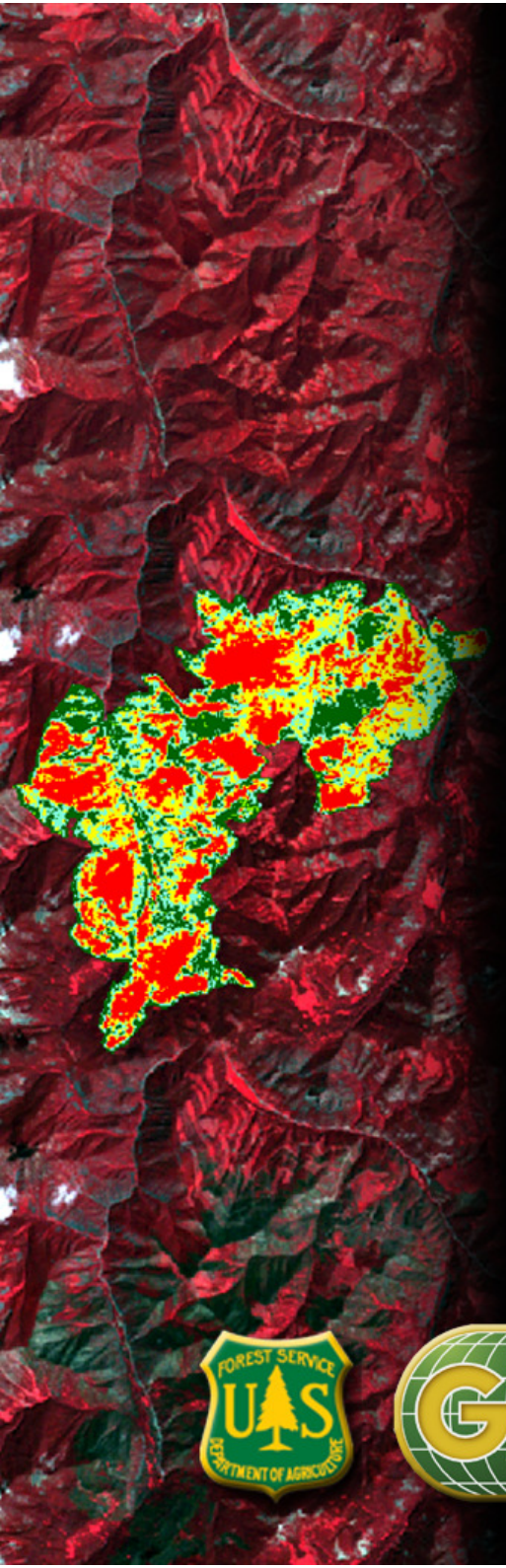


Systematic Mapping of the Location, Extent and Severity of Fires in The United States

MTBS - The Monitoring Trends in Burn Severity Project

FOREST SERVICE U.S. DEPARTMENT OF AGRICULTURE

GMO

RSAC

USGS science for a changing world

MTBS Monitoring Trends in Burn Severity

MTBS Project Background (1/2)

- Consistently map the location, extent and burn severity of large fires on all lands in the United States from 1984 and 2010
  - > 1,000 acres in the western United States
  - > 500 acres in the eastern United States
- Initiated in FY 2006
- Sponsored by the interagency Wildland Fire Leadership Council (WFLC)
  - One element of a strategy monitoring the effectiveness of NFP and HFRA
  - Provide an information base to synoptically assess environmental impacts and trends
  - Required for all lands in CONUS, AK, HI and PR

MTBS Project Background (2/2)

- GAO recommendation that land management agencies develop and implement comprehensive burn severity assessments
  - Provide consistent and comprehensive data characterizing wildfire effects to land managers and the scientific community
- Jointly implemented by USFS RSAC and USGS EROS
  - Equal funding from USDA-FS and DOI

MTBS and Burn Severity

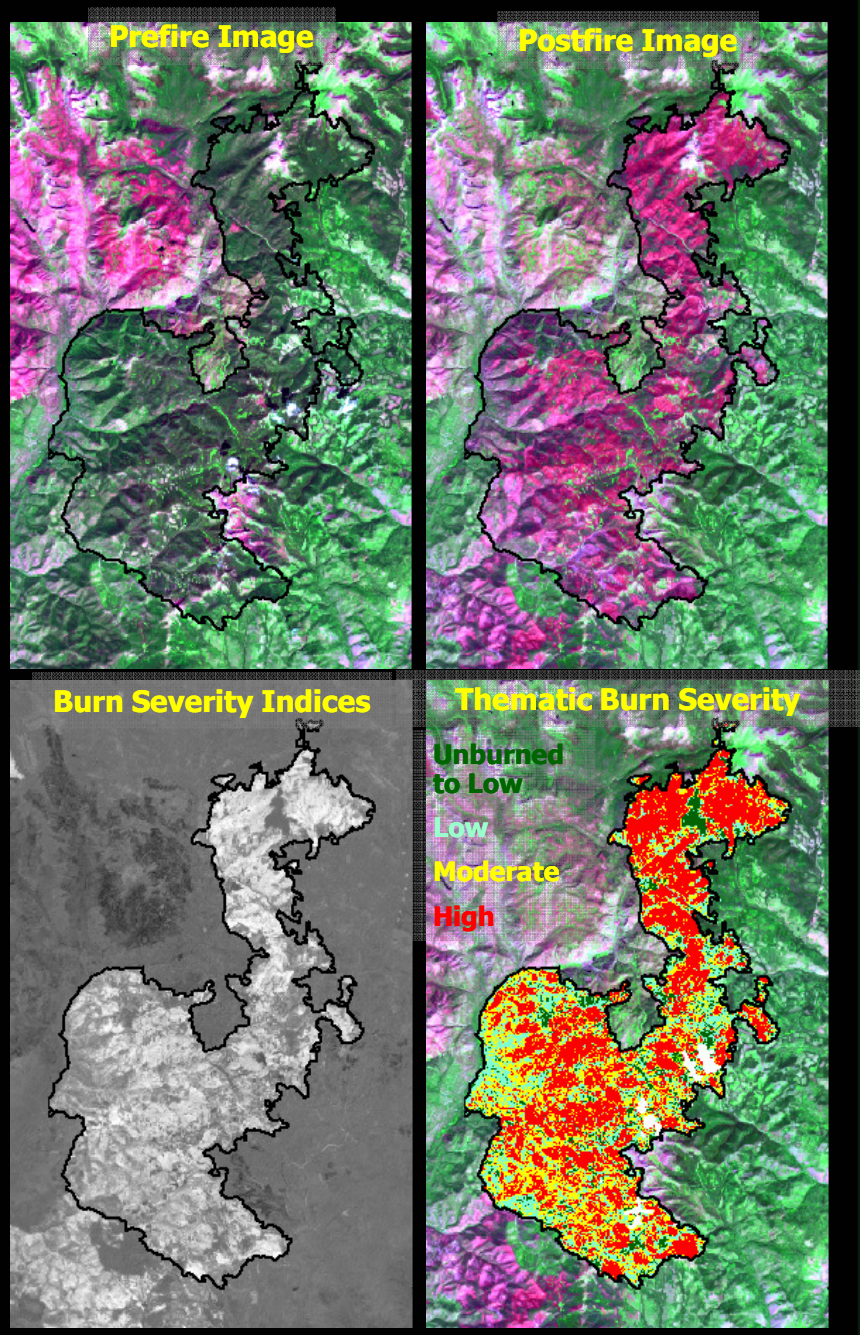
Burn Severity:

