Duff and Fuel Moisture

Science and Tools for a Common Problem

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SOUTHERN
Fire Exchange

Bridging the Gap

Natural Resource & Wildland Fire Management Community

Science Community

Photo by Patrick Tomasso on Unsplash

NORTHWEST FIRE SCIENCE CONSORTIUM

NORTHERN ROCKIES FIRE SCIENCE NETWORK

GREAT PLAINS FIRE SCIENCE EXCHANGE

Tallgrass Prairie and Oak Savanna Fire Science Consortium

OAK WOODLANDS & FORESTS FIRE CONSORTIUM

Lake States Fire Science Consortium

Great Basin Fire Science Exchange

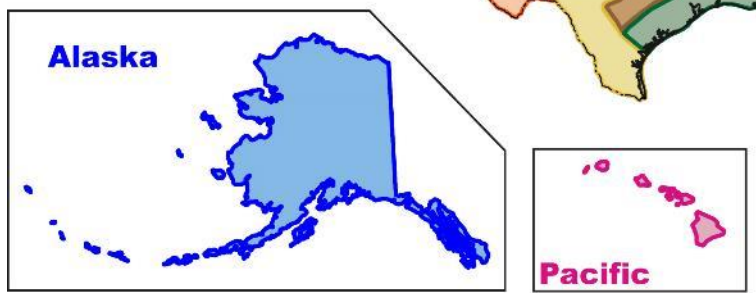
SOUTHERN ROCKIES FIRE SCIENCE NETWORK

NORTH ATLANTIC FIRE SCIENCE EXCHANGE

CALIFORNIA FIRE SCIENCE CONSORTIUM

Consortium of Appalachian Fire Managers & Scientists

SOUTHWEST FIRE SCIENCE CONSORTIUM



PFX Pacific Fire Exchange

SOUTHERN Fire Exchange

ALASKA FIRE SCIENCE CONSORTIUM

JOINT FIRE SCIENCE PROGRAM

Program Structure

UF IFAS UNIVERSITY of FLORIDA

Alan Long, Ph.D., SFRC Prof. Emeritus (Current PI and Admin. Dir.)

Rae Crandall, Ph.D., SFRC Asst. Prof. (Upcoming PI)

TALL TIMBERS Research Station & Land Conservancy

Kevin Robertson, Ph.D., Dir. Fire Ecology Program (Co-PI)

NC STATE UNIVERSITY

Joe Roise, Ph.D., Prof. Forestry and Env. Resource (Co-PI)

FOREST SERVICE US DEPARTMENT OF AGRICULTURE Southern Research Station

Joe O'Brien, Ph.D., Research Ecologist and Fire Team Leader (Co-PI)

Essential Regional Partnerships

North Florida Prescribed Fire Council

Southern Group of State Foresters

America's Longleaf

Coalition of Prescribed Fire Councils, Inc.

National Cohesive Wildland Fire Management Strategy

SERPPAS

Georgia Prescribed Fire Council — Prescribed Fire For A Healthy Forest

Prescribed Fire Training Center

Southern Fire Exchange

UF IFAS University of Florida

NC State University

Tall Timbers Research Station & Land Conservancy

Joint Fire Science Program

Forest Service U.S. Department of Agriculture

North Carolina Prescribed Fire Council
www.ncprescribedfirecouncil.org/

Ordway-Swisher Biological Station
University of Florida IFAS

The Nature Conservancy
Protecting nature. Preserving life.™
nature.org

NRCS Natural Resources Conservation Service

Southern Regional Extension Forestry

Florida Forest Service

Prescribed Fire Science Consortium

St. Johns River Water Management District

SFE Science Delivery Programing

User Accessed

- Fact Sheets
- Newsletters
- Website
- Videos
- Email / Social Media

Direct Delivery

- Webinars
- Meeting Presentations
- Fire Ecology Database

Personal Interactions

- Workshops
- Field Tours
- Classes
- Events
- Conferences

- User Effort Investment and Engagement +

Field Workshops

Since FY15:

- 51 workshops/field tours/training events
- >2,000 participants
- Locations including: FL, GA, AL, TX, LA, SC
- Topics Including:
  - Longleaf Mgt.
  - Ground Cover Rest.
  - Duff Fire Science
  - Fire Models

Newsletters Reach 3,000

Over 40 Fact Sheets

SOUTHERN
Fire Exchange
Uniting Fire Science and Natural Resource Management

FIRE LINES

A Joint Newsletter of the Southern Fire Exchange and the Southeastern Section of the Association for Fire Ecology

January - February 2016
Volume 6 - Issue 1

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Do Liability and Regulatory Standards Influence the Amount of Prescribed Burning in the South?

This is an interesting question given the diversity of standards in legislation and regulations related to certified prescribed burn managers (CPBM) across the region. Two states (Florida and Georgia) use "gross negligence" as the liability standard for loss of control of prescribed fires and civil damages and injuries. "Simple negligence" is the standard in the other southern states. In most states, statutory requirements for liability protection under either standard include a burn permit but are more variable with respect to the presence of a CPBM at the burn, written prescriptions, adequate personnel and firebreaks, and burn ban exemptions. A fascinating new study reported in *Ecological Applications* (Wonkka, Rogers, and Kreuter, 2015) asked the question at the top of this article, using Florida, Alabama, Georgia, South Carolina and North Carolina records for prescribed burns on private lands from 2008 to 2013. By pairing 66 adjacent counties across state lines, the authors were able to evaluate the effects of different liability and regulatory standards on two variables: 1) percentage of privately owned forest, range, and pasture land burned each year and 2) the annual number of prescribed fires on those lands.

In the two states with gross negligence liability, the annual percentage of private acres burned was significantly higher than in adjacent counties with simple negligence standards. These results suggest that the extra liability protection under the gross negligence standard provides an extra incentive for landowners to utilize prescribed burning for land management and resource protection. On average, the additional 3.5% of acres burned in those states is approximately 7,100 acres/county. The number of prescribed burns was also higher in "gross negligence" counties than in "simple negligence" standard counties across state lines. Interestingly, the authors did not find that other requirements (such as having a CPBM on site or written burn prescriptions) in addition to burn permits had any effect on the two main variables. Rather than discouraging landowners from burning, the additional requirements may serve to encourage them through the training and safety awareness that come with those requirements. This study provides new information that could be helpful as states and counties evaluate policies relevant to prescribed burning.

Wonkka, C.L., W.E. Rogers, and U.P. Kreuter. (2015). Legal barriers to effective ecosystem management: exploring linkages between liability, regulations, and prescribed fire. *Ecological Applications* 25(8): 2382–2393.

SFE Webinar: El Nino, La Nina and the 1998 Florida Wildfires

Wednesday, February 17, 2016
1:00 - 2:00 PM, Eastern

Click here to register for this webinar!

The current 2015-2016 El Niño event has many Florida fire managers thinking of their experiences from 1998. During the epic 1998 Florida wildfire season, more than 500,000 acres burned resulting in damage and suppression costs of $390 million. Interestingly, the 1998 fires occurred during a La Niña event that followed the last strong El Niño. During this webinar, Scott Goodrick with the U.S. Forest Service Southern Research Station will discuss what managers need to know about the impacts of ENSO events on the 1998 fires and Florida wildfire seasons in general. Following the webinar there will be time for audience questions and answers. One hour of Category 1 Society of American Foresters Continuing Education credit is anticipated.

CONTACT INFORMATION

For questions and feedback, email contactus@southernfireexchange.org

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SFE Fact Sheet 2017-1

What the Research Says: Prescribed Fire and Wildfire Risk Reduction

Alan Long and Annie Ouzts

A variety of research studies have found similar conclusions: Prescribed fire reduces wildfire risk, intensity, and size in southern pine flatwoods ecosystems, but for a relatively short time.

Most fire and natural resource managers across the Southeast agree that prescribed fire reduces wildfire risk. After all, fuels reduction is an objective that is often included in burn plans, and many managers and landowners have seen firsthand how wildfires respond in unburned versus frequently burned areas. But beyond observational and anecdotal information, what scientific findings do we have that prescribed fire reduces wildfire risk? And how long do these effects last? These questions have been asked for at least 50 years in the South and a number of research studies have addressed them from various angles. This fact sheet summarizes the conclusions of five studies conducted in pine flatwoods ecosystems.

Researchers have been studying how prescribed fire influences wildfire in pine flatwoods ecosystems for more than 50 years. Photo: David Godwin

One of the earliest studies that assessed prescribed fire effects on wildfire risk was reported by Davis and Cooper (1963). The authors tracked 380 wildfires over 4 years on almost 1 million acres in South Georgia and North Florida and classified the years since the last burn for each wildfire. Results of this study showed that the areas classified as having a 0–2 year rough had a wildfire occurrence rate of 0.73 wildfires per 10,000 acres, while the 3–5 year rough had a rate of 1.19 wildfires per 10,000 acres. In addition, the acres burned annually increased with the time since fire, with annual burn percentages ranging from 0.03% to 0.14% in the 0–5 year rough and 7.5% in the more than 5 year rough.

Conclusion: Fuel accumulations of fewer than 3 years resulted in less wildfires, fewer acres burned, and lower fire intensities than fuel accumulations greater than 3 years.

From 1998 to 2000, wildfires occured across northern Florida, with several of those fires burning up to or across areas that had been treated with prescribed fire or other fuel treatments. This provided an opportunity for researchers to evaluate the effects of fuels treatments on wildfire characteristics. For example, Brose and Wade (2002) measured fuel loads in Northeast Florida on sites where fuels had been treated through herbicide application, prescribed fire, or thinning. Fuel loads were measured 1, 2, 3, or 4 years after treatment, and the treatments were compared with unburned rough. The fuel load measurements were then used, in combination with weather conditions recorded during the 1998 wildfires, to evaluate fire behavior in the BEHAVE fire modeling system. Using flame length and rate of spread results as indicators to predict difficulty of wildfire control, the study found that "fire behavior in the 1-year-old prescribed burn and thinned stands would be mild, allowing for easy control" while the opposite is true for untreated stands and for 1-year-old barbicide stands.

Conclusion: Based on model predictions, prescribed fire reduces wildfire hazard for approximately 1 to 2 years, until shrubs recover.

