

Landsat data products: Some current limitations and needs

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Some Background in USGS EROS Fire Science Activities

- Three activities:
 - LANDFIRE
 - Monitoring Trends in Burn Severity (MTBS)
 - Insects and Disease



An interagency, multi-disciplinary national assessment of vegetation, fire fuels, and fire regime conditions

LANDFIRE in One Page

Objectives

- A national assessment of vegetation, fuel and ecosystem conditions
- Implementation of National wildland fire policies

24 primary data products, 30-meter nominal resolution nationwide

- Vegetation (potential and **existing vegetation types and structure**, succession classes)
- Fuels (surface and canopy)
- Fire regime conditions (reference conditions, landscape departure from reference conditions)

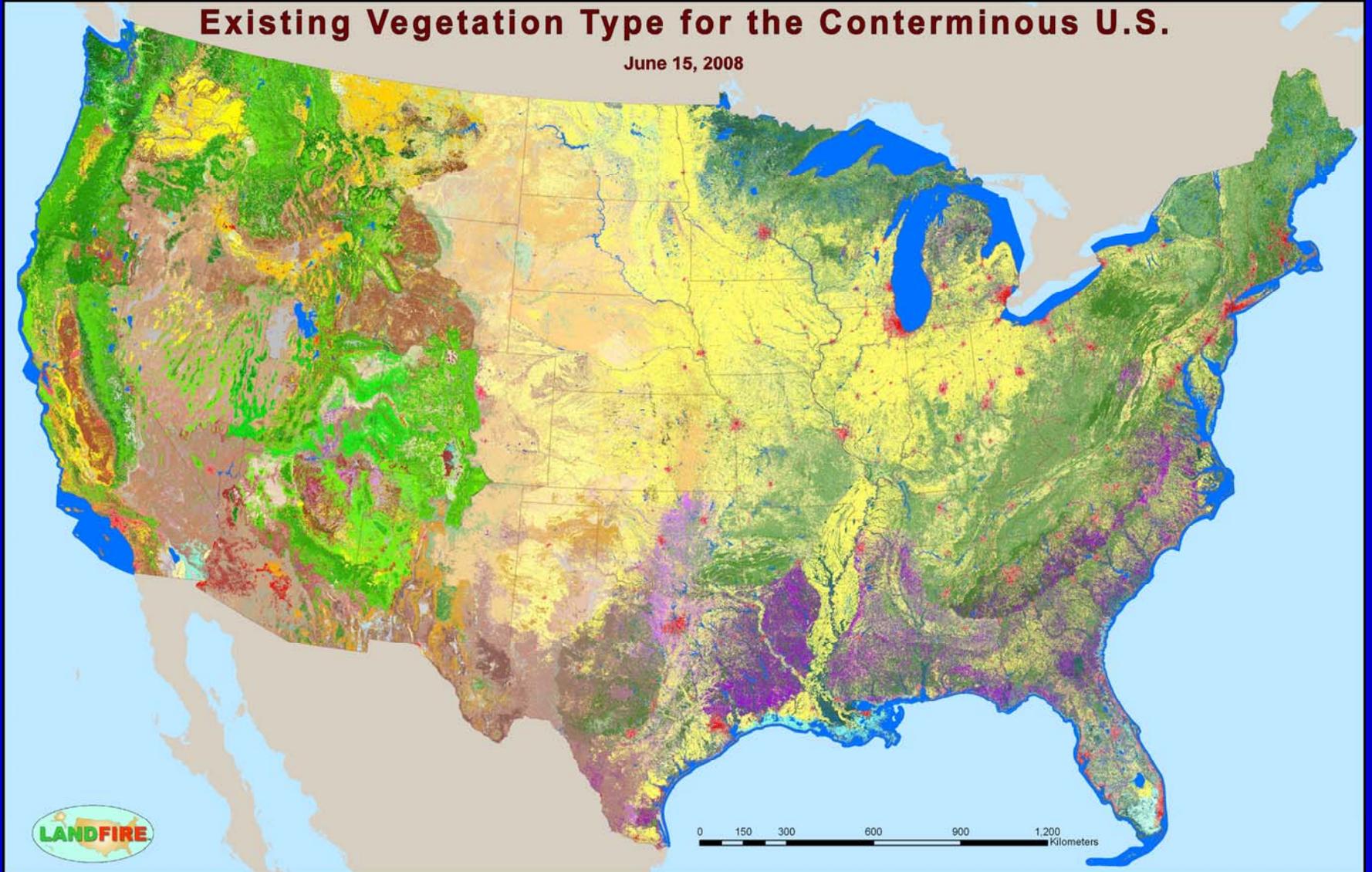
Intended applications

- Fire hazards
- Fuel reduction
- Incident planning
- National strategic planning (e.g. FPA)
- Ecosystem restoration
- Other environmental/ resource management applications

