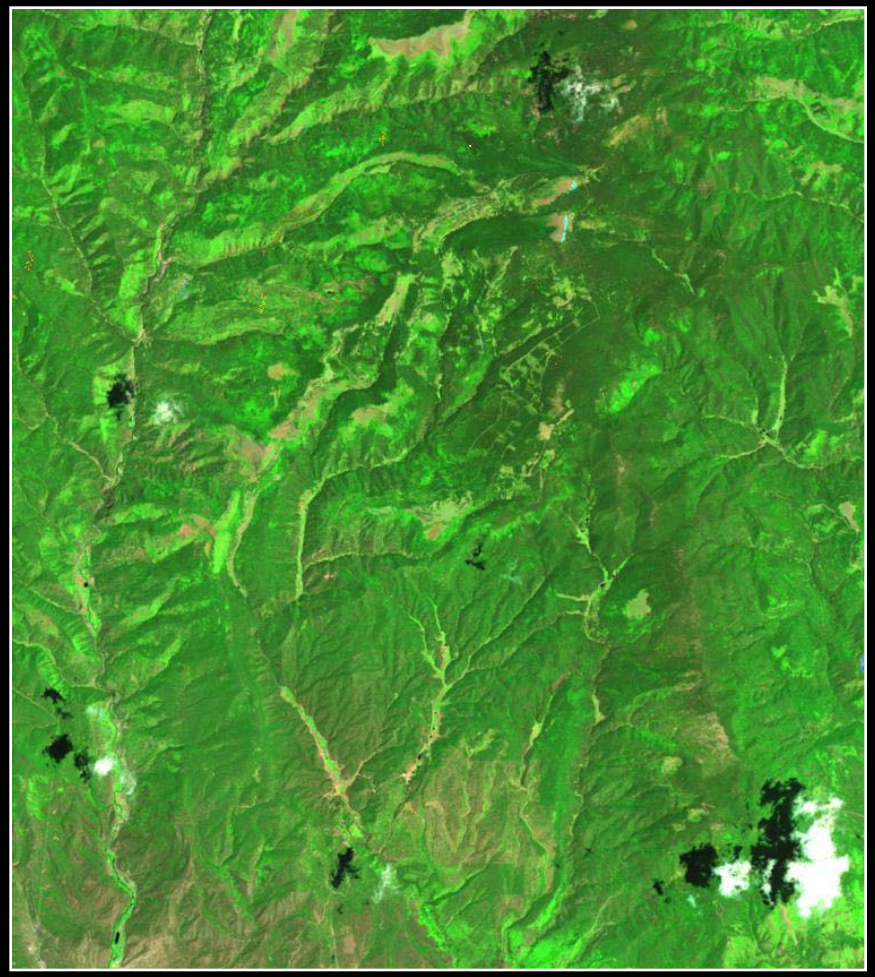
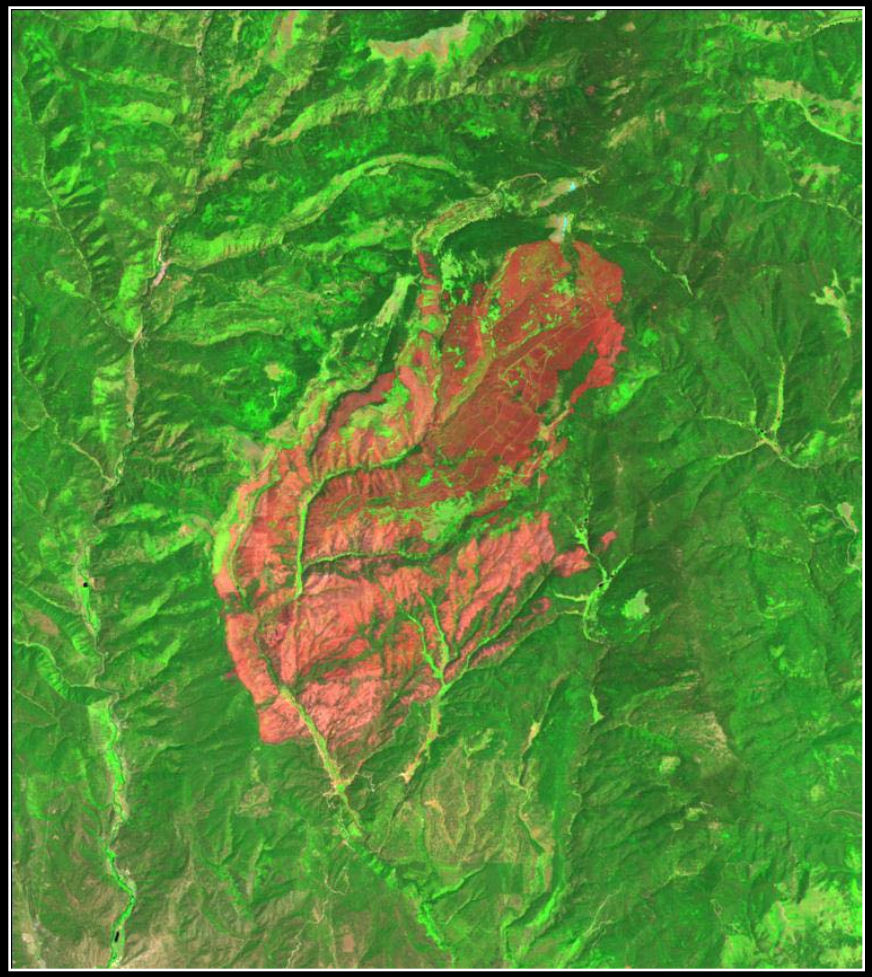
Ecological Fire Effects – Burn Severity

