Integrating Disturbance Ecology Patterns into Forest Management in Northern Michigan

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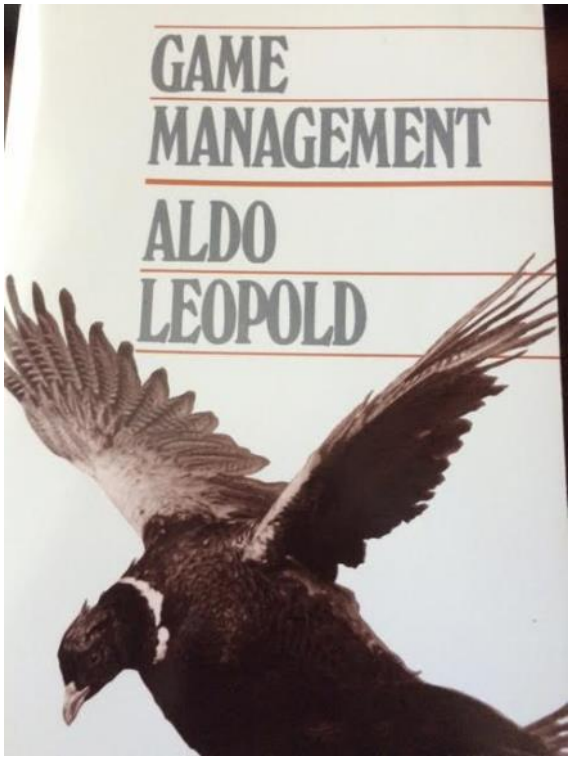
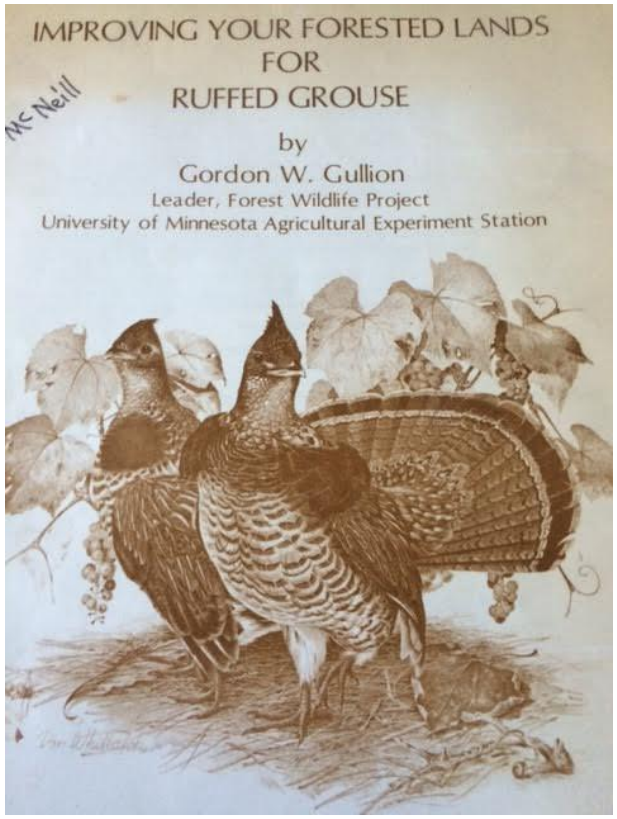
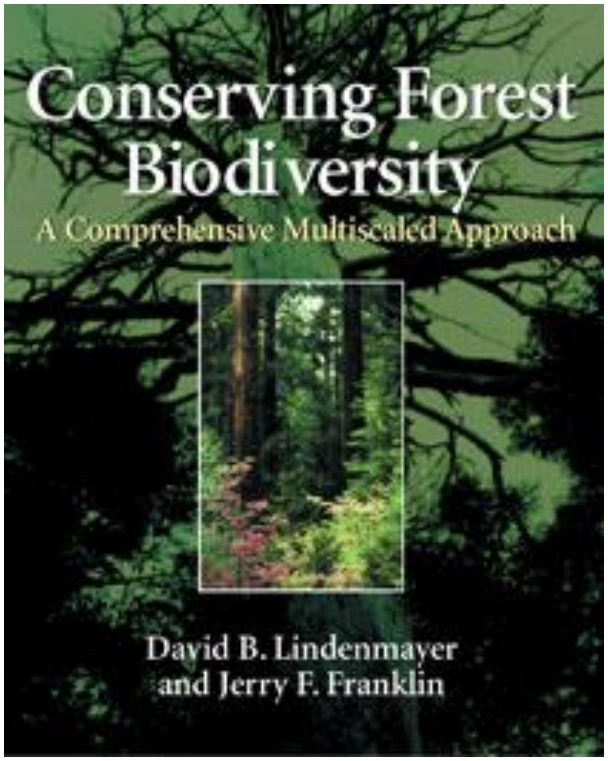
https://www.fws.gov/refuge/Seney/what_we_do/research.html

Change: The One *Truism* in the Natural World (and Science)



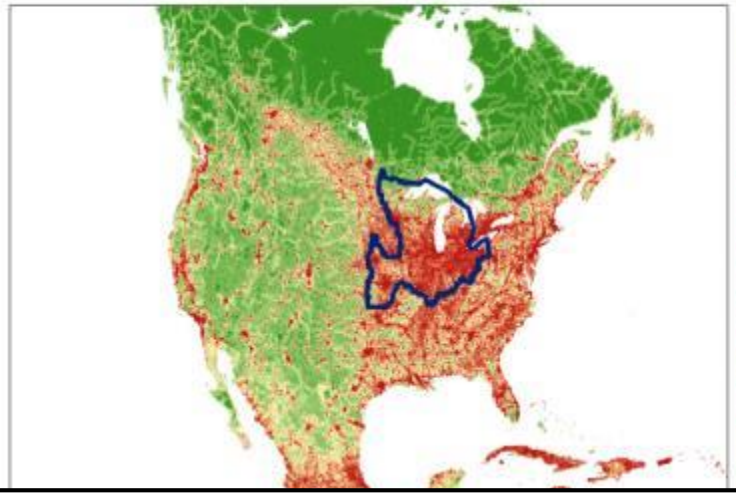


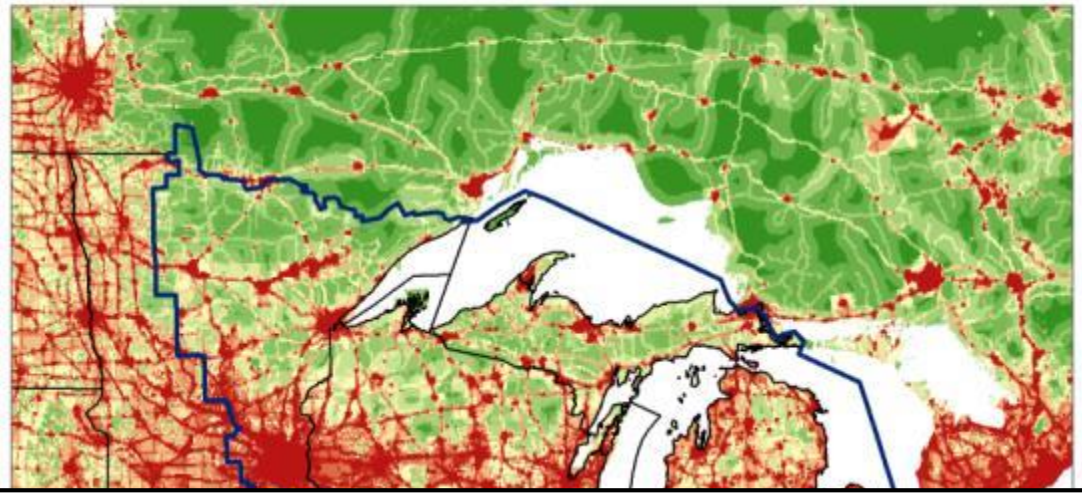


1933 vs Present

- **World population: ~1.7 billion vs ~7.5 billion;**
- **U.S. population: ~125 million vs ~322 million;**
- **Biodiversity was not even coined until ~1985, conservation and ecology were relatively new in 1933.**

The Human Influence Index





Simplification of complex ecosystem patterns and processes is the main driver of observed decline in biodiversity (Pimm 2006).

Most influenced (64)

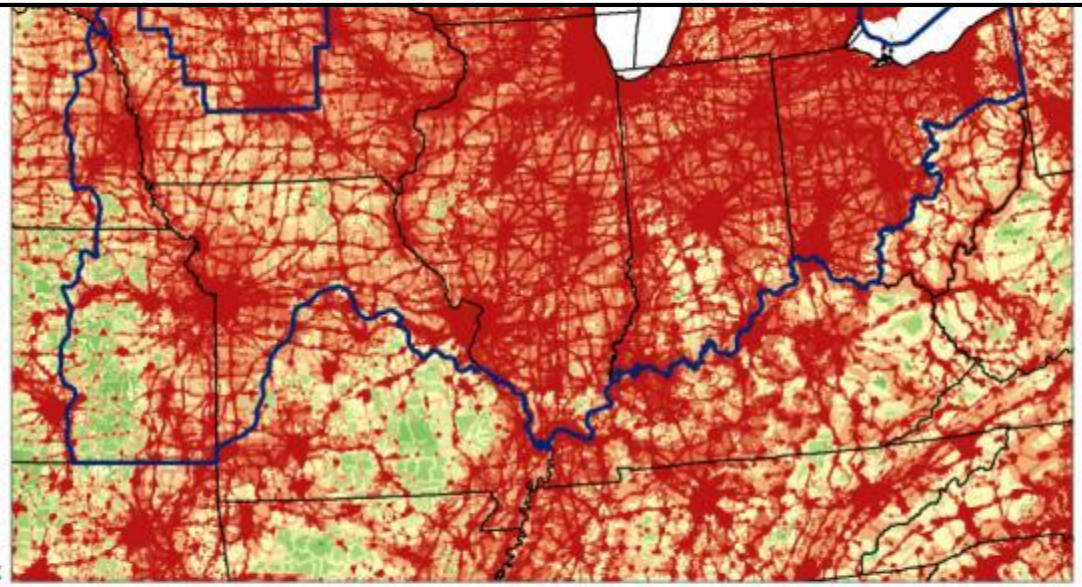
Least influenced (0)

