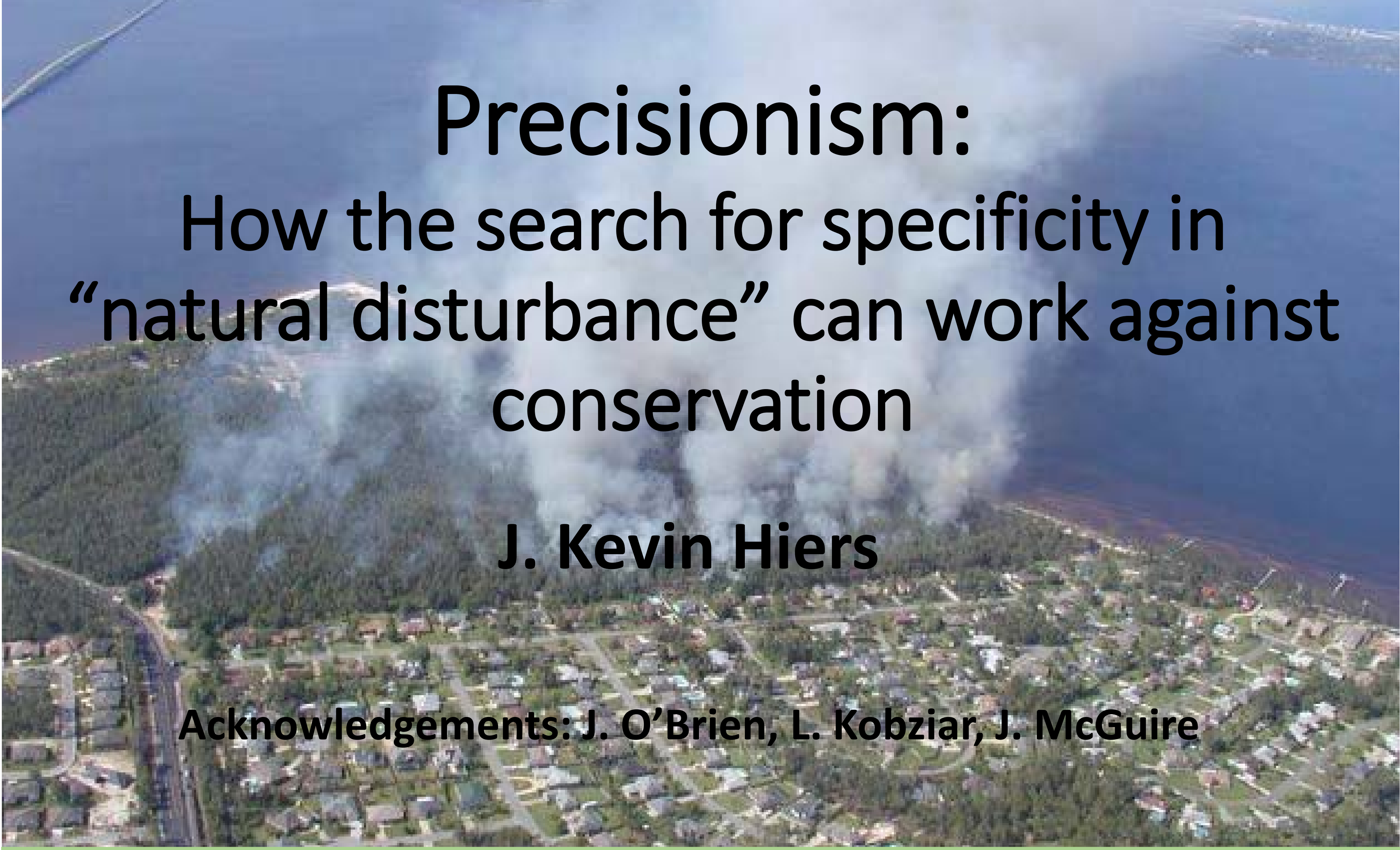

Precisionism:
How the search for specificity in "natural disturbance" can work against conservation

J. Kevin Hiers

Acknowledgements: J. O'Brien, L. Kobziar, J. McGuire

Fire Leaning Network
November 8, 2017

TALL TIMBERS

Introduction

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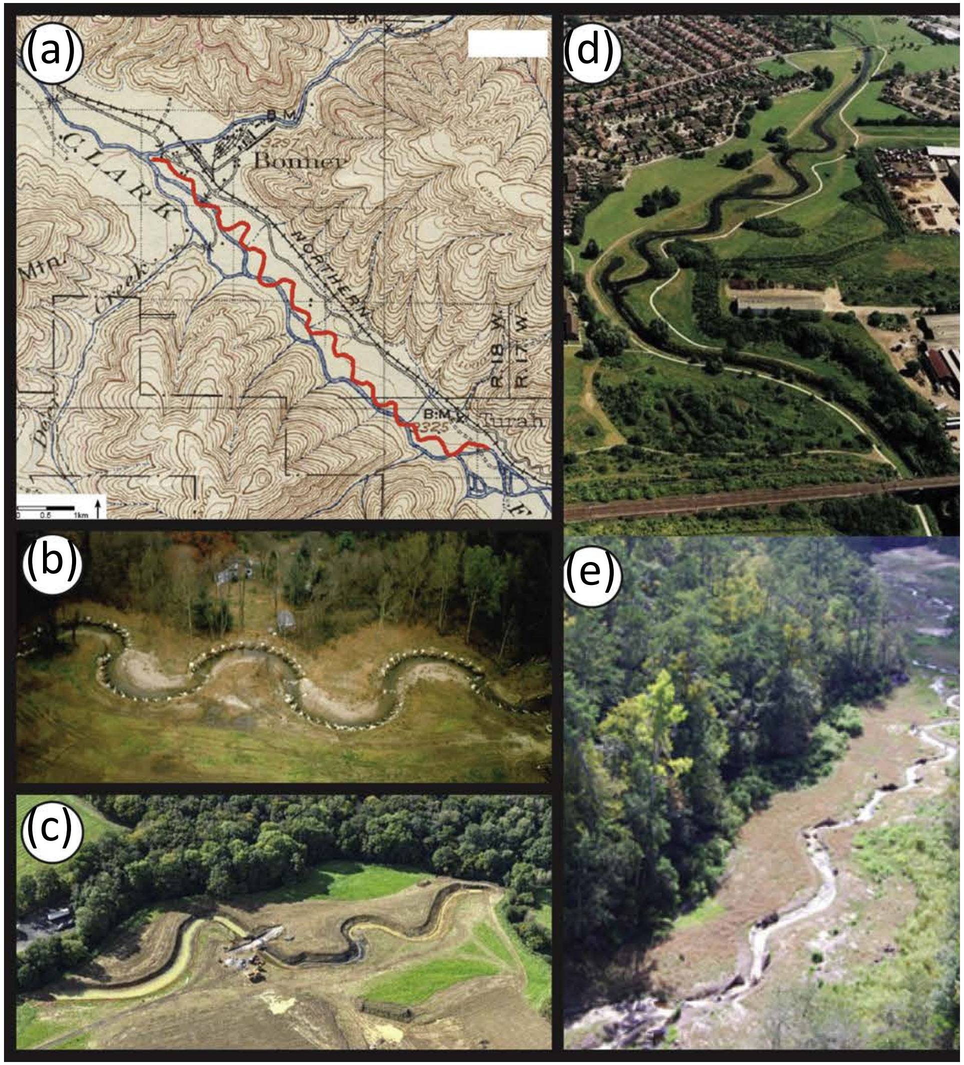
- Science is structured learning with a heavy dose of skepticism
- Generality is sought
- Results can be extended beyond the domain of inference
- Relevance in conservation science increasingly viewed as specific "management recommendations"
- Science is not management so…

Sometimes things get lost in translation!

Precisionism

- Inappropriately or unjustifiably precise management prescriptions are leading to negative conservation outcomes
- Overemphasis in policy-scale planning on specificity can homogenize ecosystems by focus on “optimum” conditions or narrow understanding of “natural disturbances”
- Overextrapolation of site data from one research project to other sites with inappropriate specificity



From Hiers et al. 2016

Precisionism in managed fire

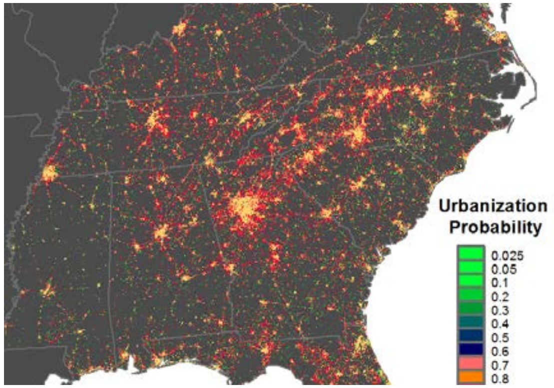
The precision problem in three parts:

1) THE FUZZY PAST: Facts about “natural” fire regimes and reference conditions can be overstated with unsafe assumptions

2) THE COMPLEX PRESENT: Managing by overly precise prescriptions and restoration targets limits options, wastes money, and can compromises biodiversity

3) THE UNCERTAIN FUTURE: The constraints of managed fire regimes in the future demand more options not fewer

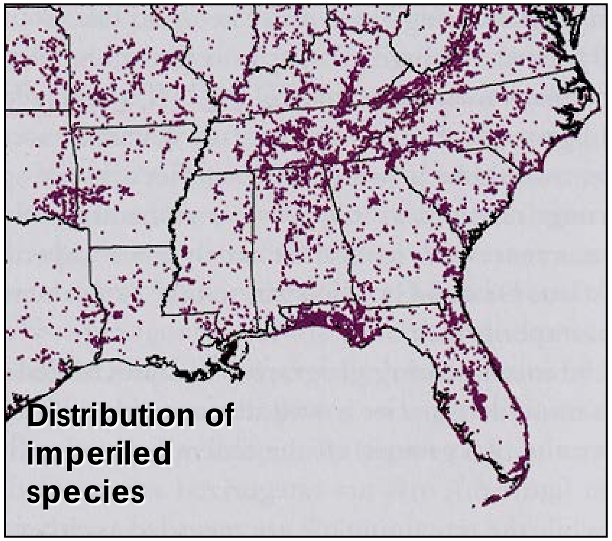
SEE ALSO: Freeman, J. et al. 2017. A critical evaluation of the historical fire regime concept. Conservation Biology.

