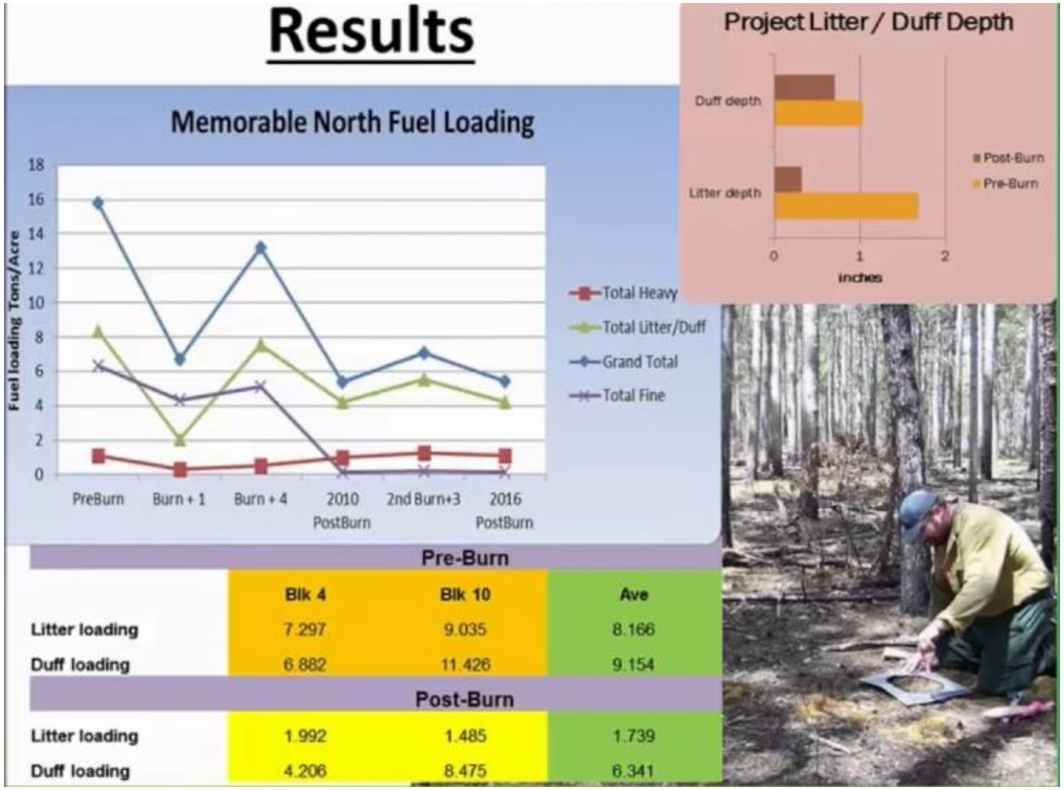
Fire Effects Monitoring

- Why monitor?
- What to measure…
- Some options for how to…
- Open discussion



	Pre-Burn		
	Blk 4	Blk 10	Ave
Litter loading	7.297	9.035	8.166
Duff loading	6.882	11.426	9.154
	Post-Burn		
Litter loading	1.992	1.485	1.739
Duff loading	4.206	8.475	6.341

- ***First-order fire effects*** occur during and immediately after a fire and are primarily heat-induced chemical processes. According to Reinhardt and others (2001), first-order effects occur during a fire or within seconds or minutes afterward. According to Ryan and Elliot (2005), they occur within hours of or up to days after the fire. Because of this ambiguity, it is best to identify the timeframe referred to when using this term. First-order fire effects include injury to organisms or immediate mortality, fuel consumption, smoke production, and soil heating (Reinhardt and others 2001; Ryan and Elliot 2005). First-order fire effects are not caused by interaction of fire or fire-caused stress with other influences, such as postfire weather, animal use, or fungal infection, and are sometimes called “immediate” or “direct” fire effects.
- ***Second-order fire effects***, also referred to as “indirect” fire effects, occur after a certain amount of time has passed after a fire (within days of or even up to years after, according to Ryan and Elliot 2005) and are often caused by interaction of fire-caused stress with other factors, such as postfire weather, animal use, or fungal infection. Second-order fire effects include soil erosion, delayed plant and animal mortality, changes in site productivity, plant regeneration, and succession (Reinhardt and others 2001; Ryan and Elliot 2005).

Why Monitor

Monitoring Goals & Objectives

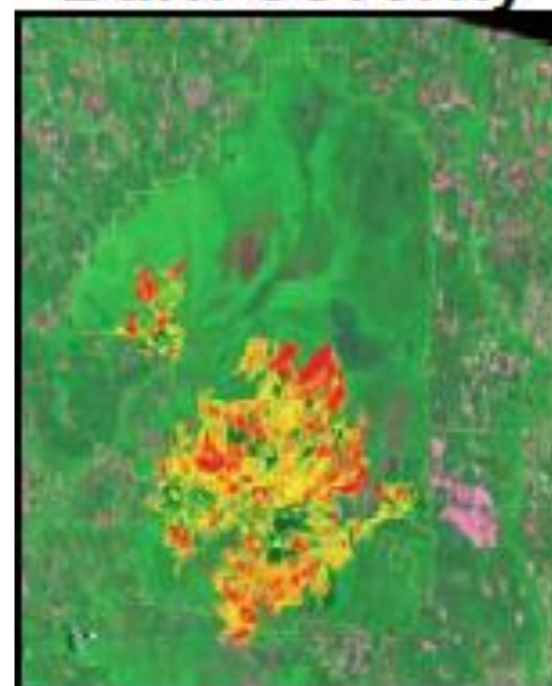
Setting clear objectives will help determine appropriate monitoring protocols and sampling techniques. The following are specific objectives for fuels and fire effects monitoring:

- Use monitoring results to determine whether the project meets management objectives.
- Document and analyze both short-term and long-term effects of prescribed fire and mechanical fuels treatments on vegetation.
- Document fire behavior to allow managers to validate burn prescriptions to determine if they achieve the fuels and resource objectives.
- Document efficacy of fuel treatments if a wildfire burns through the project area.
- Track the longevity of fuels treatment effectiveness.
- Detect unforeseen results of prescribed fire.
- Follow trends in plant communities where fire effects literature exists or research has been conducted.
- Determine if the project moves the area towards desired conditions.
- Identify areas where new hypotheses and scientific research warrant testing and implementation.