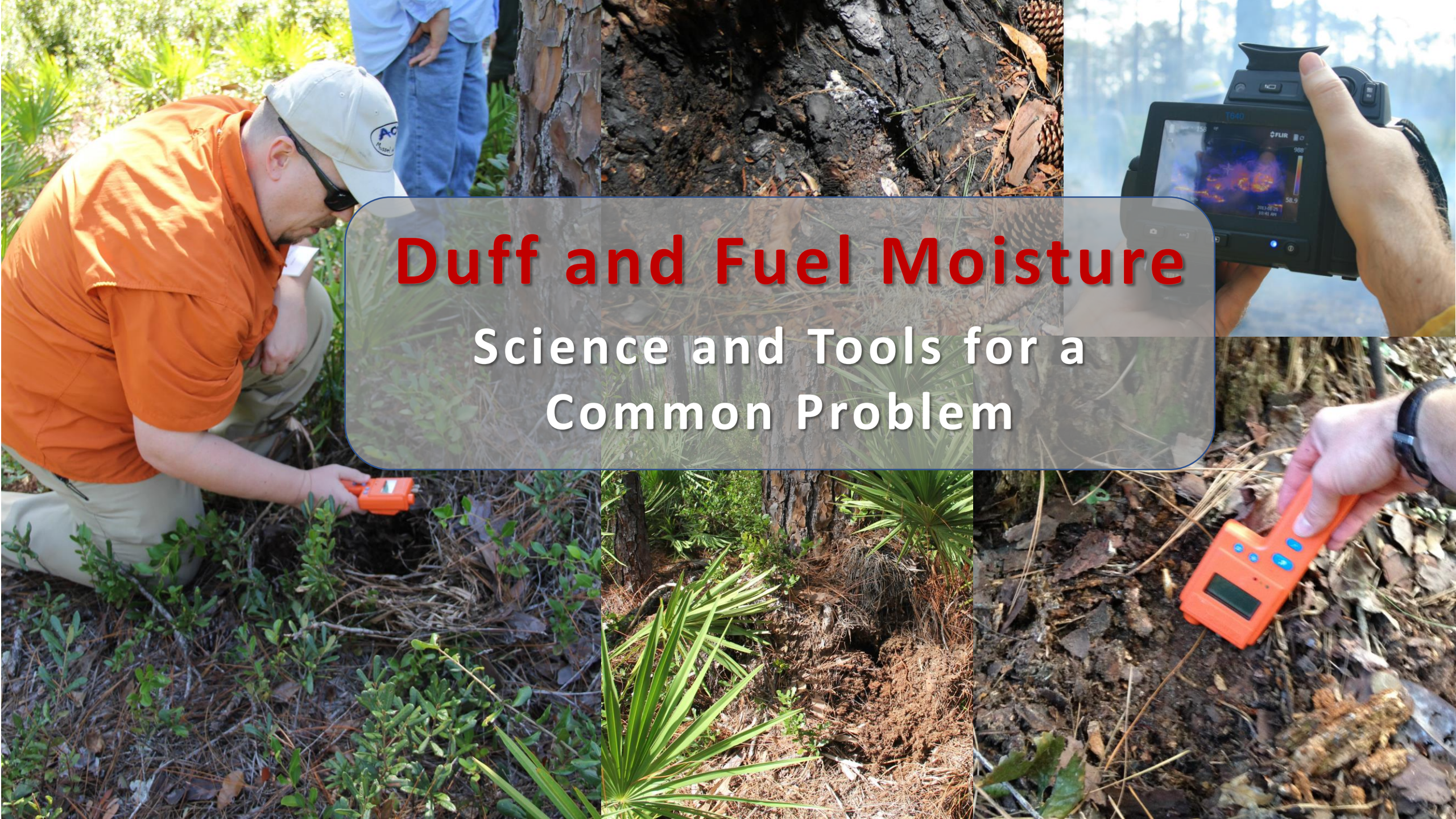
In another study, Outcalt and Wade (2004) evaluated pine mortality after the 1998 and 2000 Florida wildfires on three different properties in Northeast Florida that represented a range of prescribed burning regimes. Results from stands in the Osceola National Forest showed that pine mortality was lowest after wildfires in stands burned in the previous 1.5 years, as compared to older rough. In addition, the results showed that pine mortality was higher at Tiger Bay State Forest, where prescribed burning had been used less frequently, and was highest at Lake Butler forest where prescribed fire was not used.

Conclusion: Wildfire intensity and severity were lower on sites one to two years after prescribed fire than on sites with longer fire return intervals.

Webinars

SFE webinars have been used as training for:

- Everglades Nat. Park Wildland Fire
- Florida Forest Service
- University and Community Colleges
- Georgia Interagency RxFire Burn Teams
- State RxFire Certification Courses



Duff and Fuel Moisture

Science and Tools for a Common Problem

Fire as a Maintainer

Southeastern Coastal Plain Ecosystems are among the most fire-dependent in the world

Fire frequency of 1-3 years common in systems that sustain high levels of diversity

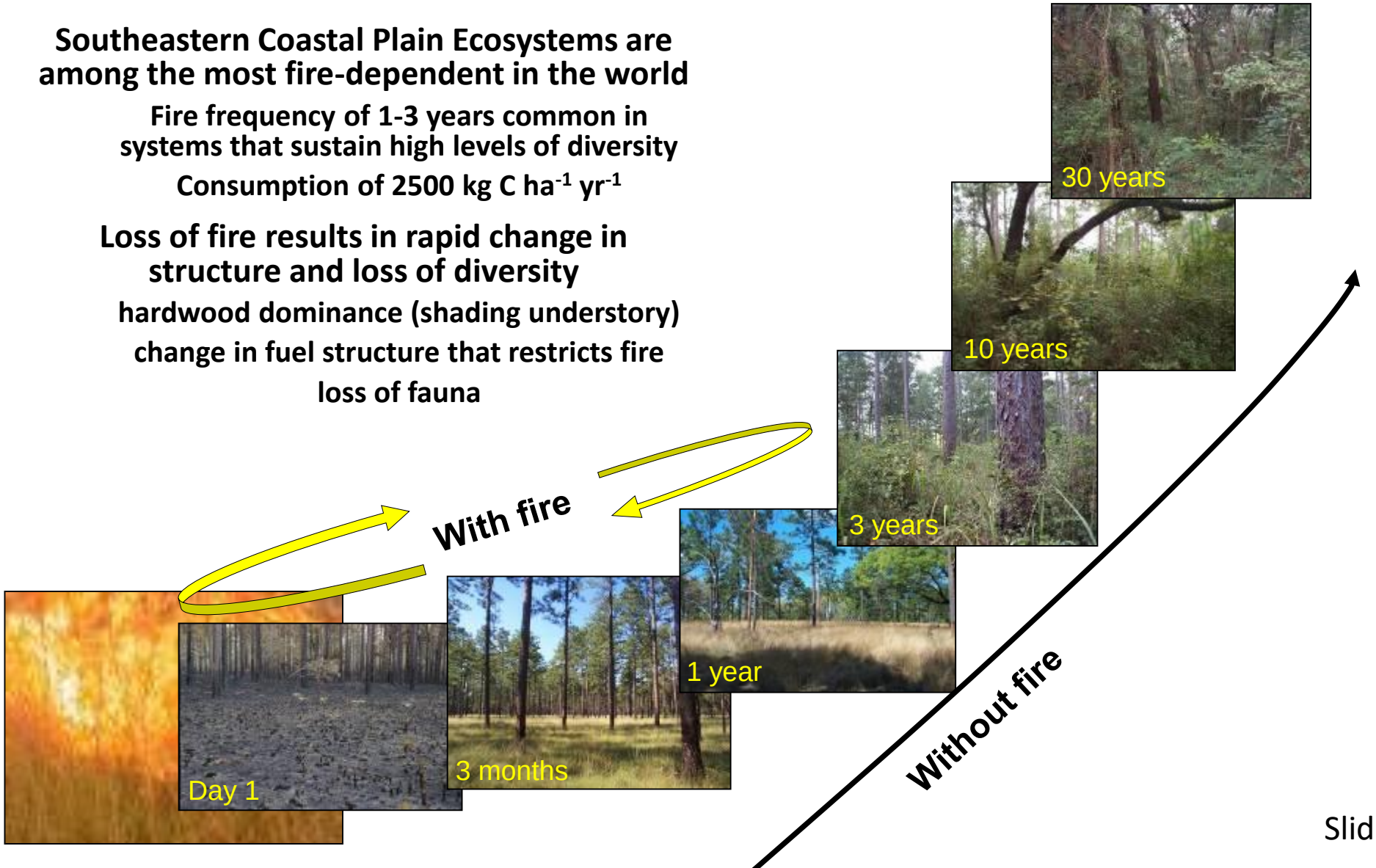
Consumption of 2500 kg C ha^{-1} yr^{-1}

Loss of fire results in rapid change in structure and loss of diversity

hardwood dominance (shading understory)