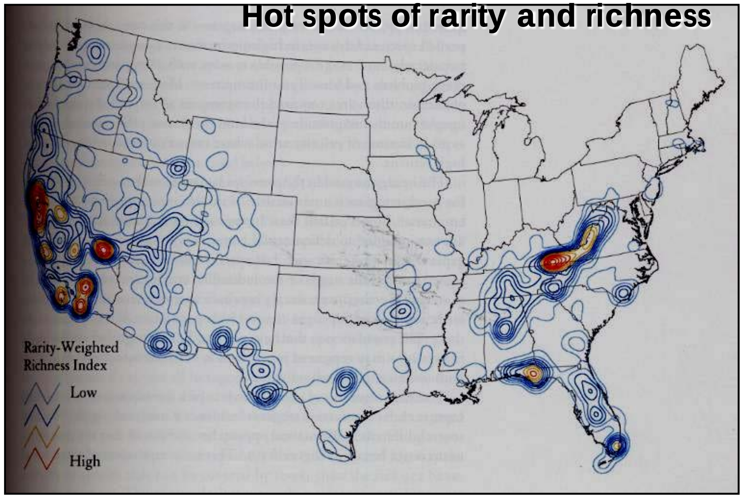


Fire and Biodiversity in Southern Appalachians

- Species Richness and Rarity
  - Many imperiled and uncommon/rare species found in SA
  - Uplands burned frequently and broadly across the region.
    - Fire endemics (TM Pine)
    - Shortleaf habitat of Cumberland Plateau supported RCW
  - Poorly understood fire response of many communities
- We are in 6th Mass Extinction

(Celballos et al. 2017, PNAS)

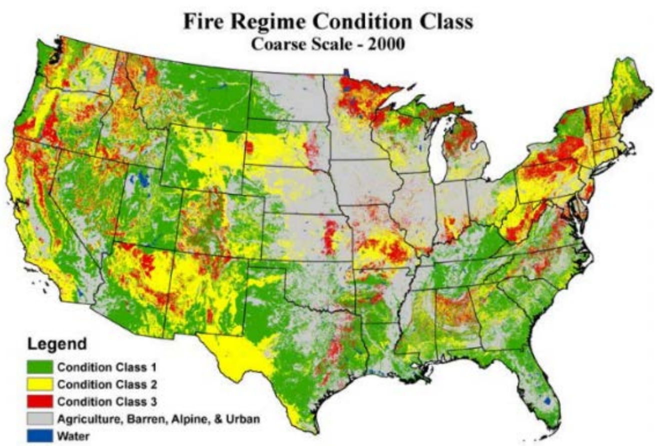


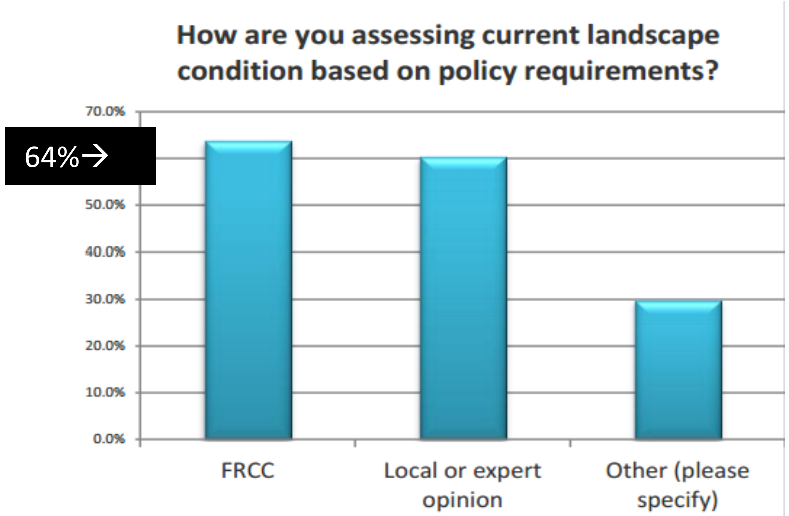


From Stein et al. (2000)

A focus on the past…

- Historical ranges of variation guide management
  - Assume fire regimes had predictable patterns of frequency, intensity, and scale
  - Ecosystems recover from "natural" disturbances
  - Human activities alter these patterns threaten ecosystem integrity
- Reference sites are key to restoration (White and Walker 1997)
  - Approximate variation of the past
  - Substitute for natural processes

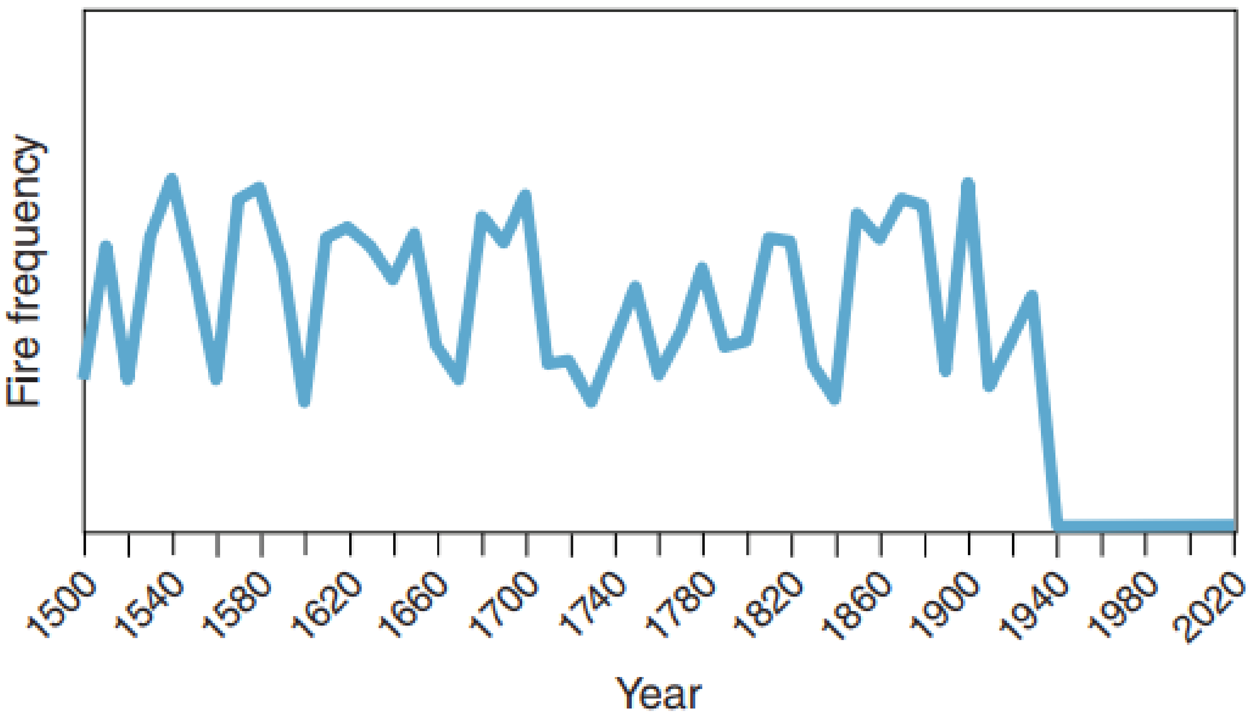




Strand et al. 2013. n = 396 fire managers

Historical fire regimes in Southern Appalachians

- Present is departure from past (much less fire!)
- General long-term stable presence of fire; local peaks in 1800s
- Lightning vs. Human ignition sources a matter of debate
- Little association with historic fire activity to historic PDSI
- “Dormant season” scars dominate



(From Lafon et al. 2017)

Tree rings, charcoal, and fire history

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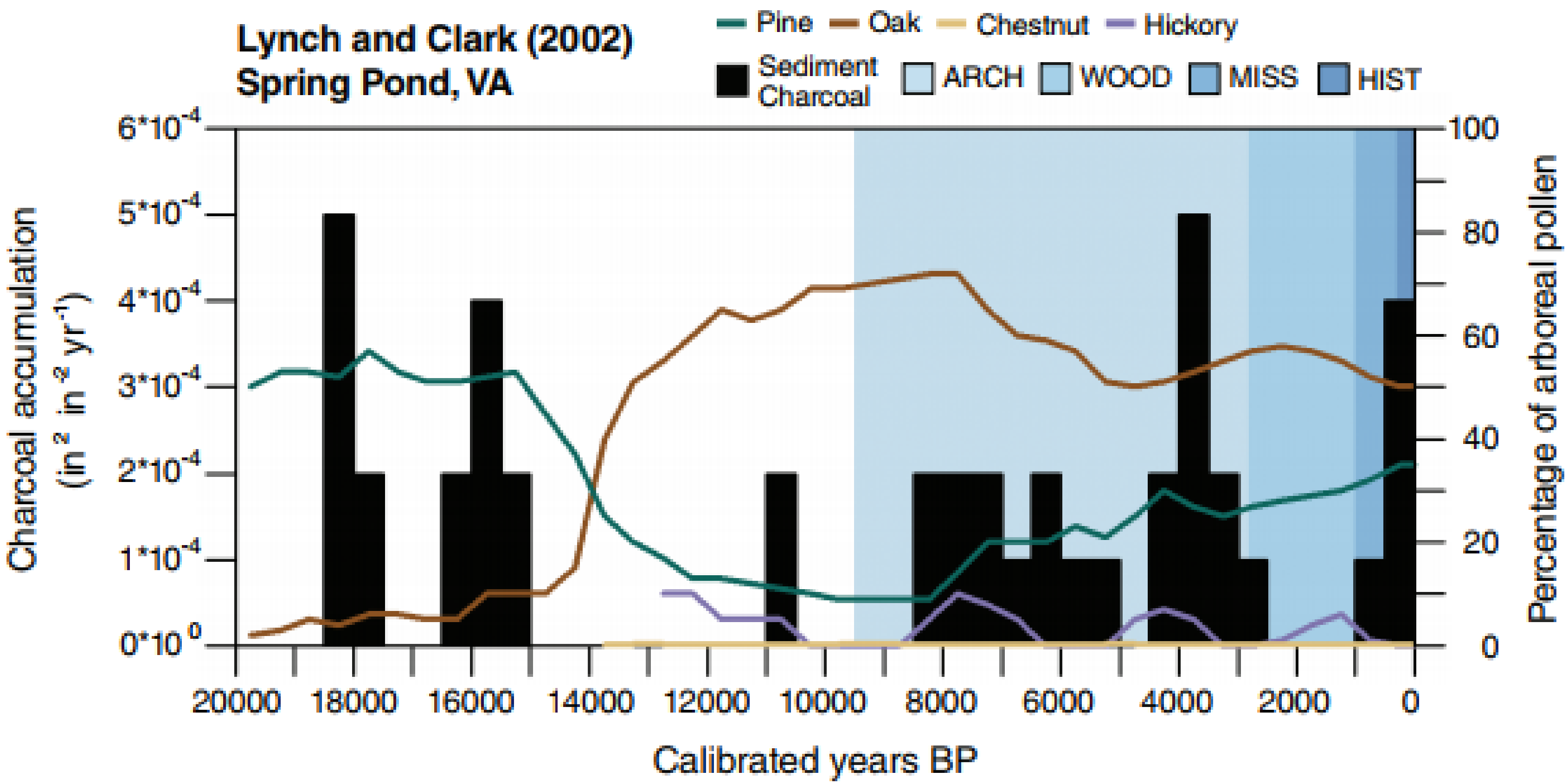
- Increasing data from tree ring records and charcoal in Region
  [Grissino-Mayer 2016, Hart et al. 2012, Hessl et al. 2011, Stambaugh et al. 2011, and Lafon et al. 2017 (a review)].
- "Historical fire" data are among the most detailed records we have, but limitations still exist:
  - cannot assign an ignition cause and cannot be conflated with a "natural fire regime" outside of human influence
  - Mean Fire Return Interval: Point vs. area vs. composite
  - Extrapolation of MFR to ignition density
- Charcoal takes us farther back
  - Issues with deposition environment and coarse resolution