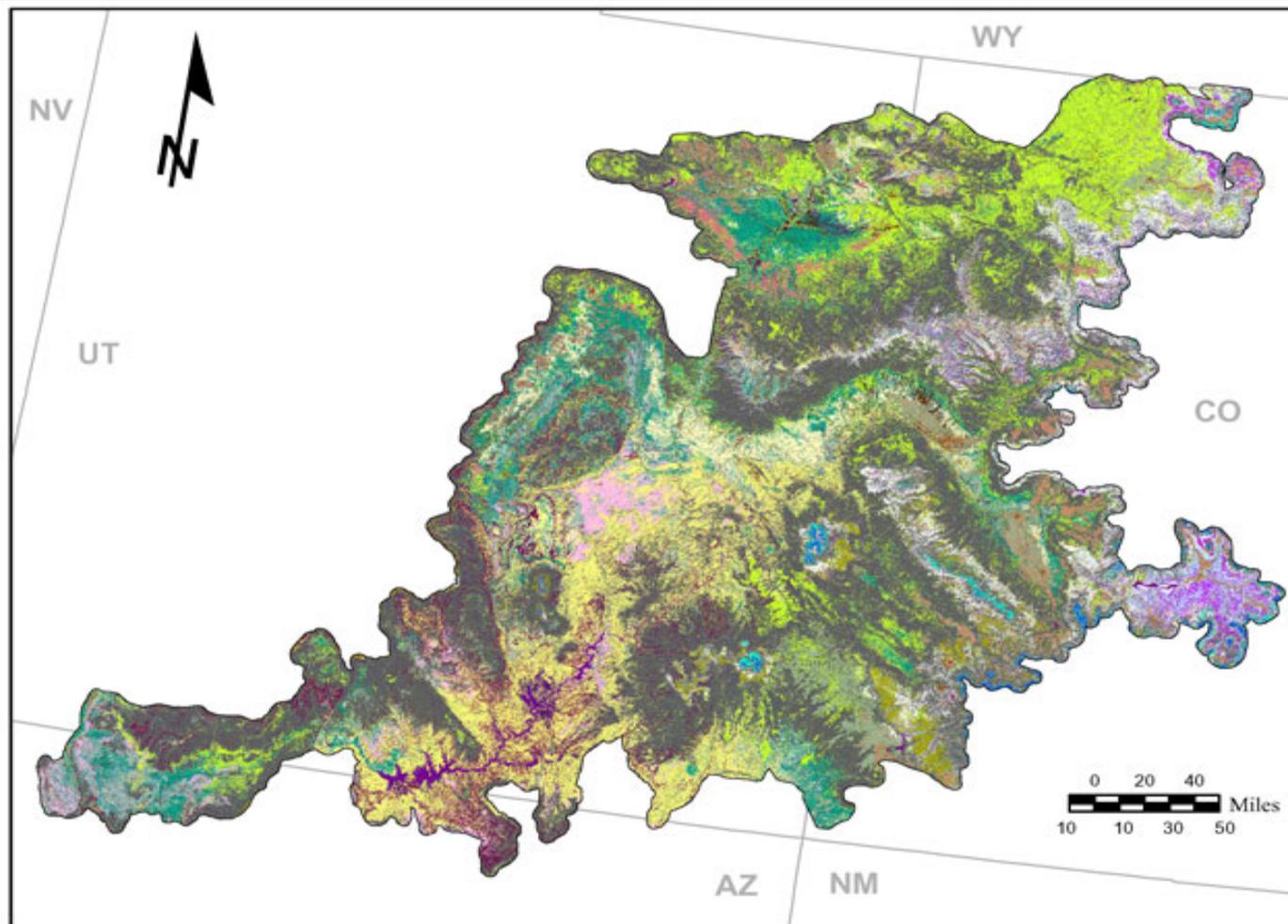


Existing Vegetation Type for the Conterminous U.S.