Carl Key, USGS NOROCK, Glacier Field Station

New Mexico Viveash Burn of 2000



Landsat TM 06/13/1998



Landsat TM 06/05/2001

dNBR – CBI Timeline

88 92 94 96 98 00 02 04 06 08

88 Red Bench Fire Glacier
White et al. B7 reflectance

94 GLAC fires
95 dNBR, CBI methods

USGS-NPS POBS Study

JFSP Study 80+ new fires

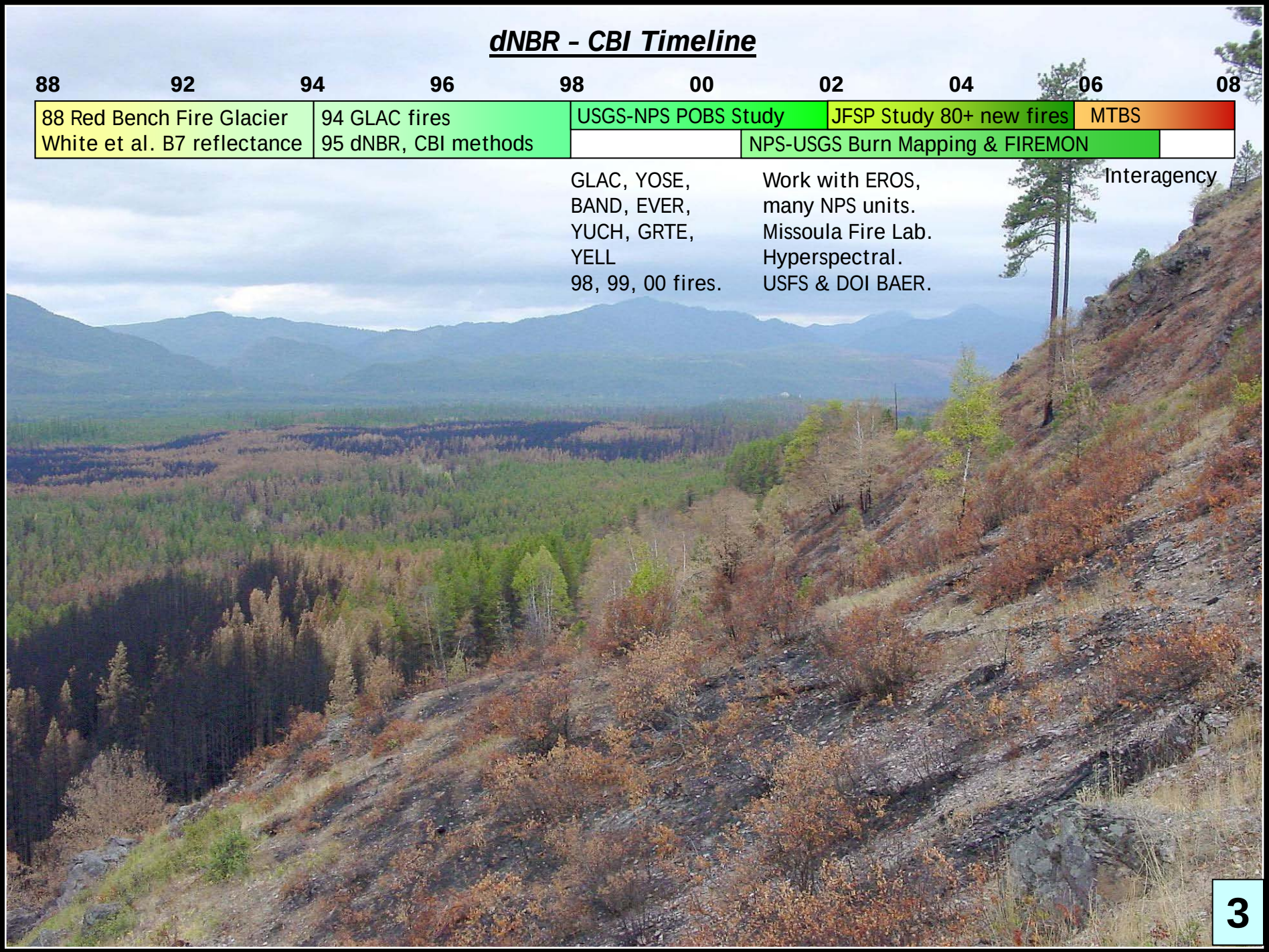
MTBS

NPS-USGS Burn Mapping & FIREMON

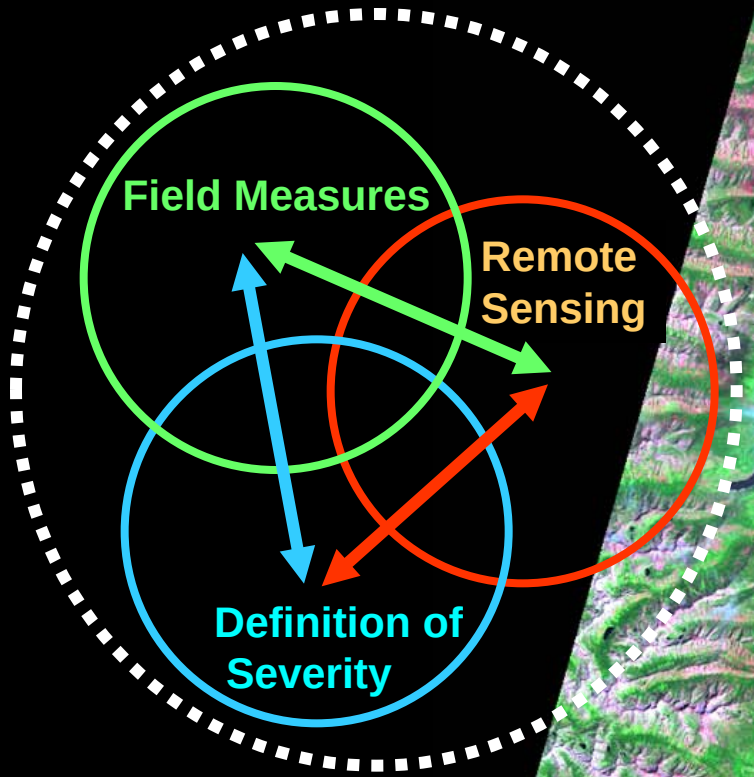
GLAC, YOSE,
BAND, EVER,
YUCH, GRTE,
YELL
98, 99, 00 fires.

Work with EROS,
many NPS units.
Missoula Fire Lab.
Hyperspectral.
USFS & DOI BAER.

