2017-2018 Webinar Series

October 19, 2017

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

Shelby Weiss

School of Environment and Natural Resources at Ohio State University

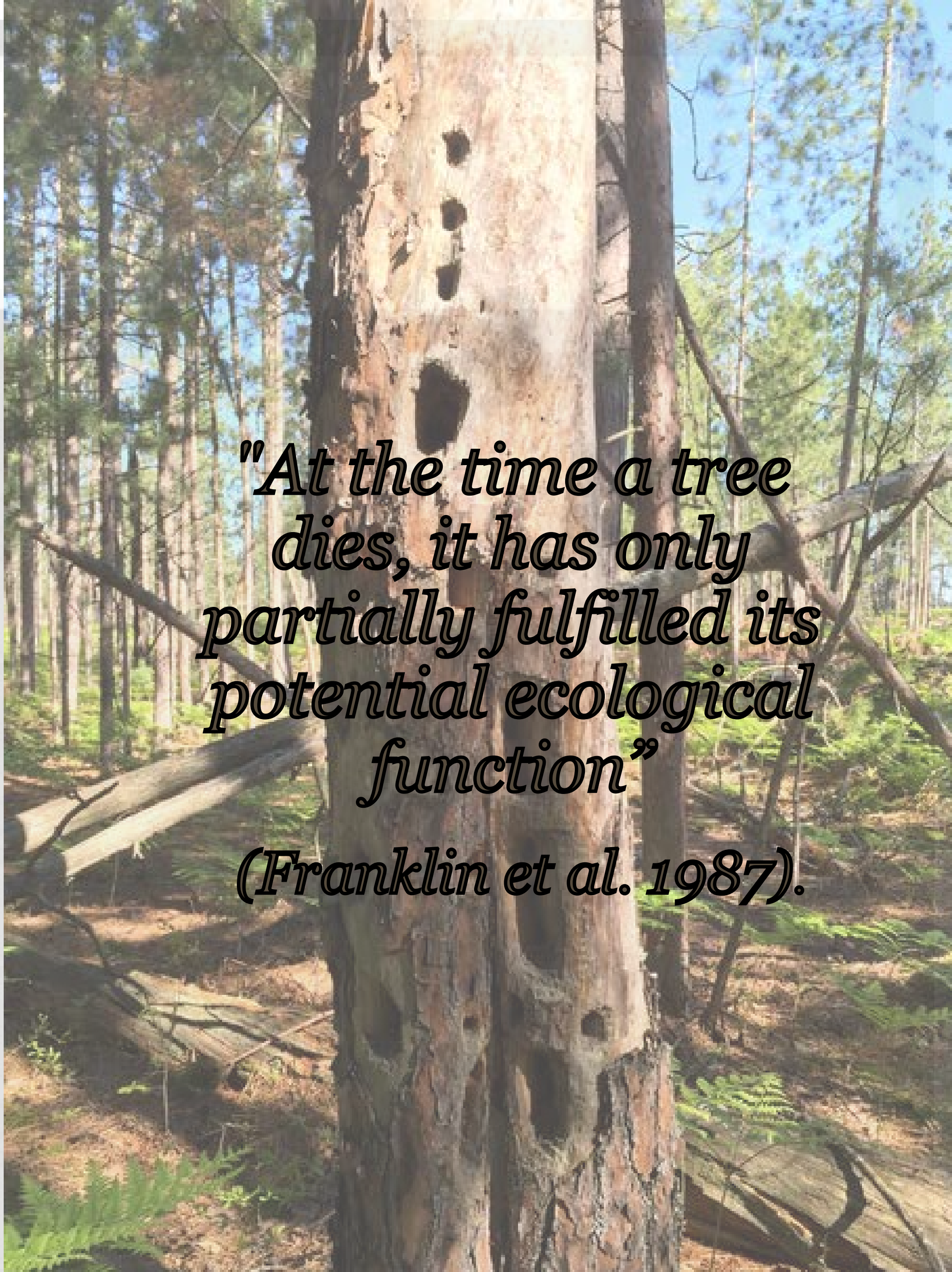
Audio will start at 2 PM Eastern / 1 PM Central.
This webinar is listen only – to ask questions please use the chat box in lower right of screen.

WILDLIFE IMPLICATIONS ACROSS SNAG TREATMENT TYPES IN JACK PINE STANDS OF UPPER MICHIGAN

Shelby Weiss, R. Gregory Corace, Eric Toman, Daniel Herms, P. Charles Goebel

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)



Franklin, J., Shugart, H., & Harmon, M. (1987). Tree Death as an Ecological Process. BioScience, 37(8), 550-556. doi:10.2307/1310665

NORTHERN LAKE STATES FORESTS

- Changes in structure and composition relative to pre-European conditions
  - Widespread fire suppression
  - Land use change
  - Forest management
- Treatments to establish Kirtland's warbler breeding habitat (clear-cutting and artificial regeneration)
  - Lower levels of snags relative to fire-regenerated stands*
    - 3 snags/ha vs. 252 snags/ha in young fire-origin stands

*Spaulding, S. E., & Rothstein, D. E. (2009). How well does Kirtland's warbler management emulate the effects of natural disturbance on stand structure in Michigan jack pine forests?. *Forest ecology and management*, *258*(11), 2609-2618.