June 15, 2008



Sample Data Product

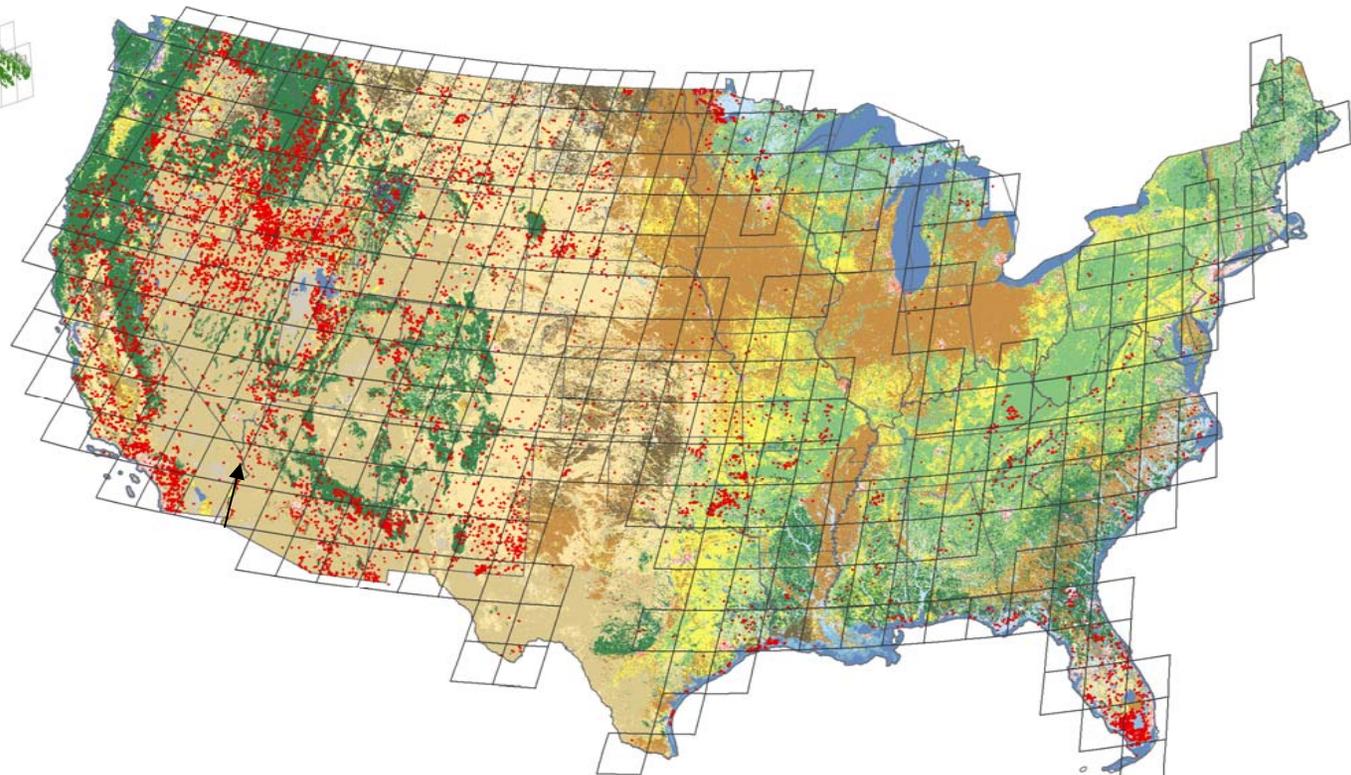
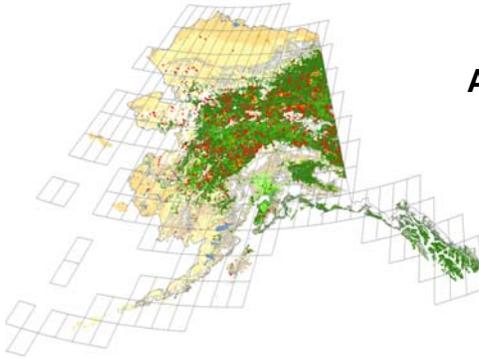


- Existing Veg. Type**
- Green sander Forest Alliance
 - Arctostaphylos patens Shrubland Alliance
 - Artemisia tridentata ssp. - nevadensis Shrubland Alliance
 - Basin Rock Sand/Clay
 - Bromus spp. Semi-Natural Herbaceous Alliance
 - Chrysothamnus viscidiflorus Shrubland Alliance
 - Colorado Pinyon Backhous-Monardella Shrubland
 - Colorado Pinyon Wood-Low Sagebrush Shrubland
 - Colorado Pinyon Pinyon-Juniper Woodland and Shrubland
 - Cultivated Crops
 - Developed, Low Intensity
 - Developed, Medium Intensity
 - Developed, Open Space
 - Elaeagnus angustifolia Semi-Natural Woodland Alliance
 - Eriogonum Shrubland Alliance
 - Great Basin Semi-Desert Chaparral
 - High Mountain Basins Aspen Wood Conifer Forest and Woodland
 - High Mountain Basins Big Sagebrush Shrubland
 - High Mountain Basins Big Sagebrush Shrub
 - High Mountain Basins Grasswood Flat
 - High Mountain Basins Juniper Savanna
 - High Mountain Basins Mt. Saffron Shrubland
 - High Mountain Basins Wood Saffron Shrub
 - High Mountain Basins Montane Sagebrush Shrub
 - High Mountain Basins Montane Mahogany Woodland and Shrubland
 - High Mountain Basins Semi-Desert Grassland
 - High Mountain Basins Semi-Desert Shrub-Steppe
 - High Mountain Basins Sparingly Vegetated Systems
 - High Mountain Basins Sparingly Vegetated Systems
 - Megatherium Chaparral
 - Mojoes Wild-Crested Wood Desert Shrub
 - Open Field
 - Pasture/Hay
 - Quercus gambelii Shrubland Alliance
 - Quercus submedia Shrubland Alliance
 - Rocky Mountain Alpine/Montane Sparingly Vegetated Systems
 - Rocky Mountain Aspen Forest and Woodland
 - Rocky Mountain Gambel Oak-Wood Montane Shrubland
 - Rocky Mountain Lodgepole Pine Forest
 - Rocky Mountain Lower Montane Foothill Shrubland
 - Rocky Mountain Montane Dry-Moist Wood Conifer Forest and Woodland
 - Rocky Mountain Montane Wood-Wood Conifer Forest and Woodland
 - Rocky Mountain Montane Riparian Systems
 - Rocky Mountain Ponderosa Pine Savanna
 - Rocky Mountain Riparian Herbaceous
 - Rocky Mountain Subalpine Dry-Moist Spruce-Fir Forest and Woodland
 - Rocky Mountain Subalpine Moist-Moist
 - Rocky Mountain Subalpine Moist-Spruce-Fir Forest and Woodland
 - Rocky Mountain Subalpine Montane Larch-Sitka Spruce Pine Woodland
 - Rocky Mountain Subalpine Upper Montane Riparian Systems
 - Southern Colorado Pinyon-Tand Shrubland
 - Southern Rocky Mountain Montane Subalpine Grassland
 - Southern Rocky Mountain Ponderosa Pine Woodland
 - Tamarix spp. Semi-Natural Temporarily Flooded Shrubland Alliance