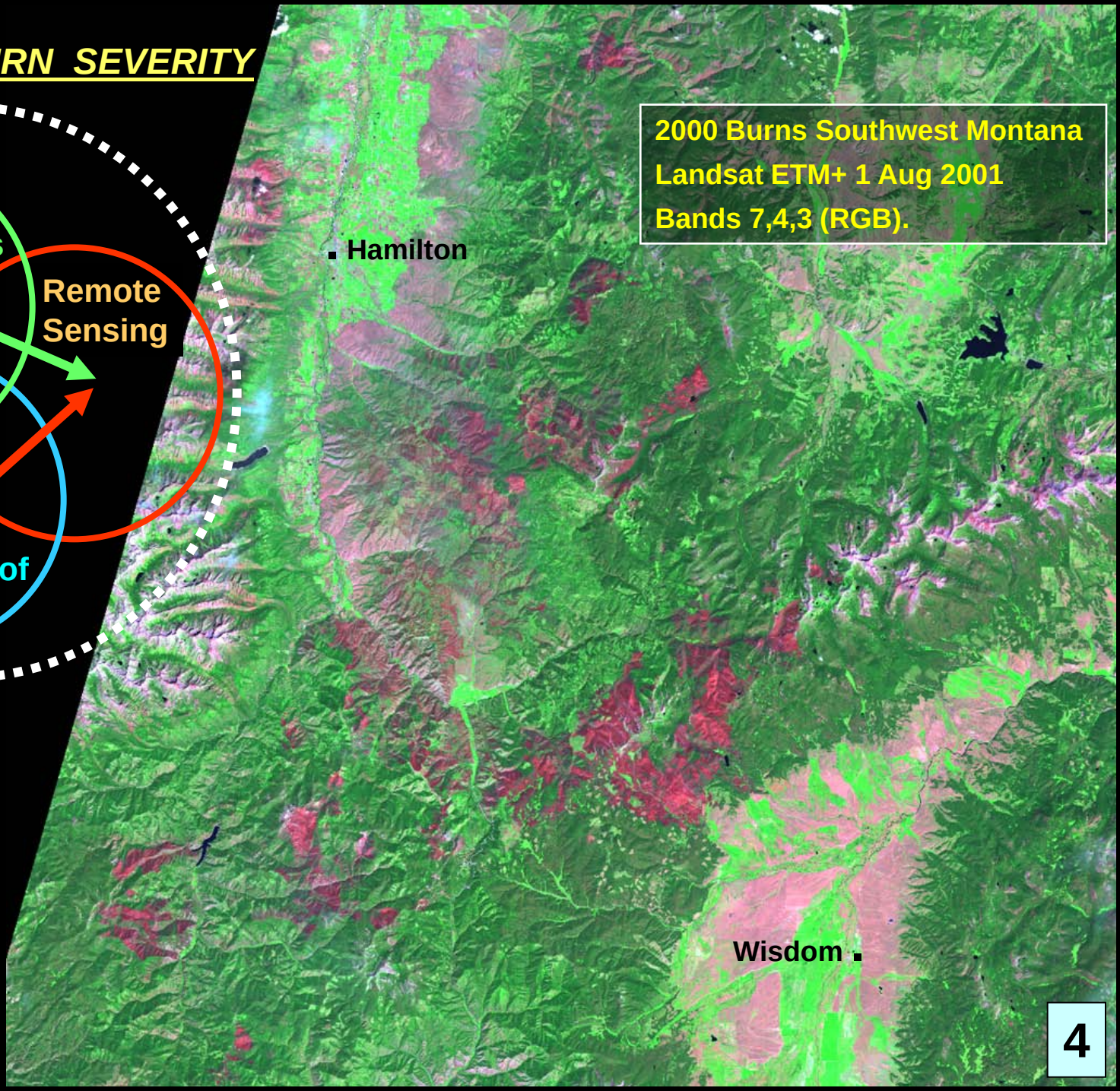
Interagency



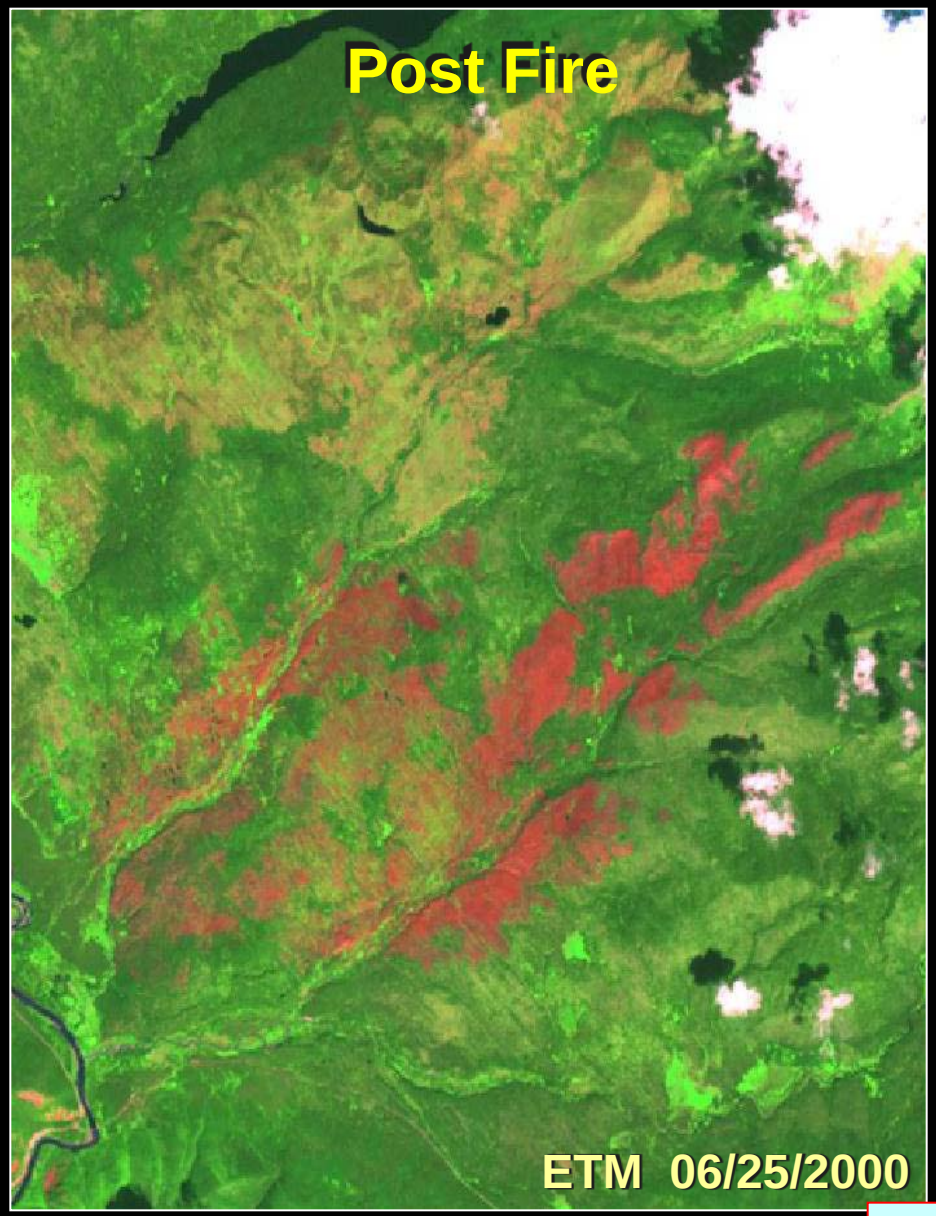
LANDSCAPE BURN SEVERITY



Implementation and Application



Landsat False Color Composites (Band 7-4-3 RGB)

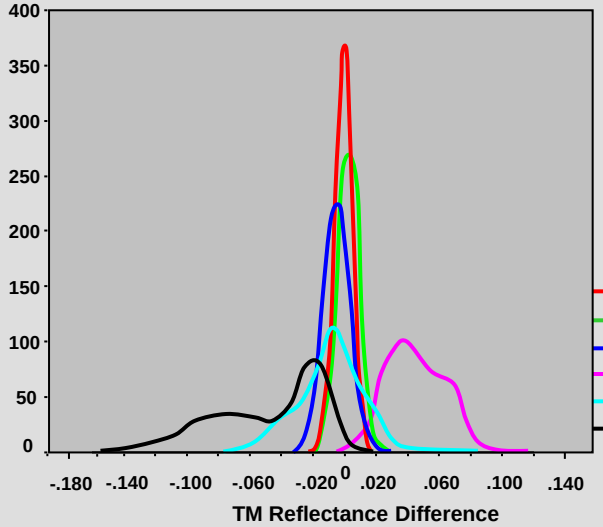


1999 Anaconda Burn

Sampling of reflectance responses over burned areas led to defining the Normalized Burn Ratio

1994 Starvation Burn 94129-95148

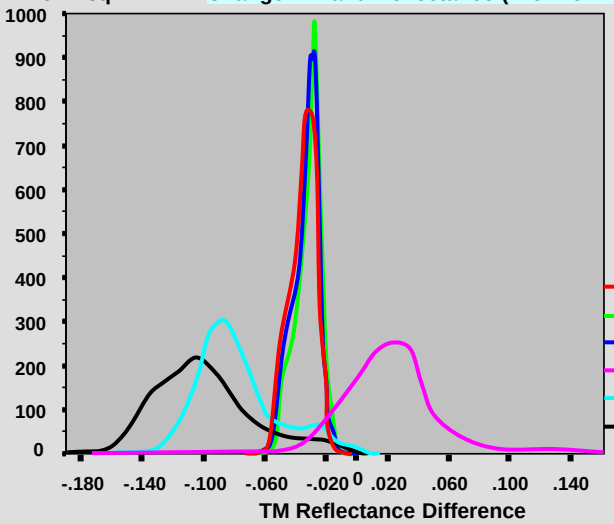
Change in Band Reflectance (Pre-fire – Post-fire)



BAND	MEAN	STD DEV.
band 1	-0.001	0.006
band 2	0.003	0.007
band 3	-0.005	0.009
band 4	0.046	0.019
band 5	-0.009	0.021
band 7	-0.049	0.035

2006 Red Eagle Burn 03202-07213

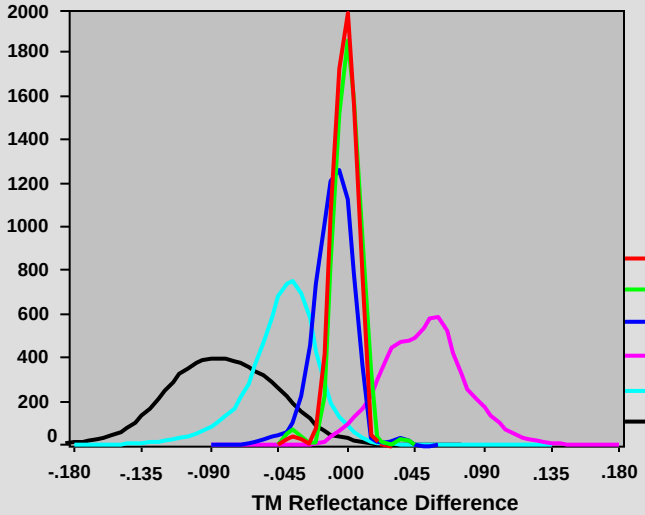
Change in Band Reflectance (Pre-fire – Post-fire)



BAND	MEAN	STD DEV.
band 1	-0.034	0.009
band 2	-0.030	0.008
band 3	-0.032	0.009
band 4	+0.026	0.035
band 5	-0.077	0.027
band 7	-0.097	0.034

2004 Winter Trail Burn, Yukon Flats NWR 01176 - 05171

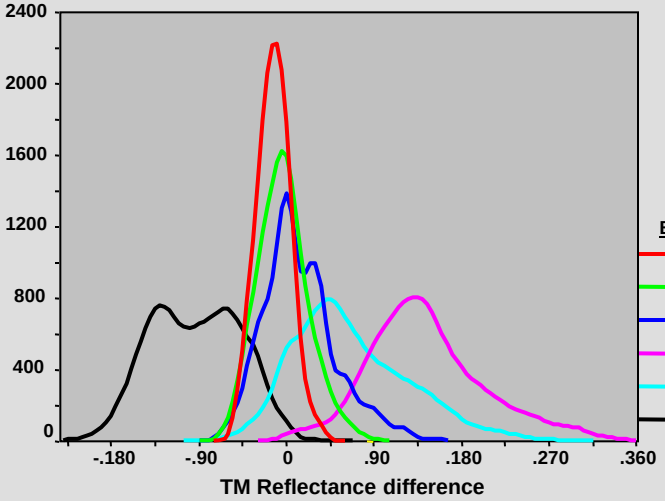
Change in Band Reflectance (Pre-fire – Post-fire)



BAND	MEAN	STD DEV.
band 1	-0.003	0.007
band 2	+0.001	0.008
band 3	-0.011	0.011
band 4	+0.052	0.026
band 5	-0.044	0.024
band 7	-0.083	0.035