- Imprecision of language
  - Historical vs. natural fire regimes
  - Fire history vs. historical fire regimes
    - Natural used to describe fire in evolutionary or ecosystem assembly
    - Site specific data vs. ecological disturbance over time

Fire, forests and past climate

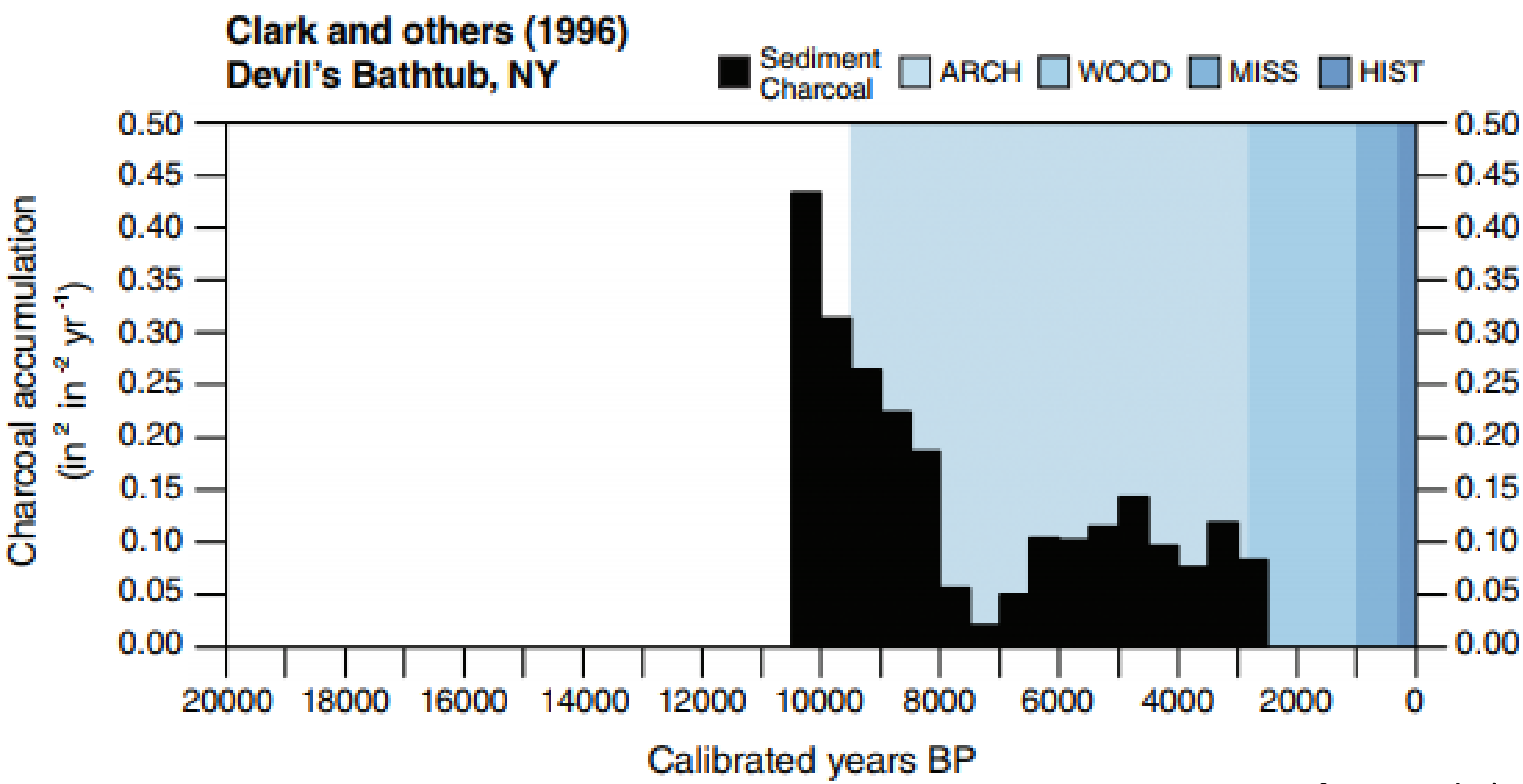
Fire, Forests and Past Climate



Lafon et al. (2017)

Past fire and humans

Native American Influence?



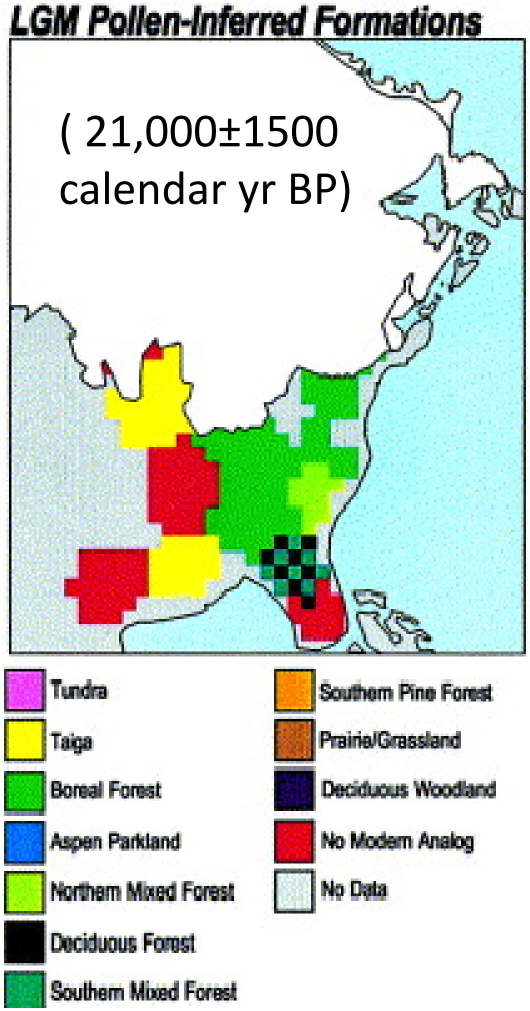
Lafon et al. (2017)

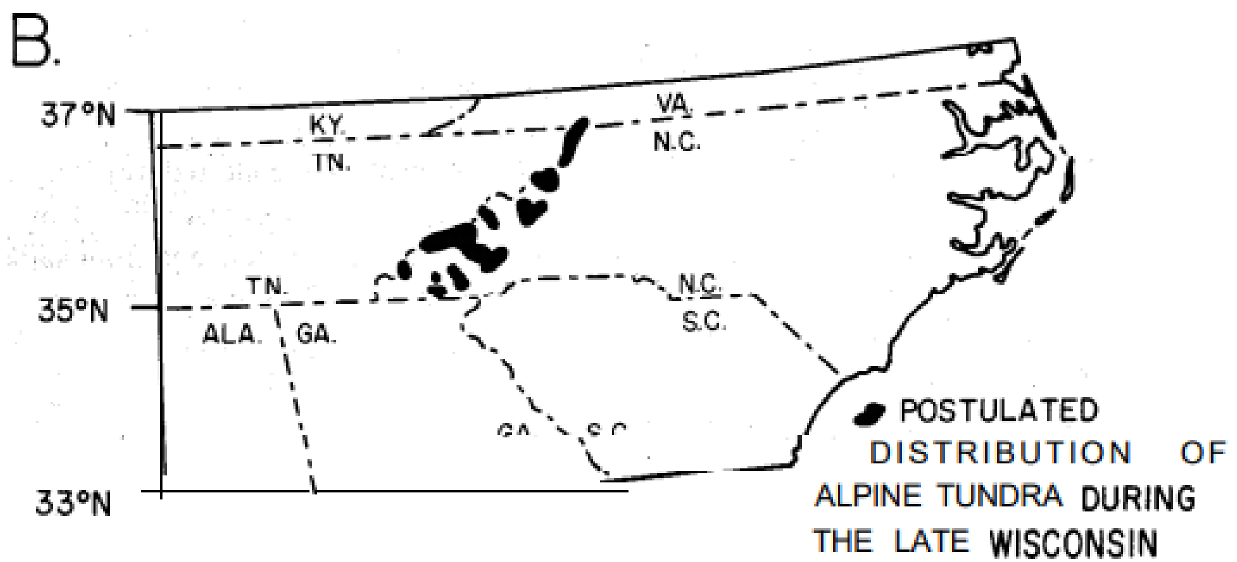
Precisionism in "natural" fire: examining assumptions

Changes in latitudes…

- During glaciation, communities assumed to shift south; assemblages and disturbance regimes similar
  - Species evolved fire regime over millennial time scales
- Mimicking historical fire regimes key to conservation
- Native Americans not here long enough to alter evolution or distributions
  - Even if they were, they were too few to dominate ignition density
  - Were they "natural" anyway?