SOURCES OF SNAGS

Natural Disturbances:

- Insects
- Disease
- Flooding
- Wind
- Fire
- Senescence

Snag Creation Treatments:

- Pheromone baiting
- Fungal inoculation
- Dynomite
- Topping
- Girdling
- Herbicide/silvicide
- Prescribed fire

PREVIOUS SNAG RESEARCH IN UPPER MICHIGAN

- Comparison of three methods of creating snags from live trees at Seney National Wildlife Refuge (NWR)

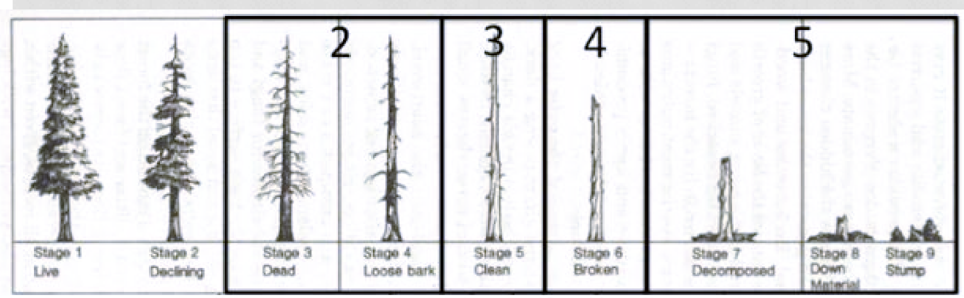
  -Topping (3m)

  -Girdling

  -Prescribed Fire

- Examined patterns of snag development across species for three treatments 4 years post-treatment

- Differences in decay class development among treatments and among species
  - No topped, 3% of fire, and 26% of girdled snags reached the most advanced decay class
  - Jack pine had a greater range of decay classes after 1 year compared with red pine and aspen



Restoration Ecology
THE JOURNAL OF THE SOCIETY FOR ECOLOGICAL RESTORATION

Corace et al. 2013

RESEARCH ARTICLE

Snag Benchmarks and Treatment Options for Mixed-Pine Forest Restoration in Eastern Upper Michigan

R. Gregory Corace III,[1,2] Anna T. Stout,[1] P. Charles Goebel,[3] and David M. Hix[4]

OBJECTIVES

- Quantify differences among treatments in terms of decay variables and use by wildlife (birds, insects)
- Determine which variables best predict the variation in observed use

WHO USES SNAGS?

- Used by a variety of vertebrate and invertebrate species throughout different stages of decay
- Subcortical insects (e.g. bark beetles, wood-borers) complete a portion of their lifecycles beneath bark
- Some bird species forage for subcortical insects on snags and/or excavate cavities for nesting

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<u>Evidence of past use:</u>

- Entrance and exit holes, galleries

- Foraging and cavity excavations

PATTERNS OF USE: INSECTS

- Colonization of dead trees by subcortical insects proceeds in two successional “waves”
  - *1st wave:* soon after a tree dies (abundance declines with time since disturbance)
  - *2nd wave:* once snag has fallen to the forest floor

Ron Long

Tamaghna Sengupta

Adam B. Lazarus

Boulanger, Y., Sirois, L., 2007. Postfire succession of saproxylic arthropods, with emphasis on Coleoptera, in the north boreal forest of Quebec. Environ. Entomol. 36 (1), 128–141. https://doi.org/10.1603/0046-225X-36.1.128.

PATTERNS OF USE: PRIMARY CAVITY-NESTERS

- Snags typically become less suitable for foraging as snags deteriorate and insect colonization declines
- As decay progresses and the interior wood of snags soften, snags may be more suitable for cavity excavation

Farris, K.L., Zack, S., 2005. Woodpecker-Snag Interactions: An Overview of Current Knowledge in Ponderosa Pine Systems. pp. 18–21. http://www.treesearch.fs.fed.us/pubs/27268.

	Reported cavity heights from ground (m)	**Reported cavity entrance diameters (cm)**	**Reported cavity depths (cm)**	**Relative abundance at SNWR[c]**
Black-capped chickadee (*Poecile atricapillus*)	0 - 20+	~2.8	10 - 46	Abundant
Boreal chickadee (*Poecile hudsonicus*)	0.1 - 10.5	~2.4	12.7 - 30.5	Rare
Black-backed woodpecker (*Picoides articus*)	2.7 – 11	3.3 - 4.4	21 - 41	Uncommon
Downy woodpecker (*Picoides pubescens*)	4.7 - 13.5	2.5 - 3.8	15.2 - 30	Common
Hairy woodpecker (*Picoides villosus*)	1 - 18.3	3.8 - 5.1	20.3 - 38.1	Common
Northern flicker (*Colaptes auratus*)	1.3 - 11.4	6.45 - 8.3	14.9	Common
Pileated woodpecker (*Dryocopus pileatus*)	13.1 - 35.3	8 - 12	47.6 - 60	Common
Red-headed woodpecker (*Melanerpes erythrocephalus*)	7 - 12.4	5.6 - 5.9	14.3	Rare
Red-bellied woodpecker (*Melanerpes carolinus*)	2 - 15	5.1 - 6.4	22 - 32	Rare
Red-breasted nuthatch (*Sitta canadensis*)	3.5 - 15.7	2.0 - 9.5	2.0 - 7.0	Common
Three-toed woodpecker (*Picoides dorsalis*)	5.2 - 7.7	3.8 - 4.7	24.1 - 30.5	Rare
Yellow-bellied sapsucker (*Sphyrapicus varius*)	2 - 9	3.2 - 4.1	27	Common

