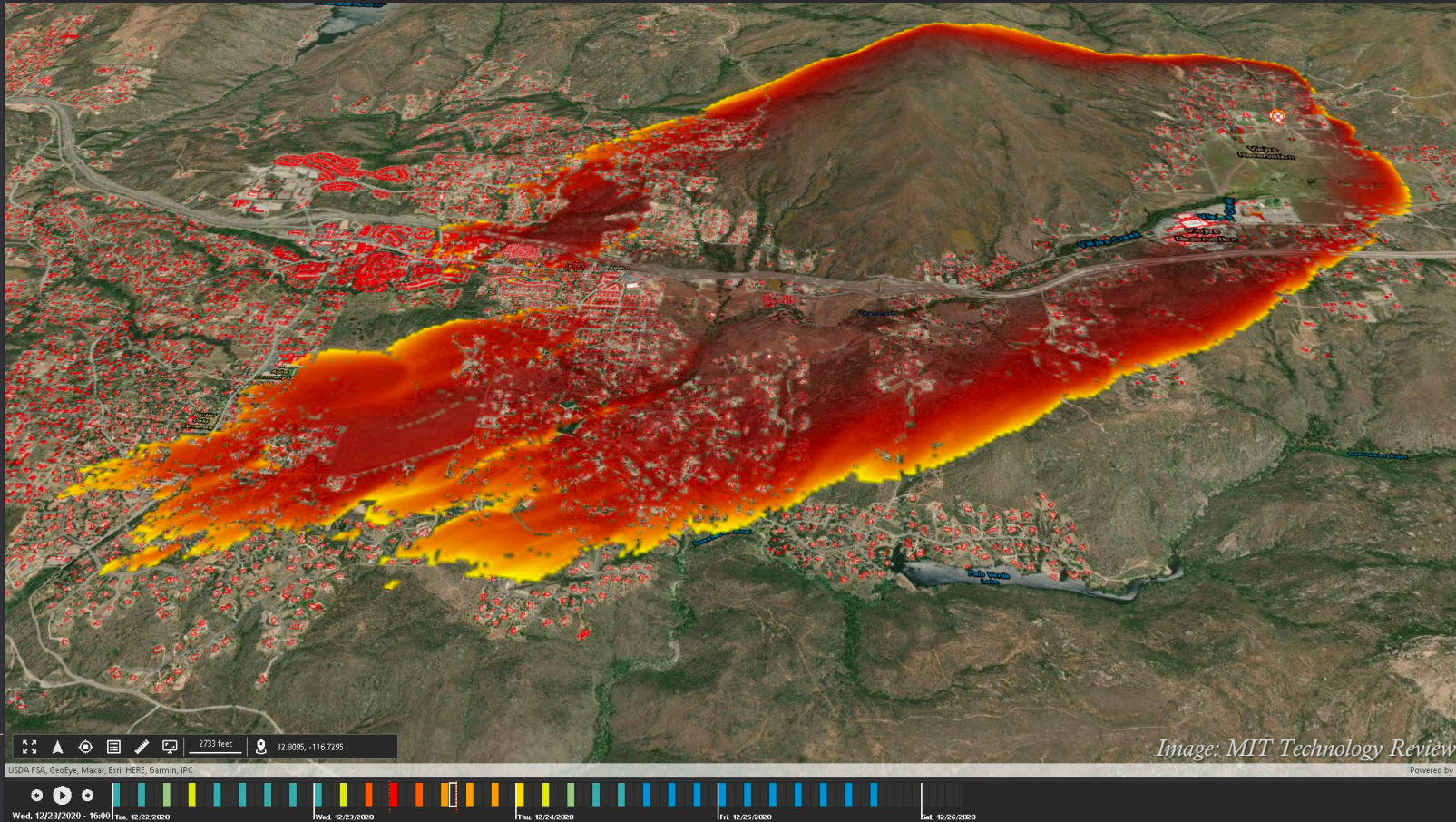




# Why care about fire behavior modeling?

## An interactive discussion

New Mexico Wildland Urban Fire Summit 2023  
Ruidoso, NM



Nathan S Gill, PhD

Department of Natural Resources Management

Texas Tech University

[PollEv.com/NathaGill754](https://PollEv.com/NathaGill754)



# Who I am

- ◇ A researcher
- ◇ A geographer
- ◇ A fire ecologist



# Who are you?

◇ Respond live on [Pollev.com/nathangill1754](https://Pollev.com/nathangill1754)

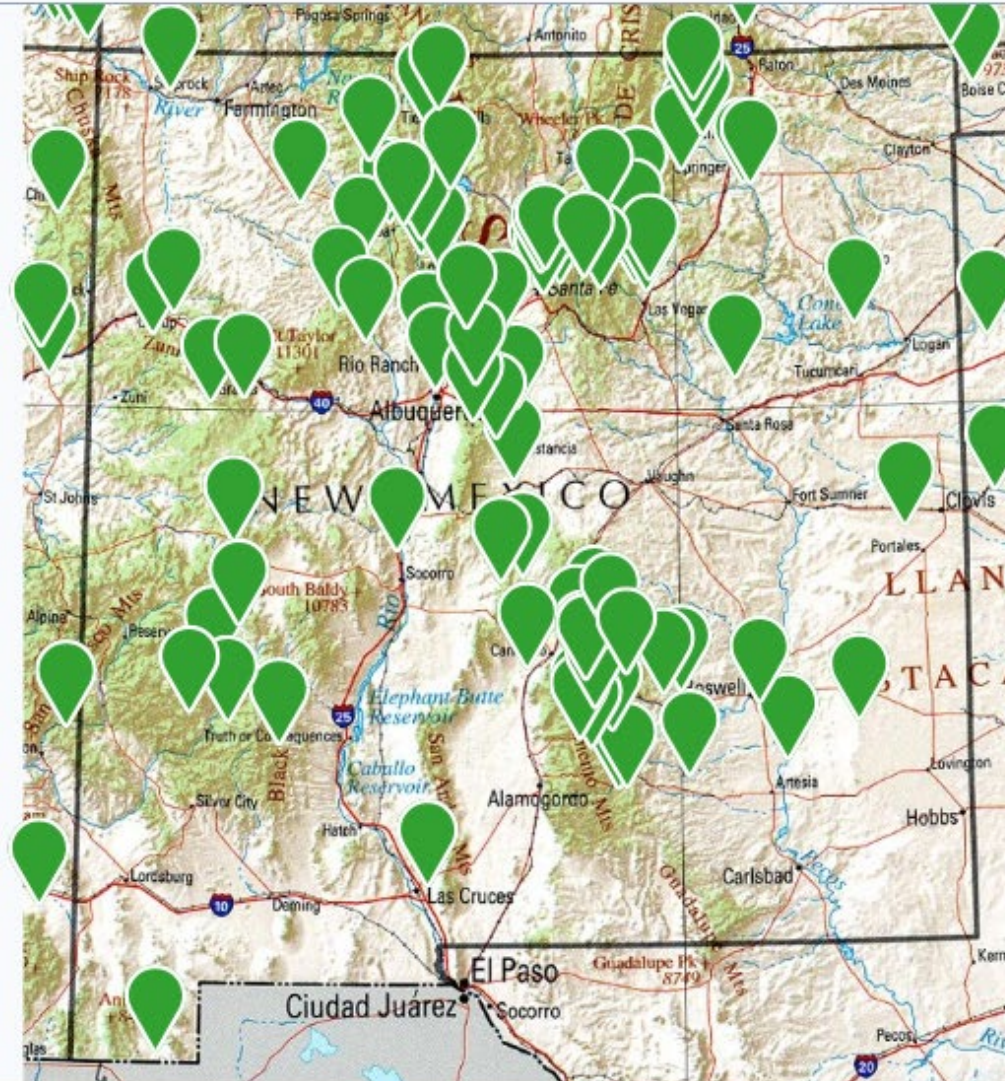
*Answer the first three questions for now... We'll get to the others in a few minutes*

*Anonymous responses, used only for our conversation today and my personal information, not part of a study*



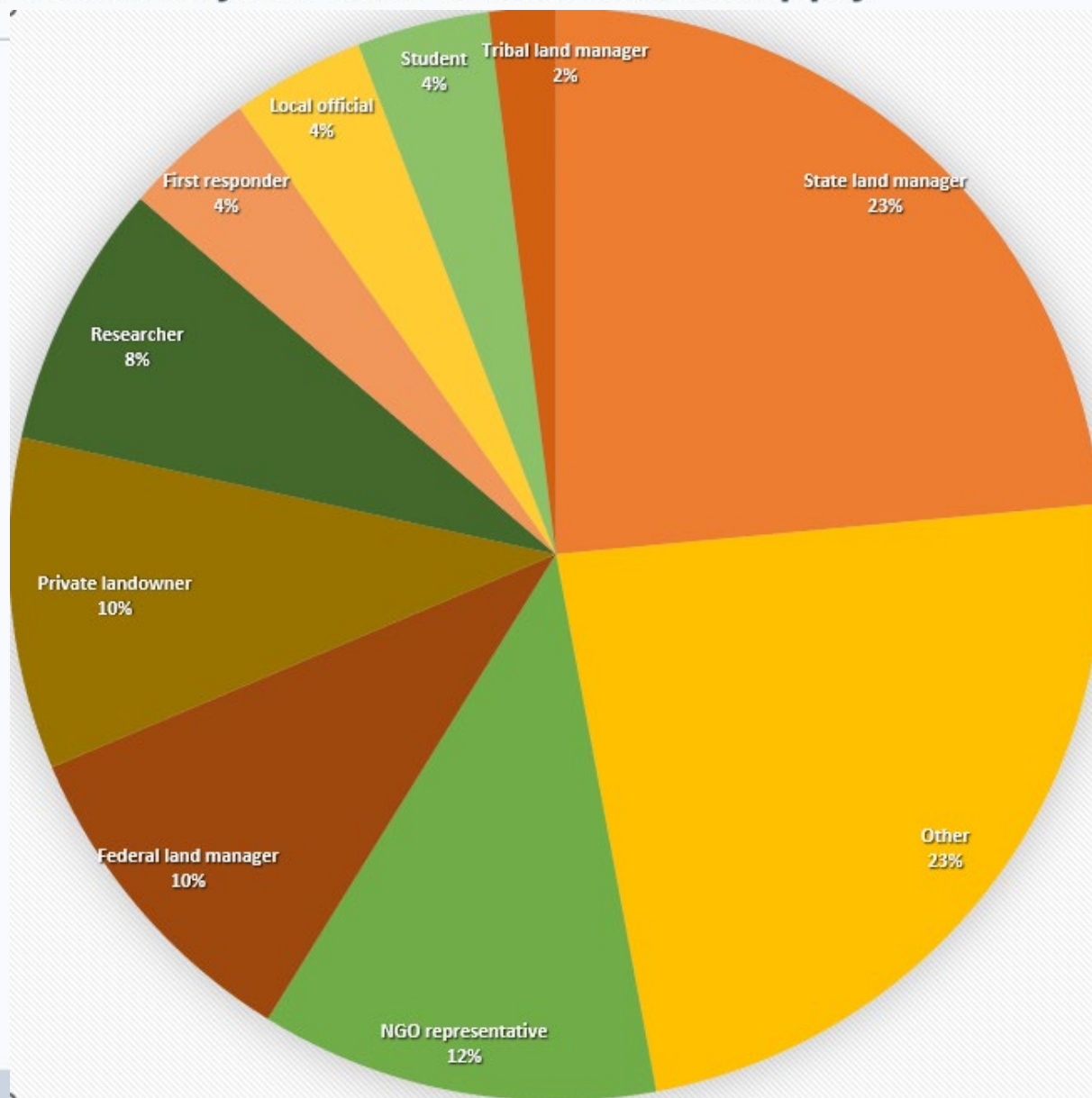
- ◇ Where do you work? (map)
- ◇ How would you describe your role?
- ◇ In a few words, what are your most important land management priorities?

