A photograph of a forest fire. Several tall, slender pine trees stand in the foreground and middle ground. At the base of these trees, there is a thick layer of bright orange and yellow flames, indicating a ground fire or a fire consuming low-lying vegetation. The background shows more trees and a hazy, smoke-filled sky. The overall scene depicts a natural fire event in a forest.

# Fire-Dependent Mixed-Pine Ecosystems, Biological Legacies, and Wildlife: A Summary of Past and Current Research at Seney National Wildlife Refuge

Greg Corace  
Applied Sciences Program, Seney NWR  
[https://www.fws.gov/refuge/Seney/what\\_we\\_do/research.html](https://www.fws.gov/refuge/Seney/what_we_do/research.html)

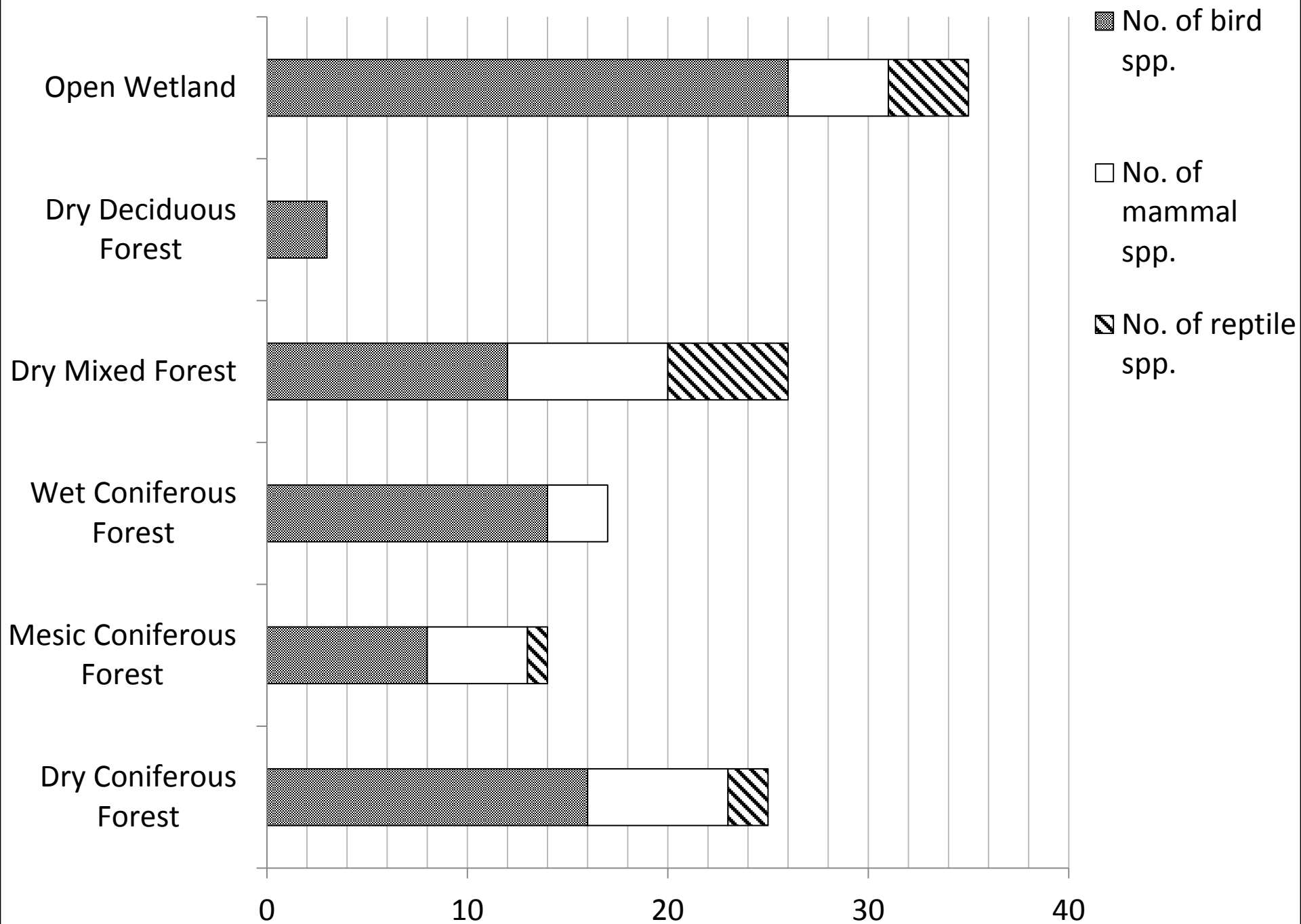
# Today's Outline

- Which vertebrate wildlife species were historically (are currently) associated with fire-dependent ecosystems of the LSFSC area?
- What is current status of published papers on these species?
- What is the past and current research being conducted on these ecosystems and related species on Seney NWR lands in UP and nLP?
  - Future directions?

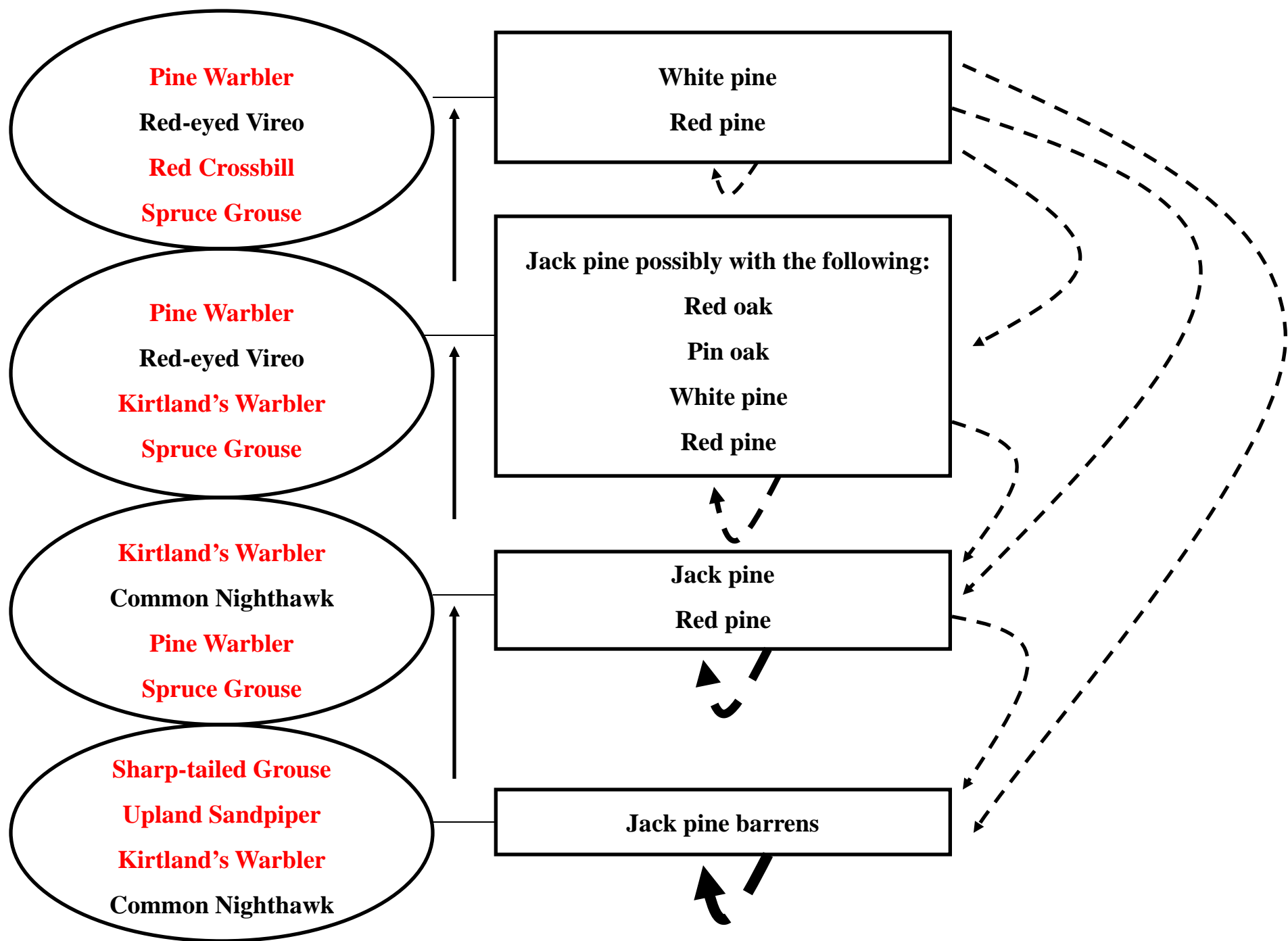


# Fire-Dependent Ecosystems of the Lake States Fire Science Consortium (LSFSC)

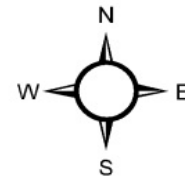
- **Fire-dependent:** an ecosystem type in which the alteration of fire regime affects composition, structure, and processes;
- **In the LSFSC area:** fire-dependent ecosystems include forests (e.g., xeric pine, lowland conifers, etc.) and wetlands (e.g., fen, bog, etc.);
- Each ecosystem type has unique fire behavior, FRI, fire rotation, seasonality, etc.;
- Vegetation often uniquely adapted (e.g., serotiny), as are wildlife species (e.g., Kirtland's Warbler vs Red Crossbill).