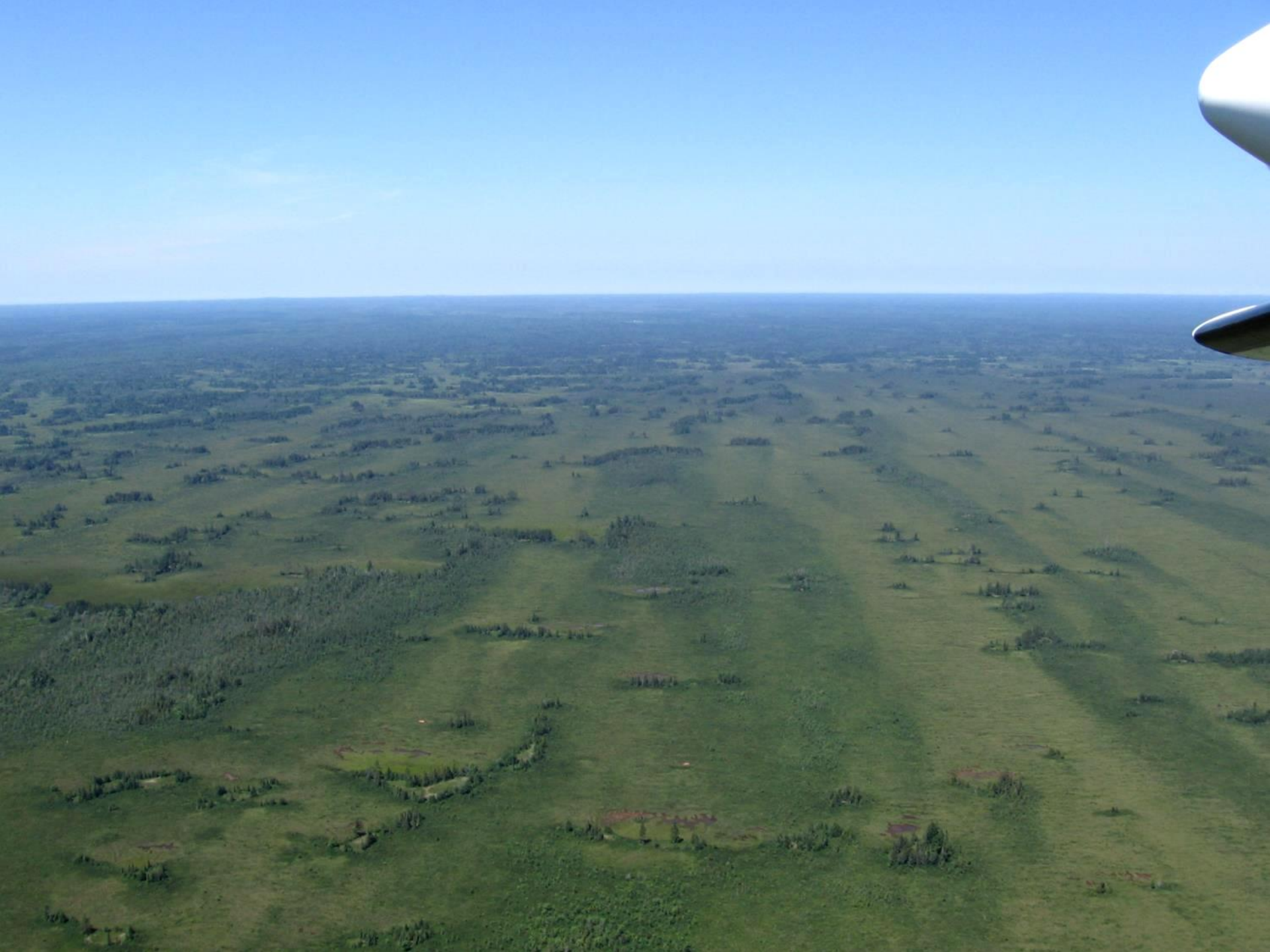
States

Joint Venture

The Human Influence Index is a measure of direct human influence on terrestrial ecosystems using the best available data sets on human settlement (population density, built-up areas), access (roads, railroads, navigable rivers, coastline), landscape transformation (land use/land cover) and electric power infrastructure (nightime lights). Values range from 0 to 64. Zero value represents no human influence and 64 represents maximum human influence possible using all 8 measures of human presence.

Source: Center for International Earth Science Information Network













Corace et al. 2009. *Forestry Chronicle* 85:695-701.
Corace and Goebel. 2010. *The Wildlife Pro.* 4:38-40.

National Wildlife Refuge System 2001 Biological Integrity Policy

….favoring *"management that restores or mimics natural ecosystem processes or function to achieve refuge purposes*."

…..*"the highest measure of biological integrity, diversity, and environmental health (as)...those intact and self-sustaining habitats and wildlife populations that existed during historic conditions*."

Contemporary Terrestrial Ecosystem Management: Tenets of Ecological Forestry

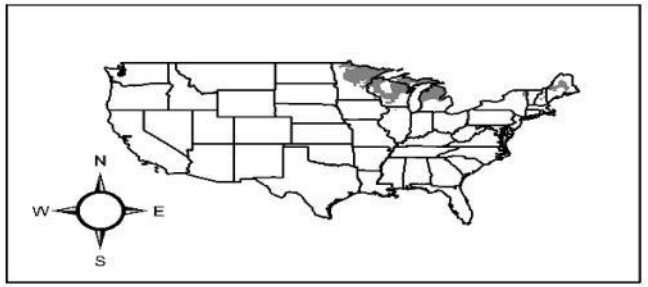
"*Biology without its ecological context is dead*." (Rowe 1989)

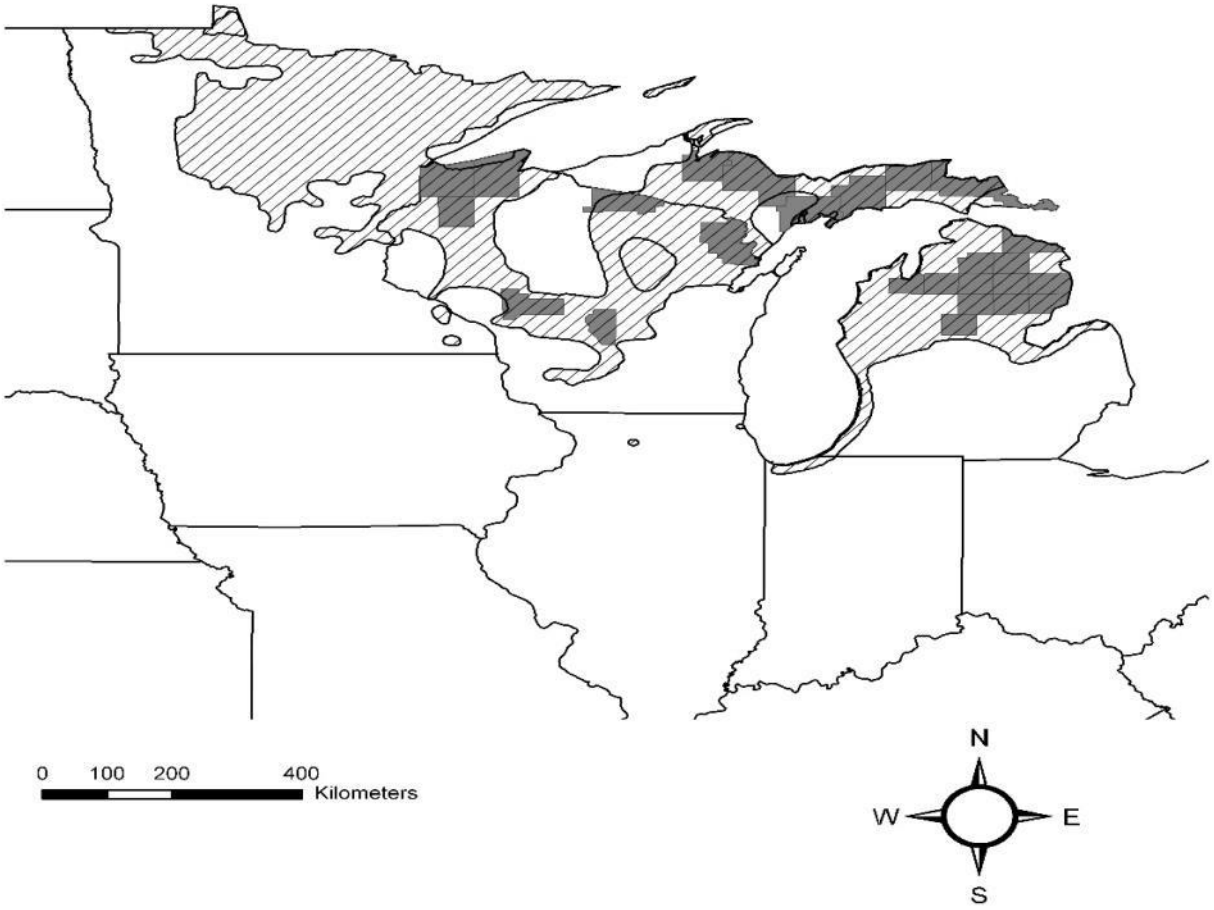
- **Within the context of biodiversity maintenance, more (not less!) forest management is needed, but within an ecological framework;**
- **Management can not ignore geology, biogeography, and evolutionary patterns and processes (constraints);**
- **Emulation of natural disturbance regimes (e.g., fire, windthrow, etc.);**
- **Recovery periods between disturbances;**
- **Emulation of natural stand development processes;**
- **Consideration of biological legacies (snags, CWD, etc.);**
- **Implemented within the context of matrix management (e.g., landscape scales).**

Seymour and Hunter. 1999. In *Managing biodiversity in forest ecosystems*.
Franklin et al. 2007. USDA For. Serv. Gen. Tech. Rep. NRS-GTR-19.