change in fuel structure that restricts fire

loss of fauna



Slide: Kevin Hiers

Problems Arise Without Fire

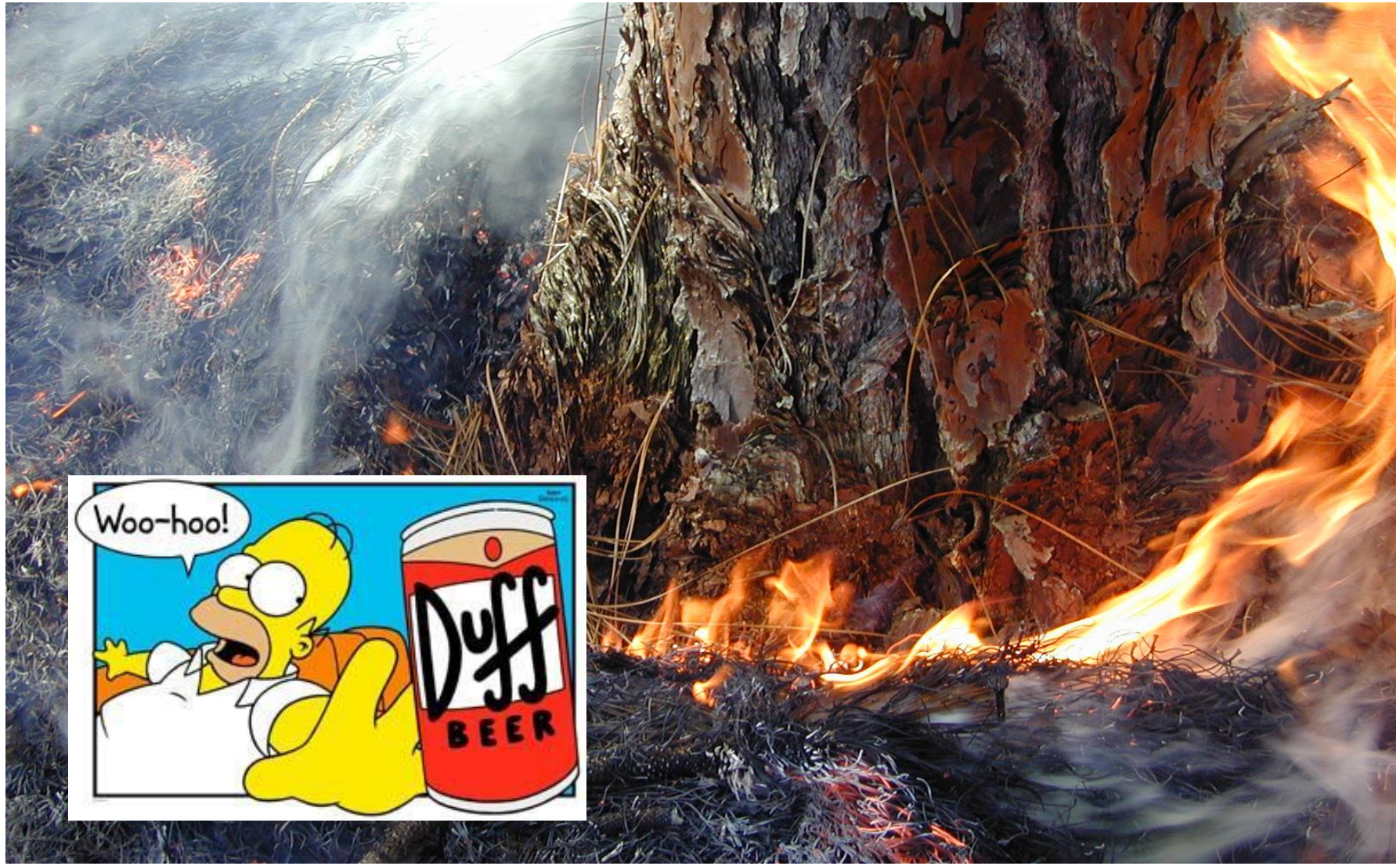
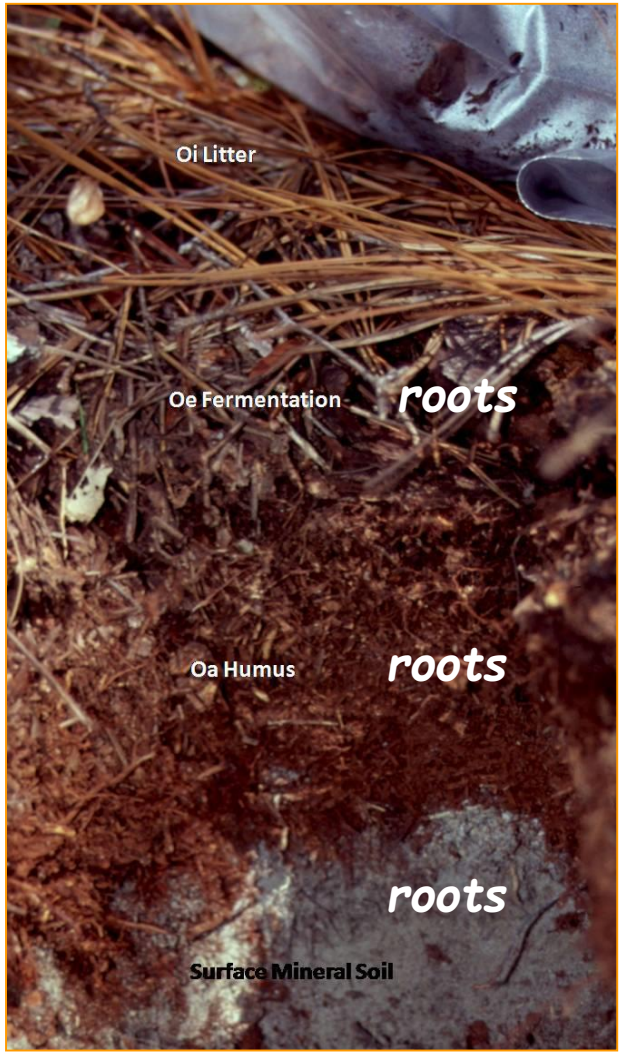
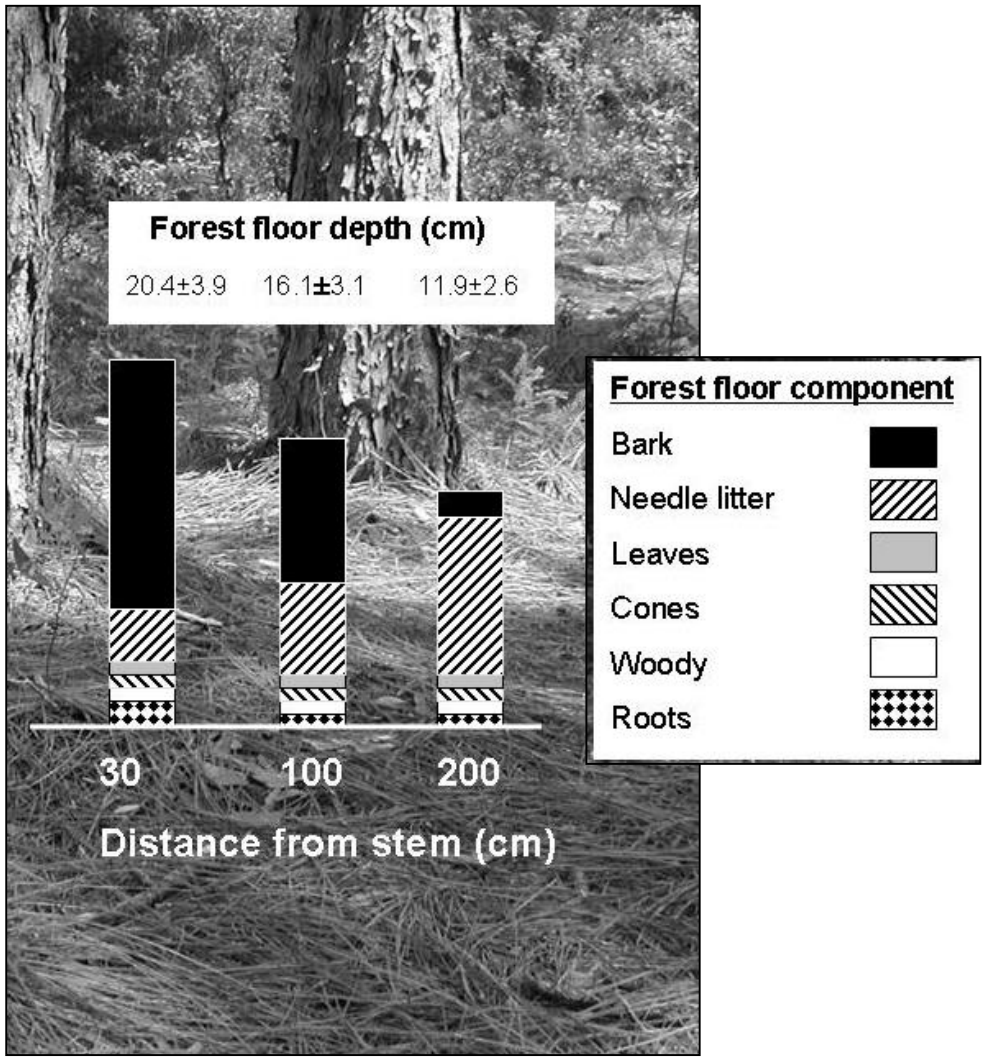


Photo: J.M. Varner

Duff Composition





Long Duration Heating

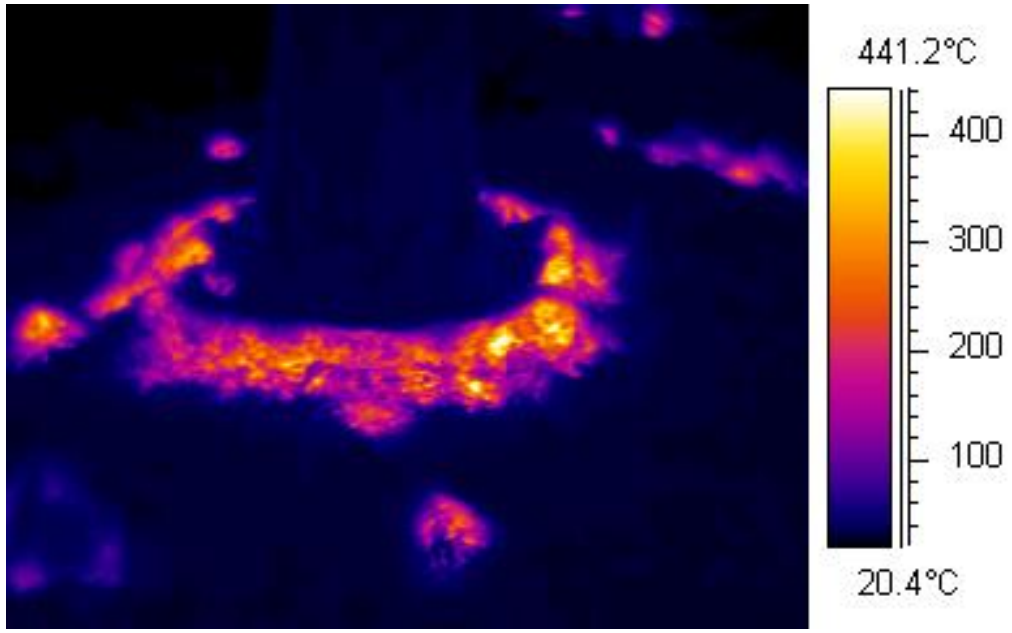


Photo by J. O'Brien.