# Fire-Dependent Wildlife Species Richness



## Species Richness

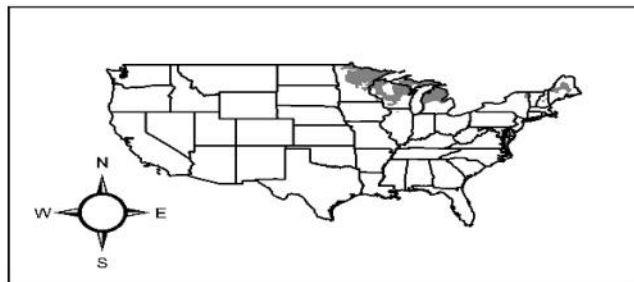


0 65 130 260 Miles

Corace et al, 2015. *TWP*. 9:52-55.

# Status of Knowledge of Fire-Dependent Wildlife Species

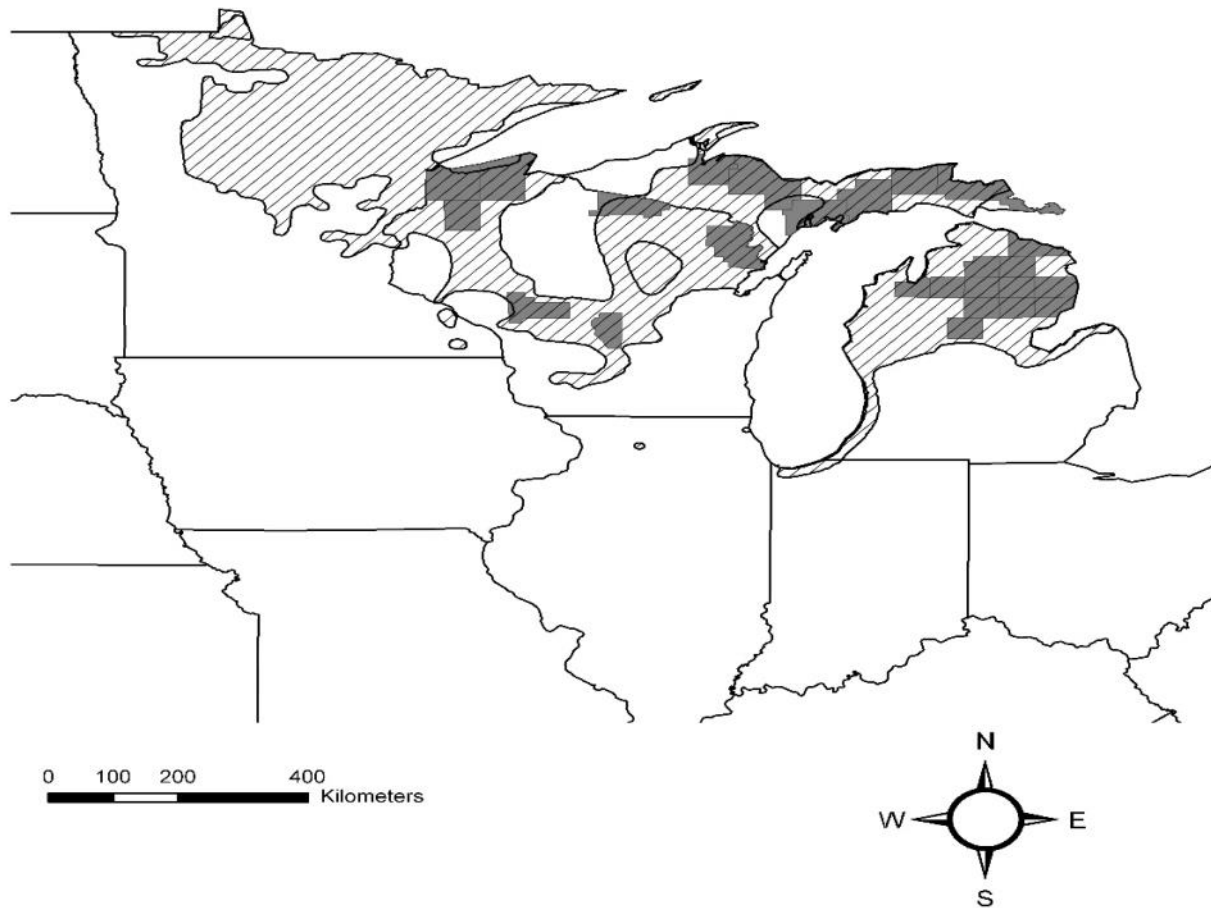
- J. Miesel (Michigan State Univ.) conducted gap analysis based on published literature (see LSFSC website for searchable database);
- Findings suggests that vast majority of literature centers around vegetation (52% of all are pine studies), fewer wildlife studies;
- Corace et al. (2015) looked at State Wildlife Action Plans for MN, WI, and MI and interviewed biologists. Fire rarely mentioned in northern forest ecosystem relative to prairie ecosystems; differences exist among biologists in perceptions re: role of fire in northern ecosystems;
- In the case of Kirtland's Warbler, a compiled database of literature with >1,300 records has "fire" as a keyword in ~185 (<14%).