US Distribution of Jack Pine (*Pinus banksiana*)

World Breeding Distribution of Kirtland's Warbler (*Setophaga kirtlandii*)





~98% of <u>all</u> breeding Kirtland's Warbler found in xeric, outwash plains of nLP of Michigan

Kirtland's Warbler (KIWA) Annual Census Results: 1971-2008

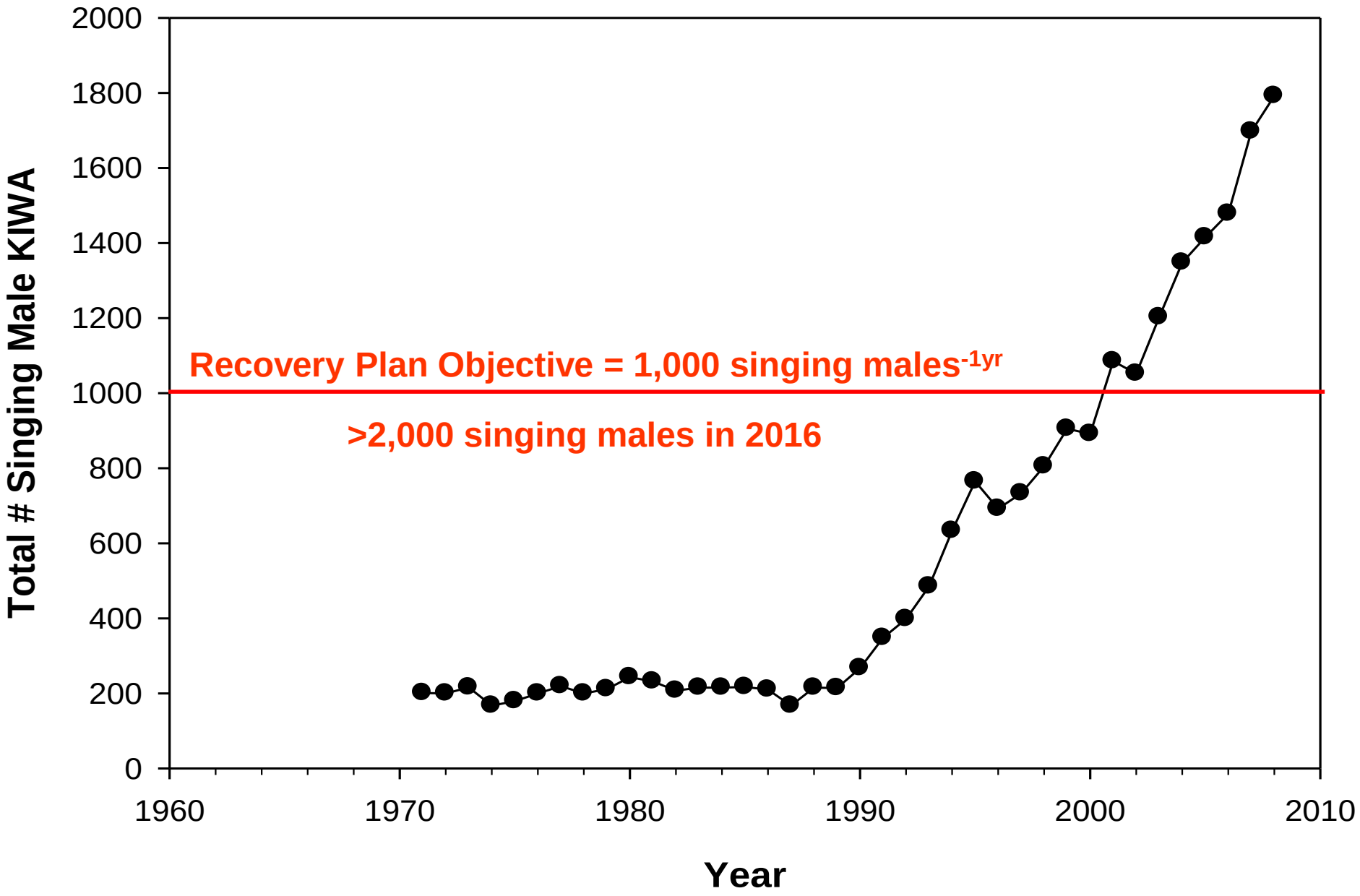
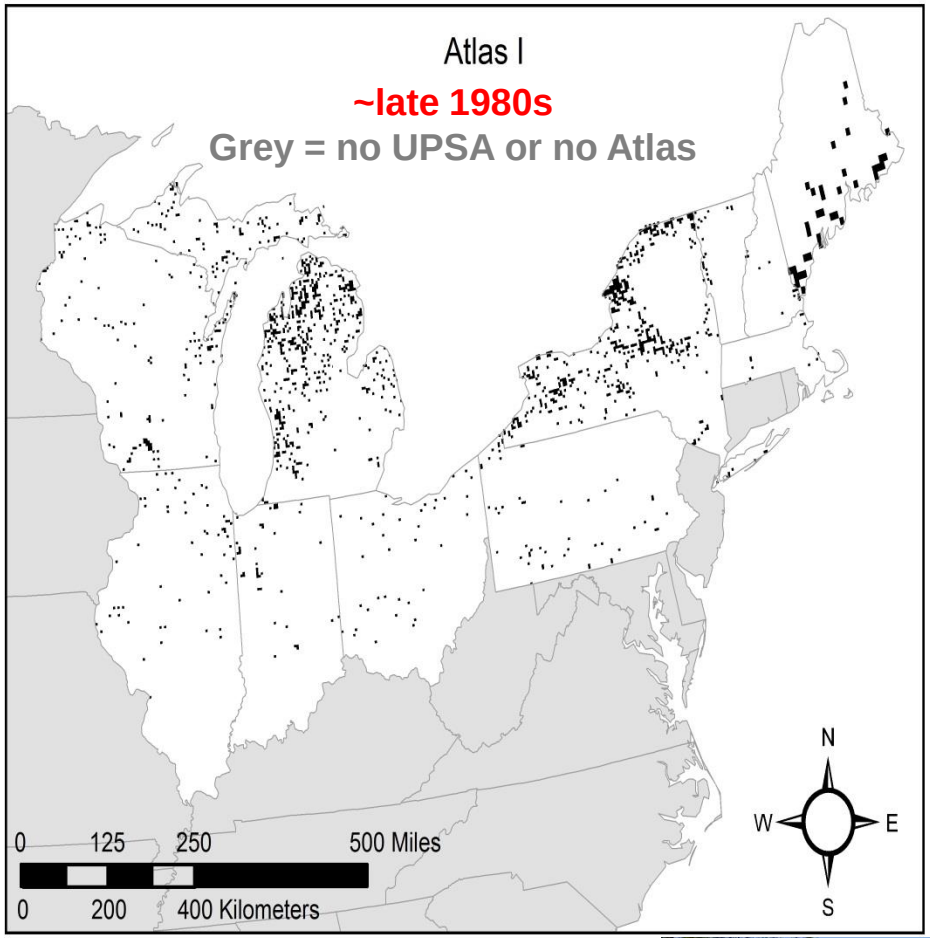


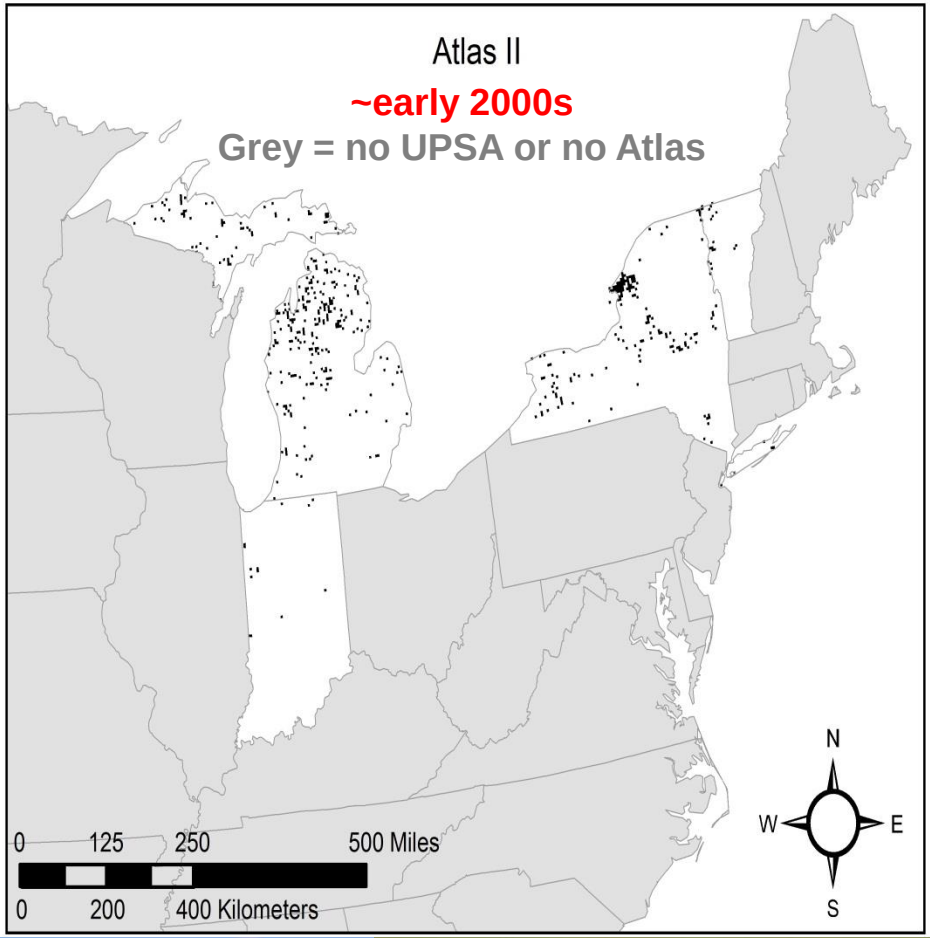
Table 1. Indicator species for young (< 5 years), KW (5-23 years), and old (> 23 years) jack pine stands at KWWMA.

