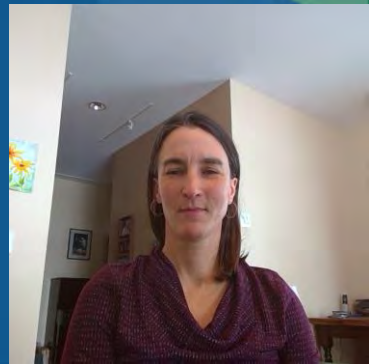


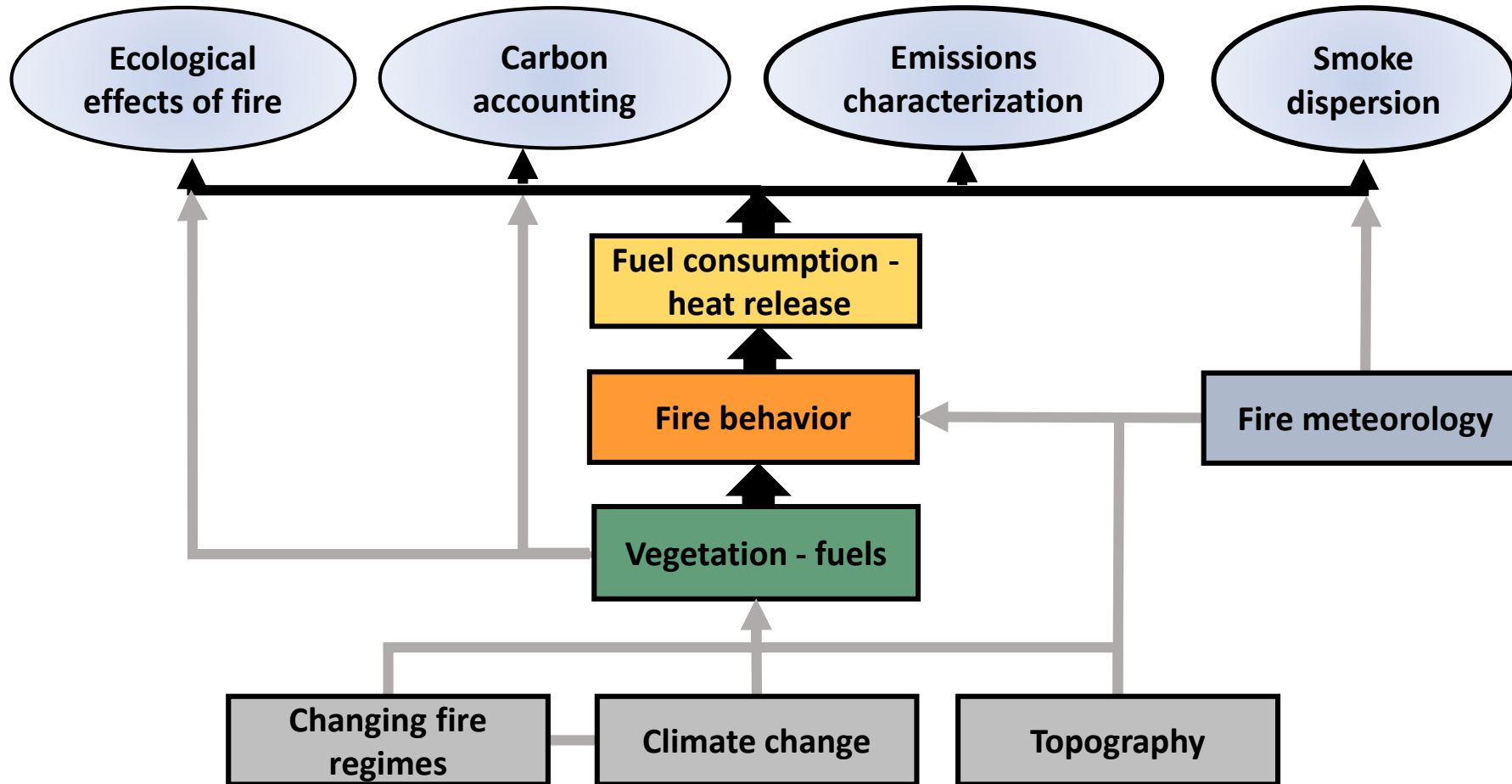


3D Fuels Library as Related to Inter-Project Collaboration and Shared Data

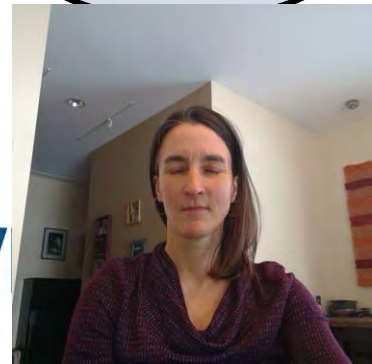
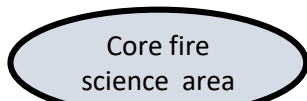
Susan J Prichard



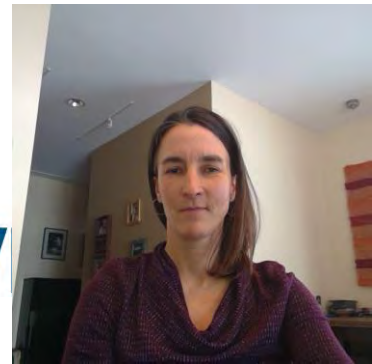
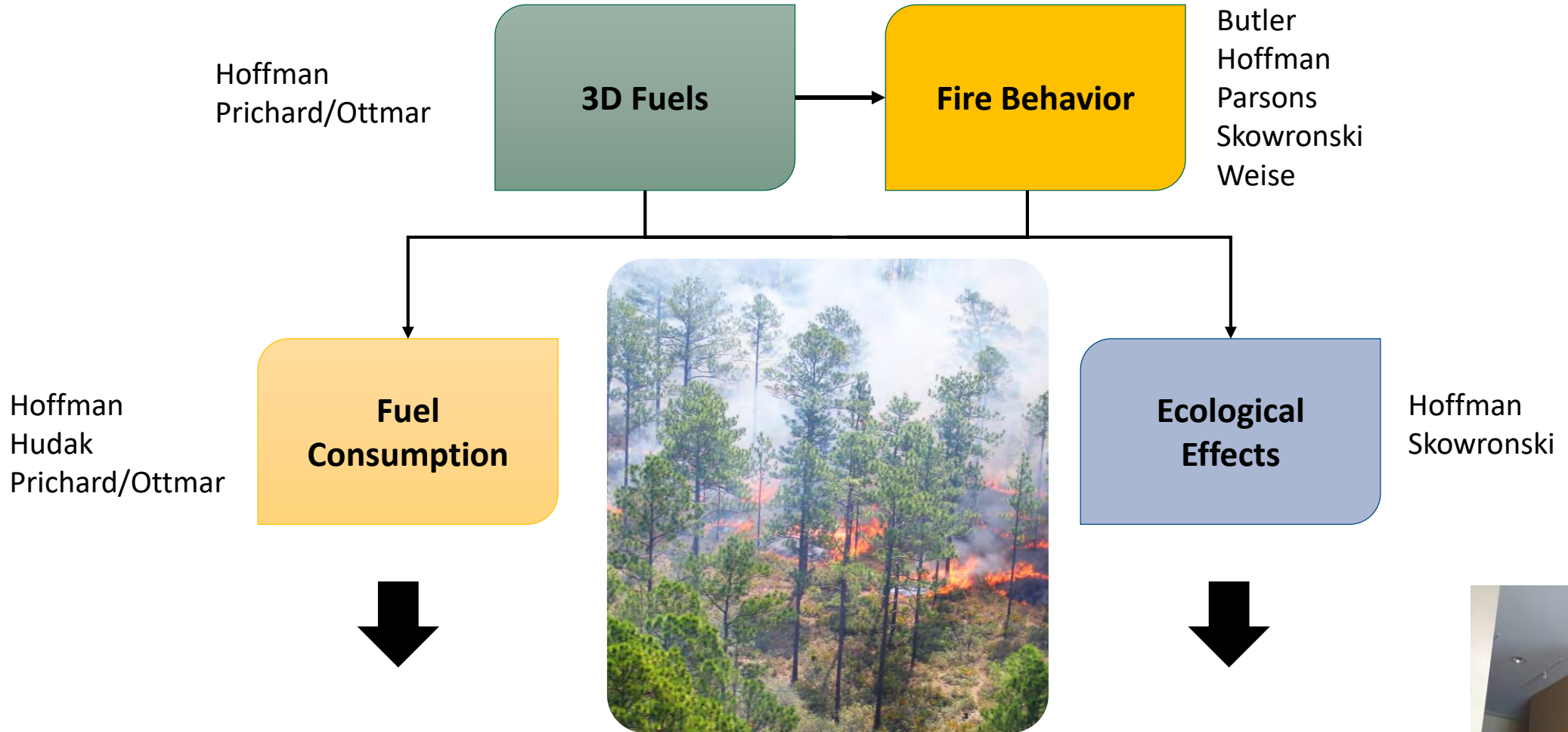
SERDP Core Fire Science Strategy