SNAG TREATMENTS

Fire: 2003

Topped: 2004

Girdled: 2007

- Mechanical treatments
  - Part of a larger effort to restore red pine, reduce heavy fuels (e.g., jack pine), and prepare sites for prescribed fire
    - Harvesting occurred in mixed-pine stands with even-aged jack pine being the most common over-story species
    - Variable retention of 10-70% of pre-treatment basal area and yielded a heterogeneous distribution of residual
  - Trees marked for snag treatments were generally larger, healthy trees spaced to allow equipment to work

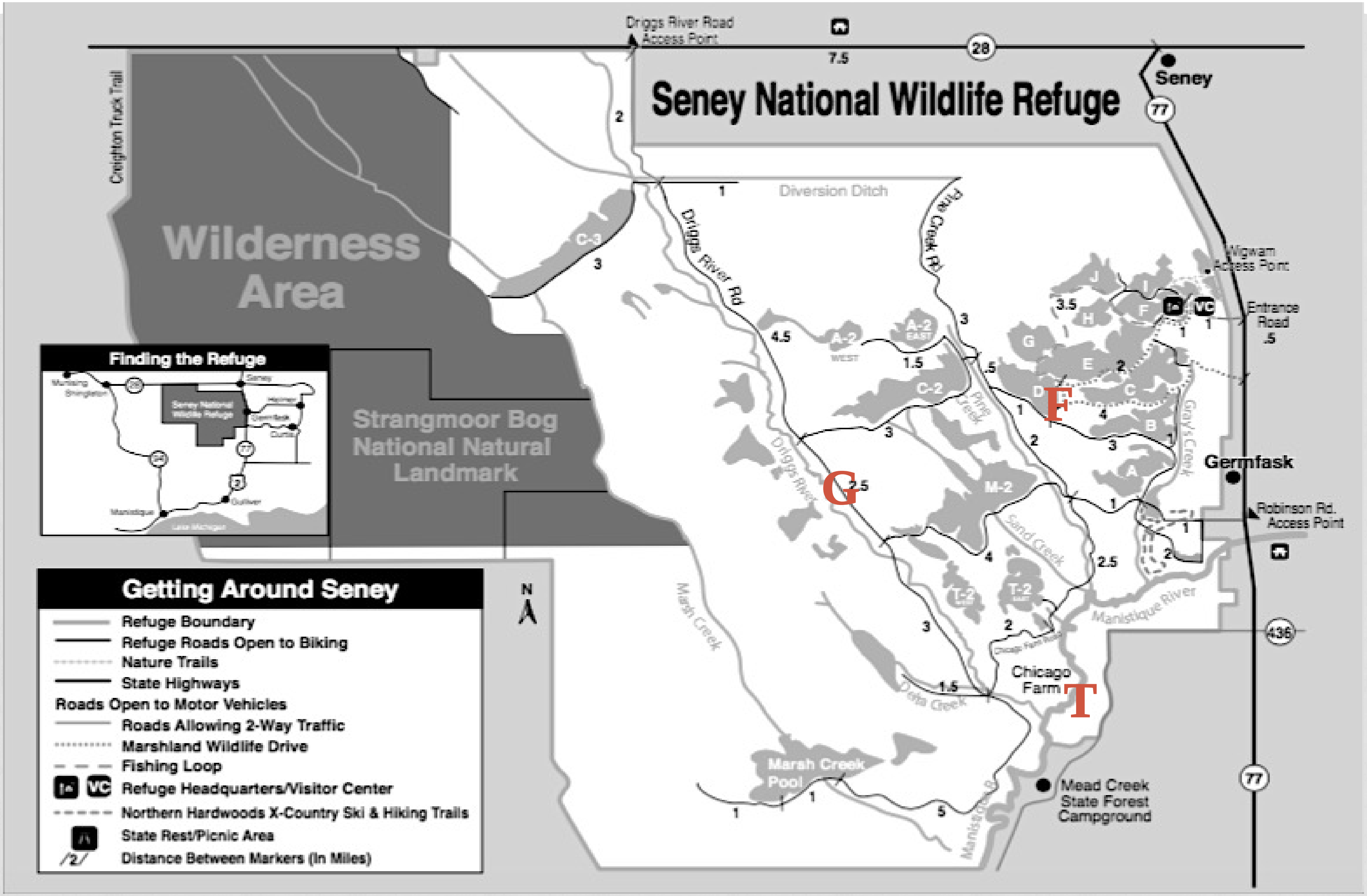
SNAG TREATMENTS

- Prescribed Fire
  - Mixed-severity
  - >70% jack pine mortality and many (70%) red pine trees remaining alive post-fire

Fire:
2003

Topped:
2004

Girdled:
2007



- Sampled 35 snags from each treatment
  - >10.2 cm in diameter
  - >2 m in height

VARIABLES MEASURED

Snags (2014/2016):