2005 Southern Nevada Complex Initial Assmnt. 050525 - 050712

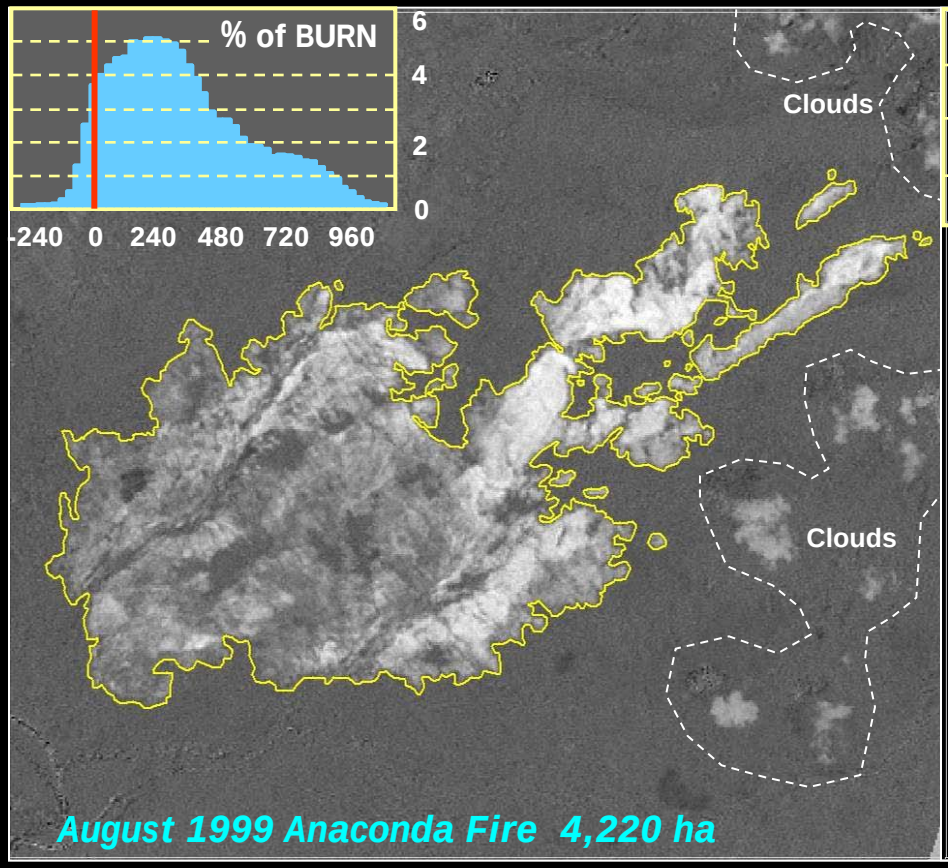
Change in Band Reflectance (Pre-fire – Post-fire)



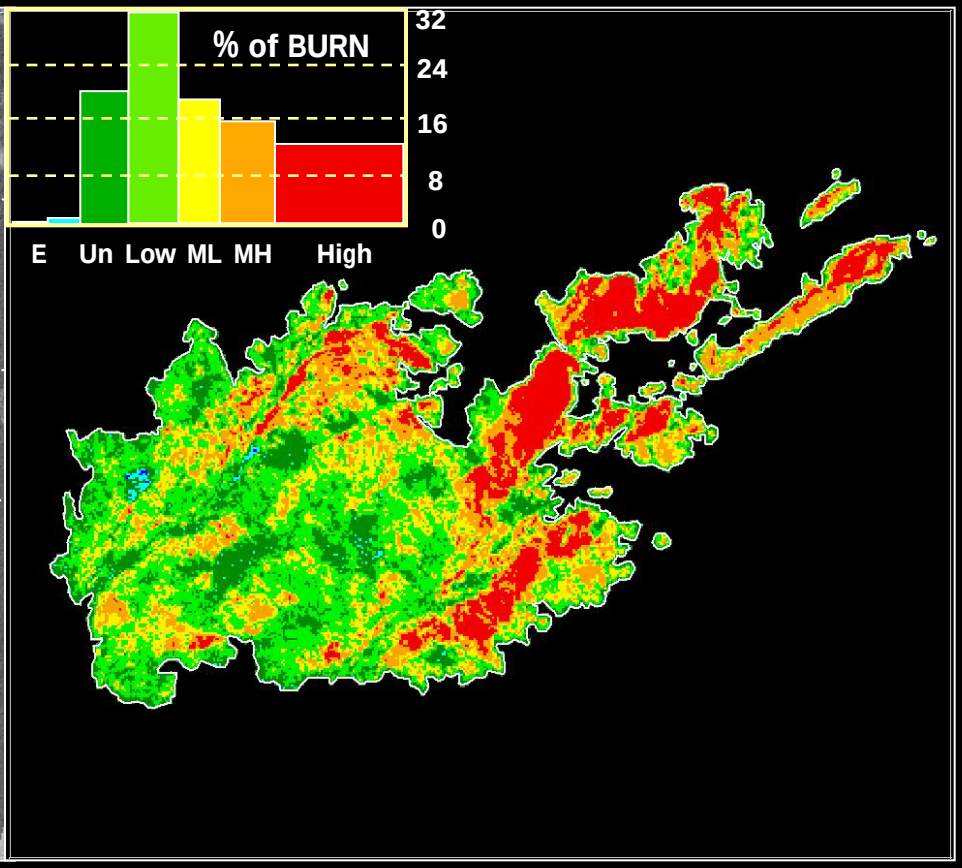
BAND	MEAN	STD. DEV
band 1	-0.014	0.018
band 2	-0.003	0.027
band 3	+0.013	0.038
band 4	+0.145	0.060
band 5	+0.066	0.060
band 7	-0.095	0.045

Quantifying Whole-Burn Spatial Qualities
Differenced Normalized Burn Ratio dNBR

dNBR 7/10/1999 – 6/25/2000
Burn Perimeter Mapped



Burn Data Extracted by Perimeter
Burn Severity Levels or Classes



beta variation

Application Timing

BAER

Rapid Assessment

Large Area Burns

<10 days

Initial Assessment

ASAP After All Fire, <2 months

Extended Assessment

1st Regrowth

USGS science for a changing world

http://burnseverity.cr.usgs.gov

USGS science for a changing world

National Park Service - U. S. Geological Survey
National Burn Severity Mapping Project

Fire Science | Burn Severity | Abstract | Overview | Methodology | Data Contents | Download Data | Contributors | Contact Us

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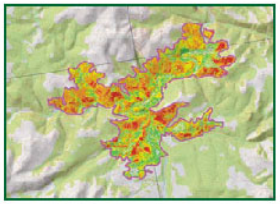
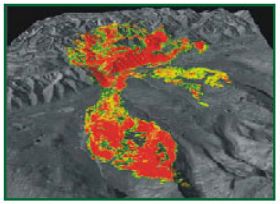
The Joint NPS-USGS National Burn Severity Mapping Project addresses the need to quantify fire effects over large, often-remote regions and long time intervals. It reflects collaborative efforts to bring previous research into operational implementation for fire managers and scientists. The project focuses on National Park Service Units and adjoining lands throughout the U.S., mostly beginning with fire-year 2000, although earlier burns have been examined in some areas. It combines processing, data archive, and remote sensing expertise of the USGS EROS Data Center with the local knowledge and field sampling capability of the NPS, and the fire-effects research of the USGS Northern Rocky Mountain Science Center to deliver an effective yet simple approach to mapping severity.

This web site provides access to accumulating data within that database. Search and query functions lead users to individual burn information pages. Product deliverables may be retrieved, including textual information, graphic images, digital spatial data, and metadata. Through such standardized methodology and products, information can be compared or aggregated across multiple burns.

Users should carefully review the following information for proper interpretation and application of products: Overview, Methodology, and Data Contents.