YOUNG	KW	OLD
Indigo Bunting*** (*Passerina cyanea*)	Kirtland's Warbler*** (*Dendroica kirtlandii)*	Eastern Wood-Pewee*** (*Sayornis phoebe)*
Eastern Bluebird*** *(Sialia sialis)*	Nashville Warbler*** (*Vermivora ruficapilla)*	Hermit Thrush*** (*Catharus guttatus)*
Field Sparrow*** *(Spizella pusilla)*	Eastern Towhee*** (*Pipilo erythrophthalmus*)	Ovenbird*** (*Seiurus aurocapilla)*
Lincoln's Sparrow*** *(Melospiza lincolnii*)	Brown Thrasher** (*Toxostoma rufum)*	Rose-breasted Grosbeak*** (*Pheucticus ludovicianus)*
Black-billed Cuckoo* *(Coccyzus erythropthalmus)*	Alder Flycatcher** (*Empidonax alnorum)*	Red-breasted Nuthatch*** (*Sitta vireo)*
		Red-eyed Vireo*** (*Vireo olivaceus)*
		Black-capped Chickadee** (*Poecile atricapillus)*
		Chipping Sparrow** (*Spizella passerina)*

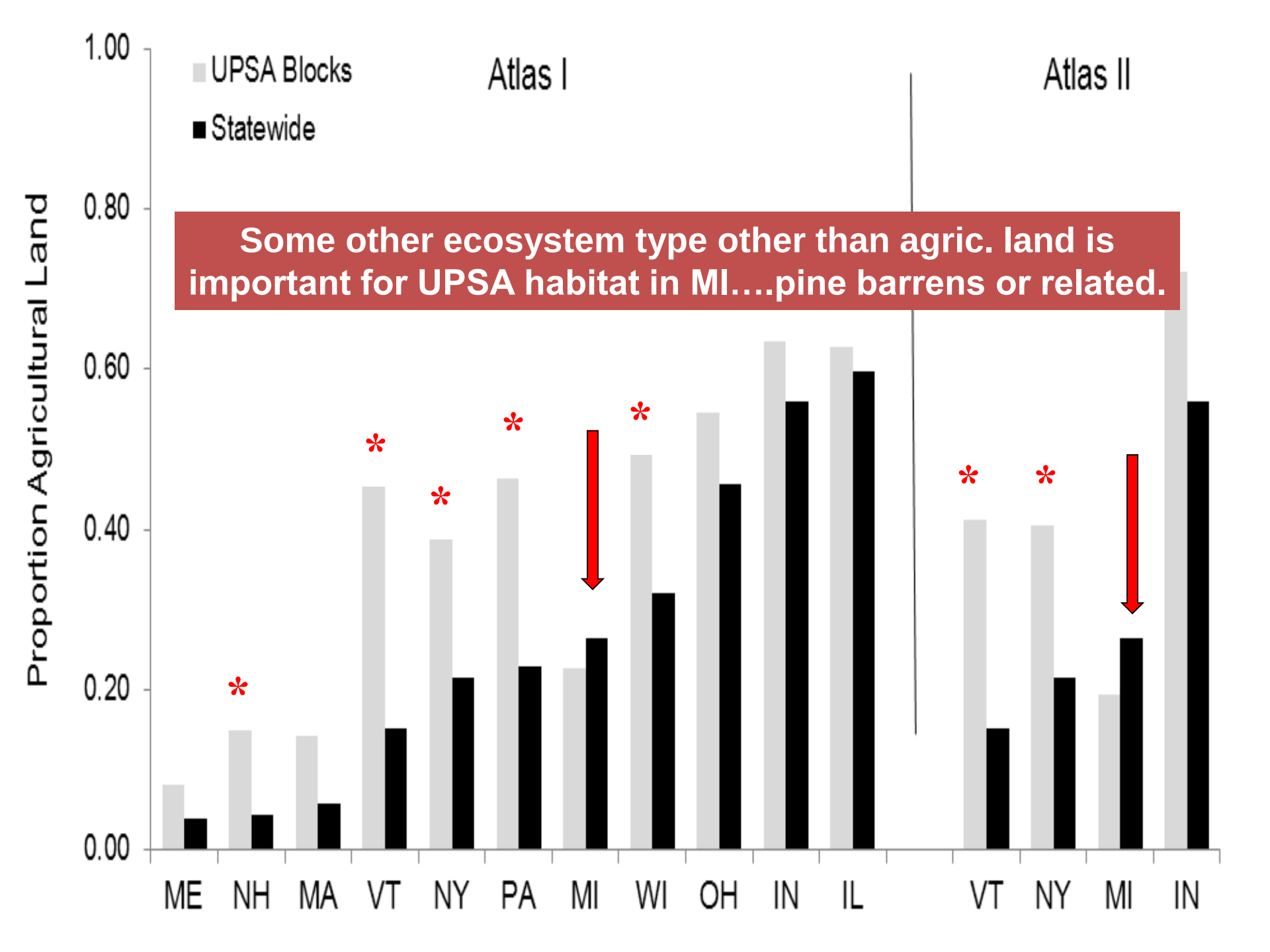
* $P \leq 0.05$; ** $P \leq 0.01$; *** $P < 0.001$.

Corace et al. 2010. *Nat. Areas J.* 30:174-190.