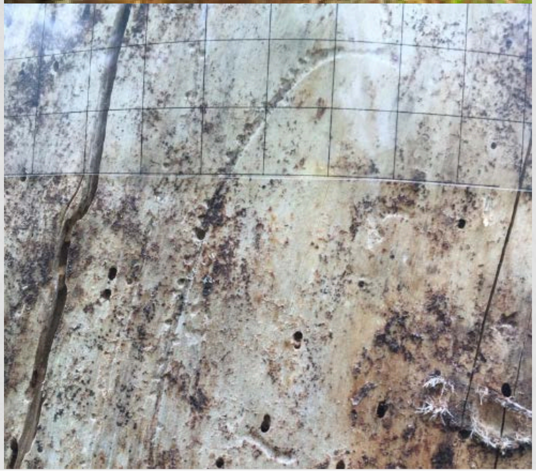
- Diameter at breast height (DBH)
- Snag/tree height
- Number of nearby snags/trees
- Wood penetrability
- Bark coverage
- Bark looseness

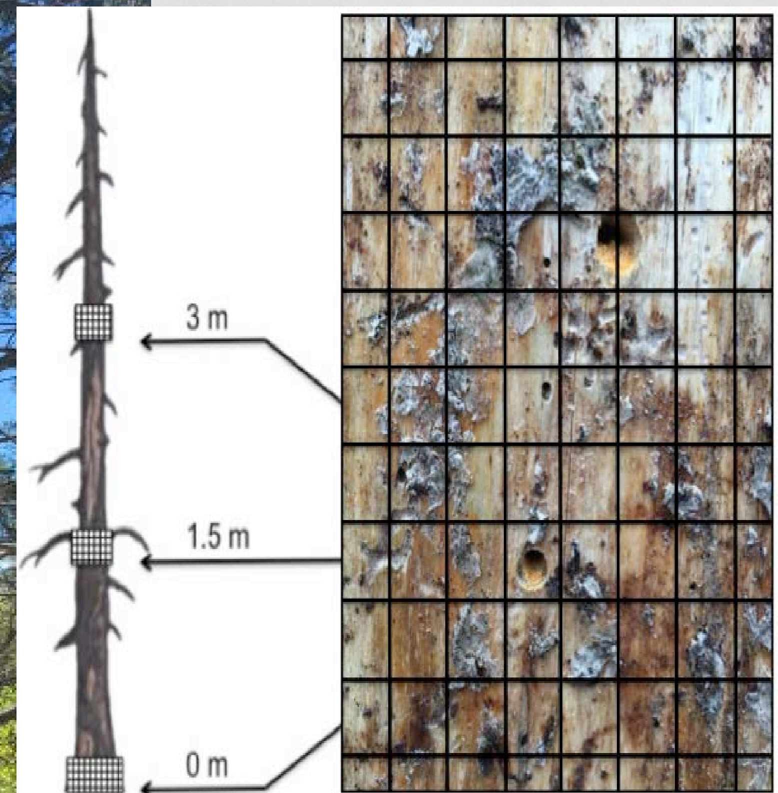
Bird activity (2014):

- Number of foraging excavations
- Number of cavity excavations
- Excavation length, width, and depth
- Excavation height from the ground

Past insect activity (2016):

- Number of entrance/exit holes
- Coverage by galleries




3 m
1.5 m
0 m

METHODS OF ANALYSIS

- Analysis of Variance (ANOVA) and post-hoc Tukey contrasts to compare treatments

- Generalized Linear Models (GLMs) for predicting abundance of **foraging excavations** and presence of **cavities**
  - Based on review of literature, constructed candidate models which were ranked using Akaike's Information Criterion (AIC)

RESULTS: COMPARING TREATMENTS

- **Snag diameter** differed among treatments ($F_{2,101}$=6.93, $p<0.01$)
  - Prescribed fire-created snags smaller in diameter ($p<0.01$)

- **Snag height** differed among treatments ($F_{2,101}$ =17.07, $p<0.01$)
  - G>F>T ($p<0.05$ for all comparisons)

- **Snag density** differed among treatments ($F_{2,101}$=32.61, $p<0.01$)
  - Prescribed fire treatment had snags that were aggregated more densely ($p<0.01$)

- **Snag penetrability** differed among treatments ($F_{2,101}$=16.89, $p<0.01$)
  - Topped snags more penetrable (“softer”) than both other treatments ($p<0.01$ for both)

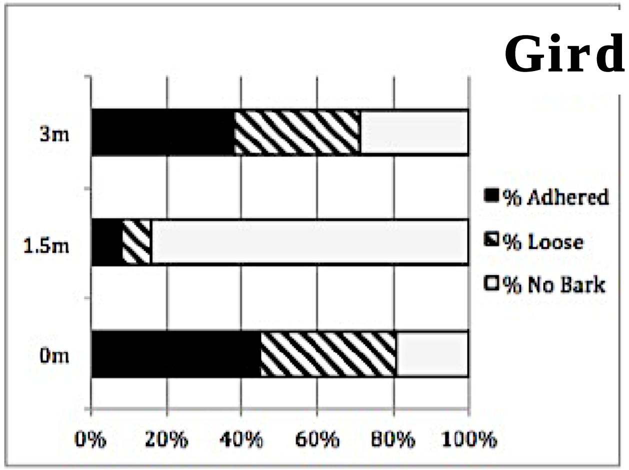
	DBH (cm)	Height (m)	Integrity		% Bark Cover	Penetrability (1-4)*	Trees (ha^{-1})	Snags (ha^{-1})
	Mean *(SD)*	Mean *(SD)*	Intact	Broken	Mean *(SD)*	Mean *(SD)*	Mean *(SD)*	Mean *(SD)*
Girdled	30.2 *(5.6)*	7.4 *(3.9)*	7	28	48 *(24)*	1.7 *(0.4)*	183 *(144)*	31 *(53)*
Topped	33 *(3.6)*	3.4 *(0.3)*	0	35	53 *(27)*	2.2 *(0.5)*	180 *(197)*	26 *(56)*
Prescribed Fire	27.7 *(8.4)*	5.6 *(3.0)*	7	27	40 *(29)*	1.8 *(0.4)*	82 *(151)*	200 *(160)*

*Four-point scale with 1 being the least penetrable and 4 being the most penetrable.