TALL TIMBERS

Research Station & Land Conservancy

Burn Severity



Landsat → dNBR

Final Report

for the

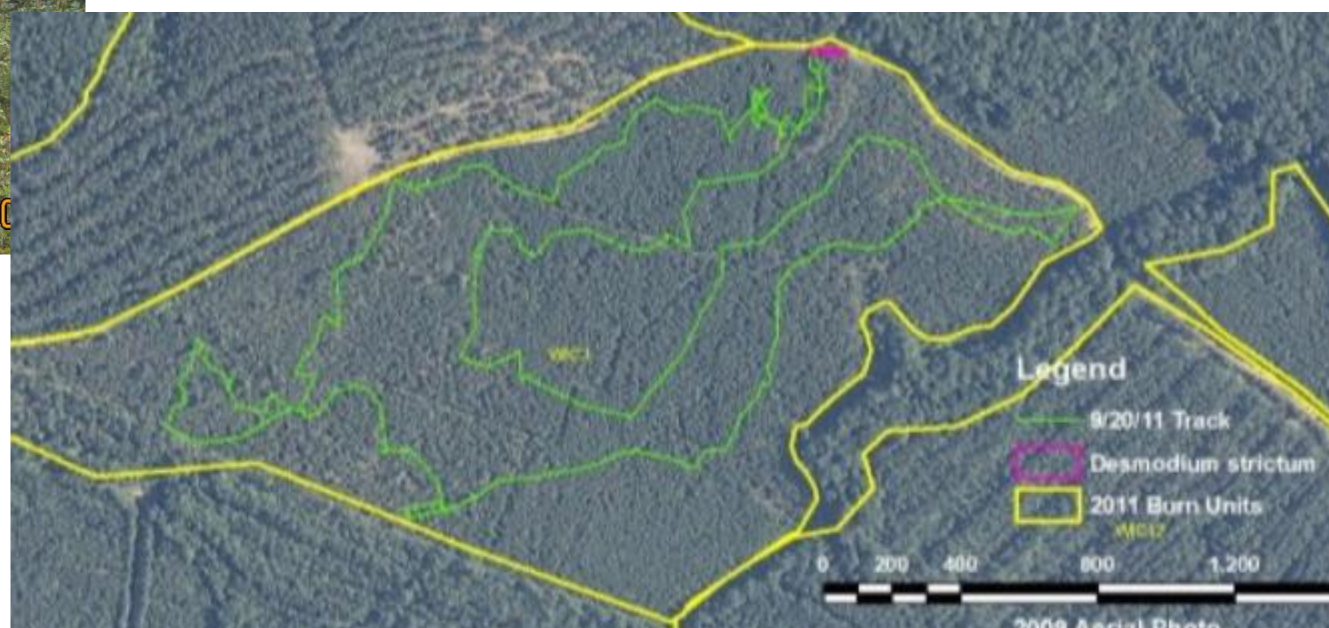
2014 RTE Plant Survey of 4 Burn Units on the TNC Johnson Tract

Submitted by Ron Wilson
January 21, 2015

Common Name	Scientific Name
Three-seeded Mercury	*Acalypha rhomboidea*
Red Maple	*Acer rubrum*
Thread-leaved Gerardia	*Agalinis setacea*
Pursh's Amphicarpum	*Amphicarpum purshii*
Bushy Bluestem	*Andropogon glomeratus*
Silver Bluestem	*Andropogon ternarius*
Broom-Sedge	*Andropogon virginicus*
Sand Hickory	*Carya pallida*
Wild Sensitive Plant	*Cassia nictitans*

Etc…

Ron Wilson, Botanist




Fire and Fuels Monitoring Workshop
June 6-8, 2017
Albany Pine Bush Preserve, Albany, NY

IMMEDIATE POST-BURN EVALUATION CHARTS

Table 1. Fuel models

Fuel Model	Description
1	improved pasture / glades
2	pine or oak savanna
3	tallgrass prairie
6	cedar thickets

Fuel Model	Description
7	pine plantation / young regeneration
8	riparian bottoms or bottomland forest
9	oak or oak-pine woodland or forest

SUBSTRATE (litter/duff)

Table 2. Substrate Burn Severity Class (USNPS 1991)

0	1 (scorched)	2 (lightly burned)	3 (moderately burned)	4 (heavily burned)
not burned	litter partially blackened; duff nearly unchanged; wood/leaf structures unchanged	litter charred to partially consumed; upper duff layer burned; wood/leaf structures charred, but recognizable	litter mostly to entirely consumed, leaving coarse, light colored ash; duff deeply burned; wood/leaf structures unrecognizable	litter and duff consumed, leaving fine white ash; mineral soil visibly altered, often reddish

UNDERSTORY (ground layer: grasses and forbs, woody stems ≤ 1 meter tall)

Table 3. Understory Burn Severity Class (USNPS 1991)

0	1 (scorched)	2 (lightly burned)	3 (moderately burned)	4 (heavily burned)
not burned	foliage scorched and attached to supporting twigs	foliage & smaller twigs partially to completely consumed	foliage, twigs and small stems consumed	all plant parts consumed, leaving some or no major stems/trunks

MIDSTORY (live woody stems > 1 meter tall and < 8" diameter-at-breast-height)

Table 4. Midstory Scorch Percent Class

0	1	2	3	4	5
not burned	≤ 25%	> 25 ≤ 50%	> 50 ≤ 75%	> 75 ≤ 99%	> 99 ≤ 100%

OVERSTORY (live stems, 8"+ diameter-at-breast-height)

Table 5. Overstory Char Degree (Plumb and Gomez 1983)

0	1 (light)	2 (medium)	3 (heavy)
not burned	spotty char or scorch with scattered pitting of bark	continuous charring with areas of minor reduction in bark thickness	continuous charring, pronounced reduction in bark thickness with underlying wood sometimes exposed

Table 6. Overstory Char Height Class

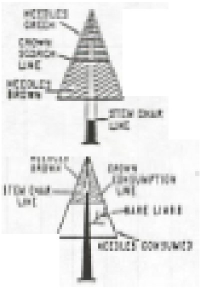
0	1	2	3	4
not burned	≤ 5 ft	> 5 ≤ 10 ft	> 10 ≤ 20 ft	> 20 ft