- …relates to detectable changes in living and non-living biomass, fire by-products (ash) and soil exposure
- …is a composite of first order effects and second order effects that arise within one growing season
- …occurs on a gradient or ordinal scale
- ..is a mosaic of effects that occur within a fire area
- ..is "mappable" using remote sensing and change detection methods

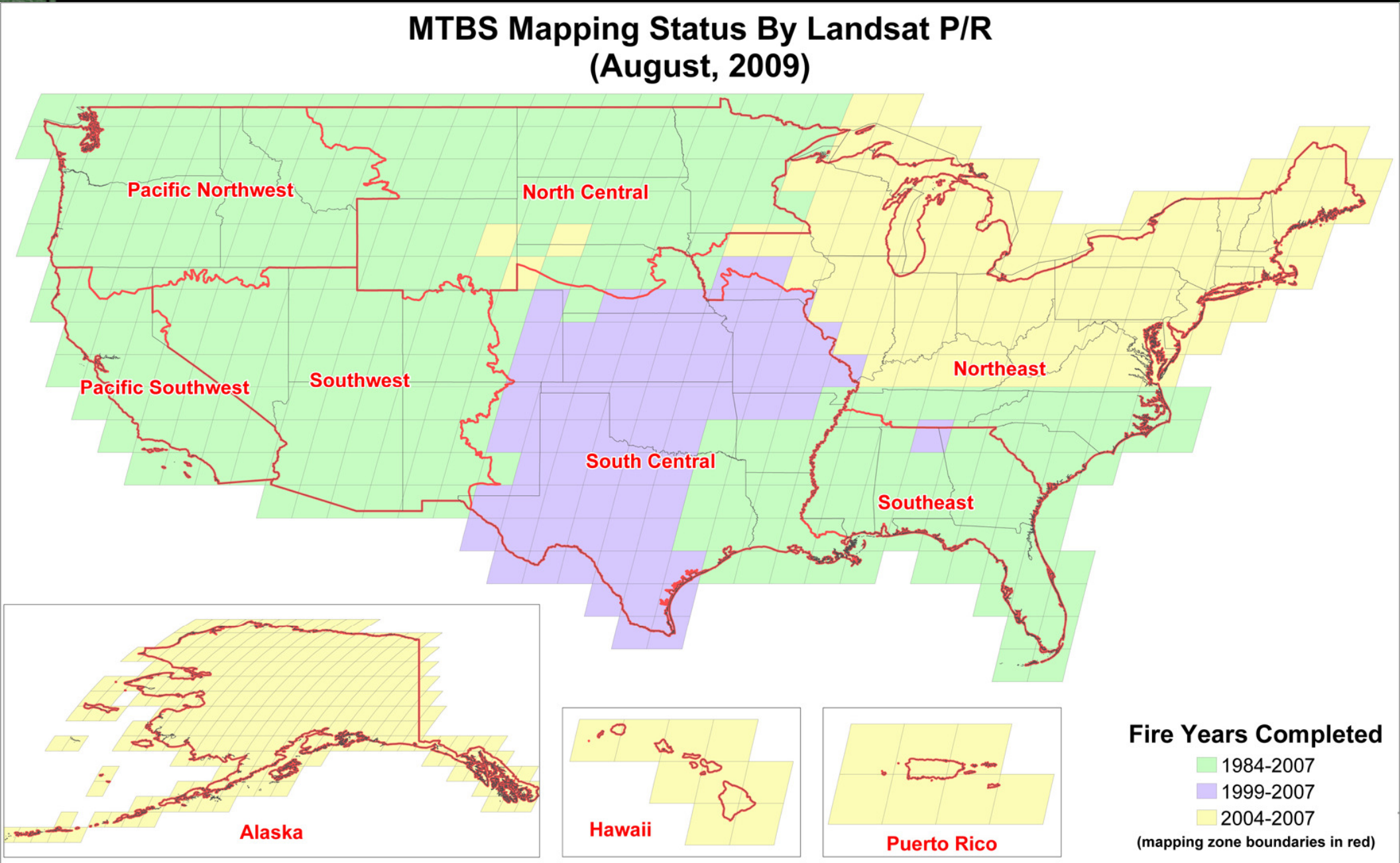
MTBS Geospatial Products

Fire Level Datasets

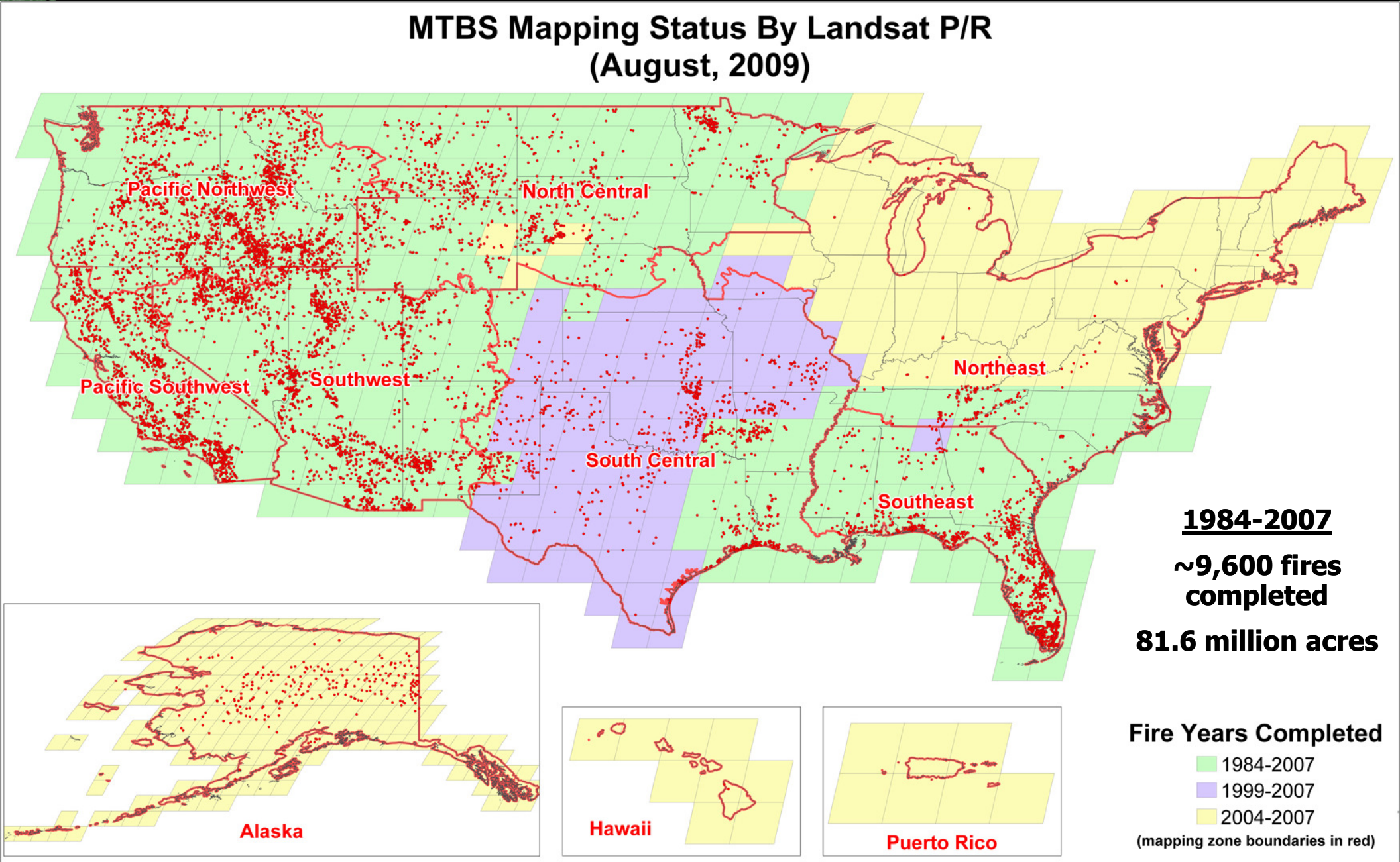
- Available at http://www.mtbs.gov/dataaccess.html
- Pre/Post-fire Landsat imagery
  - Bands 1-5, 7
- Burn scar boundary
  - Vector delineation of burned area extent based on image analysis
- Continuous burn severity indices
  - dNBR/RdNBR
- Thematic burn severity data
  - 6 classes (unburned to low, low, moderate, high, increased vegetation response, non-mappable areas)
- Metadata
