Aspen and fire in the Lake States

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January 19, 2017

Audio will start at 2 PM ET/ 1 PM CT

This webinar is listen only – to ask questions please use the chat box

How does aspen fit into the landscape mosaic created by disturbance?

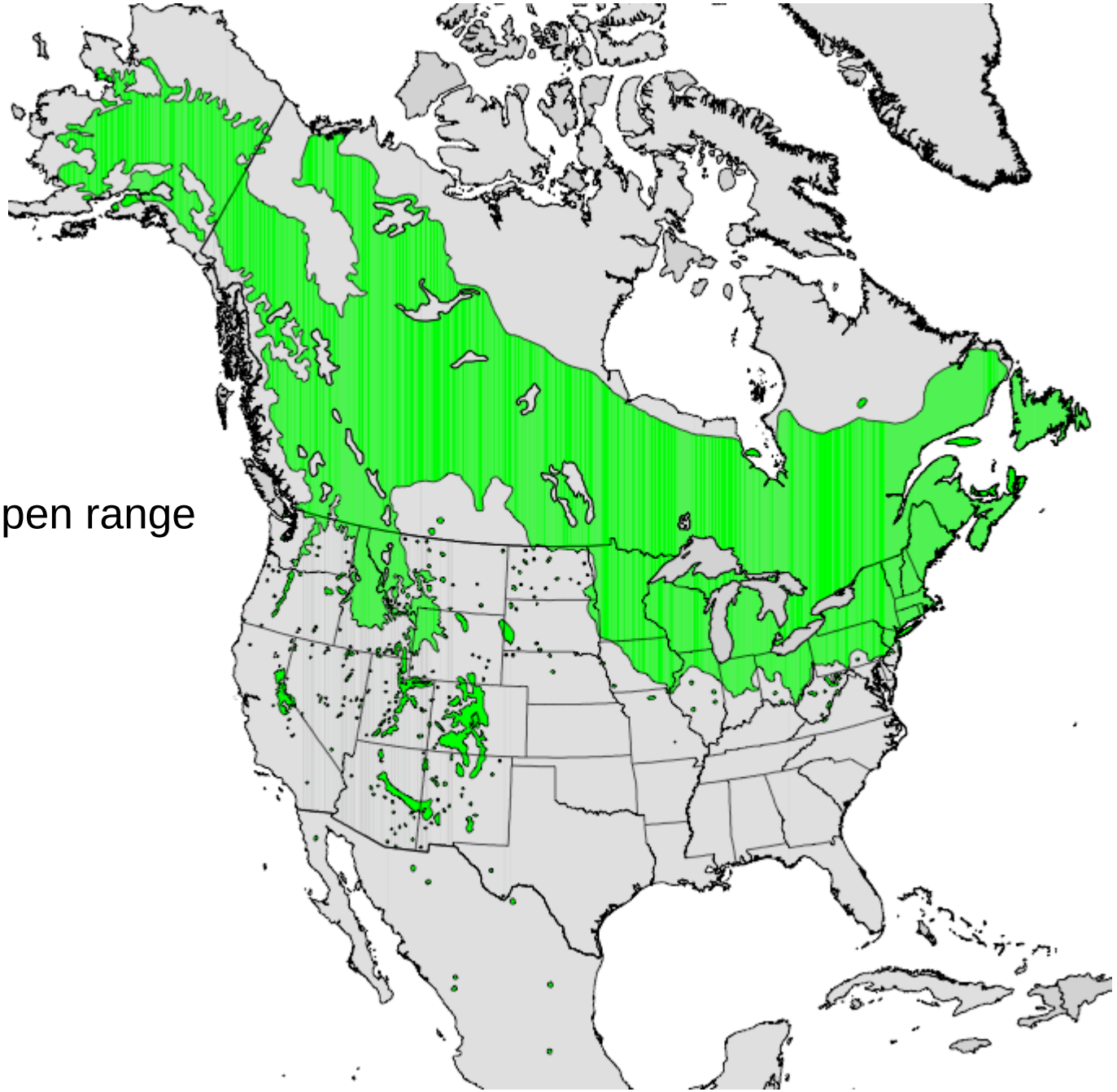
- Northern hardwoods
- Mixed pine forests
- Boreal jack pine, spruce, fir

What determines dominance by aspen versus paper birch after fire?

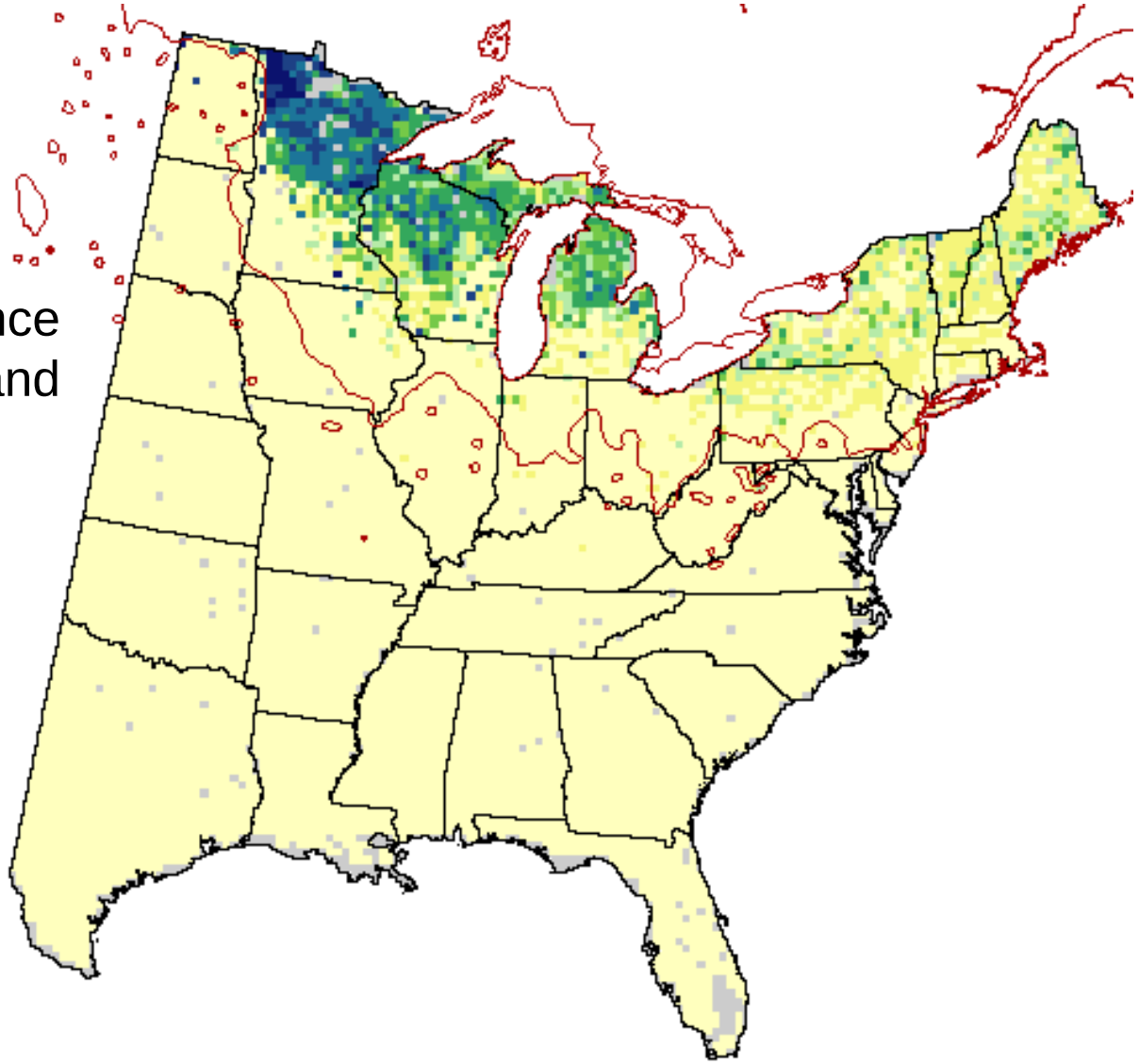
Future of aspen and fire with a warmer climate

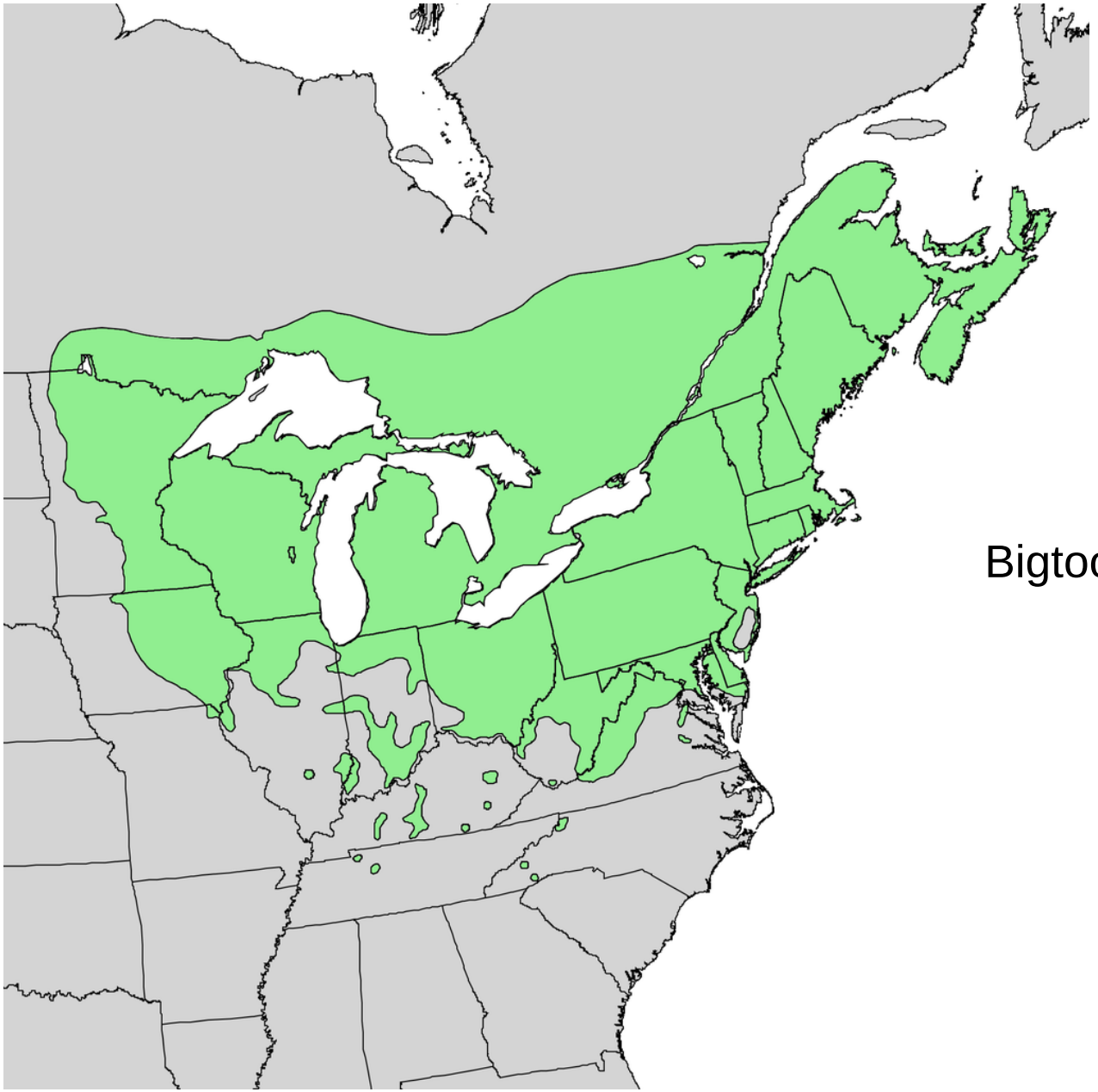
Invasive species (Earthworms, buckthorn)

