2017-2018 Webinar Series

January 18, 2018

Prescribed fire in pine stands, tree mortality and the response of insects and pathogens.

Steve Katovich, Ph.D.

Forest Entomologist

USDA Forest Service - Forest Health Protection

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.

Prescribed fire in pine stands, tree mortality and the response of insects

Steve Katovich
USFS
Forest Health Protection

Fire and insects - references

ELSEVIER

Forest Ecology and Management 144 (2001) 245–254

Forest Ecology and Management

www.elsevier.com/locate/foreco

Interactions between fire and bark beetles in an old growth pine forest

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Received 2 January 2000; accepted 12 March 2000

Abstract

Management strategies for old growth pine forests have recently begun to include prescribe
interactions between bark beetles and mature pine trees, but we cannot predict the effects becaus
numeric and functional responses of bark beetle populations to fire, and because we do not know
defense system of pine trees. We estimated population abundance of *Ips* spp. (Coleoptera: Scol
mature red pines (*Pinus resinosa*), before and after a prescribed burn, inside and outside the bu
Itasca State Park, Minnesota. Following a prescribed burn in April, the local abundance of *Ip*
during May, decreased by a comparable amount during 6 weeks starting in mid-July, and wa
abundance of *I. grandicollis* and *I. perroti* were unaffected, while that of a specialist predator, *Th*
Cleridae) increased by 30–90% during May. Many mature trees that sustained no visible crow
attacked by *Ips* within the scorched region of the lower bole. Oleoresin flow increased substa
boles, which may limit the probability that trees will be killed by bark beetles following a groun
increases the probability that a healthy tree will sustain bark beetle attacks by locating beetle-inf
the burned area, and comparing their growth history (from growth rings) with paired, unattacked
no indication of recently declining growth, or chronically slow growth, in beetle-infested trees
prescribed burn. Half of the trees attacked by *Ips* in 1998 were dead in 1999 and the remaind
attacks, which increases their subsequent vulnerability to fires, insects, and pathogens. *Ips* bark
effects on the survivorship of red pine populations, and their demographic impact is probabl

Keywords: Fire; Itasca State Park; Tree defense; Scolytidae

1. Introduction

Fire suppression has altered the structure of many forest ecosystems by disrupting patterns of distur-

bance and regrowth (Clark
some forests, prescribed bu
mented in an attempt to re
and re-create natural distu
and Taylor, 1992; Attiwil
addition to promoting regen
tree species, prescribed fi
breaks and have been advoc

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0378-1127/01/$ – see front matter
PII: S0378-1127(00)00389-3

Longhorned and Flatheaded Borers Attacking Fire-Killed Coniferous Timber in Michigan[1]

FRANK T. PARMELEE, *Department of Entomology Michigan State College, East Lansing*

Wood-boring insects, chiefly beetles, often do a great deal of damage to dead standing or fallen timber, which would be highly merchantable were it not for their depredations. Losses following fires and windstorms in coniferous forests, especially if death of the trees occurs at a time when the adult beetles are flying, have been reported as high as 50 per cent in three years and commonly 100 per cent in

study was begun in the fall of 1937 and continued through 1938 and 1939. During that time several truck loads of infested, fire-killed, storm-felled, and slash, coniferous timber was cut from various Michigan localities and brought to the laboratories at East Lansing for study. Infested material from native Michigan jack pine, *Pinus banksiana* (Lamb); white pine, *Pinus strobus* (L.); Norway or red pine,

Fire and Insects in Northern and Boreal Forest Ecosystems of North America*

Annual Review of Entomology
Vol.43:1-726 (Volume publication date January 1998)
DOI: 10.1146/annurev.ento.43.1.107

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What role insects can play in fire-damaged trees following a prescribed burn?

Mature red and white pine stand

Superior National Forest

18 mile burn unit, Tofte RD

What role insects can play in fire-damaged trees following a prescribed burn?

Red pine plantation
Chippewa National Forest

6 Mile Lake burn unit, burned 2014

Common questions.....

- Will insects find and infest fire-damaged trees? Are these trees attractive to insects?
- Are insects contributing to the mortality or are they simply utilizing trees killed by the fire?
- will insect populations build in fire damaged trees and threaten nearby trees and nearby stands?
- Could this have been avoided?