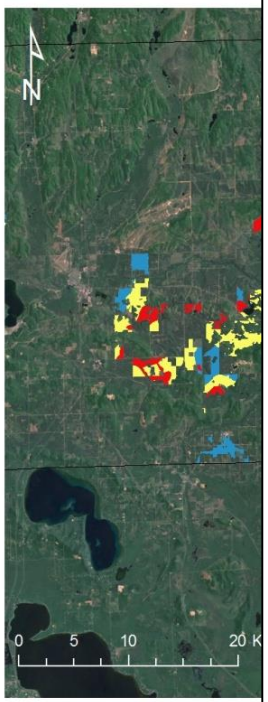


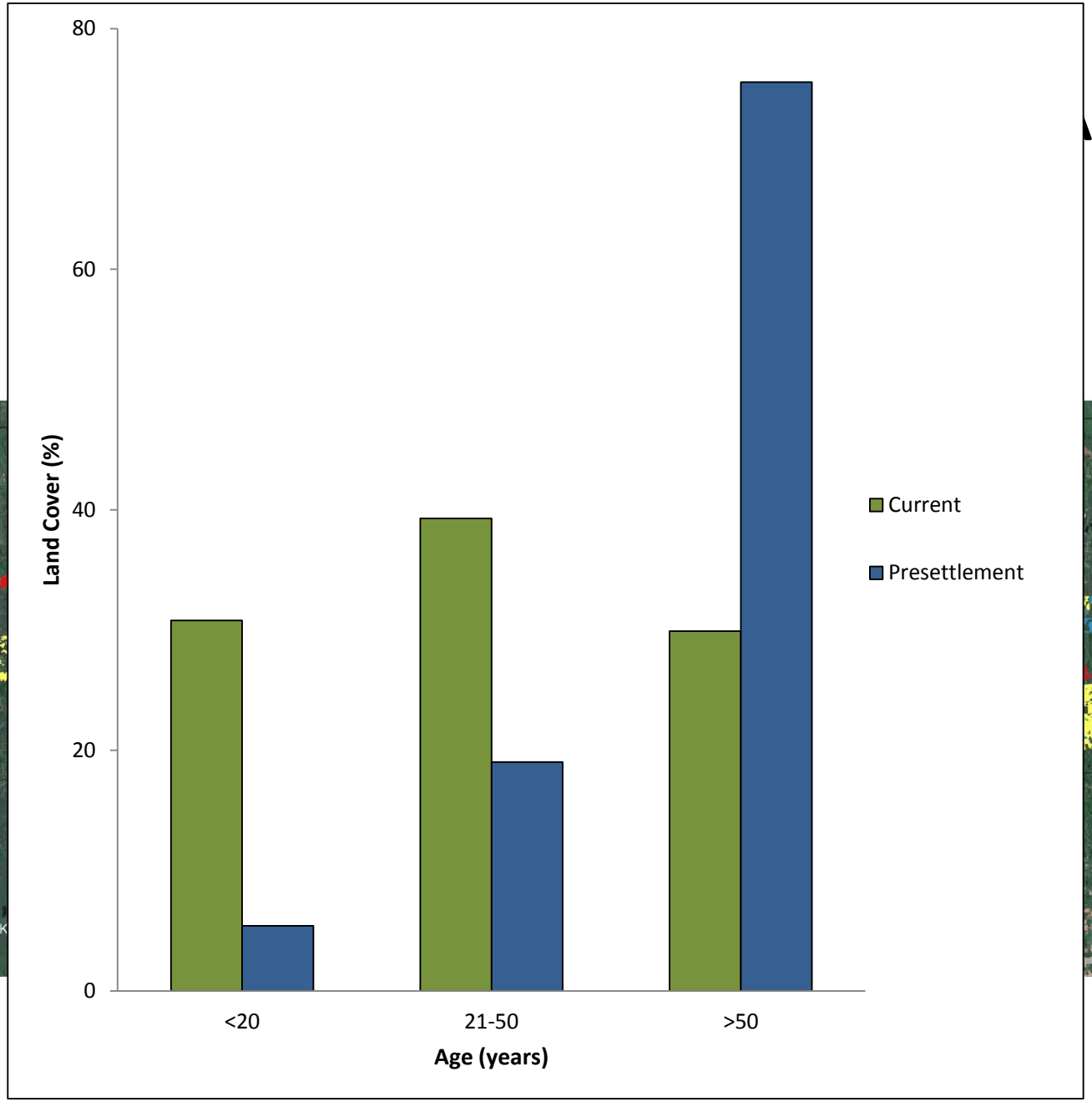


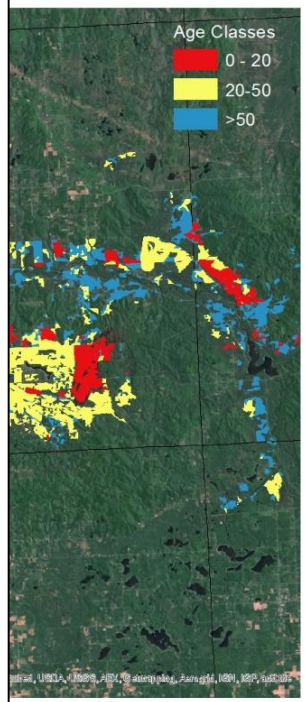
Corace et al. 2016. *Res. Ec.* 34:49-60.


1.00
0.80
0.60
0.40
0.20
0.00
Proportion Agricultural Land
UPSA Blocks
Statewide
Atlas I
Atlas II
Some other ecosystem type other than agric. land is important for UPSA habitat in MI….pine barrens or related.
ME
NH
MA
VT
NY
PA
MI
WI
OH
IN
IL
VT
NY
MI
IN

Age reas



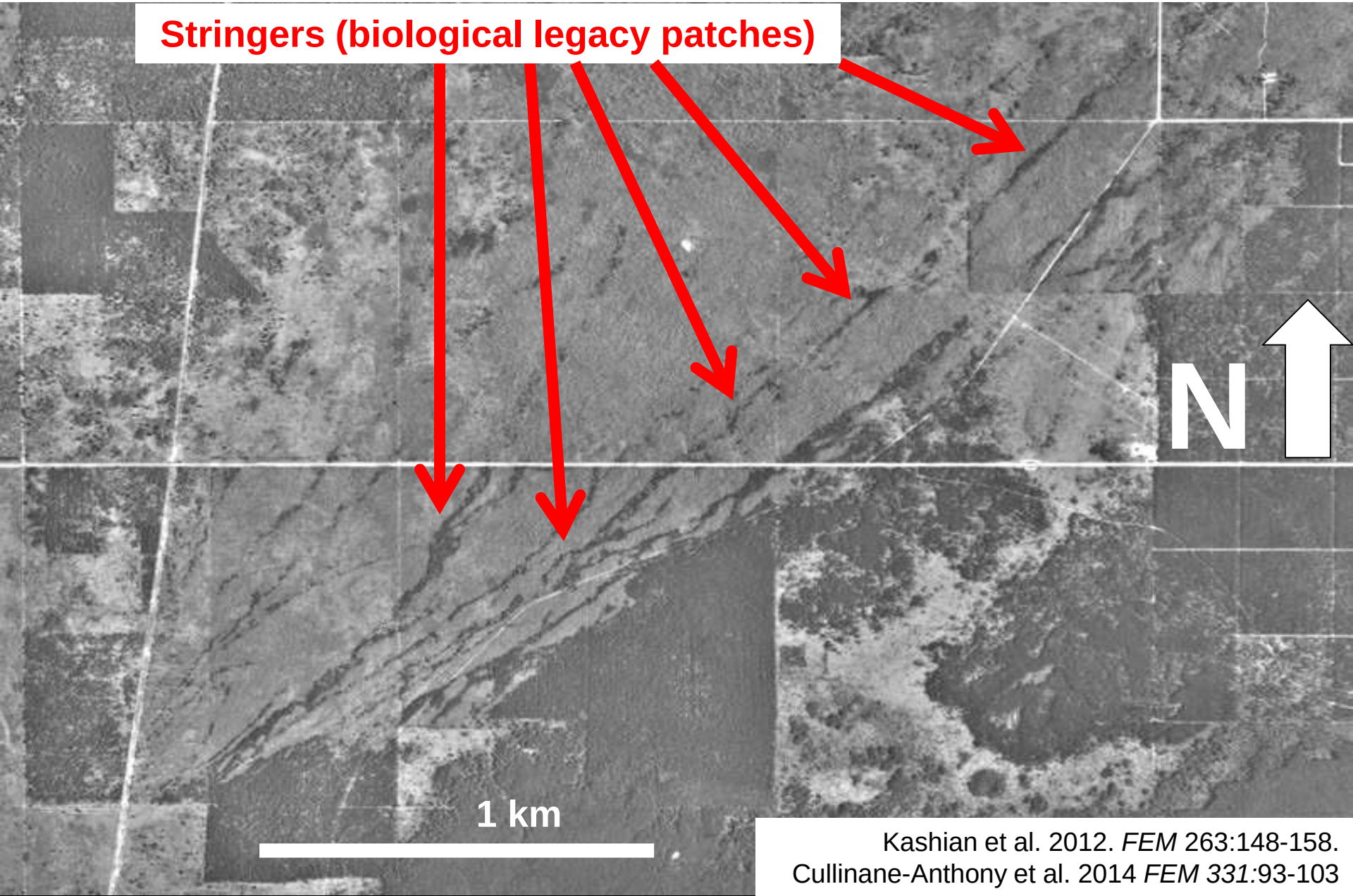




Tucker et al. *In Press*. *Landscape Ec.*

It All Doesn’t Burn: Biological Legacy Patches!

Quantify Wildfire-Induced Structural Patterns Using Chronosequence of Aerial Imagery



Kashian et al. 2012. *FEM* 263:148-158.
Cullinane-Anthony et al. 2014 *FEM 331:*93-103

Overview of Findings: Disturbance History and Jack Pine Plantation Management for Kirtland's Warbler (KW)

- **Plantations management has resulted in an increase in KW beyond recovery objectives, with the likelihood of downlisting on the horizon;**

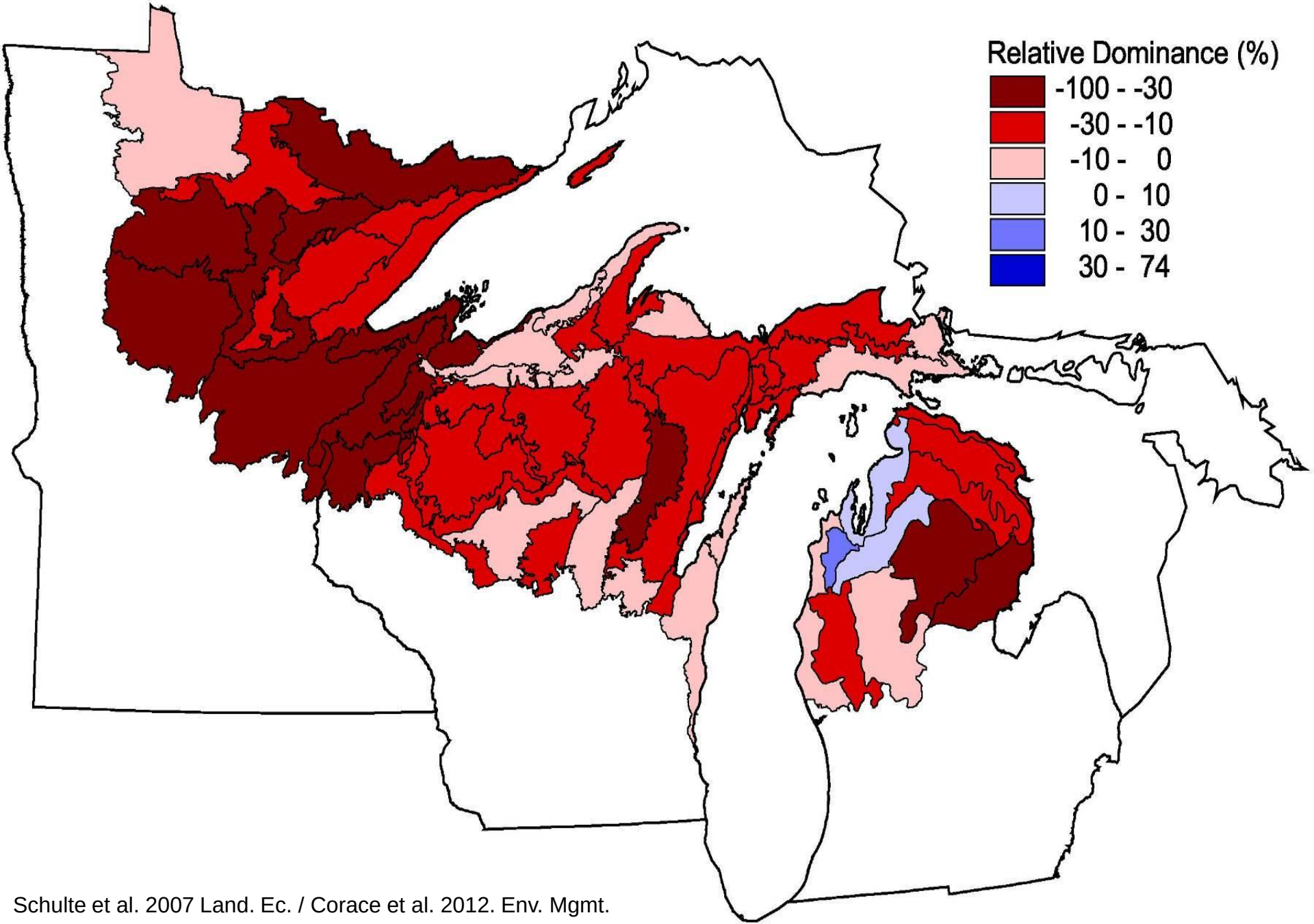
- **Plantation management has shifted jack pine age classes significantly, with a much reduced natural range of variation across the nLP landscape;**