No modern-analog pollen in SE





- Past included no-analog vegetation Jackson, et al. (2000), *Quat. Sci. Rev.*
- SA was highly dynamic during Pleistocene (Delcourt and Delcourt 1988)
- Influx of sediment from aggradation in Younger Dryas accompanied by shifts in spruce and cold pines (Kneller and Peteet 1999)

Species adaptation and exaptation

- Adaptation or fire-adaptive?
  - These traits often respond to multiple triggers (herbivory, drought) and may be a response to multiple selection pressures (Bradshaw et al. 2011)
- "Just so" stories are a staple of modern conservation that can look appealing but not testable hypotheses.
- Neoendemism: Through mutation and polyploidy plants can evolve quickly as reproductively distinct entities (Macnair 1989).
- Leads to overspecification for endangered species
  - Bats anyone?

"The "correct" historical fire regime is the one to which characteristic species show the strongest and most positive response." *(Beckage et al. 2005)*

How fast do ecosystems assemble?

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- First Bison species to N.A. ~135,000 ybp (Froese et al. 2017, *PNAS*)
  - Quickly diversified genetically.
- Second wave of bison ~30,000 ybp, rapidly re-colonizing N. America (Froese et al. 2017, *PNAS*)
- Bison wallows are critical for biodiversity in tallgrass prairies (Collins et al. 1998, Science)
- **Rags to species richness story:** Invasive species from Asia 30,000 years ago to keystone species in a few thousand years!

The role of indigenous peoples

- New Paradigm: Pre-Clovis humans at least 15-30,000 years old
  - Aucilla R. butchered mastodon 14,500 years ago under 20’ of water (Halligan et al. 2016)
  - ~30,000 from genetics data (Schurr 2008, *Science,* Waters and Stafford 2007, *Science*)
  - Topper site in SC 16,000+ YBP (Goodyear 2005, *Paleoamerican Origins*)
- Homo sapien the first arrival?
  - Humans not first: a species of *Homo* arrived in North America 130,000 YBP (Holen et al. 2017, Nature)
- Evidence for fire use is extensive
  - Review by Fowler and Konopik 2007

Are indigenous people "natural?"

"Anthropogenic fire regimes obscure natural fire regimes, reducing the ability to manage fire-frequented habitats ecologically."

-Slocum et al. 2007

- It is very likely that the entire regional landscape was modified by human fire
- At what point did human fire use become unnatural?

Southen Appalachians
c. 1910

"Nature is not natural." Bob Mitchell



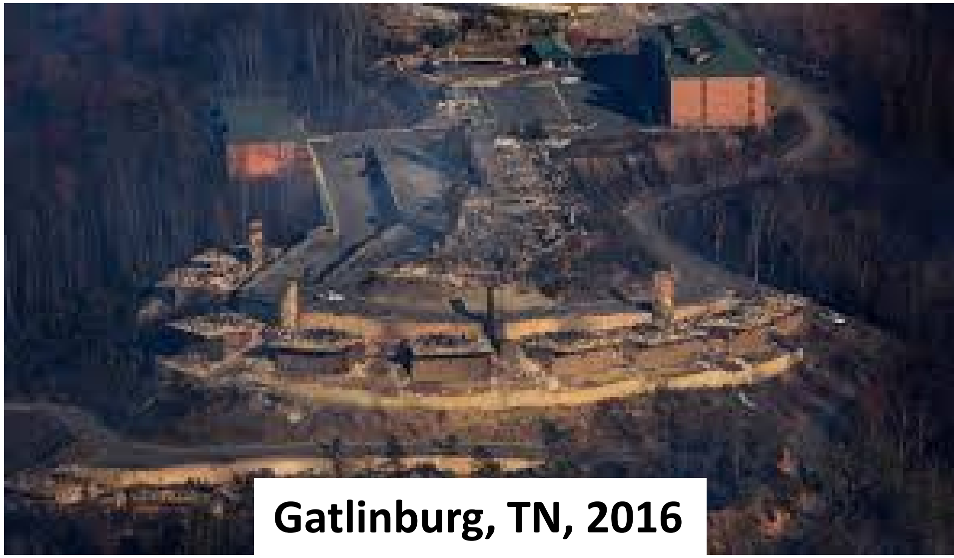




The Complex Present

Dangers of precisionism in the present management landscape?

- We are at a chronic shortage of prescribed fire
- Managers choose daily between competing objectives, which may also compete with their personal liability
- Even IF natural fire was possible, there exists a much different context



Gatlinburg, TN, 2016

I-4 incident 2008

From the fuzzy past comes too much specificity…

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Ecological Restoration and Historic Range of Variation

- Too few reference sites to capture range of variation
- Over reliant on stand age and structure to characterize references codifies expert bias
- When is the target that “restore” to? Pre-Columbian issue…
- Goals for pine and oak density can be remarkably specific in documents like forest plans, RCW Recovery Plan [1993 and 2000], desired future conditions planning documents
- Species extinctions and exotic additions make new assemblages and interactions not present in the past

The path that got us here is not the path back….

“Natural” bias in ecosystem restoration

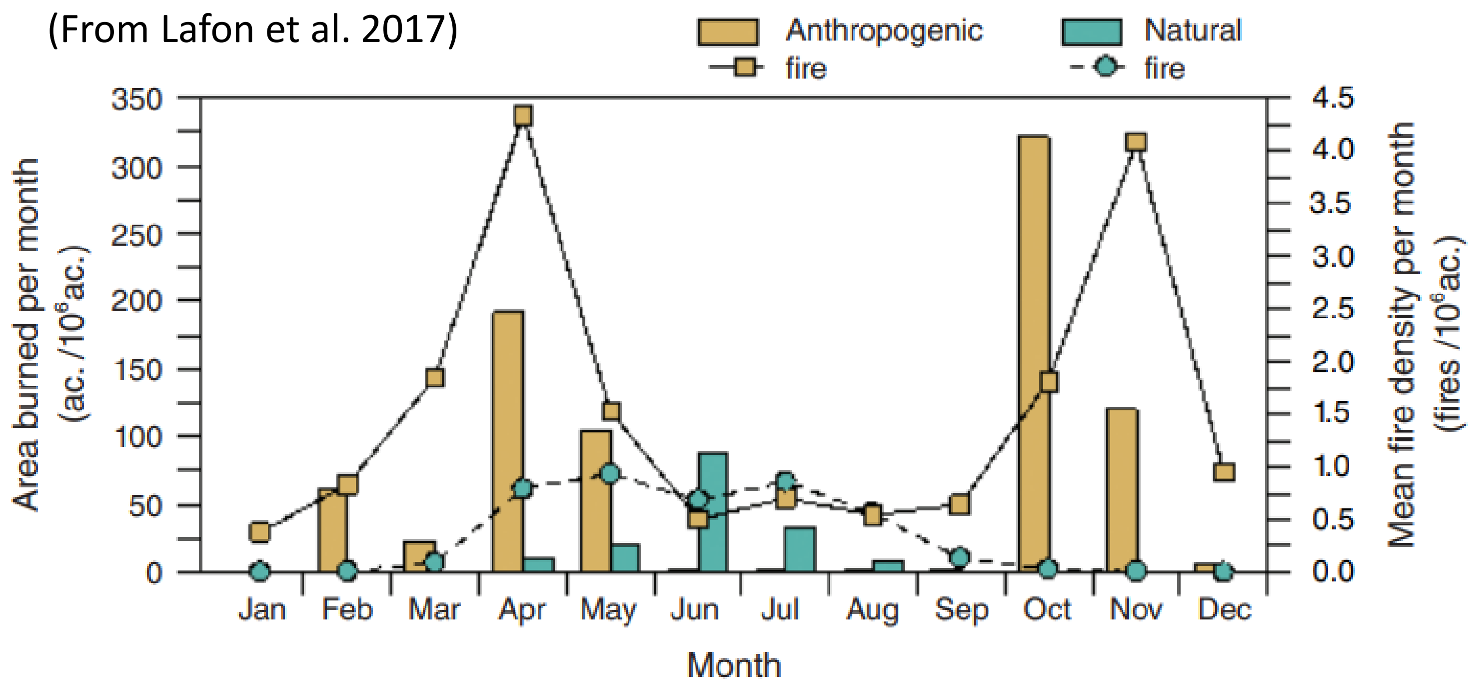
HRV has a problem:

- Who/What defines reference?
- What if there are no reference sites or we have limited variability?
- How do we measure ecological change relative to reference sites?
- Are managed disturbances changing reference sites?
- What if the reference sites are not static?

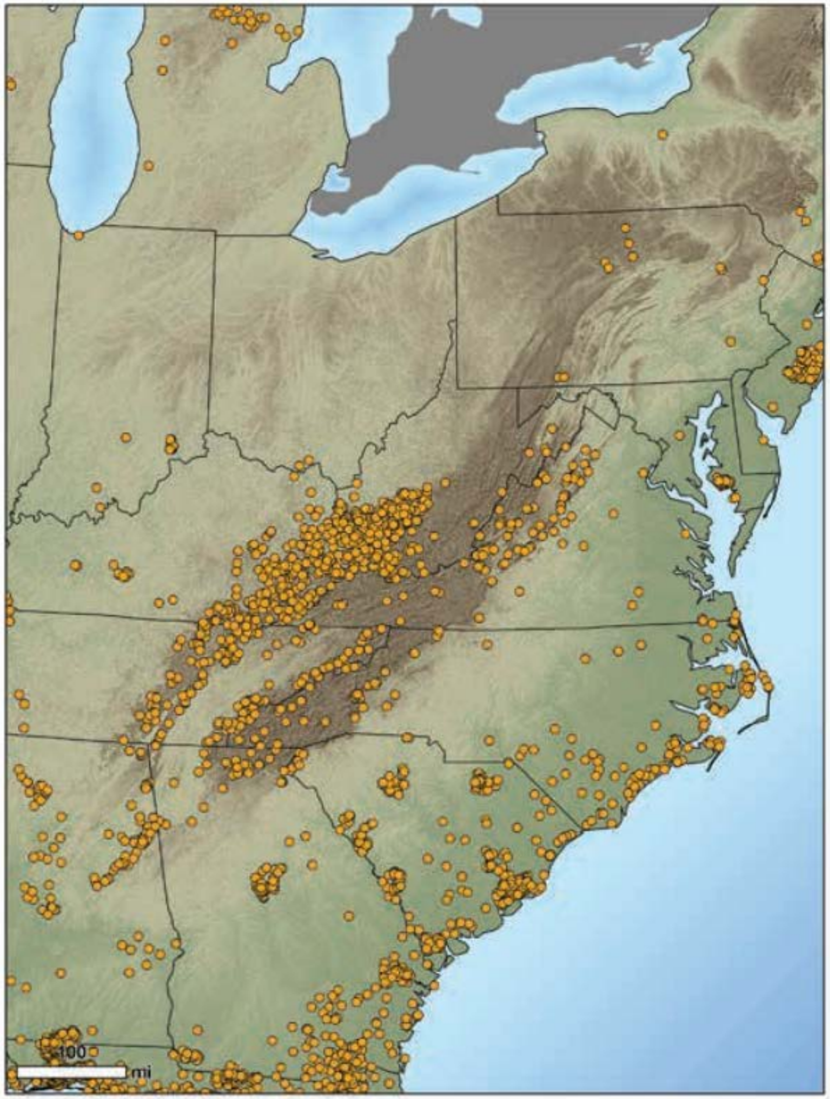
Current fire regimes in Southern Appalachians