- Expanded Landsat MRLC archive
  - 10,000+ scenes
  - Thousands more scenes to be added
  - See http://glovis.usgs.gov



MTBS Production Status



MTBS Production Status



MTBS Methods

Burn scar and burn severity products are based on Landsat TM/ETM data and the differenced Normalized Burn Ratio (dNBR) approach

NBR = (NIR – Mid IR) / (NIR + Mid IR)
dNBR = pre NBR – post NBR

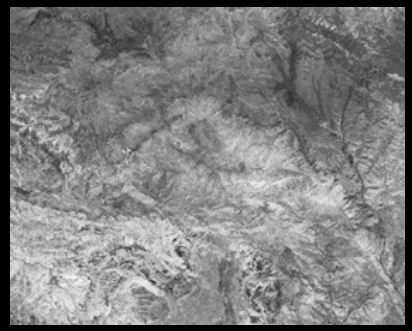
- Mature science established in the literature
  - Lopez-Garcia and Caselles, 1991; Brewer et al., 2005; Cocke et al., 2005; others
- Operational precedent
  - Implemented by Key and Benson for development of NPS fire atlases
  - USFS/DOI BAER Programs
- Landsat TM/ETM data record
  - Consistent data record spanning ecologically and possibly climatically significant time frame
- Resolution synergy
  - Spatial and spectral resolutions comparable to other national scale data