Quaking aspen range

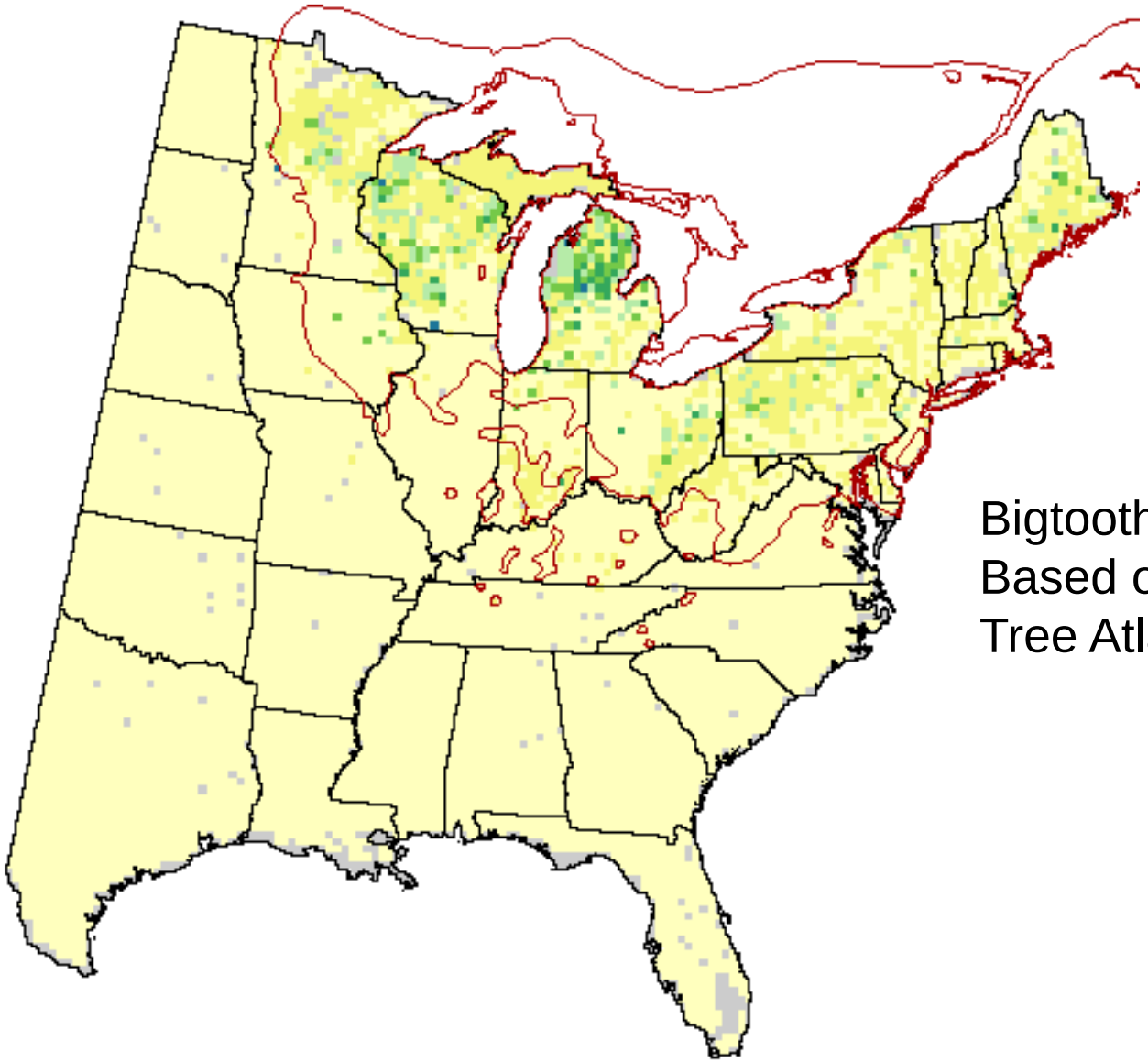


Quaking aspen abundance
Based on FIA, Climate and
Tree Atlas





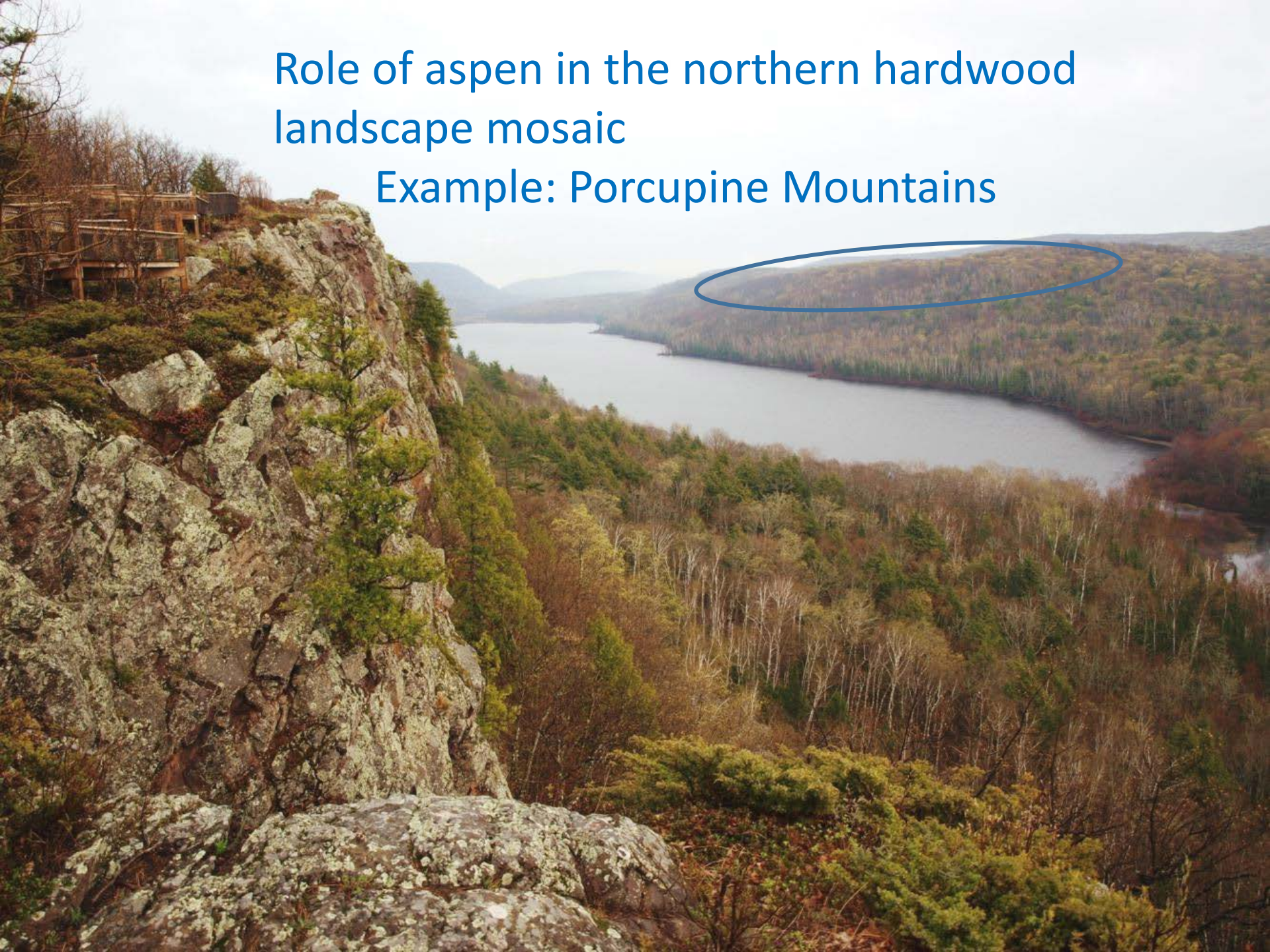
Bigtooth aspen range



Bigtooth aspen abundance
Based on FIA, Climate and
Tree Atlas

Role of aspen in the northern hardwood landscape mosaic

Example: Porcupine Mountains



Most disturbance is not stand leveling—the frequency of partial disturbance is an order of magnitude higher

Spot fires in hemlock-hardwood forest

60-year-old paper birch and aspen under older hemlock and maple (upper) and fire scar on hemlock (lower)

Compositional change in the Hemlock maple forest—after wind followed by fire paper birch can replace the maple and hemlock, initiating an episode of succession

Don Breneman, MN Agricultural Experiment Station

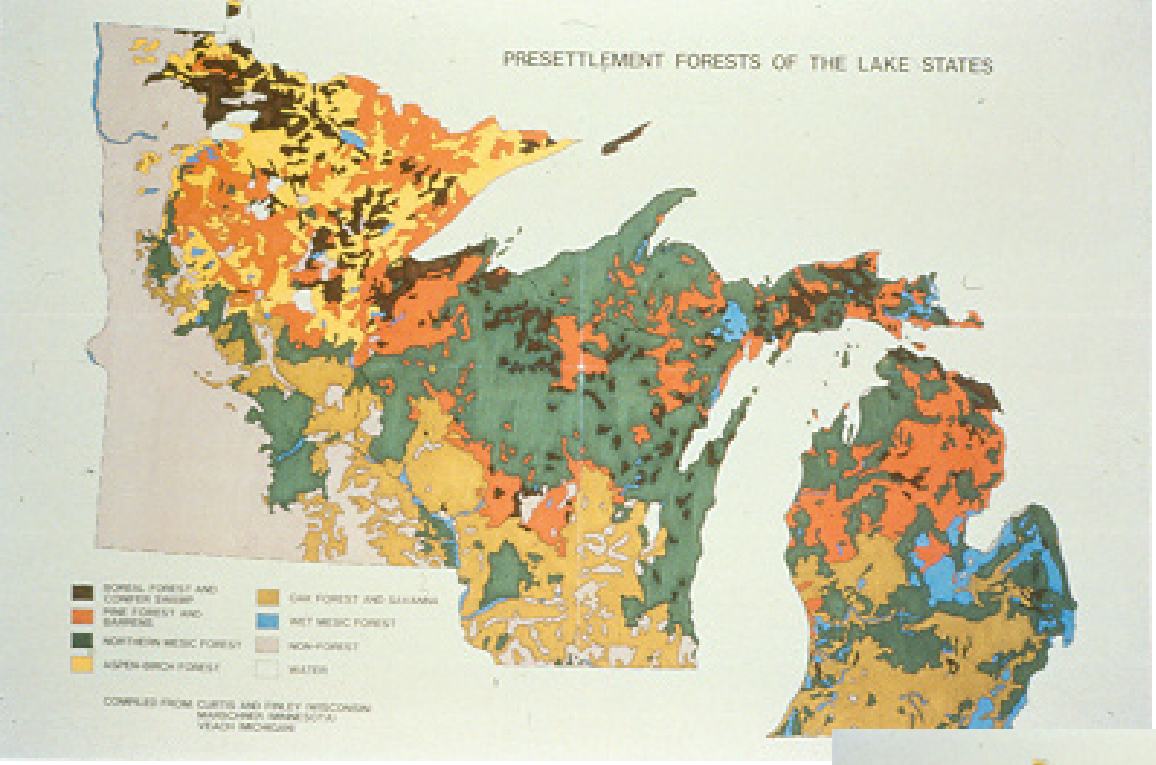
Development and succession in hemlock-hardwood forest

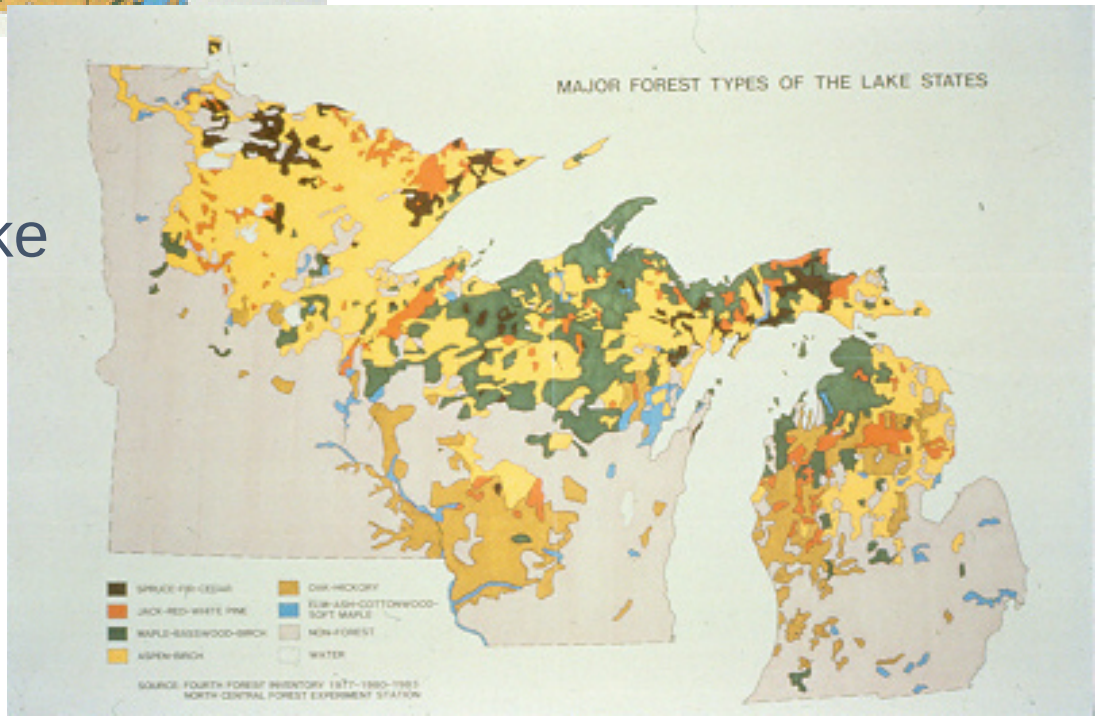
Wind + fire

Succession

Growth and development

Wind





Presettlement and current forest vegetation of the Lake States

Several hundred red maple saplings per acre followed by wind or harvesting
Without scarification = instant transition from early to late successional forest.
Photo: Dave Hansen

White and red pine with multiple cohorts--BWCAW

Aspen is often invaded by white pine—and then there are three possible trajectories