- Present is departure from past (much less fire)
- Seasonally Trimodal
- Lightning vs. Human ignition sources a matter of debate

(From Lafon et al. 2017)



Regional Fire Activities



Large fire occurrence from MTBS data base

Current studies estimate return intervals regionally between 200-1000 y based on current treatments (Flatley et al 2011, Lafon et al 2005, Lynch and Hessl 2010))

Reference sites in the Southern Appalachians

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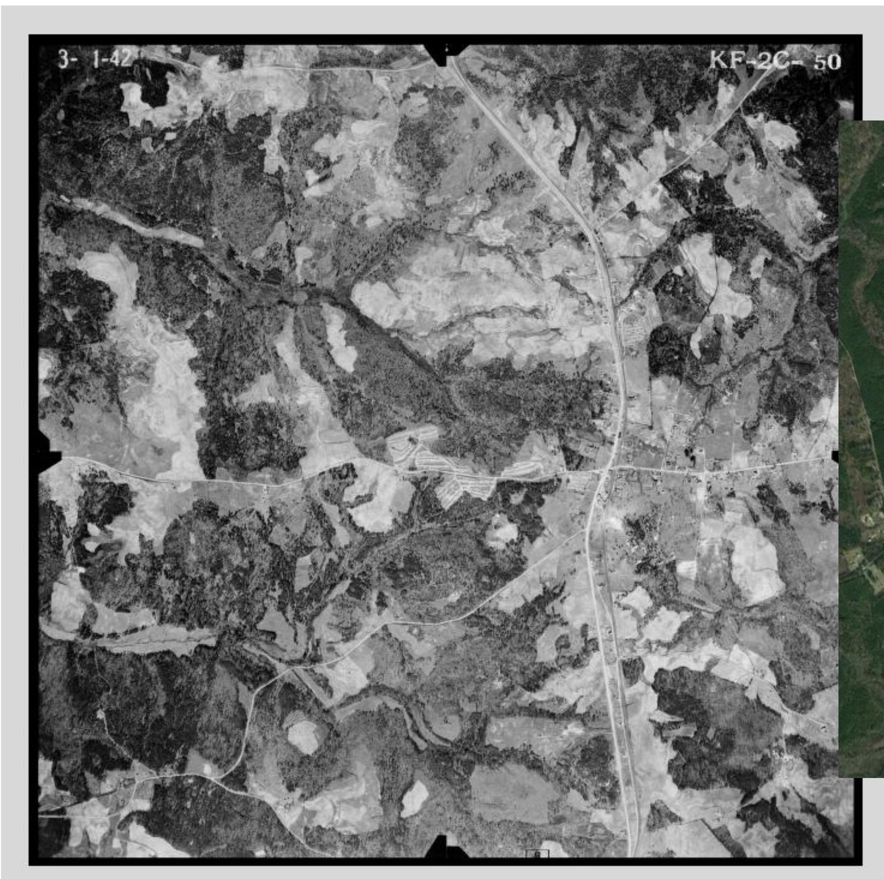
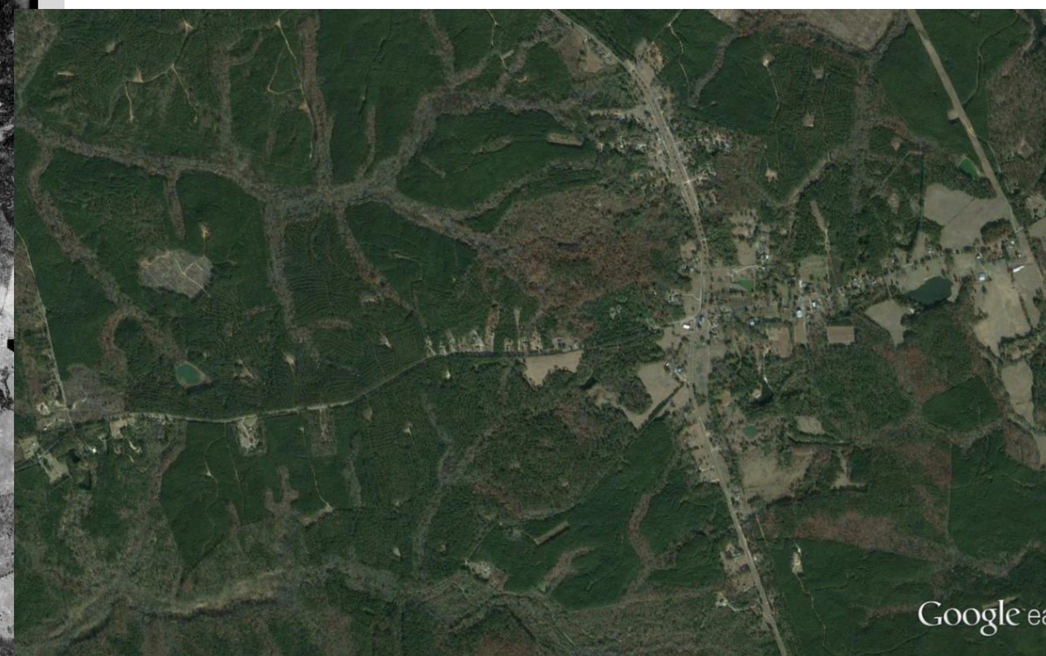
- Sifting through a mess of history…



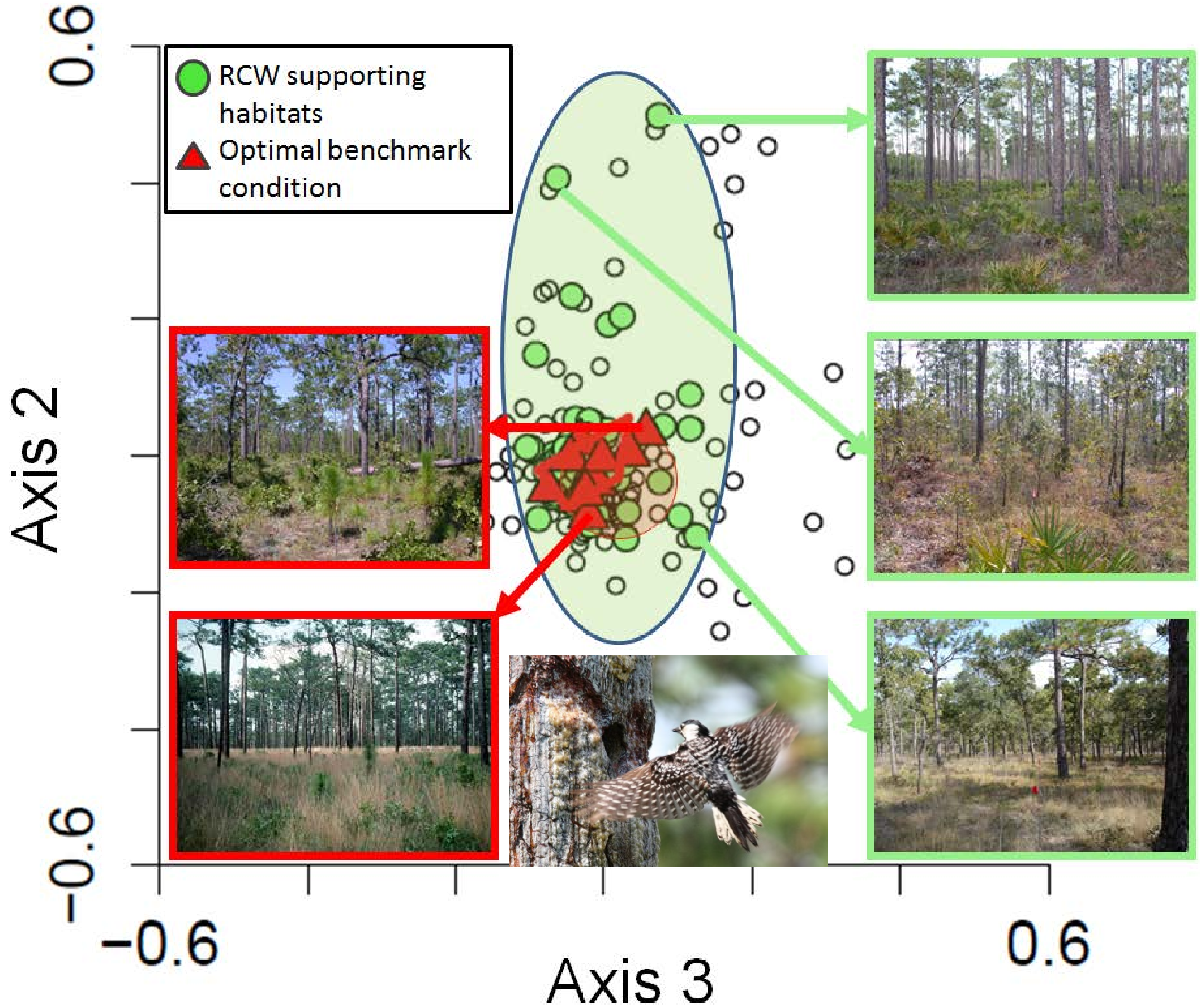


Piedmont = novel ecosystem

Adaptation of RCW to open pine habitat

- Eglin RCW occupy significantly more ecological variability than 1) USFWS Matrix tool or 2) Subjective reference sites.