USGS science for a changing world

Joint Fire Science Program

USGS science for a changing world

National Park Service - U. S. Geological Survey
National Burn Severity Mapping Project

Burn Severity | Abstract | Overview | Methodology | Data Contents | Resources | Data Archive | Contributors | Contact Us

Fire Name: Divide

Park Name:	Bridger Teton National Forest
Start Date:	2002-08-05
Estimated DNBR Acres:	2820
Assessment Type:	extended
Latitude:	42 49 30
Longitude:	109 26 52
Landsat Path/Row:	37/30
Image Dates:	L5-07/03/2001 L5-07/09/2003
Contact Point:	fsedc@usgs.gov

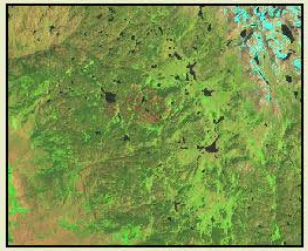


Image Processing and Validation Status

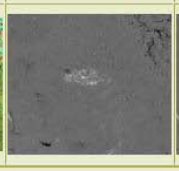
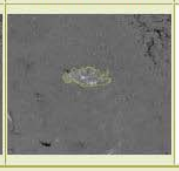
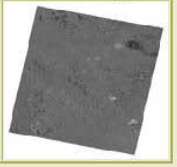
Links To Data:

Metadata (product projection information, image calibration parameters) - Download Adobe Acrobat Reader
Fire Perimeter (shape file) - Download Zip Application
Pre-Fire Image subset (multi-band Geo-TIFF)
Post-Fire Image subset (multi-band Geo-TIFF)

Differenced NBR subset(s)
Full Scene DNBR (large file >75MB)

Downloadable Image Gallery:

Click Images To Enlarge

Pre-Fire Image	Post-Fire Image	DNBR Image	DNBR Image With Fire Perimeter	Full-scene DNBR Image
				

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U.S. Department of the Interior
U.S. Geological Survey
USGS: Privacy Statement, Disclaimer, Accessibility, FOIA
DOI: Privacy Statement, Privacy Disclaimer, No FEAR Act, FOIA, Performance Plan, Children's Privacy
URL: http://burnseverity.cr.usgs.gov/show_fire.php
Maintainer: webmapping@usgs.gov
Last Update: December 20, 2007

Monitoring Trends in Burn Severity (MTBS)

- Home
- Background and Partners
- Documents and References
- Methods
- Product Descriptions
- Schedule
- Uses
- Project Reports
- Data Access
- Tech Transfer
- Glossary
- Related Websites
- Contact Us

USGS

RSAC

MTBS

Forest Service:
Accessibility
Privacy Policy
Important Notices
FOIA

DOI:
Accessibility
Privacy Policy
Important Notices
FOIA

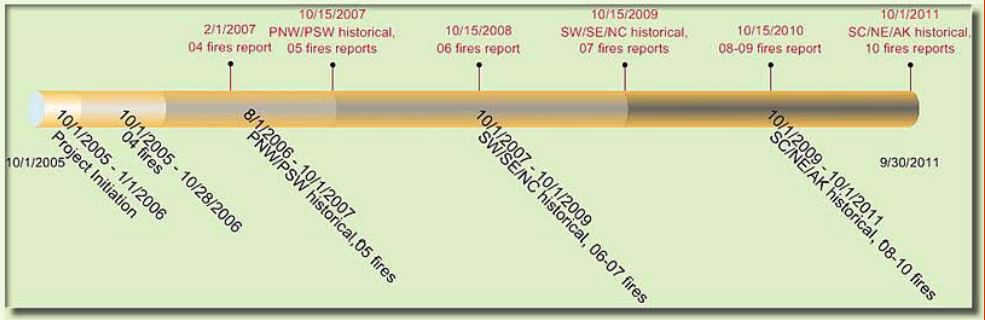
Last Update
June 2008

Historical Fire Mapping Schedule

Click on mapping zone to view general distribution of historical fires.

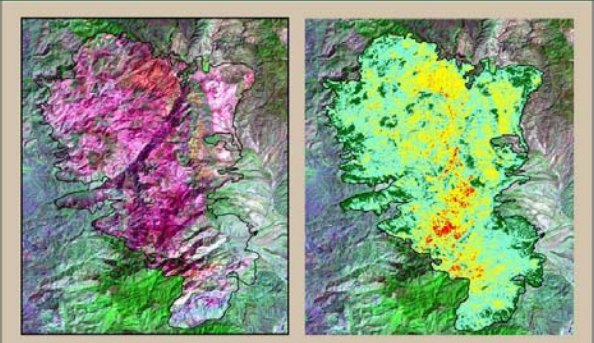
Project Timeline

The timeline below illustrates the expected progression of processing events over the life cycle of the project. Reporting milestones are indicated in red, which also coincides with estimated availability of associated geospatial data.



http://www.mtbs.gov

Monitoring Trends in Burn Severity: Report on the 2004 Mapped Fires



Acreage of Burn Severity—Willow Fire, AZ

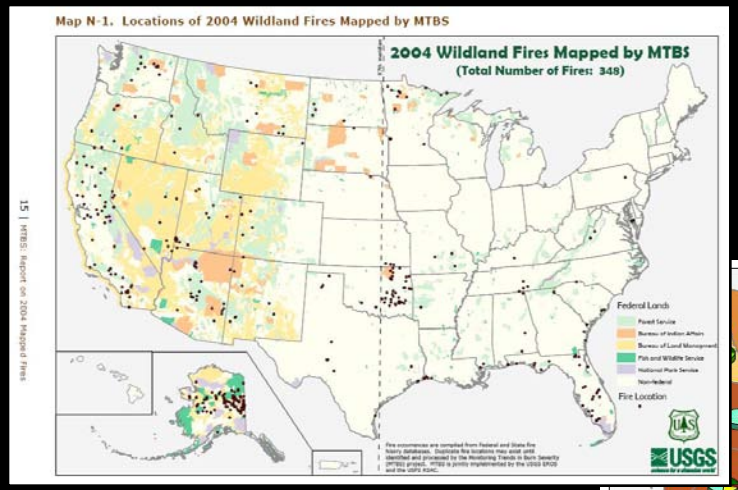
Burn Severity	Acres
Unburned to Low	20,691
Low	61,455
Moderate	33,993
High	2,297
Increased Greenness	51
Non-Processing Area Mask	0
Total	**118,487**

MTBS Home Page: http://svinetfc4.fs.fed.us/mtbs/

2004 Burn Areas Reported in 2007

- 7,781,049 acres (CONUS, AK, HI)
- 1,188,428 acres (CONUS)
- 6,592,621 acres (AK)

348 Fires



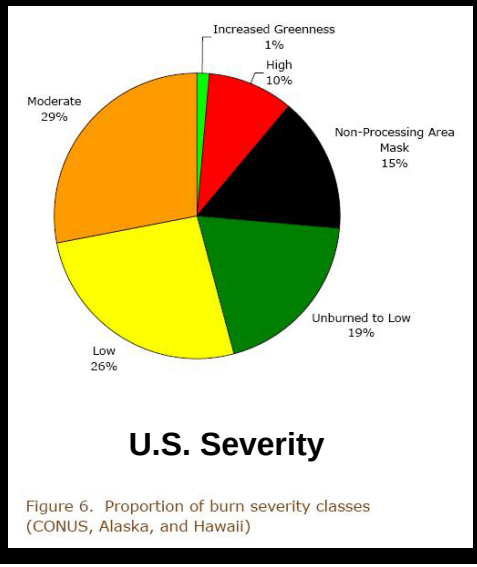


Figure 6. Proportion of burn severity classes (CONUS, Alaska, and Hawaii)

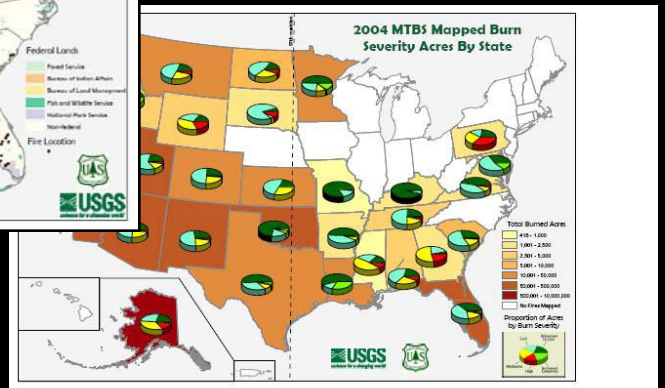


Figure 12. Total burned acres and proportion of acres by burn severity for each state where MTBS fires were mapped. Darker colors indicate a higher number of acres burned. Refer to appendix C of this report for exact burned acreage figures for each state.

