Evaluate Sensitivities of Burn Severity Mapping Algorithms for Different Ecosystems and Fire Histories in the United States

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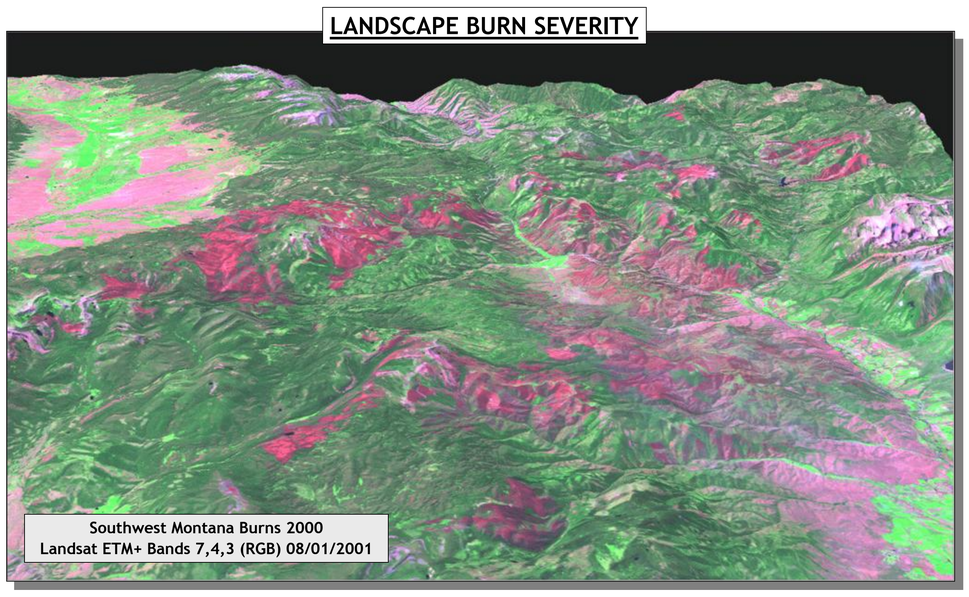
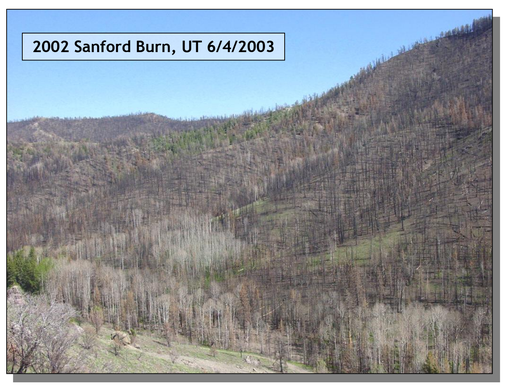
Goals refer to whole-burn landscape perspectives at 30-m resolution:

1. Understand remote sensing constraints and sensitivities in different ecosystems.
2. Refine field measures of burn severity, understand relationships to remote sensing.
3. Further National Implementation of high quality, consistent geospatial burn data.

LANDSCAPE BURN SEVERITY





Introduction

This project was funded under JFSP 2001-1, Task 4 for research to develop, apply, and validate improved remote sensing applications to quantify fire effects such as fire distribution and severity, where approaches must be validated by, and linked to, ground measurements. The research seeks to conduct a broad evaluation of the differenced Normalized Burn Ratio (dNBR), a burn-area mapping algorithm, and the Composite Burn Index (CBI), a field validation method, to ensure sound scientific methods for operational and standardized burn-area mapping that supports land management and scientific investigation. Key to this research has been the cooperation between the National Park Service, the U.S. Geological Survey (USGS) Biological Resources Discipline, and the USGS National Center for Earth Resources Observation and Science (EROS).

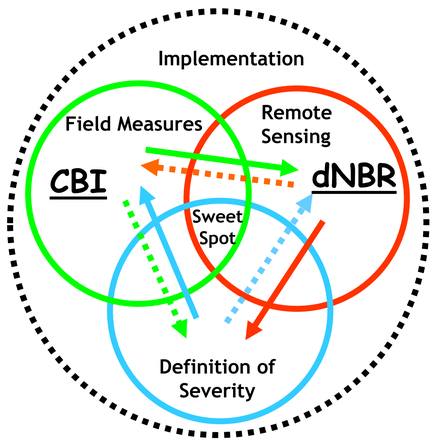
Burn Severity Niche

1) Landscape Perspective.
   a) Meso-Scale, 30-meter
   b) Large Burns and Burned Regions
   c) Remote-Difficult Terrain
   d) Makeup, Pattern, Heterogeneity