3. No fire allows maple and hemlock (or spruce-fir) to replace white pine

2. Low-intensity surface fire maintains white pine

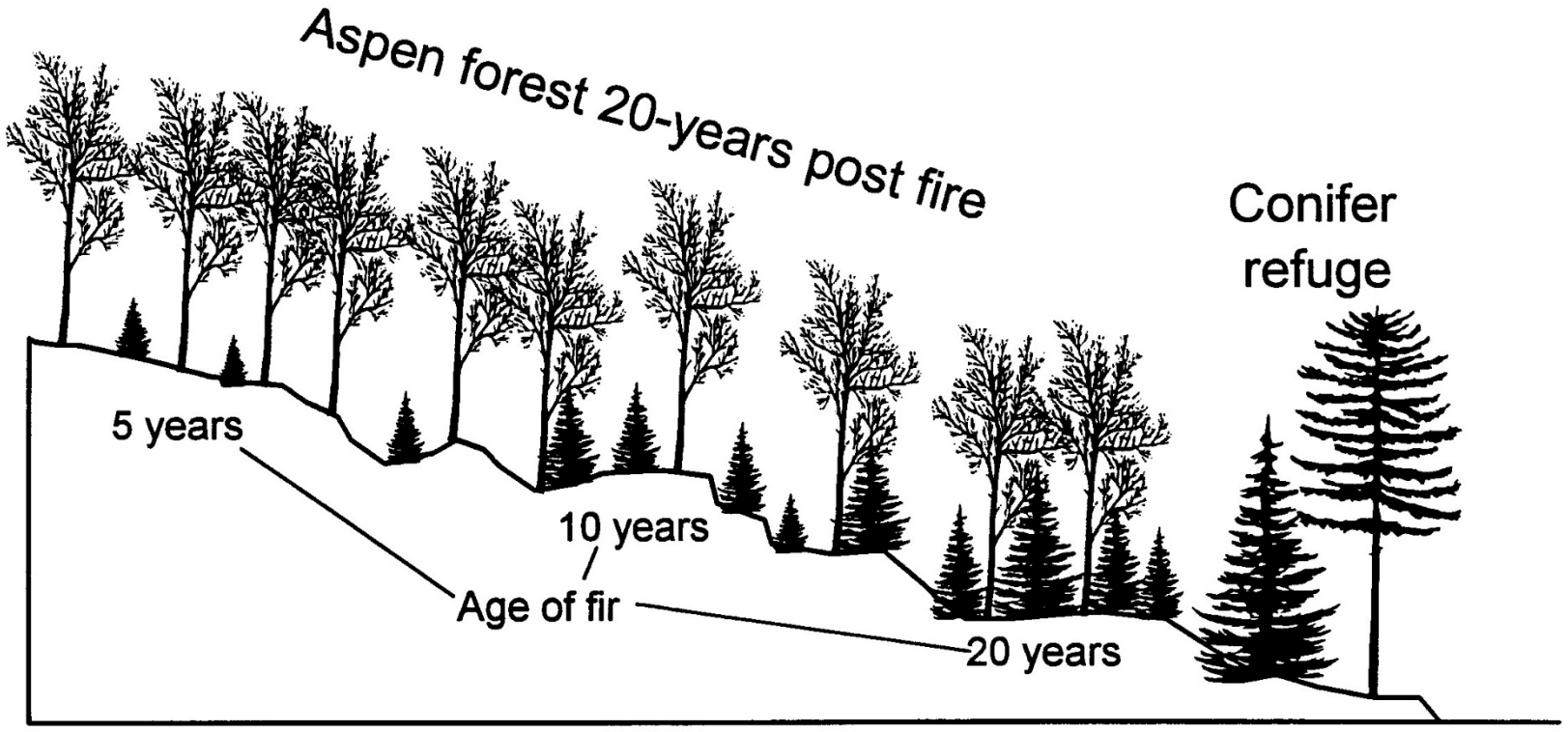
1. High intensity fire and return to aspen

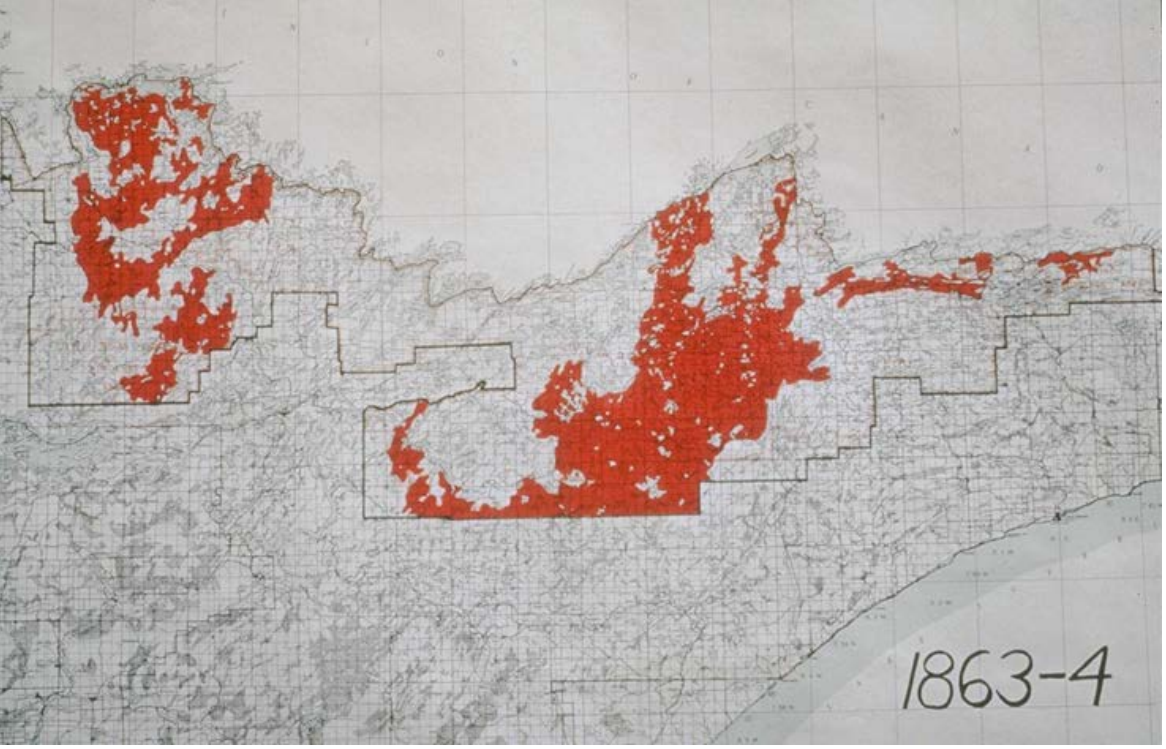
Surface fires and regeneration
9-years post fire

Photos: Bud Heinselman, Eli Anoszko

White and red pine forest with thick duff after the fire!

Legacy concept—what is left after disturbance helps determine course of succession





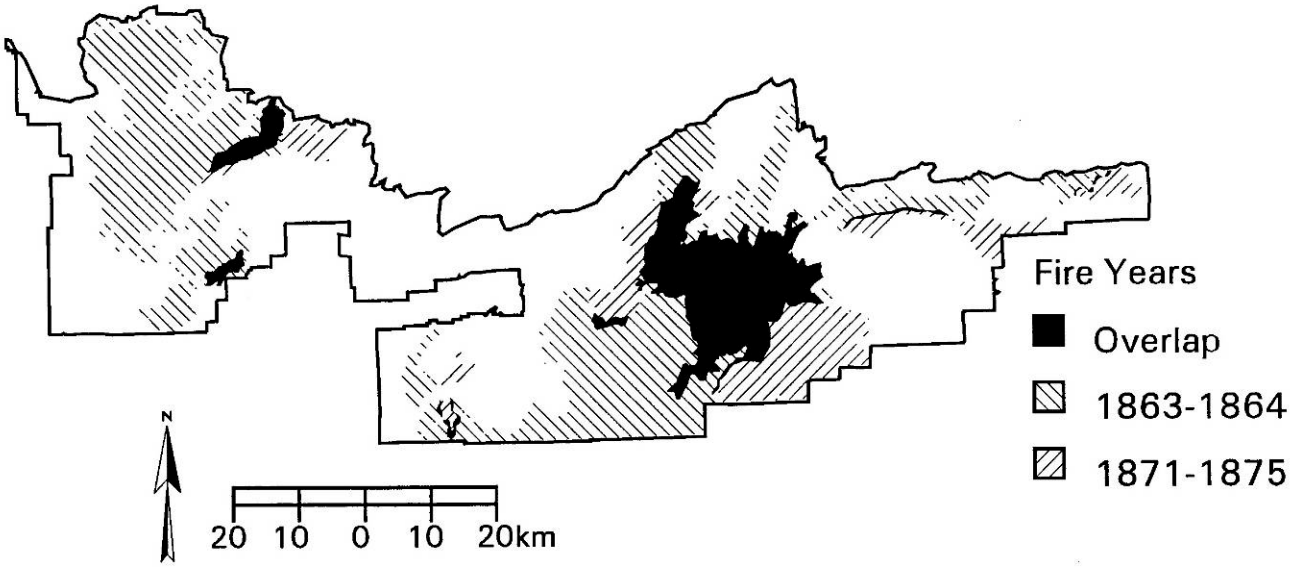
Boreal regime with large crown fires: Heinselman's area burn maps for 1864 and 1875

Boreal jack pine, black spruce, aspen forest with high-intensity crown fire

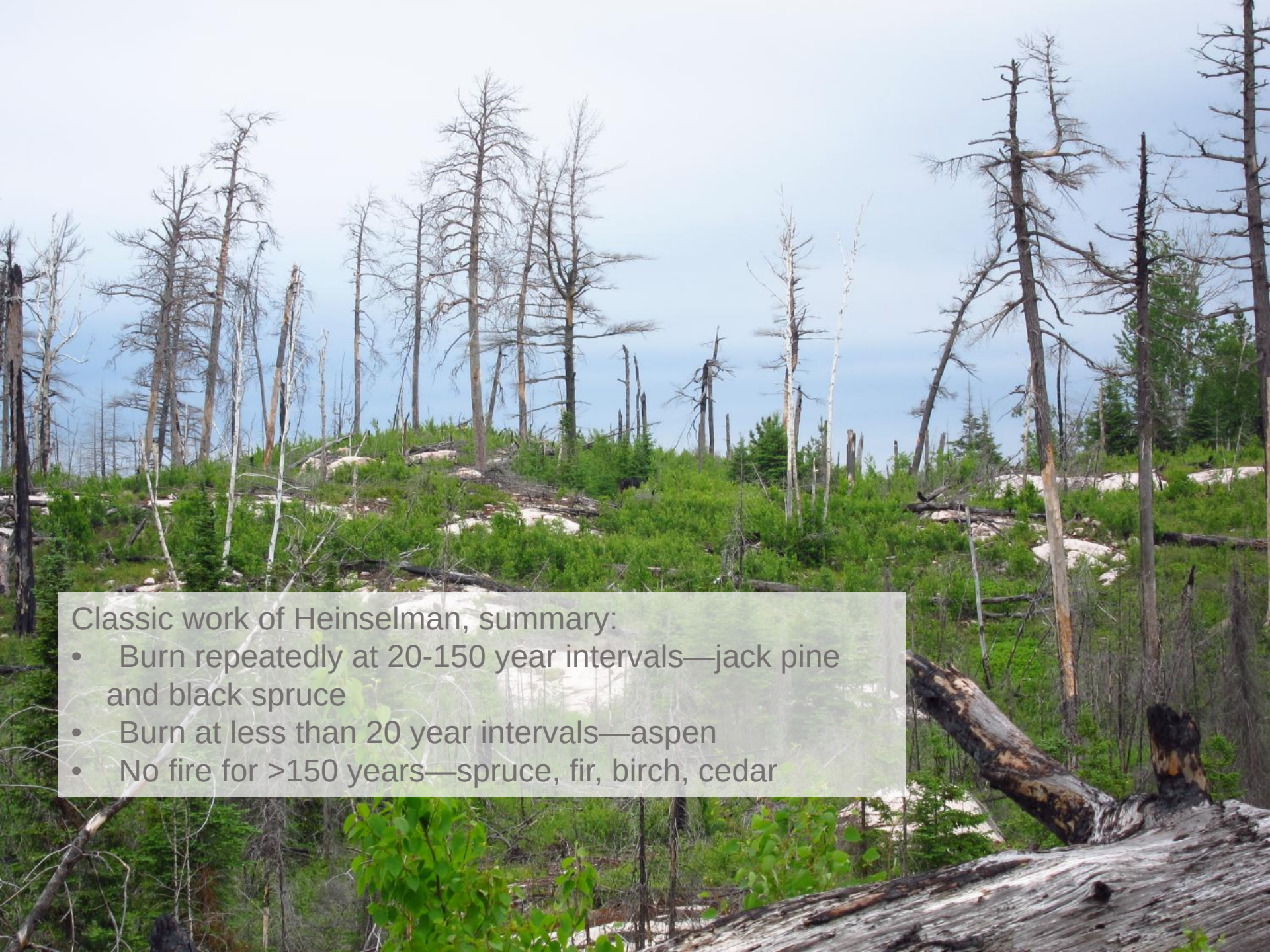
Photos: Bud Heinselman

Even-aged regeneration from serotinous cones, sprouts, buried seeds and wind blown seeds

Aspen stand created by two burns at short within a short time



From Frelich 2002, Forest dynamics and disturbance regimes
Cambridge University Press