Click on the map to indicate the land where you work. You may click on more than one area, if applicable. You may click on the edge of the image to indicate lands that fall outside of the state.



How would you describe your role? Check all that apply

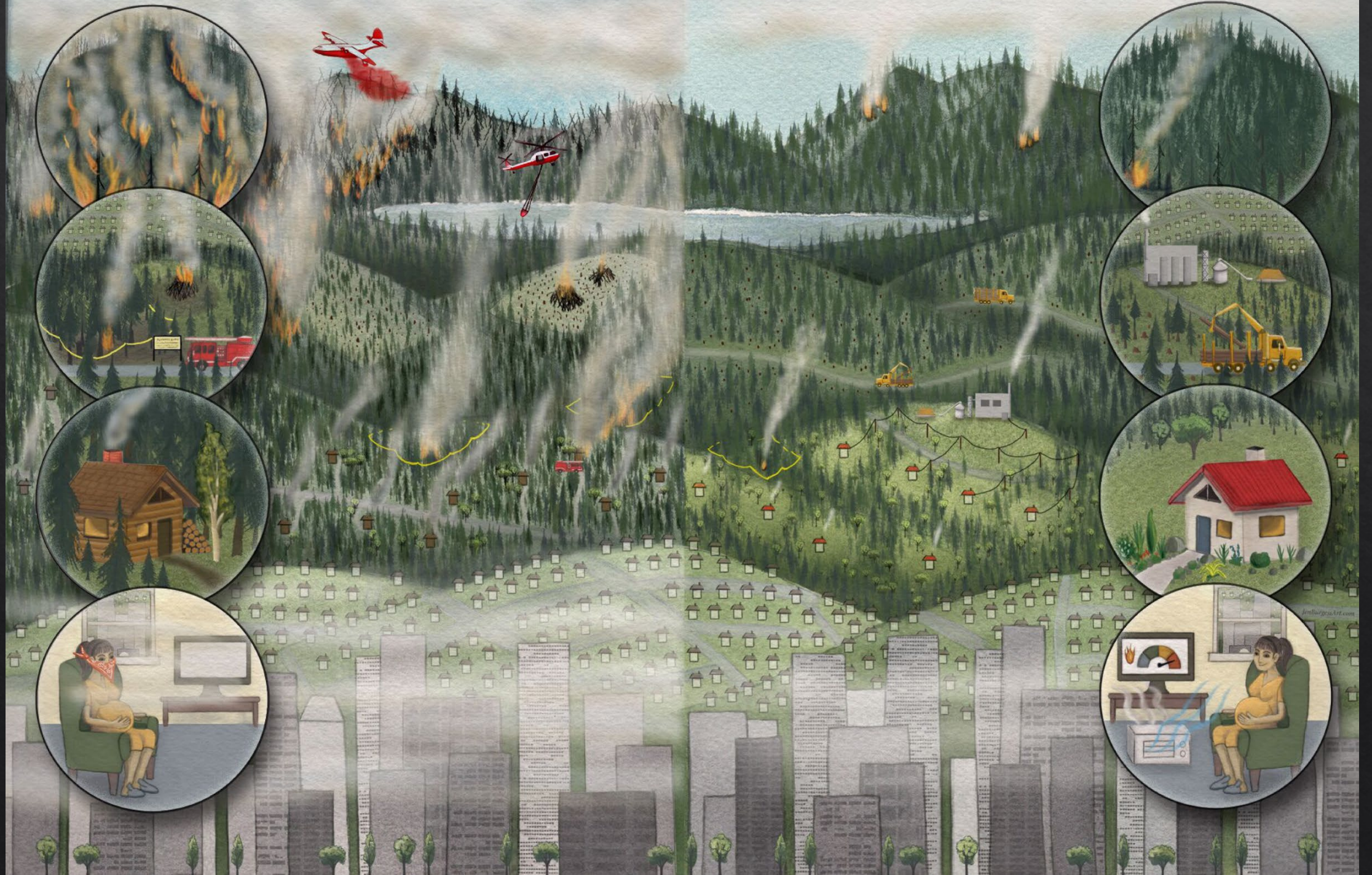
Next



For next question, type in key words with commas

**In only a few words, what are some of your top priorities related to land management?**





What words pop into your head when you hear "defensible space" ?

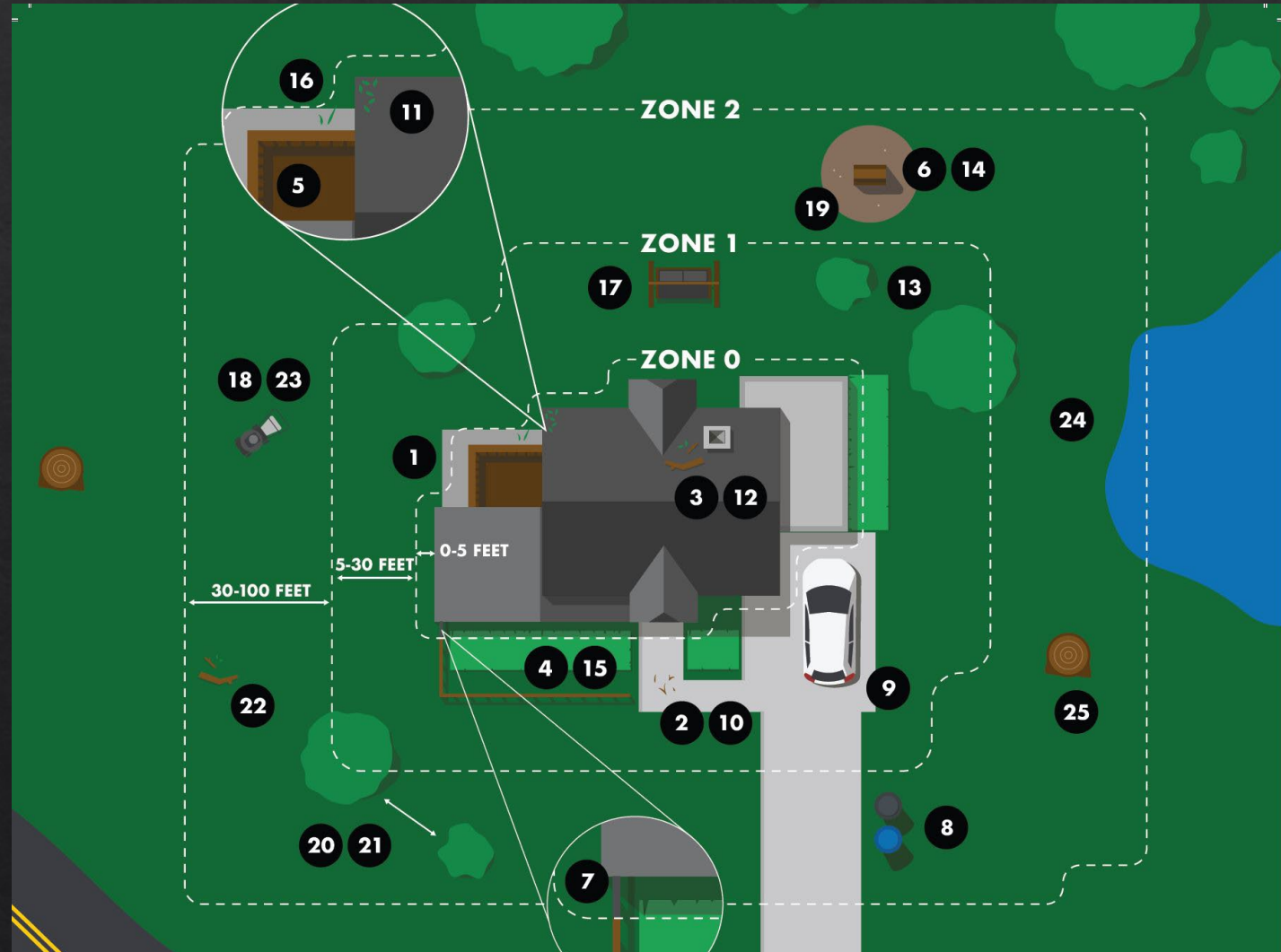
A word cloud featuring various terms related to wildfire management and defensible space. The words are arranged in a dense, overlapping manner, with some words being significantly larger than others. The colors of the words vary, including shades of green, blue, purple, red, and yellow. The most prominent words, shown in the largest font sizes, are 'safety', 'protection', 'thinning', and 'education'. Other notable words include 'home', 'wildfire', 'mitigation', 'management', 'neighborhoods', 'reduction', 'land', 'communities', 'hands', 'ignition', 'challenging', 'creating', 'trees', 'owner's', 'homeowner', 'work', 'resource', 'fuel', 'place', 'homes', 'choices', 'rights', 'hardened', 'collaborative', 'urgency', 'democratic', 'ladder', 'mowing', 'clearings', 'zone', 'firewood', 'workforce', 'neighbor', 'risk', 'go', 'space', 'forest', 'clear', 'difficult', 'keeping', 'thinking', 'necessary', 'healthy', 'fuels', 'proactive', 'safe', and 'tree'.

wildfire mitigation management neighborhoods  
reduction land communities hands ignition  
thinking cleared challenging creating trees owner's  
keeping necessary education homeowner  
difficult healthy work  
forest clear safety home resource fuel place  
space fuels choices rights  
tree protection proactive hardened  
risk go thinning safe collaborative  
neighbor democratic urgency  
workforce firewood clearings zone ladder mowing

# “Defensible space”

“The buffer you create between a building on your property and the grass, trees, shrubs, or any wildland area that surround it. This space is needed to slow or stop the spread of wildfire and it helps protect your home from catching fire—either from embers, direct flame contact or radiant heat. Proper defensible space also provides firefighters a safe area to work in, to defend your home.”