**US Distribution of Jack Pine**  
(*Pinus banksiana*)



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



**~98% of all breeding Kirtland's Warbler found  
in xeric, outwash plains of nLP of Michigan**













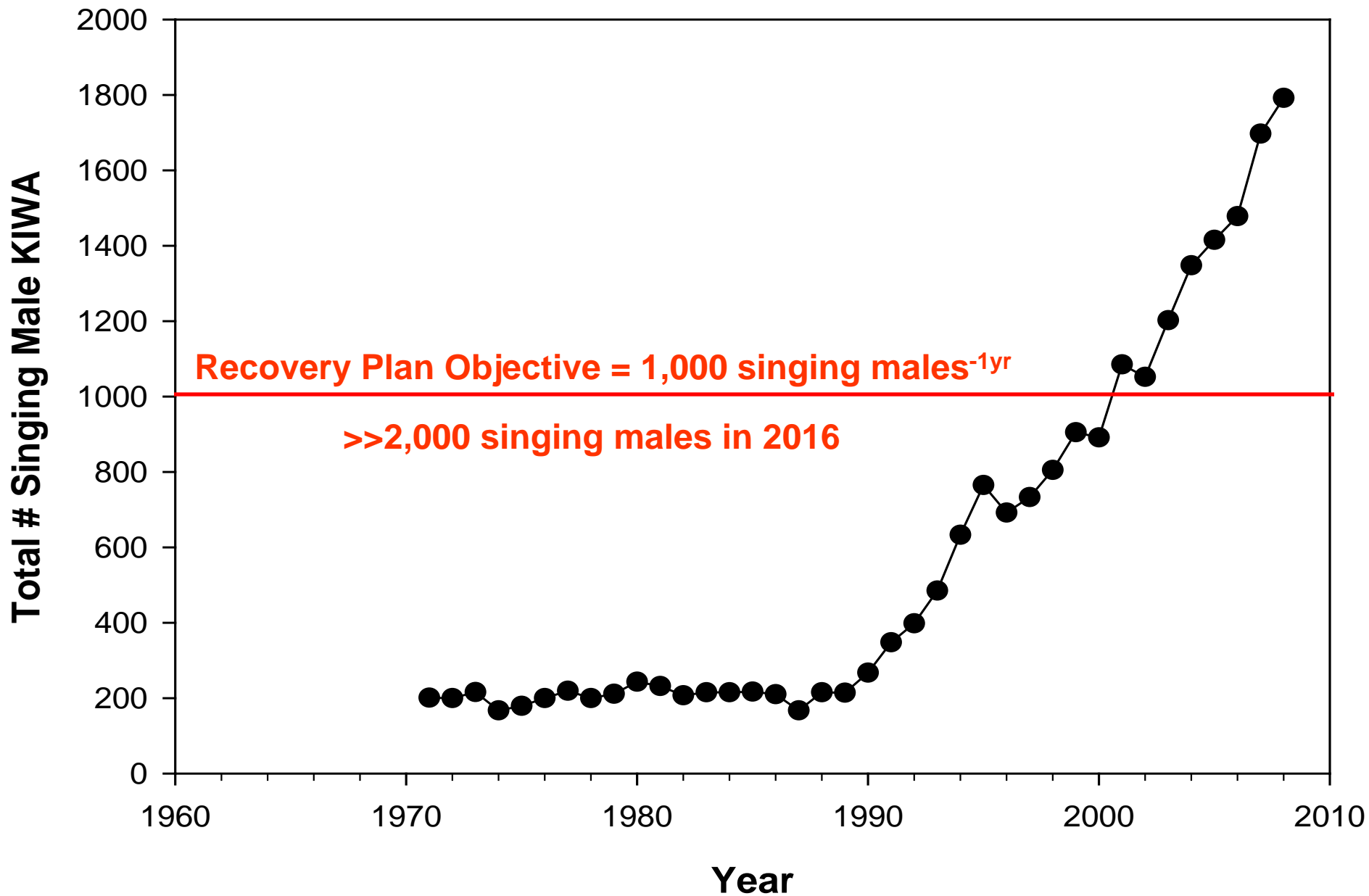






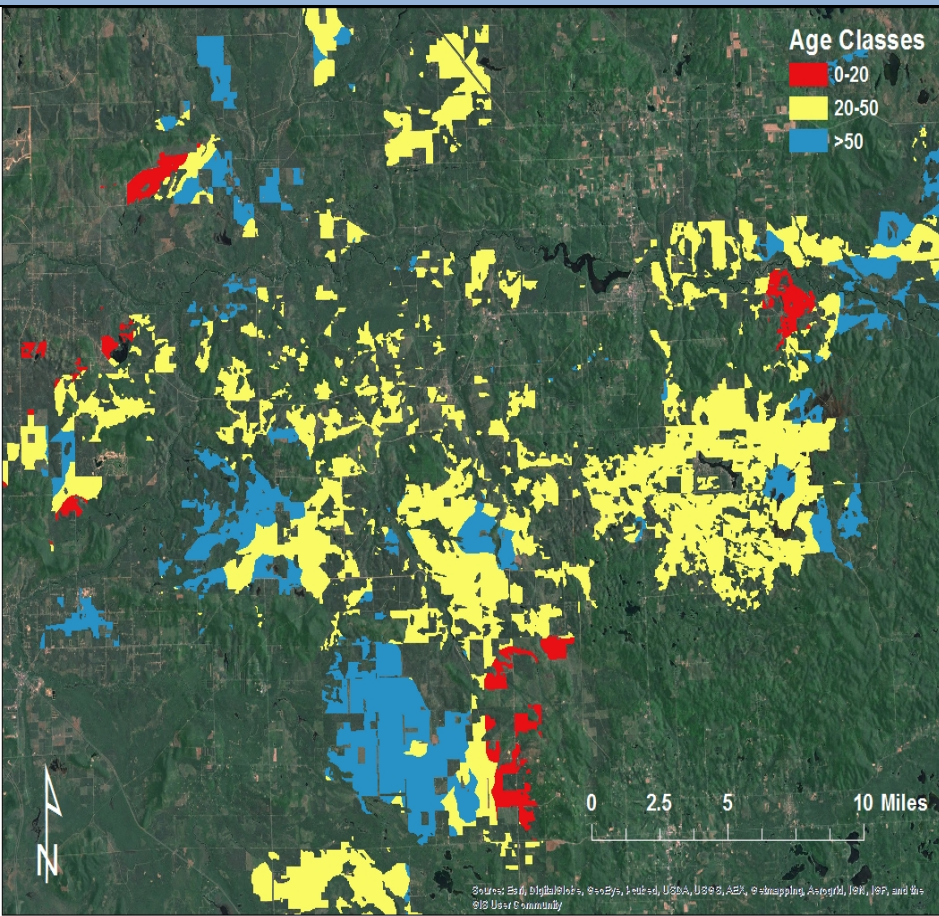


# Kirtland's Warbler (KIWA) Annual Census Results: 1971-2008

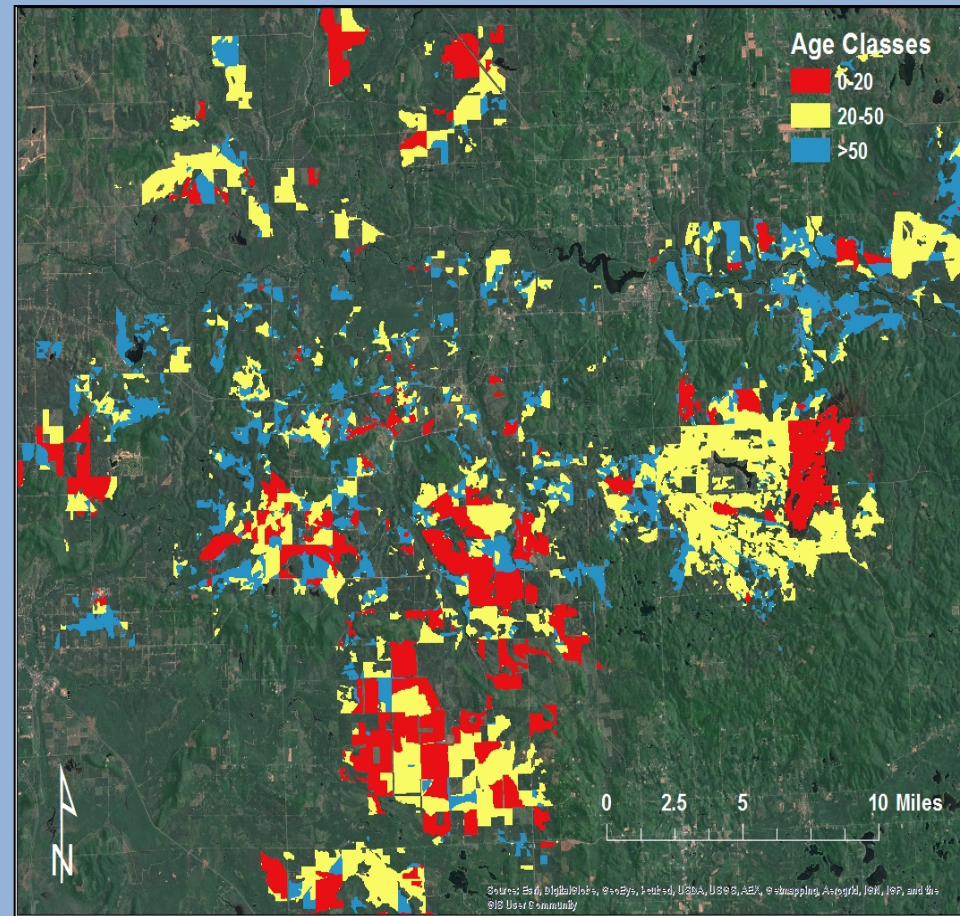


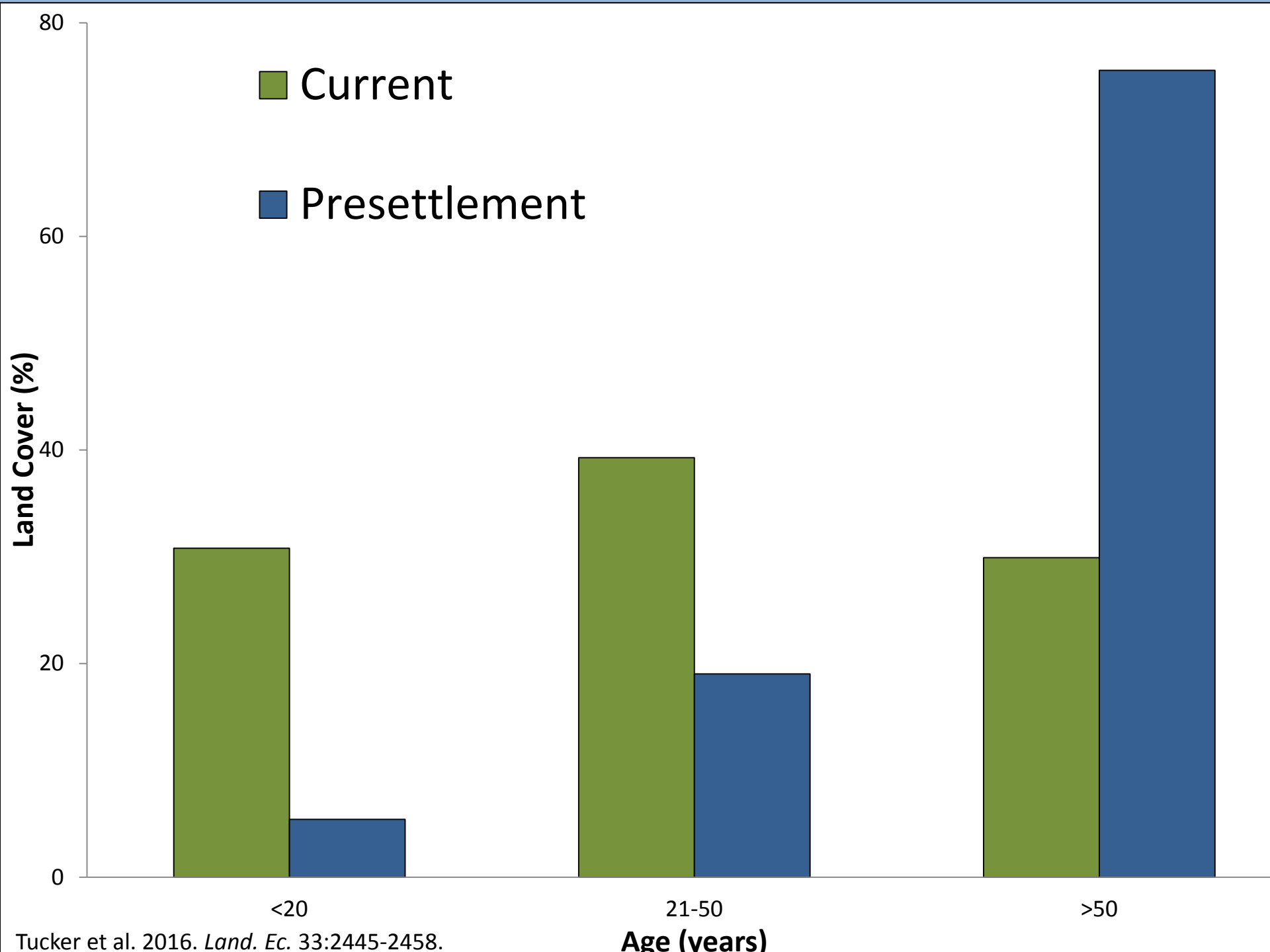
# Stand Age Distributions in Management Areas