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Pine trees killed by fires and many trees damaged by fire are generally infested by an array of insects

Evidence of insect attack

Fire-damaged trees create a signature on the landscape that many insects (bark beetles, wood borers) can perceive and respond to very quickly

- Smoke
- Heat (infrared detection)

- Release of alcohols such as ethanol

- Sex pheromones

J Comp Physiol A (1998) 182: 647–657

ORIGINAL PAPER

H. Schmitz · H. Bleckmann

The photomechanic infrared receptor for the detection of forest fires in the beetle *Melanophila acuminata* (Coleoptera: Buprestidae)

Accepted: 1 November 1997

Abstract We recorded from single units of individual sensilla of the thoracic infrared (IR) pit organs of *Melanophila acuminata*. When the organ was stimulated with a thermal radiator whose emission spectrum was similar to that of a typical forest fire, units responded phasically with up to seven spikes within 30–40 ms at a radiation power of 24 mW cm^{-2}. In the experiments all wavelengths shorter than 1.6 µm were excluded by a longpass IR filter. Response latencies were about 4 ms and initial impulse frequencies were up to 250 impulses per second (ips). A single spike could be generated even when stimulus duration was only 2 ms. Reduction of total radiation power from 24 mW cm^{-2} to 5 mW cm^{-2}

forest fires (Ricksecker 1885; Champion 1909; 1913; Apel 1988; 1989). The larvae of *Mela* absolutely depend on wood of fresh fire-killed tr cause they can not cope with the defence reactio living tree to insect feeding (Graham 1939; K-H personal communication). For this reason *Melanophila* approach forest fires in "sometimes lievable numbers" (Linsley 1943). Mating usuall place while the fire is still burning and females their eggs under the bark of burnt trees imme after the flames have subsided. Under ordinary tions the beetles are rarely encountered in (Linsley 1943). Therefore, *Melanophila* must be

nature
International journal of science

Altmetric: 0 Citations: 84 More detail »

Scientific Correspondence

Insect antenna as a smoke detector

Stefan Schütz, Bernhard Weissbecker, Hans E. Hummel, Karl-Heinz Apel, Helmut Schmitz & Horst Bleckmann

Nature **398**, 298–299 (25 March 1999)
doi:10.1038/18585
Download Citation

Published online: 25 March 1999

Abstract

The larvae of jewel beetles of the genus *Melanophila* (Buprestidae) can develop only in the wood of trees freshly killed by fire[1]. To arrange this, the beetles need to approach forest fires from as far as 50 kilometres away[1, 2]. They are the only buprestid beetles known to have paired thoracic pit organs[3], which behavioural[2], ultrastructural[4] and physiological experiments[5] have shown to be highly sensitive infrared receptors, useful for detecting forest fires. It has been suggested that *Melanophila* can sense the smoke from fires[6], but behavioural experiments failed to show that crawling beetles approach smoke sources[2]. We find that the antennae of jewel beetles can detect substances emitted in smoke from burning wood.

Similar group of insects that respond to storm damage

Stem boring insects and bark beetles are attracted to fire damaged trees

- Many stem invading insects (wood borers and bark beetles) are attracted to fire-damaged trees.
- This process can happen quickly. Many of these insects can respond during or soon after a burn (volatile chemical cues, smoke, infrared heat).

- Once attracted can they successfully infest the damaged trees?

How do pine trees defend themselves from stem boring insects?

- Pines utilize resin production and resin pressure to defend against insects that are attempting to chew through the bark and gain entry to the phloem or cambial tissue

How does fire injury impact a pine trees ability to produce resin?

- Dead trees stop resin production and have little or no resin pressure
- Fire damaged trees can have a short term drop in resin production/pressure. This can create a window of opportunity for some wood boring insects.
- Over time (10-30 days) stem damaged trees often increase resin production

How does fire injury impact a pine trees ability to produce resin?

- The increase in resin production may not last in trees that have lost much of their crown due to scorch. Over time those trees can show a reduction in resin production and therefore an increased risk to bark beetles or other wood borers.