MTBS Fire Mapping Methods Overview

- Compile a single MTBS fire occurrence database (FOD) from existing data sources
- Based on FOD and prescribed assessment strategy, select pre and post-fire Landsat scenes
- Landsat TM/ETM+ data ordered and acquired from EROS
- Analysts perform necessary image pre-processing, image differencing, burned scar delineation and threshold dNBR images into burn severity classes
- Metadata, map products, burn severity data analysis and summary, and reporting

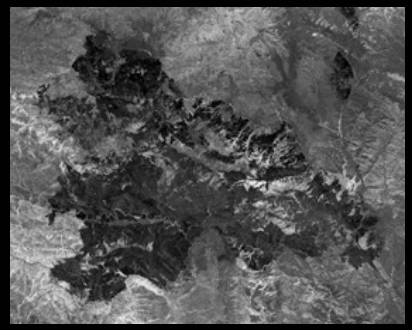
Landsat **NBR**

Pre-fire

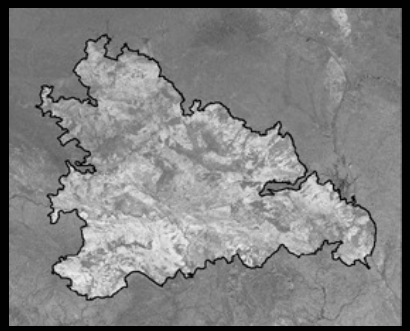


Difference

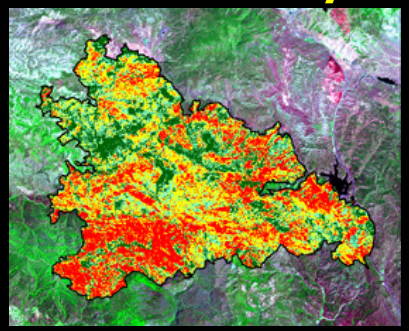
Post-fire



dNBR



Burn Severity



Normalized Burn Ratio (NBR)

NBR = (NIR – SWIR) / (NIR + SWIR)

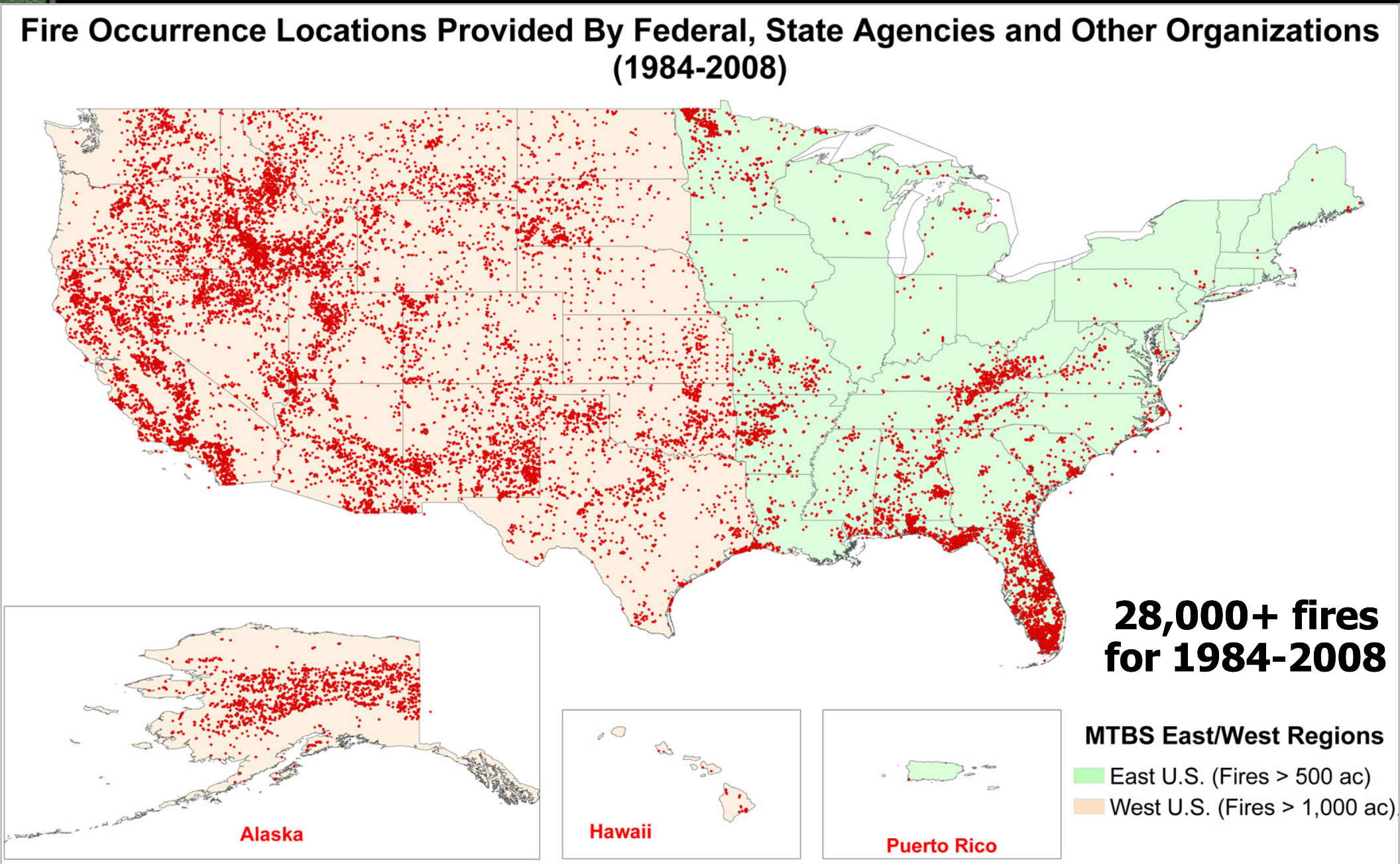
Differenced Normalized Burn Ratio (dNBR)