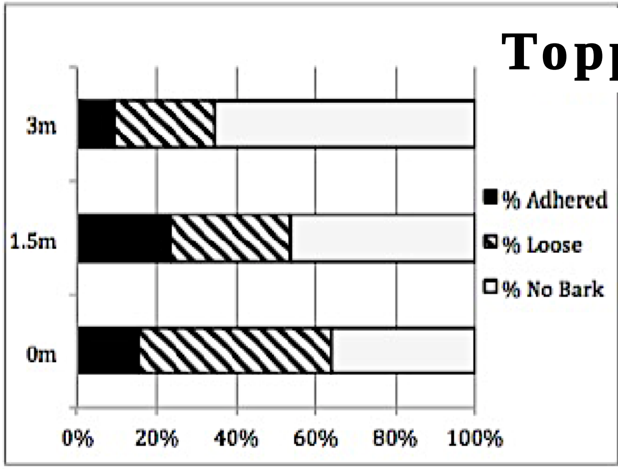
BARK COVERAGE/ LOOSENESS

- **Bark Looseness** differed among treatments ($F_{2,101}$=12.32, p<0.01)
  - Topped snags had a greater percentage of loose bark than both girdled (p=0.03) or prescribed fire (p<0.01)
  - Prescribed fire snags also had less loose bark than girdled snags (p=0.04)

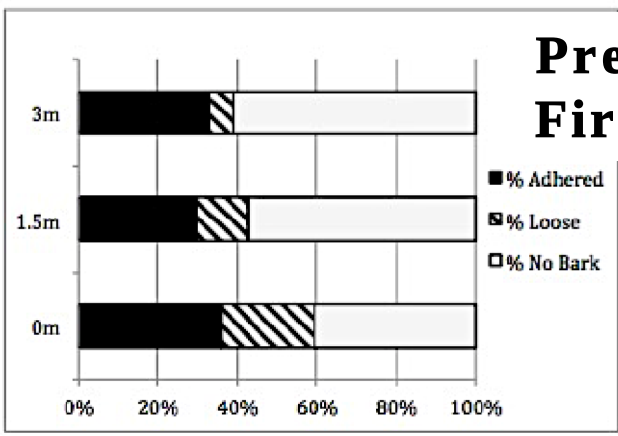
Girdled



Topped



Prescribed Fire



RESULTS: COMPARING TREATMENTS

- **Abundance of foraging excavations** differed among treatments ($F_{2,101}$=6.78, p<0.01)
  - Prescribed fire-created snags had greater numbers of foraging excavations than the girdled (p<0.01) or topped treatment (p=0.02)
  - No significant difference between girdled and topped treatments (p=0.66)

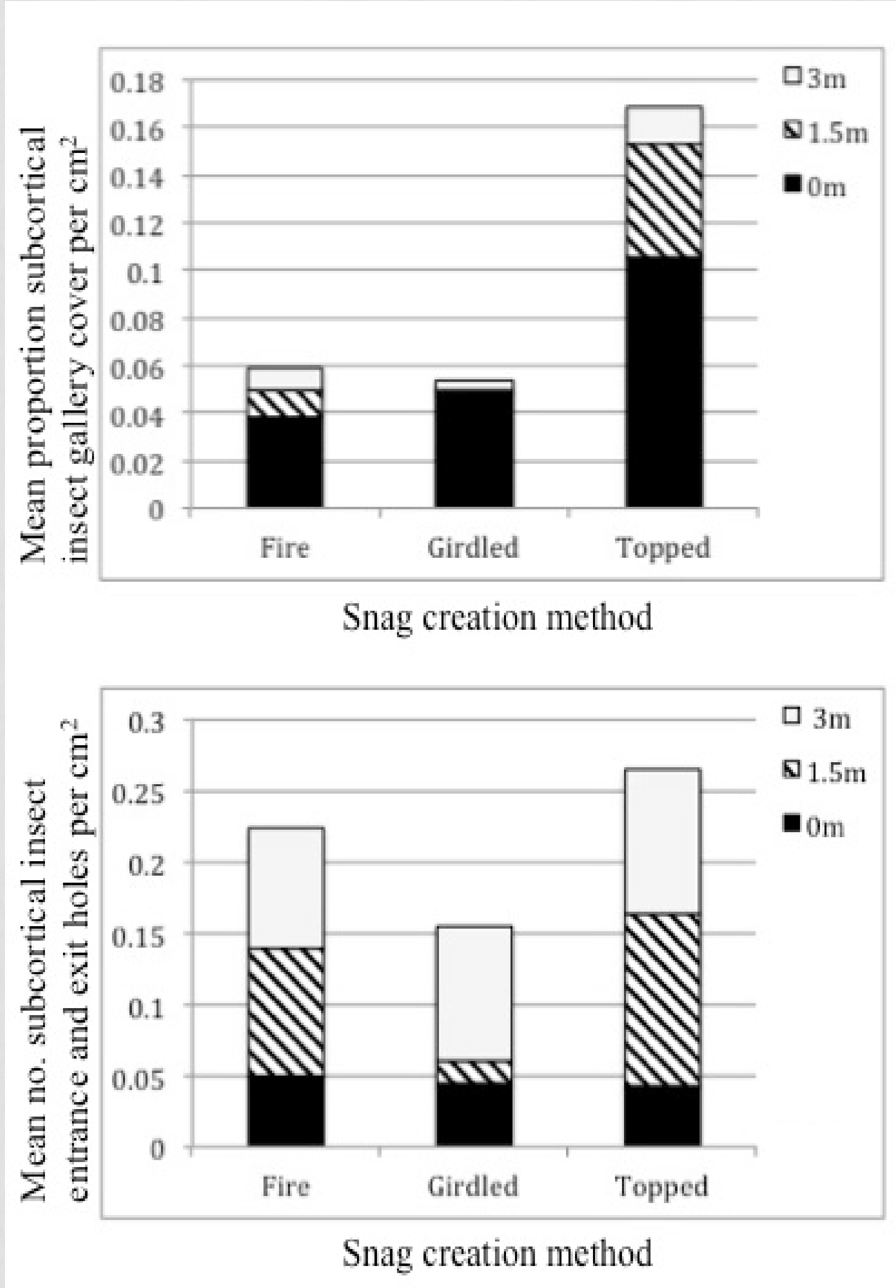
- No significant difference in **cavity presence** on snags among the three treatments ($F_{2,101}$=0.824, p=0.44)