- **Less area in barrens likley have direct implications for conservation of species such as Upland Sandpiper;**

- **Plantation managment has generally produced conditions with fewer biological legacies relative to fire;**

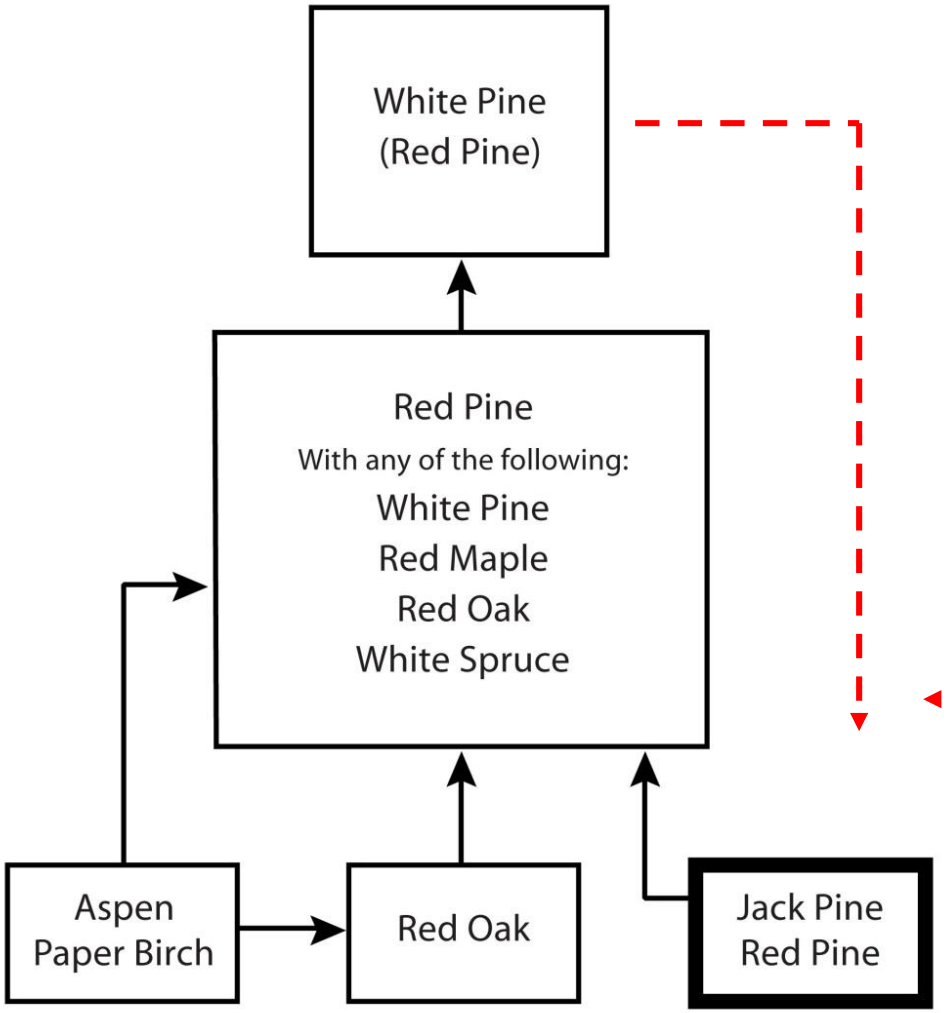
- **Bird communities respond to plantation management with distinct assemblages and biological legacies provide for stand-level biodiversity.**

Change in Mixed-Pine Dominated Forests (~1850 – 2000)



Schulte et al. 2007 Land. Ec. / Corace et al. 2012. Env. Mgmt.

Ecological Considerations for Forest Restoration Based on Soils, Disturbances, and Resulting Composition and Structure