dNBR = Pre NBR – Post NBR

MTBS Methods- Source Fire Occurrence Data

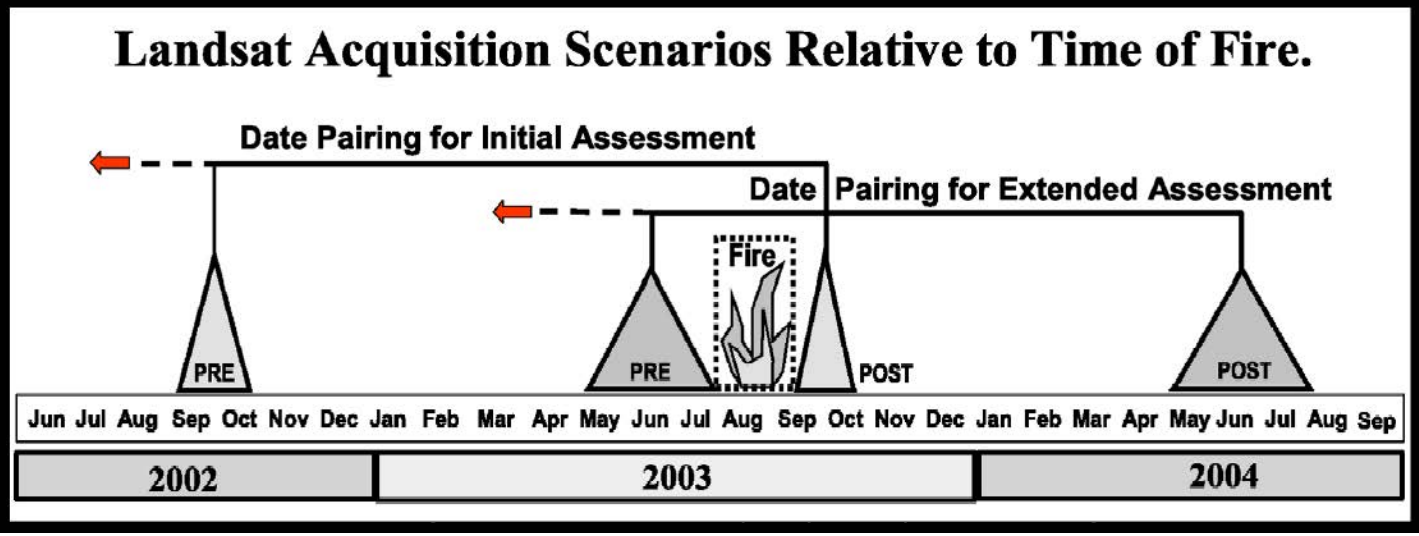
- Compile from existing fire occurrence databases
  - Federal fire history database
    - Compiled from ICS209 database
  - Most state fire databases
  - Other related databases (NASF, NFPORS, etc)
- 28,000+ MTBS fire records for years 1984 - 2008
  - Numerous duplicates and spatial anomalies
- Standardize to address format and content variability
  - Core fire data harvested (fire name, fire size, database id, ignition date, containment date, out date)
  - Unique MTBS id assigned; links to database of origin
- Discovered fires on Landsat imagery are added to database

MTBS Fire Occurrence Locations



MTBS Methods – Assessment Strategy

- Based on fire type
  - Extended Assessment (EA)
    - Severity based on post-fire assessment at peak of green of next growing season
    - Forests/shrublands
  - Initial Assessment (IA)
    - Severity based on immediate post-fire assessment
    - Grasslands/shrublands
  - "Single Scene" Assessment
    - Lack of suitable pre-fire imagery or other factors; use post-fire NBR
    - Conducted on a limited basis (EAs and IAs)