Fires and insects - summary

- Dead trees – killed outright by a burn
- Wood borers and bark beetles quickly lay eggs on these trees that have no ability to defend themselves from insect attack
- Damaged trees –Fire injury can impact resin flow which has a direct effect on stem boring insects
- Fire damage can compromise a once healthy tree

Can insects successfully infest fire-damaged pines

- Seems very likely – though it may depend on the level of damage that a tree sustained, local insect populations, timing of the fire with insect presence, ...

Common questions.....

- Will insects find and infest fire-damaged trees? Are these trees attractive to insects?
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- Could this have been avoided?

Key insect groups infesting fire killed or damaged red pine

Longhorned beetles

Ips spp.

Metallic woodborers

Turpentine beetle

Longhorned beetles – roundheaded woodborers

G. Lenhard

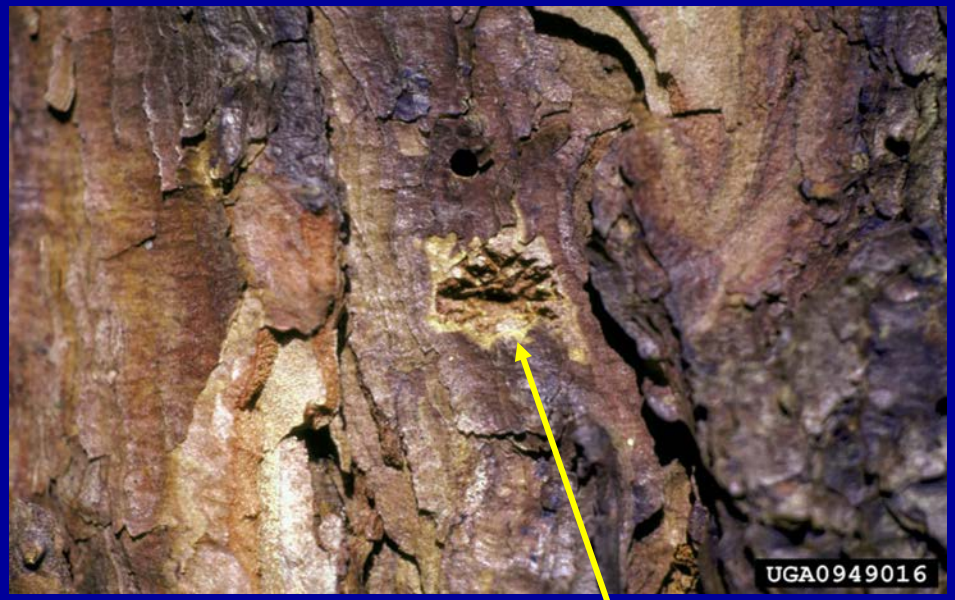
Wood fibers

Cerambycid beetles

- Generally infest dead trees or trees on the verge of dying.
- Not normally considered a threat to living trees.
- Long life cycles of 1-3 years, this means it takes awhile for them to respond numerically to a fire.

Longhorned beetles or roundheaded woodborers - signs

Long wood fibers



egg niche

Metallic woodborers – flatheaded woodborers

The larvae stay in the phloem, and cambium tissues.

They do not tunnel deep into the wood

Oval exit holes

Buprestid beetles

- Generally attack dead trees or trees on the verge of dying.
- In pines - not normally considered a threat to living trees.
- Long life cycles of 1-3 years, this means it takes awhile for them to respond numerically to a fire.

Ips bark beetles

Fine sawdust – may be covering Entrance holes or collecting at The base of the tree