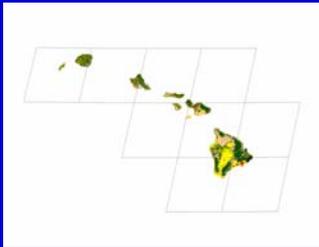
LANDFIRE Map Zone 23 Existing Vegetation Type

Monitoring Trends in Burn Severity 1984 to Present and into the Future

A collaborative effort between the US Geological Survey and US Forest Service to map the burn severity of fires greater than 1000 acres in the west and 500 acres in the east.

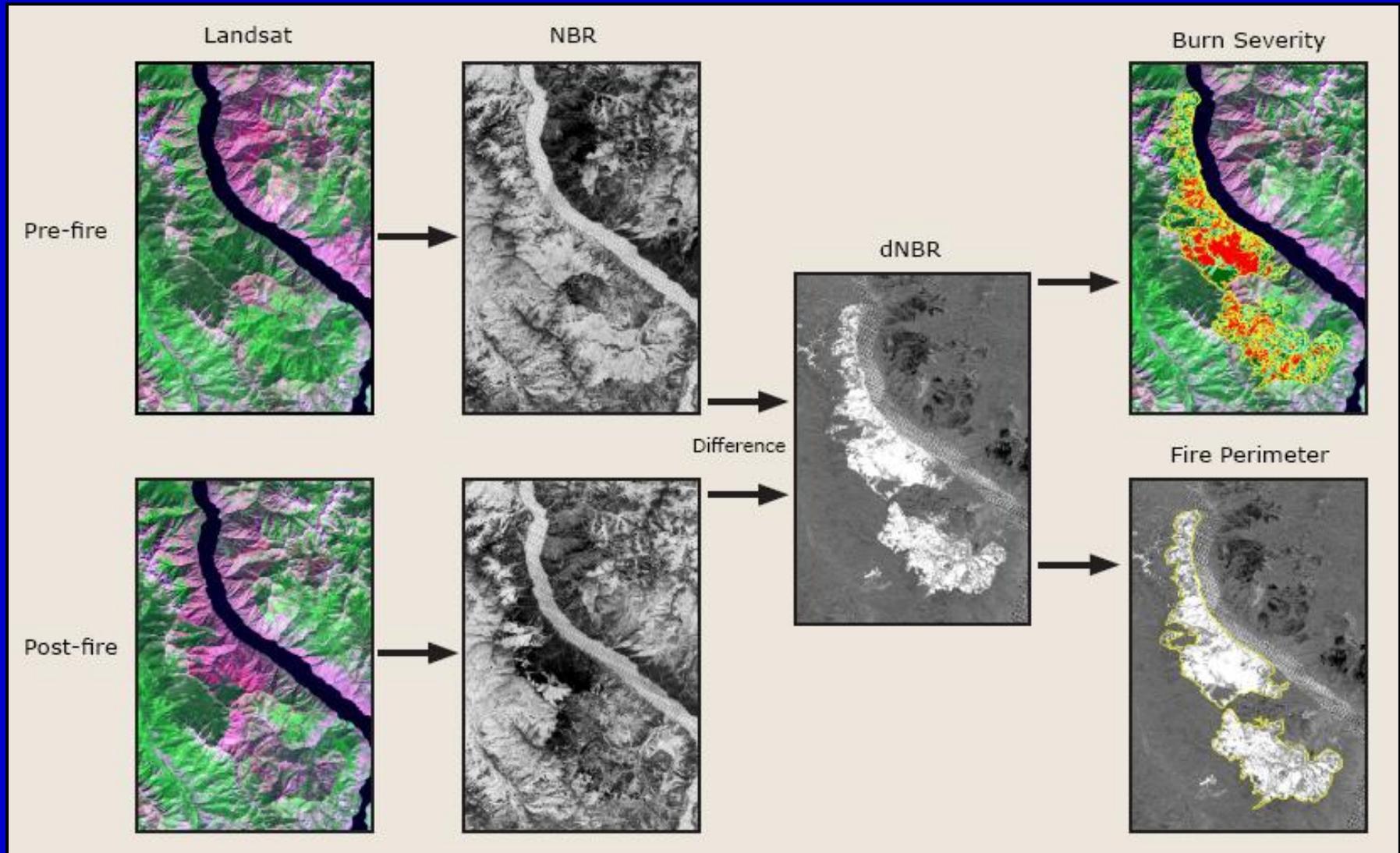


Historical Landsat scenes are being used to assess and monitor trends in burn severity from 1984 onward.