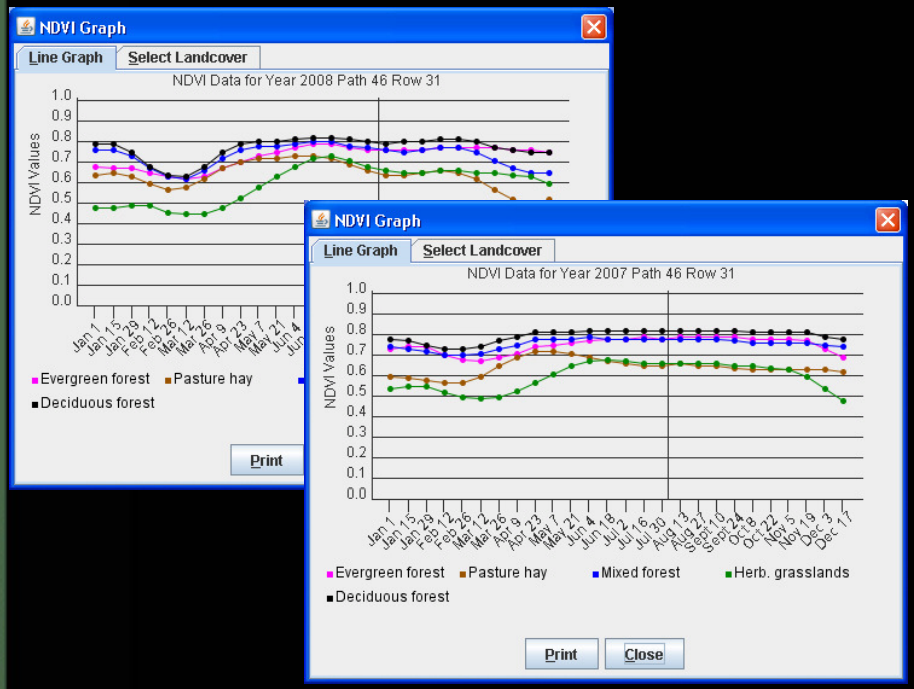


MTBS Methods – Landsat Scene Selection

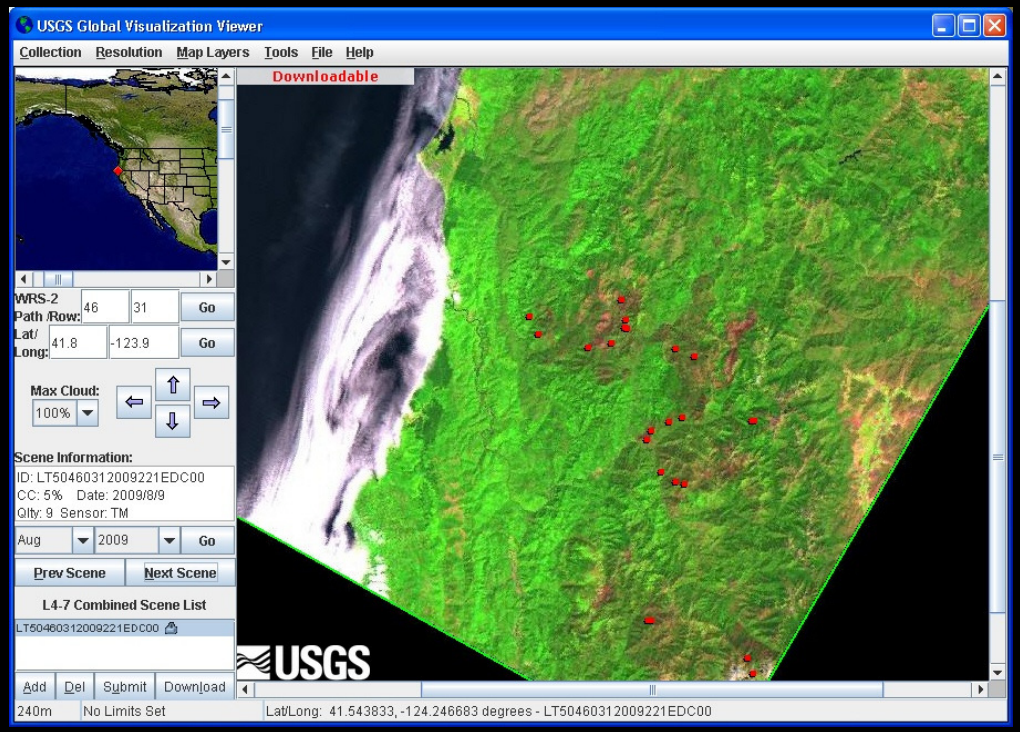
- Scene selection based on assessment strategy
  - Variables: fire location/date, cloud-free availability, and optimal seasonality
- USGS Global Visualization Browser (GloVis)
  - http://glovis.usgs.gov
  - Review browse images for Landsat data record
  - MTBS driven enhancements include:
    - Input and overlay of user supplied shape files
    - Annual NDVI/land cover summary graphs by path/row
- MTBS scene selection tool
  - Database application containing MTBS fire occurrence data and Landsat metadata
  - Select/record fire type, selected scenes, etc.