Legend



SERDP Fire Science Projects



SY

3D fuel characterization for evaluating physics-based fire behavior, fire effects, and smoke models on US Department of Defense military lands (RC19-C1-1064)

Performers: Susan Prichard, Roger Ottmar, Ben Bright, James Cronan, Christie Hawley, Andrew Hudak, Louise Loudermilk, Russ Parsons, Eric Rowell, Carl Seielstadt, Nick Skowronski, Carlos Silva

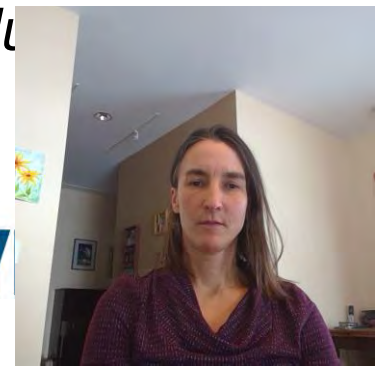
Students: Jonathan Batchelor, Michelle Bester and Gina Cova

Technology Focus

- *Develop and evaluate hierarchical sampling methods for 3D fuel characterization required for next-generation physics-based models of fire behavior and smoke production.*

Research Objectives

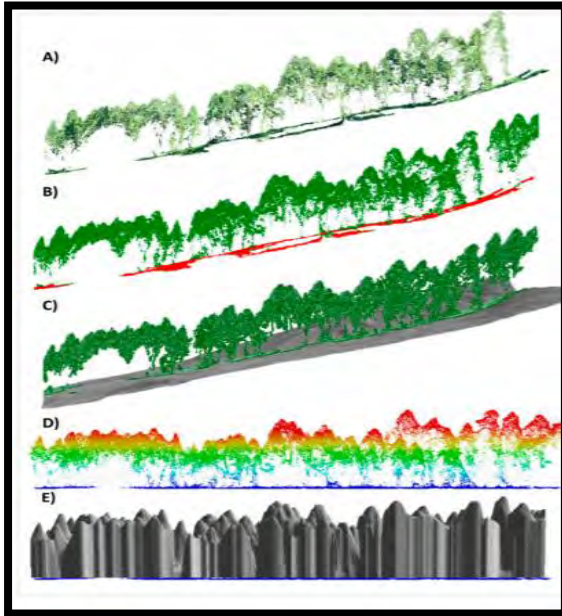
- *Create building blocks (physical fuels libraries, 3D fuel models, sampling resolution) for next-generation fuels mapping of SE pine and western pine/grasslands*



Technical Approach: Hierarchical sampling design

Coarse scale (5 x 5 x 5 m)
ALS canopy & modeled surface
fuels

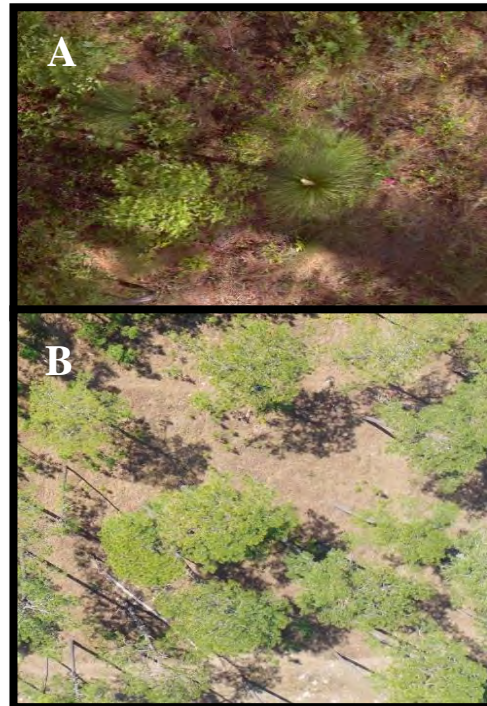
Canopy fuel characterization
& landscape mapping



(Mohan et al. 2017)

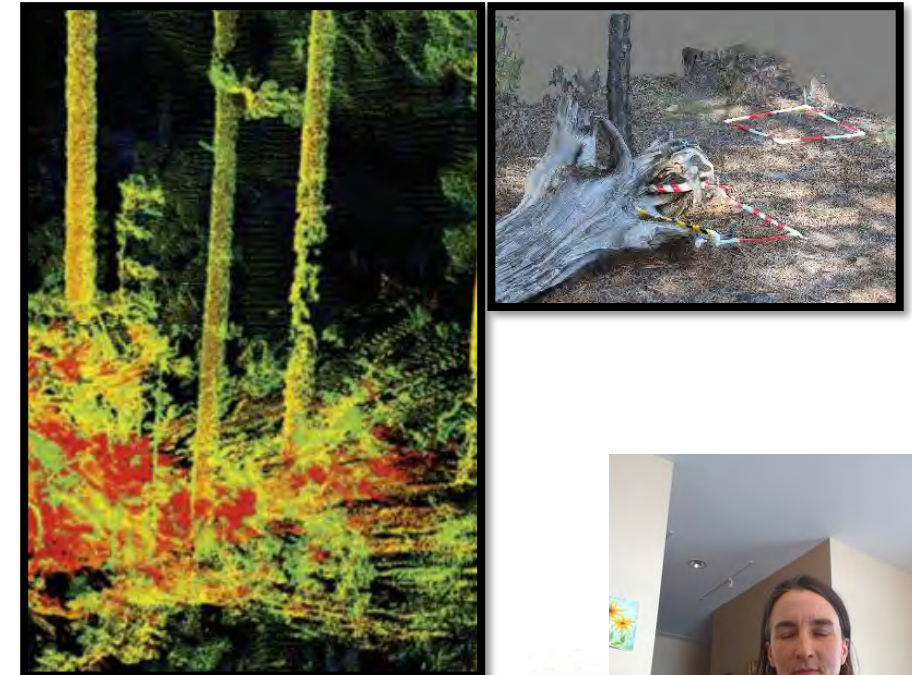
Meso scale (1 x 1 x 1 m)
Canopy and understory fuels

Synoptic TLS,
Drone-based photogrammetry

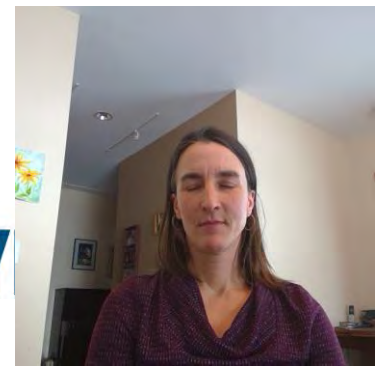


(Rowell et al. 2020)