110 min

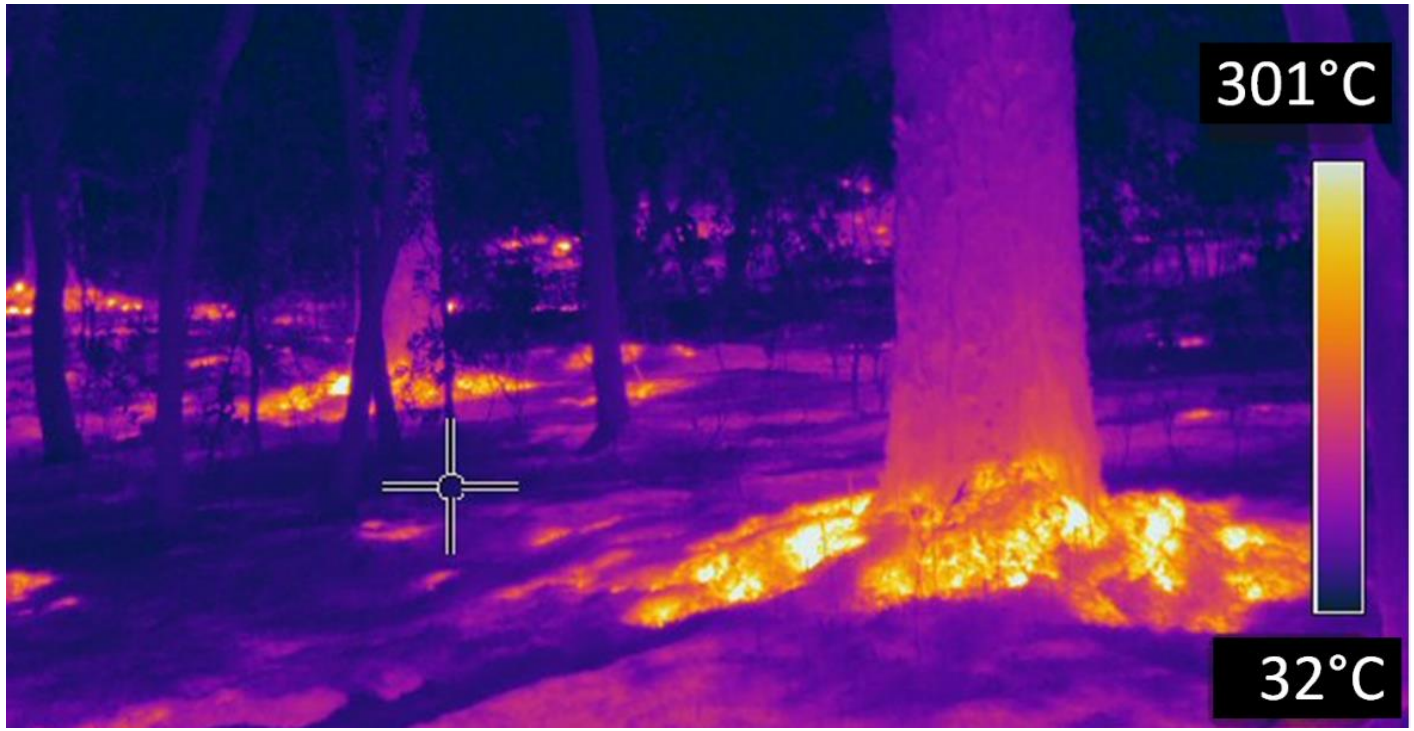
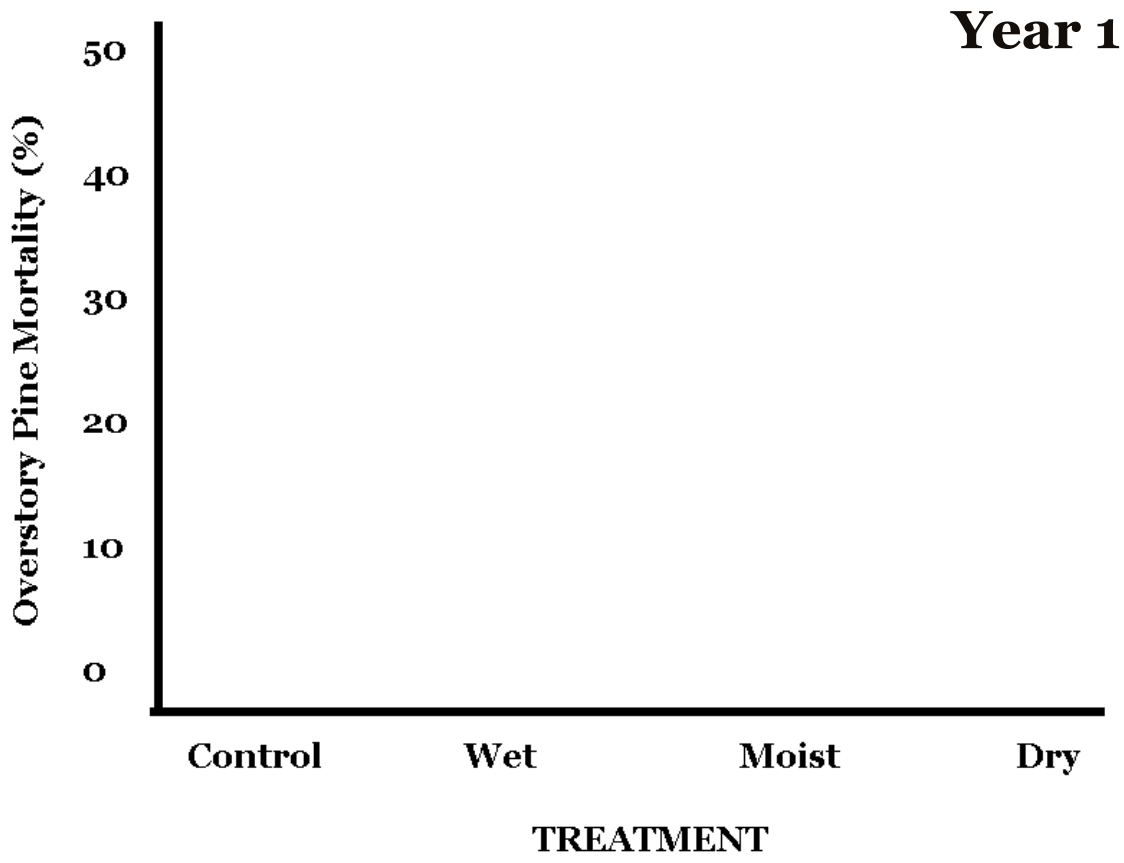


Photo by J. Kreye, Eglin AFB

Delayed Duff Mortality

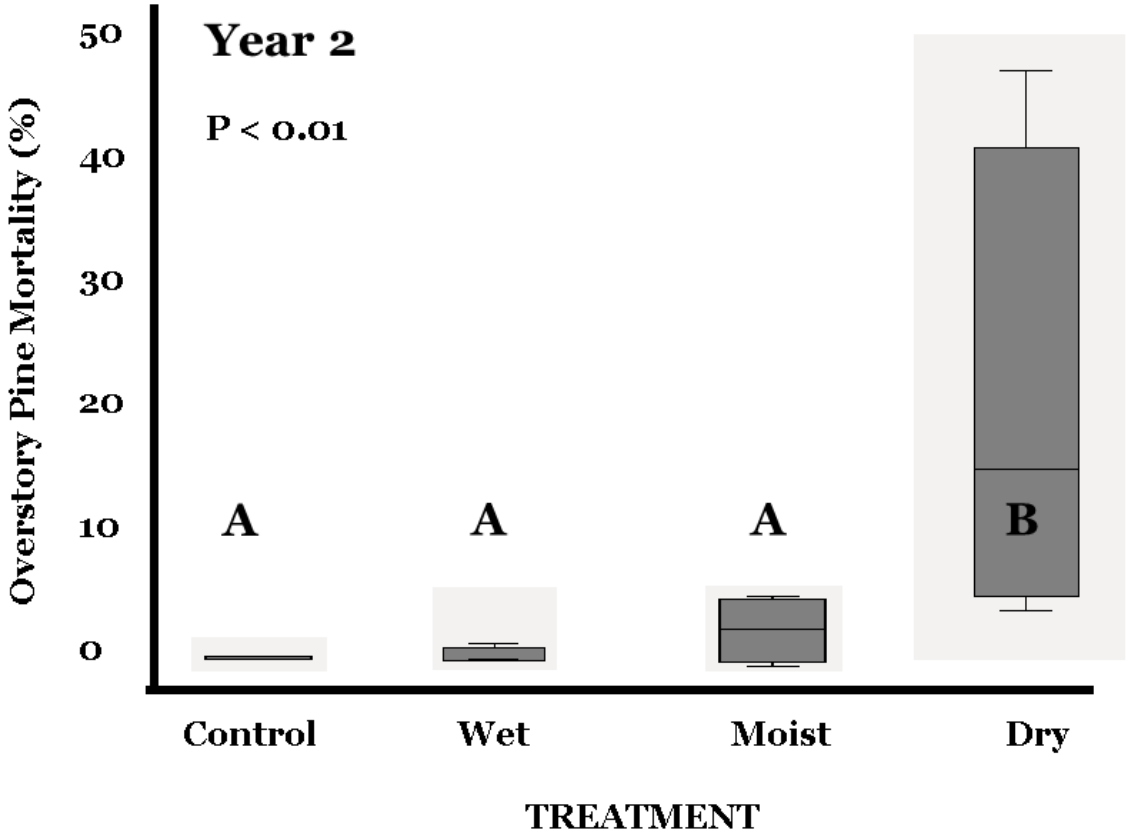
Eglin Air Force Base, Florida

- 4 treatments × 4 reps (>25 ac)
  - No burn
  - Wet duff (115% mc)
  - Moist duff (85% mc)
  - Dry duff (55% mc)
- Injury surveyed within 3 wks
- Mortality surveyed every 6 mo



Varner et al. 2007. *Canadian Journal of Forest Research* 37: 1349-1358.

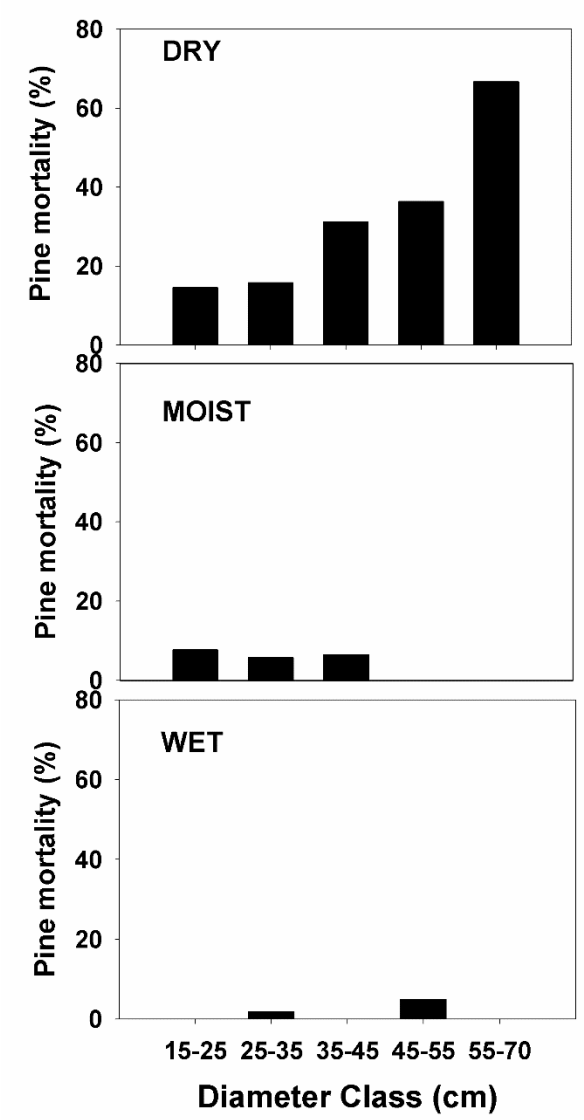
Delayed Duff Mortality



- Mortality delayed 18-24 months
- Mortality peaked in dry burns
- Mortality in unburned not different from moist & wet

Varner et al. 2007. *Canadian Journal of Forest Research* 37: 1349-1358.