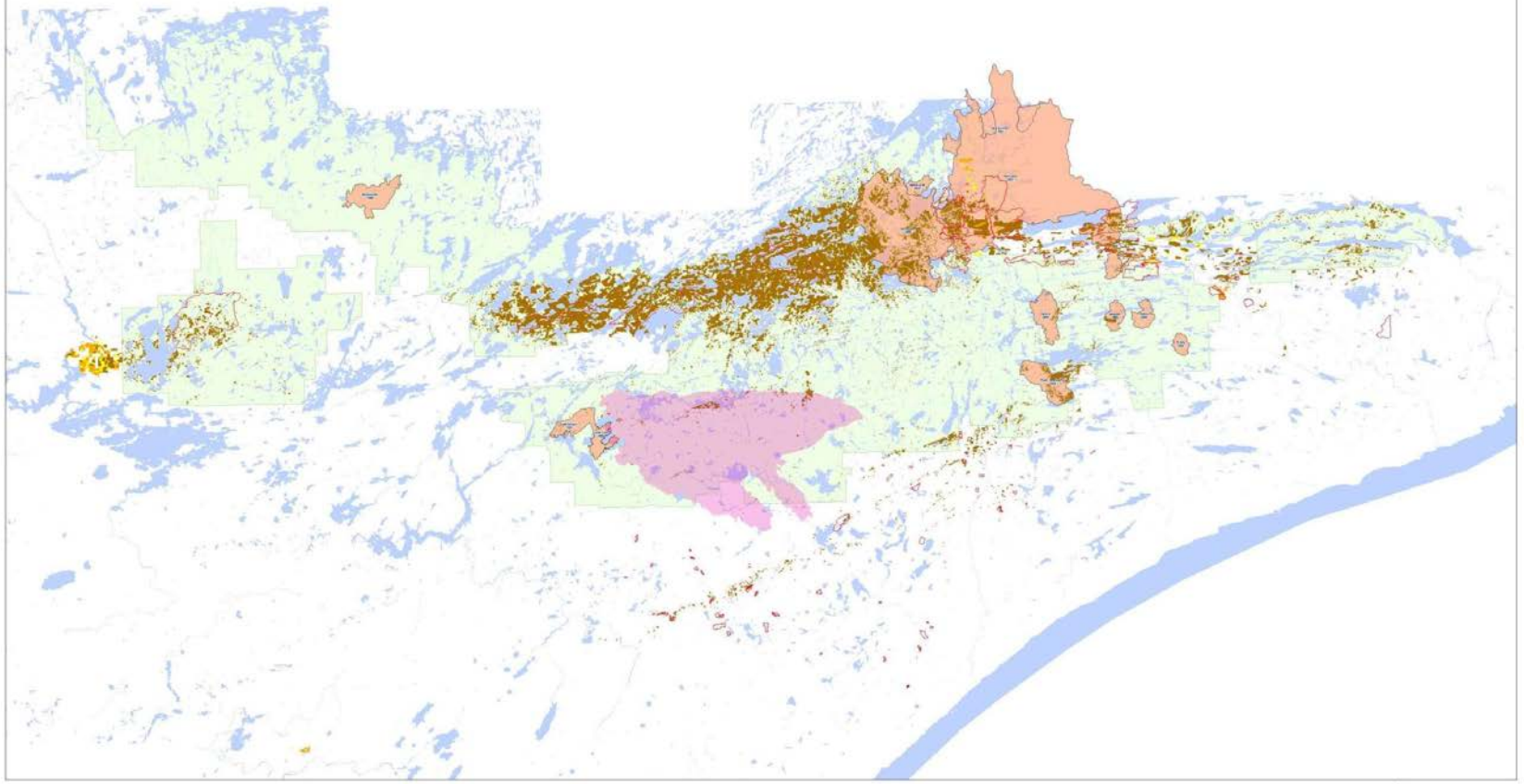


Classic work of Heinselman, summary:

- Burn repeatedly at 20-150 year intervals—jack pine and black spruce
- Burn at less than 20 year intervals—aspen
- No fire for >150 years—spruce, fir, birch, cedar

Pagami Creek Fire
MN-SUF-110519
Boundary Waters Canoe Area Wilderness Fire History 1995-2010

Pagami Creek Perimeter As of 09-22-2011 1200
NAD83 - UTMz15



Legend

- Completed Blowdown Burns
- BWCAW
- Wildfire History 1995-2010

Blowdown Severity

- high
- medium
- low

0 5 10 20 Miles

09/22/2011 1700

Complex Matrix of Disturbance Combinations (850 plots, Eli Anoszko)

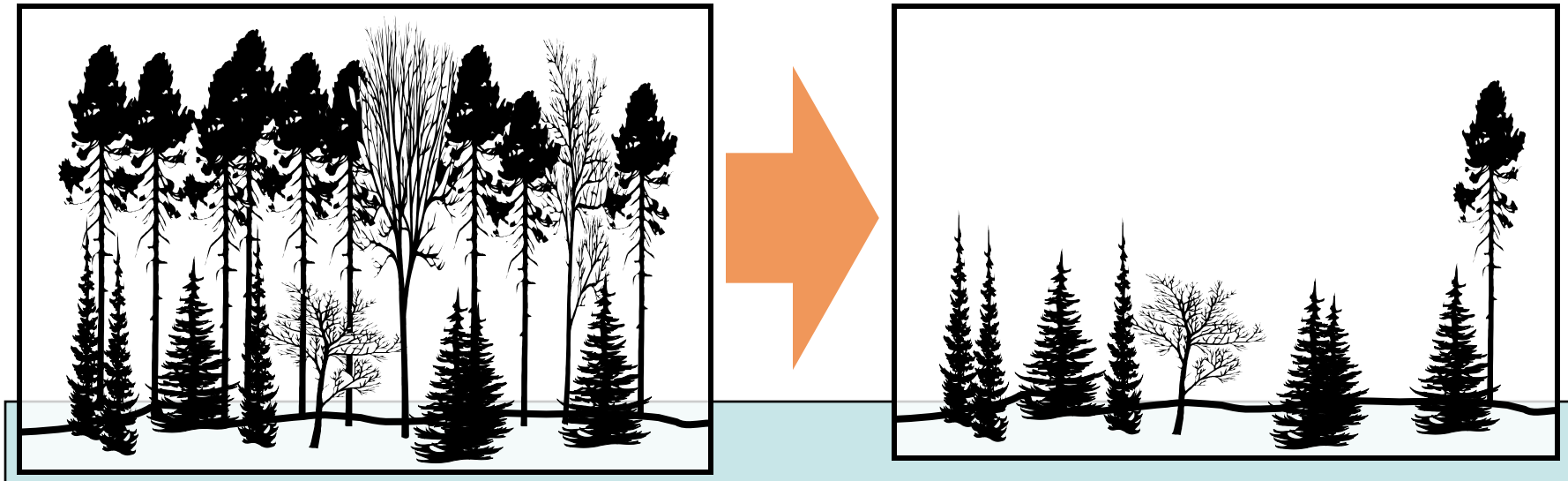
- Blowdown (1999)
- Blowdown + Prescribed Fires (2002-05)
- Blowdown + Cavity Lake Fire (July 2006)
- Blowdown + Ham Lake Fire (May 2007)
- Blowdown+ Prescribed Fire+ Ham Lake Fire
- Multiple Fires (1974, 1995, 2007)
- Ham Lake Fire (Non-blowdown)
- Red Eye and Famine Lake Fires (Non-blowdown September 2006)

Sample size smack down among the scientists at ESA 2014

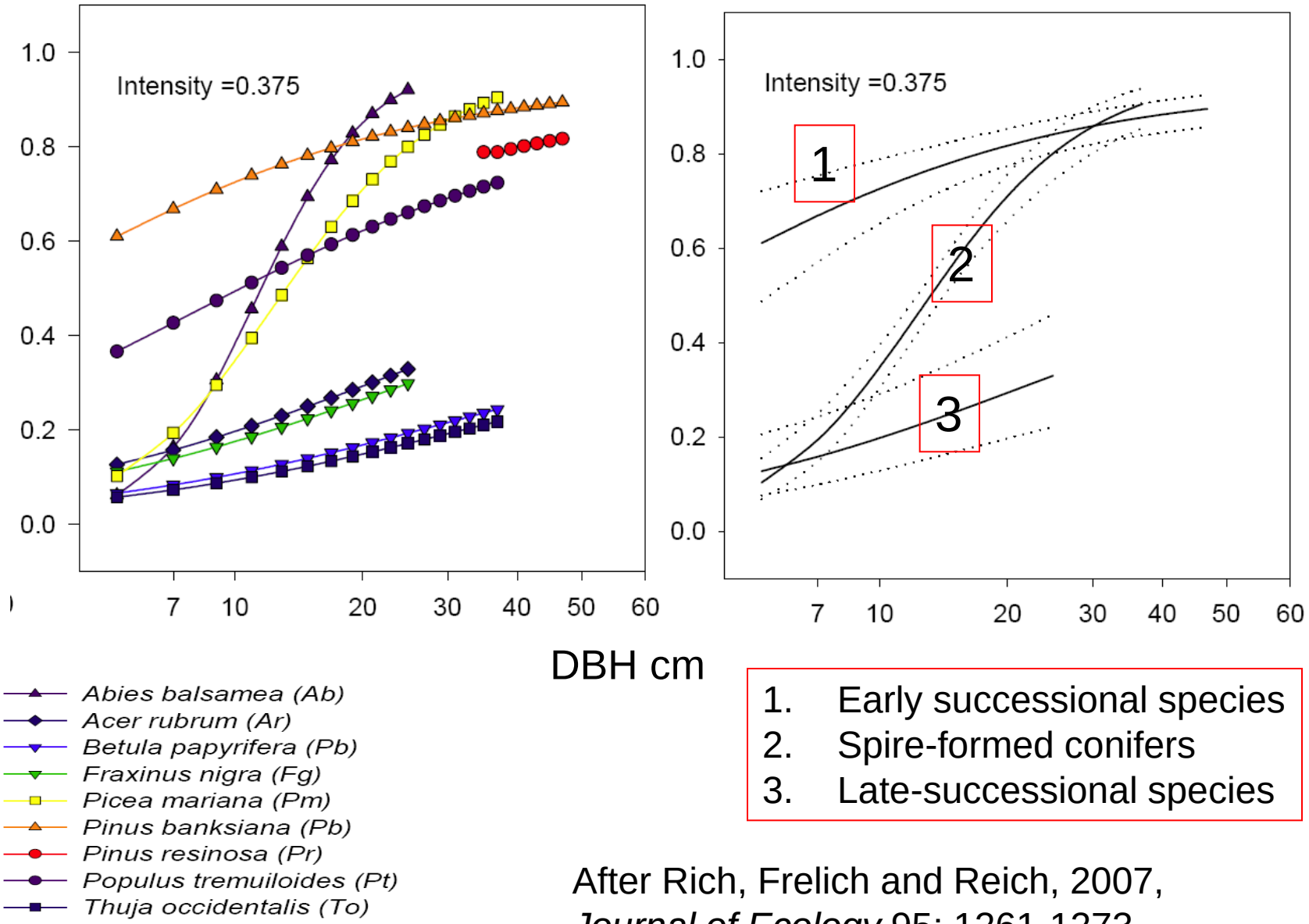
Minneapolis Star Tribune

Before and after the 1999 derecho in northern Minnesota, with wind speeds of 30-60 m/s (65-130 mph)

<u>Late successional or persistent species:</u>
Black Spruce, Paper Birch, White Cedar, Balsam Fir (Frelich and Reich 1995) and Red Maple



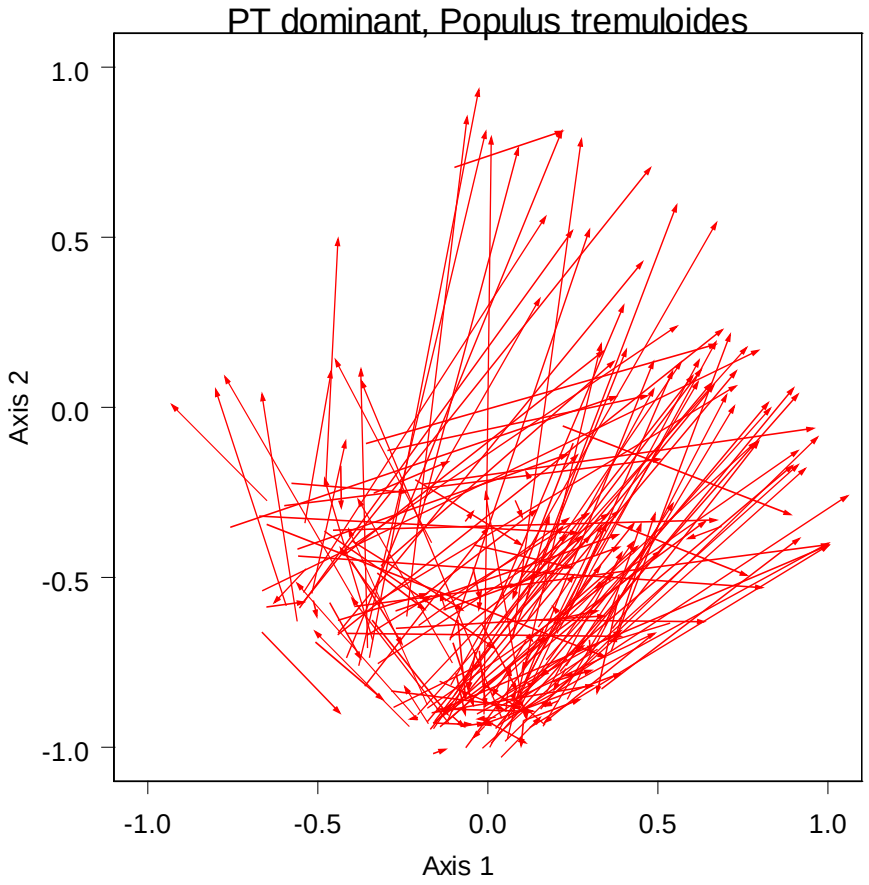
Mechanisms:
1. Direct selection of resilient canopy trees
2. Release of understory regeneration