Fine scale (0.1 x 0.1 x 0.1 m)
TLS & close-range
photogrammetry



(Hudak et al. 2020)



SY

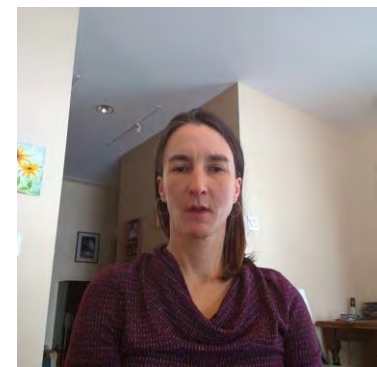
Study Design

Spatial scale	Dimensions	Imagery	Resolution
Site (synoptic)	200x200 m	ALS TLS SfM (UAS)	5m < 1m
Macro plot	5 x 5 m (n = 18)	TLS	
Voxel plot	0.5 x 0.5 m x 1 m (n = 45)	TLS SfM (close range)	



6

Sycan Marsh Reserve, Oregon



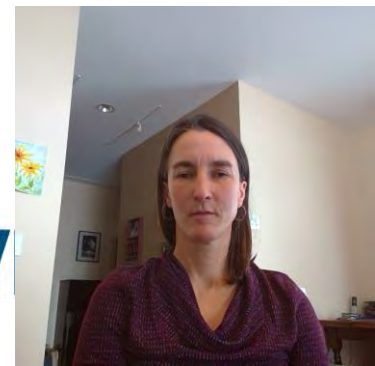
3D Fuel Characterization of Pine Forest Structure



Southern pine (FL)



Western pine (MT)



Study Areas

SE flatwoods understory

Tate's Hell A, FL



Tate's Hell B, FL



SE loblolly/sweetgum forests



1 yr rough



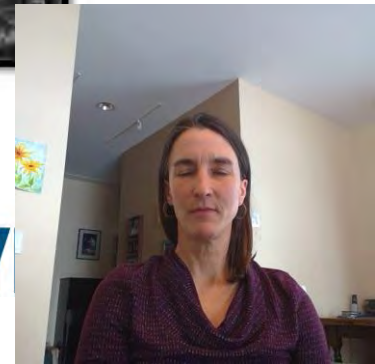
2 yr rough



3 yr rough



4-5 yr rough



Study Areas

Western grasslands

Sycan, OR



Tenalquot, WA



Glacial, WA



Western ponderosa pine forests

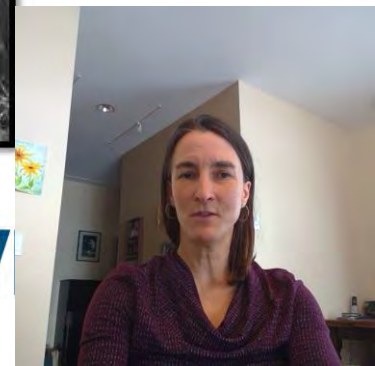
Lubrecht, MT



Sycan, OR



Methow, WA



Additional Sites

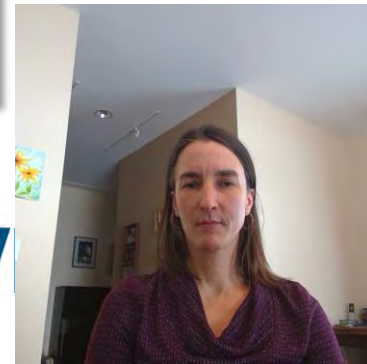
Blackwater, FL



Pebble Hill, FL



Voxel Plot Sampling



Project Work Plan and Website

3D Fuels Work Plan

SERDP Project RC19_C1_1064

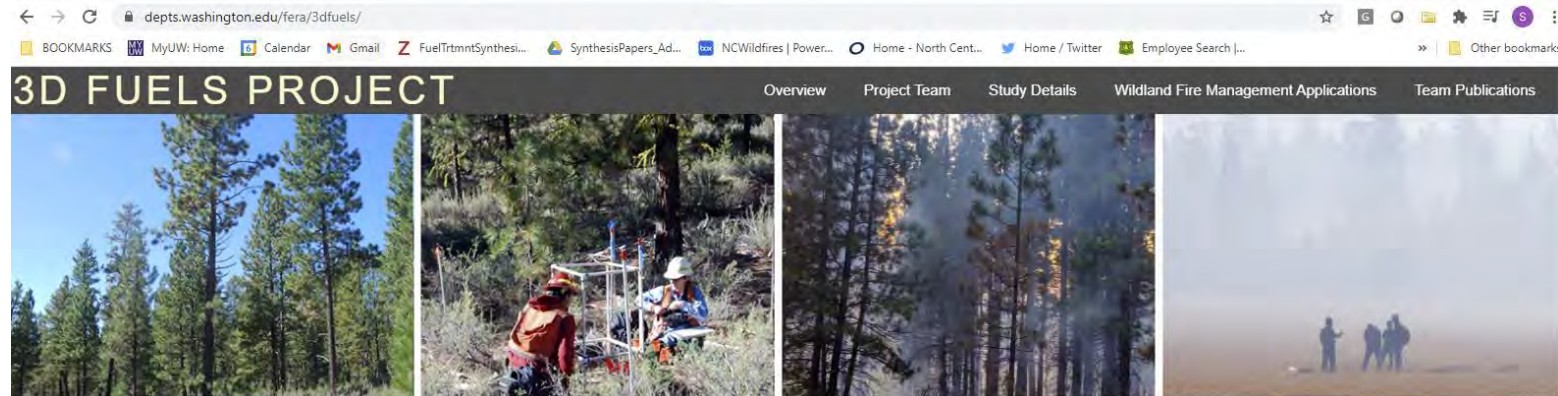
3D fuel characterization for evaluating physics-based fire behavior, fire effects, and smoke models on US Department of Defense military lands

Project Team:

Susan Prichard (overall lead), Roger Ottmar (federal PI), Andrew Hudak (coPI), Maureen Kennedy (coPI), Russ Parsons (coPI), Eric Rowell (coPI), Carlos Silva (coPI), Nicholas Skowronski (coPI), Jonathan Batchelor (PhD student), Michelle Bester (PhD student), Gina Cova (Ms student)

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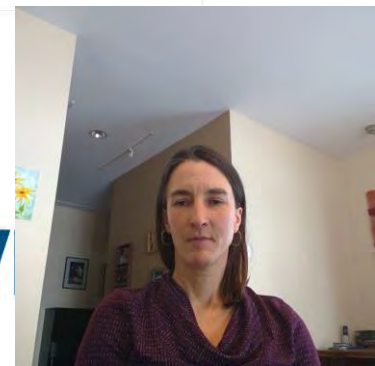
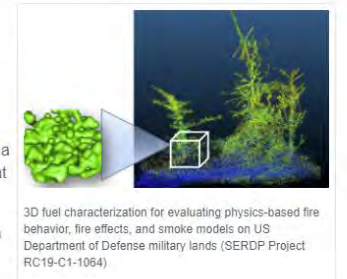
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OVERVIEW