Duff Kills Big Trees



$DBH_{dead} > DBH_{surviving}$ $P = 0.002$

trees < 16” dbh: 19% mortality

trees > 16 “ dbh: **53% mortality**

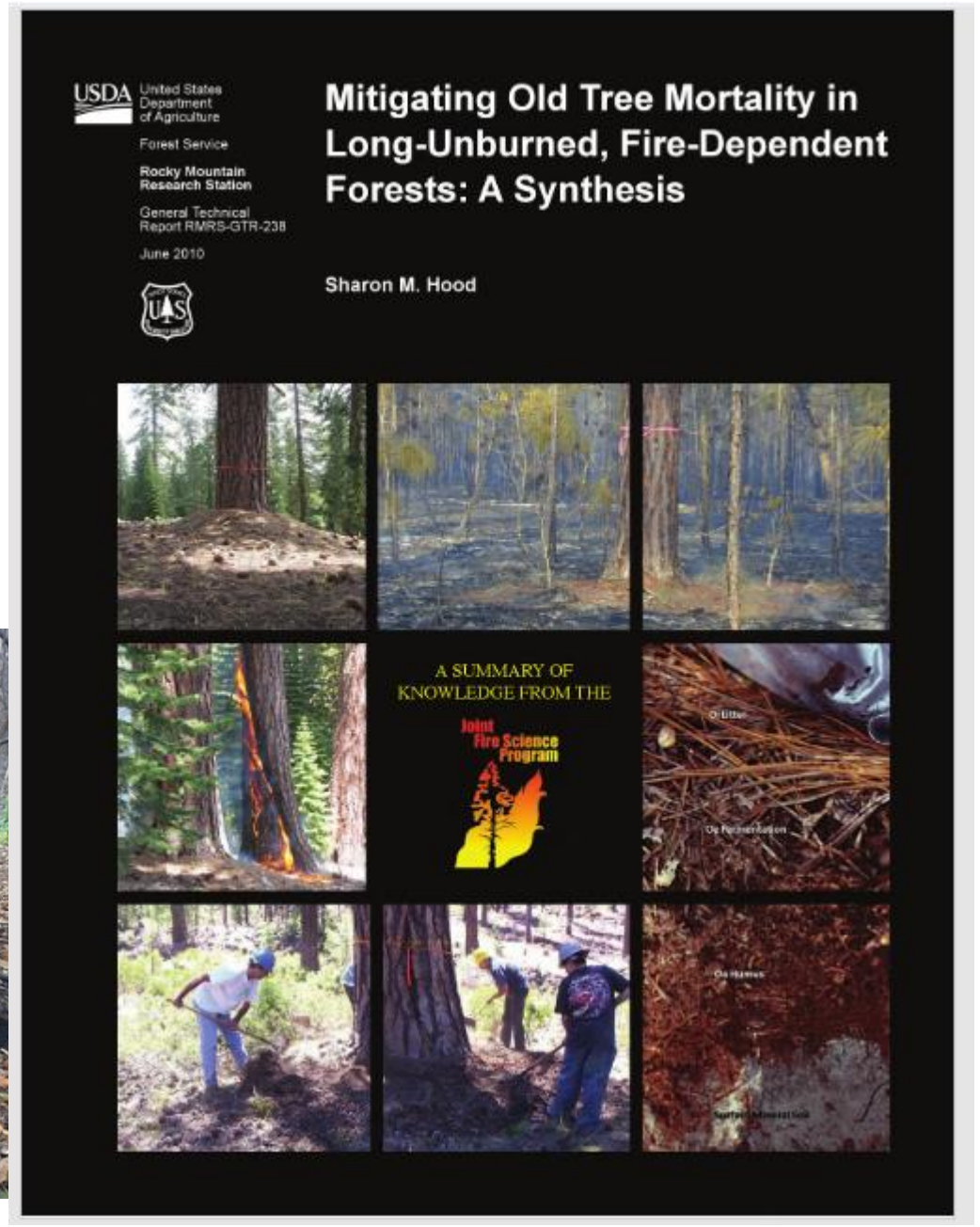
Overstory tree mortality resulting from reintroducing fire to long-unburned longleaf pine forests: the importance of duff moisture

J. Morgan Varner III, J. Kevin Hiers, Roger D. Ottmar, Doria R. Gordon, Francis E. Putz, and Dale D. Wade

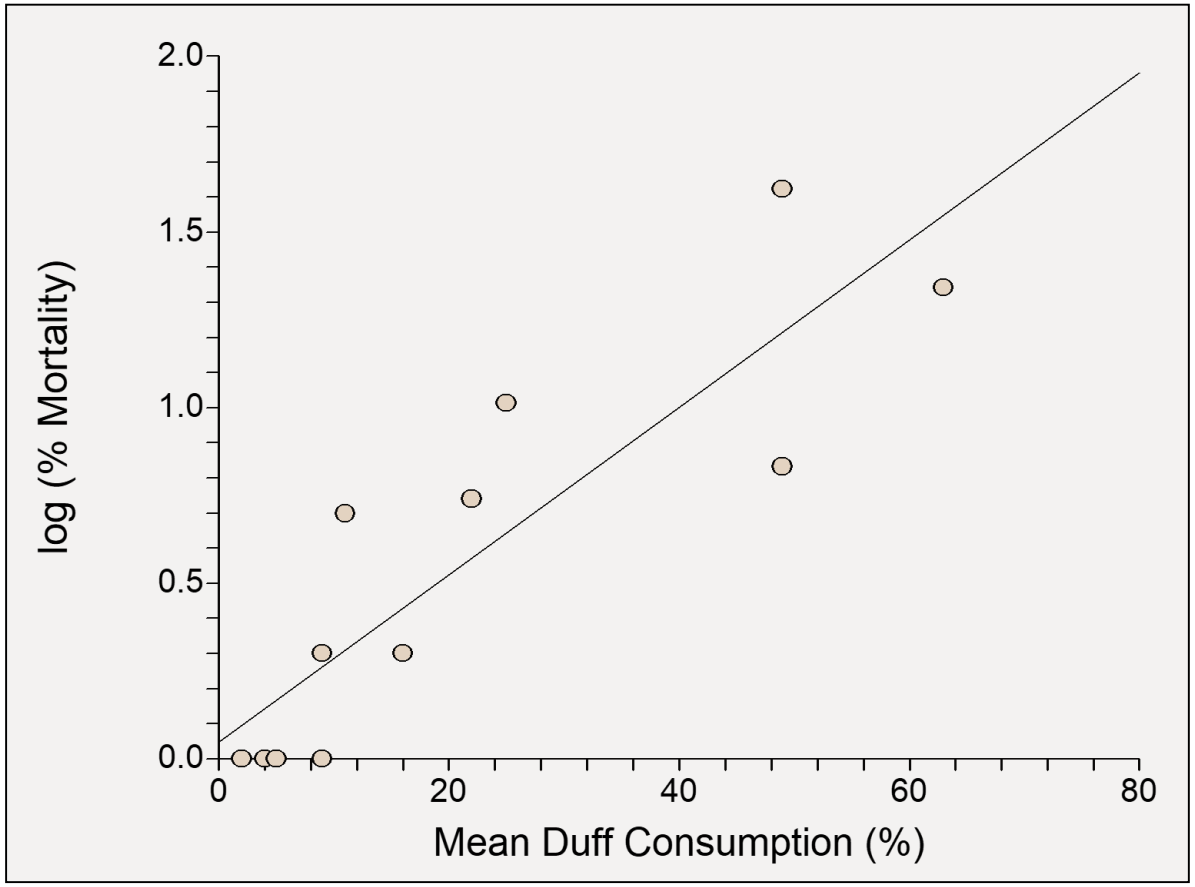
Varner et al. 2007. *Canadian Journal of Forest Research* 37: 1349-1358.

Not Simply a Coastal Plain Issue

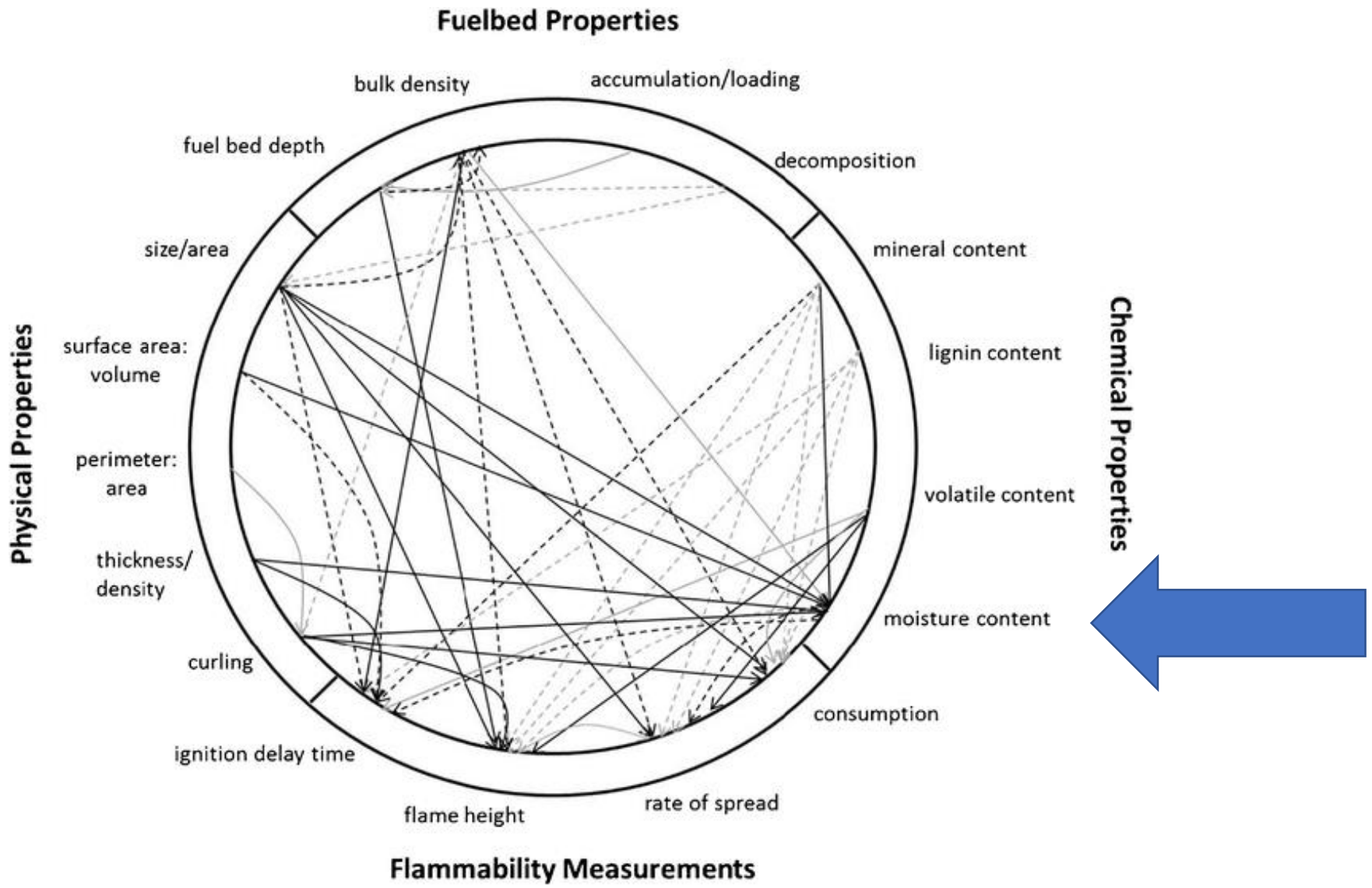
Rough Ridge Fire 2016, sampled 1-yr later Photos: Kevin Hiers