## Pre-settlement



## Current



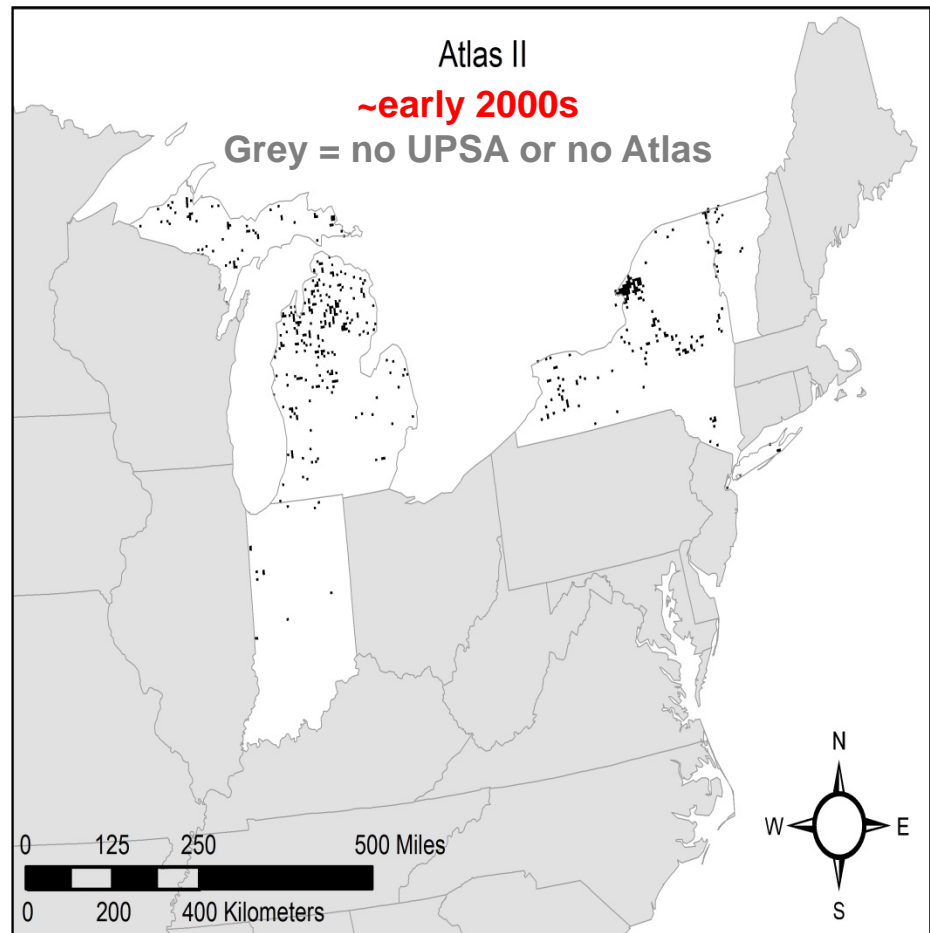
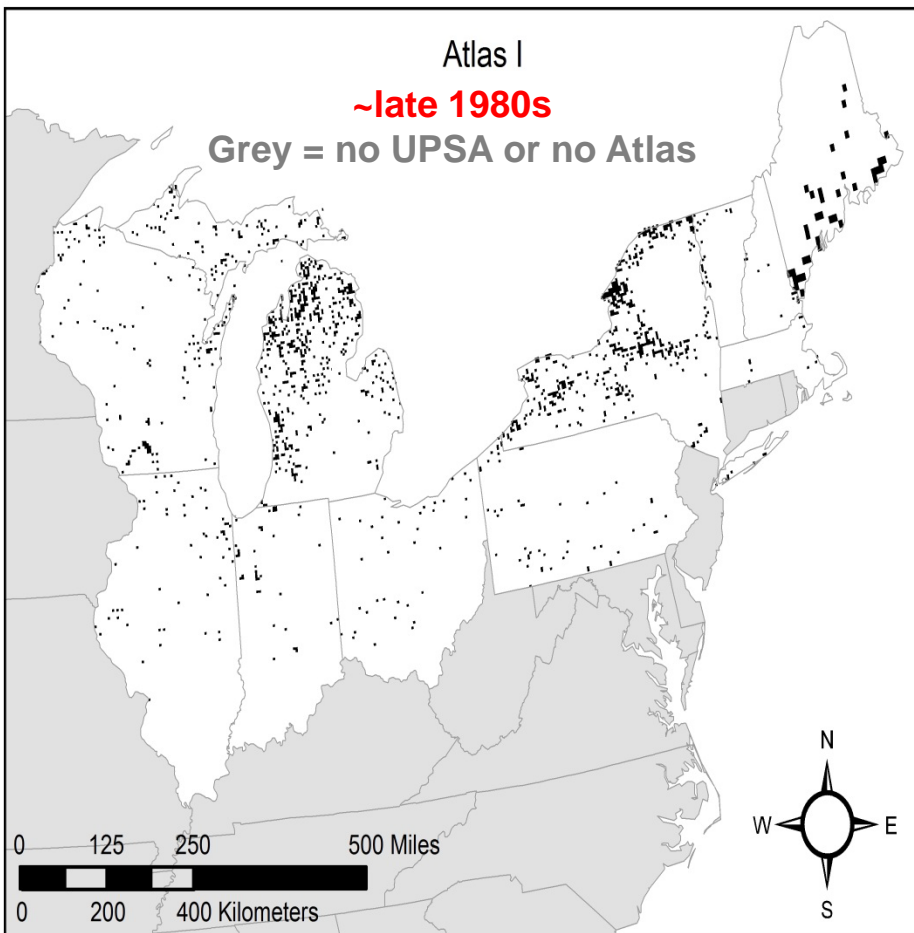