Ips pini

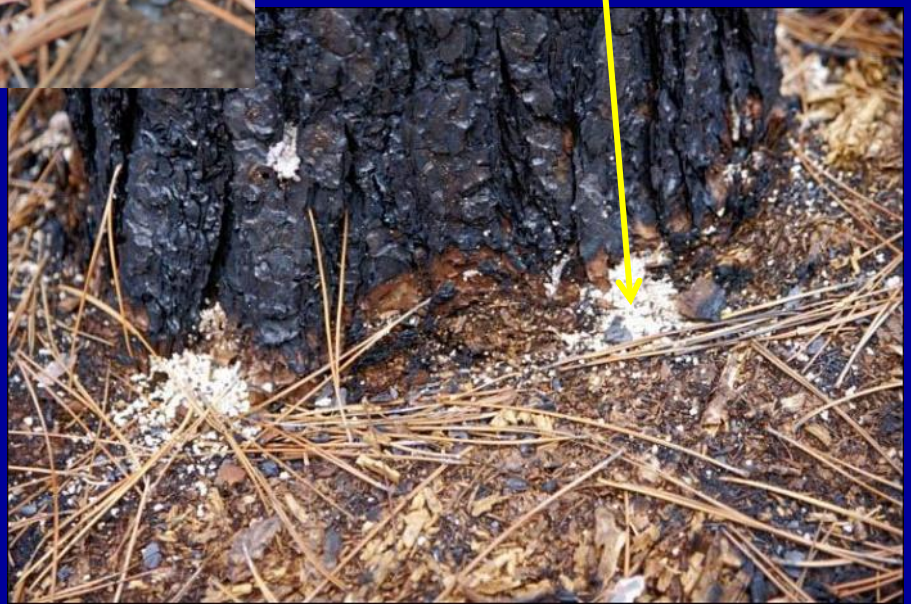
Ips beetles

- Three *Ips* species in Lake States red pine
- Common, 2-3 generations per year. *Ips* are capable of quick increases in local populations
- *Ips pini* is the most likely culprit in killing fire-injured red pines – this is the beetle species most likely to kill trees 1-2 years after a burn.

Turpentine beetles

Pitch tubes

Granular



Dendroctonus valens – red turpentine beetle

- Cave gallery – creates small pockets of dead phloem and cambial tissue.
- One attack is not serious, multiple attacks can lead to significant decline and attack by other beetles (*Ips* spp.).
- Trees with just turpentine beetle attacks may recover

Fires can create conditions very favorable to these insects

- It seems very likely that bark beetles are contributing to mortality following fires. How much additional mortality and how long this persists in a stand is difficult to predict.
- In the Lake States this group of insects would be considered rather nonaggressive, unlikely to kill healthy, vigorous trees.

Common questions.....

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Will insect populations build in fire damaged trees and threaten nearby trees and nearby stands?

- Nearby trees – probably – especially trees that have significant crown loss and/or stem damage
- Nearby stands – seems unlikely – we do not have documented cases of this happening.

Common questions.....

- Will insects find and infest fire-damaged trees? Are these trees attractive to insects?
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- Could this have been avoided?

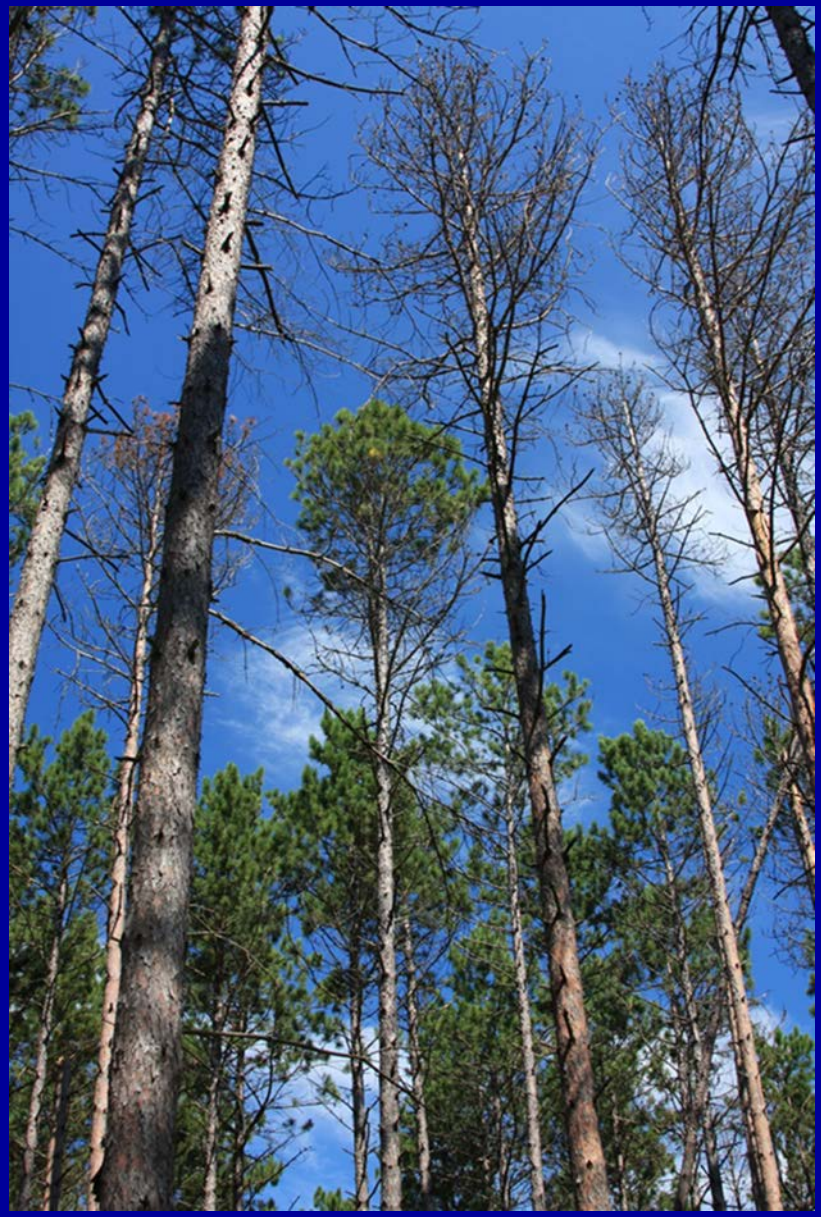
Could this have been avoided? Lets focus on younger red pine plantations