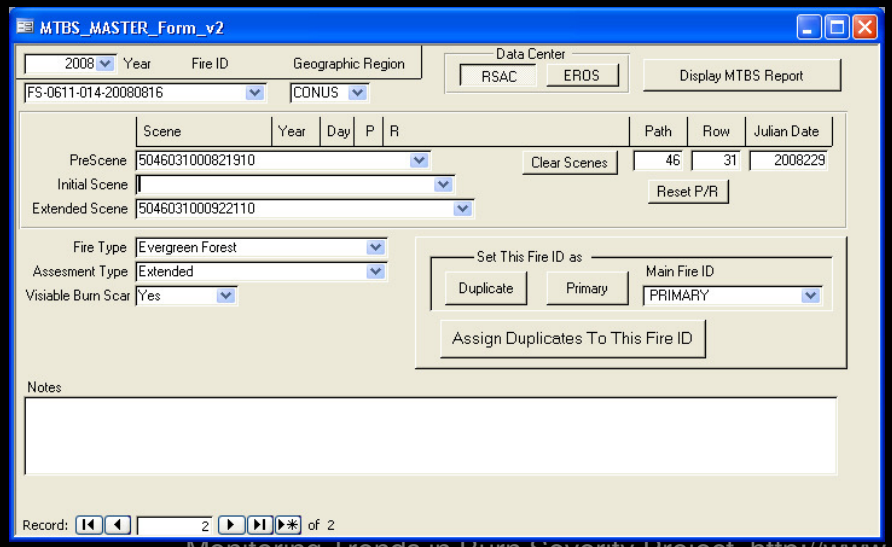
GloVis Scene Selection Process

GloVis NDVI trend summaries by land cover type and P/R



GloVis viewer w/targeted MTBS fire locations





MTBS scene selection tool records selection parameters for each fire

Image orders submitted to EROS through GloVis interface

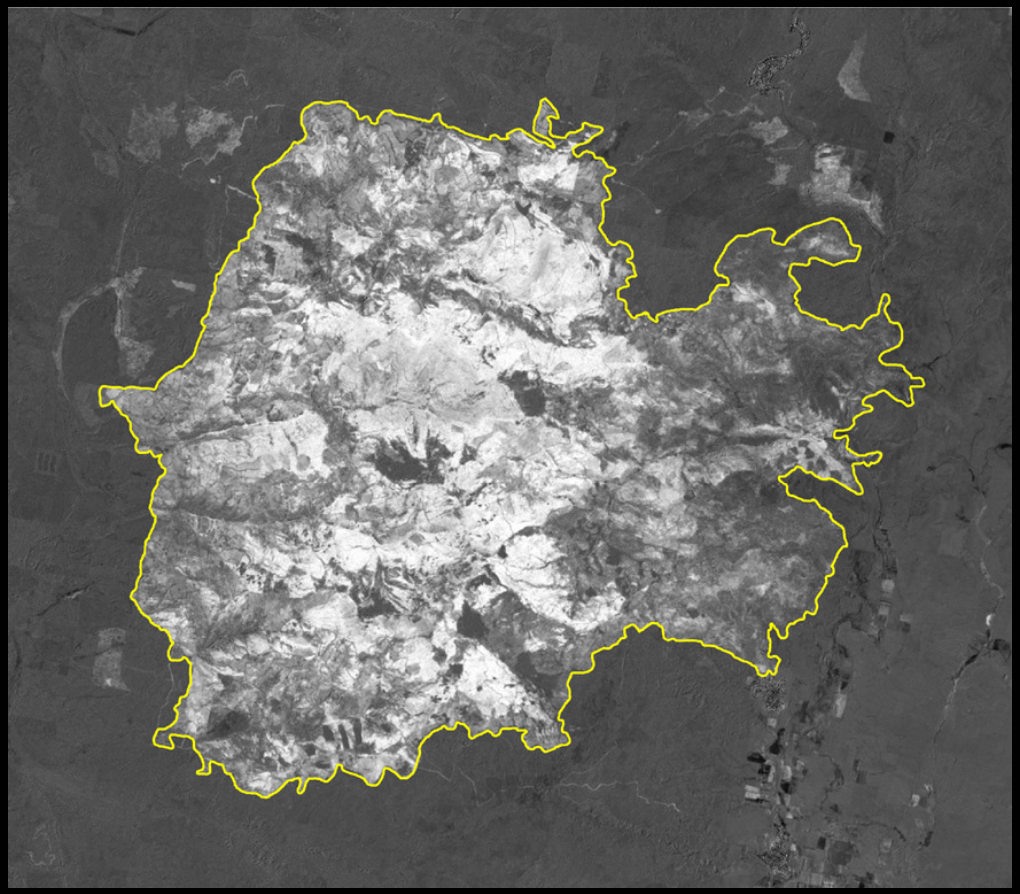
MTBS Methods – Landsat Data Processing

- Data are processed using Level 1 Product Generation System (LPGS) at EROS
  - Level 1T product (terrain corrected)
  - UTM projection
- LPGS images are downloaded and pre-processed to create an "MRLC-like" product
  - Calibrate to At-Satellite reflectance
  - Reproject to Albers Equal Area
  - Derive full scene NBR image
- Prepare Landsat imagery and derivatives used in fire-level mapping
  - Generate full scene dNBR image from NBR pairs
  - Subset pre/post-fire reflectance, dNBR images to extent of fire
  - Generate RdNBR

MTBS Methods – Burn Scar Delineation

- Goal is to utilize a consistent method and data to derive perimeters
- Perimeters digitized using dNBR and reflectance data
- Scale of delineation: 1:24,000 to 1:50,000
- Incident perimeters do not directly affect delineation
- Perimeter confidence levels included as feature level metadata

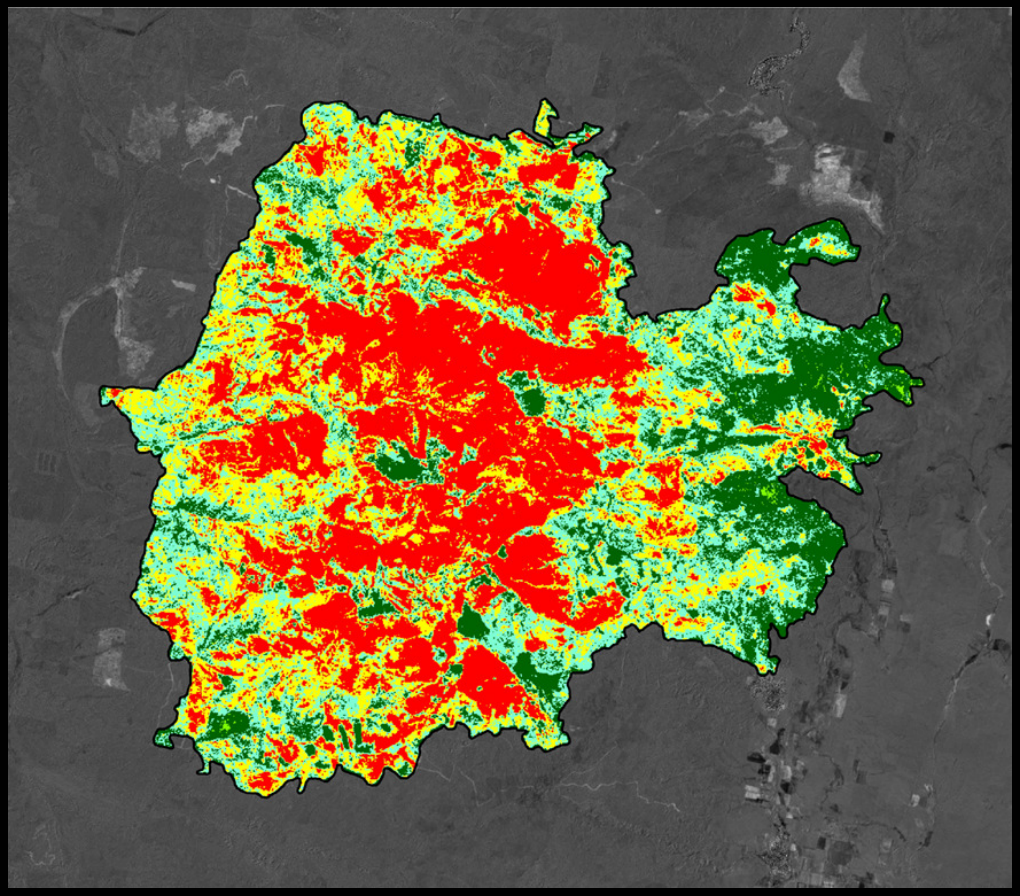
2007 Chippy Creek Fire (western Montana)