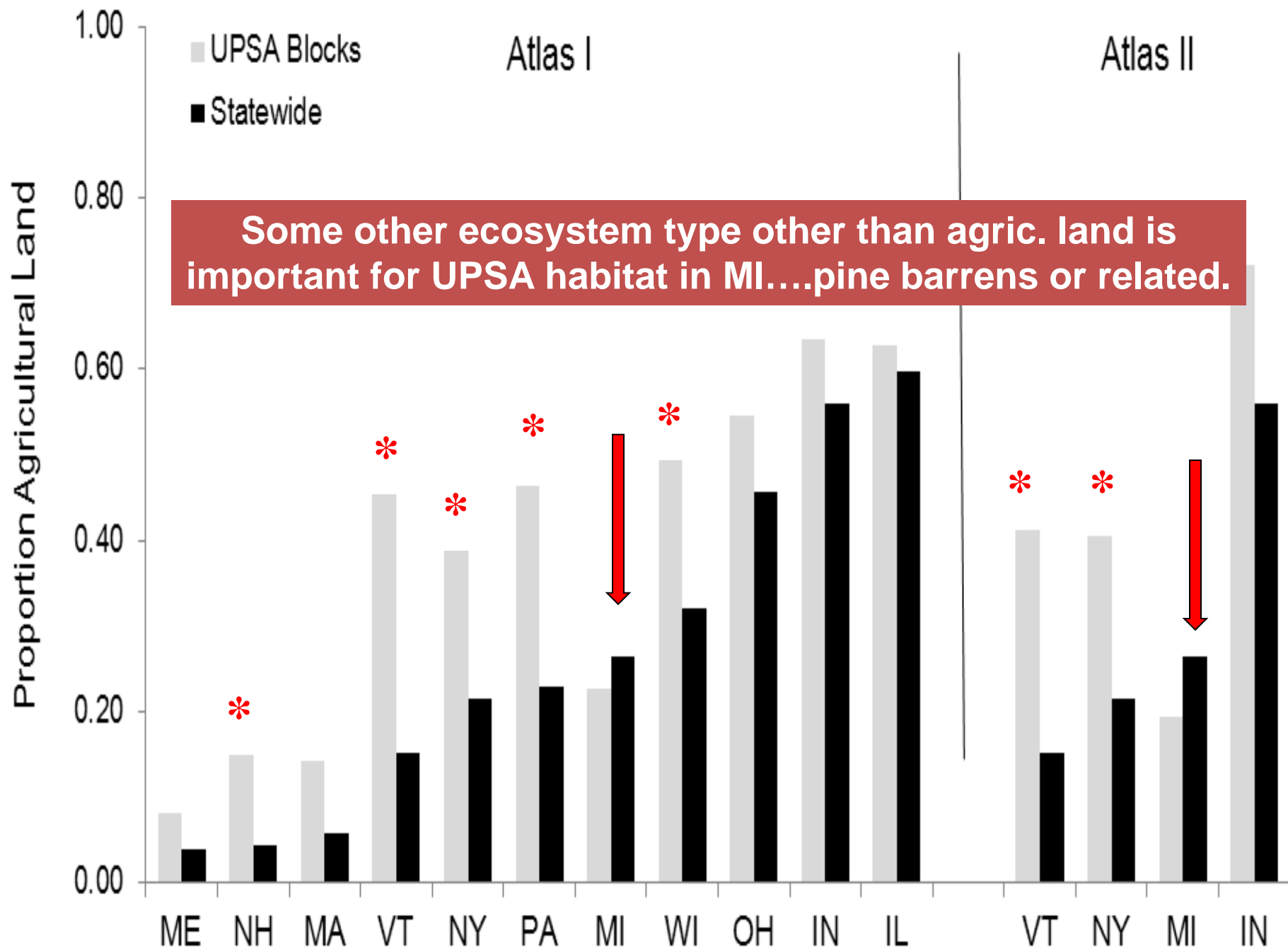


**Table 1.** Indicator species for young (< 5 years), KW (5-23 years), and old (> 23 years) jack pine stands at KWWMA.

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

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







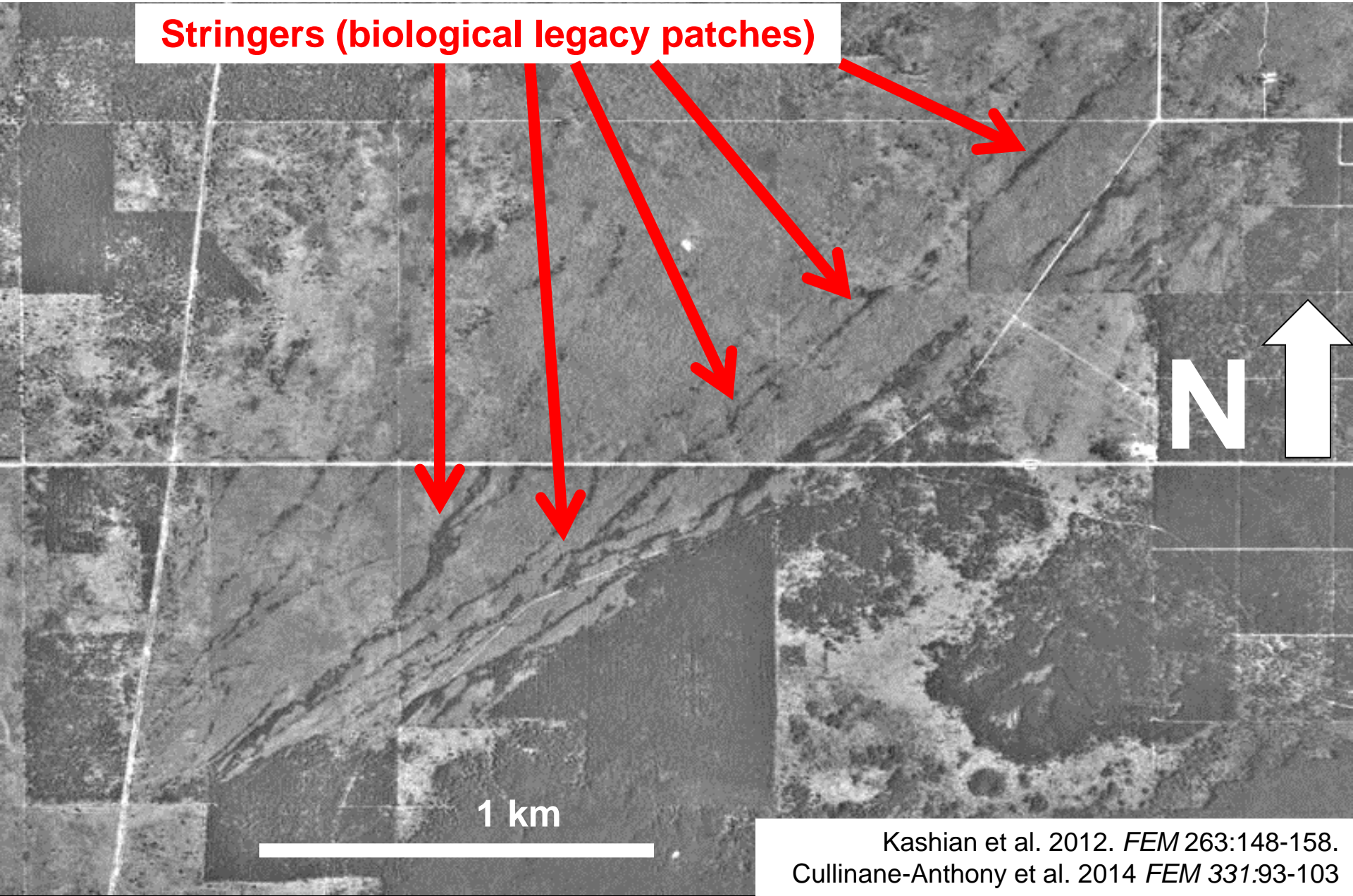


**It All Doesn't Burn: Biological  
Legacy Patches!**



# Quantify Wildfire-Induced Structural Patterns Using Chronosequence of Aerial Imagery

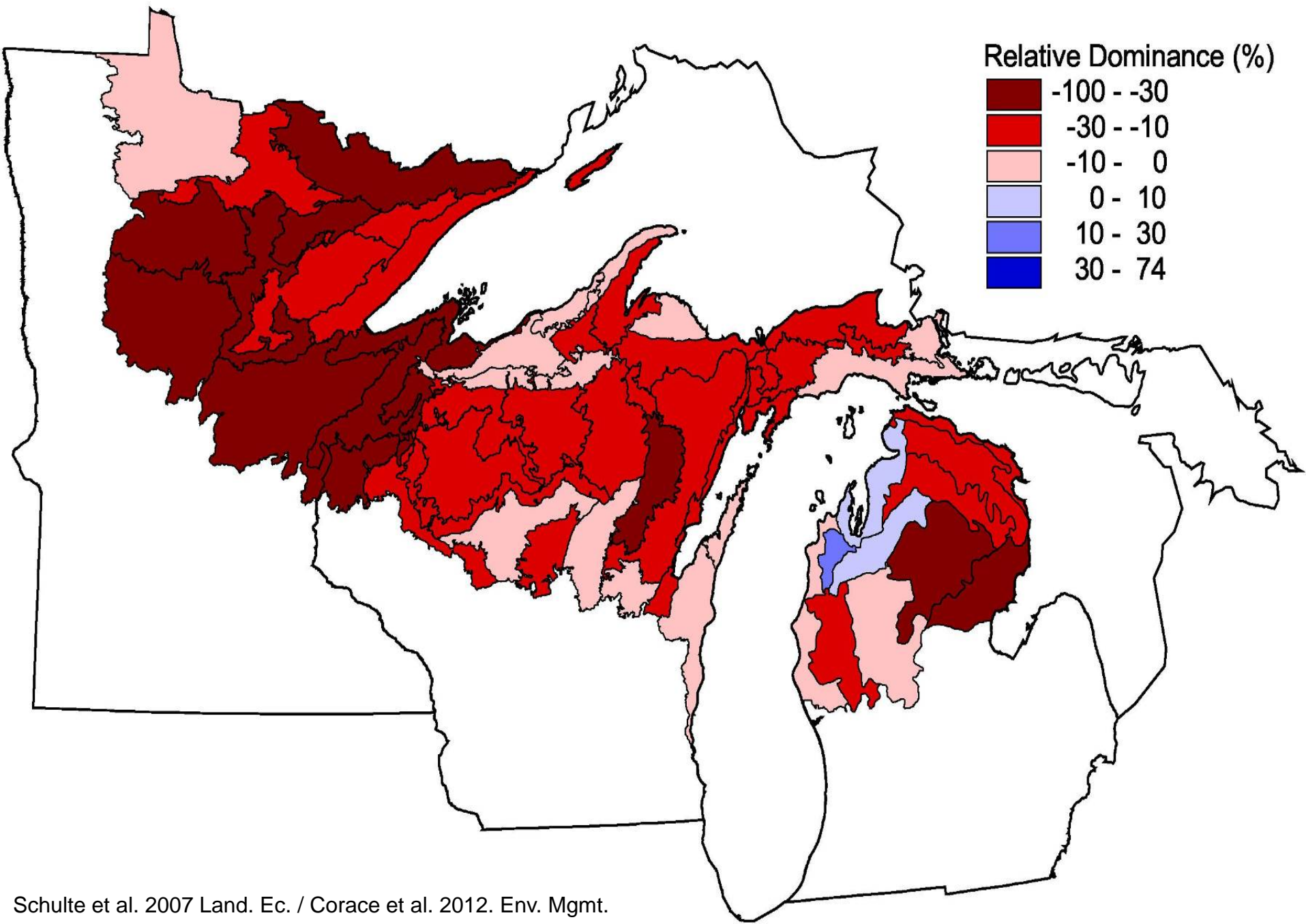
**Stringers (biological legacy patches)**