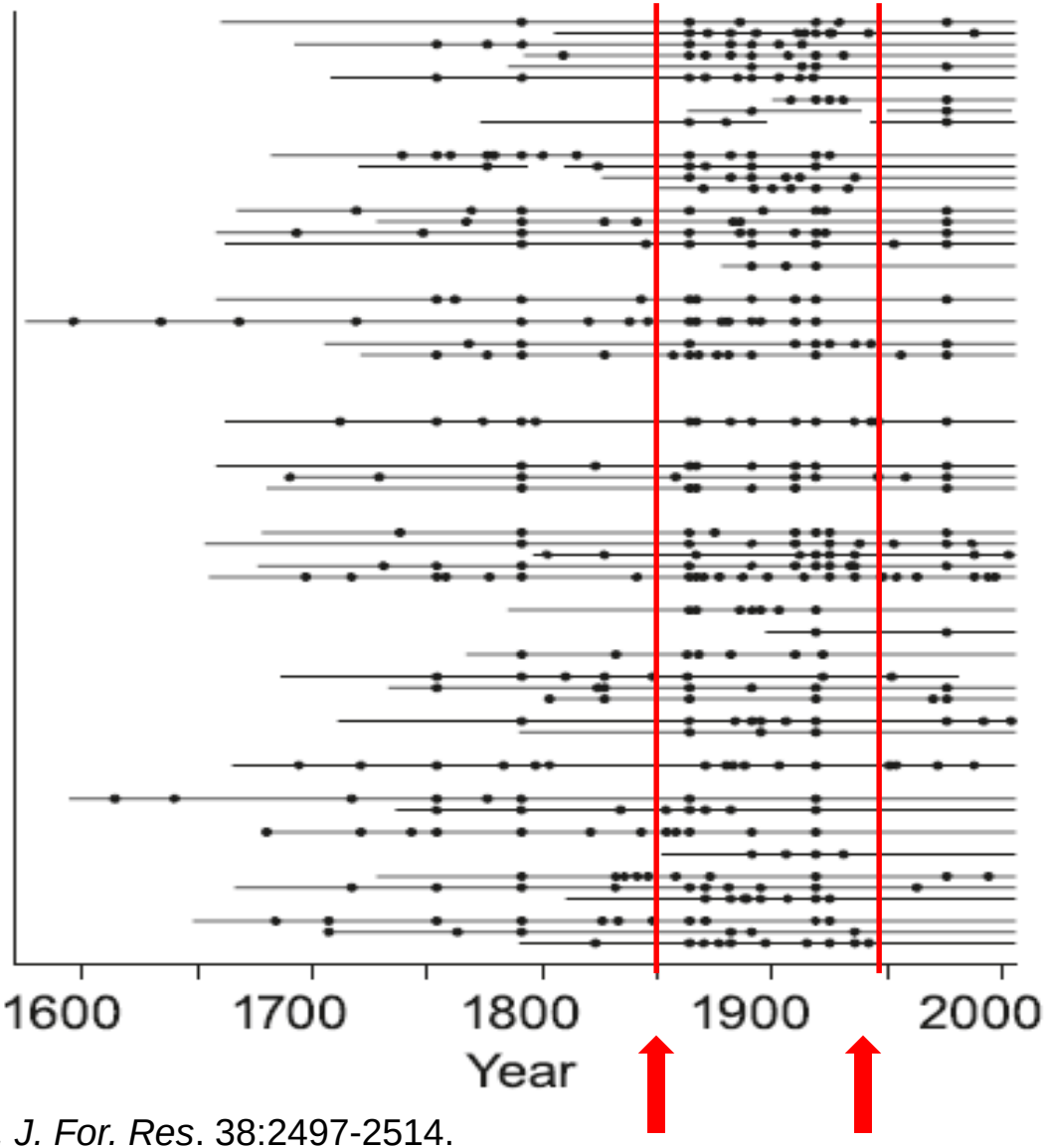


***Pinus strobus/Vaccinium angustifolium-Epigaea repens* (PVE) Habitat Type[1]**

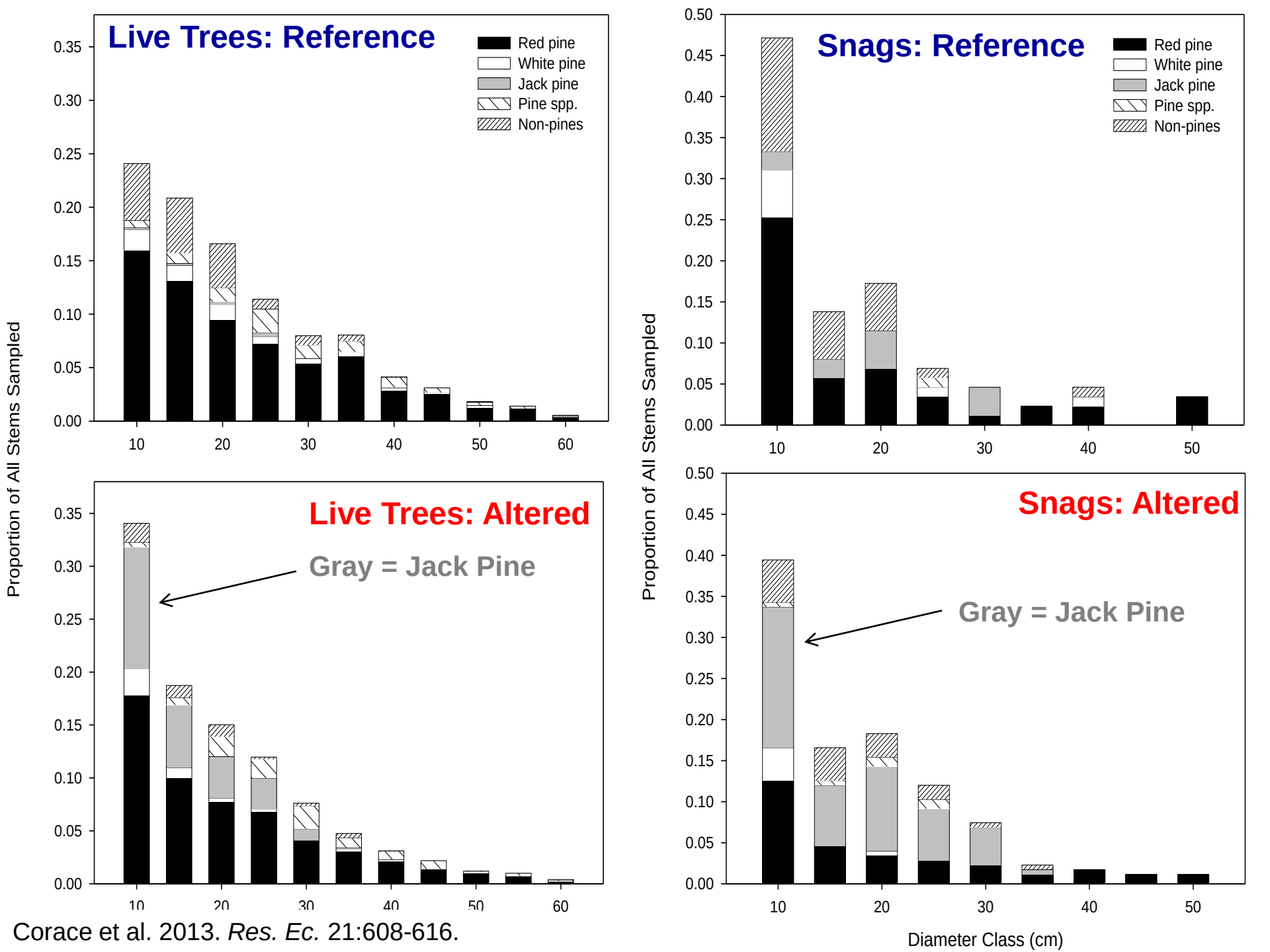
Major and/or frequent ecological disturbances (e.g., crown fire) push stands to earlier seral stages, minor and/or infrequent disturbances (e.g., surface fire) to later seral stages.

[1]**Burger and Kotar. 2003. Forest community and habitat types of Michigan.**

Fig. 2. Time span of each of the 49 fire history sites within SNWR. Each chronology is based on a mean of five samples. Fires are recorded as "points" and blank spaces indicate a hiatus in a chronology (i.e., stand was not recording during that period).



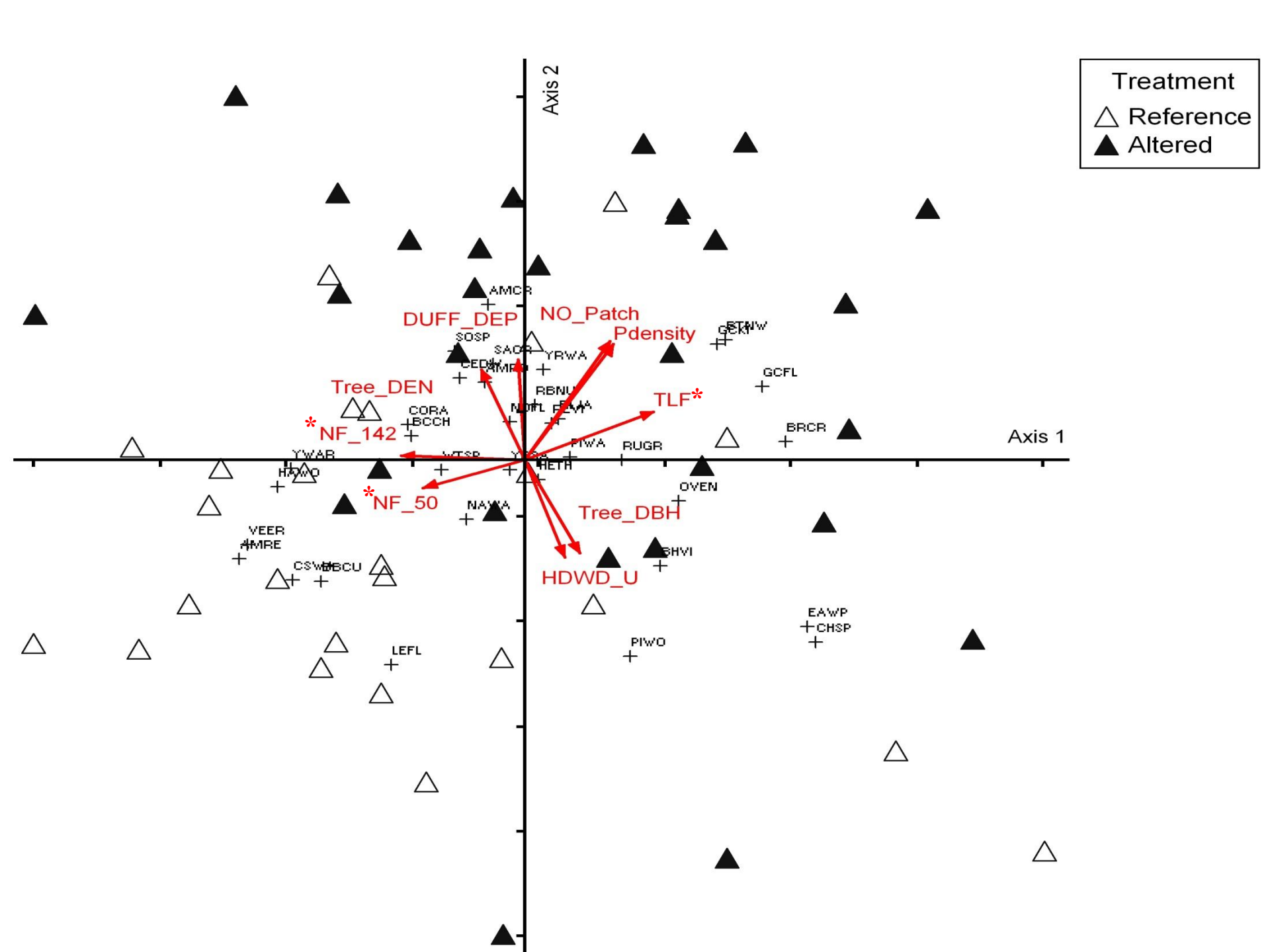
Drobyshev et al. 2008. *Can. J. For. Res*. 38:2497-2514.



Corace et al. 2013. *Res. Ec.* 21:608-616.

Reference (PIF Score)	*p*-value	Altered (PIF Score)	*p*-value
Hairy Woodpecker (11)	0.07	American Robin (9)	0.03
Yellow Warbler (11)	0.01	Pileated Woodpecker (11)	0.06
American Redstart (12)	0.00	Song Sparrow (12)	0.07
White-throated Sparrow (12)	0.02	Ruffed Grouse (14)	0.06
Least Flycatcher (13)	0.02		
Nashville Warbler (13)	0.04		
Chestnut-sided Warbler (14)	0.00		
Veery (16)	0.02		

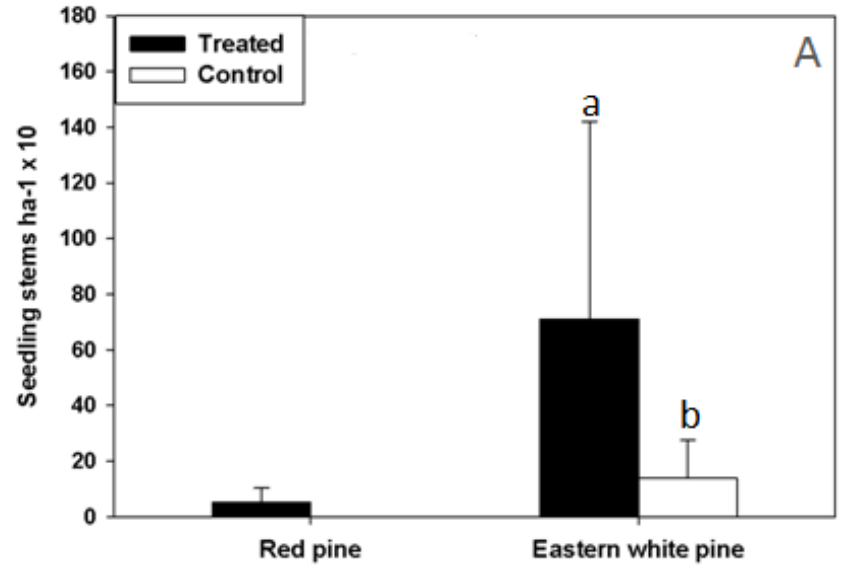
Corace et al. 2013. *FEM 318:183-193.*


Treatment
Reference
Altered
Axis 2
Axis 1
DUFF_DEP
NO_Patch
Pdensity
Tree_DEN
TLF*
*NF_142
*NF_50
Tree_DBH
HDWD_U
AMCR
SOSP
SACR
YRWA
CEDW
AMRO
RBNU
NOFL
PIWA
RUGR
CORA
BCCH
YWAB
WTSP
HETH
HAWO
NAWA
OVEN
BRCR
GCFL
BTNW
GCKI
VEER
AMRE
CSWA
BBCU
BHVI
EAWP
CHSP
PIWO
LEFL