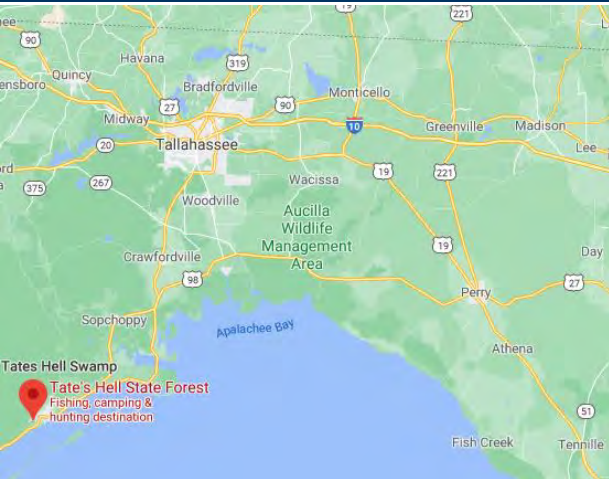
The **3D fuels project** is funded by the US Department of Defense Strategic and Environmental Research and Development Program to develop 3D fuels inputs for next-generation fire and smoke modeling. Our research team is collaborating with multiple organizations, including the US Department of Defense, Florida State Forest Service, University of Montana, The Center for Lands Management, and Washington State Department of Fish and Wildlife, to establish demonstration sites and collect integrated datasets of 3D fuels clip plots, terrestrial laser scanning (TLS), and airborne laser scanning (ALS). Plans are underway to continue 3D fuel characterization on pine-dominated sites in the western and SE United States and western grasslands that are representative of fuels commonly characterized for prescribed burning on US Department of Defense lands. Through this initiative, a library of tools and datasets are being developed to leverage multi-scaled estimates of 3D fuels tied with intrinsic fuel properties that can be used directly with the QUIC-Fire modeling initiative. Through these data, fire and fuel managers will be able to:

1. Evaluate the effectiveness of fuels and thinning treatments as a result of not only alteration of surface and canopy fuels but changes in the effect of wind flow on wildland fire behavior.
2. Inform the expansion of prescription margins for planning and executing prescribed burning and managed wildfires.

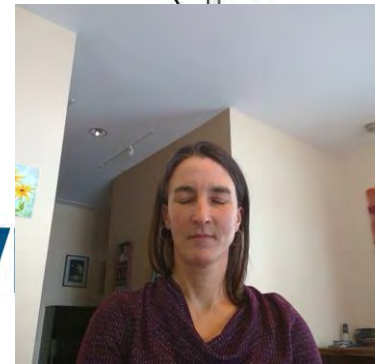
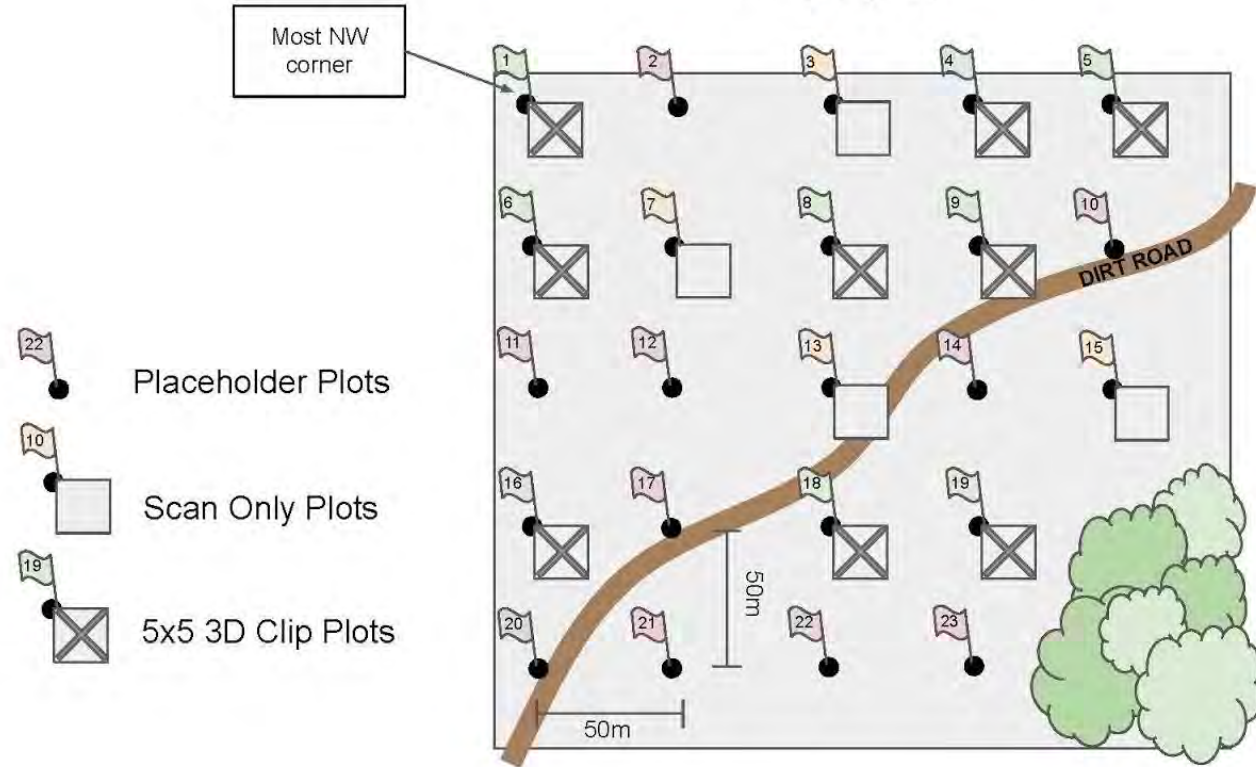


SY

Sample 3D Fuels Dataset



Tate's Hell B Plot Layout



Tate's Hell

Voxel Plot: B 4-CTR

Site: Tate's Hell State Forest, Florida

Location: To be added

Overstory: Slash pine (*Pinus elliottii*)

Dominant fuel types: pine litter, shrub litter, perennial grass, gallberry (*Ilex spp.*)



Tate's Hell B 4-CTR

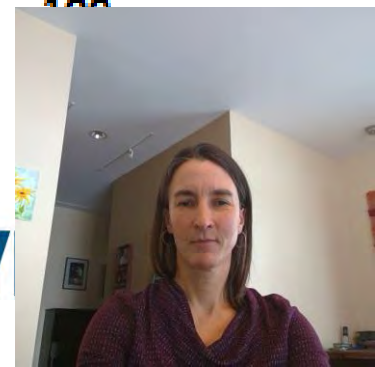
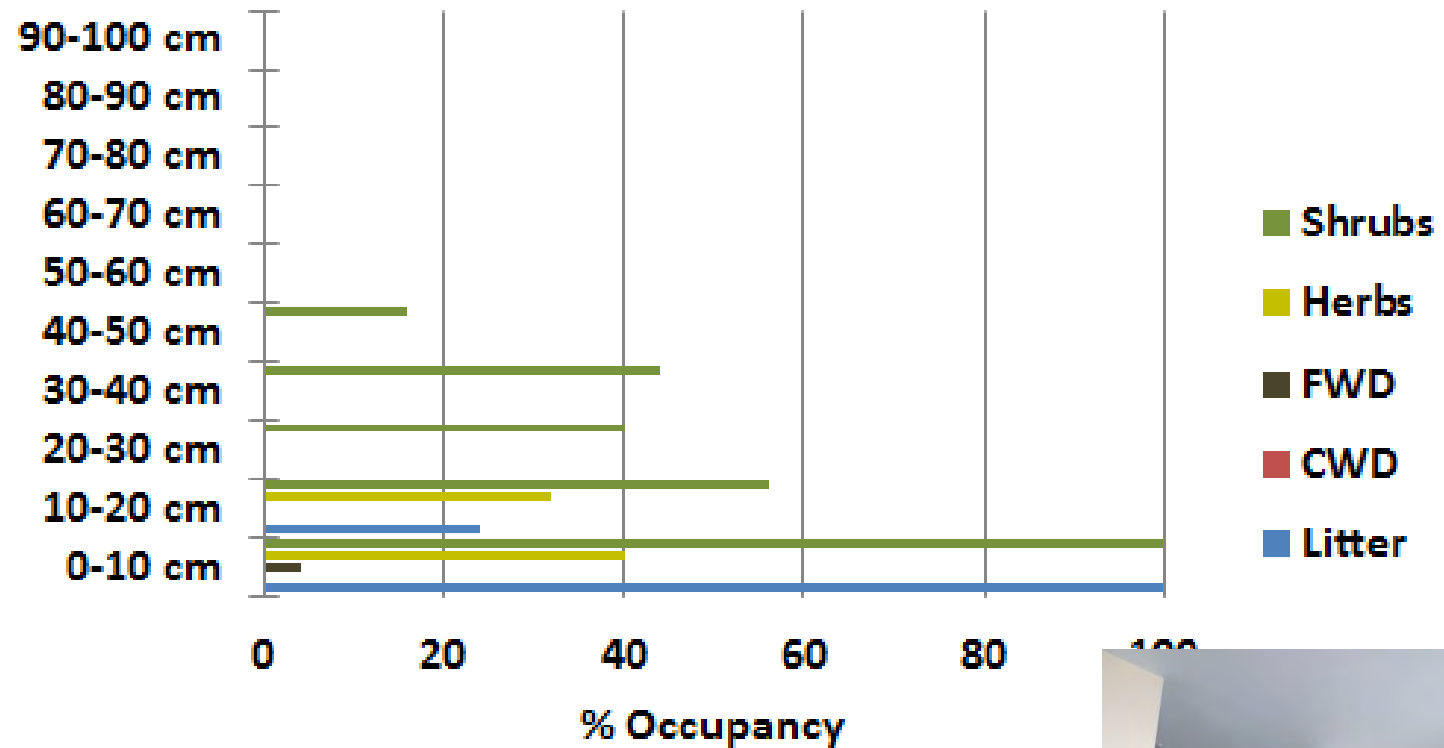