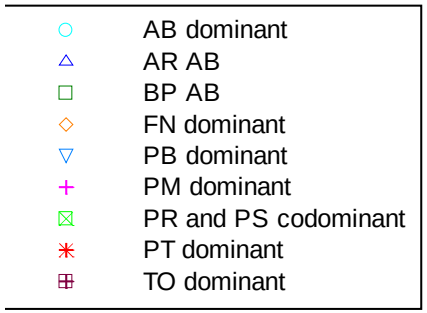


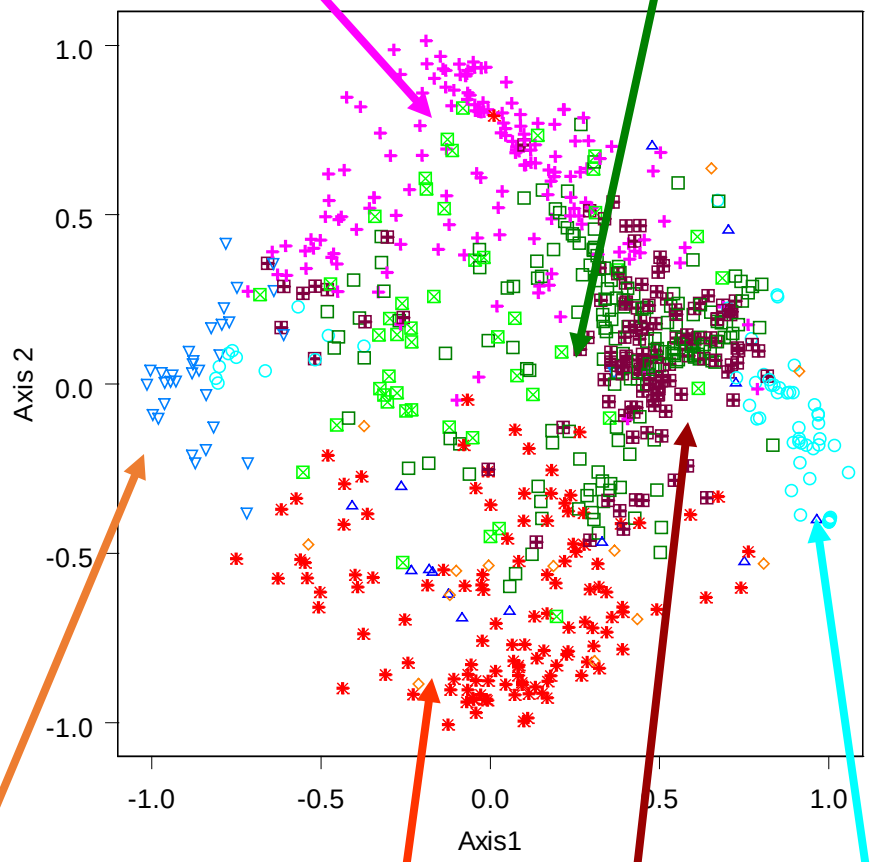
1. Early successional species
2. Spire-formed conifers
3. Late-successional species

After Rich, Frelich and Reich, 2007, *Journal of Ecology* 95: 1261-1273

Quaking aspen transitions—divergence to several types







P.mariana

B.papyrifera

P. banksiana

P. tremuloides

T.occidentalis

A. balsamea

Post-blowdown tree survival

Photos: Dave Hansen

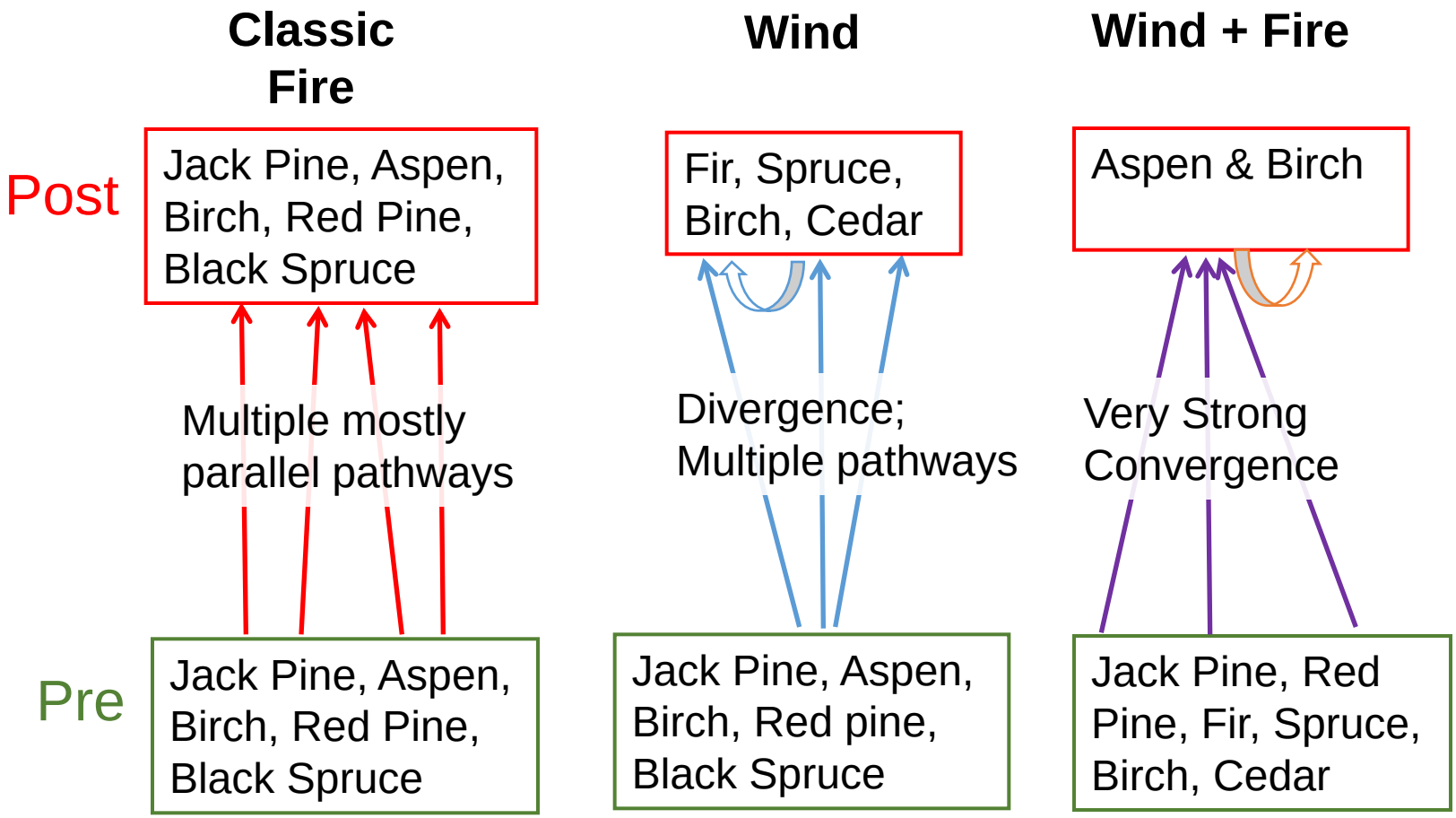
Plot 28 pre and post fire transect

Photos: Roy Rich

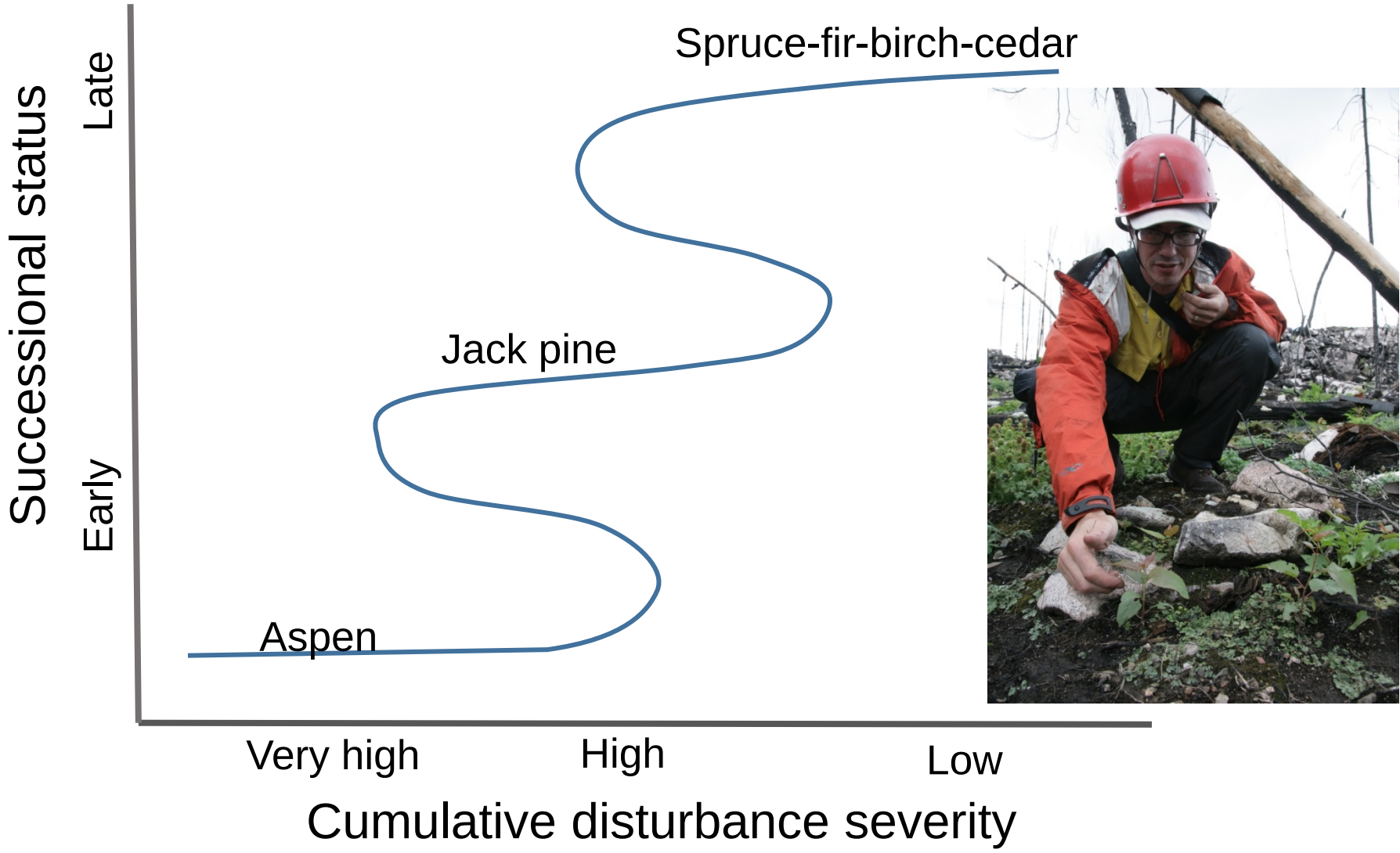
200 year old red pine forest before and after 1999 blow down

The same forest as previous slide immediately after fire and five years post fire

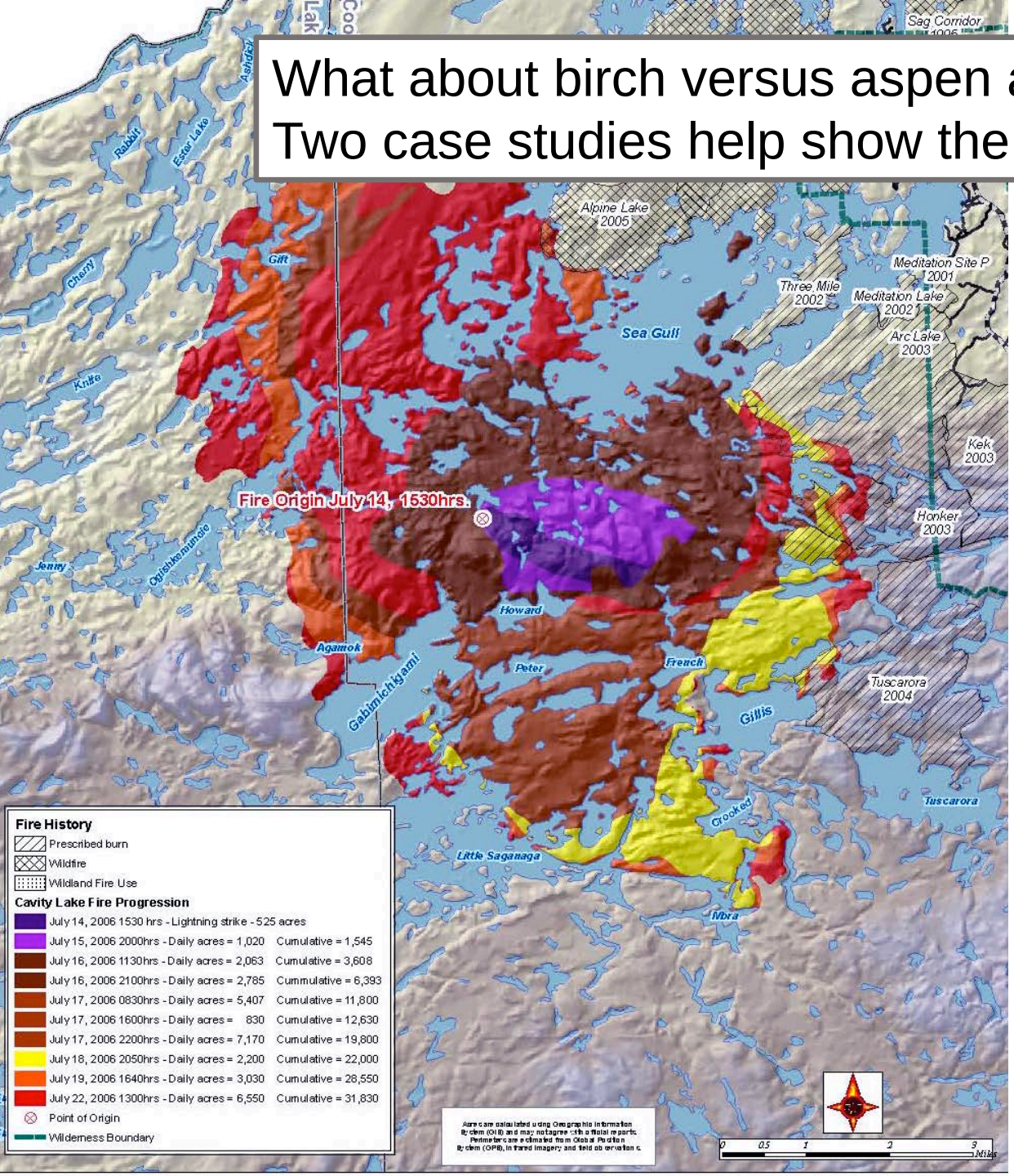
Disturbance dependent successional pathways—boreal forest