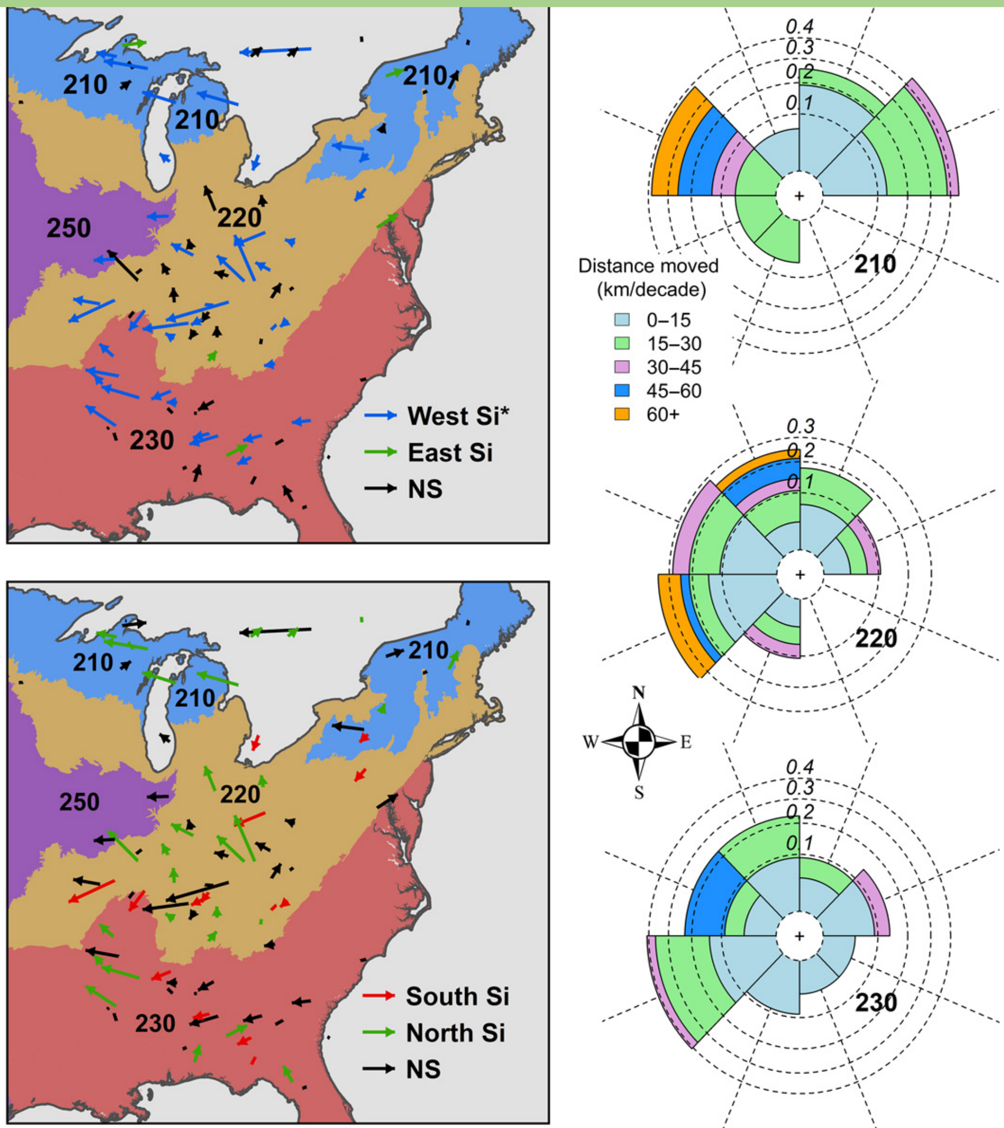
- Population is the fastest growing large population with more than 450 breeding pairs.



Hiers et al. 2016

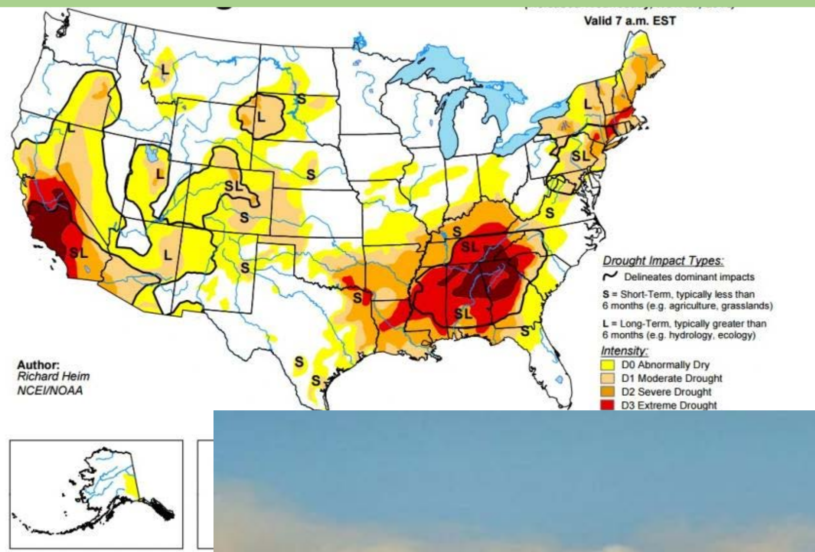
No analog present…

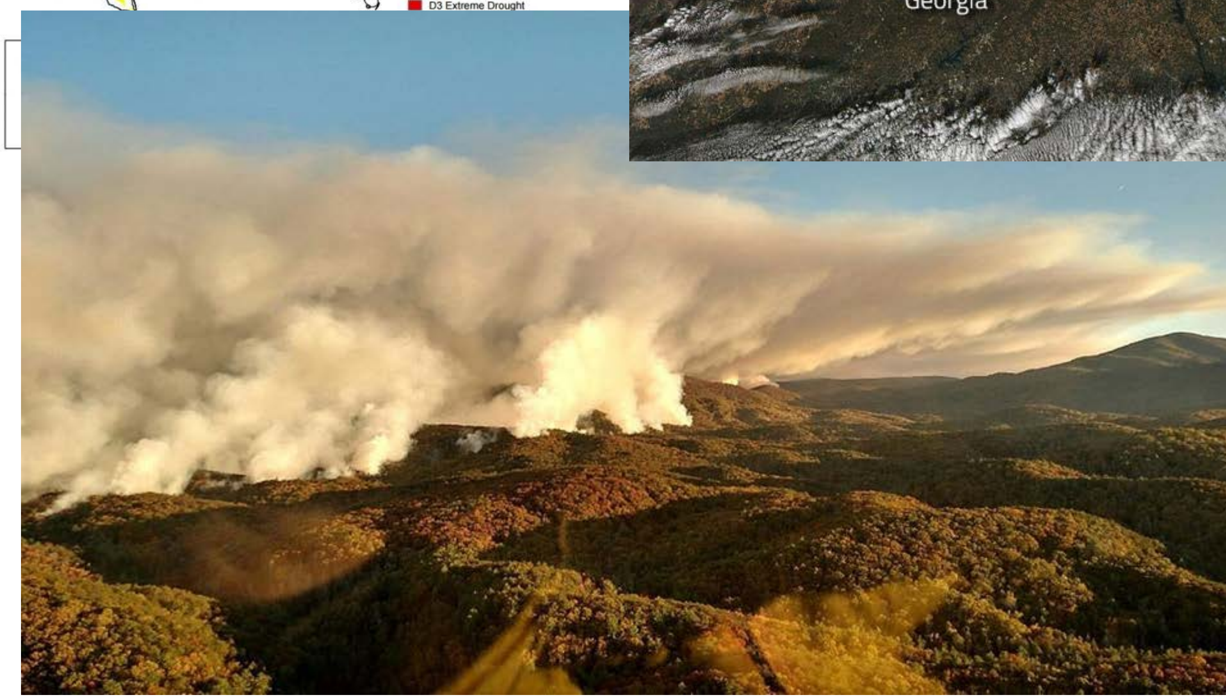
- Change is not necessarily what we expected
- Shift of species mean abundance center by ecoprovinces in the eastern United States during the last three decades
- Westward shift of angiosperms, northern shift of conifers



(Fei et al. 2017; Science Advances)

2016 wildfires





Novel fuels?

- **The path back is not the same as the path forward…**

Conservation costs to restoration

Wildfire and duff consumption eliminate overstory pines

Altered ecosystem trajectory?

Mesic species not eliminated by fire due to duff consumption and resprouting?

Rough Ridge Fire 2016

Hiers et al. 2014.

Burning by objective

- Historic fire is not an objective—it's a guide

- Most burns or landscapes have multiple objectives that ensure variability over time.

- Precisionism all too common in S.M.A.R.T. objectives and prescriptions!

- Fire regime objectives?