-Cal Fire



What words pop into your head when you hear "cross-boundary fuels treatment" ?



A word cloud featuring various terms related to cross-boundary fuels treatment. The words are arranged in a cluster, with 'cooperation', 'collaboration', and 'partnership' being the most prominent. A yellow thumbs up emoji is placed over the word 'accomplish'.

Words included in the cloud:

- cooperation
- collaboration
- partnership
- watershed
- softedge
- complicated
- capacity
- expensive
- borderless
- anything
- scale
- accomplish
- shared
- interagency
- partners
- crucial
- debris
- necessary
- way
- coordination
- essential
- connectedness
- stewardship
- long-term
- working

# “Cross-boundary fuels treatment”

“Local, state, tribal, federal, and private land authorities working together to share and leverage resources and build partnerships focused on mitigation actions on the ground”

“Wildfire knows no boundaries. Mitigation must involve cross-boundary partners”

*--National Wildfire Coordinating Group, Standards for Mitigation in the Wildland Urban Interface (2023)*



Scott Williams, USFS

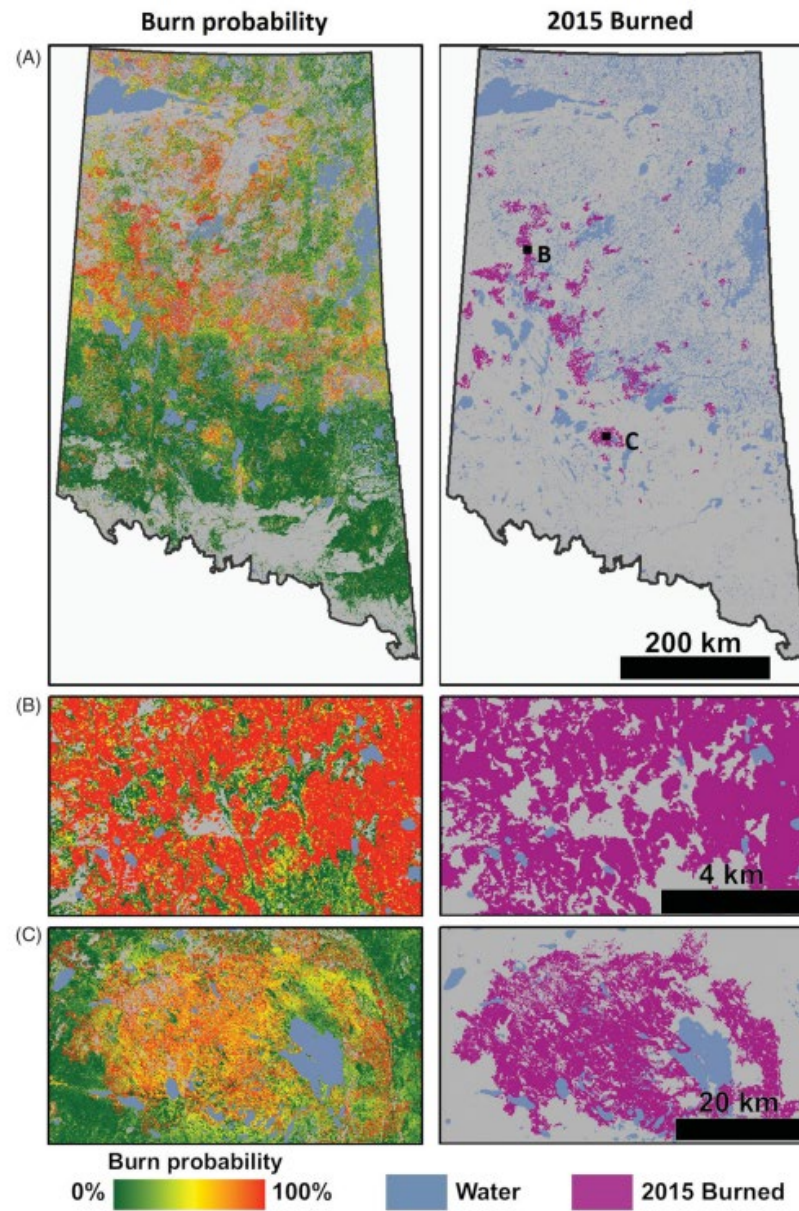
## What comes to mind when you hear the phrase "fire behavior modeling"?



# Modeling gets a bad rap

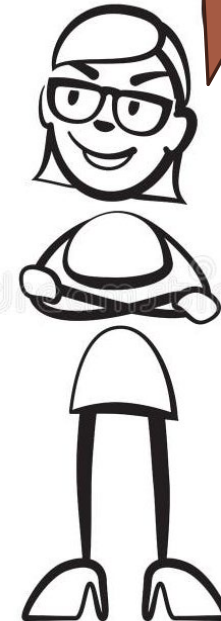
- ◇ Inaccurate or erroneous
- ◇ Untethered to reality
- ◇ Infeasible
- ◇ Complex

"The model was wrong!"

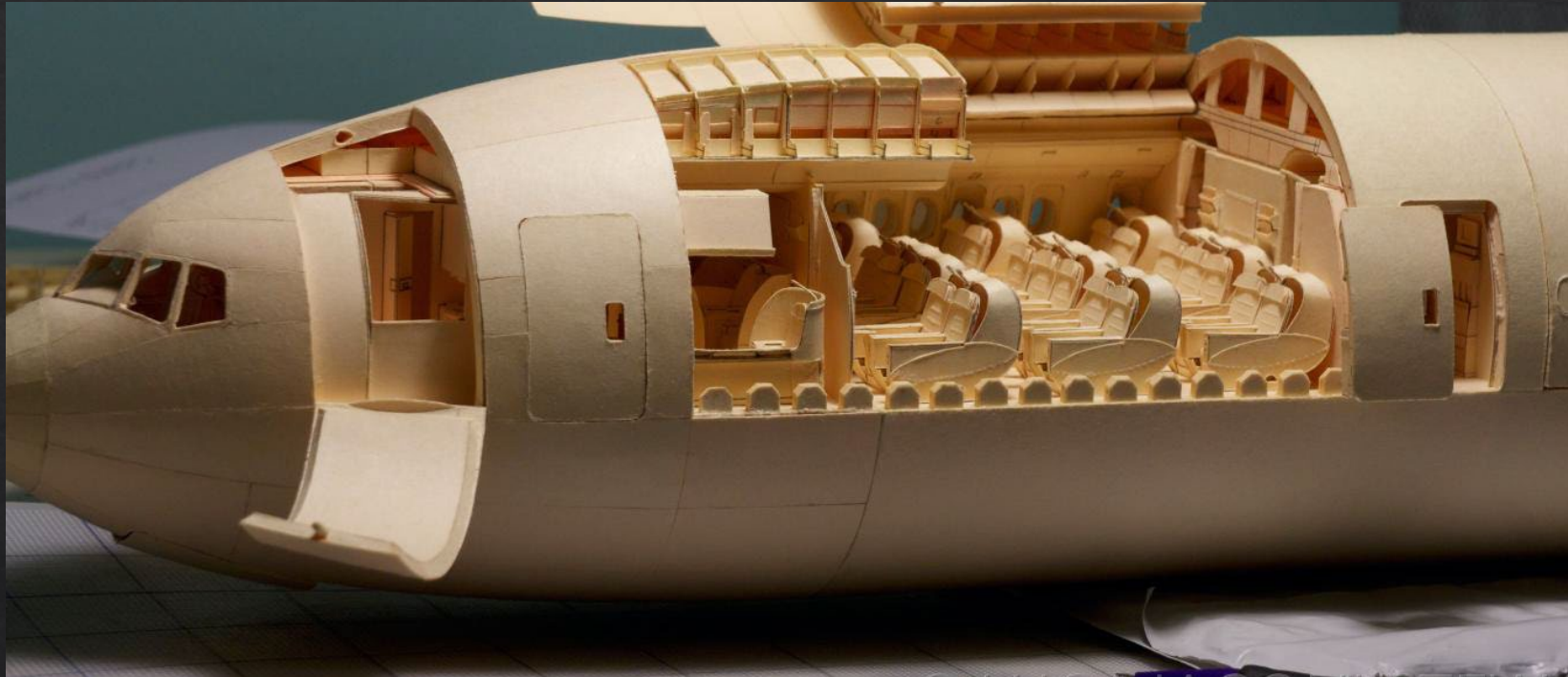


**Figure 7.** (A) Predicted forest burn probability in 2015 in Saskatchewan's forested ecosystems, in comparison to actual burned forest areas for 2015, as detected independently by the C2C approach. Zoom-in examples showing spatially detailed agreement between predicted burn probability and detected fires in (B) Boreal Shield West and (C) Boreal Plains.

"The model worked!"



What is the purpose of a model?



A model lets us explore probabilities based on relationships that exist in reality.

We can test a variety of scenarios that would take too long, be too expensive, and/or be too dangerous to study in real life.

It also lets us simplify the complexity of reality to better isolate the effects of things that are most important, or have the largest implications.

# For example...

We can test how likely a property is to burn

We can see how this probability changes when we hypothetically alter conditions, such as the amount of fuel on the property, the fuels treatments that have happened on surrounding properties, or the weather.

We can alter each of these conditions one at a time to understand how influential things are that are in our control (fuels reduction) compared to things outside of a community's direct control (climate).