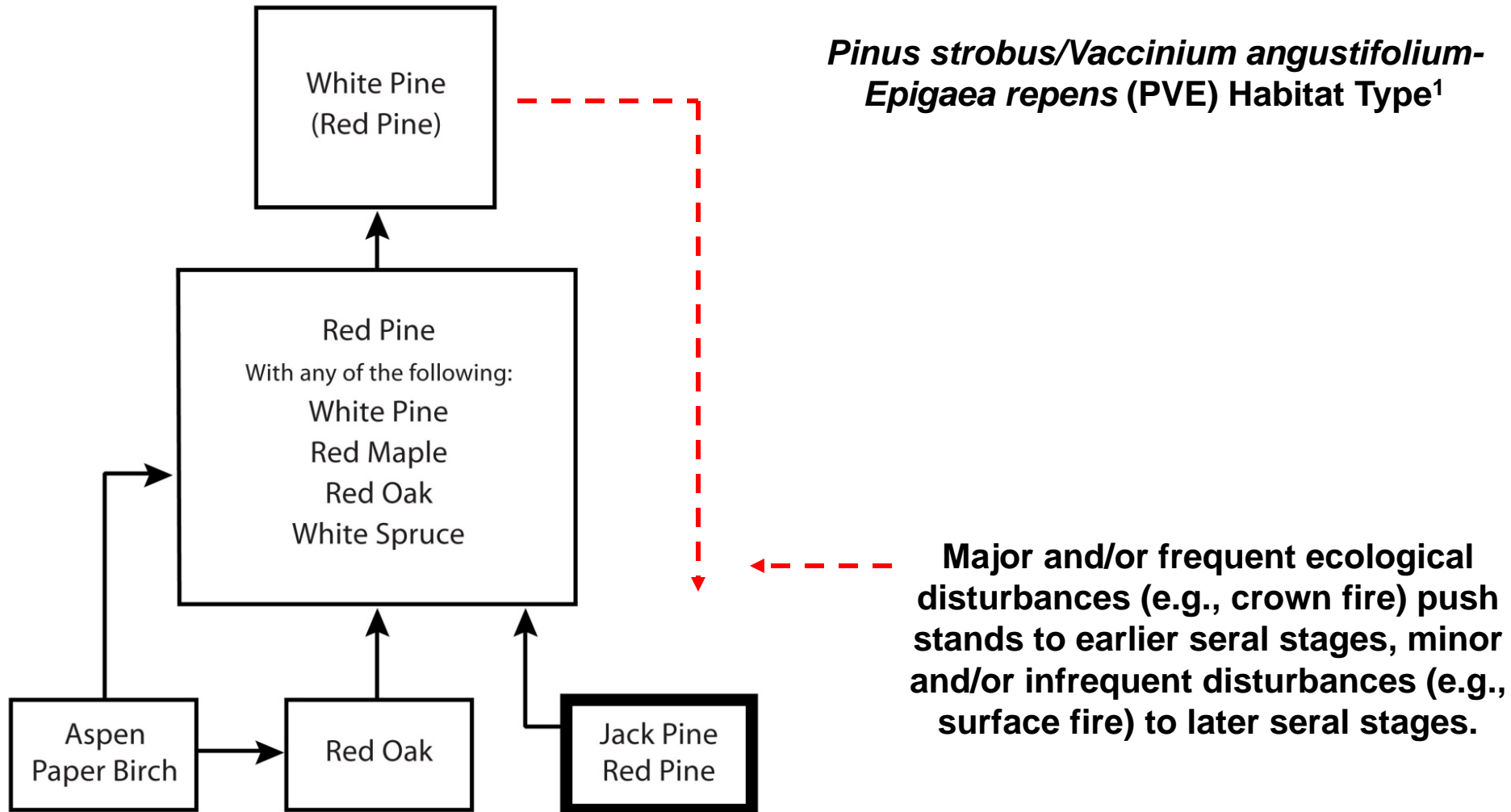
1 km

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

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



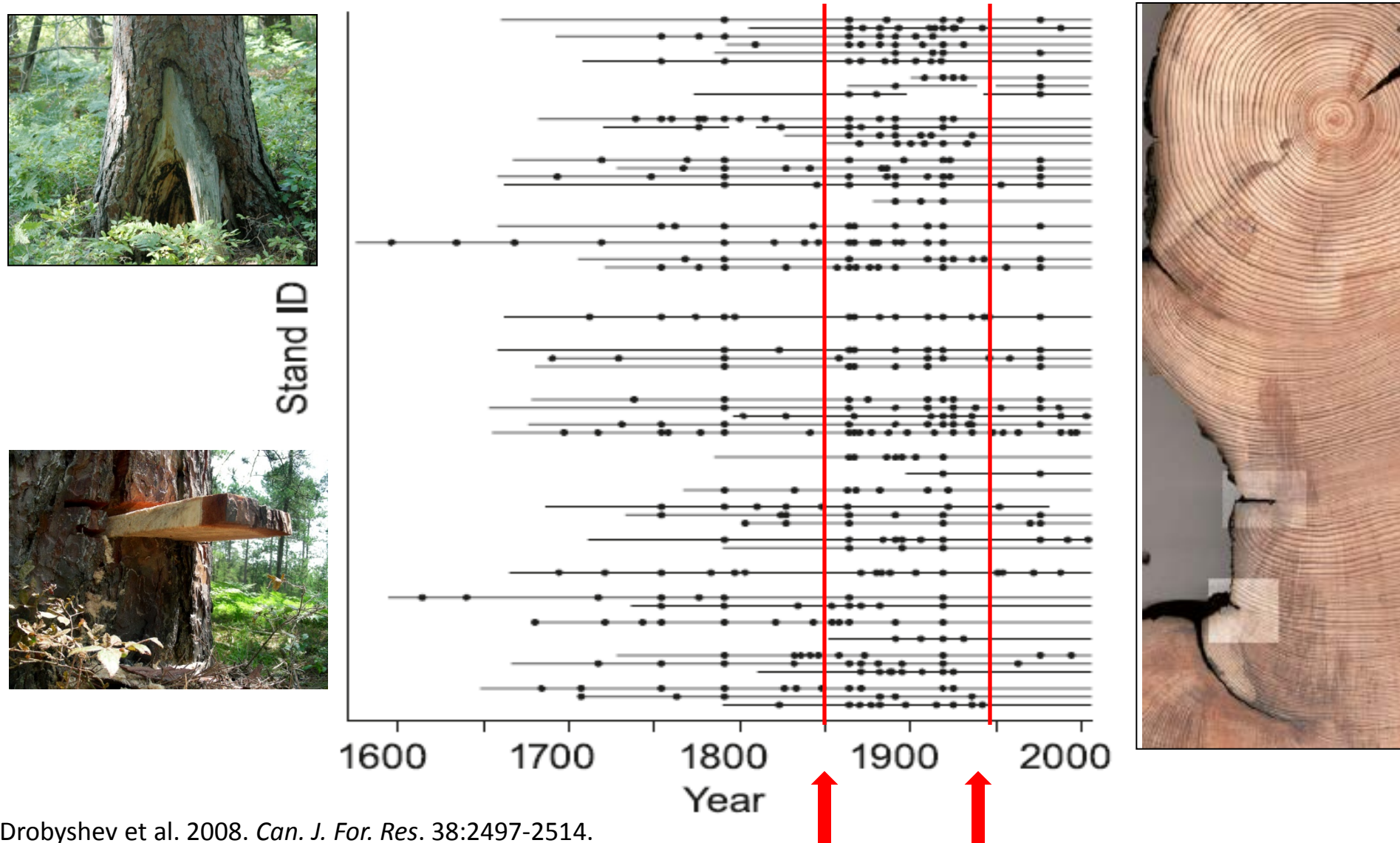
# Ecological Considerations for Forest Restoration Based on Soils, Disturbances, and Resulting Composition and Structure