Prescription Precision

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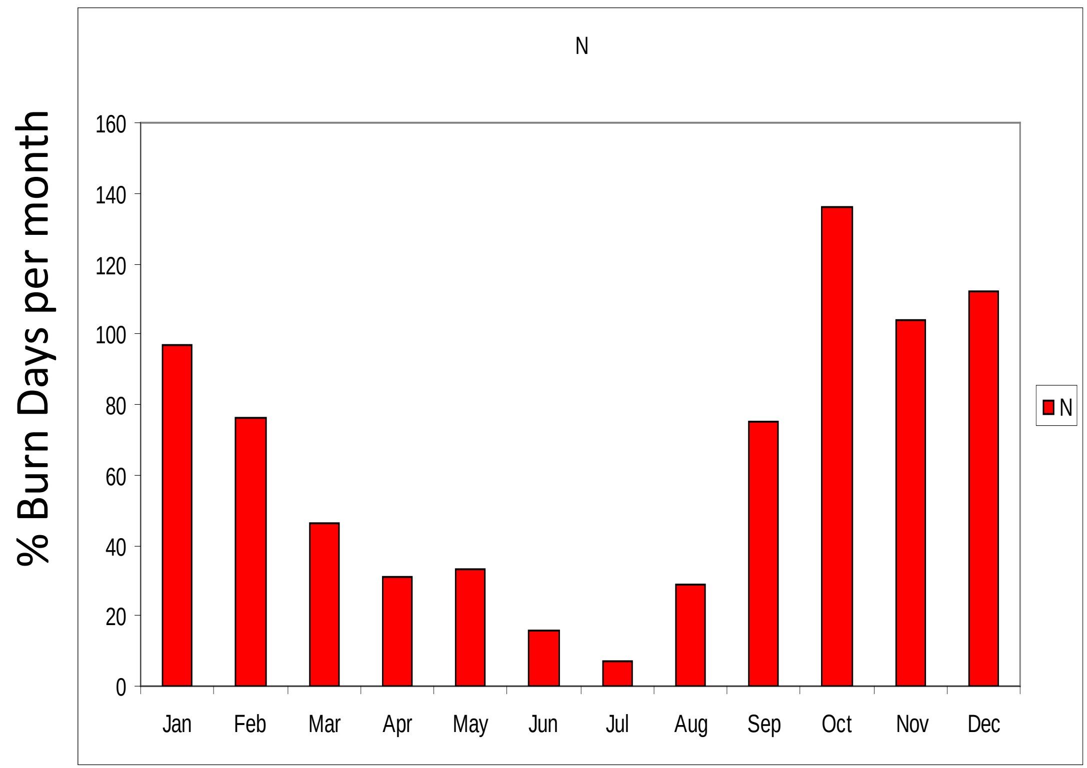
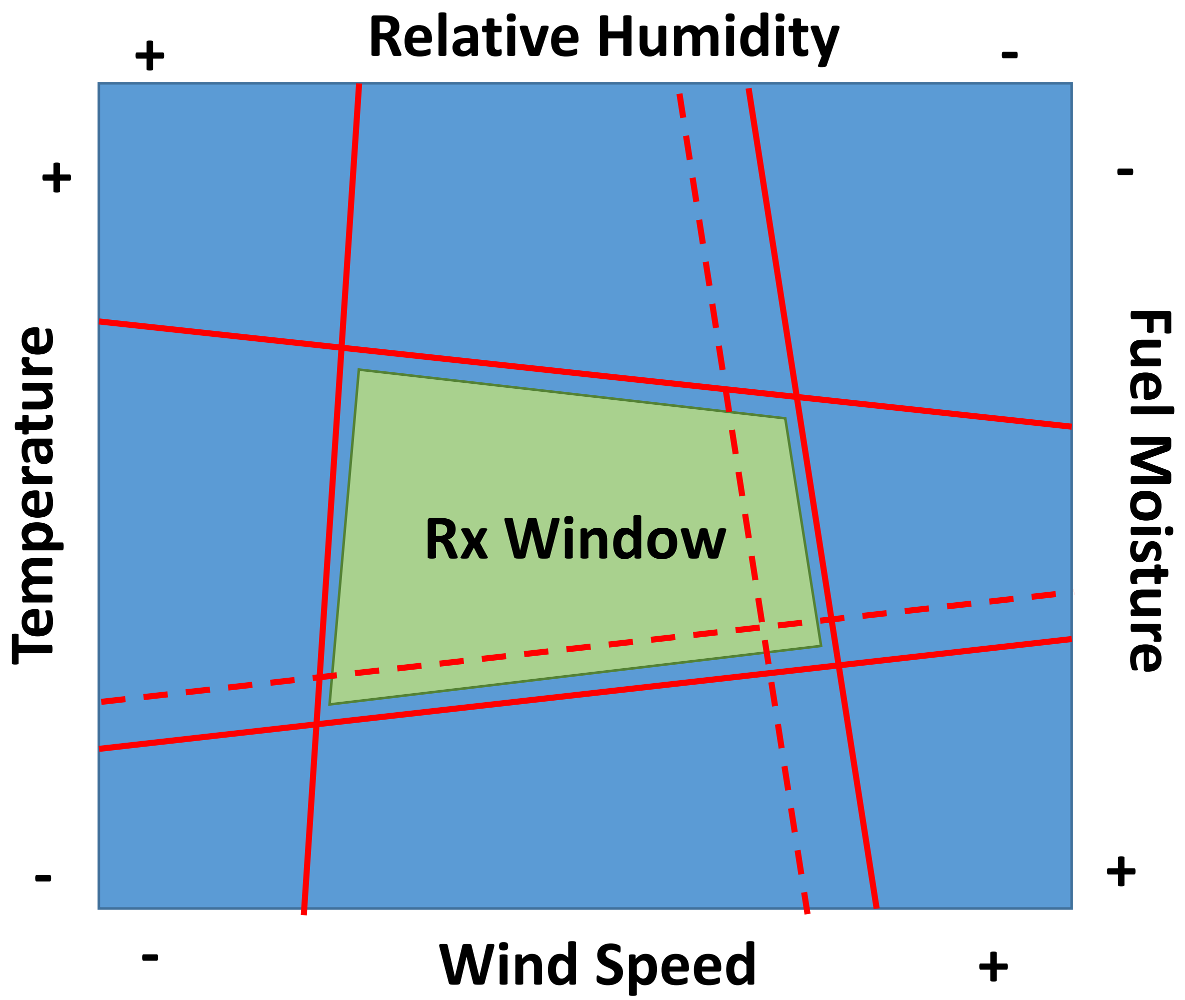
- Prescriptions are legal documents with artificial precision (Hiers et al. 2016)
  - Model tools used to est. flame lengths return 0.1 ft intervals
  - Wind speeds and dispersion
  - Legal consequences to precisionism



N Wind 5-15 mph
Humidity >15%

Prescription Precisionism

- Prescriptions only get narrower
- Trial and error not allowed to expand
- Why not specify a fire behavior as the Rx parameter?

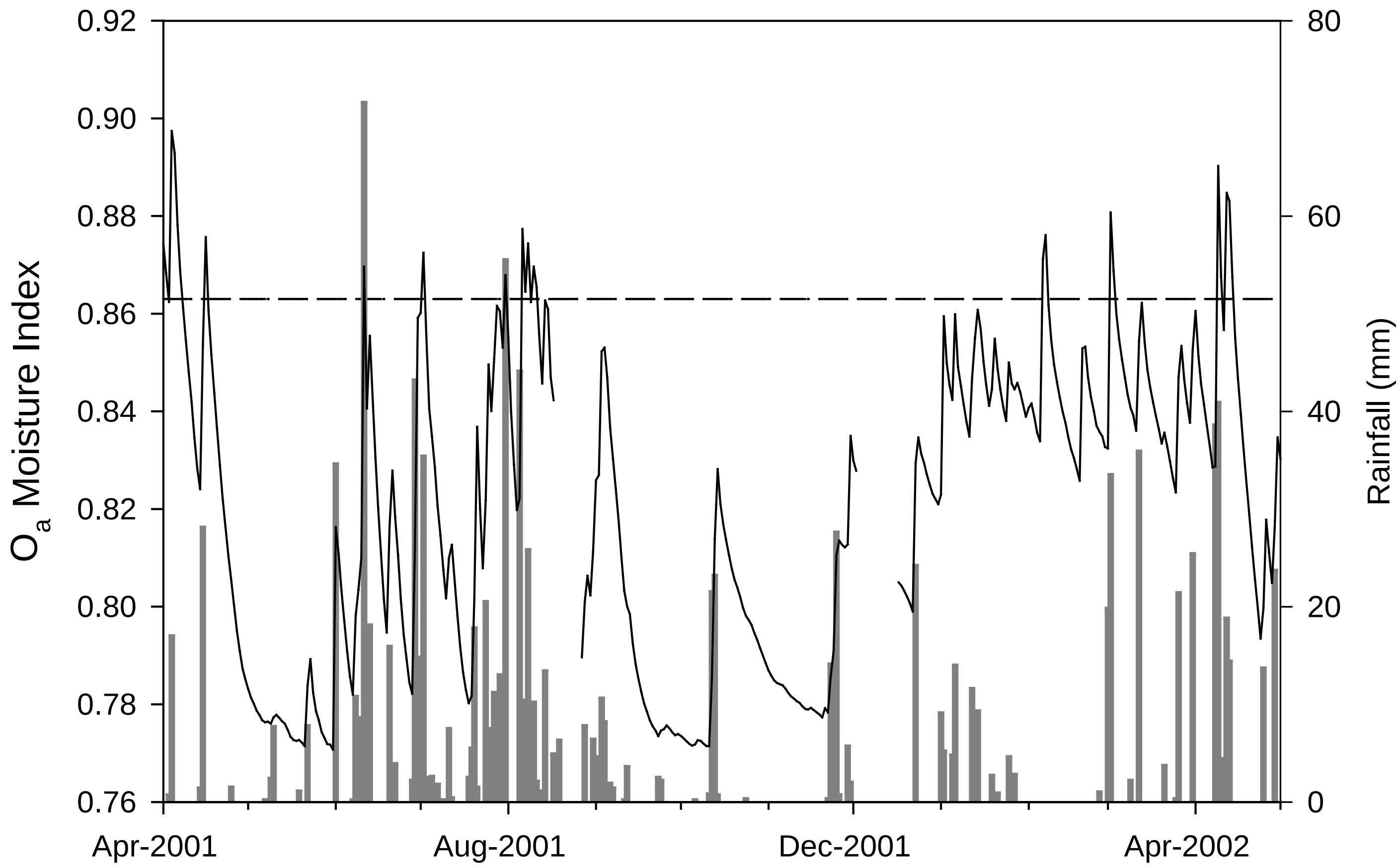


Conflicting objectives

- The focus on individual species and optimizing fire regimes leads to reduced variation and declines in species.
  - Sherman fox squirrel (Perkins et al. 2008)
  - Indiana Bat (Josh Campbell, pers. comm.)
- Metapopulation dynamics of multiple rare species and seasonal burn restrictions.
  - Mustang Corner fire in Everglades
- Interaction of other altered disturbance regimes change seasonal fire effects
  - Wind events with duff consumption and loss of overstory trees

Does "historic" fire help prescriptions?