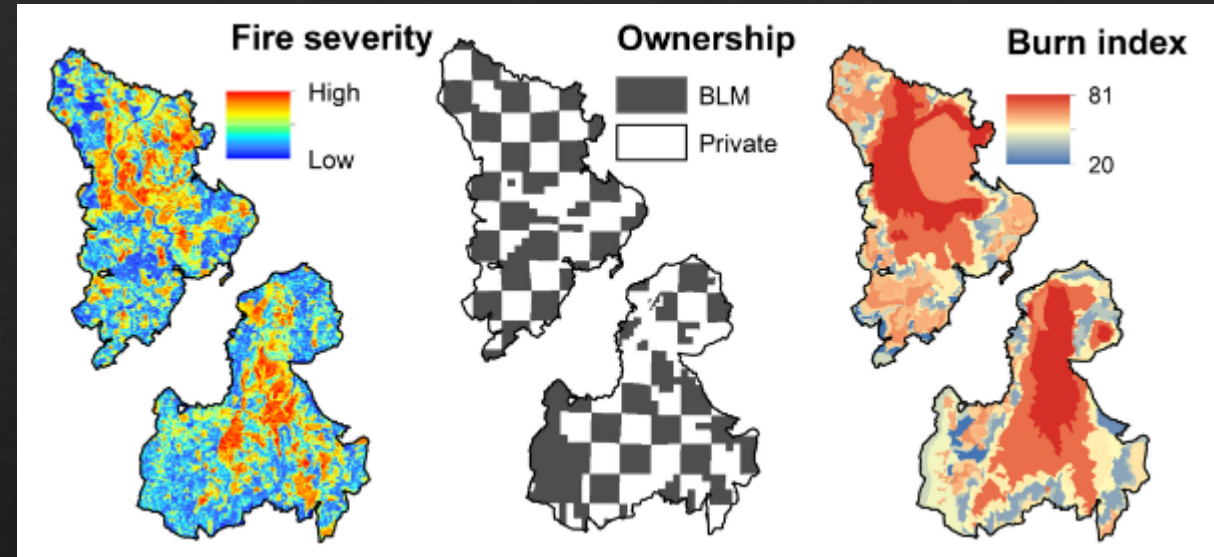
# Probabilities of a range of outcomes

Without treatment

**80%-90%**



# Spatial pattern matters!



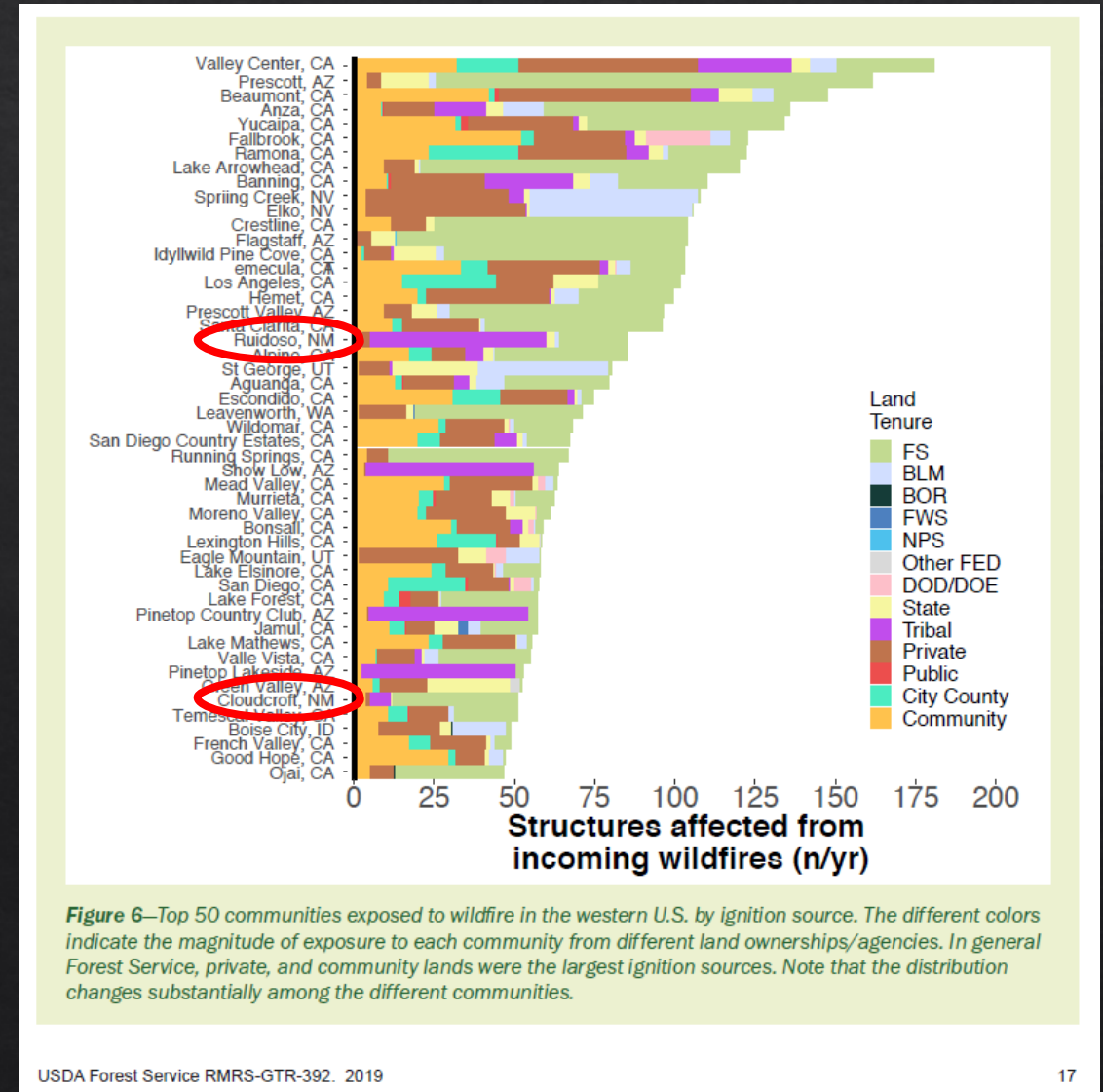
Zald, H.S.J. and Dunn, C.J. (2018), Severe fire weather and intensive forest management increase fire severity in a multi-ownership landscape. *Ecol Appl*, 28: 1068-1080

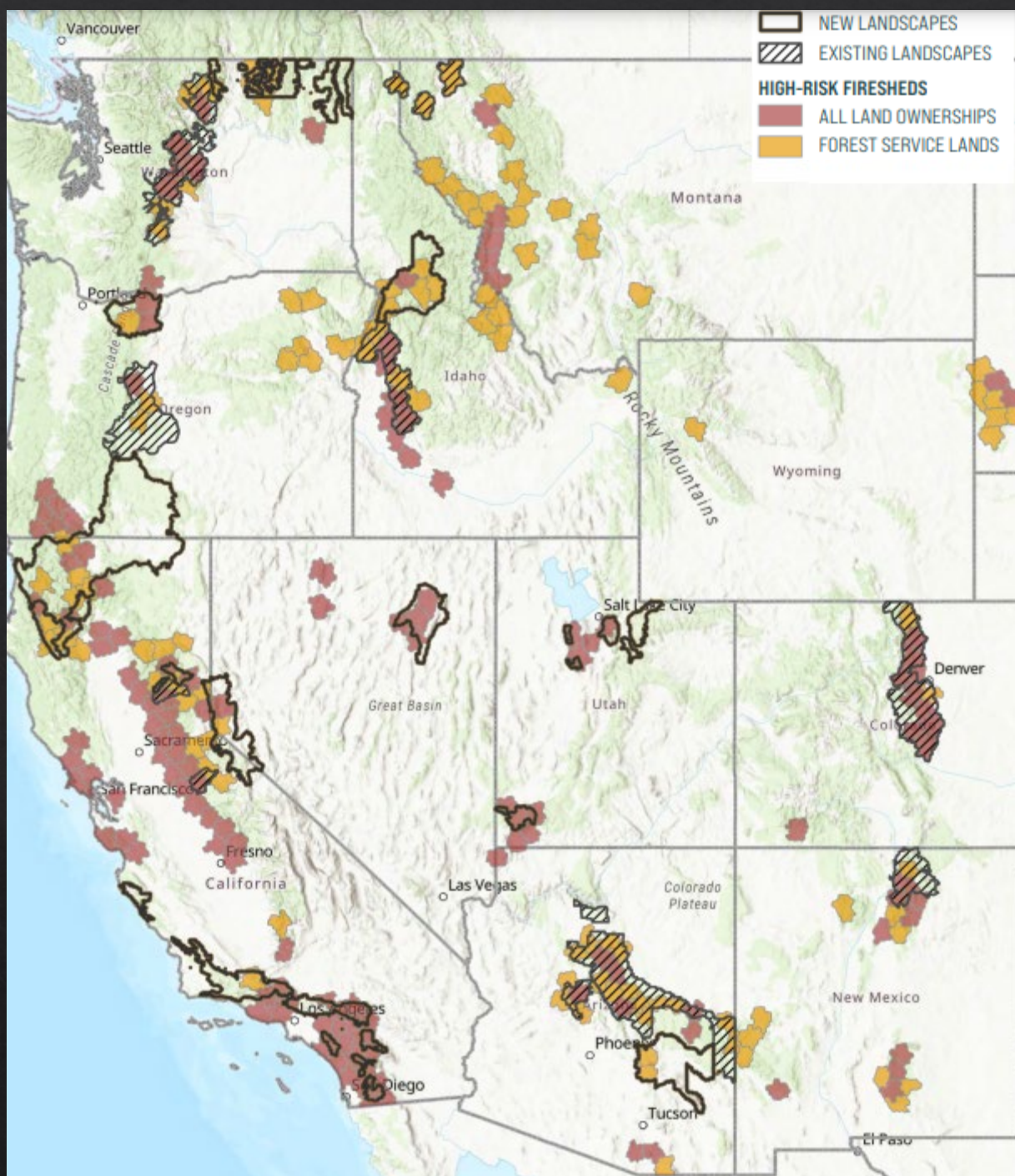
Spatial  
pattern  
matters!