Table 7. Overstory Scorch Percent Class

0	1	2	3	4	5
not burned	≤ 25%	> 25 ≤ 50%	> 50 ≤ 75%	> 75 ≤ 99%	> 99 ≤ 100%

Table 8. Overstory Scorch Height Class

0	1	2	3	4
not burned	≤ 10 ft	> 10 ≤ 20 ft	> 20 ≤ 50 ft	> 50 ft



Two burn areas from the 2011 Wallow Fire in eastern Arizona experienced drastically different fire intensities. The previously treated area (top) had a low fire intensity due to the prior removal of excess fuels. This fire burned mostly on the ground with a large tree survival rate. The untreated area (bottom) experienced a high-intensity crown fire that scorched all of the trees and understory. *Photo courtesy of the Ecological Restoration Institute*

BURN SEVERITY

TOTAL ACRES BURNED:		AVE. SCORCH HEIGHT (FT):	

BURN SEVERITY	UNBURNED (%)	SCORCHED (%)	LOW SEVERITY (%)	MOD. SEVERITY (%)	HIGH SEVERITY (%)
SUBSTRATE (TOTAL = 100%)					
HERBACEOUS VEGETATION					
LOW - WOODY VEGETATION					
HIGH - WOODY VEGETATION					
TREES - WOODY VEGETATION					

	UNBURNED	SCORCHED	LOW SEVERITY	MODERATE SEVERITY	HIGH SEVERITY
SUBSTRATE	•UNBURNED	•DUFF NEARLY UNCHANGED •LITTER PARTIALLY BLACKENED •WOOD/LEAF STRUCTURES UNCHANGED	•UPPER DUFF LAYER BURNED •LITTER CHARRED TO PARTIALLY CONSUMED •WOOD/LEAF STRUCTURES CHARRED, BUT RECOGNIZABLE	•DUFF DEEPLY BURNED •LITTER MOSTLY TO ENTIRELY CONSUMED •WOOD/LEAF STRUCTURES UNRECOGNIZABLE	•MINERAL SOIL VISIBLY ALTERED •LITTER AND DUFF CONSUMED, LEAVING FINE WHITE ASH
HERBACOUS VEGETATION	•UNBURNED	•FOLIAGE SCORCHED •TUSSOCKS INTACT •SUPPORTING STEMS ATTACHED	•SOME FOLIAGE AND STEMS CONSUMED WITH INTACT STEMS LIEING ON BURNED AREAS •TUSSOCKS INTACT	•FOLIAGE AND STEMS CONSUMED •ONLY TUSSOCKS INTACT	•FOLIAGE AND STEMS CONSUMED • TUSSOCKS SCORCHED OR BURNED
WOODY VEGETATION	•UNBURNED	•FOLIAGE SCORCHED •SUPPORTING TWIGS ATTACHED	•FOLIAGE & SMALLER TWIGS PARTIALLY TO COMPLETELY CONSUMED	•FOLIAGE, TWIGS, AND SMALL STEMS CONSUMED	•ALL PLANT PARTS CONSUMED LEAVING SOME OR NO MAJOR STEMS/TRUNKS

LITTER – The layer composed of relatively un-decomposed organic material such as twigs leaves and branches.
DUFF – The layer of loosely compacted, decaying debris underlying the litter layer.

Evaluation / Report

Ecological Objectives

1. <u>80% + unit coverage.</u> 73% of the unit burned. Unburned areas occurred where soils were retaining water, which did occur in all communities. The willow oak flat community at the southern end of the unit had the lowest coverage and remained mostly unburned.

2. <u>Organic substrate burn severity class = 1.0 – 2.5.</u> Substrate burn severity = 2.0 (lightly burned). Overall, litter and duff were partially removed. Bare soil was exposed in the savannah, woodlands and nebkhas. In the wet prairie community, the fire consumed most of the dormant, standing herbaceous plants, but left most of the substrate scorched or unburned. Leaf litter was scorched in the small areas of willow oak flats that burned.

3. <u>Understory burn severity class = 1.5 - 3.5.</u> Understory burn severity = 2.2 (moderately burned). Small diameter woody vegetation was partially consumed and top-killed in the woodlands and savannah. Herbaceous vegetation was partially to mostly consumed in all but the willow oak flats.

4. <u>Midstory scorch percent class = 1.0 – 4.0.</u> Midstory scorch percent = 3.6 (75 - 95% of live crowns). Midstory scorch was evident on young pine regeneration in the woodlands and savannahs, and was mostly scorched. The midstory scorch line ranged from 5' to up to 15'. Young pine regeneration that was found in pockets throughout the unit should experience mortality and, consequently, decrease in density. Shrubs in the wet prairie (mostly saltbush) were mostlv scorched.

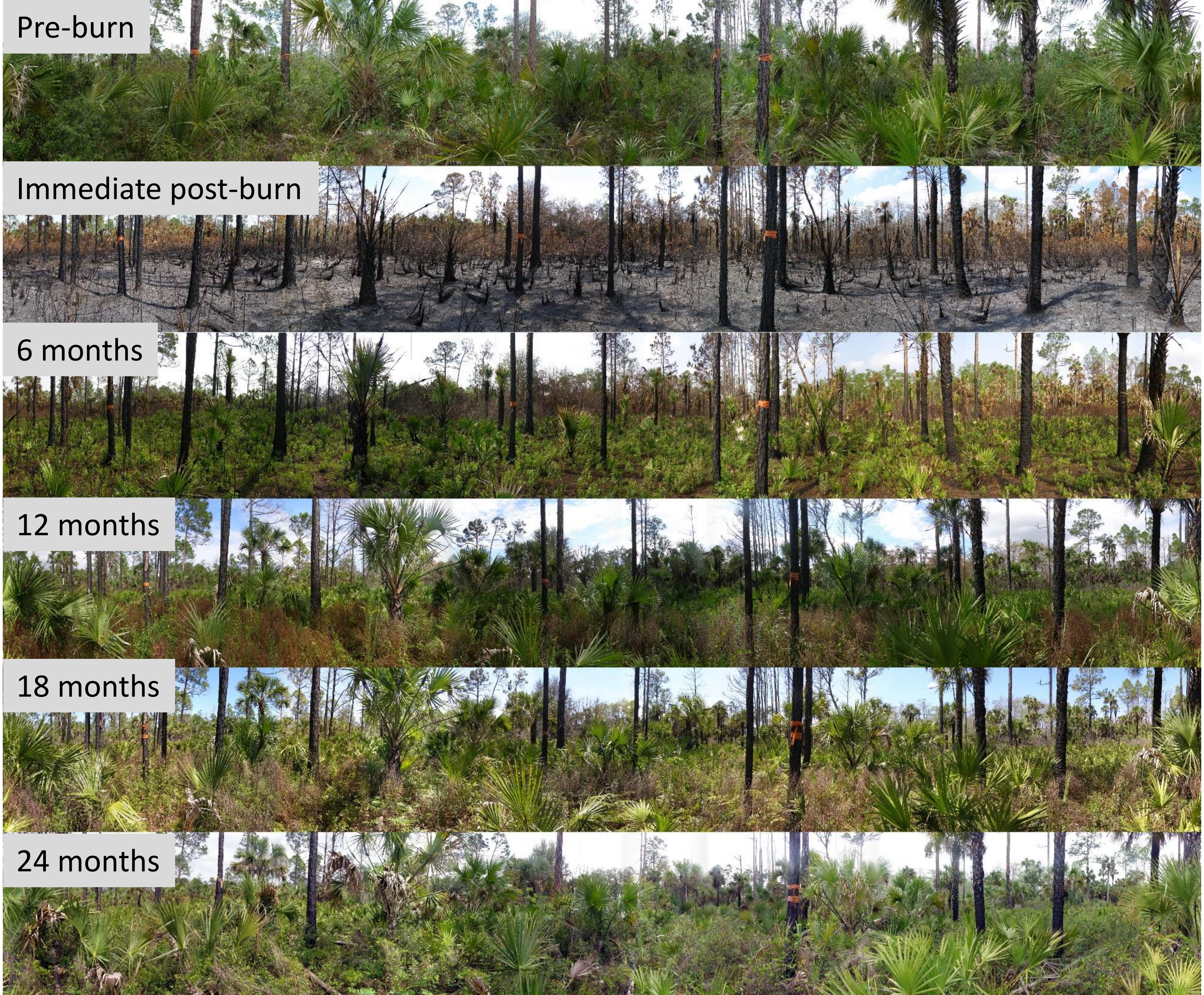
8. <u>Overstory scorch height = 1.5 – 3.0.</u> Overstory scorch height was 1.6 (10' – 20'). Lower to mid-level branches of some overstory pine trees were scorched in the savannah and woodlands.