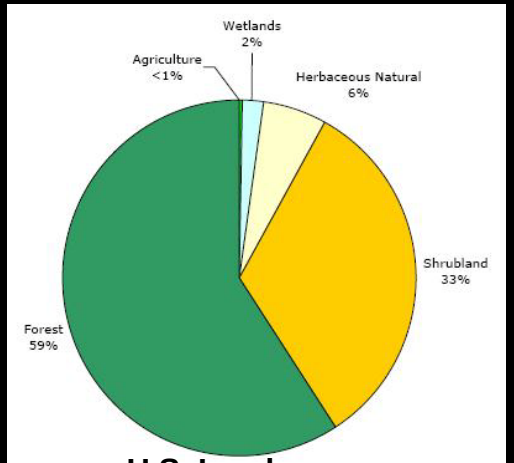


Figure 9. Proportion of vegetated land cover with mapped burn severity (CONUS, Alaska, and Hawaii)

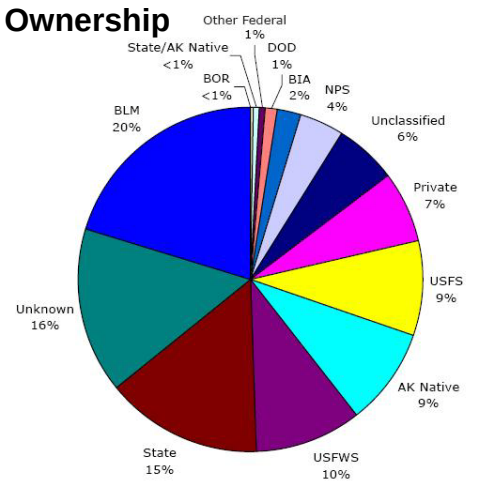
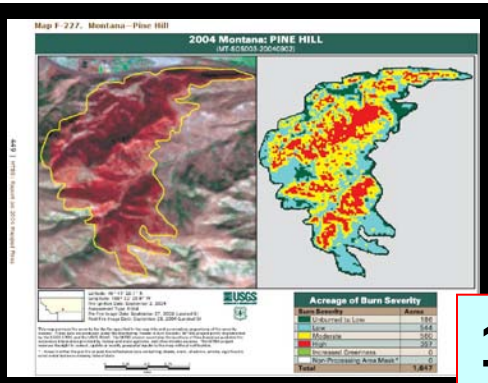


Figure 8. Proportion of mapped acres by Government ownership (CONUS, Alaska, and Hawaii)



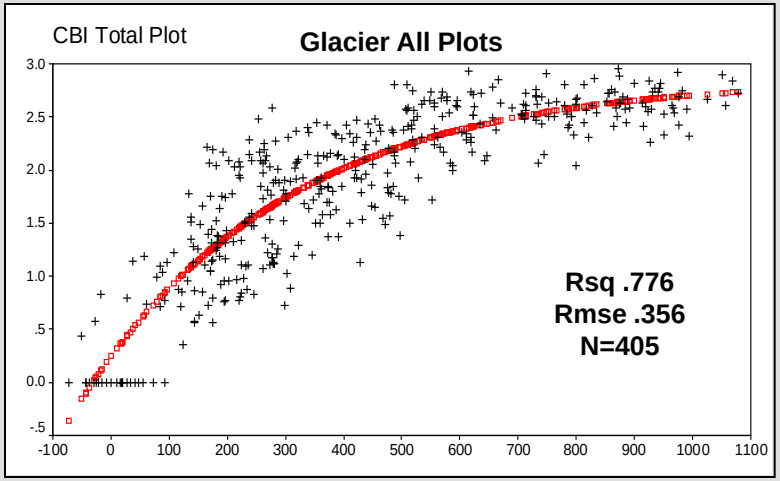
How can we estimate severity on the ground in a context complementary to the magnitude of change detected by 30-m dNBR?
Led to defining severity by the Composite Burn Index.

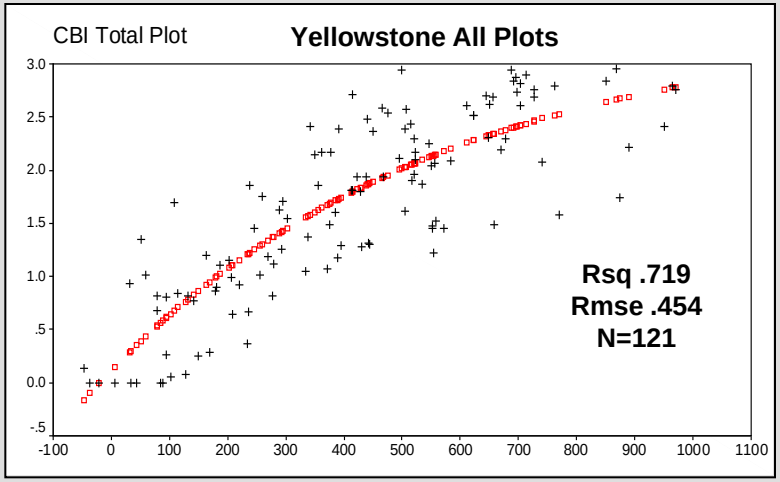
Yellowstone

Current research centers on the remote sensing methodology and data provided by MTBS and NPS-USGS programs, in combination with field data supplied by CBI through various collaborations.

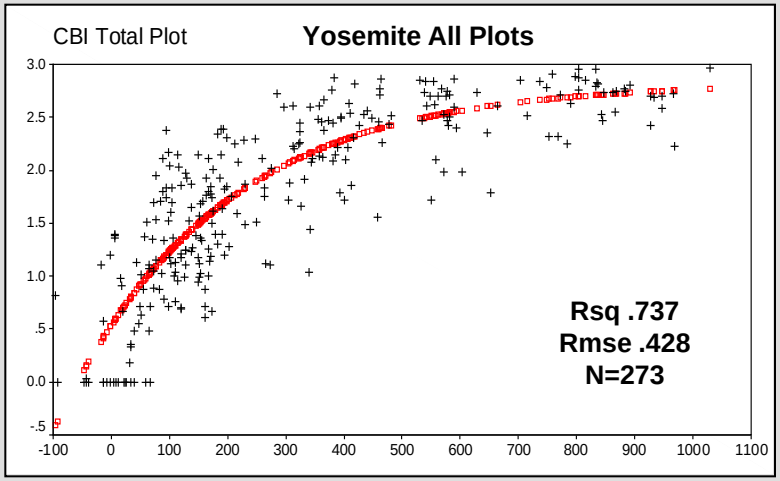
BURN STUDY EFFORT by REGION

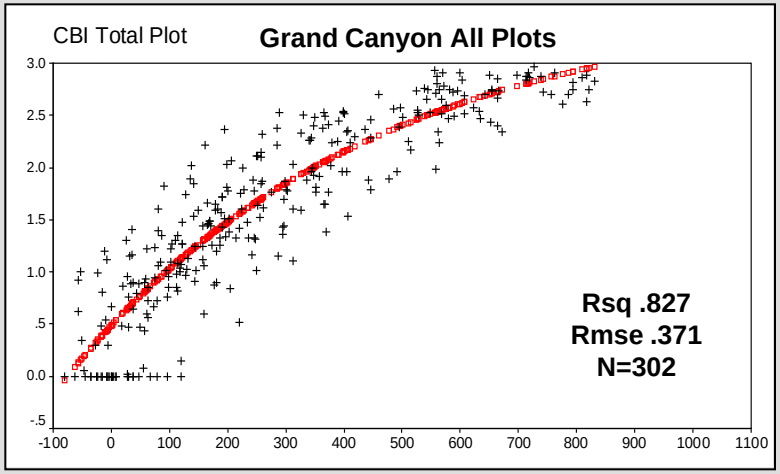
Region	State	Land Management Unit	N Fires	EA diff pairs	IA diff pairs	EA Plots	IA Plots
Alaska	AK	Alaska BLM	1	1		48	
	AK	Denali National Park & Preserve	4	3	1	84	24
	AK	Noatak National Preserve	2	1	1	19	18
	AK	Yukon Charley Rivers National Preserve	3		2		111
		Regional Total	***10***	***5***	***4***	***151***	***153***
California Other	CA	Sequoia & Inyo National Forests	1	1	1	38	38
	CA	Sequoia & Kings Canyon National Parks	4	2		64	
	CA	Whiskeytown National Recreation Area	1	1		32	
California Yosemite	CA	Yosemite National Park	7	6	2	273	118
		Regional Total	***13***	***10***	***3***	***407***	***156***
Rockies Glacier	MT	Glacier N. P. / Flathead N. F.	11	13	5	405	284
Rockies Tetons	WY	Bridger-Teton N. F. / Grand Teton N. P.	13	8	2	464	152
Rockies Yellowstone	WY	Yellowstone National Park	7	2		121	
		Regional Total	***31***	***23***	***7***	***990***	***436***
Southwest Other	CO	Mesa Verde National Park	2	1	1	29	29
	NM	Santa Fe N. F. / Bandelier N. Monument	2	3	2	22	19
	UT	Dixie National Forest	2	4	1	42	41
	UT	Zion National Park	3	2	1	12	7
	UT/CO	Dinosaur National Monument	1	1	1	46	55
Southwest Grand Canyon	AZ	Grand Canyon National Park	5	3	3	302	282
		Regional Total	***15***	***14***	***9***	***453***	***433***
Central	SD	Badlands Natonal Park	1	1	1		51
	SD	Black Hills N. F. / Wind Cave N. P.	2	2		77	
	MN	Voyageurs National Park	1	1		9	
		Regional Total	***4***	***4***	***1***	***86***	***51***
Southeast	AR	Buffalo River National River	1	1	1	14	13
	FL	Big Cypress & Everglades National Parks	2	2	1		
	KY/TN	Big South Fork Natl. River Recreation Area	3	1	1	9	9
	TN	Great Smoky Mountains National Park	1	1	1	35	34
	VA	Shenandoah National Park	3	3	1	46	38
		Regional Total	***10***	***8***	***5***	***104***	***94***
Total	**15**	**32**	**83**	**64**	**29**	**2191**	**1323**





dNBR Extended Assessments





CBI = a * (1 - EXP(b * dNBR + c))

