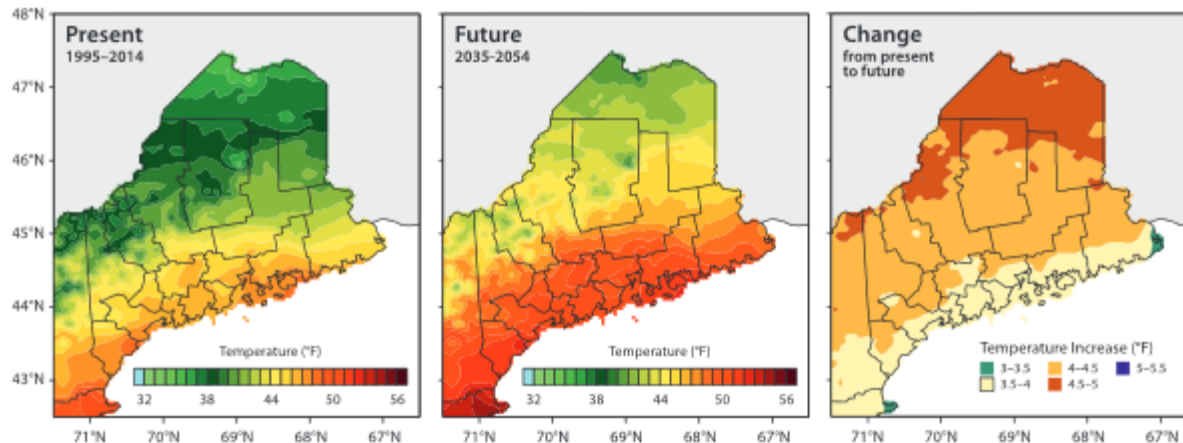
**Figure 1.** Mean annual temperature, 1895–2014, averaged across Maine from gridded monthly station records from the U.S. Climate Divisional Dataset ([ncdc.noaa.gov/monitoring-references/maps/us-climate-divisions.php](http://ncdc.noaa.gov/monitoring-references/maps/us-climate-divisions.php)). A simplified linear trend (black line) indicates that temperature increased 3 °F over the record period.

## Maine's Changing Seasons



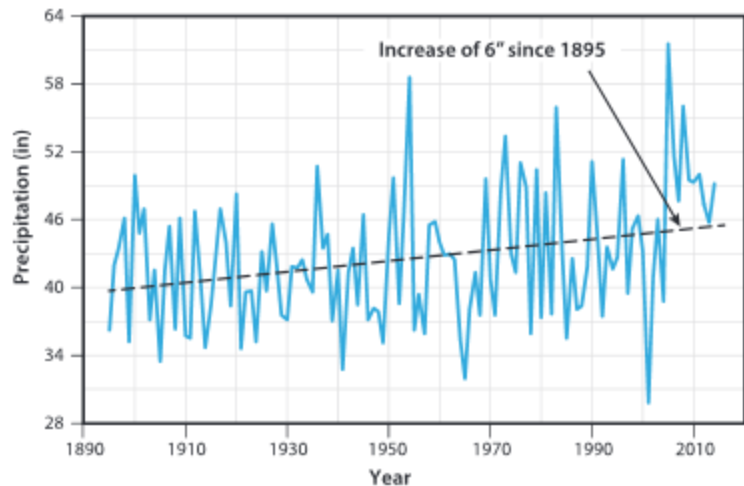
**Figure 3.** Mean monthly temperature averaged across Maine for historical (1895–1914), recent (1995–2014), and future (2035–2054) time periods. Historical and recent data from the U.S. Climate Divisional Dataset ([ncdc.noaa.gov/monitoring-references/maps/us-climate-divisions.php](http://ncdc.noaa.gov/monitoring-references/maps/us-climate-divisions.php)), and future prediction from an ensemble simulation of the IPCC emissions scenario A2.