Alternate states in near-boreal forest



What about birch versus aspen after fire? Two case studies help show the answer



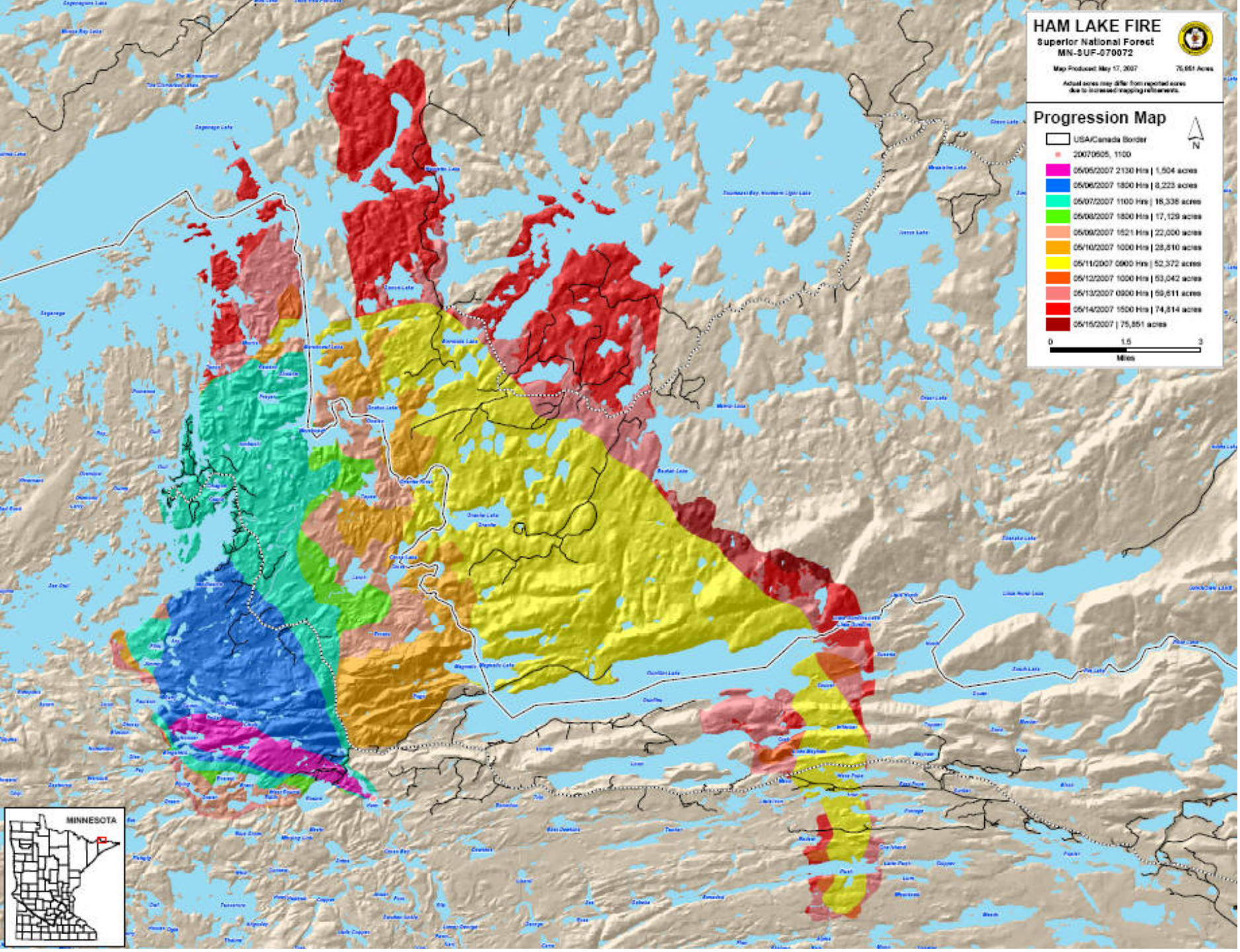
Progression map for
Cavity Lake Fire—July 2006

Start of Cavity Lake Fire
and escape by University of MN
Post-Doc Roy Rich

The Cavity Lake fire aftermath. Photos: Alex Reich

Five years post fire birch forest on Three Mile Island, Seagull Lake

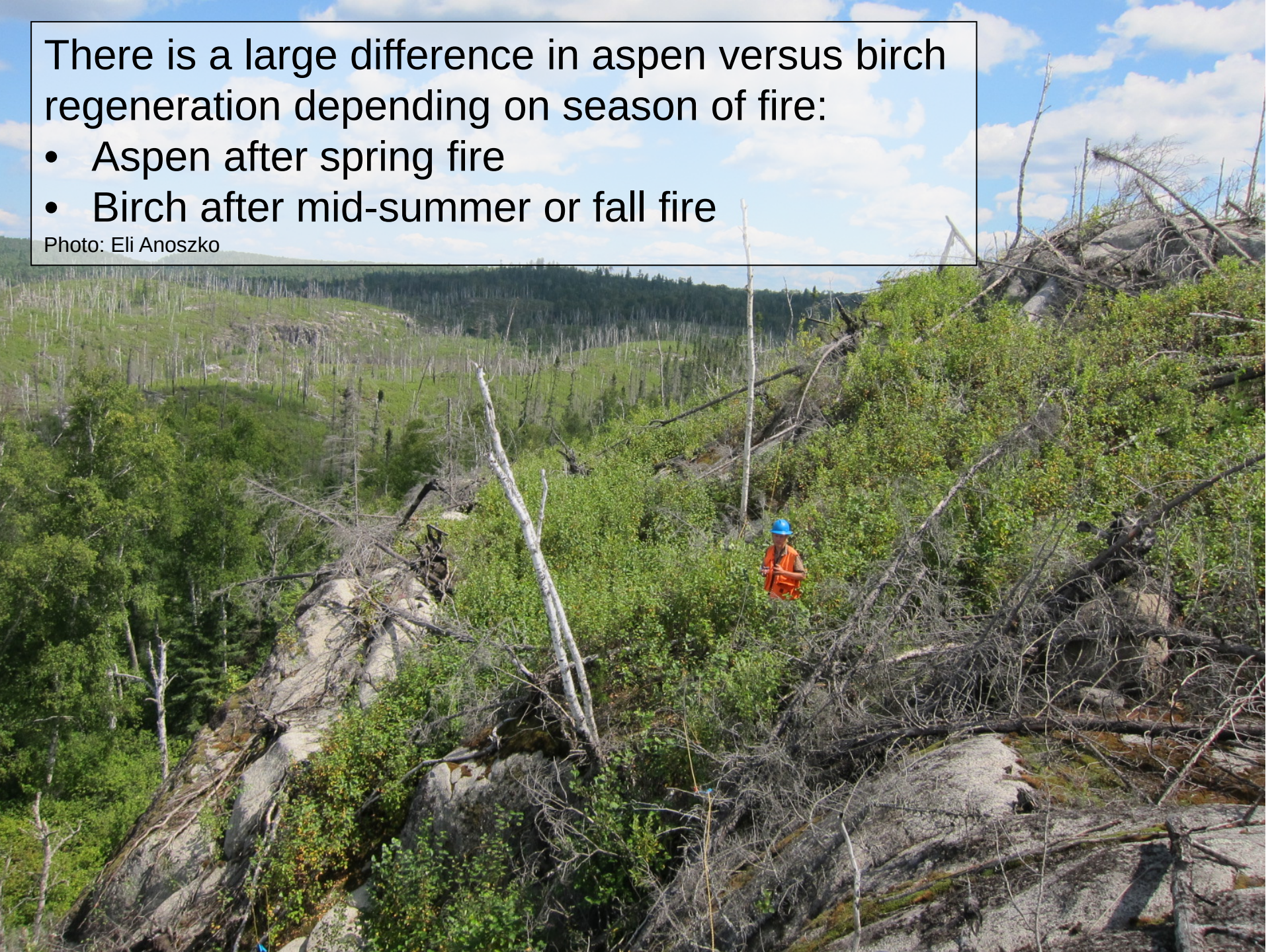
Photo: Dave Hansen, University of MN


HAM LAKE FIRE
Superior National Forest
MN-SUF-070072
Map Produced: May 17, 2007
75,851 Acres
Actual acres may differ from reported acres due to increased mapping refinements.
Progression Map
N
USA/Canada Border
20070505, 1100
05/05/2007 2130 Hrs | 1,504 acres
05/06/2007 1800 Hrs | 8,223 acres
05/07/2007 1100 Hrs | 16,338 acres
05/08/2007 1800 Hrs | 17,129 acres
05/09/2007 1621 Hrs | 22,000 acres
05/10/2007 1000 Hrs | 28,810 acres
05/11/2007 0900 Hrs | 52,372 acres
05/12/2007 1000 Hrs | 53,042 acres
05/13/2007 0900 Hrs | 59,611 acres
05/14/2007 1500 Hrs | 74,814 acres
05/15/2007 | 75,851 acres
0
1.5
3
Miles
MINNESOTA

View of Ham Lake Fire from Seagull Palisades—midnight May 6, 2007. Layne Kennedy (left) and Gus Axelson (Right).

Ham Lake burn, 3 months later. Shows effects of spring burn with uneven severity Photo: Dave Hansen.


5 years post fire aspen
Photo: Eli Anoszko



There is a large difference in aspen versus birch regeneration depending on season of fire:

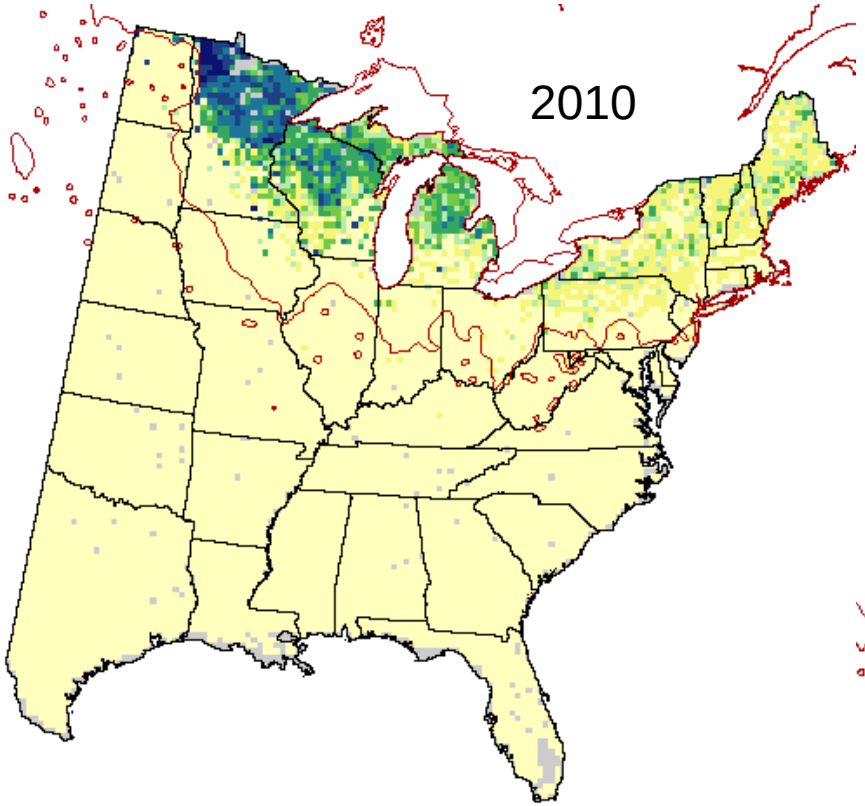
- Aspen after spring fire
- Birch after mid-summer or fall fire