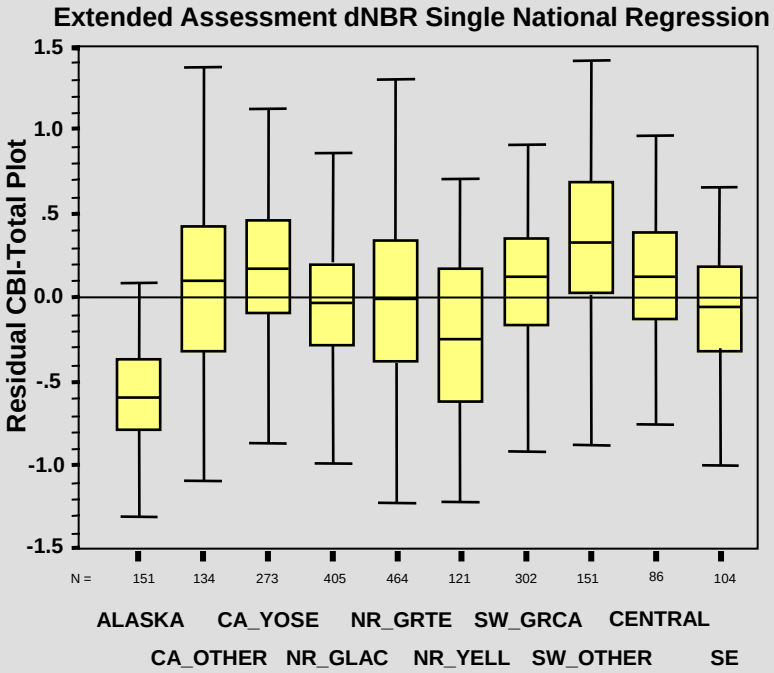
dNBR Regression Coefficients

Region	a	b	c
CA_YOSE	2.820085639	-0.003635073	58.32153553
NR_GLAC	2.861123086	-0.002822371	31.53663351
NR_YELL	3.388069861	-0.001737866	20.05298627
SW_GRCA	3.596310918	-0.001917733	76.07206544

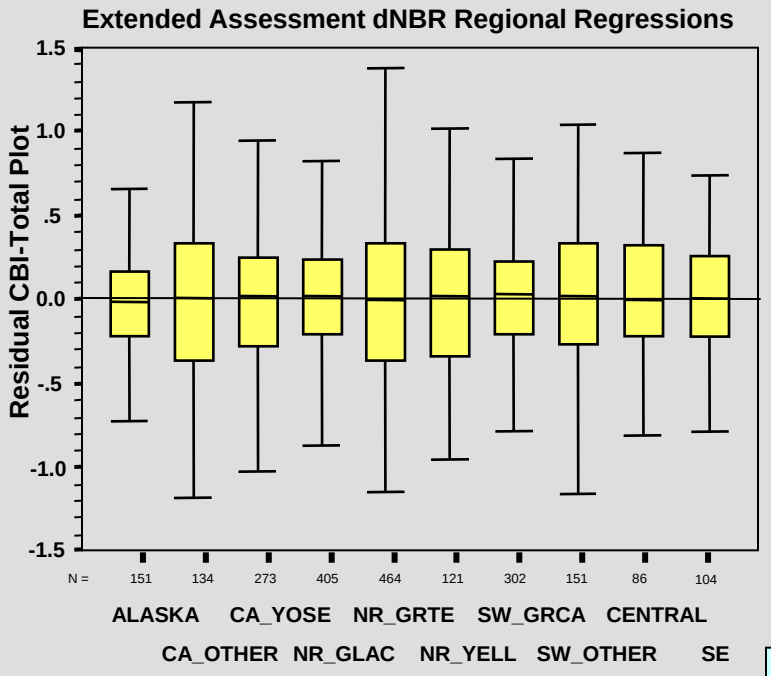
Regression Results for 10 Regions

Extended Assessment, EA						
Region	**N Fires**	**N Plots EA**	**EA dNBR rsq.**	**EA RdNBR rsq.**	**EA dNBR rmse**	**EA RdNBR rmse**
Alaska	6	151	0.813	0.803	0.302	0.310
California Other	6	134	0.614	0.632	0.484	0.472
California Yosemite	7	273	0.737	0.702	0.428	0.455
California Combined	*13*	*407*	*0.690*	*0.675*	*0.454*	*0.465*
Glacier N. P. / Flathead N. F.	11	405	0.776	0.759	0.359	0.372
Bridger-Teton NF/Grand Teton NP	13	464	0.695	0.671	0.517	0.537
Yellowstone National Park	7	121	0.719	0.654	0.454	0.504
North Rockies Combined	*31*	*990*	*0.720*	*0.685*	*0.458*	*0.486*
Southwest Other	9	151	0.727	0.786	0.504	0.446
Southwest Grand Canyon	5	302	0.827	0.810	0.371	0.388
Southwest Combined	*14*	*453*	*0.774*	*0.801*	*0.445*	*0.417*
Central	4	86	0.721	0.740	0.382	0.369
Southeast	8	104	0.782	0.782	0.345	0.345
All Sites Combined	**76**	**2191**	**0.682**	**0.694**	**0.483**	**0.474**
Average of Regions	**76**	**2191**	**0.741**	**0.734**	**0.415**	**0.420**