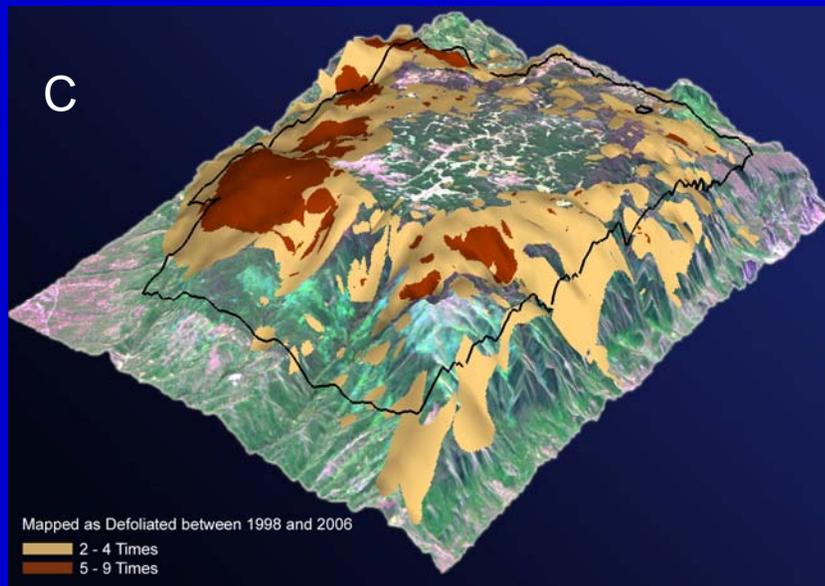
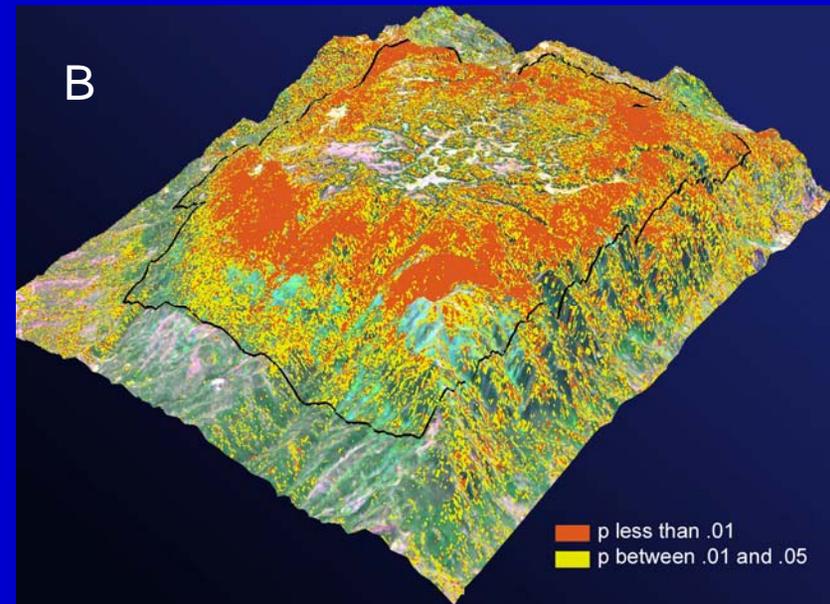
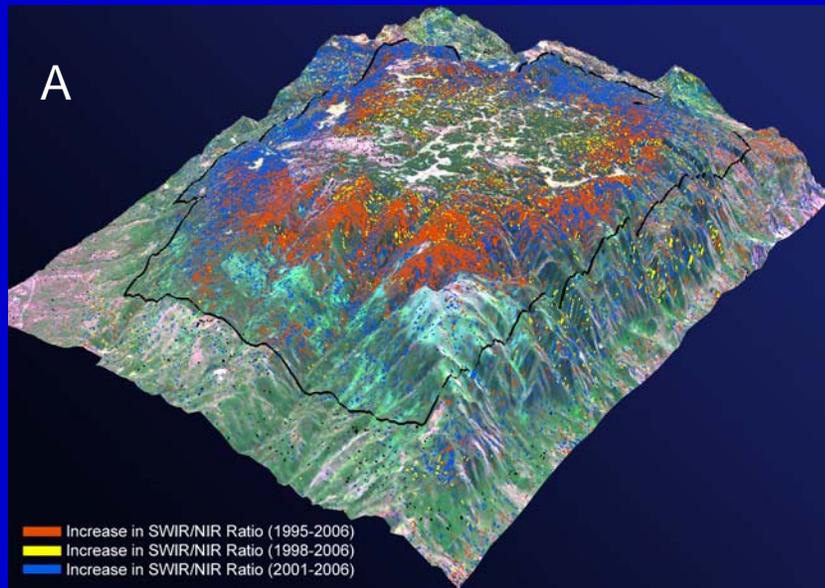


The red dots depict over 8000 large fires recorded by state or federal agencies from 1984 to the present. The intensity, size and number of wildland fires fluctuate from year to year. MTBS data sets offer great potential for exploring issues of climate variability and change from 1984 to present. Expansion to include MSS data would enable assessment of climate-landscape interactions from 1972 to present.