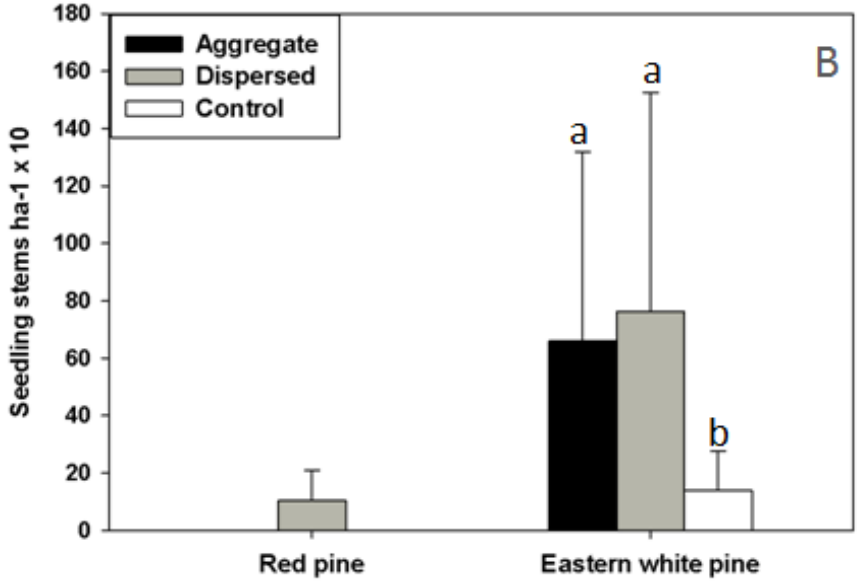
Aggregate treatment

Dispersed treatment

Regeneration of target species



Significantly higher eastern white pine seedlings in treated stands, little red pine response



No significant differences in response between spatial patterns of retention

Nyamai. 2013. Dissertation, Ohio State Univ.

Biological Legacies

- Snags play important roles in ecosystems
  - Resources released (light, moisture, nutrients)
  - Provide structure to shelter and feed wildlife
  - Habitat for decomposers
  - Dead material in forests can contain high proportions of living cells (e.g., fungi)

"At the time a tree dies, it has only partially fulfilled its potential ecological function"

(Franklin et al. 2013).

Wildlife implications across snag treatment types in jack pine stands in eastern Upper Michigan

How do snag characteristics and the method of snag creation relate to the intensity of wildlife use?

OBJECTIVES

1.Build on past research regarding snag development in eastern Upper Michigan characterizing snag decay class patterns in jack pine.

2.Understand how the method of snag creation can influence the use of a snag by subcortical insects and woodpecker excavators.

METHODS

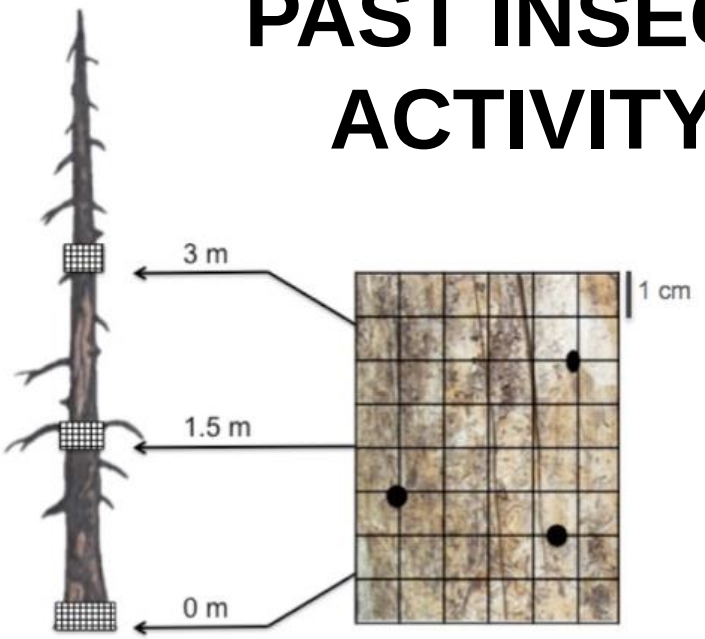
35 snags sampled each from three treatments and a control.

Variables on snag characteristics, past woodpecker activity and past insect activity were measured in 2014 and 2016.

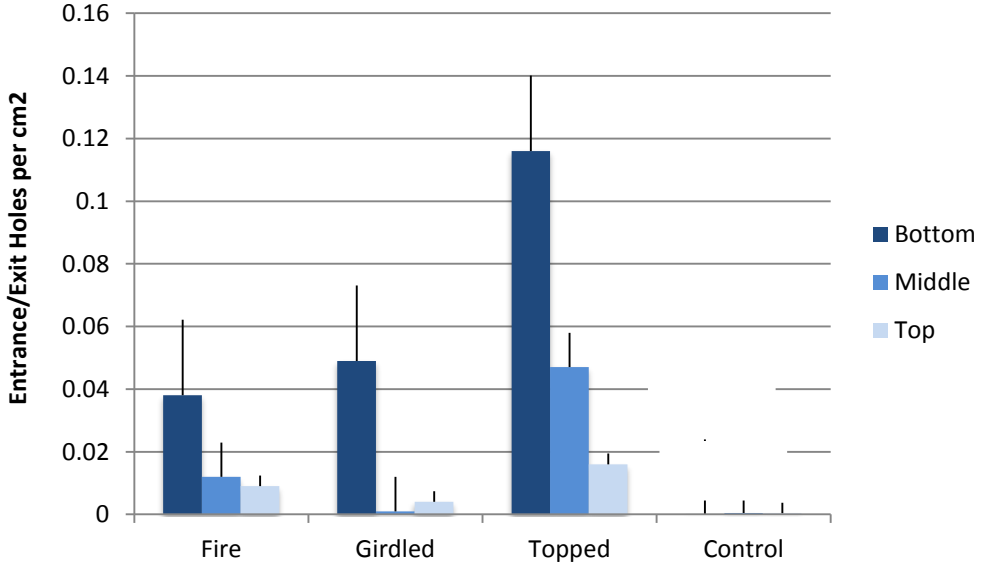
WOODPECKER EXCAVATIONS

	TREATMENT								
	Girdled (n=35)			Topped (n=35)			Fire (n=35)		
	Cavity excavations	Foraging excavations	Depth per snag (cm)	Cavity excavations	Foraging excavations	Depth per snag (cm)	Cavity excavations	Foraging excavations	Depth per snag (cm)
Range	0	0 - 33	0 - 5.560	0 - 2	0 - 50	0 - 8.756	0 - 6	0 - 80	0 - 5.334
Sum	0	152	-	3	251	-	12	557	-
Mean	0	4.343	1.165	0.086	7.171	3.195	0.343	15.914	2.452
SD	0	7.989	1.437	0.373	11.11	2.114	1.11	19.352	1.011

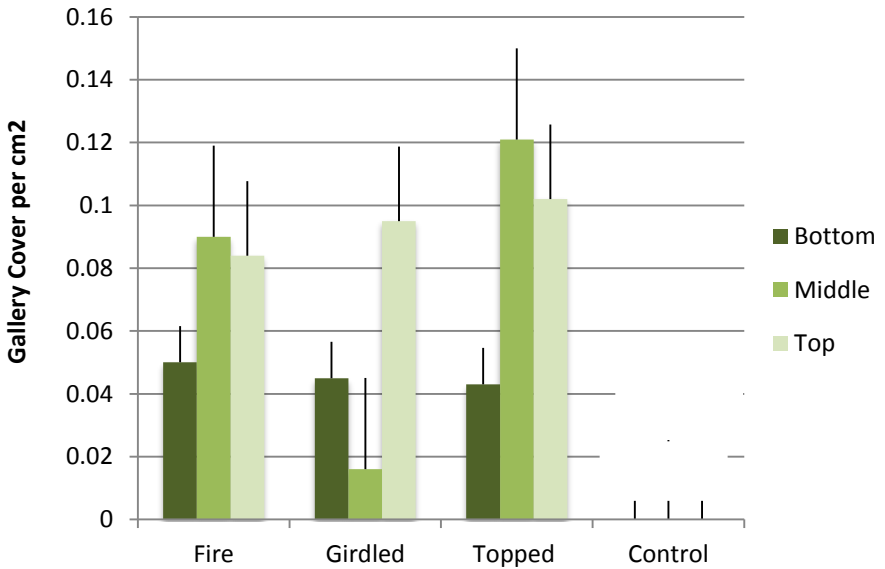
PAST INSECT ACTIVITY



Entrance and Exit Holes at Three Heights



Gallery Cover at Three Heights



Overview of Findings: Disturbance History and Mixed-Pine Management

- **Fire return interval (FRI): 24-33 year (on average) pre-European, but Great Cutover fires significantly more frequent and fires less common now;**

- **FRI of large (>10,000 ha) events mean 37 years, range 19 – 73 years (landscape-scale fires in 1754, 1791, 1864, 1891, 1910, 1976);**

- **Seasonality: fires occurred in early, mid- and late-season, but large fires were solely late season events.**

- **Benchmark stands have bird communities comprised of neotropical migrants, while altered stands are comprised of non-migratory species;**

- **Relatively few, but larger, snags in benchmark stands;**

- **Silvicultural treatments that do <u>not</u> include prescribed fire yield poor red pine (target) regeneration; fire needed in fire-dependent system.**


Biological Planning
Conservation Design
Conservation Delivery
Outcome-based Monitoring
Assumption-based Research

Big Frog Can't Fit In: A pop-up book by Mo Willems

Balding and Williams. 2016 (In Press). *Con. Bio.*

Integrating Disturbance Ecology Patterns into Forest Management in Northern Michigan

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More about regional fire ecology, including wildlife aspects, can be found through our ongoing efforts with the Lake States Fire Sciences Consortium: http://lakestatesfiresci.net/

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Applied Sciences Program (Seney NWR)
https://www.fws.gov/refuge/Seney/what_we_do/research.html