Duff Consumption Matters

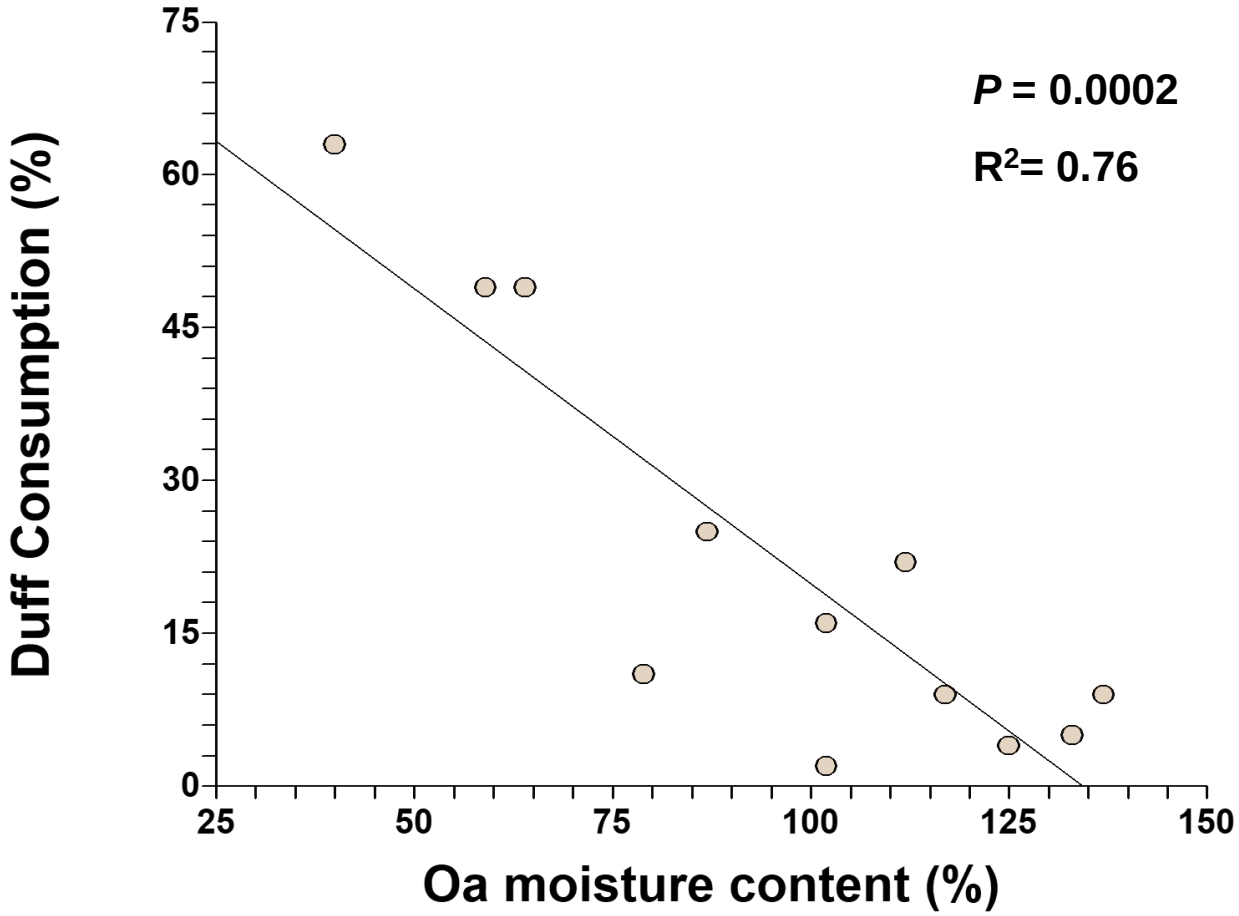


Varner et al. 2007. *Canadian Journal of Forest Research* 37: 1349-1358.



Varner, J.M., J.M. Kane, J. E. Kreye, and E. Engber. 2015. The Flammability of Forest and Wildland Litter: A Synthesis. Current Forestry Reports. 1 (2) pg 91-99.

Duff Moisture Matters



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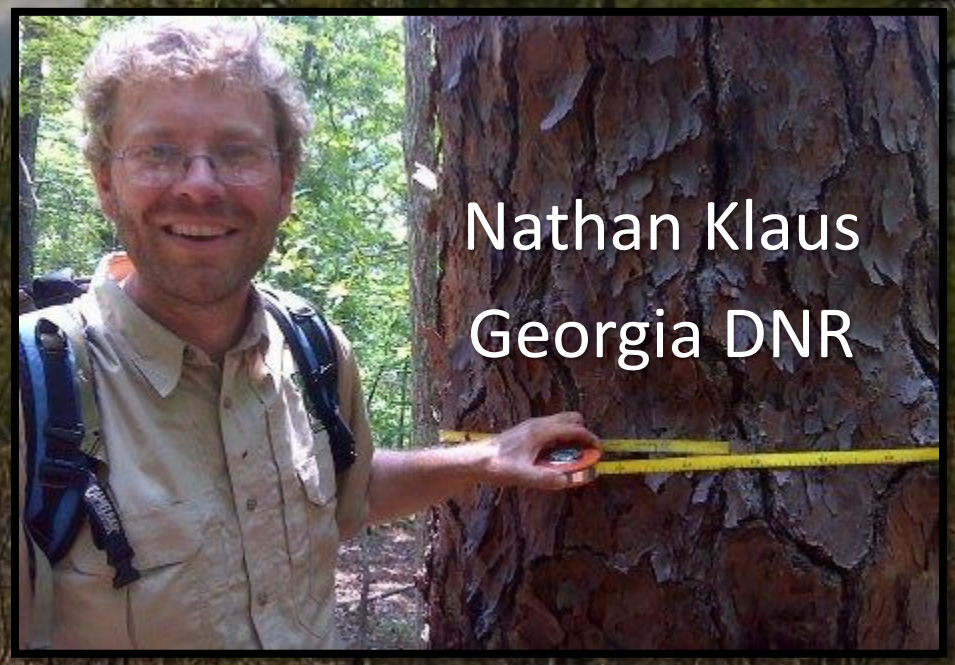
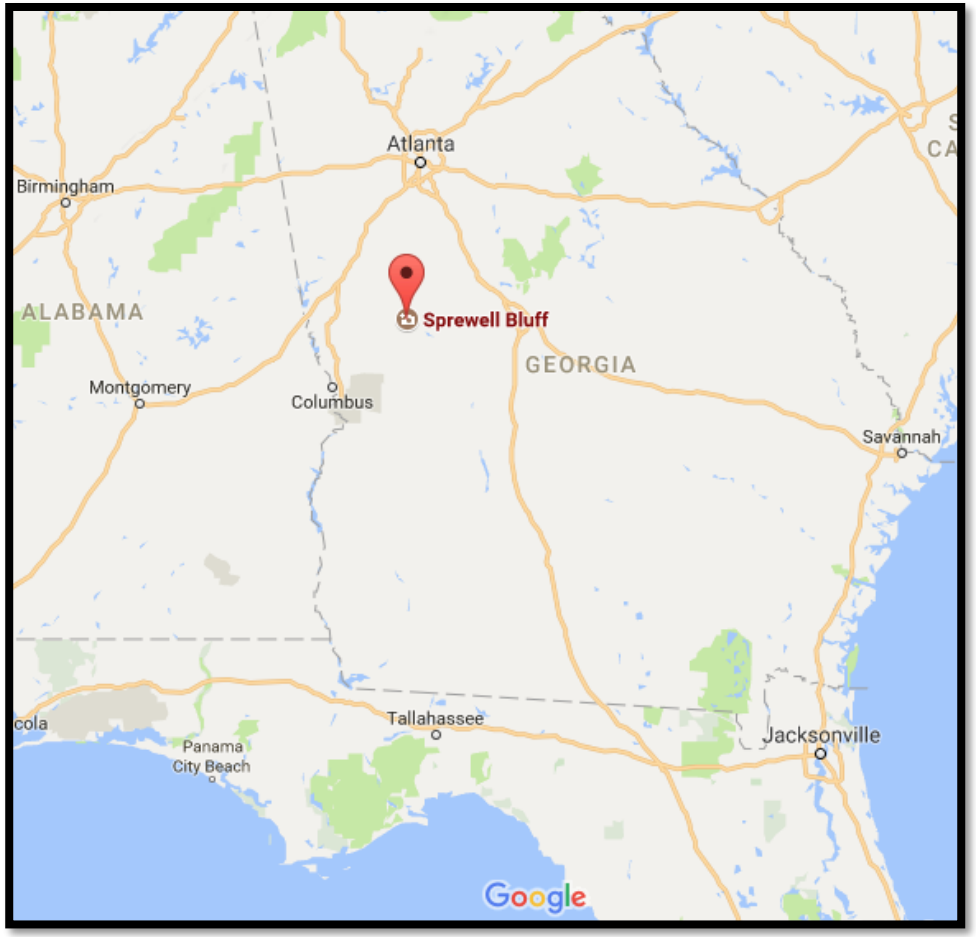


Duff Moisture Assessment Tool

Sprewell Bluff WMA Restoration

- Sprewell Bluff WMA near Thomaston, GA and the Flint River
- Scattered old growth montane longleaf pine duff trees (some > 400 years old)
- Dry rocky soil, steep ground, lots of hardwoods



Sprewell Bluff WMA Restoration

Sprewell Bluff WMA Restoration

Sprewell Bluff WMA Restoration

Challenges with Duff Management

- Average duff depth was 9” (23 cm) many trees much deeper
- Standard prescription was to burn <24 hrs of 1” or more of rain
- Most burns in Feb-Mar
- Many years with only 4-5 burn days

Challenges with Duff Management

- Duff can still burn after 1-2” of rain during drought years
- Questions remained: What if they had three rain events each separated by 4 days, none over 1”, total accumulation 1.75”, should they burn or not?
- Checking duff meant feeling it with our hands, hard to teach this to techs or landowners