MTBS Process



Insects and Disease



A. Trends of declining forest as measured by Landsat TM trend analysis (1995-2006). Red, blue and yellow indicate different rates of decline.

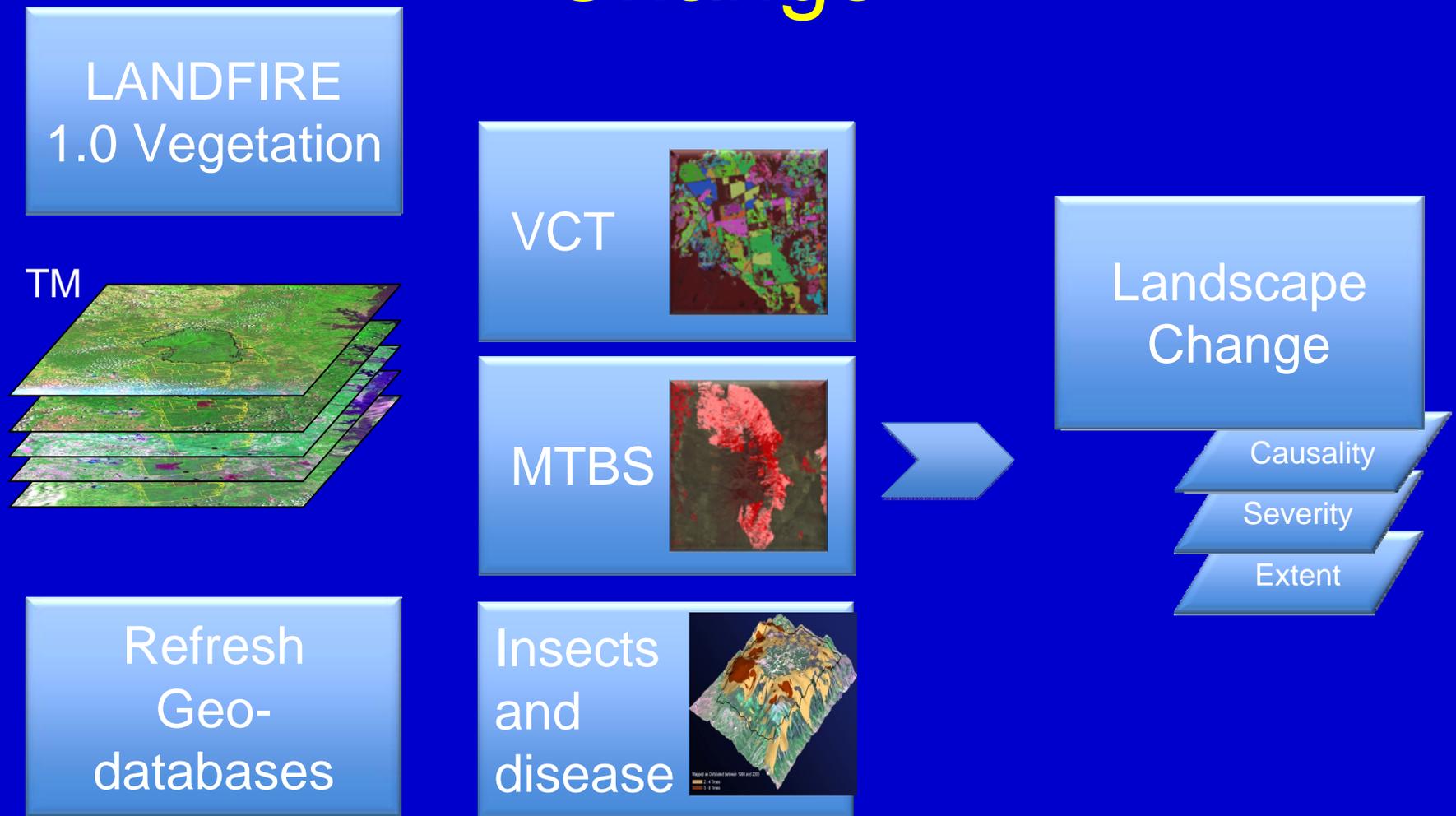
B. Trends of declining forest as measured by Landsat TM trend analysis (1995-2006). Red, blue and yellow indicate different rates of decline.

C. Forest Health Monitoring Program data (multiple defoliations caused by western spruce budworm) as detected by aerial sketch mapping (1998-2006)

How do we keep LANDFIRE current and relevant?