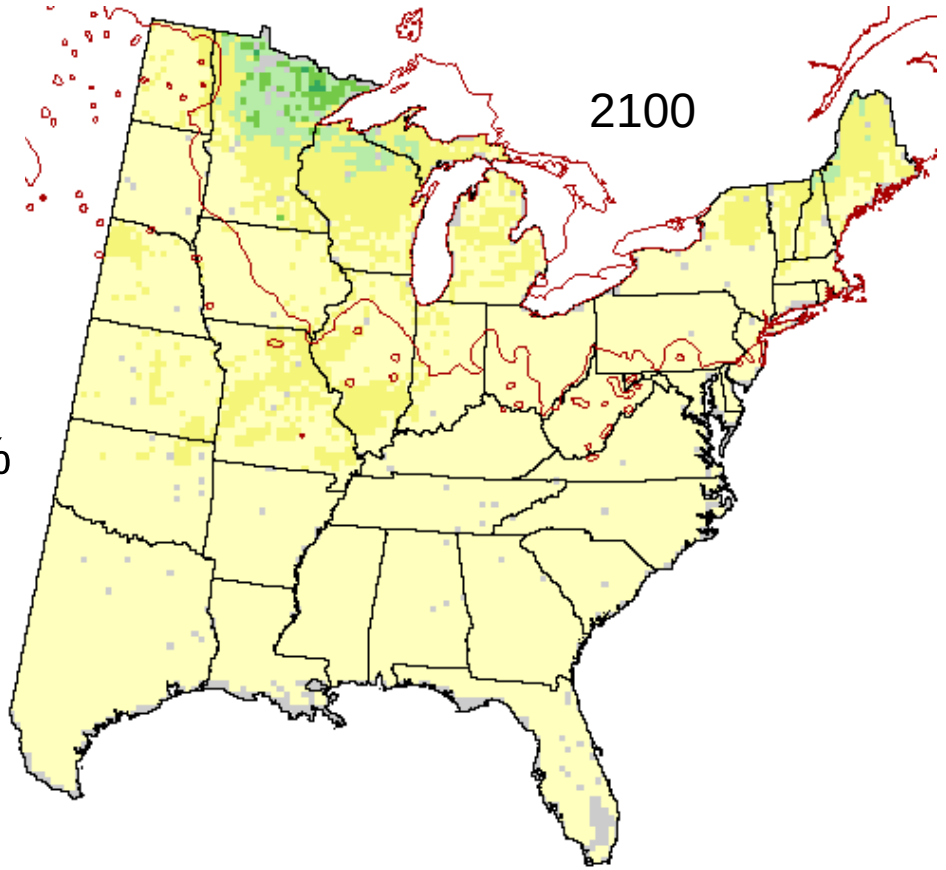
Photo: Eli Anoszko

Global warming and aspen: vast acreages of boreal conifer will die, and initially be invaded by aspen

Browning of post-fire regeneration, BWCAW, June 2012
Photo: Eli Anoszko

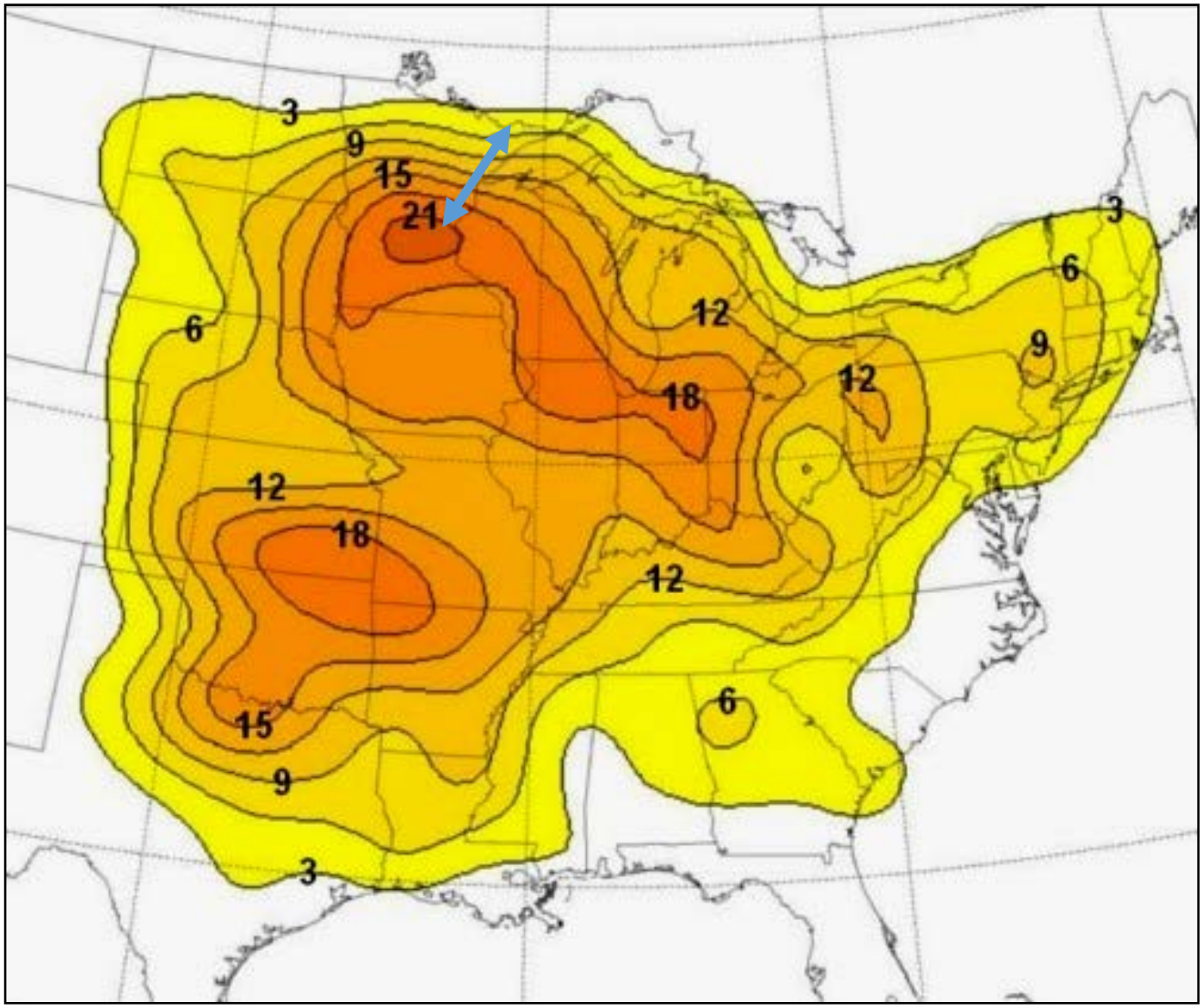
Winter browning of spruce in Ontario, May 2012. Ontario Ministry of Natural Resources





Aspen changes from >30% to 4-10% abundance by end of century.
USDA Forest Service,
Climate and tree atlas
https://www.fs.fed.us/nrs/atlas/tree/746

Number of derechos observed in 22 years,
note gradient along blue arrow



From: R.H. Johns and J.S. Evans: www.spc.noaa.gov/misc/AbtDerechos

Wind plus fire = major forest transformation to aspen or red maple and oak

Nick Fisichelli and Roy Rich, Cavity Lake Burn, Seagull Lake, July 2007.
Photo: Dave Hansen, University of MN

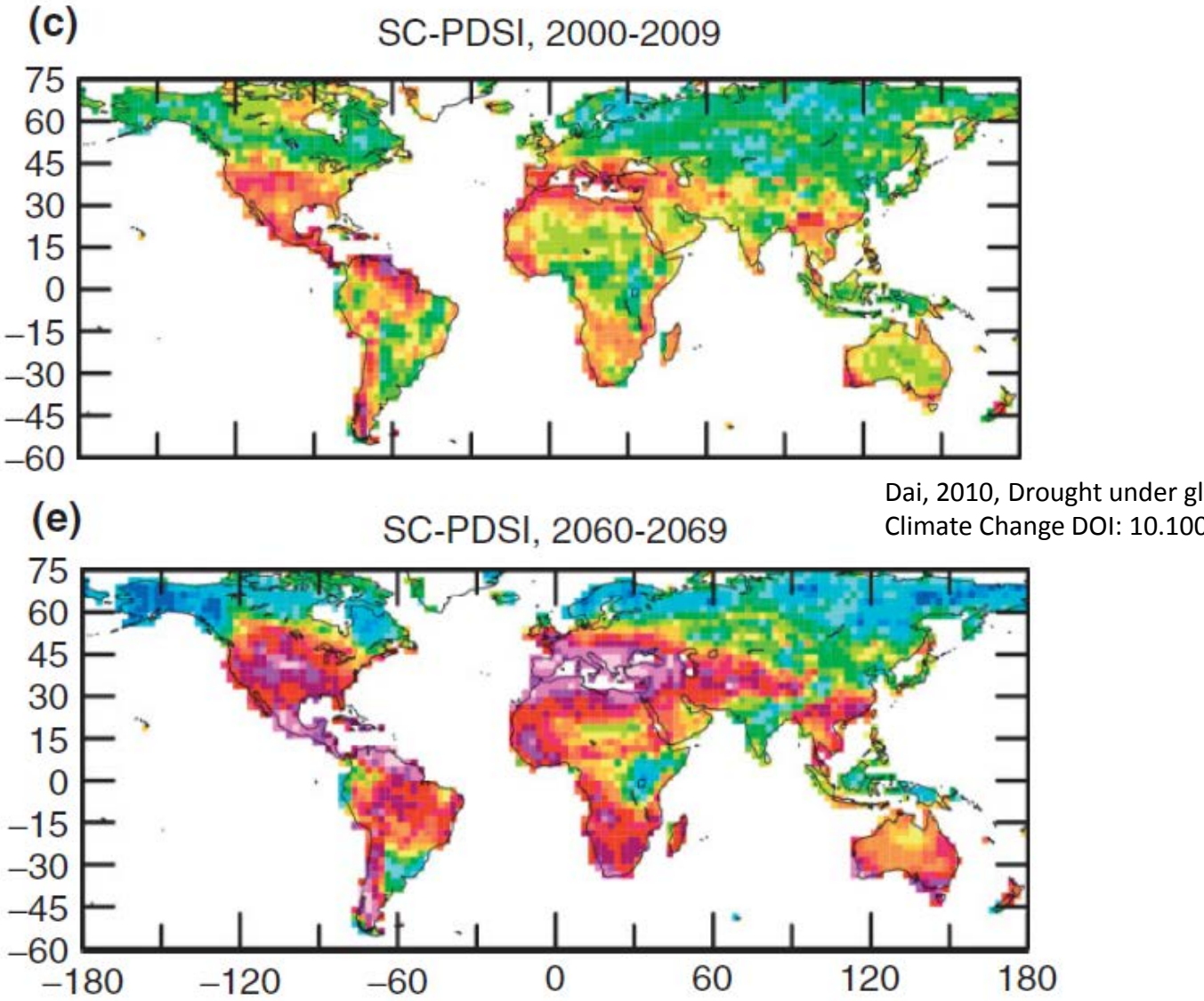

5 years post wind + fire
Photo: Eli Anoszko

Several hundred red maple per acre followed by wind = instant transition from boreal to temperate forest and a new less flammable fuel model.

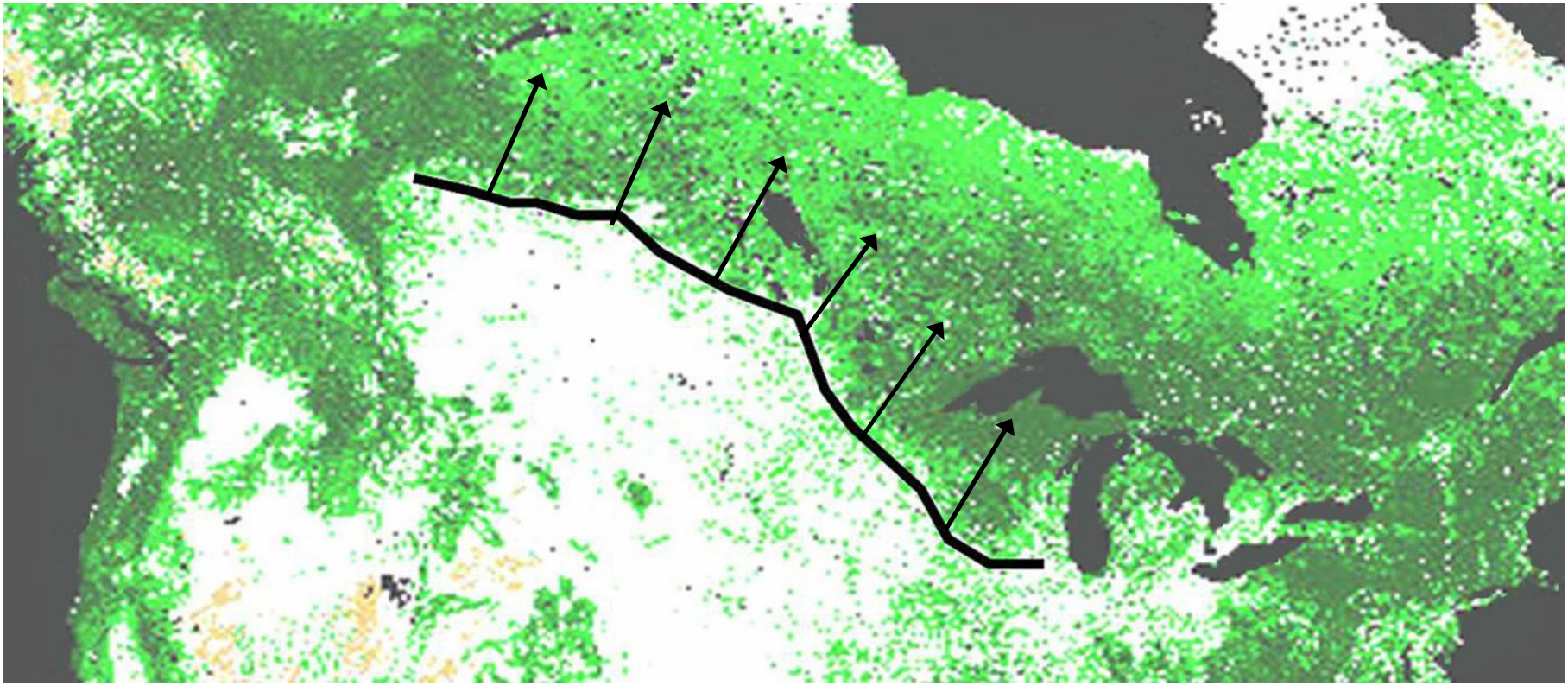
Red maple densities range from 62 to 384 per acre from east to west in the BWCAW