# Lincoln National Forest

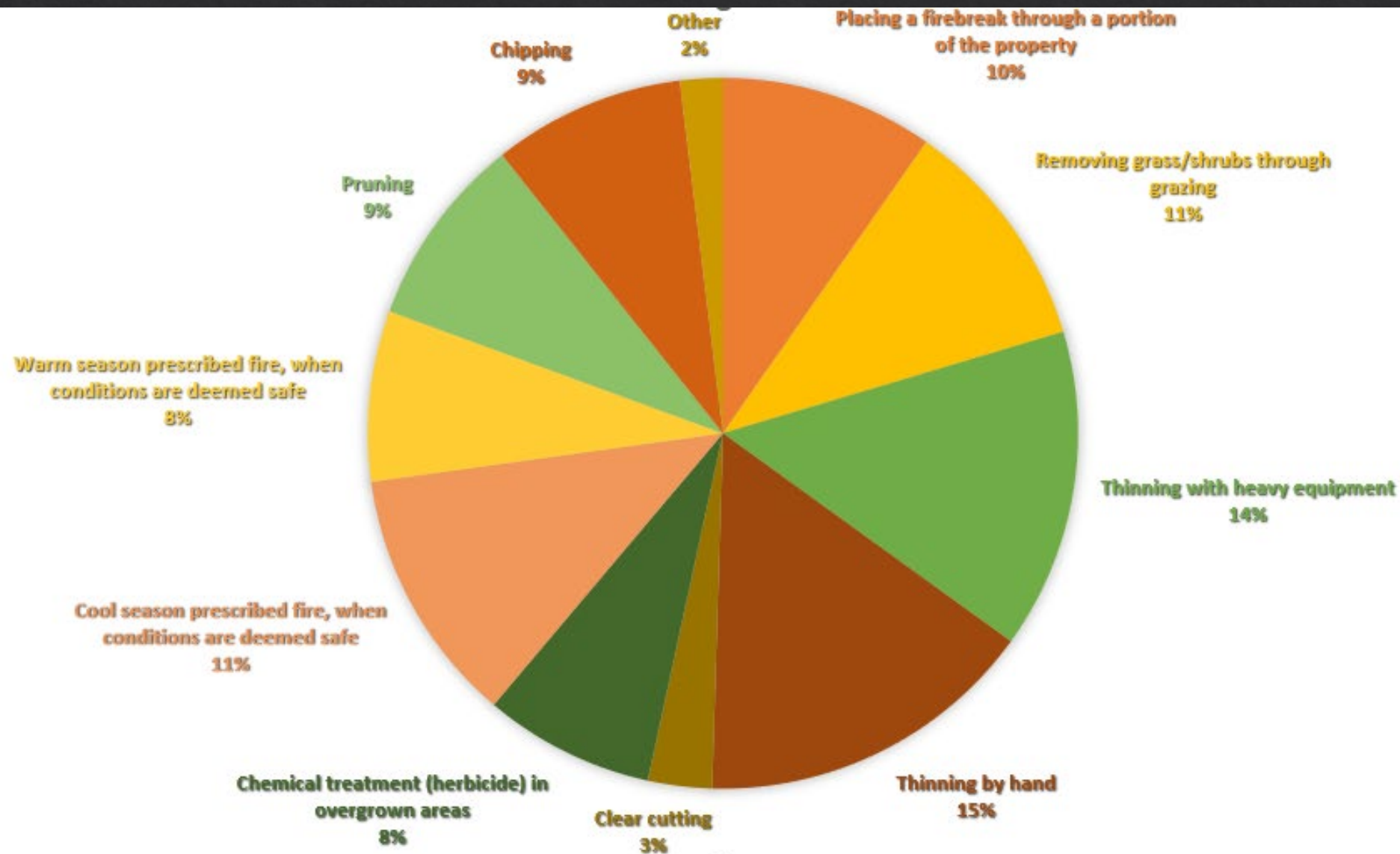
Ager et al. 2019; USDA Report:  
Confronting the Wildfire Crisis Strategy





Next

# Which fuel treatment options have you used or would you consider using?



How do you feel about a few of these fuel treatment options?



Adamantly  
opposed



Would not  
support



Neutral or  
mixed  
feelings

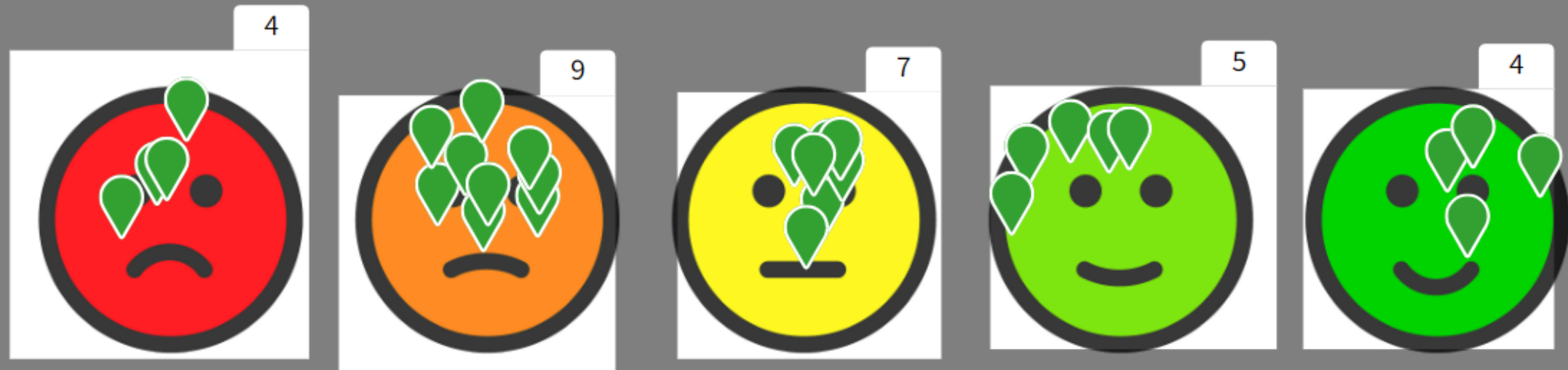


Would support  
or allow

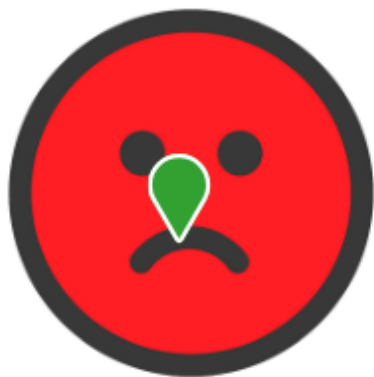


Would strongly  
support, maybe  
even contribute  
toward cost

On the land that you work with, how do you feel about the prospect of clear cutting?



On the land that you work with, how do you feel about the prospect of thinning with heavy equipment?



On the land that you work with, how do you feel about the prospect of prescribed burning?



What barriers do you face in having fuel treatments implementing on the land you work with?

HOA  
Community buy in  
Understaffed  
Treatment design  
Expertise  
Public support  
Capacity and timing restrictions  
Perception  
Money

Mixed ownership, narrow burn windows, administrivia (contracting, NEPA)

landowners' fear and lack of understanding of crucial need for fuels management on public and private land

Residents  
Safety concerns RX  
Culture  
Cost  
Funding  
Negative views  
Federal regulation on public land  
Public support  
Out of town owners  
Political views  
Cost  
Public buy-in

Cost, ignorance, bad decisions coloring public opinion  
Mill capacity  
Conditions  
Funding  
Firefighter-standby  
Staff  
All the red tape

Lack of appreciation/recognition of small water utilities in the context of wildfire and postfire

# Pilot study: What I am trying to do

1. How do different **patterns** in hypothetical scenarios influence fire behavior outcomes for structures?

I am trying to understand whether the spatial arrangement of fuels treatments can meaningfully influence fire behavior, ignoring effects of area treated or treatment type



# A pilot study: What I am not trying to do

- ◇ Predict behavior of one particular fire
- ◇ Tell land managers what to do
- ◇ Advocating for one particular treatment or strategy
- ◇ Imagine a world where fuels treatments are feasible at incredibly broad scales

# A single, crude estimation of modifying fuels



A single, cr



Control 2015



Burn 2015



Thin 2015

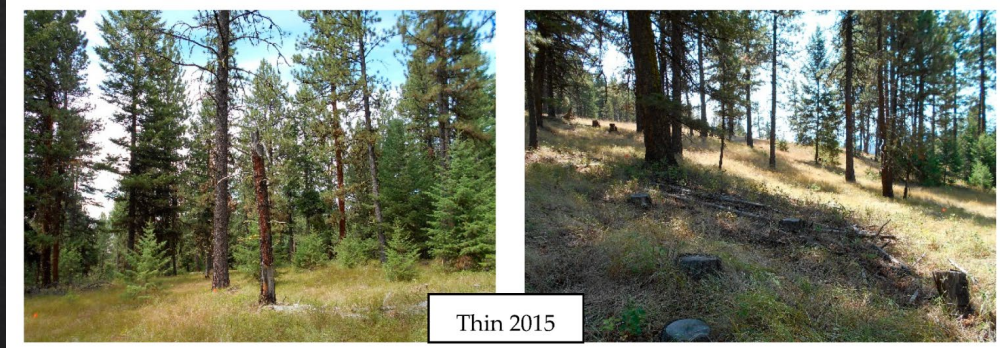


Thin and Burn 2015



lifying fuels

# A single, crude estimation of modifying fuels



# Scenarios in the Sacramento Mountains

## ◆ Scenarios:

- ◆ Null scenario (no hypothetical treatments; ‘actual’ landscape)