Image Calibration with Field Data





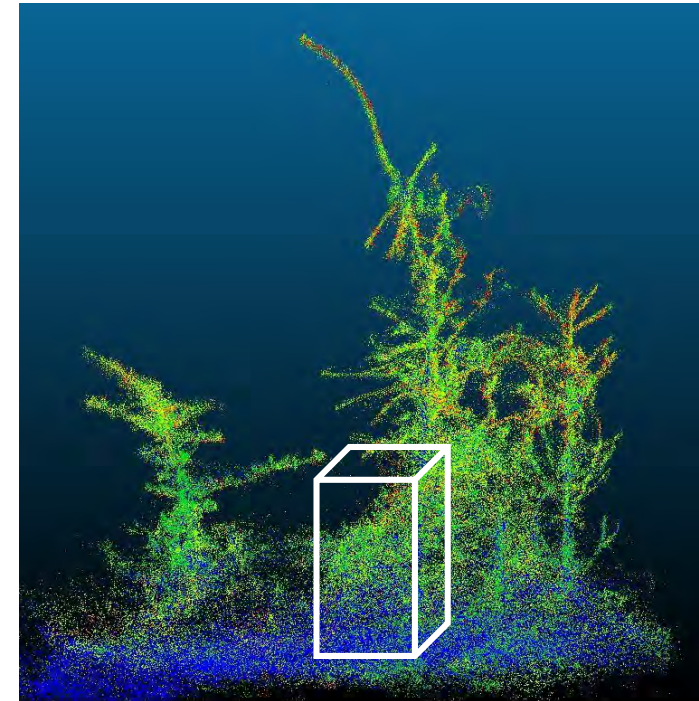
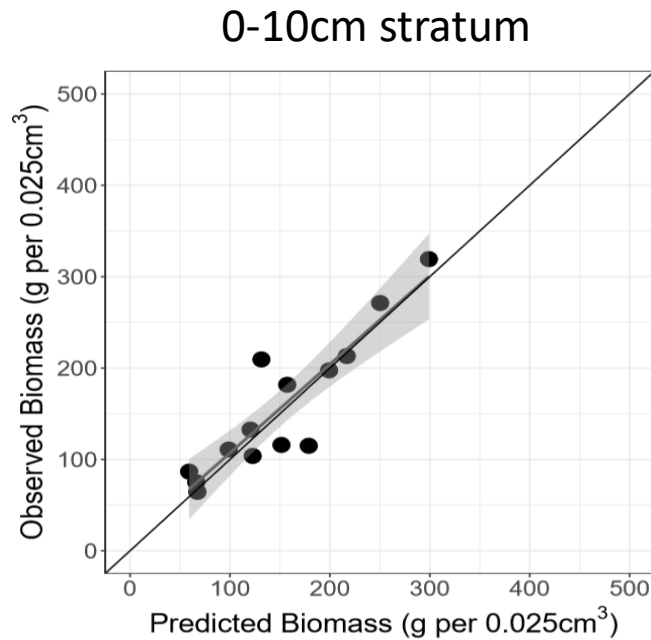
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Coupling Terrestrial Laser Scanning with 3D Fuel Biomass Sampling for Advancing Wildland Fuels Characterization

Eric Rowell, E. Louise Loudermilk, Christie Hawley, Scott Pokswinski, Carl Seielstad, Lloyd Queen, Joseph J. O'Brien, Andrew T. Hudak, Scott Goodrick, J. Kevin Hiers
 doi: <https://doi.org/10.1101/771469>



Porosity Index

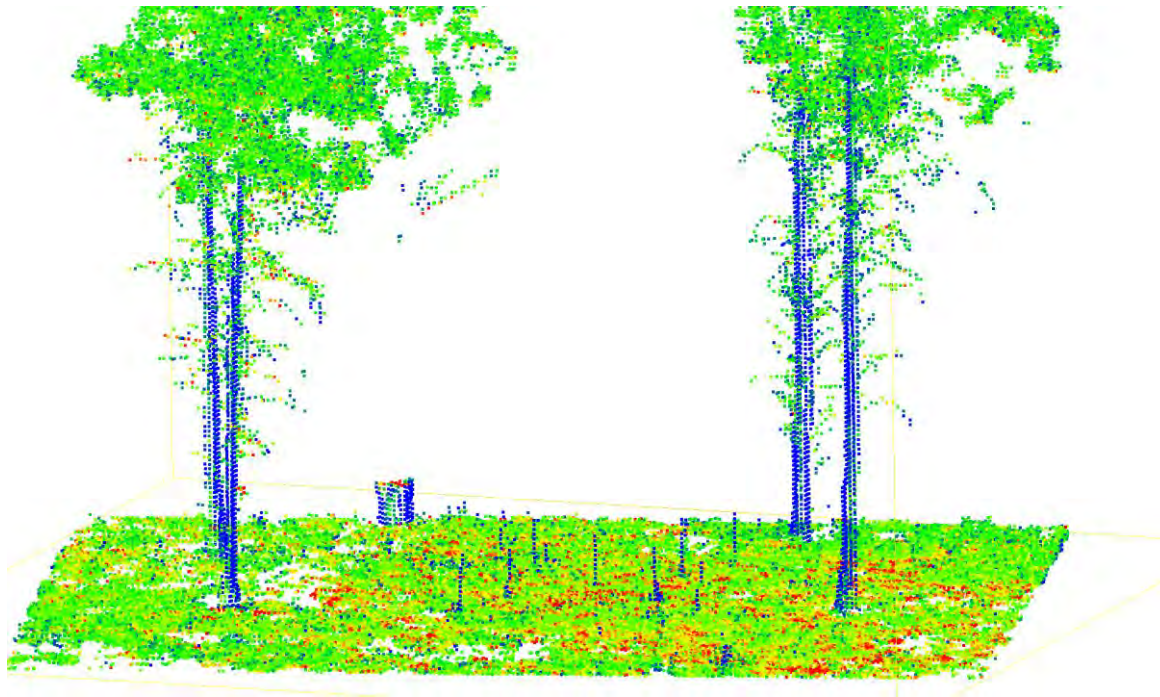
$$(\lambda) = 1 - \frac{\sum V}{\text{Volume}}$$