- **Numbers of insect holes** differed among treatments ($F_{2,101}$=19.8, p<0.01)
  - Topped snags had greater levels of insect holes than the other treatments (p<0.01 for both)
  - No significant difference between insect holes between girdled and prescribed fire treatments (p=0.82)

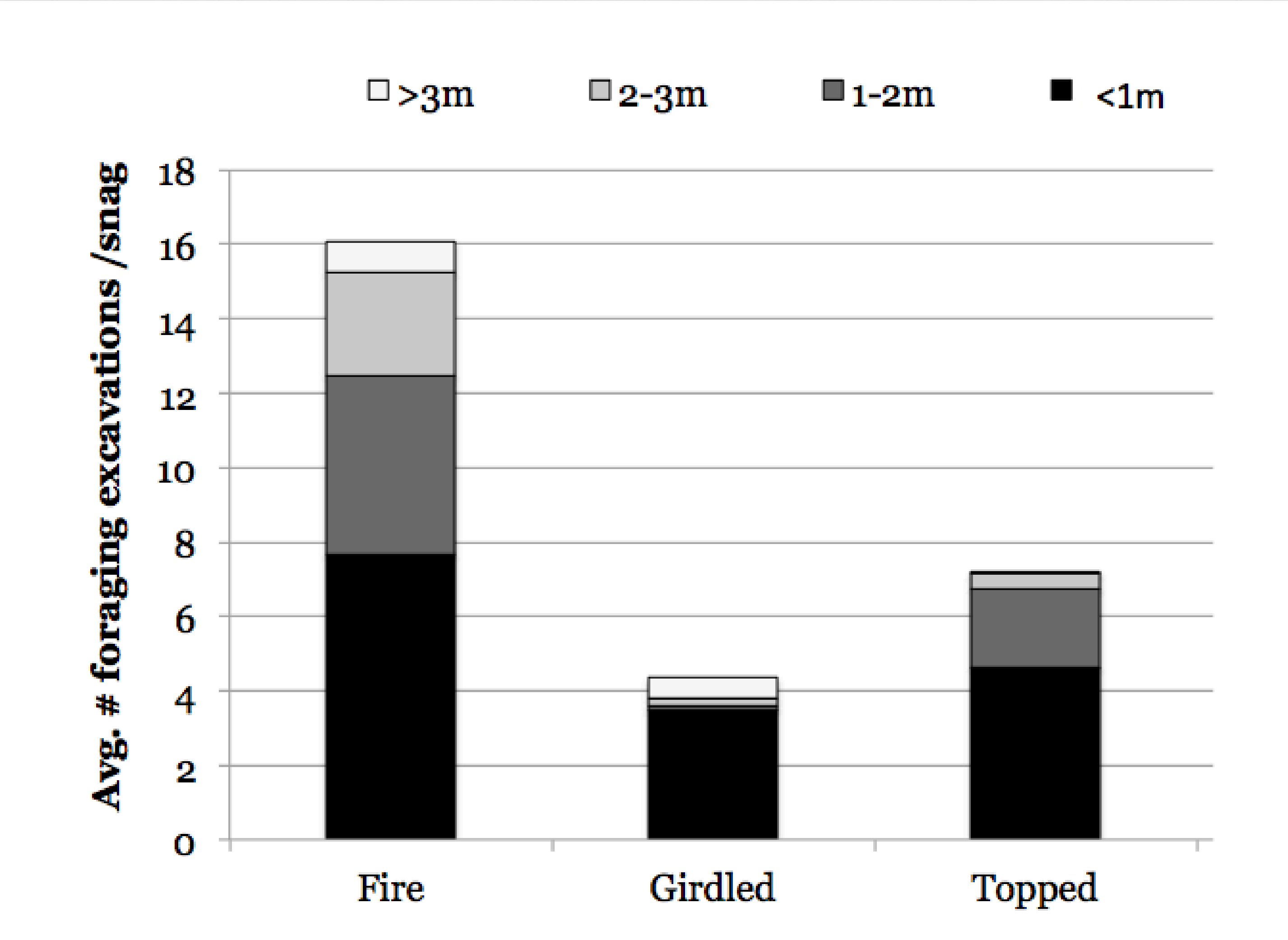
	Foraging Excavations		Cavities	Entrance and Exit Holes (m^{-2})	Entrance and Exit Holes (m^{-2}) by Size			Gallery Cover (m^{-2})
	Total	Mean *(SD)*	Total	Mean *(SD)*	# Small <0.2mm Mean *(SD)*	# Medium 0.2-0.5mm Mean *(SD)*	# Large >0.5mm Mean *(SD)*	Mean *(SD)*
Girdled	152	4.3 *(8.0)*	2	2 *(3)*	1 *(1)*	1 *(1)*	<1 *(<1)*	5 *(4)*
Topped	252	7.2 *(11.1)*	3	8 *(6)*	5 *(3)*	2 *(1)*	1 *(<1)*	9 *(5)*
Prescribed Fire	546	16.1 *(19.7)*	11*	3 *(2)*	1 *(1)*	1 *(1)*	<1 *(<1)*	7 *(8)*