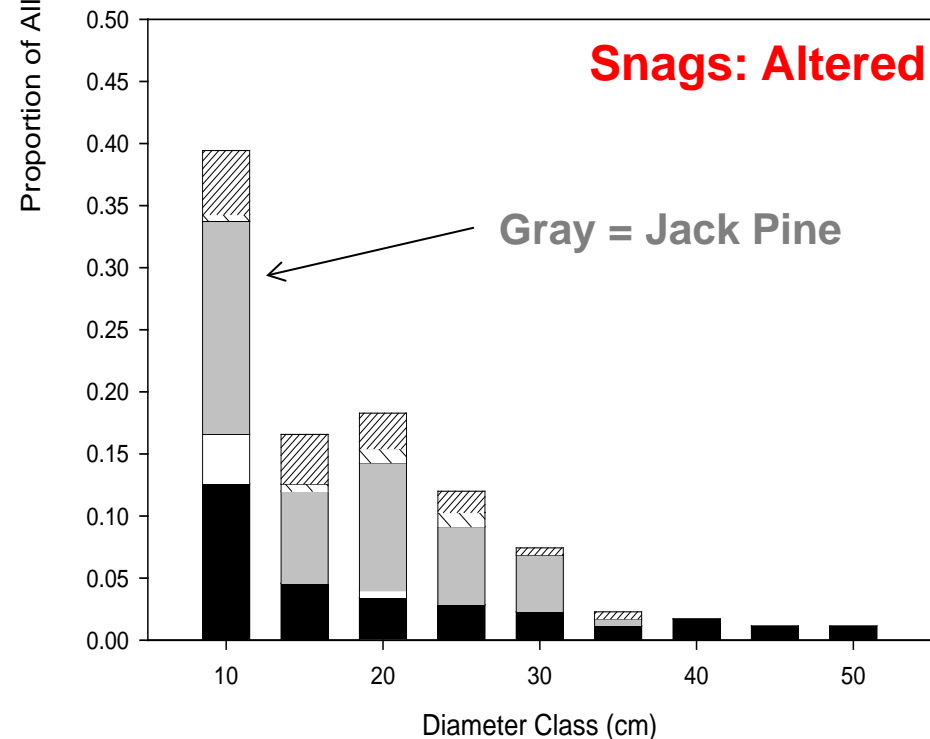
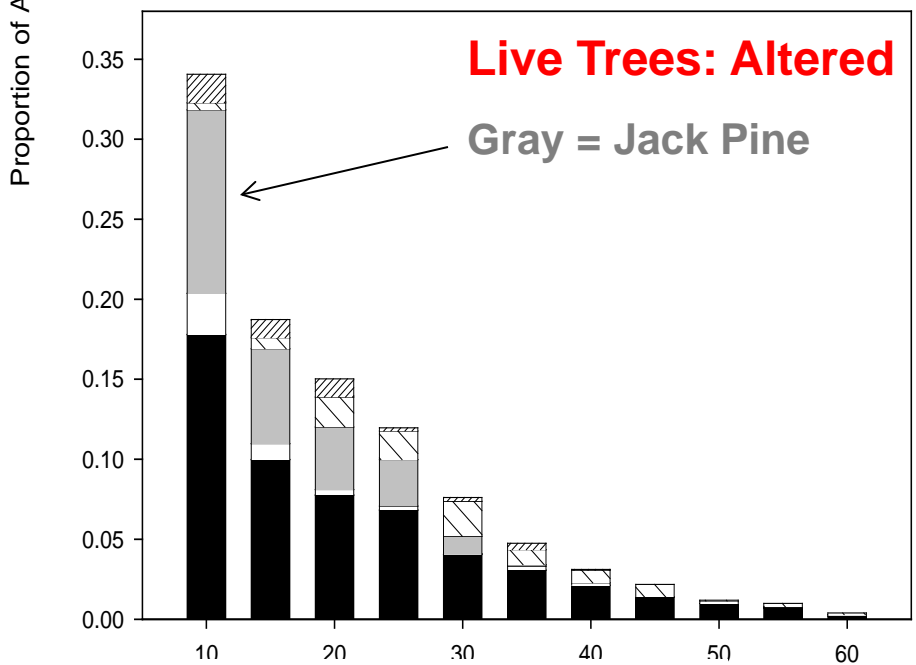
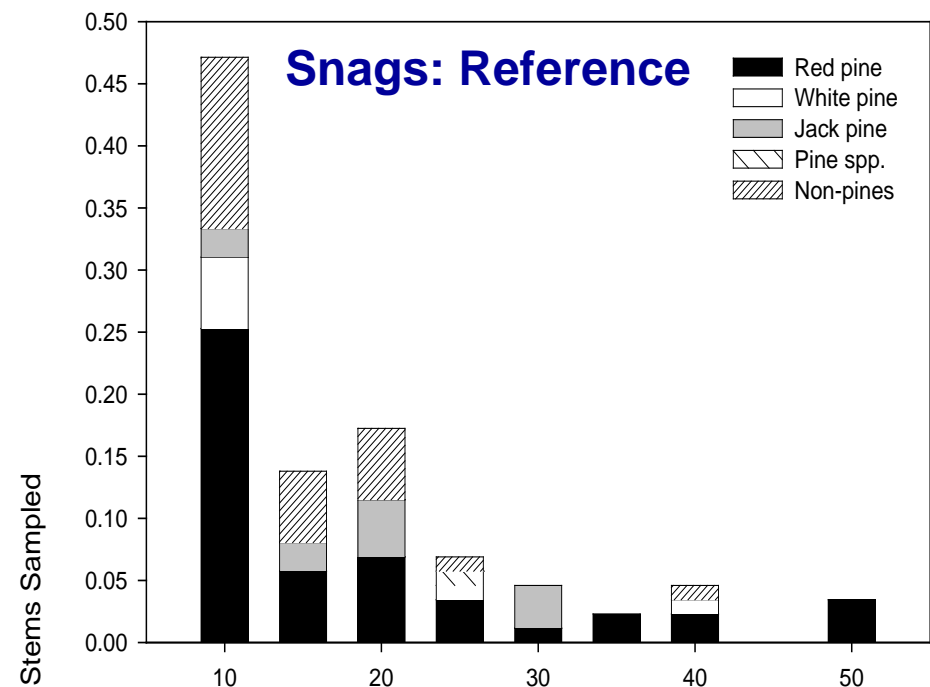
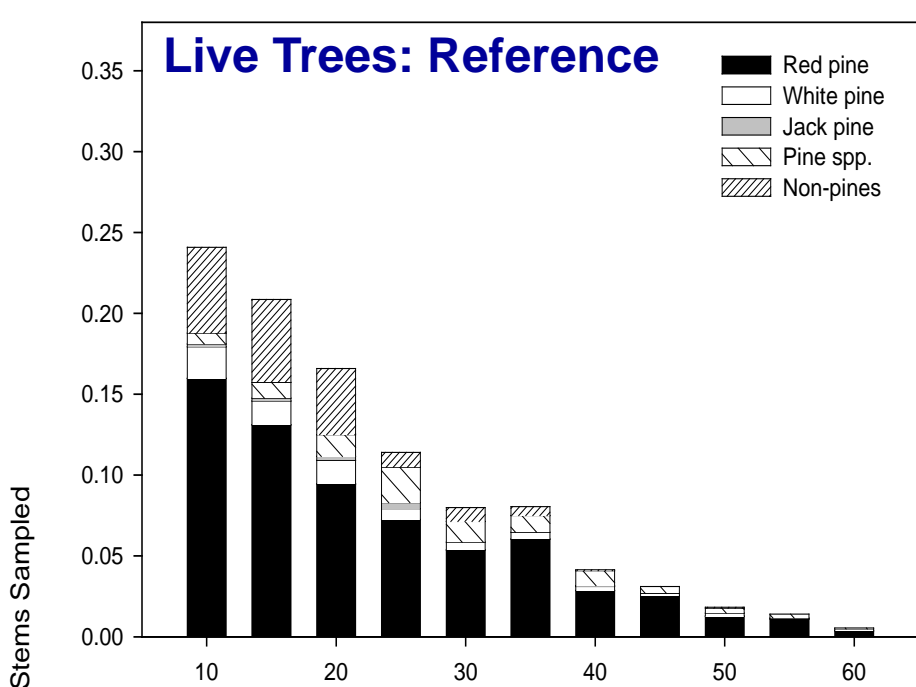
<sup>1</sup>Burger and Kotar. 2003. Forest community and habitat types of Michigan.



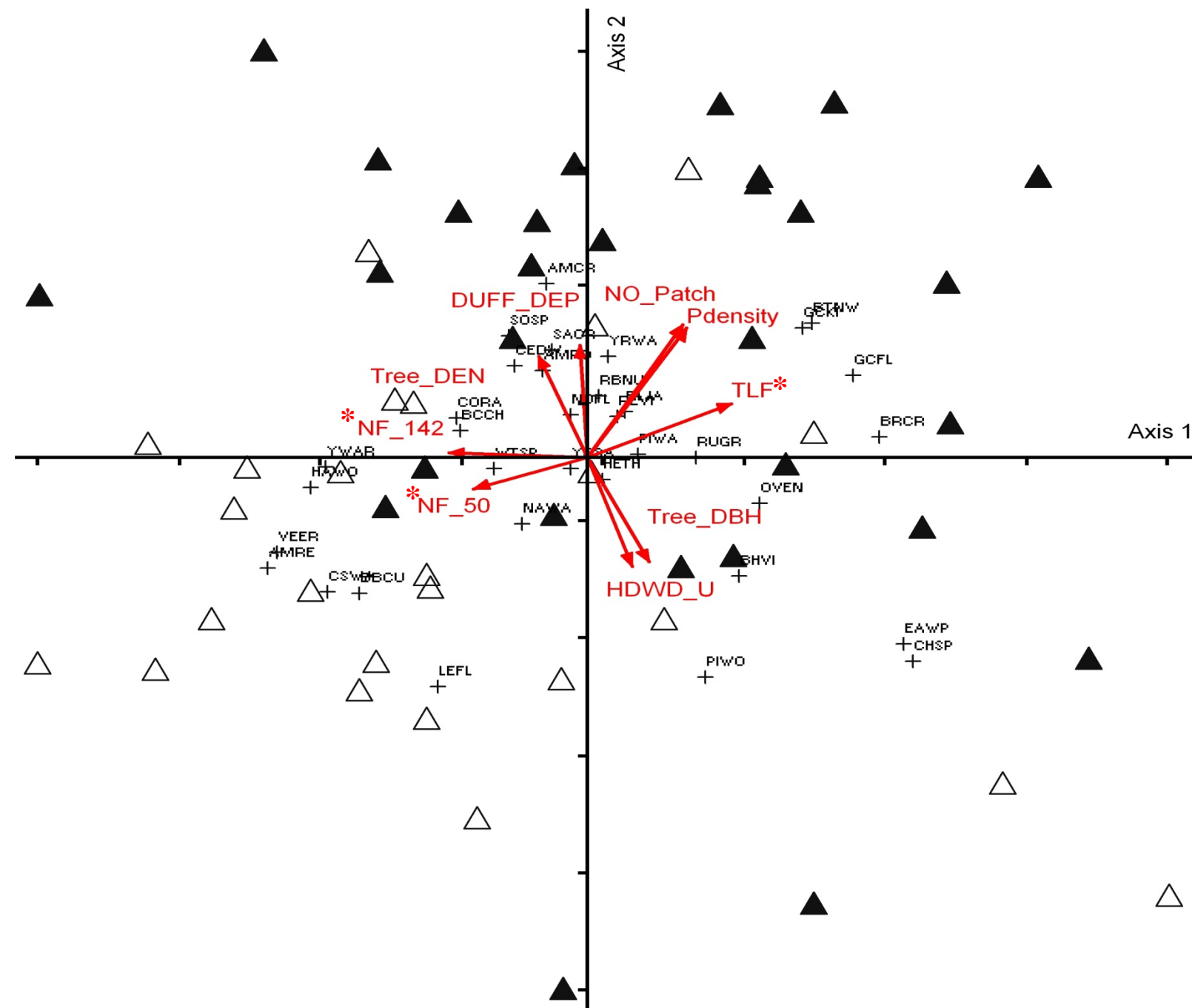
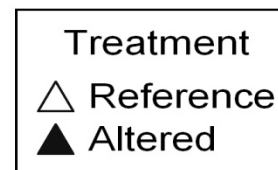
**Fig. 2.** Time span of each of the 49 fire history sites within SNWR. Each chronology is based on a mean of five samples. Fires are recorded as “points” and blank spaces indicate a hiatus in a chronology (i.e., stand was not recording during that period).