Photo points (N-E-S-W)

IMMEDIATE POST-BURN EFFECTS

Scorch and burned grass tops in the wet prairie

Pine savannah and saline barrens


Pre-burn
Immediate post-burn
6 months
12 months
18 months
24 months

TL6 (186)

Moderate Load Broadleaf Litter

Standard Fire Behavior Fuel Models, Scott & Burgan

Description: The primary carrier of fire in TL6 is moderate load broadleaf litter, less compact than TL2. Spread rate is moderate; flame length low.

Fine fuel load (t/ac)	2.4
Characteristic SAV (ft-1)	1936
Packing ratio (dimensionless)	0.02296
Extinction moisture content (percent)	25

FFI: A software tool for ecological monitoring

Duncan C. Lutes[1]
U.S. Forest Service

Nathan C. Benson
National Park Service

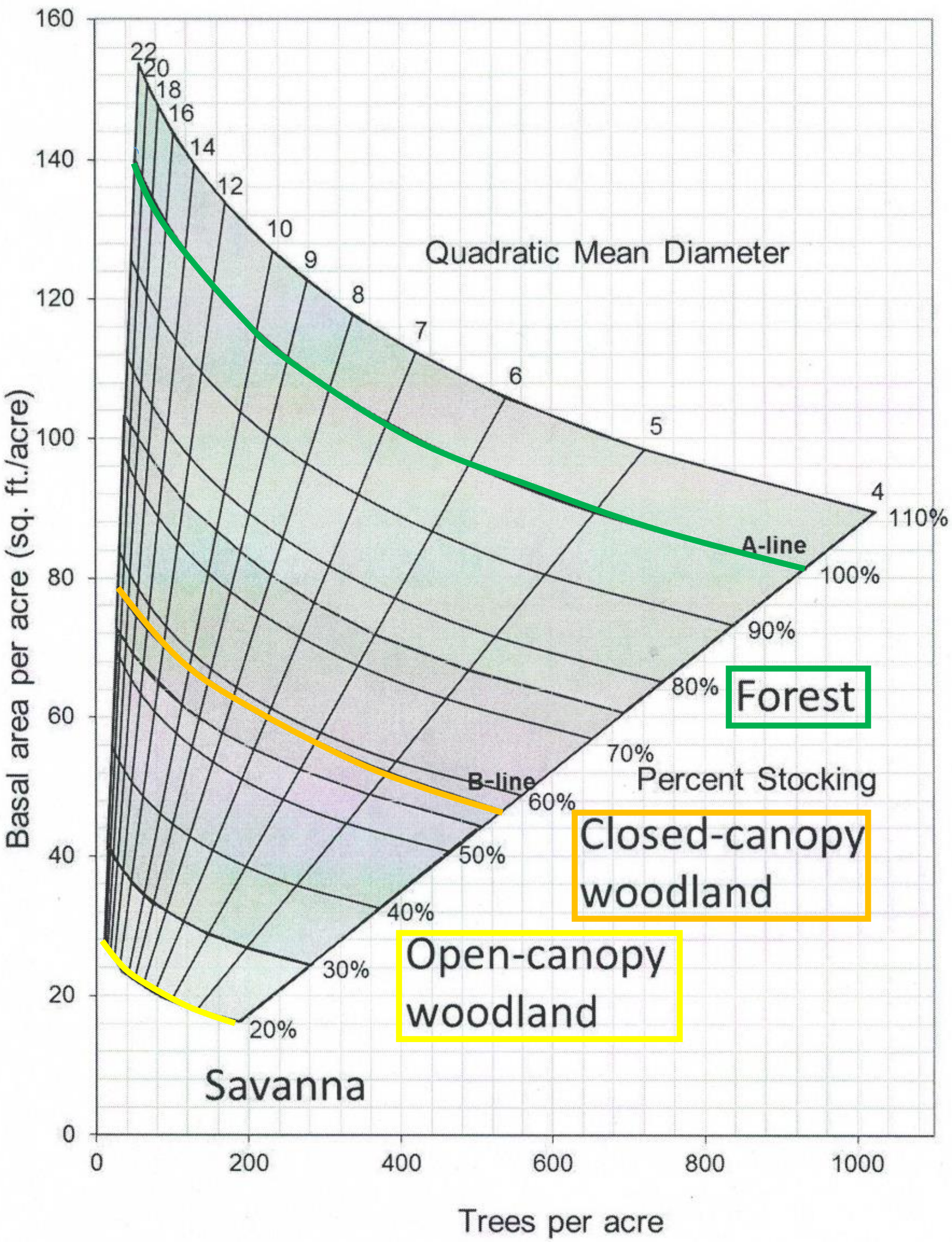
MaryBeth Keifer
National Park Service

Abstract

A new monitoring tool called FFI (FEAT/FIREMON Integrated) has been developed to assist managers with collection, storage and analysis of ecological information. The tool was developed through the complementary integration of two fire effects monitoring systems commonly used in the United States: FIREMON (Lutes 2006) and the Fire Ecology Assessment Tool (Sexton 2003). FFI provides software components for: data entry, data storage, Geographic Information System, summary reports, analysis tools and Personal Digital Assistant use. In addition to a large set of standard FFI protocols, the Protocol Manager lets users define their own sampling protocol when custom data entry forms are needed. The standard FFI protocols and Protocol Manager allow FFI to be used for monitoring in a broad range of ecosystems. FFI is designed to help managers fulfill monitoring mandates set forth in land management policy. It supports scalable (project to landscape scale) monitoring at the field and research level, and encourages cooperative, interagency data management and information sharing. Though developed for application in the U.S., FFI can potentially be used to meet monitoring needs internationally.

https://www.frames.gov/partner-sites/ffi/ffi-home/

Forest Inventory Plots



Gingrich stocking guide for oak as modified by Ben Knapp

The use of witness trees as pyro-indicators for mapping past fire conditions

Melissa A. Thomas-Van Gundy [a,*], Gregory J. Nowacki [b]

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[b] USDA Forest Service, Eastern Regional Office, Milwaukee, WI 53202, United States

Common name used in deeds	Scientific name	Relationship to fire
Pine	*Pinus* spp.	Pyrophilic
Pitch, yellow, or Virginia pine	*Pinus rigida* or *virginiana*	Pyrophilic