2) Severity As An Index of Ecological Change.
   a) Averaged Over An Area
   a) Aggregated Over The Ecological Effects
   c) Based On Multiple Strata of Substrates, Downed Fuels, and Vegetation

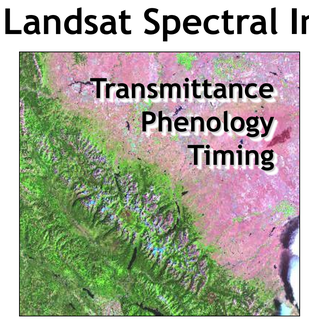
3) Emphasis on Extended Assessment.
   a) Final Picture of Burn and 1st-order Effects
   b) Survivorship & Delayed Mortality Included
   c) Try To Optimize Remote Sensing Conditions
   d) Improve on Rapid & Initial Assessments

4) National Standard Implementation.
   a) Comparable Spatial and Temporal Data
   b) Simple and Cost Effective
   c) Within existing capabilities and facilities
   d) User Accessible, Web-based

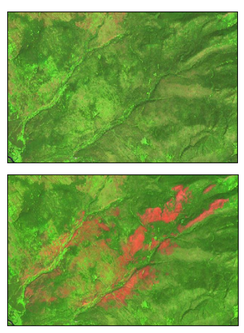


Methods

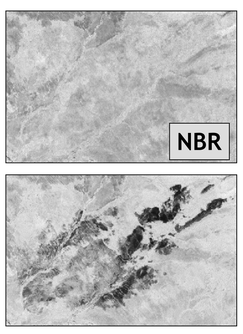
Landsat Spectral Indices:



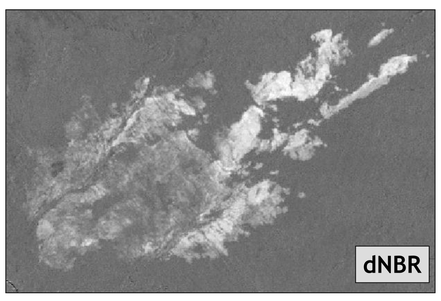
Controlled Scene Selection → Pre Fire / Post Fire → Level 1 Terrain Correction → Reflectance Conversion



Pre & Post Indices →



Pre-Post Difference →



Indices

Normalized Burn Ratio (NBR)
differenced or delta NBR (dNBR)
Normalized Difference Vegetation Index (NDVI)
differenced or delta NDVI (dNDVI)

$NBR = R_4 - R_7 / R_4 + R_7$

$NDVI = R_3 - R_4 / R_3 + R_4$

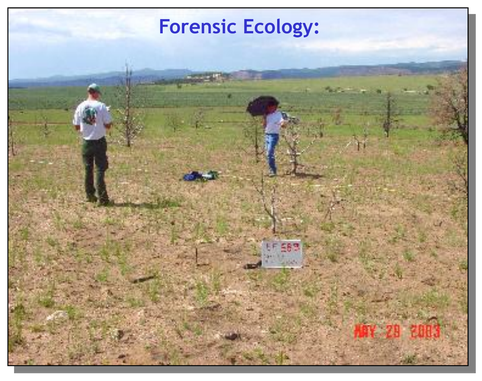
Initial Assessment (IA)
0-8 weeks after fire.

Extended Assessment (EA)
2-12 months after fire.

Composite Burn Index (CBI): To estimate site severity in the field, a collective rating of responses over a 30-m diameter plot to relate to Landsat data.

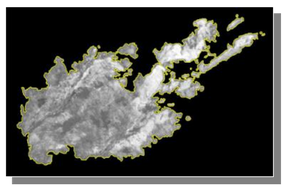
(5 factors Substrates) + (4 factors Vegetation < 1 m) + (4 factors Vegetation 1 to 5 m) = Understory CBI
(5 factors Intermediate Trees) + (5 factors Big Trees) = Overstory CBI
} Whole Plot CBI

Sampling Strategy: Random stratified by hiking time, safety, local homogeneity, available range of severity.