Red pine plantation
Chippewa National Forest

Tree mortality is lingering in this stand 2-3 years after the burn occurred.

Ips pini populations are actively infesting trees that have small live crowns and stem scorch on the lower bole. A good portion of the intact stand has some level of damage related to the burn.

Other wood borers are also active in dead and dying trees.



6 Mile Lake burn unit, burned 2014

This was a relatively young plantation when burned.

The level of tree damage and insect response should not be a surprise.

Red pine fire references –

The role of insects is largely ignored.

General perception that red pine trees are very tolerant of fire.

United States Department of Agriculture

Forest Service

North Central Forest Experiment Station

General Technical Report NC-129

Fire Effects in Northeastern Forests: Red Pine

Cary Rouse

Forest Ecology and Management 368 (2016) 7–16

Contents lists available at ScienceDirect

Forest Ecology and Management

journal homepage: www.elsevier.com/locate/foreco

Long-term impacts of prescribed fire on stand structure, growth, mortality, and individual tree vigor in *Pinus resinosa* forests

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ARTICLE INFO

Article history:
Received 2 December 2015
Received in revised form 5 February 2016
Accepted 29 February 2016
Available online 5 March 2016

Keywords:
Great Lakes region
Forest structure
Long-term silviculture study
Pinus resinosa
Prescribed fire

ABSTRACT

Prescribed fire is increasingly being viewed as a valuable tool for mitigating the ecological consequences of long-term fire suppression within fire-adapted forest ecosystems. While the use of burning treatments in northern temperate conifer forests has at times received considerable attention, the long-term (>10 years) effects on forest structure and development have not been quantified. We describe the persistence of prescribed fire effects in a mature red pine (*Pinus resinosa* Ait.)-dominated forest in northern Minnesota, USA over a ~50 year period, as well as the relative roles of fire season and frequency in affecting individual tree and stand-level structural responses. Burning treatments were applied on 0.4 ha compartments arranged in a randomized block design with four blocks. Burning treatments crossed fire season (dormant, summer) and frequency (annual, biennial, and periodic), and include an unburned control for comparison. Treatments were applied from 1960 to 1970, with no further management interventions occurring since. Data were collected periodically from 1960 to 2014.