White pine	*Pinus strobus*	Pyrophilic
Red spruce, spruce, black spruce, yew pine	*Picea rubens*	Pyrophobic
Yew	*Taxus canadensis*, possibly *Picea* (?)	Pyrophobic
Balsam fir, fir, balsam	*Abies balsamea*	Pyrophobic
Spruce-pine	Likely *Picea rubens* or *Tsuga canadensis* (?)	Pyrophobic
Hemlock, hemlock-spruce	*Tsuga canadensis*	Pyrophobic
Red cedar, cedar	*Juniperus virginiana*	Pyrophilic
Willow	*Salix* spp.	Pyrophobic
Aspen, cottonwood	*Populus* spp.	Pyrophilic
Butternut, white walnut	*Juglans cinerea*	Pyrophobic
Black walnut, walnut	*Juglans nigra*	Pyrophobic
Hickory	*Carya* spp.	Pyrophilic
Hornbeam, ironwood, hophornbeam, Bluebeech	*Carpinus caroliniana*, *Ostrya virginiana*	Pyrophobic
Birch	*Betula* spp.	Pyrophobic
Black or sweet birch	*Betula lenta*	Pyrophobic
River birch	*Betula nigra*	Pyrophobic
American beech	*Fagus grandifolia*	Pyrophobic
Chestnut	*Castanea dentata*	Pyrophilic
Oak	*Quercus* spp.	Pyrophilic
White oak	*Quercus alba*	Pyrophilic
Chestnut or rock oak	*Quercus prinus*	Pyrophilic
Northern red oak	*Quercus rubra*	Pyrophilic
Scarlet, span, Spanish, or pin oak	*Quercus coccinea*	Pyrophilic
Black oak	*Quercus velutina*	Pyrophilic
Elm	*Ulmus* spp.	Pyrophobic
Magnolia, cucumber, elkwood	*Magnolia acuminata* or *fraseri*	Pyrophobic
Yellow-poplar, poplar, tulip tree, tulip	*Liriodendron tulipifera*	Pyrophobic
Sassafras	*Sassafras albidum*	Pyrophilic
Sycamore	*Platanus occidentalis*	Pyrophobic
Apple, crab apple, plum, and peach	*Malus* spp.	Pyrophobic
Serviceberry, service, sarvice	*Amelanchier* spp.	Pyrophobic
Black or wild cherry	*Prunus serotina*	Pyrophobic
Locust	*Robinia pseudoacacia*	Pyrophilic
Holly	*Ilex opaca*	Pyrophobic
Maple	*Acer* spp., possibly *A. rubrum*?	Pyrophobic
Sugar or hard maple, sugar tree, sugar	*Acer saccharum*	Pyrophobic
Striped maple	*Acer pensylvanicum*	Pyrophobic
Buckeye	*Aesculus* spp.	Pyrophobic
Basswood, yellow or white lynn, lin	*Tilia* spp.	Pyrophobic
Blackgum, gum, sour gum	*Nyssa sylvatica*	Pyrophilic
Dogwood	*Cornus* spp.	Pyrophilic

CBI-Forensic Ecology

J. Picotte

CBI-Components

- Burn Index: 0-3
  - 0-Unburned
  - 3-Severe Burn
- Five Strata
  - 4-5 Ratings Factors
    - Ryan and Noste 1985
    - Landsat
  - Averaged

FIREMON LA Form

BURN SEVERITY -- COMPOSITE BURN INDEX (BI)

PD - Abridged	Examiners:		Fire Name:	
Registration Code		Project Code		Plot Number
Field Date mmddyyyy	/ /	Fire Date mmyyyy	/	
Plot Aspect		Plot % Slope		UTM Zone
Plot Diameter Overstory		UTM E plot center		GPS Datum
Plot Diameter Understory		UTM N plot center		GPS Error (m)
Number of Plot Photos		Plot Photo IDs		