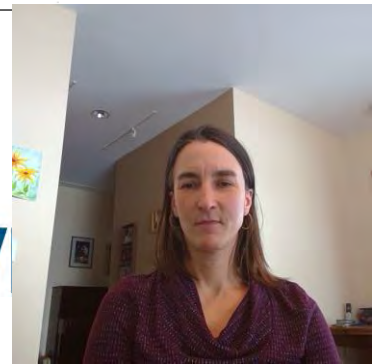
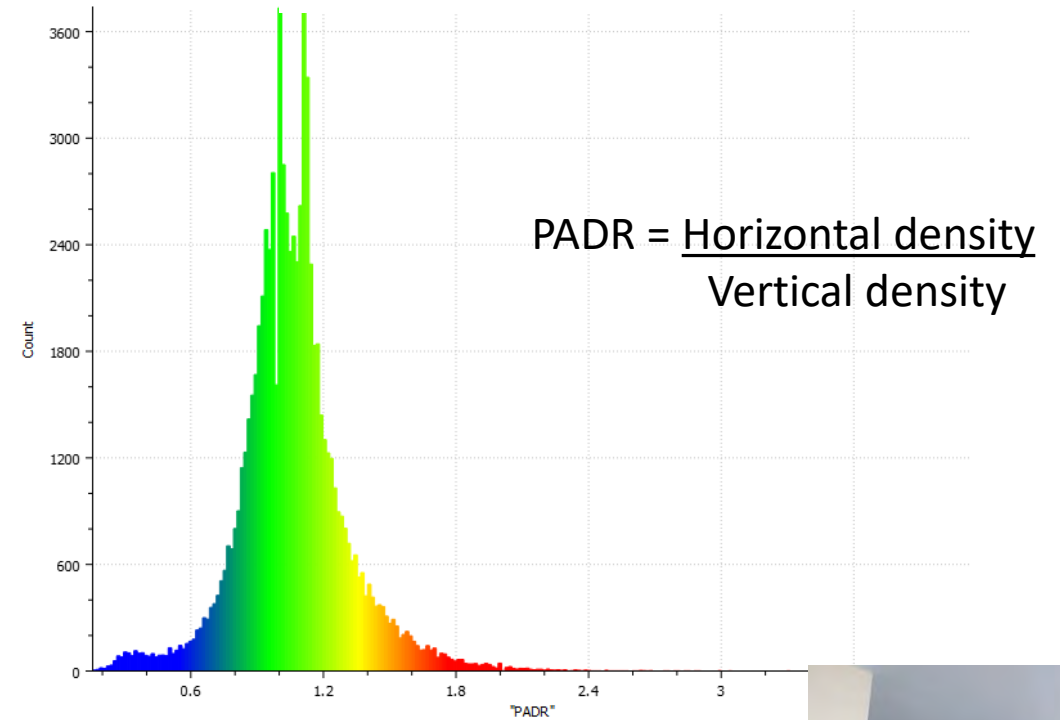
SY

Plant Area Density Ratio

Plant Area Density Ratio
(derived from TLS point cloud)



Plant Area Density Ratio
(histogram)



Predictive Bulk Density Models

Density of occupied voxels Hudak et al. (2020)

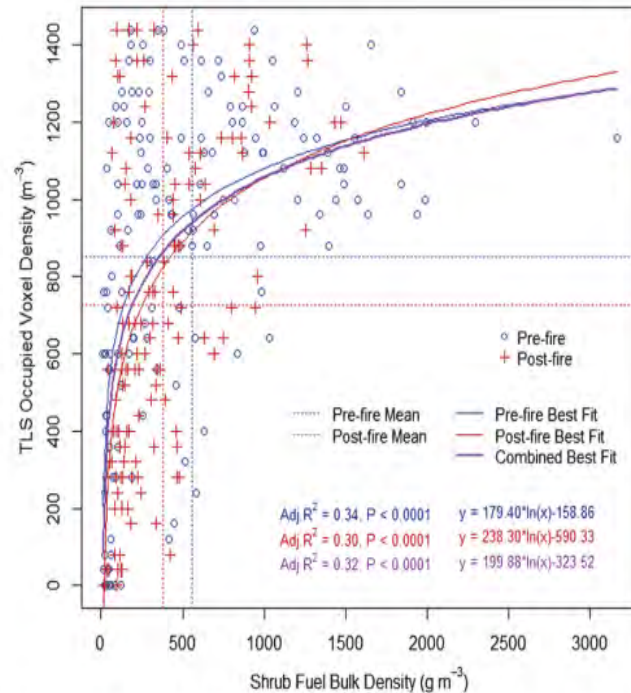
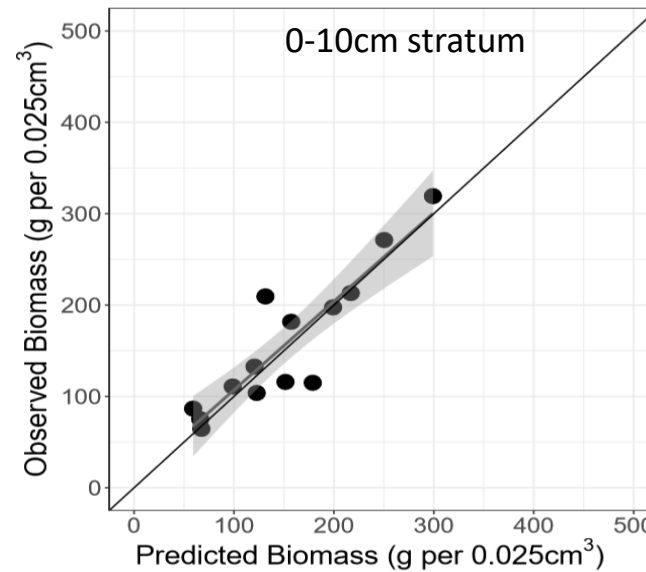
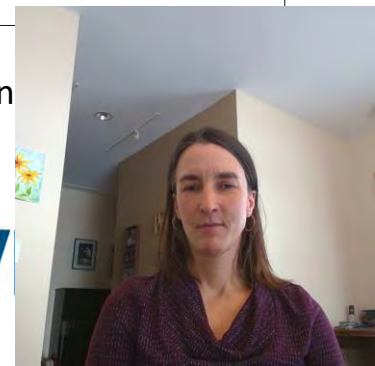
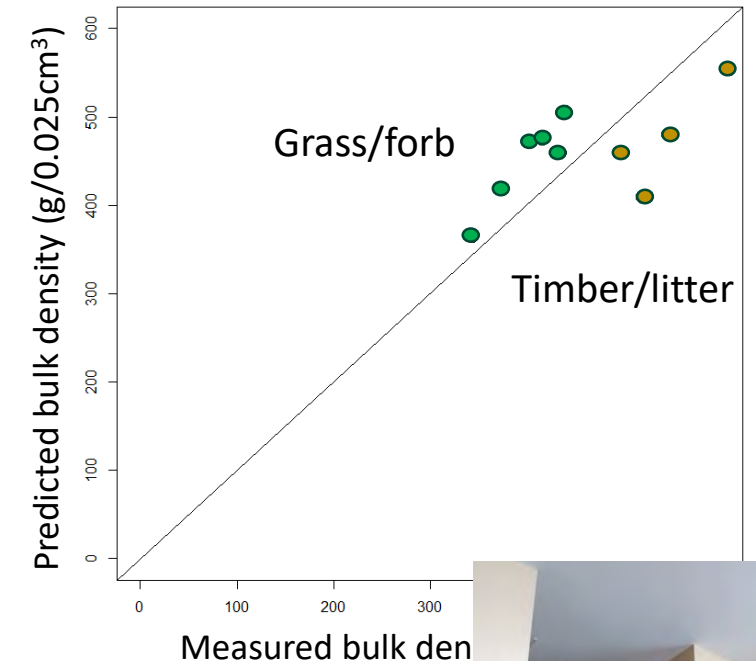


Figure 8. Natural logarithm relations between shrub fuel bulk density measured in 3D shrub sample plots and the density of voxels occupied by terrestrial laser scanning (TLS) points extracted from the point cloud within corresponding virtual x, y, z frames (0.5-m \times 0.5-m \times 0.1-m intervals). Because the pre- versus postfire functions differed so little, all data were pooled into a single combined equation.