Forest structural development trajectories were significantly altered by the application of fire treatments. Burning treatments led to lower overstory densities, lower stand basal area, and larger tree diameters when compared to the unburned control over the study period. Differences between burning treatments were less apparent suggesting that the application of burning itself rather than a particular season and/or frequency of burning drives this long-term response. Overstory tree mortality and stand growth showed little or no response to burning treatments. In addition, we detected no impact of burning on long-term overstory tree growth efficiency (based on assessments >40 years post burning) suggesting these treatments had little cumulative effect on tree vigor. Our results indicate that the effects of burning treatments on structural dynamics are not ephemeral, but rather alter stand development trajectories in

Fire and Red Pine

C. E. VAN WAGNER

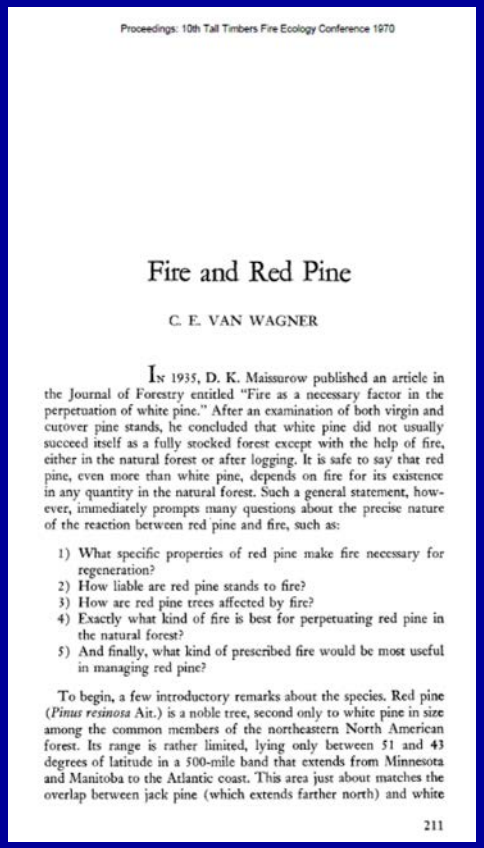
In 1935, D. K. Maissurow published an article in the Journal of Forestry entitled "Fire as a necessary factor in the perpetuation of white pine." After an examination of both virgin and cutover pine stands, he concluded that white pine did not usually succeed itself as a fully stocked forest except with the help of fire, either in the natural forest or after logging. It is safe to say that red pine, even more than white pine, depends on fire for its existence in any quantity in the natural forest. Such a general statement, however, immediately prompts many questions about the precise nature of the reaction between red pine and fire, such as:

1) What specific properties of red pine make fire necessary for regeneration?
2) How liable are red pine stands to fire?
3) How are red pine trees affected by fire?
4) Exactly what kind of fire is best for perpetuating red pine in the natural forest?
5) And finally, what kind of prescribed fire would be most useful in managing red pine?

To begin, a few introductory remarks about the species. Red pine (*Pinus resinosa* Ait.) is a noble tree, second only to white pine in size among the common members of the northeastern North American forest. Its range is rather limited, lying only between 51 and 43 degrees of latitude in a 500-mile band that extends from Minnesota and Manitoba to the Atlantic coast. This area just about matches the overlap between jack pine (which extends farther north) and white

How tolerant of fire are red pine trees?

- “Fires of more than moderate intensity during the first 50 years would likely destroy the whole stand.” (p. 212)
- “red pine produces the most flammable pure stand of any northeastern tree species when growing at high density with a clean floor.” (p. 213)
- “it (red pine) is very liable to total destruction before the age (about 50) at which it produces appreciable seed and has fairly protective bark.” (p. 216)



Proceedings: 10th Tall Timbers Fire Ecology Conference 1970

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211

Limit injury to residual trees when you burn

- These insects are dependent on dead, dying and stressed trees
- So, limit significant crown scorch and limit stem damage
- How do you do that? One thought….be wary of burning in plantations, and burning at younger stand ages

Questions, comments....

- Numbered images were obtained from Forestry images.org

2017-2018 Webinar Series

January 25, 2018 at 11 AM Eastern/ 10 AM Central

We will be hearing about the 3 funded Intern Projects from 2017:

1. Prescribed Burning to Improve Management for Brushland-Dependent Species.
2. Leveraging research and monitoring networks to inform management of at-risk species in the globally rare Pine Barrens ecosystem.
3. Investigating the Relative Importance of Climate and People in the Historical Patterns of Fire to Inform Management of Red Pine at the University of Minnesota Cloquet Forestry Center.