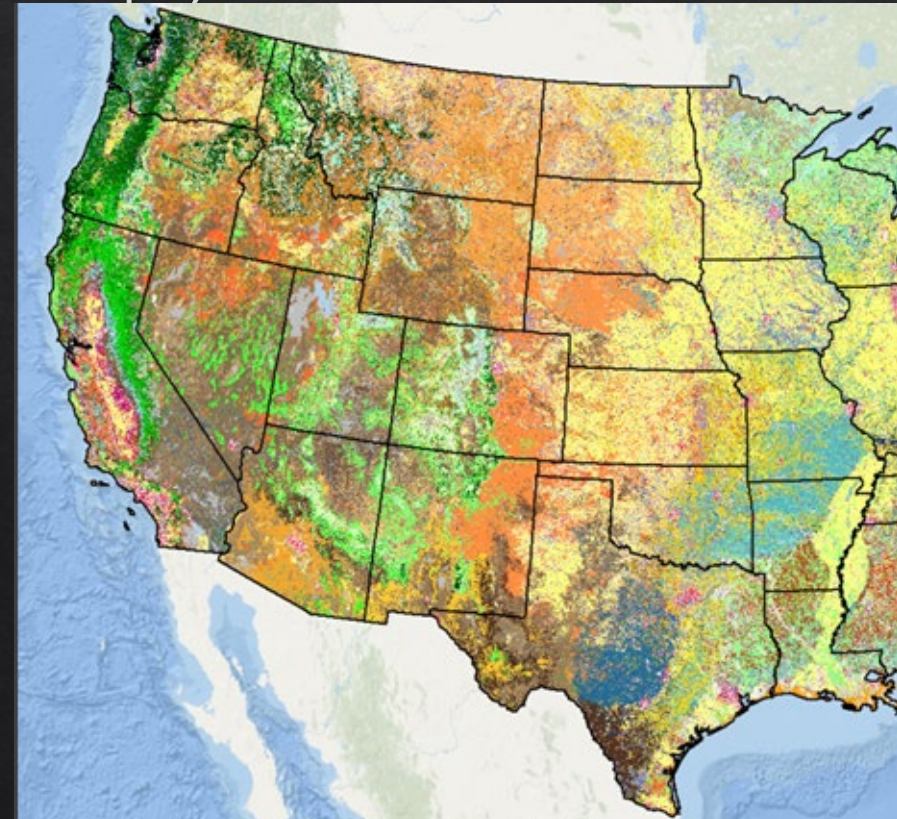
## ◆ Treatments:

- ◆ All priority WUI on USFS land (204,000 acres): “FS only”

- ◆ Structure-scale buffer (21,000 acres): “Individual buffer”

- ◆ Community-scale buffer (all lands) (187,000 acres):

“Community buffer”

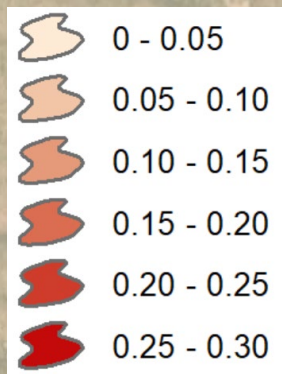


# Ruidoso: McBride Fire

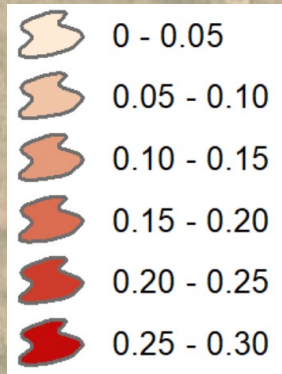
Fire engine on the McBride Fire April 14, 2022



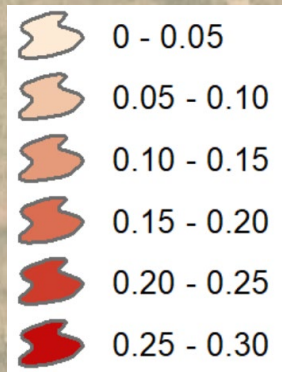
# Null



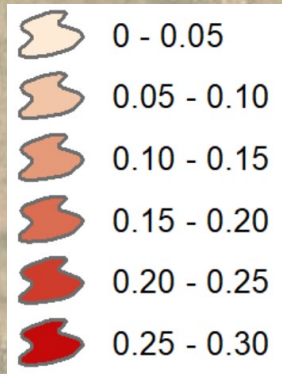
# FS only thinning



# Individual buffer



# Community buffer



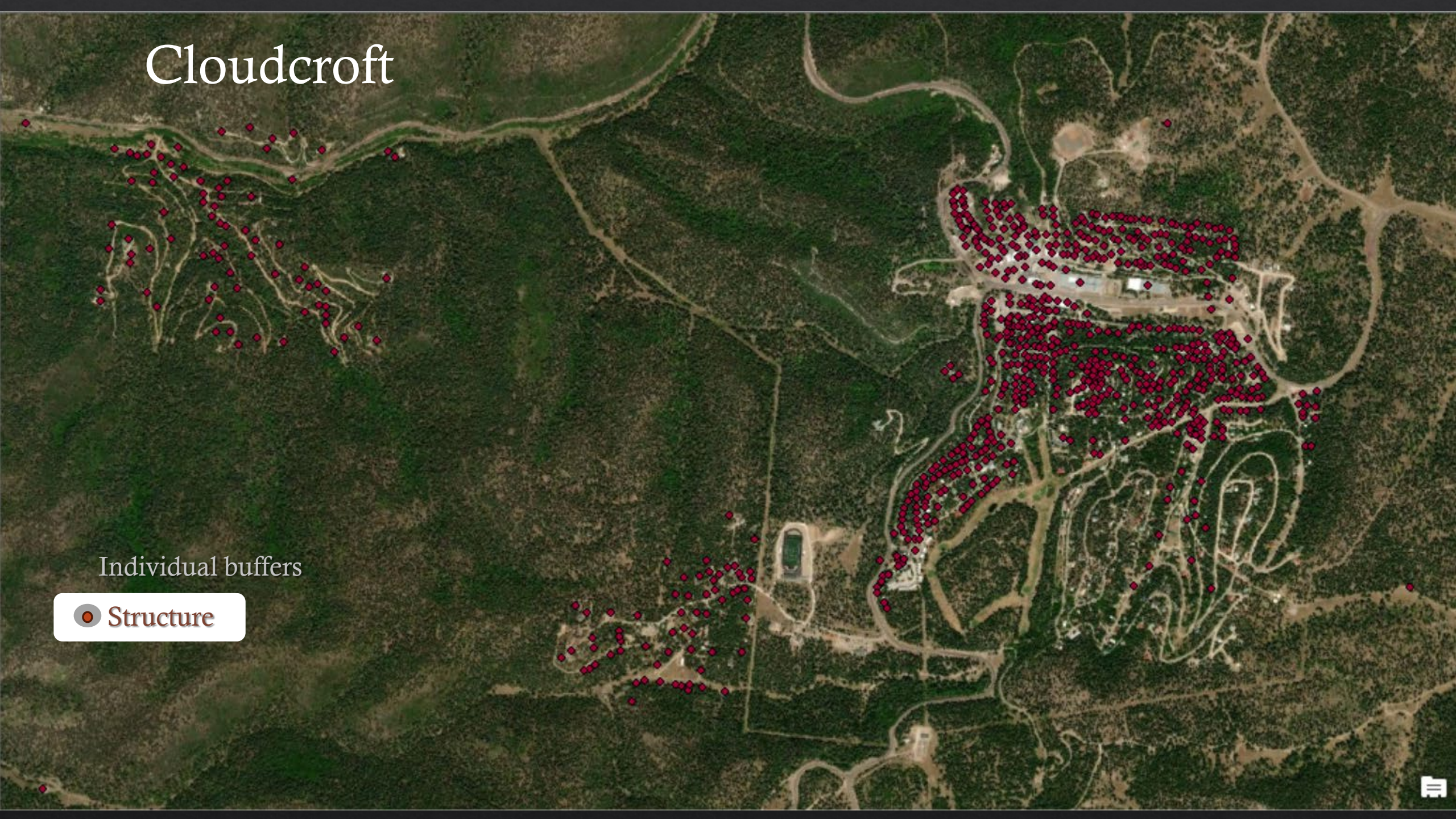
# Cloudcroft



# Cloudcroft

Individual buffers

● Structure






Community buffers

● Structure

Thinning  
on Forest  
Service  
land only

● Structure



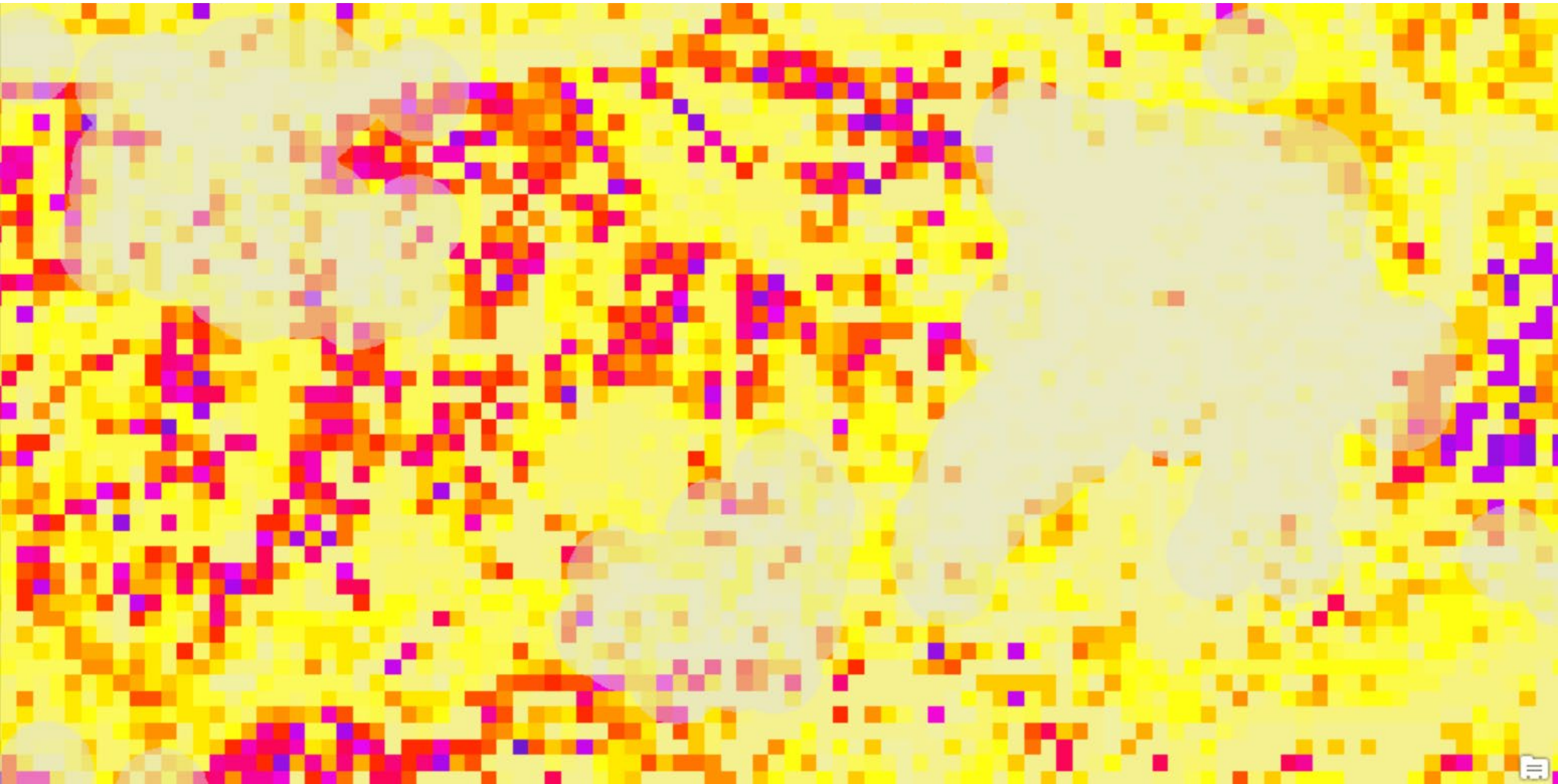
Clusters of structures,  
for reference

Null scenario

Low (0 BTU/m<sup>2</sup>)