Porosity Index Pebble Hill



Porosity Index + H/V ratio (Lubrecht – preliminary)



Object-based Fuel Characterization (I)

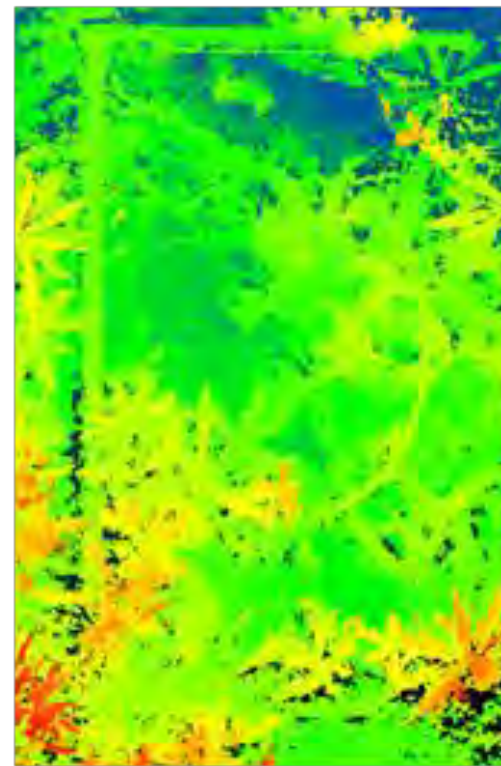
Ortho Photo



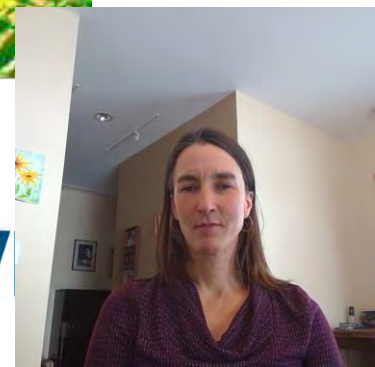
RGB Point Cloud



Height



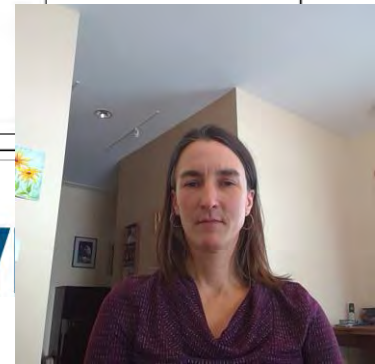
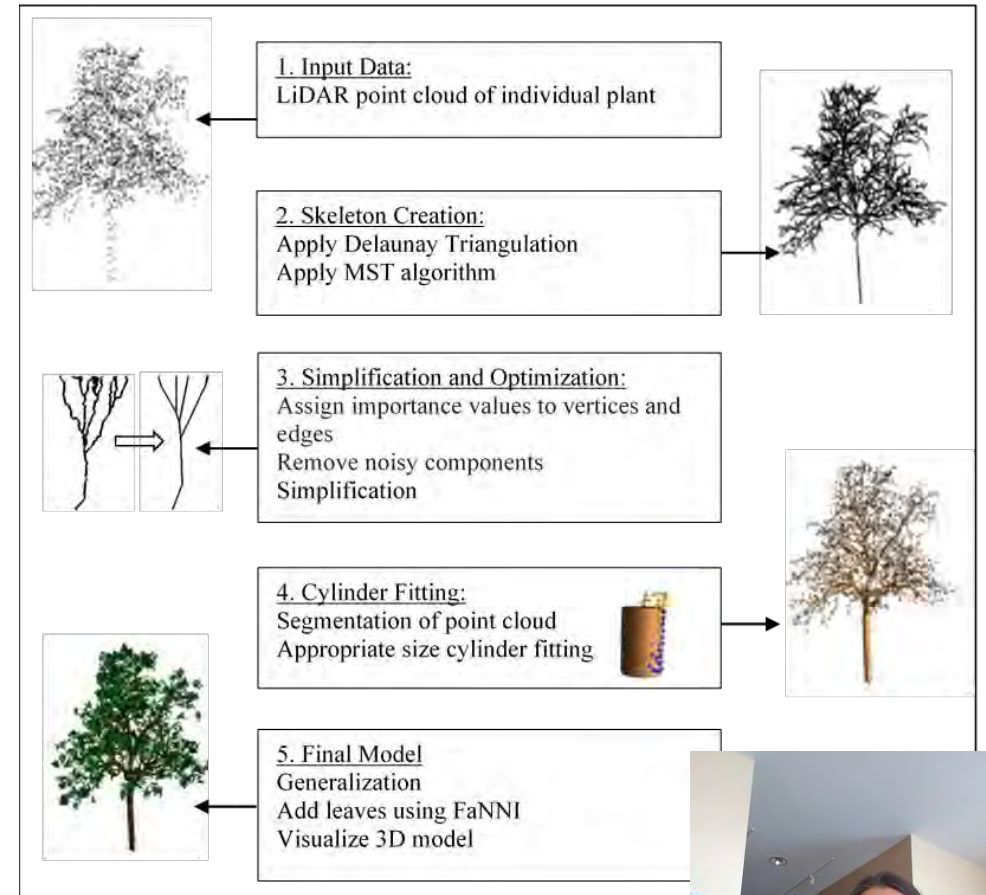
Live/Dead Classification



Object-based Fuel Characterization (II)