BI – Long Form	% Burned 100 feet (30 m) diameter from center of plot =						Fuel Photo Series =	
STRATA RATING FACTORS	BURN SEVERITY SCALE							FACTOR SCORES
	No Effect	Low		Moderate		High		
	0.0	0.5	1.0	1.5	2.0	2.5	3.0	
A. SUBSTRATES								
% Pre-Fire Cover: Litter = Duff = Soil/Rock = Pre-Fire Depth (inches): Litter = Duff = Fuel Bed =								Σ =
Litter/Light Fuel Consumed	Unchanged	–	50% litter	–	100% litter	>80% light fuel	98% Light Fuel	
Duff	Unchanged	–	Light char	–	50% loss deep char	–	Consumed	N =
Medium Fuel, 3-8 in.	Unchanged	–	20% consumed	–	40% consumed	–	>40% loss, deep ch	
Heavy Fuel, > 8 in.	Unchanged	–	10% loss	–	25% loss, deep char	–	>40% loss, deep ch	X̄ =
Soil & Rock Cover/Color	Unchanged	–	10% change	–	40% change	–	>80% change	
B. HERBS, LOW SHRUBS AND TREES LESS THAN 3 FEET (1 METER):								
Pre-Fire Cover = % Enhanced Growth =								Σ =
% Foliage Altered (blk-brn)	Unchanged	–	30%	–	80%	95%	100% + branch loss	
Frequency % Living	100%	–	90%	–	50%	< 20%	None	N =
Colonizers	Unchanged	–	Low	–	Moderate	High-Low	Low to None	
Spp. Comp. - Rel. Abund.	Unchanged	–	Little change	–	Moderate change	–	High change	X̄ =
C. TALL SHRUBS AND TREES 3 to 16 FEET (1 TO 5 METERS):								
Pre-Fire Cover = % Enhanced Growth =								Σ =
% Foliage Altered (blk-brn)	0%	–	20%	–	60-90%	> 95%	Significant branch loss	
Frequency % Living	100%	–	90%	–	30%	< 15%	< 1%	N =
% Change in Cover	Unchanged	–	15%	–	70%	90%	100%	
Spp. Comp. - Rel. Abund.	Unchanged	–	Little change	–	Moderate change	–	High Change	X̄ =
D. INTERMEDIATE TREES (SUBCANOPY, POLE-SIZED TREES)								
Pre-Fire % Cover = Pre-Fire Number Living = Pre-Fire Number Dead =								Σ =
% Green (Unaltered)	100%	–	80%	–	40%	< 10%	None	
% Black (Torch)	None	–	5-20%	–	60%	> 85%	100% + branch loss	N =
% Brown (Scorch/Girdle)	None	–	5-20%	–	40-80%	< 40 or > 80%	None due to torch	
% Canopy Mortality	None	–	15%	–	60%	80%	%100	X̄ =
Char Height	None	–	1.5 m	–	2.8 m	–	> 5 m	
Post Fire: %Girdled = %Felled = %Tree Mortality =								
E. BIG TREES (UPPER CANOPY, DOMINANT, CODOMNANT TREES)								
Pre-Fire % Cover = Pre-Fire Number Living = Pre-Fire Number Dead =								Σ =
% Green (Unaltered)	100%	–	95%	–	50%	< 10%	None	
% Black (Torch)	None	–	5-10%	–	50%	> 80%	100% + branch loss	N =
% Brown (Scorch/Girdle)	None	–	5-10%	–	10-70%	< 30 or > 70%	None due to torch	
% Canopy Mortality	None	–	10%	–	50%	70%	%100	X̄ =
Char Height	None	–	1.8 m	–	4 m	–	> 7 m	
Post Fire: %Girdled = %Felled = %Tree Mortality =								

Community Notes/Comments:	CBI = Sum of Scores / N Rated:	Sum of Scores	N Rated	CBI
	Understory (A+B+C)			
	Overstory (D+E)			
	Total Plot (A+B+C+D+E)			

% Estimations: 20 m Plot: 314 m² 1% = 1x3 m 5% = 3x5 m 10% = 5x6 m
30 m Plot: 707 m² 1% = 1x7 m (<2x4 m) 5% = 5x7 m 10% = 7x10 m

After Key and Benson 1999, USGS NRMSC Glacier Field Station, Version 4.0 8/27/2004

Strata and Factors are defined in FIREMON Landscape Assessment, Chapter 2, and on accompanying BI "cheatsheet." www.fire.org/firemon/lc.htm

CBI Example-Overstory Strata

Intermediate Trees/Subcanopy

Average: 1.9

	Score
% Green (Unaltered)	2.4
% Black (Torch)	1.0
% Brown (Scorch/Girdle)	2.0
% Canopy Mortality	2.0
Char Height	1.9

Big Trees/Upper Canopy

Average: 1.7

	Score
% Green (Unaltered)	2.3
% Black (Torch)	0.0
% Brown (Scorch/Girdle)	2.0
% Canopy Mortality	2.0
Char Height	2.4

A Project for Monitoring Trends in Burn Severity

Jeff Eidenshink[1,*], Brian Schwind[2], Ken Brewer[2], Zhi-Liang Zhu[1], Brad Quayle[2] and Stephen Howard[3]