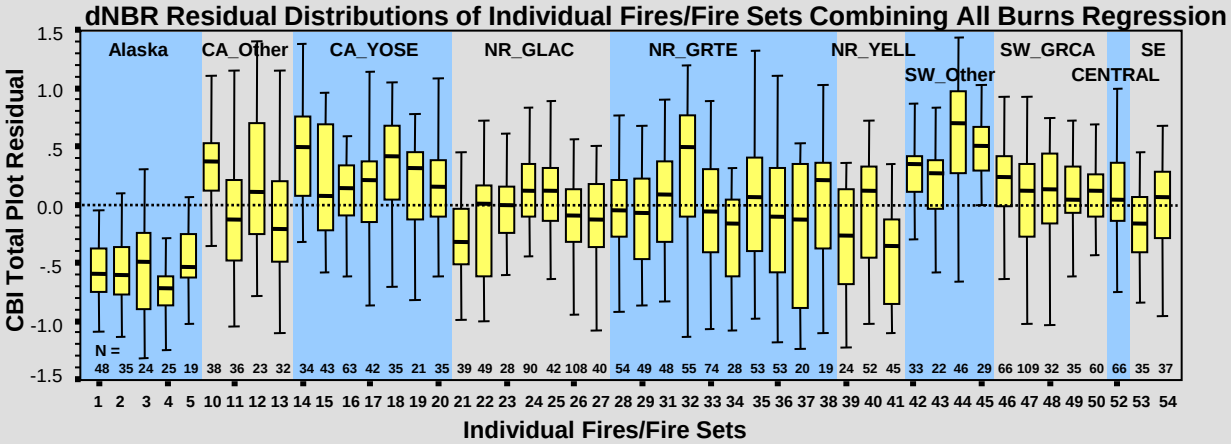
Pooled National Model



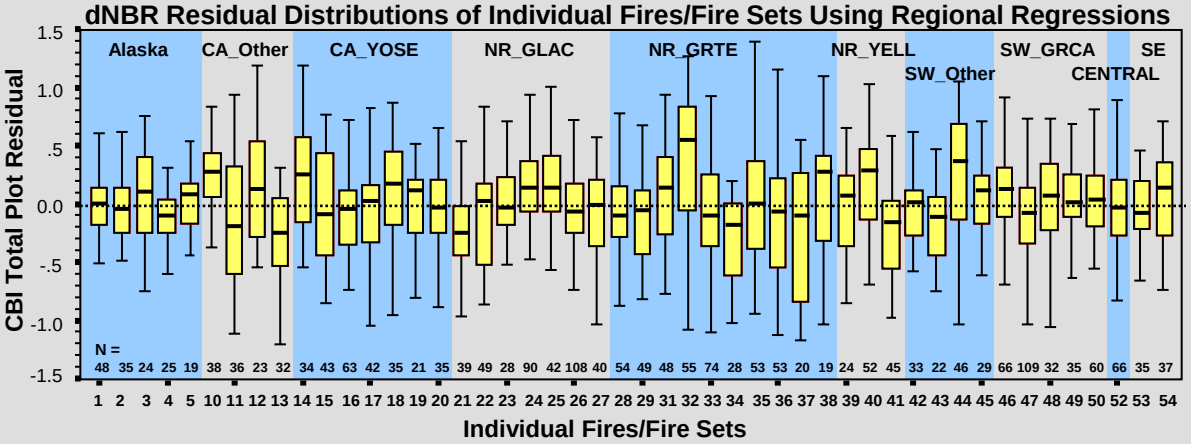
Separate Regional Models



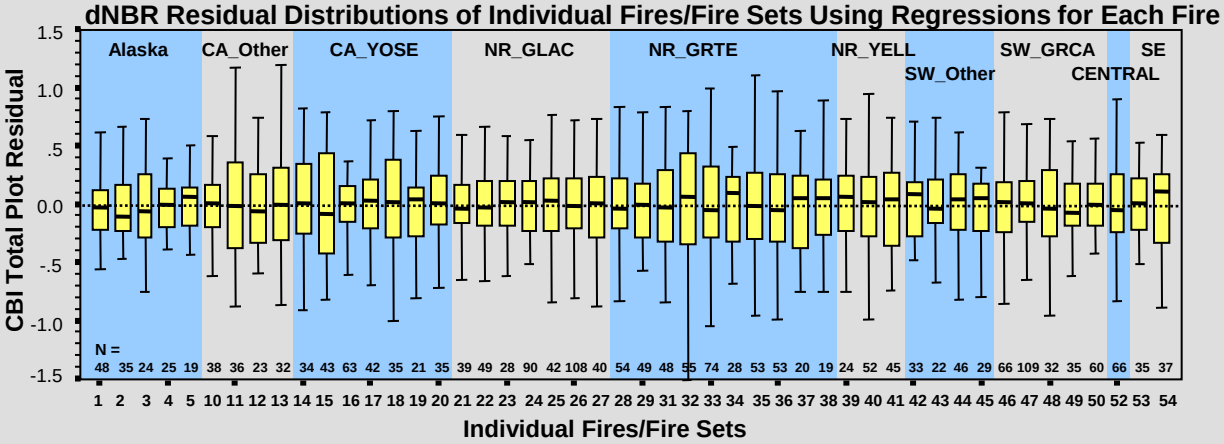
Pooled National Model



Separate Regional Models



Individual Burn Models



2007 Black Cat Burn in 2008 with USFS FIA team.

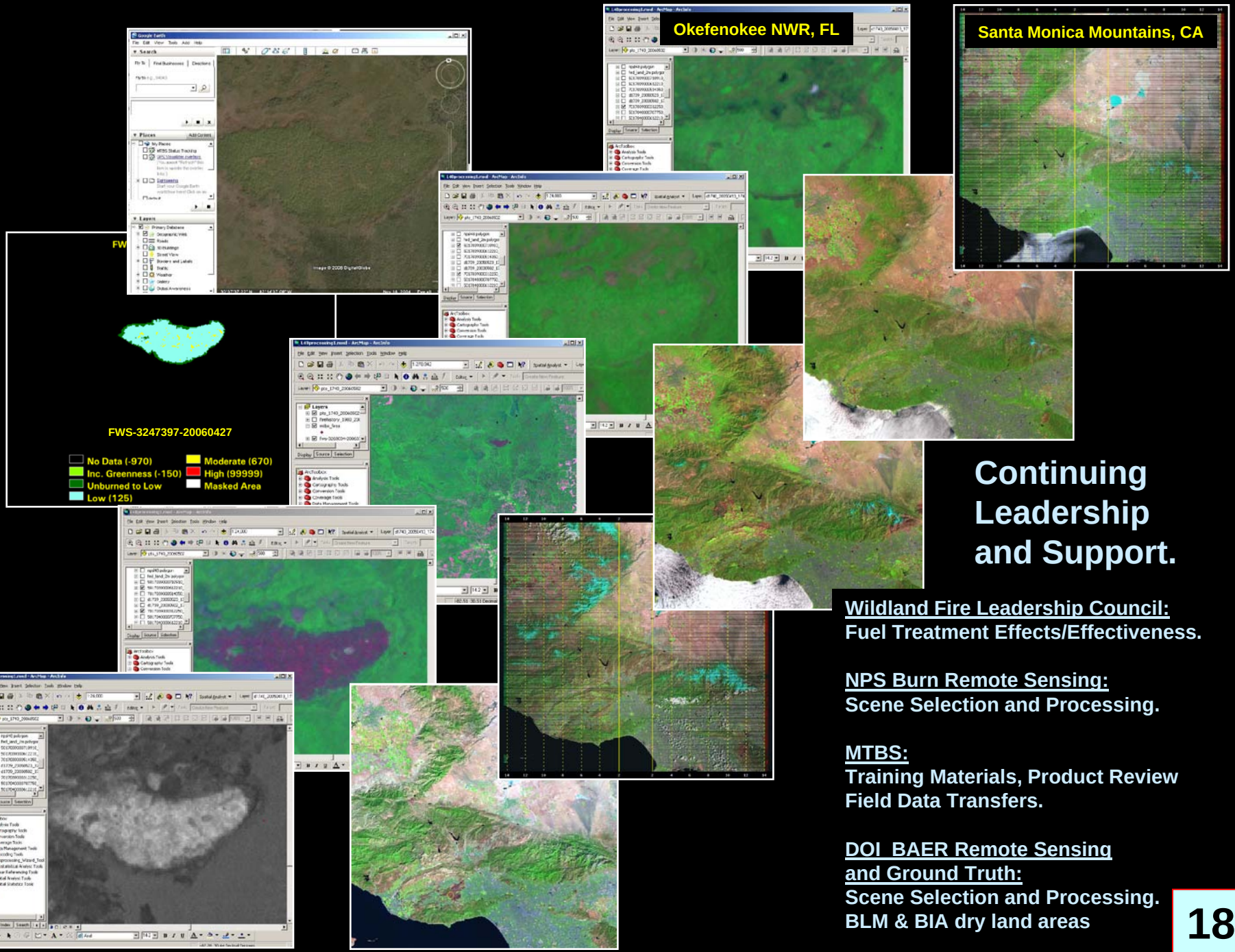
2007 Chippy Creek Burn in 2008 with USFS FIA team.

2008 Training and Field Work.

Montana Workshop/Fieldwork:
USFS FIA Intermountain Team.

Alaska Workshop:
USFWS, NPS, U. of Alaska
EROS and RSAC.

Wyoming Workshop/Fieldwork:
EROS and RSAC.



Continuing Leadership and Support.

Wildland Fire Leadership Council:
Fuel Treatment Effects/Effectiveness.

NPS Burn Remote Sensing:
Scene Selection and Processing.

MTBS:
Training Materials, Product Review
Field Data Transfers.

DOI BAER Remote Sensing and Ground Truth:
Scene Selection and Processing.
BLM & BIA dry land areas

Growth enhancements offset carbon emissions from ecosystem disturbances in California.

Jinxun Liu; James E. Vogelmann; Zhiliang Zhu; Carl H. Key; Benjamin M. Sleeter; David T. Price; Jing M. Chen; Mark A. Cochrane; Jeffery C. Eidenshink; Stephen M. Howard; Norman B. Bliss; Hong Jiang

Submitted to Nature Research Letters.

Calibration and validation of the relative differenced Normalized Burn Ratio (RdNBR) to three measures of fire severity in the Sierra Nevada and Klamath Mountains, California, USA

Jay D. Miller; Eric E. Knapp; Carl H. Key; Carl N. Skinner; Clint J. Isbell; R. M. Creasy; Joseph W. Sherlock

Submitted to Remote Sensing of Environment.

Relationships between the dNBR and CBI indices of burn severity.

Carl Key; Nathan Benson; Zhiliang Zhu; Donald Ohlen; Stephen Howard

In preparation for International Journal of Wildland Fire, or Remote Sensing of Environment.

The End