Photo: Dave Hansen

Comparing the 2060s with current

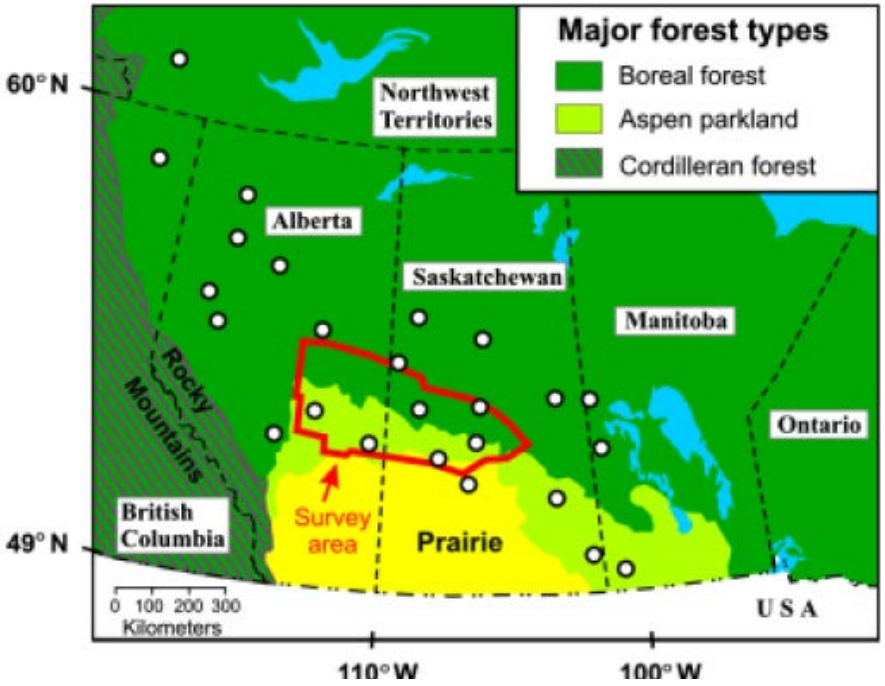


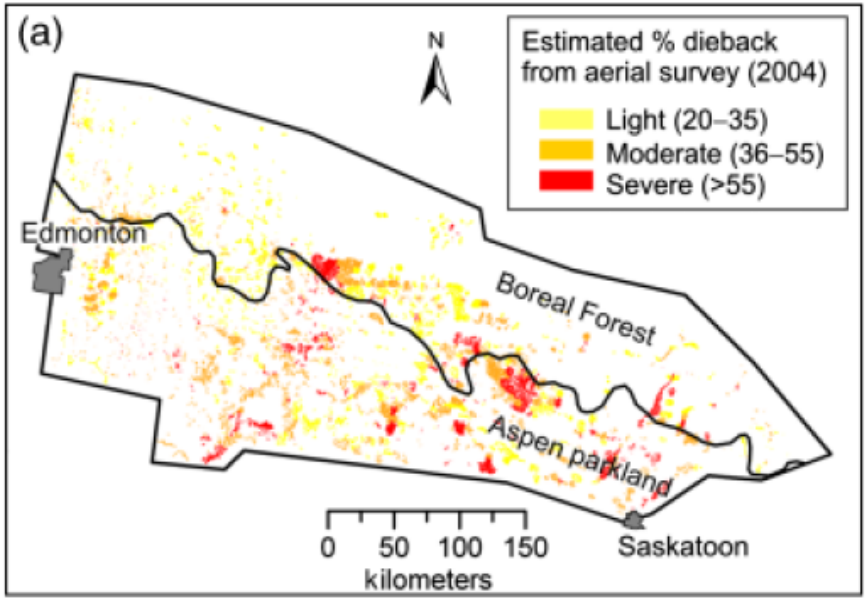
Dai, 2010, Drought under global warming, Climate Change DOI: 10.1002/wcc.81



Forest cover of central North America (green). Prairie-forest border (black line), and arrows showing the border moving 300 miles to the northeast by 2100 for a business as usual climate change scenario.
Modified from Frelich and Reich 2010, *Frontiers in Ecology and the Environment*

The Boundary waters boreal forest will be at the prairie-forest border!





Global Change Biology

Global Change Biology (2011) 17, 2084–2094, doi: 10.1111/j.1365-2486.2010.02357.x

Massive mortality of aspen following severe drought along the southern edge of the Canadian boreal forest

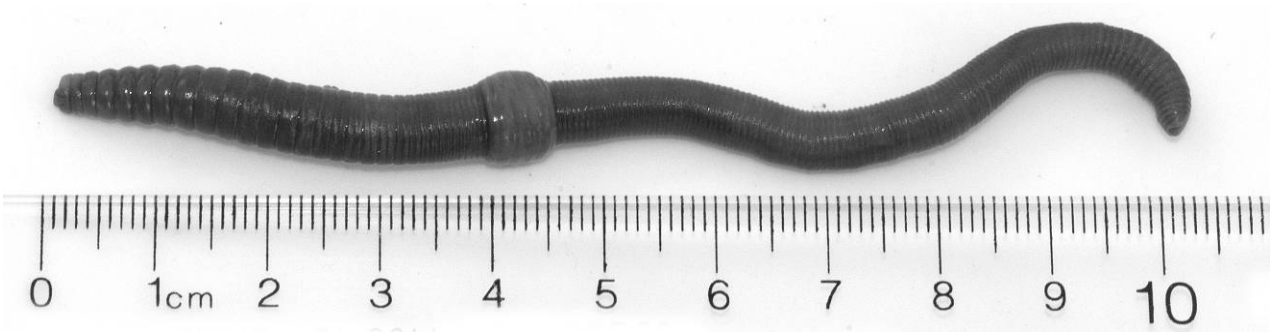
MICHAEL MICHAELIAN, EDWARD H. HOGG, RONALD J. HALL and ERIC ARSENAULT

Natural Resources Canada, Canadian Forest Service, 5320-122 Street, Edmonton, AB, Canada T6H 3S5

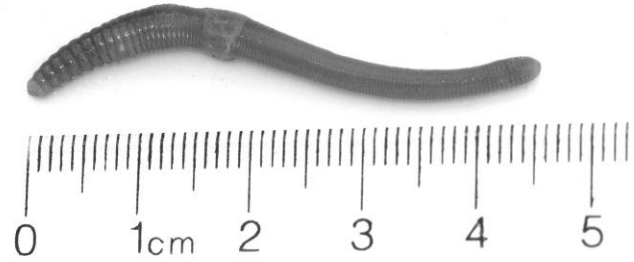
Lake and rocky island scenery, Gneiss Outcrops Natural Area
(photo Dave Hansen, UMN)

Earthworm functional groups

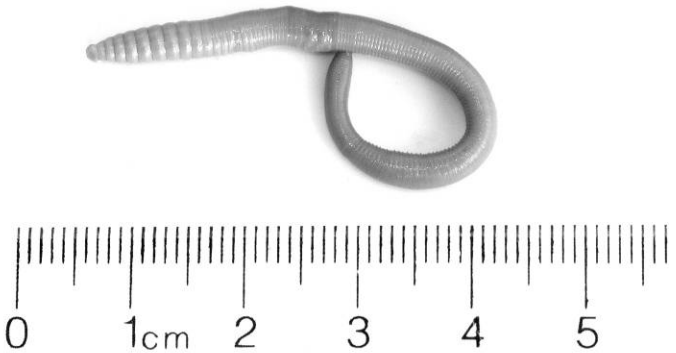
Epigeic: *Dendrobaena octaedra*



Anecic: *Lumbricus terrestris* (nightcrawler)



Epi-endogeic: *Lumbricus rubellus*



Endogeic: *Aporrectodea caliginosa*

Direct effects of earthworm invasion

- Removal of organic horizon
- Compaction of mineral soil
- Disturbance of soil

Indirect effects

- Alteration of seedbed conditions
- More runoff, drier soils
- Lower nutrient availability

Cascading effects on plant community

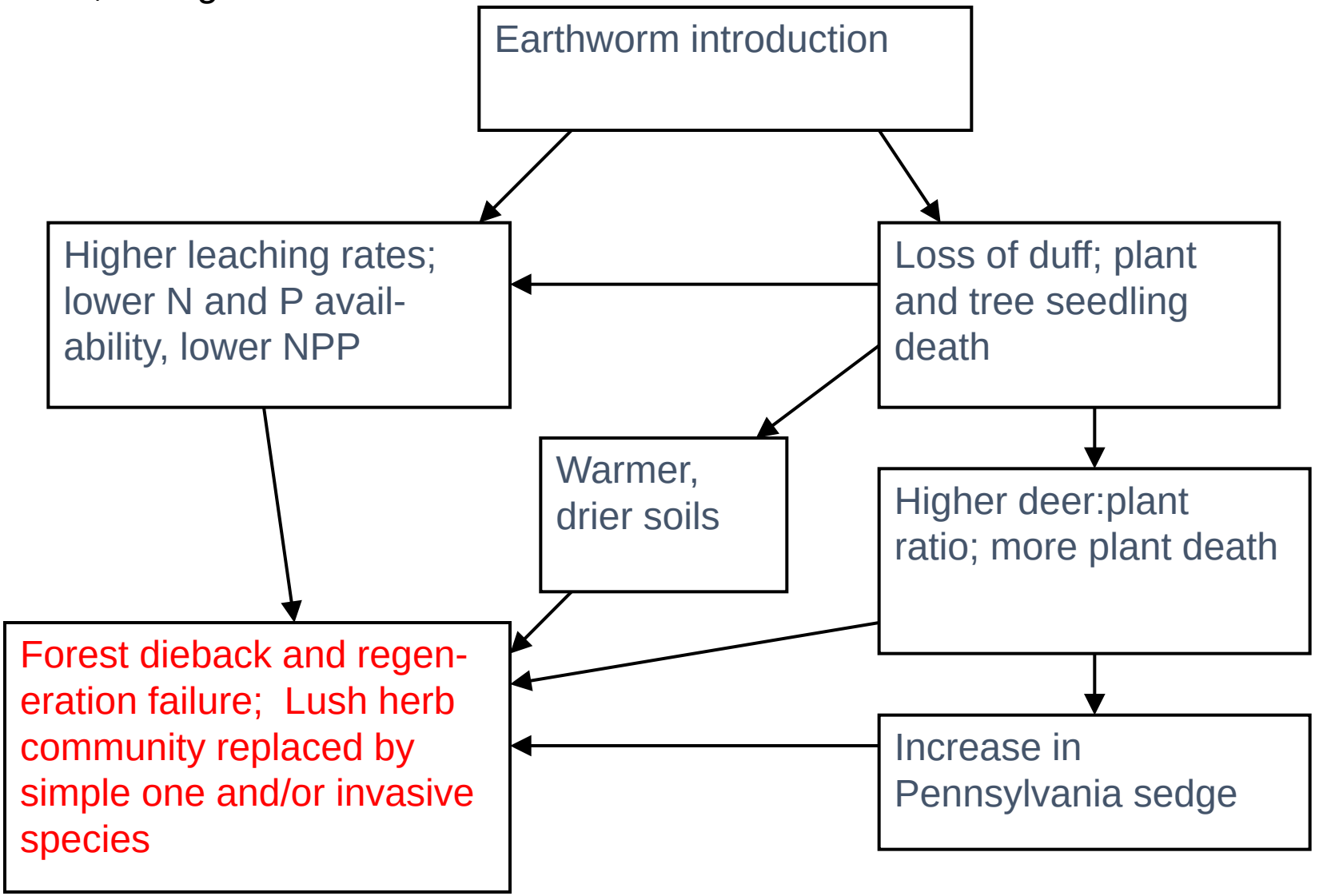
- Drought stress
- Changing growth rates and alteration of competitive relationships
- Mortality of plant populations
- Lower native plant species richness

Continued cascading effects

- Water quality
- Wildlife and insect habitat
- Facilitation of invasive plant species
- Plant animal interactions

Forest Decline Syndrome caused by earthworm invasion

After Frelich, Hale, Scheu, Holdsworth, Heneghan, Bohlen and Reich, 2006, *Biological Invasions*



Are invasive species poised to take over? European buckthorn in northern MN

Photos: Paul Ojanen

Summary

How does aspen fit into the landscape mosaic created by disturbance?

- Northern hardwoods, after wind+fire
- Mixed pine forests, after crown fire
- Boreal jack pine, spruce, fir, after two firs in a short time or wind+fire

What determines dominance by aspen versus paper birch after fire?

- Spring fires have more aspen due to root sprouting and less heat penetrating the soil
- Late-season fires have more birch due to seed bed and season of seed production

Future of aspen and fire with a warmer climate

- Transient dynamics, more aspen initially, then invasion by red maple
- Large impacts of wind and drought, transition to savanna

Invasive species (Earthworms, buckthorn)

- Earthworm invasion negatively impact aspen growth
- No duff to support fire
- Susceptible to buckthorn and other invasive species

Questions?

Bruce Dayton

2016-2017 Webinar Series

February 16, 2017

Common Denominators for Escaped Prescribed Fires in the Lake States :

Overview of Escaped Prescribed Fires in the Eastern Region of the U.S. Forest Service and Methods for Situational Learning.

Steven Goldman

Assistant Director, Fuels Program, Eastern Regional Office,

USDA Forest Service