MTBS Methods - Burn Severity Mapping

- dNBR images are interpreted to derive 5 severity classes
- Analysts use knowledge of site ecology, and knowledge of fire behavior and effects in given ecological settings, as guidance for choosing severity thresholds
- Composite Burn Index (CBI) thresholds applied where available
- Analysts also have access to advice and feedback from regional experts

2007 Chippy Creek Fire (western Montana)



- Unburned to Low
- Low
- Moderate
- High
- Increased Response
- Non-mapping Area

MTBS Project Challenges and Limitations

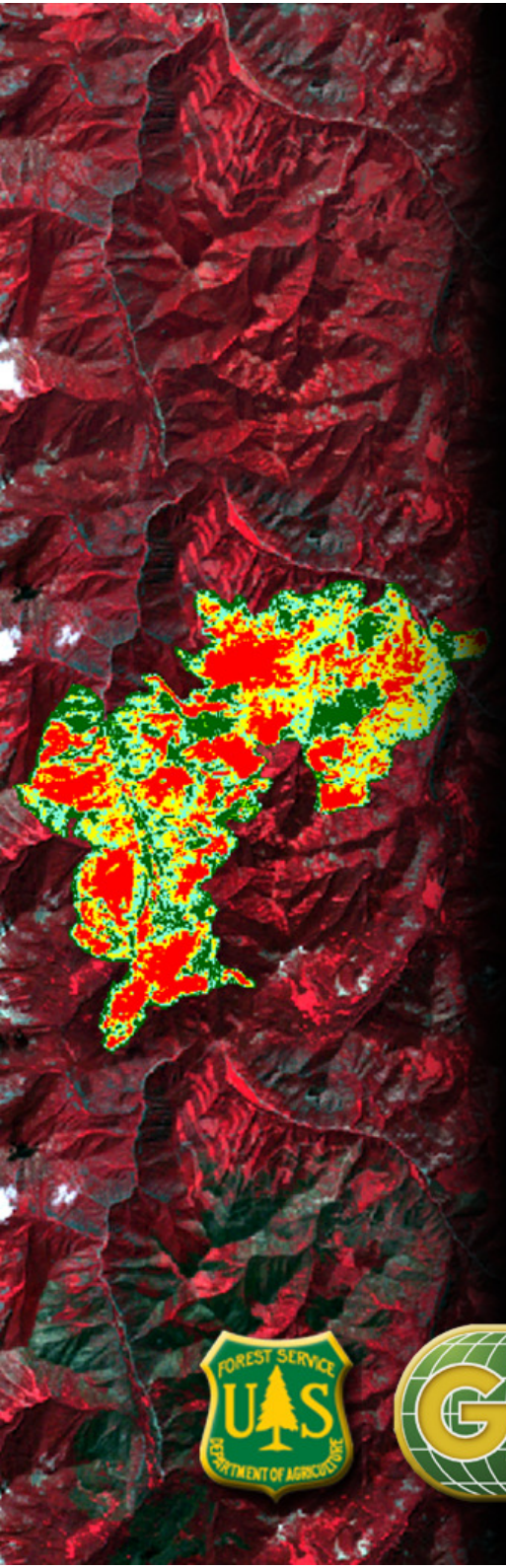
- FOD accuracy/completeness
  - Erroneous locations
  - Incorrect acreage reports
  - Source database revisions/updates
- Landsat data continuity/quality
  - Investigating alternative sensors in case of data gap
  - L7 SLC-off data
- Limitations of sensor characteristics
  - Detection of low intensity/understory fire areas
- Ability of NBR/dNBR to characterize fire effects
  - Adaptability to wide range of biophysical settings
  - Pre-fire/post-fire reflectance data provided by MTBS to facilitate application of other methods

MTBS Project Challenges and Limitations

- Consistency in thresholding severity classes
  - Feedback from regional experts
  - MTBS internal calibration
  - Apply regional threshold models calibrated using plot data
- Assessment timing relative to burn scar delineation and severity characterization
  - Challenges to obtaining appropriate imagery (cloud cover, lack of data coverage, etc.)
  - Post-fire management activities
- Inclusion of "small" fires (< 500 and < 1,000 acre fires)
  - Significant costs involved to capture these additional fires
  - ~5% of the fire occurrences and ~95% of burned area is captured by MTBS

MTBS – Looking Forward

- Production continues
  - 2008 nationwide fire mapping started
  - Completion of historical fire mapping in South Central mapping zone later this year
  - Start historical fire mapping in Alaska, Hawaii and Northeast mapping zones in FY10
  - Plans for MTBS annual maintenance and update for years 2011+
- Cal/Val efforts
  - Field trip to several fires in TN and NC in September 2009
- Technology transfer
  - Tutorials/training modules coming soon to MTBS project website
  - MTBS workshop at Association for Fire Ecology Conference in November 2009



MTBS Contact Information

USDA-FS – Brad Quayle (bquayle@fs.fed.us)

USGS – Steve Howard (smhoward@usgs.gov)

http://www.mtbs.gov

Monitoring Trends in Burn Severity