## Present and Future Temperature



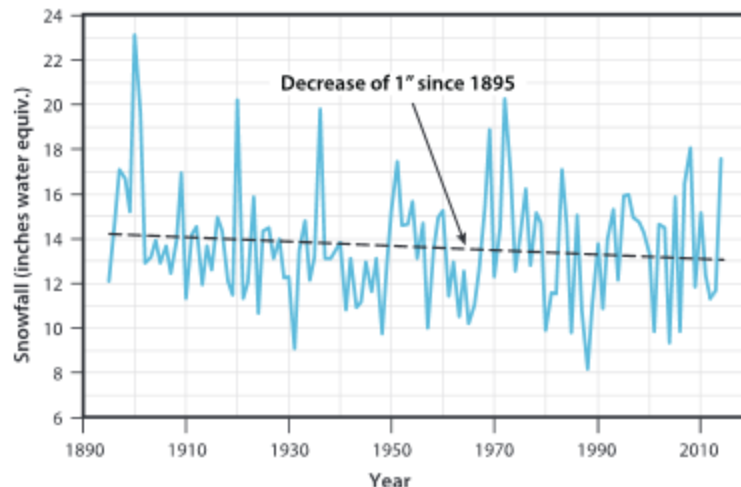
**Figure 2.** Maps showing mean annual temperature for 1995–2014 (left), 2035–2054 (center), and the predicted change or difference between the two time periods (right). The predicted rise in temperature by 2050 ranges 3.0–5.0 °F from the coast inland to the Canadian border. Maps derived from an ensemble simulation of the IPCC A2 emissions scenario.<sup>1</sup>

### Maine's Total Annual Precipitation



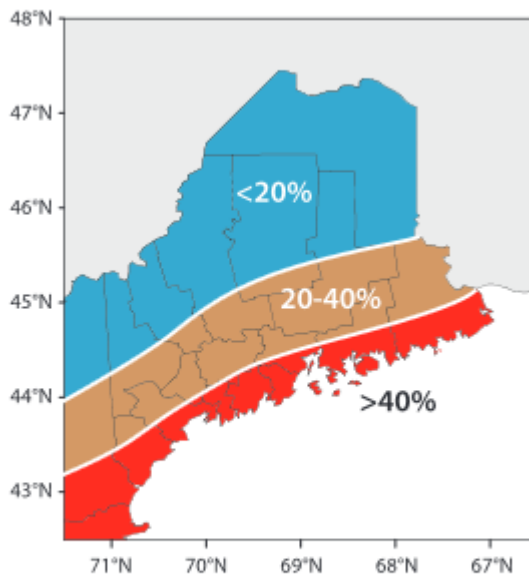
**Figure 6.** Total annual precipitation, 1895–2014, averaged across Maine from gridded U.S. Climate Divisional Dataset ([ncdc.noaa.gov/monitoring-references/maps/us-climate-div](http://ncdc.noaa.gov/monitoring-references/maps/us-climate-div)) (black line) indicates that precipitation increased six inches, or about 13%, during the record

### Maine's Total Annual Snowfall



2014, averaged across Maine, derived from gridded monthly temperature and precipitation data from the U.S. Climate Divisional Dataset ([ncdc.noaa.gov/monitoring-references/maps/us-climate-div](http://ncdc.noaa.gov/monitoring-references/maps/us-climate-div)) (black line) indicates that snowfall decreased approximately 1.0 inches (6.6%) during the

### Projected Snowfall Decline



**Figure 10.** Map showing the predicted change or difference in total accumulated winter snow by climate zone from 1995–2014 to 2035–2054. The greatest changes are predicted to be along the coast, where many winters of the future will bring rain instead of snow. Map derived from an ensemble simulation of the IPCC A2 emissions scenario.

# Forest Management & Lynx Habitat Trends

Erin Simons-Legaard

Collaborators: Kasey Legaard, Dan Harrison, Mark McCollough, Aaron Weiskittel, Caitlin Andrews