Reference (PIF Score)	<i>p</i> -value	Altered (PIF Score)	<i>p</i> -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	<div> <div></div> <div>Corace et al. 2013. <i>FEM</i> 318:183-193.</div> </div>	
Nashville Warbler (13)	0.04		
Chestnut-sided Warbler (14)	0.00		
Veery (16)	0.02		













# Aggregate treatment

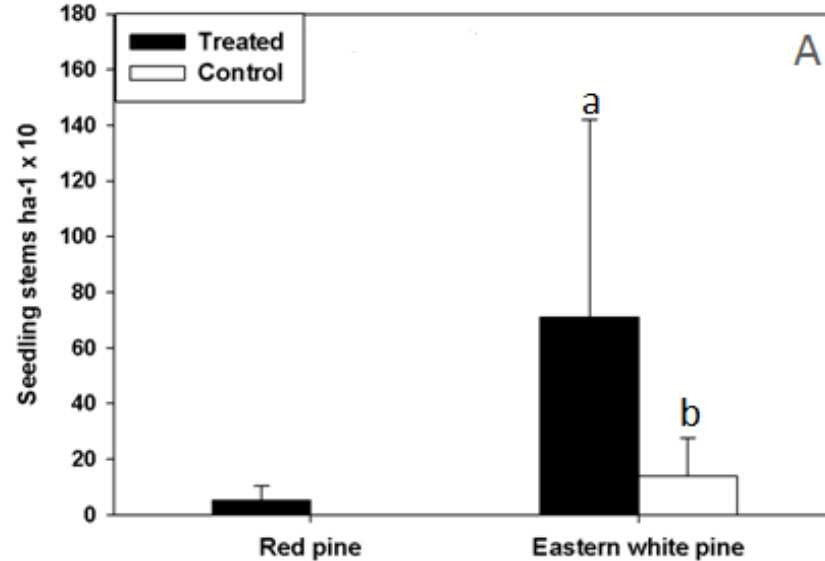




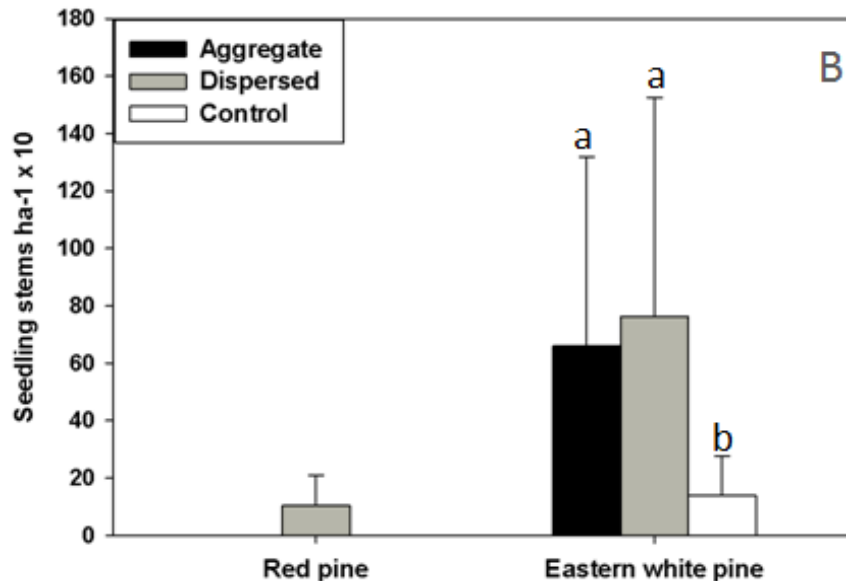
# Dispersed treatment



# 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**



# 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)





# 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.

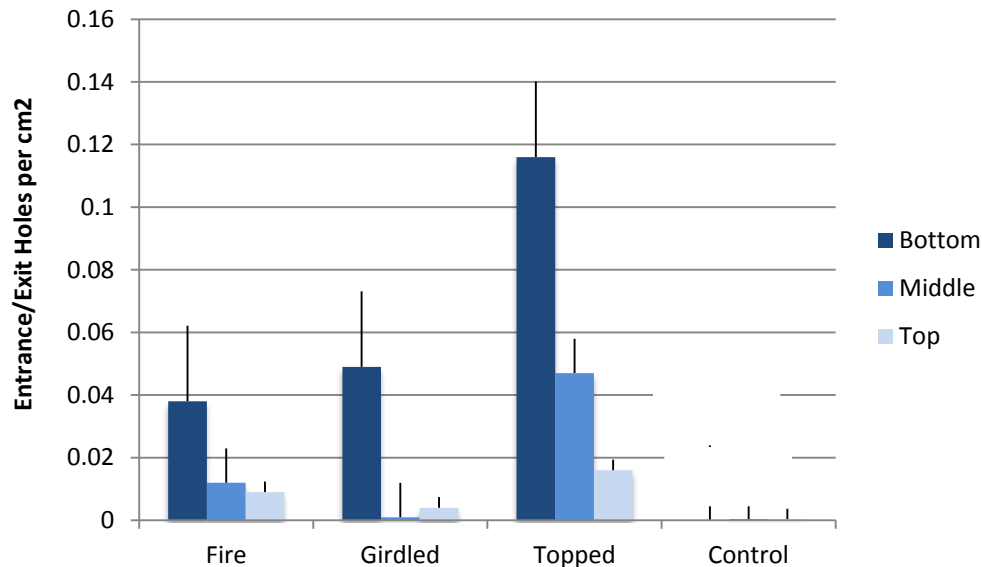
## WOODPECKER EXCAVATIONS



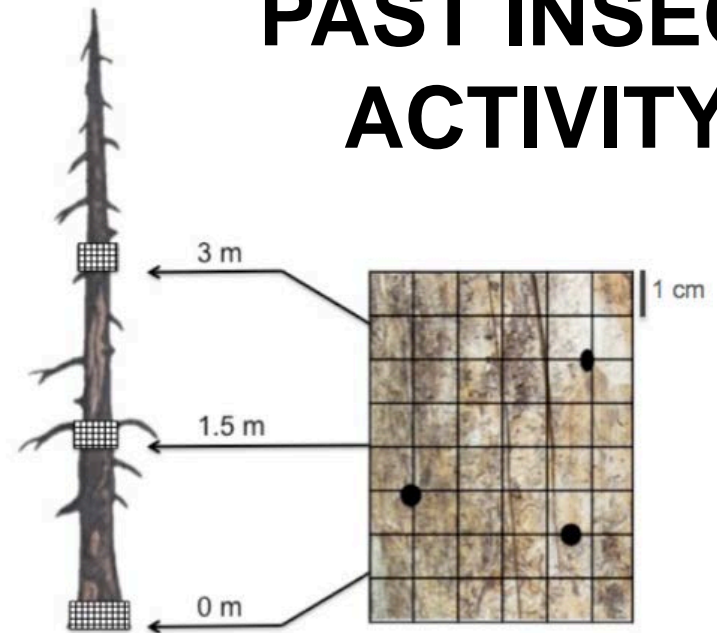
	TREATMENT								
	Girdled (n=35)			Topped (n=35)			Fire (n=35)		
	Cavity excavations	Foraging excavations	Depth per snag (cm)	Cavity excavations	Foraging excavations	Depth per snag (cm)	Cavity excavations	Foraging excavations	Depth per snag (cm)
Range	0	0 - 33	0 - 5.560	0 - 2	0 - 50	0 - 8.756	0 - 6	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



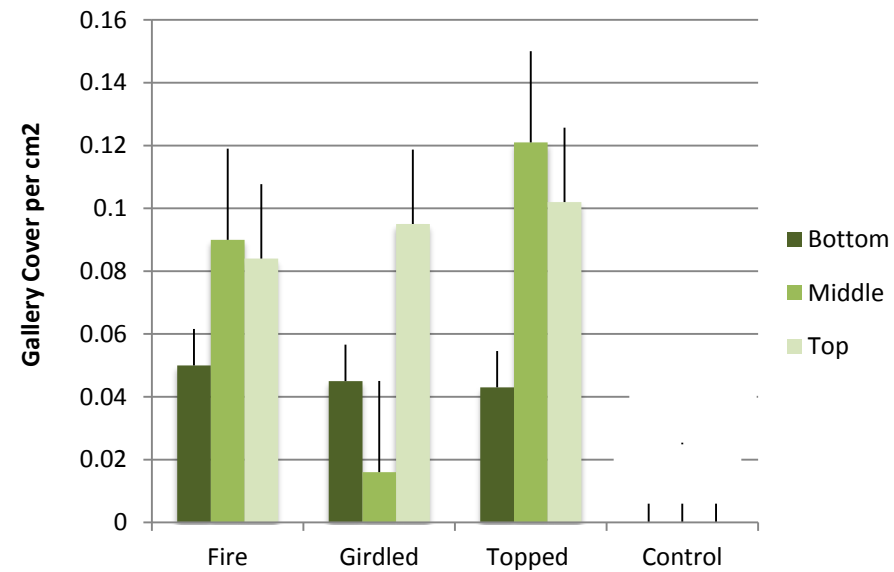
**Entrance and Exit Holes  
at Three Heights**



# PAST INSECT ACTIVITY




**Gallery Cover  
at Three Heights**



# Future Directions of Fire-Wildlife Efforts in LSFSC

- Upcoming webinars from LSFSC: wood turtle monitoring (March 19, 2017), pine snags and wildlife, brushland wildlife and fire, fire and moose (all winter 2017-2018, pending funding);
  - Provide an ecological context to aspen management (2017+, pending funding);
- Evaluate monitoring protocols: Sharp-tailed Grouse and Black-backed Woodpecker (2017+, pending funding);
- Evaluate potential shifts in distribution of fire-dependent bird species in Michigan (2017+, pending funding).





# **Fire-Dependent Mixed-Pine Ecosystems, Biological Legacies, and Wildlife: A Summary of Past and Current Research at Seney National Wildlife Refuge**

**Acknowledgements:** Special thanks to funding agencies (Joint Fire Sciences Program, Seney Natural History Assoc., Joint Venture, etc.) and colleagues at agencies (Lindsey Shartell, MN-DNR) and academic institutions (Shelby Weiss and Charles Goebel and students, Ohio State; Dan Kashian and students, Wayne State).

**Greg Corace**  
Applied Sciences Program, Seney NWR  
[https://www.fws.gov/refuge/Seney/what\\_we\\_do/research.html](https://www.fws.gov/refuge/Seney/what_we_do/research.html)