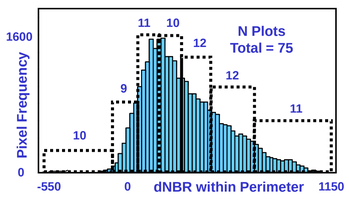


Derivatives:

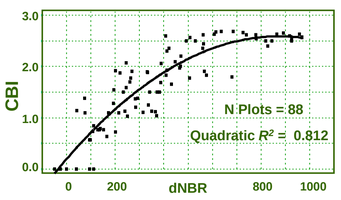
Perimeters



Within-burn Histograms



Regression Coefficients

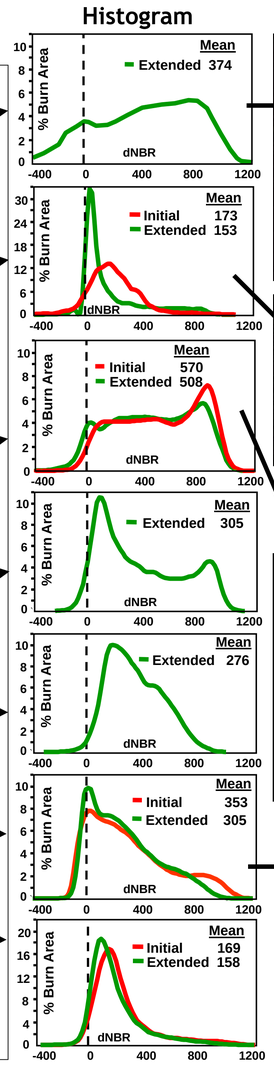
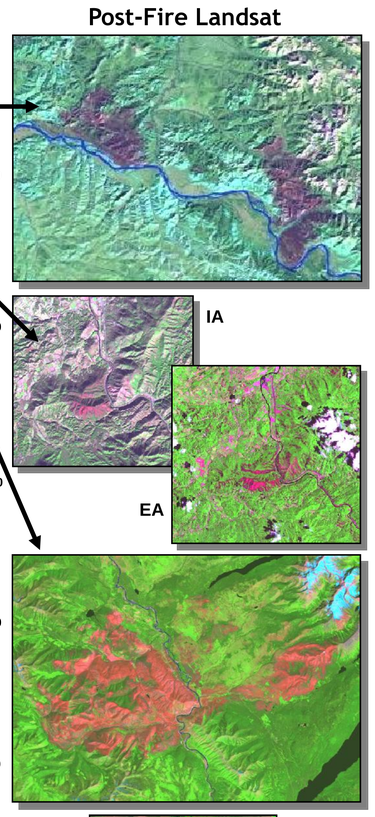
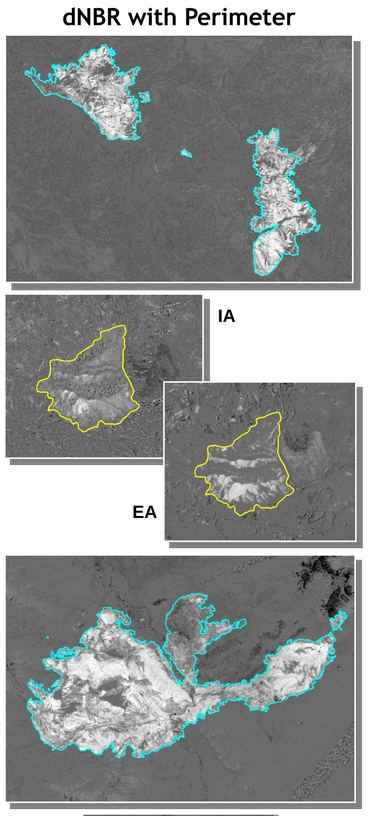
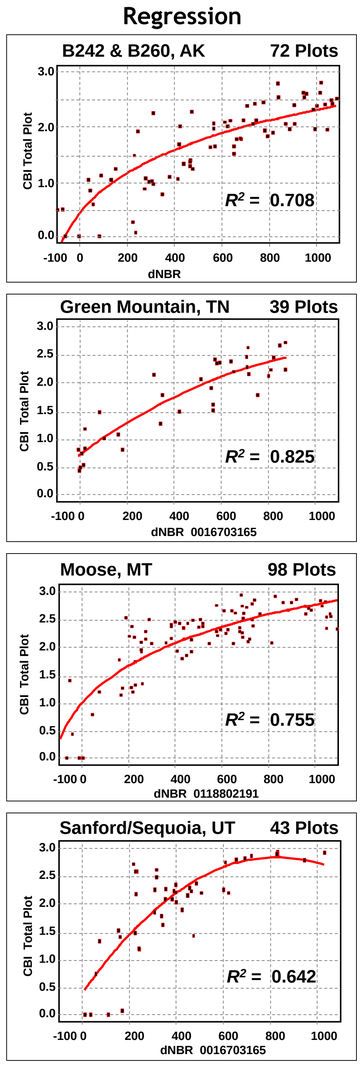


Results

- 71 dNBR datasets covering 82 Fires.
- 2606 CBI Plots collected from 64 Field Projects.
- 21 cases with both Initial and Extended Assessments.
- About 140 Landsat TM/ETM+ scenes processed.