- Safe threshold for burning over duff varies by rainfall
- Several seasons but few safe times are available in this window



Ferguson et al. (2002); Int'l Journal of Wildland Fire

“Natural” fire for an unnatural landscape

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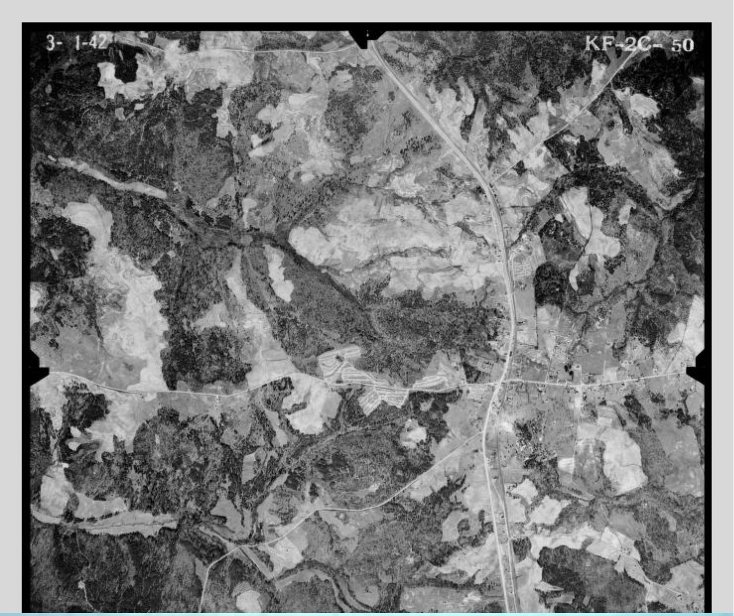
Impacts of artificially limited season of burn:

- EQUALS LESS FIRE
- Clean Air Act non-attainment conflicts in certain areas
- Increased conflict with fire suppression activities (fall fire season here summer in CP)
- Fewer prescription windows with increasing temperature (and declines in RH)



An Uncertain Future

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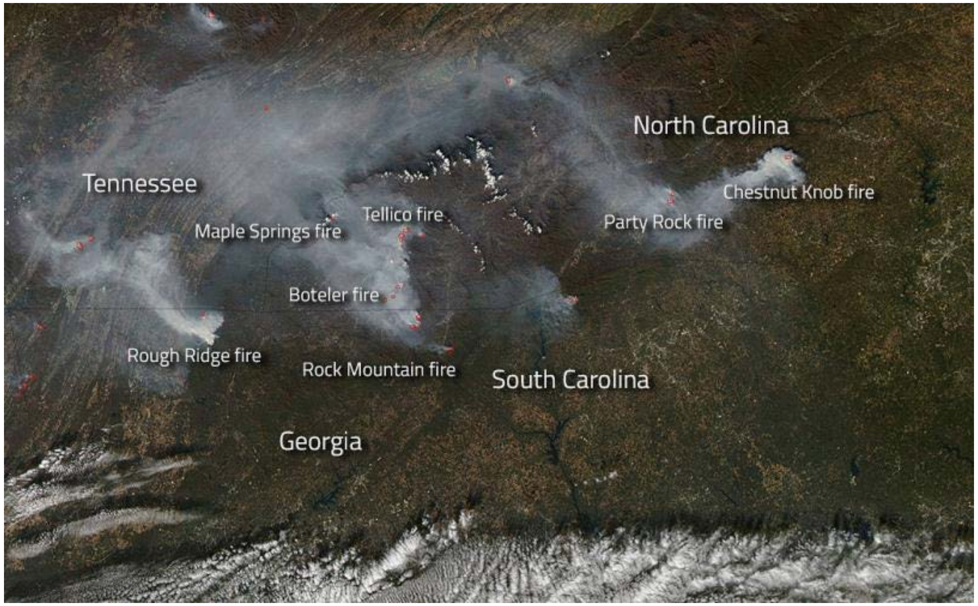
"If you don't know where you are going, you might wind up somewhere else."
Yogi Berra

- **Food fights over "what was" are counterproductive to conservation challenges**
- **Expected global change will challenge biodiversity in novel ways** (Williams and Jackson 2007)
- **Migration from coastal areas inland** (Hauer 2017, NOAA)
- **Increasing constraints on Rx Fire prescription windows**



No analog fire regimes

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- Alternative stable states resulting from fire and pests
- The Caicos Pir
  caribbea var. *l*

When shifting paradigms…

(always remember to depress the clutch)

Time to abandon “natural” management

This does not imply management and restoration can’t be usefully informed by the past or that we don’t love nature…

Reassess historical ranges of variation as <u>strict</u> guides for management and restoration (Heyward et al. 2012)

Facing the no-analog future: consider <u>*future*</u> ranges of variation

A different approach

Future Range of Variation

- Quantify species responses to variability not optimality
- Management variation (with data!) is an opportunity to achieve a “possible” future rather than some specific time in the past
- Science-management partnerships to monitor achievable outcomes for conservation objectives

Golladay et al. (2016)

Variation as innovation

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- The past is not prolog, but can provide lessons about the future
- Variation in species habitat usage provides managers with critical options for balancing competing objectives
- Variation maintains options for responding to future climate change
- Variation makes more efficient use of limited resources in the present

Oconee National Forest: a novel forest

Biodiversity is diverse

- Variation in fire regime maintains species diversity in the East
- Pyrodiversity is recommended
- Place based fire history as guide
    - (Hart and Buchanan 2012)
- Burn by objectives but avoid overly specific prescriptions

Photo by Kevin Rose

Photo by T. Ann Williams

What does success look like?

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- More prescribed fire!
  - More innovation—ok to make "mistakes"
- More monitoring data!
  - Managers/researchers partnership
  - long term plots and data management
- Research should be mechanistic rather than correlative to predict future fire effects
- Lots of robust discussion about what works for objectives

Conclusions and recommendations

- "Natural fire" is unknowable; historical fire is a GENERAL guide.
- Test assumptions in historical fire regimes--if they don't work, loosen our grip on the past.
- Innovate with fire and follow change *with monitoring data*
  - management is context specific
  - Correlation is error prone in a rapidly changing world
  - Monitor ecosystem trajectories to see what is *achievable*
- Achievable future range of variation
  - Reorient toward a forward-looking approach
  - Consider ecosystem resiliency at multiple scales
  - *Use variation as natural experiments*

Suggested reading on the topic: Dufour & Piegay 2009, Kirkman et al. 2013, Perring et al. 2013, Christensen 2014, Hiers et al. 2016, Freeman et al. 2017

Questions?

Searching for climate resilience

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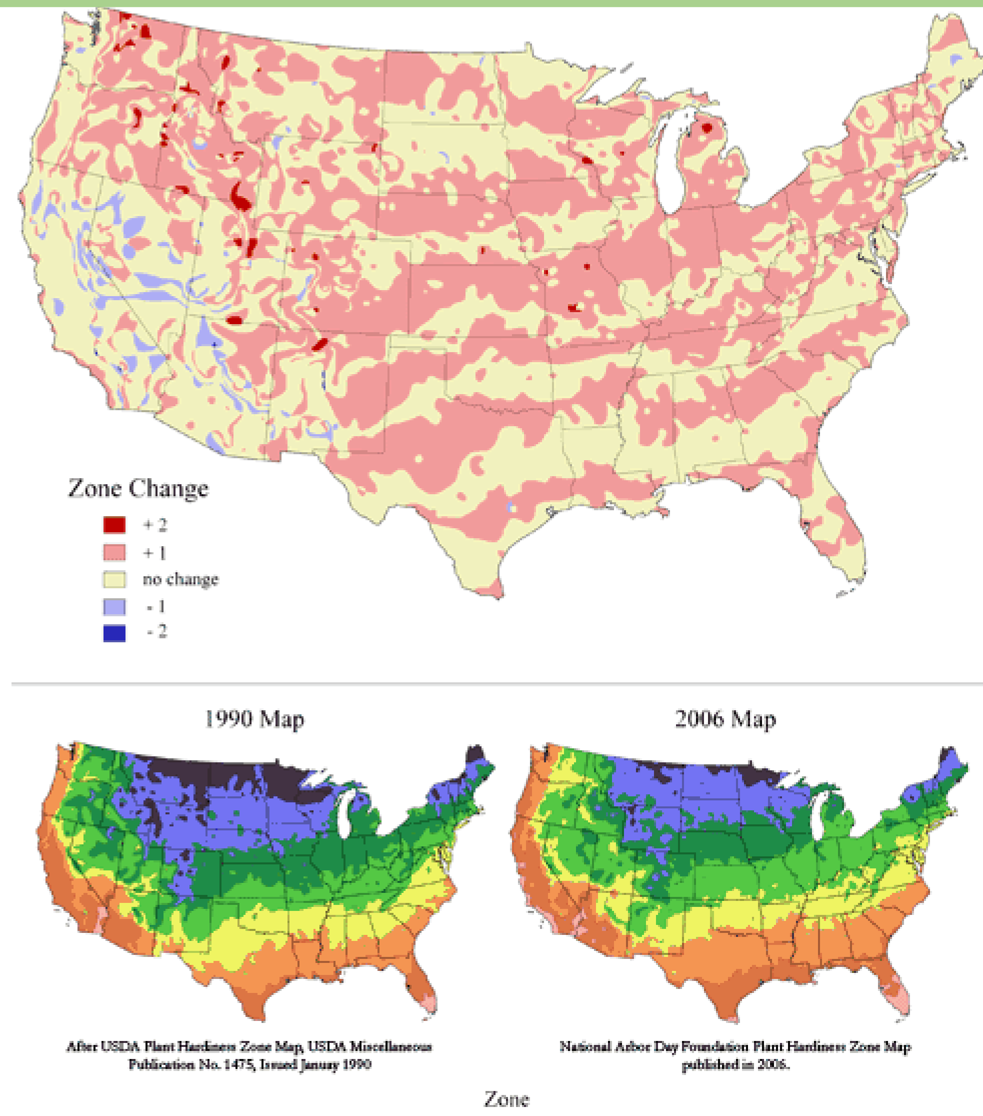
- Wahlenberg (1946) described Turkey Oak as “nurse trees”
- Midstory oaks to provide a microsite for longleaf regeneration in dry sandhills

See Loudermilk et al. (2016)

Climate change: warmer and more variable

- Increased nighttime low temps driving species migration (Osland et al. 2017)
- Reference conditions are increasingly impossible on the historic landscape with exotic species
- Increased temp restricts prescriptions
- See National Climate Assessment (NCA3&4)



The Importance of Frequent Fire in Sustaining Plant Diversity

- NMDS Ordination of understory plant species from monitoring plots at Eglin Air Force Base, FL. Axis one scores were primarily driven by fire frequency: contours with higher numbers indicate higher fire frequency