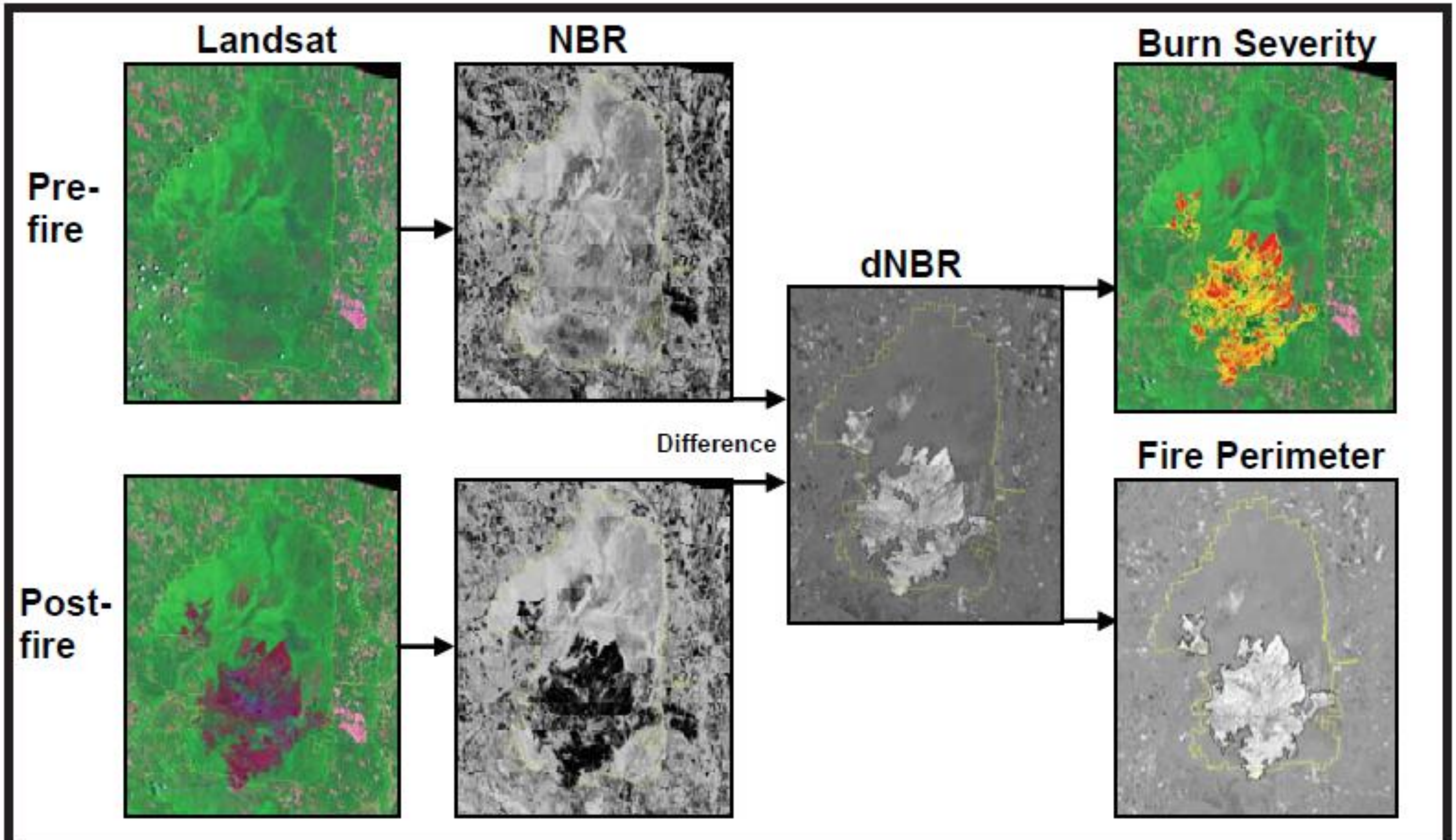
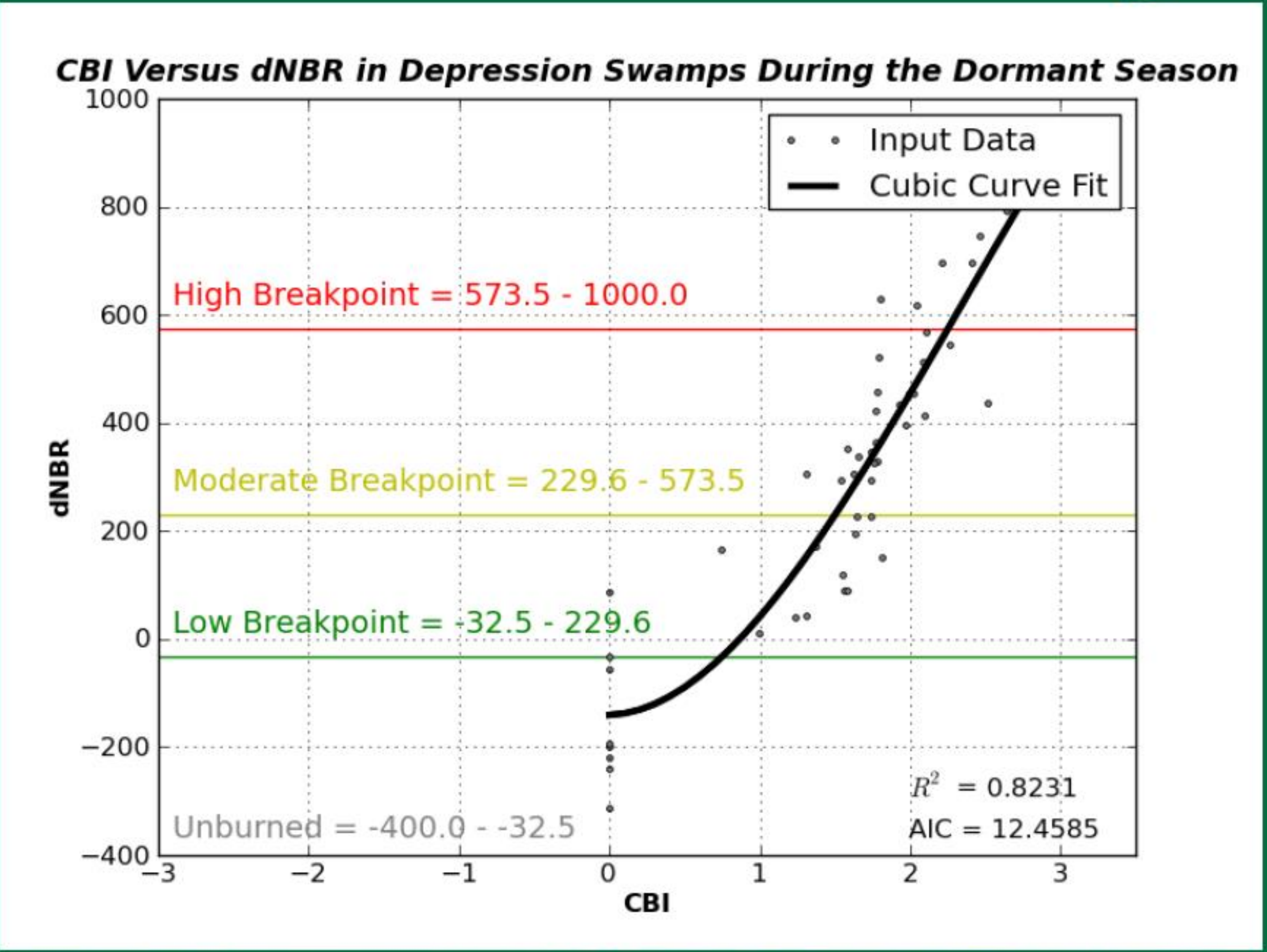


Figure 2. The processing sequence for using Landsat images to map burn severity and a fire perimeter for a fire in the Okefenokee National Wildlife Refuge (yellow line is the refuge border).