Note: Multiple fires occur on some dNBR, and multiple dNBR are used for some fires.

Completed Evaluations (Arrayed Geographically)

Fire Year	N Fires	Burned Acres	CBI Plots	dNBR datasets	Fire Names (Locale)
1999	3	115000	119	EA	B242 Witch/B248 Beverly/B260 Jessica (*Yukon-Charlie*)
2000	3	34780	59	EA	Foraker/Otter Creek/Chitsia (*Denali*)
2001	1	6260	25	IA-EA	Herron River (*Denali*)
2002	1	21530	53	EA	Milepost85 (*BLM Alaska*)
2002	2	13986	40	EA	Cottonwood Bar/Uyon Lakes (*Noatak*)
2000	1	16120	11	EA	Shenandoah Complex (*Shenandoah*)
2002	2	5750	39	IA-EA(2)	Fultz Run/Rocky Top (*Shenandoah*)
2001	1	2360	39	IA-EA	Green Mountain (*Great Smoky Mountains*)
2004	1	10750	14	IA-EA	Lower Wilderness (*Buffalo River*)
2000	3	5430	9	IA-EA	Schoolhouse/Camp Branch/Darrow Ridge (*Big South Fork*)
2001	1	25000	12	EA	Bear Island (Big Cyprus)
2004	1	1500	9	EA	Section 33 (*Voyageurs*)
2000	2	83120	85	EA	Jasper/Highland (*Wind/Jewel Caves/Black Hills NF*)
2001	1	3710	54	IA-EA	West Sage (*Badlands*)
1994	2	16993	88	EA(2)	Adair/Starvation (*Glacier*)
1998	1	7311	4	EA	Challenge (*Glacier*)
1999	1	9657	29	EA	Anaconda (*Glacier*)
2000	1	380	5	EA	Sharon (*Glacier*)
2001	1	66686	98	IA-EA	Moose (*Glacier*)
2003	5	161443	273	IA-EA(2-3)	Robert/Wedge/Middle Fork/Rampage/Trapper (*Glacier*)
2000	2	1470	25	EA	Moose/Boundary (*Yellowstone*)
2001	5	6840	103	EA	Falcon, Arthur, Little, Little Joe, Stone (*Yellowstone*)
2000	2	7313	100	EA	Enos/Upper Slide (*Bridger Teton NF*)
2000	3	14853	135	EA	Blind Trail/ Boulder/ Glade (*Grand Teton*)
2001	1	3790	54	EA	Green Knoll (*Bridger Teton NF*)
2002	3	1780	24	EA	Wolff Ridge/Elbo/Kelly (*Grand Teton*)
2002	2	5980	107	IA-EA	Mule/Divide (*Bridger Teton NF*)
2003	2	5860	107	IA-EA	Blacktail/East Table (*Grand Teton*)
2000	2	65882	23	IA-EA(2)	Cerro Grande/Viveash (*Bandelier/Santa Fe NF*)
2000	1	11870	68	EA	Outlet (*Grand Canyon*)
2001	3	11040	128	IA-EA	Vista/Tower/Swamp Ridge (*Grand Canyon*)
2003	1	7400	109	IA-EA	Poplar Complex (*Grand Canyon*)
2000	2	27140	31	IA-EA	Bircher/Pony (*Mesa Verde*)
2001	1	680	5	EA	Langston (*Zion*)
2002	2	8436	18	IA-EA	Blue Creek/Sequoia (*Zion*)
2002	1	81161	33	IA-EA	Sanford (*Dixie NF*)
2002	1	4600	55	IA-EA	Bear (*Dinosaur*)
2003	1	365	2	EA	Timber Top (*Zion*)
2001	1	670	32	EA	Sunshine (*Whiskeytown*)
1999	2	2679	79	EA	Dark/Lost (*Yosemite*)
2001	1	7230	63	IA-EA	Hoover (*Yosemite*)
2002	2	3360	79	EA	PW-3/Wolf (*Yosemite*)
2003	2	4715	57	IA-EA	Tuolumne/Whiskey (*Yosemite*)
2002	4	2710	66	EA	Highway/Tar/Palisades/Sherman (*Sequoia/Kings Canyon*)
2002	1	145300	38	IA-EA	McNally (*Inyo/Sequoia NF*)
Totals	82	1040890	2606	21 IA + 50 EA	

Histogram | Post-Fire Landsat | dNBR with Perimeter | Plot Photo | Regression