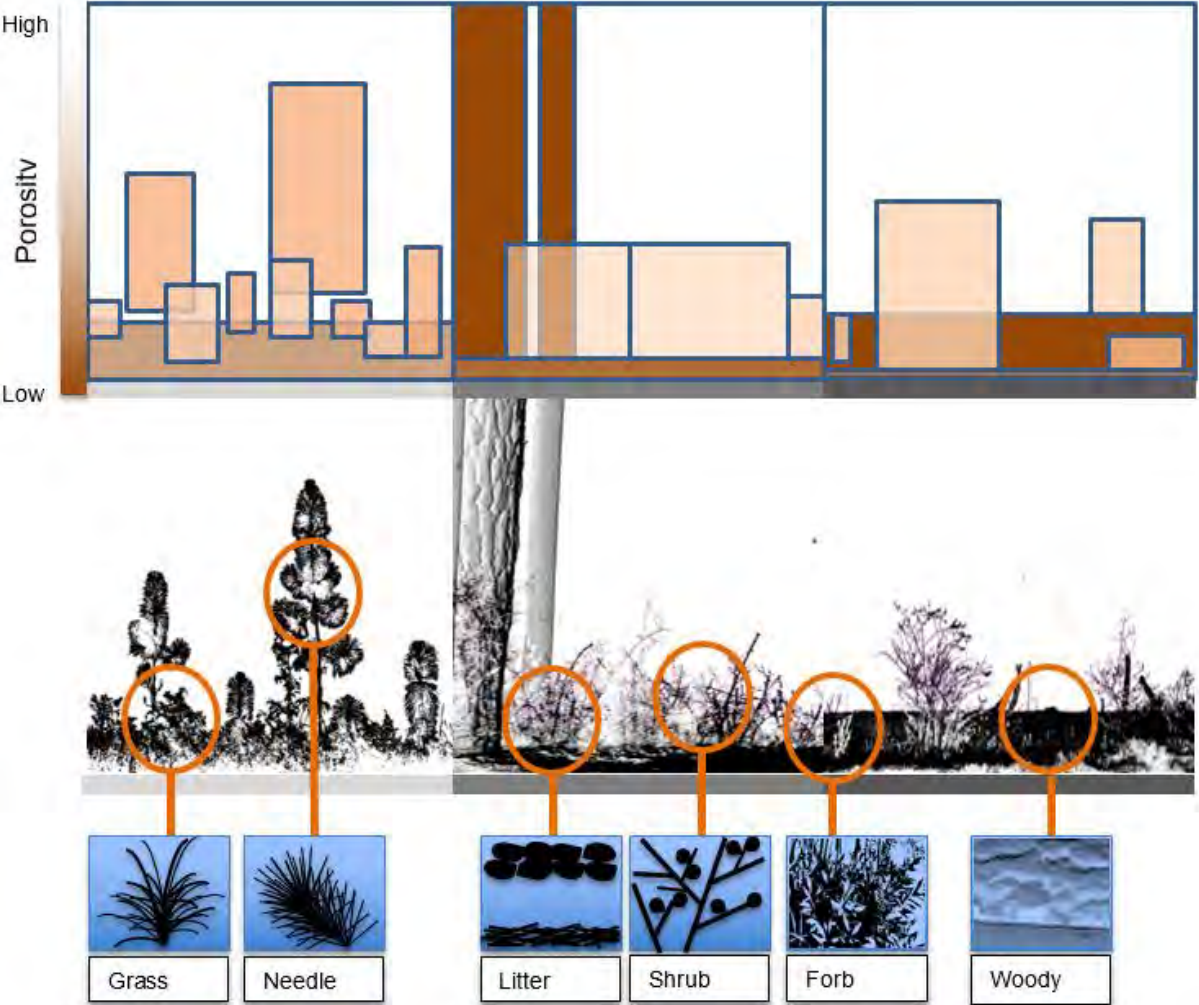


Quantitative Structural Modeling (Bester/Skowronski)

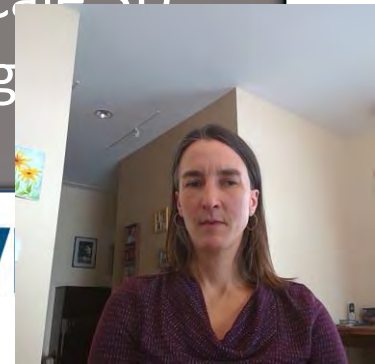
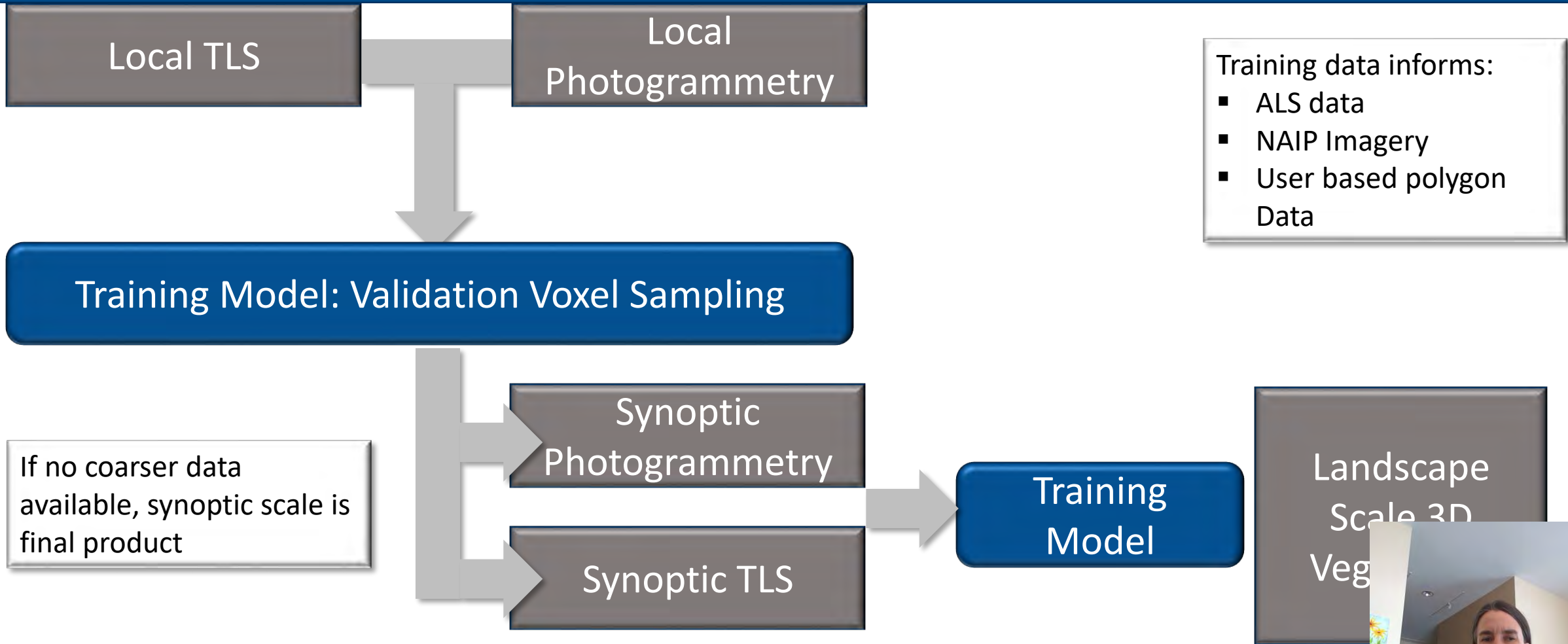


Landscape Metrics and Mapping

Canopy gaps (lacunarity)



Landscape Mapping



JFSP Wildland Fire Data Synthesis



FIRESCIENCE.GOV
Research Supporting Sound Decisions

Project team:

Susan Prichard (PI)
Eric Rowell (Tall Timbers)
Alina Cansler (UW)
Roger Ottmar (USFS)
Michael Billmire (Michigan Tech)
Matt Jolly (RMRS)
Duncan Lutes (RMRS)
Kurtis Nelson (USGS)
Birgit Peterson (USGS)

Wildland Fuel Characterization for Fire Science and Management: synthesis of existing knowledge and research needs (JFSP Project 20-S-01-3)

I. Introduction to wildland fuels

- *Traditional approaches to wildland fuel characterization*
- *Emerging technologies*

II. Current application of wildland fuel datasets in fire behavior and effects modeling

III. Next-generation fuel characterization

- *Requirements for multi-scaled fuel characterization inputs to computational fluid dynamics models*
- *Sources and limitations of existing datasets for fire and smoke modeling*

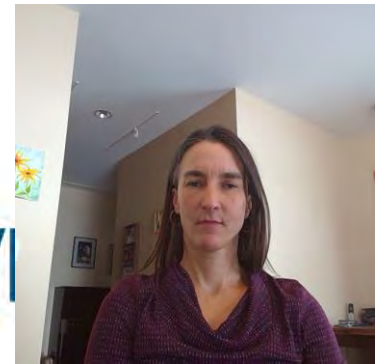
IV. Spatial and temporal dynamics of wildland fuels

- *Challenges in creating relevant and up-to-date maps of wildland fuels, including impacts from disturbances*
- *Ecosystem process modeling of live and dead biomass*
- *Fuel moisture dynamics*

V. Recommendations for fuel libraries and code repositories

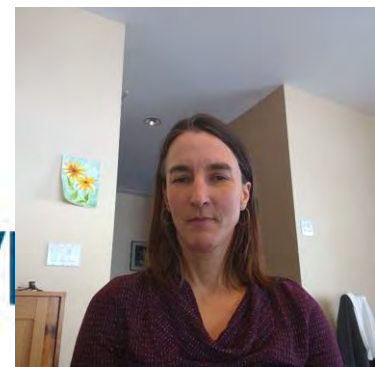
- *Prototype development*
- *Design recommendations*

VI. Research needs



SYI

Questions?



SY