High (>6,500 BTU/m<sup>2</sup>)

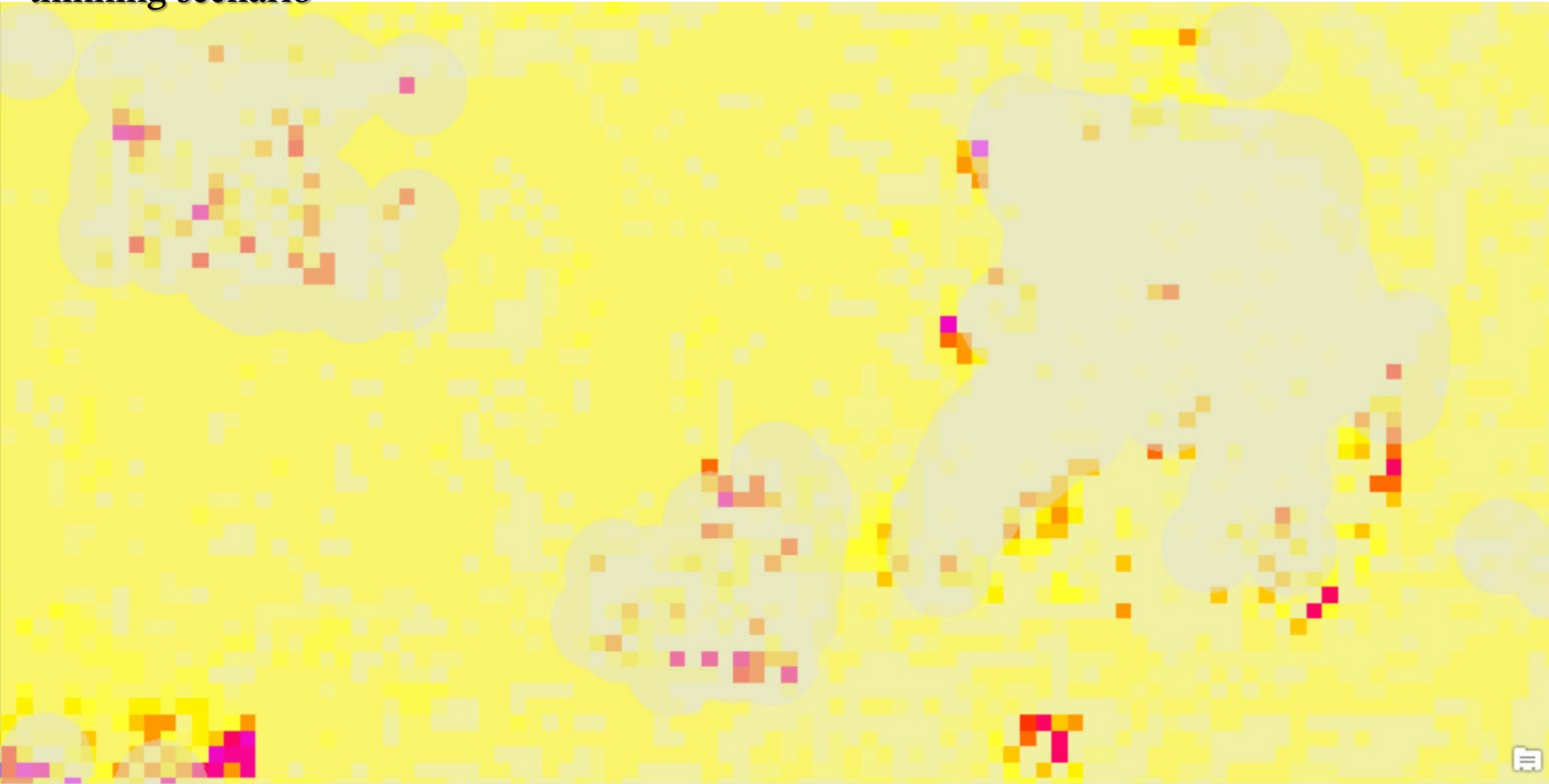


FS only  
thinning scenario

Low (0 BTU/m<sup>2</sup>)



High (>6,500 BTU/m<sup>2</sup>)

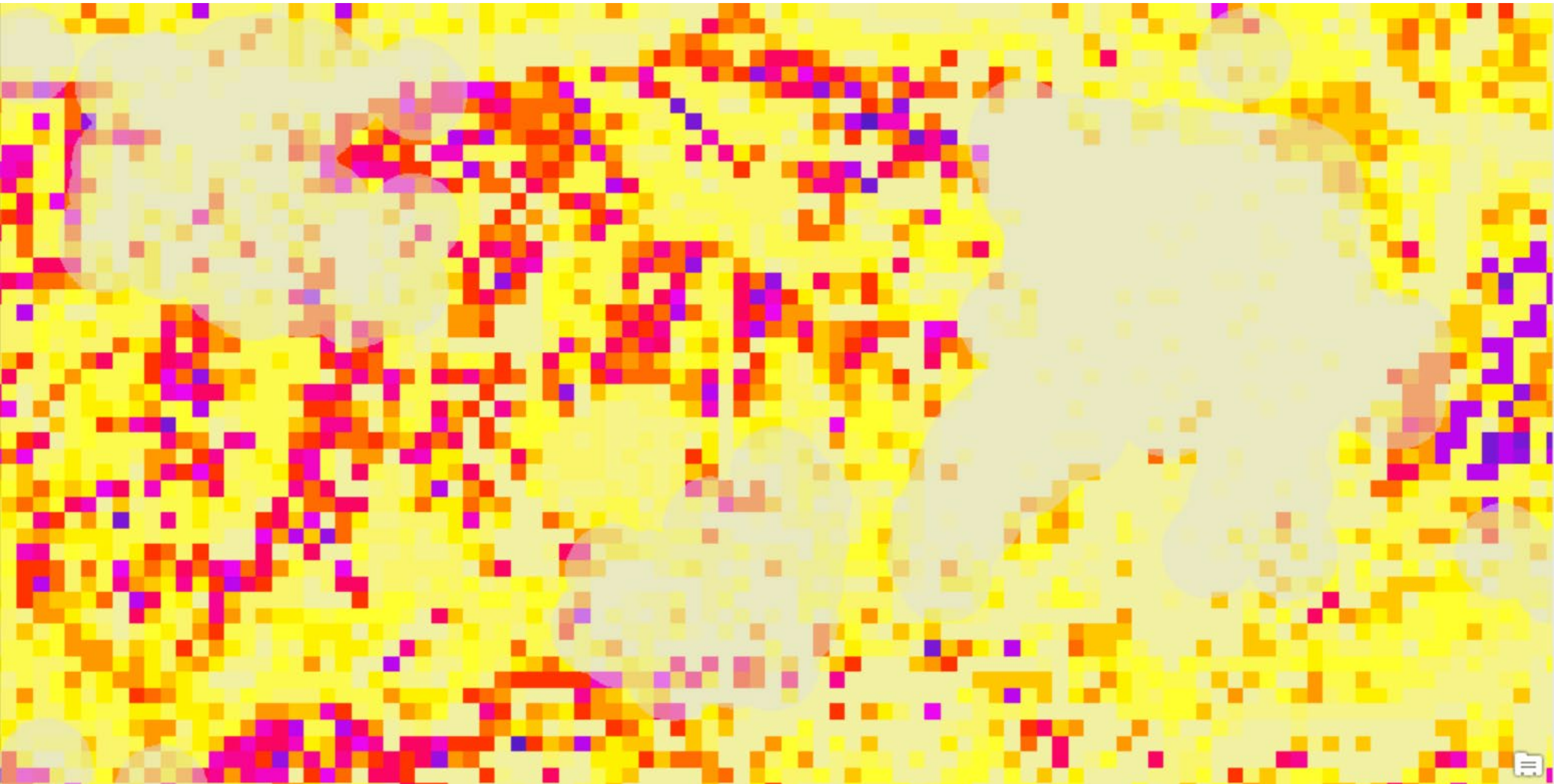


Individual structure buffer  
scenario

Low (0 BTU/m<sup>2</sup>)



High (>6,500 BTU/m<sup>2</sup>)