New Tool: Delmhorst BD-2100 Moisture Meter

- Designed to sample moisture in sawn lumber
- Gives a true and consistent value
  - Quick to train people to use
  - % scale, 0-100
  - No more guesswork
- Gives values instantly
- Very rugged, holds up to use in fire

How to use the BD-2100 Moisture Meter

- Set meter to % scale
- Pull away straw/litter
- Gently insert probes, get reading
- Remove top layer of duff and repeat, take 4-5 measurements through entire column of duff
- Measure 2-3 spots per tree, different sides of tree
- Measure 10-20 trees, various aspects and slope positions

BD-2100 Measurement Tips

- Take lots of readings. If in doubt sample 20 trees total, sampling three areas in your unit is reasonable, ~ 20 minutes.
- Take readings from multiple parts of your unit. Try to pick the most likely places for duff fires: high ridges, steep slopes, windward side of ridge, leeward side of trees during rain

BD-2100 Measurement Tips

- Compressing duff around probes squeezes moisture out, resulting in inflated readings
- Make sure you are using percent scale
- Make sure there isn’t a dry layer of duff below the top layer, sample duff all the way to mineral soil

Duff Moisture Thresholds for BD-2100

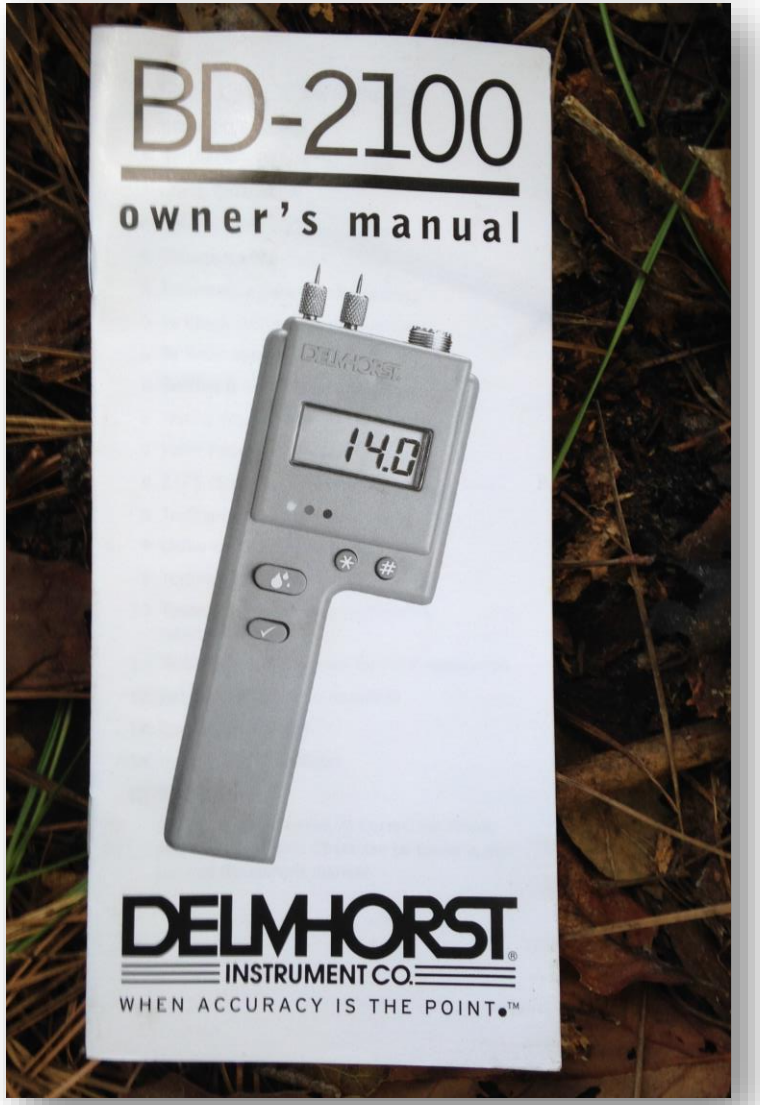
- **Above 80% duff will not burn**
- **85%+ you are golden**
- **Below 73% duff will burn**
- **Mid 70s is risky, maybe can get away with it but not on 1st entry, likely will have some trees burn**

BD-2100 Benefits

- Lower mortality rates of most valuable trees. We are losing 1-3% of trees total over a ten year period of reintroducing fire.
- Anyone can get info on duff moisture to burn boss, allows burn boss to focus on other things the morning of the burn

BD-2100 Benefits

- Greatly expanded # of days to burn duff, we found our duff burn days went up 3X!
- Wider prescriptions – most rain events that bring 1+” of rain are from a cold front.
- Burning right after this rain/cold front meant high wind and low RH. We now know how long we can wait before it is too dry and burn under calmer conditions. We also can assess whether we can burn during wet periods of smaller rain events that don’t have extreme weather



Where can I get one?

- Google “Delmhorst BD-2100 WCS”
- About $400 online. It’s not cheap but what is a 200 year-old tree worth?
- Other moisture meters?
  - We have only evaluated one other, extremely cheap ($10) meter used to measure soil moisture in potted plants. It was worthless
  - Likely other high-end meters would work but we have not evaluated them

Questions? Nathan.Klaus@dnr.state.ga.us

Sometimes things still go wrong.

Photos: Shan Cammack and Bryn Pipes

Why not just drown it?

- Smoldering duff is insidious and doesn’t always produce smoke or surface evidence
- Time intensive
  - Requires a lot of water
  - Where is your water source?
  - Regular checkups even after treatment
- Wear and tear on equipment

Slides: Shan Cammack and Bryn Pipes

There is a better way

DUFF BUSTERS!

- No water
- Resource and time efficient
- Identifies duff spots, even the “hidden” ones
- Minimal impact (Good M.I.S.T. practice)
- Actually kind of fun!

Slides: Shan Cammack and Bryn Pipes

What you need

- Full PPE (Safety first!)
- Leaf blower
- Boots with fire-resistant soles (Vibram)
- Breathing mask (Whiff or paper)
  - If not available, blow from the upwind side!

Slides: Shan Cammack and Bryn Pipes

Step by Step

- Blow around base of tree
  - Look for any glowing embers or flare ups
- Kick out hot spots
  - Must separate heat from unburned duff
  - Sometimes the leaf blower does all the work for you!
- Blow the area again to get heat away from duff and check for residual spots
- Repeat as necessary

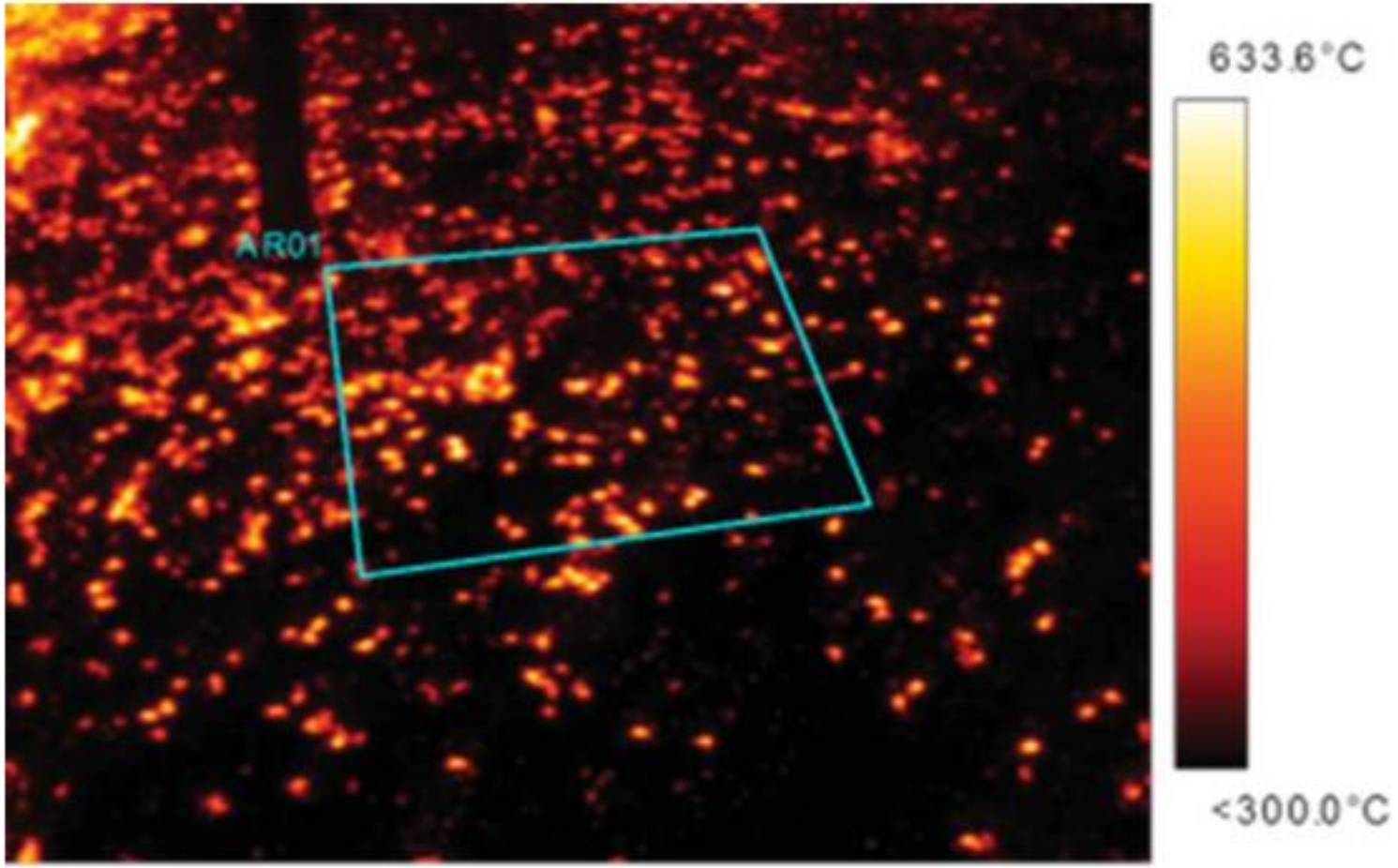
Slides: Shan Cammack and Bryn Pipes

Fight duff smarter!