*Cavities were found in 5 snags, two of which were red pines.

INSECT ACTIVITY



FORAGING ACTIVITY



RESULTS: GLMS

No decay variables were included in foraging models

- Foraging : 17 candidate models

Predictor Type	Predictors	K	AICc	ΔAICc	w.AICc
TREATMENT	**Trtmt**	**4**	**645.56**	**0.00**	**0.27**
SNAG DIAMETER	DBH	3	654.89	9.33	0.00
STEM DENSITY	NearSnags	3	652.01	6.45	0.01
	NearTrees	3	657.91	12.36	0.00
	NearSnags + NearTrees	4	654.25	8.69	0.00
INSECT ACTIVITY	Holes	3	654.94	9.39	0.00
	Galleries	3	657.37	11.82	0.00
COMBINATIONS	DBH + Holes	4	654.72	9.17	0.00
	DBH + Galleries	4	656.31	10.75	0.00
	Trtmt+Holes	**5**	**646.20**	**0.64**	**0.20**
	Trtmt+Galleries	5	647.63	2.08	0.10
	Trtmt+DBH	5	647.97	2.41	0.08
	Trtmt+NearSnags	5	648.02	2.47	0.08
	Trtmt+NearTrees	5	647.15	1.59	0.12
	Trtmt+DBH+Holes	6	648.64	3.08	0.06
	Trtmt+DBH+Galleries	6	650.07	4.52	0.03
	Trtmt+NearSnags + NearTrees	6	649.73	4.18	0.03

TOP MODELS FOR FORAGING

		Estimate	SE	z-value	p-value
	Predicting the number of foraging excavations				
Model 1 (Trtmt):	Intercept	1.47	0.24	6.11	<0.01
	Fire	1.31	0.34	3.90	<0.01
	Topped	0.51	0.34	1.51	0.13
Model 2 (Trtmt+Holes):	Intercept	1.58	0.25	6.38	<0.01
	Fire	1.30	0.33	3.90	<0.01
	Topped	0.73	0.38	1.90	0.06
	Holes	-4.69	3.33	-1.41	0.16

- **Treatment** significantly predicted abundance of foraging excavations
  - Nearly 2 times the number of foraging excavations predicted for a snag in the fire treatment compared to the girdled treatment
  - 1.4 times as many foraging excavations predicted in prescribed fire treatment compared to the topped treatment

RESULTS: GLMS

- Cavity Presence: 34 candidate models

Predictor Type	Predictors	K	AICc	ΔAICc	w.AICc
TREATMENT	Trtmt	3	70.72	5.52	0.01
SNAG DIAMETER	**DBH**	**2**	**65.21**	**0.00**	**0.15**
STEM DENSITY	NearSnags	2	67.36	2.15	0.05
	NearTrees	2	70.05	4.85	0.01
	NearSnags + NearTrees	3	69.59	4.38	0.02
DECAY	Integrity	2	69.98	4.77	0.01
	Penet	2	70.08	4.87	0.01
	BarkCover	2	70.09	4.88	0.01
COMBINATIONS	DBH + BarkCover	3	67.20	2.00	0.06
	DBH + Penet	3	67.46	2.26	0.05
	DBH + Integrity	3	66.79	1.58	0.07
	NearSnags + Integrity	3	69.62	4.41	0.02
	NearSnags + Penet	3	69.53	4.33	0.02
	NearTrees + Integrity	3	72.19	6.99	0.00
	NearTrees + Penet	3	72.30	7.09	0.00
	NearSnags + NearTrees + Integrity	4	71.94	6.74	0.01
	NearSnags + NearTrees + Penet	4	71.86	6.65	0.01
	Trtmt+DBH	4	67.35	2.14	0.05
	Trtmt+NearSnags	**4**	**65.45**	**0.24**	**0.13**
	Trtmt+NearTrees	4	72.77	7.57	0.00
	Trtmt+NearSnags + NearTrees	5	66.44	1.23	0.08
	Trtmt+Integrity	4	72.89	7.69	0.00
	Trtmt+Penet	4	73.05	7.85	0.00
	Trtmt+BarkCover	4	73.01	7.81	0.00
	Trtmt+DBH + BarkCover	5	68.55	3.34	0.03
	Trtmt+DBH + Penet	5	69.82	4.61	0.02
	Trtmt+DBH + Integrity	5	68.25	3.05	0.03
	Trtmt+NearSnags + Integrity	5	67.72	2.52	0.04
	Trtmt+NearSnags + Penet	5	67.92	2.71	0.04
	Trtmt+NearTrees + Integrity	5	75.05	9.85	0.00
	Trtmt+NearTrees + Penet	5	75.21	10.00	0.00
	Trtmt+NearSnags + NearTrees + Integrity	6	68.60	3.39	0.03
	Trtmt+NearSnags + NearTrees + Penet	6	69.02	3.82	0.02