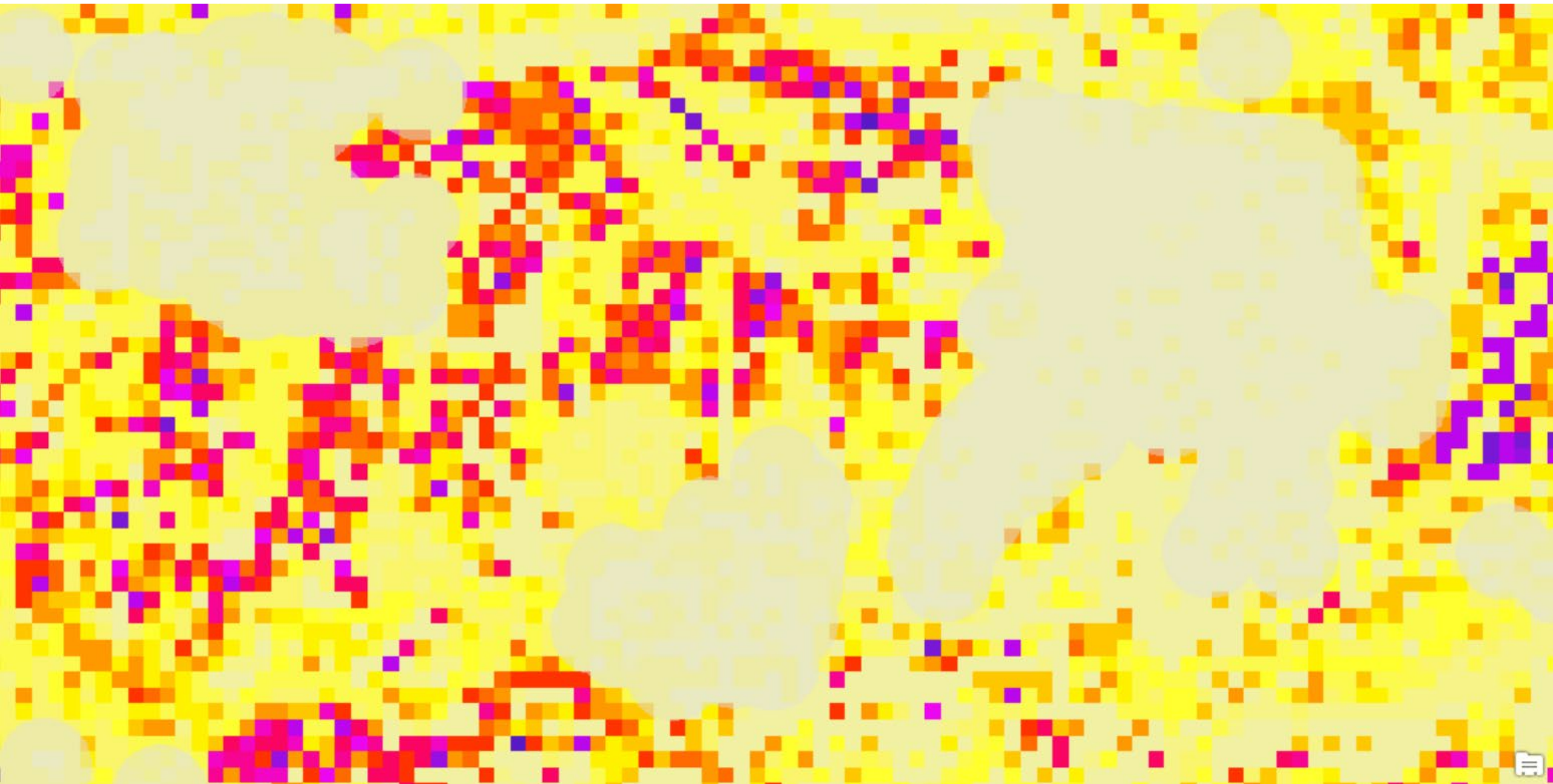


Community buffer  
scenario

Low (0 BTU/m<sup>2</sup>)



High (>6,500 BTU/m<sup>2</sup>)



# What does this tell us so far?

- ◆ Only early results, but...
- ◆ The problem is not solved, but positive results when ‘defensible space’ starts to overlap (suggesting benefits of cross-boundary fuels treatment)
- ◆ Likely to have more (efficient) success with an “all hands all lands” approach



**Thinning Only**

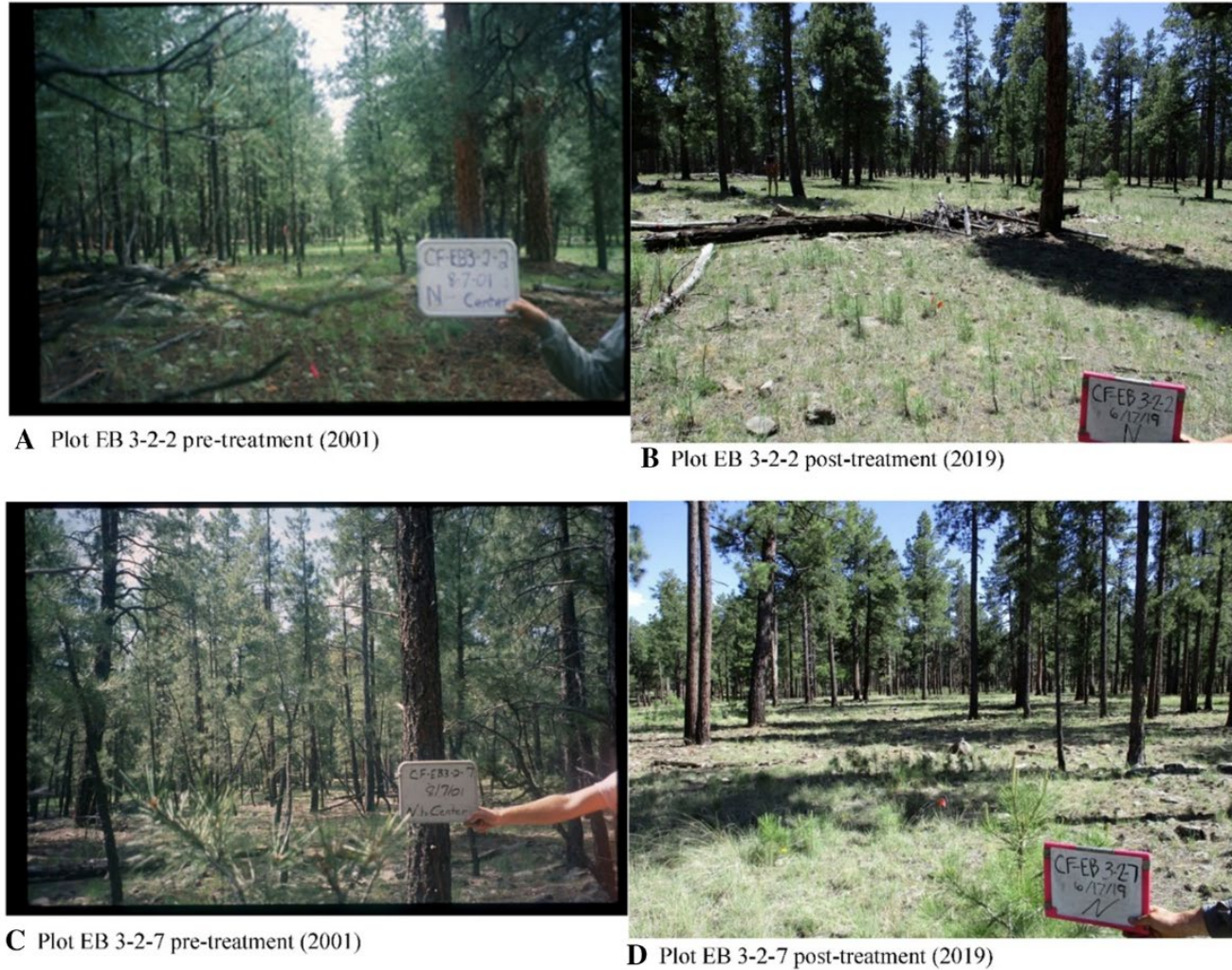
This aerial photograph shows a vast forest landscape. The left side, labeled 'Thinning Only', shows a forest with a mix of green and brown trees, indicating some thinning work. The middle section, labeled 'Thinning + Prescribed Fire', shows a more uniform green forest. The right side, labeled 'No Treatment', shows a forest with a higher density of brown trees, suggesting a lack of management. The background features rolling hills and a river valley under a cloudy sky.

**Thinning + Prescribed Fire**

**No Treatment**

**Fig. 2**

**From: Natural regeneration responses to thinning and burning treatments in ponderosa pine forests and implications for restoration**



Two ponderosa pine plots (EB 3–2–2 and EB 3–2–7) in northern Arizona at the Centennial Forest Long-term Ecological Assessment and Restoration Network (LEARN). Photos taken in 2019 show increased regeneration 15 years post thinning and 8 years post prescribed burning, and two plots pre-treatment (2001) and post-treatment (2019). Plots were mechanically thinned in 2004 and prescribed burned in 2011. Pre-treatment plots had zero and 100 seedling ha<sup>-1</sup> respectively, and post-treatment seedlings increased to 7,400 and 10,600 seedlings ha<sup>-1</sup> respectively by 2019

# Next steps

More data,  
additional  
models



- ◆ Microsoft AI Building Footprints
- ◆ Patch attributes
- ◆ FARSITE
- ◆ Additional scenarios- informed by stakeholders (Ruidoso WUI Working Group)
  - ◆ Feasible?
  - ◆ Varying treatments (quantify)
  - ◆ Incorporate other goals and limitations

- ◆ Researchers like me don't know the ins and outs of management decisions, the additional limitations, the other land management goals, etc.
- ◆ We need your help!

If approved:

- Compensation
- Contracting costs

...Either way:

- Collaboration
- Products to compete for your grants



If you would be interested in participating in a co-production of knowledge group, please provide your email address



Next

*These responses will not be displayed or shared*

## What did you learn or find helpful today?

Tbd

Prevention

Overall concept introduction

Piqued curiosity about fire modeling

Being able to interact with the guest speaker.

The effect of community level thinning efforts

How modeling can identify priority areas for wildfire mitigation

Great supporting documentation for future grant applications.

Learned about the output of modern sophisticated models.

Access to models possible

Information

Seeing modeling in action - cool!

The interactive element of this presentation is excellent

How different treatment scenarios impact community burn probability.

# What questions do you still have?

Are you looking for any grad students in the future?

Questions are still in development

How accurate do you think LANDFIRE data are?

Does the model framework you use integrate potential for embers and spot fires?

How is burn probability calculated?

How work most effectively at the landscape and community/home/structure levels!

How the urban fuels impact burn probability and intensity.

How can we reach teachers and students in schools to think about and train for fire science technology such as this - build our future workforce to address increasing demand, expand scope of application?

How well do you understand the underlying maths of these models (non-linear dynamics, chaos theory, etc.), do you collaborate with folks that do?

What programs do you use to generate these models?

# Thank you!



Nathan Gill

Department of Natural Resources Management

Texas Tech University

[nathan.gill@ttu.edu](mailto:nathan.gill@ttu.edu)