- Extinguishing duff is never ideal, but it is inevitable.
- Increase productivity from your crew
- Expand your burn window to prevent making a bad situation worse

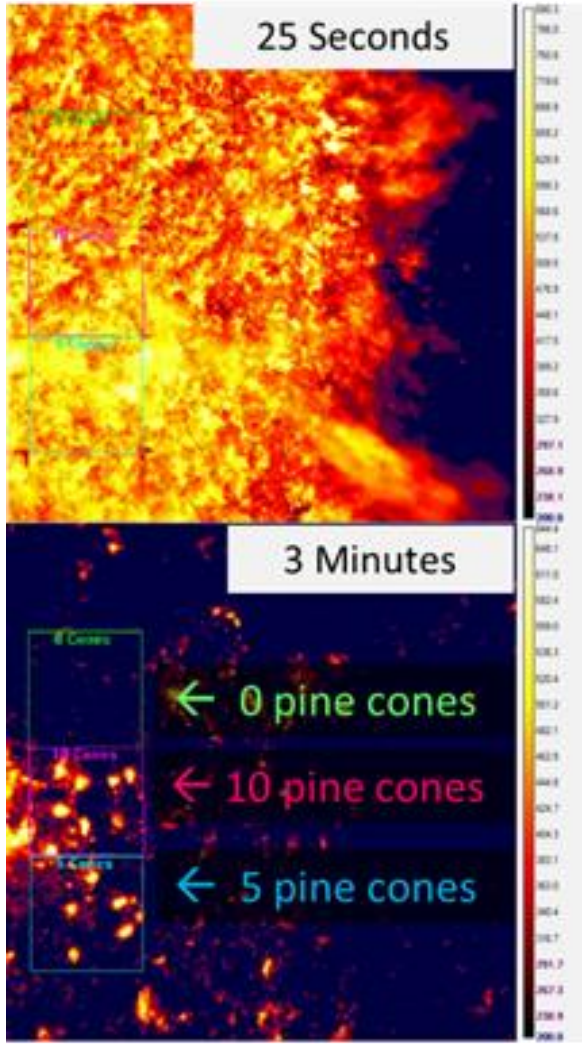
Slides: Shan Cammack and Bryn Pipes

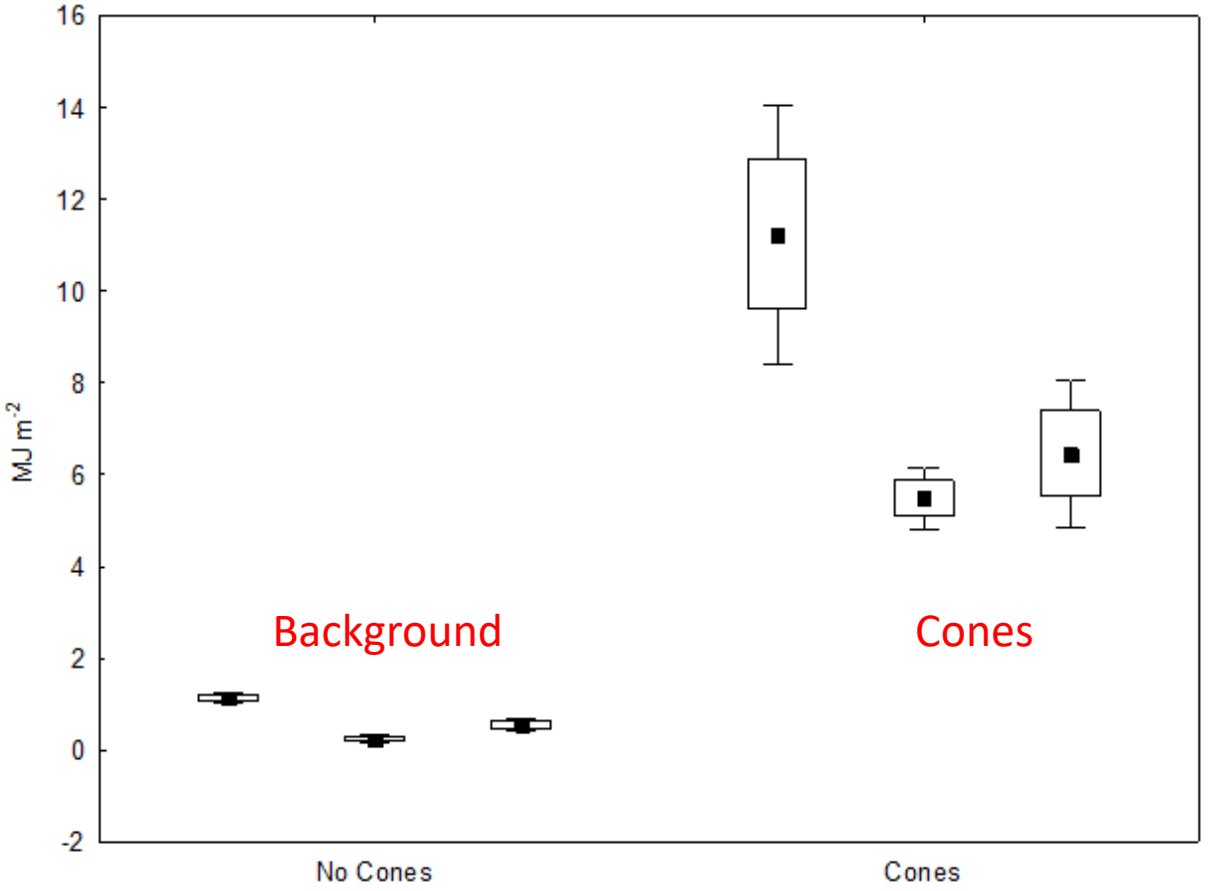
Pine Cones: A Wildcard?



O'Brien et al. 2016. Canopy-derived fuels drive patterns of in-fire energy release and understory plant mortality in a longleaf pine (Pinus palustris) sandhill in northwest Florida, USA. Canadian Journal of Remote Sensing. 42(5): 489-500.

Pine Cones: A Wildcard?





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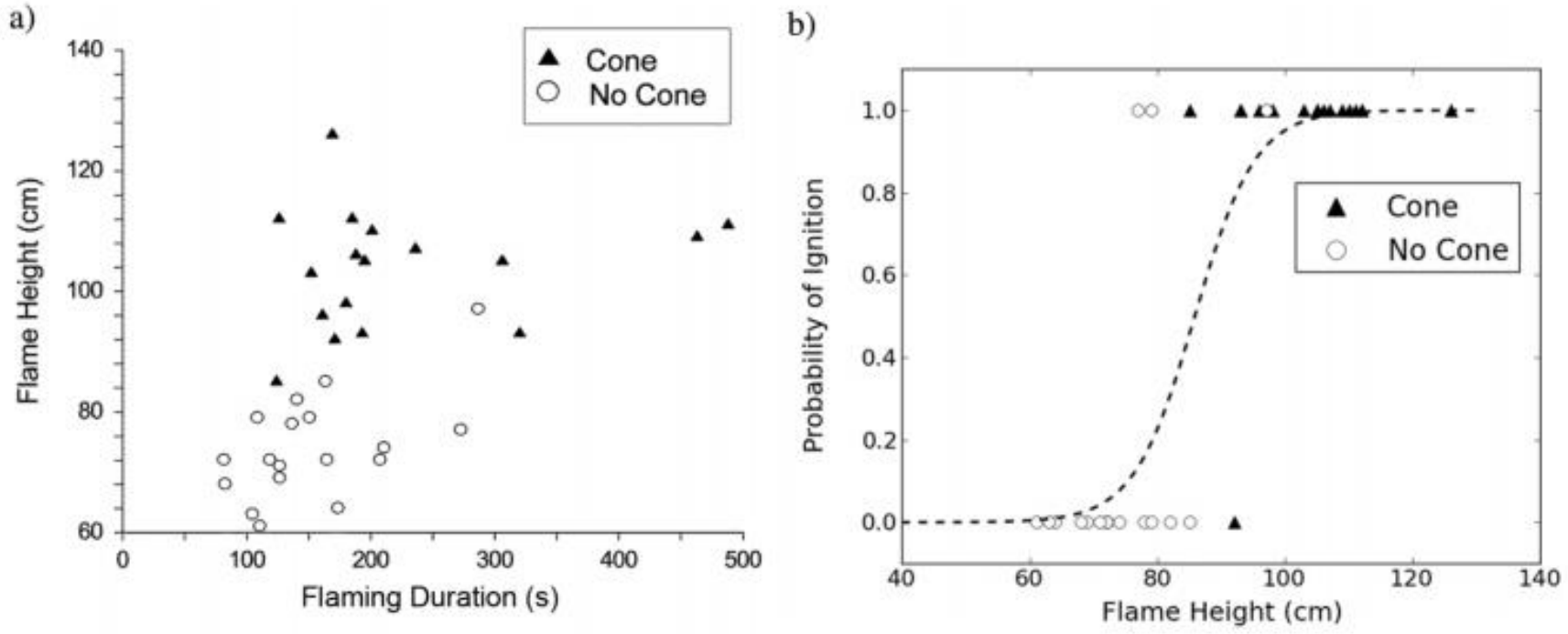

Figure 3. The effects of pine cones on flame height and probability of ignition of forest floor samples (from Kreye et al. 2013)

Kreye, J.K., Varner, J.M., Dugaw, C.J., Cao, J., Szecsei, J., Engber E.A., 2013. Pine cones facilitate ignition of forest floor duff. *Canadian Journal of Forest Research*. 43:512-516,https://doi.org/10.1139/cjfr-2013-0019

Pine Cones: A Wildcard?

“The ignition of longleaf pine forest floor duff in this study was primarily a result of the presence of pine cones.”

“Sixteen of the 17 burn trials that included a cone vector resulted in duff ignition, whereas only 3 of 18 burn trials without a cone resulted in duff ignition.”

Kreye, J.K., Varner, J.M., Dugaw, C.J., Cao, J., Szecsei, J., Engber E.A., 2013. Pine cones facilitate ignition of forest floor duff. *Canadian Journal of Forest Research*. 43:512-516,https://doi.org/10.1139/cjfr-2013-0019

Recommendations

- **You are in it for the long haul (but the haul is not as long as we once thought)**
- **Mortality can cause management problems for years—don't break the eggs to make the omelet!**
- **Restore fuels before forest structure**
- **Burn on the margins of combustion**
  - **After rain, night (if you can), in front of rain**
- **Dedicate mop up resources for 2-3 days afterwards**
  - **Focus on "vector" fuels**
- **When safe conditions are present prioritize duff units!**
- **Use conservative prescription for 3+ burns**
- **Monitor depth reduction with duff pins**

-Adopted from Kevin Hiers and Morgan Varner.

Further Information

- Ferguson et al. 2002. *International Journal of Wildland Fire* 11: 267 – 279.
- Varner et al. 2005. *Restoration Ecology* 13:536-544.
- Varner et al. 2007. *Canadian Journal of Forest Research* 37: 1349-1358.
- Hiers et al. 2007. *Ecological Applications* 17(3):806-814
- Varner et al. 2009. *Forest Ecology and Management* 258:2457-2474.
- O'Brien et al. 2009. *Fire Ecology* 6(2):1-12.
- Hiers et al. 2012. *Ecological Restoration* 30(1):27-36.
- Kreye et al. 2013. *Canadian Journal of Forest Research*. 43:512-516.
- O'Brien et al. 2016. *Canadian Journal of Remote Sensing*. 42(5): 489-500.

Slide, Image and Content Credit

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