TOP MODELS FOR CAVITY PRESENCE

	Estimate	Odds Ratio	SE	z-value	p-value
Predicting the presence of cavities					
Intercept	-6.35	0.00	2.15	-2.95	<0.01
DBH	0.13	1.14	0.06	2.04	0.04
Intercept	-2.57	0.08	0.73	-3.50	<0.01
Fire	2.21	9.09	0.96	2.30	0.02
Topped	0.37	1.45	0.95	0.39	0.69
NearSnags	-1.15	0.32	0.55	-2.10	0.03

- **Diameter** is a significant predictor of cavity presence
  - The odds of a cavity being present was 1.14 times more likely for every cm increase in DBH
- **Treatment** is a significant predictor of cavity presence
  - Cavities were 9.09 times more likely to be present on a snag within the prescribed fire treatment
- **Nearby snags** (snag density) was a significant predictor
  - Cavities were ~1/3 less likely to be present at every increase in the number of nearby snags

SUMMARY

Treatment	**Major Snag Characteristic(s)**
Girdled	• Low bark retention at site where girdling occurred • Wood density is highest and wood is relatively harder • Prone to breaking • Lowest level of colonization by subcortical insects
Topped	• High bark retention • Greater proportions of loose bark • Wood is relatively softer, less dense • Most heavily colonized by subcortical insects
Prescribed Fire	• Low bark retention • Greater adherence of remaining bark • Wood hardness is similar to that of live trees • 2nd most colonized by subcortical insects

CONCLUSIONS

- Treatment with highest insect use (topped) did not have the most foraged-on snags
- Treatment was an important predictor of both foraging excavations and cavity presence
  - Birds selecting snags to forage on based on additional cues? (recently burned stands)
- Large diameter snags important for cavity excavation
- Height a limiting factor on topped snags?


Photo credit: Greg Corace

CONSIDERATIONS FOR OTHER TAXA

Treatment	Major Snag Characteristic(s)	Implications for Birds	Implications for Mammals	Implications for Herptofauna
Girdled	• Low bark retention at site where girdling occurred • Wood density is highest and wood is relatively harder • Prone to breaking • Lowest level of colonization by subcortical insects	• Lowest snag value for cavity-nesting birds over periods of 9-13 years? • The hardness of wood and lower insect use may preclude foraging by some birds • For perching species (e.g., raptors) the soundness of wood may be useful.	• May yield long-lasting coarse wood material benefiting small mammals as cover over time.	• May yield long-lasting coarse wood material benefiting herptofauna as cover over time.
Topped	• High bark retention • Greater proportions of loose bark • Wood is relatively softer, less dense • Most heavily colonized by subcortical insects	• Use by insects is relatively high. • Decay and wood softness resulting from this treatment may provide a substrate that is easily excavated for weaker cavity-nesters, such as nuthatches and chickadees. • The height of this specific treatment may preclude cavity excavation by some species.	• Possibly high value for bats due to high bark retention and bark looseness. • Combined with high levels of insect use, this treatment could provide feeding sites and cover for rodents as well.	• Possibly high use by herptofauna due to high bark retention and bark looseness. • (Two snake species and one tree frog were observed beneath the bark of topped snags)
Prescribed Fire	• Low bark retention • Greater adherence of remaining bark • Wood hardness is similar to that of live trees • 2nd most colonized by subcortical insects	• May be preferred (or necessary) for many primary cavity-nesters.	• In terms of amount of bark present, possibly lower use by bats and mammals in short-term. • Over time the remaining bark may become less adhered providing cover for bats and small mammals.	• In terms of amount of bark present, possibly lower use by herptofauna in short-term. • Over time the remaining bark may become less adhered and provide cover for herpetofauna.

ACKNOWLEDGEMENTS

- The Ohio State University
- Seney National Wildlife Refuge
- Seney Natural History Association
- Sarah Rademacher, Lyndsay Morrison, and Tayelor Gosselin

QUESTIONS?

ADDITIONAL INFORMATION

- Email: shlbweiss@gmail.com

- Weiss, S.A., R.G. Corace III, E.L. Toman, D.A. Herms, P.C. Goebel. 2017. Wildlife Implications Across Snag Treatment Types in Jack Pine Stands of Upper Michigan. Forest Ecology and Management: *In Press*.

2017-2018 Webinar Series
November 16, 2017

CanFIRE: predicting fire behaviour and fire effects.

Dr. W.J. (Bill) de Groot
Fire Research Scientist
Natural Resources Canada-Canadian Forest Service