MTBS- www.mtbs.gov

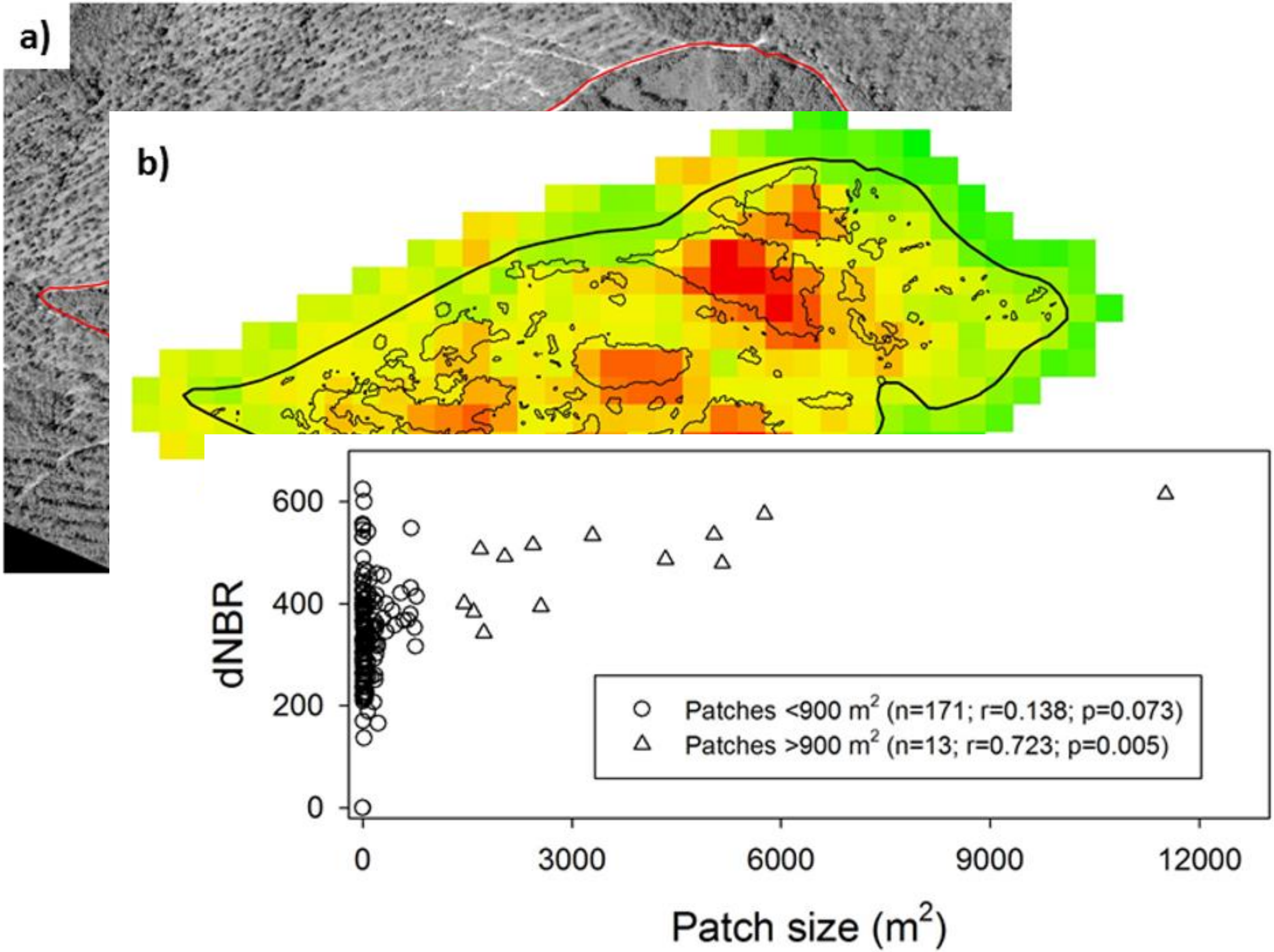
CBI versus dNBR-Thresholding



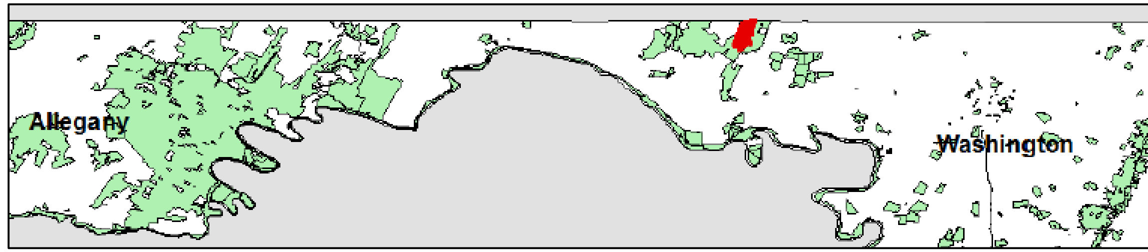
USGS

MTBS

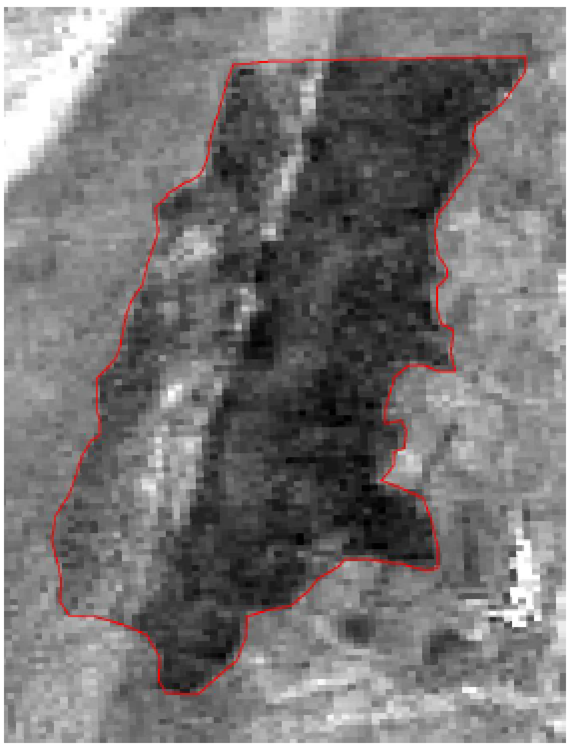
J. Picotte


a)
b)
dNBR
600
400
200
0
0
3000
6000
9000
12000
Patch size (m^2)
Patches <900 m^2 (n=171; r=0.138; p=0.073)
Patches >900 m^2 (n=13; r=0.723; p=0.005)

2001 Sword Mountain Wildfire



Burn scar- 865 acres
Fire date reported as 11/10/2001
Landsat image date 11/21/2001



dNBR (est 1)
pre=11/01/2000
Post=11/21/2001

dNBR (est 2)
pre=11/05/2001
Post=11/21/2001