- Concern was expressed by southern foresters that LANDFIRE 2000s data were outdated
 - Lots of changes due to timber operations
 - Changes due to fire
- Early on started R&D efforts with the goal of updating LANDFIRE data

Remote Sensing of Landscape Change



Vegetation Change Tracker

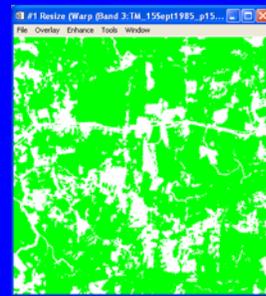
- Abbreviated “VCT”
- Mostly a University of Maryland enterprise (C. Huang)
- General idea is to use Landsat time series data (data stacks) to generate forest disturbance change information that can be used for “updating” land cover data

VCT – overview

Landsat time series



Single image analysis



Confident forest

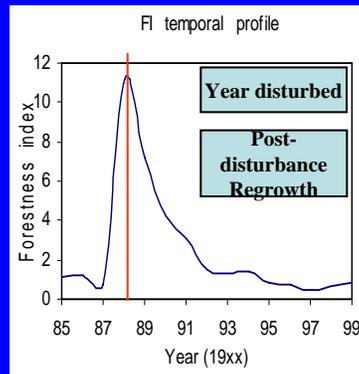


Forest index

Forest index time series

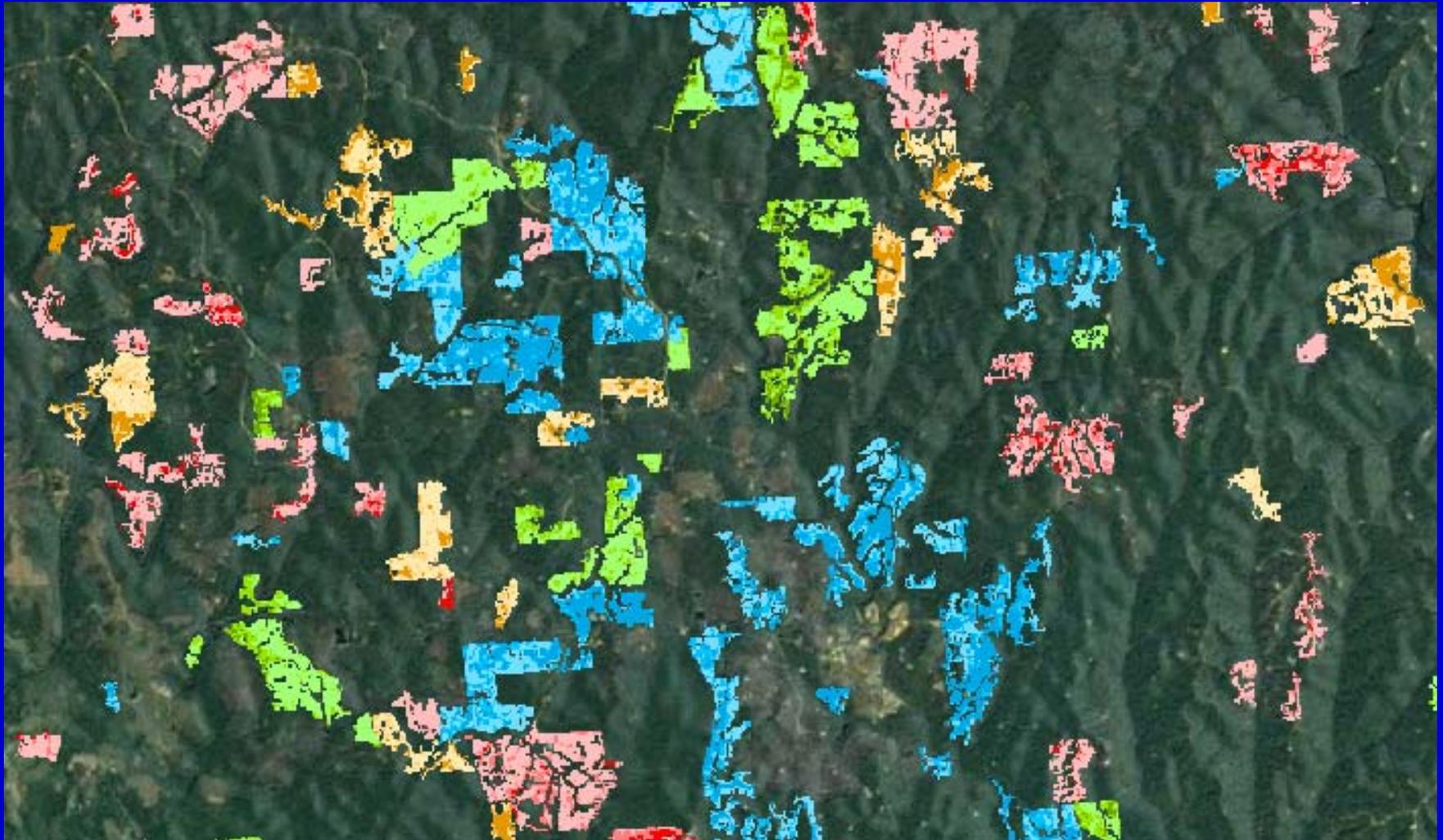


Time series analysis



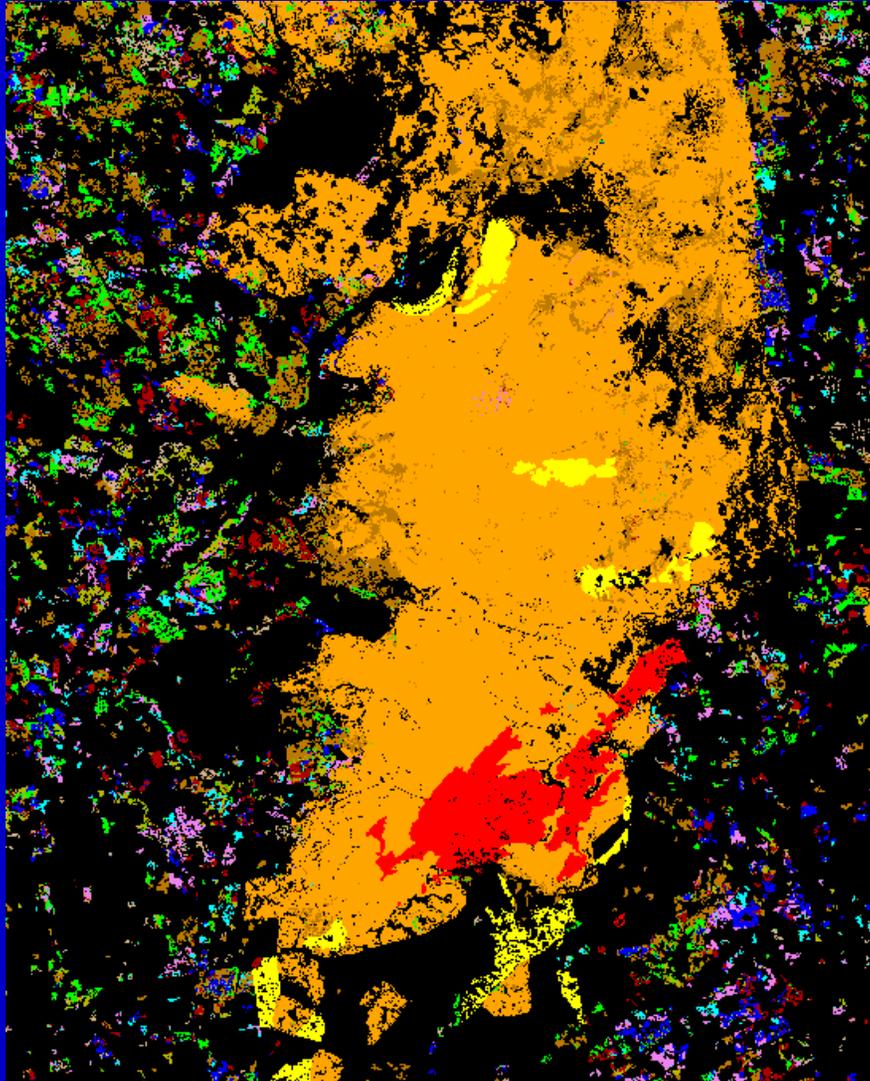
disturbance map

Example of VCT product. Different colors
Represent different years of disturbance



Causality not assigned yet—we need to do that through our own
non-automated decision making

VCT Product with Causality Assigned (Okefenokee Swamp)



	Logged in 1999
	Logged in 2000
	Logged in 2001
	Logged in 2002
	Logged in 2003
	Logged in 2004
	Burned in 2004
	Logged in 2005
	Burned in 2005
	Logged in 2006
	Logged in 2007
	Burned in 2007

Some things that hold us back

- We spend a lot of time preprocessing data! Scene selection, downloading, converting to (at sensor) reflectance, masking out clouds, finding places to store all of the data....)
- Lack of good scenes at the “right” time of year hinders us
- Phenology affects our disturbance products a lot
- We could use more “baseline” data sets (more on this later)

Some limitations with what we are doing

- Lack of field reference data is ALWAYS a problem.
 - Much of what we have to work with is either inaccurate or outdated
 - Warren Cohen's work will help
 - More integration with FIA will help and other field data acquisition efforts
 - Still will be lacking field information in many locations and for rangeland/wetland/grassland vegetation
- * We could really use an integrated effort to acquire and serve up good field information

Some limitations with what we are doing

- Lack of Landsat data (despite all of the free data!) will hamper our activities
 - Ideally, we want to use data that represent same phenological status on an annual or biennial basis
 - The data sets that we need are often cloudy
 - WELD will help in some cases, but
 - I see a need for user defined composites
 - As an example, I personally would rather use a composite of two semi-cloudy data sets from early September in adjacent years, than a composite of early September and late September data from the same year. Other users will view things differently.
 - Can we use WELD methods and logic for scenes defined by the user?

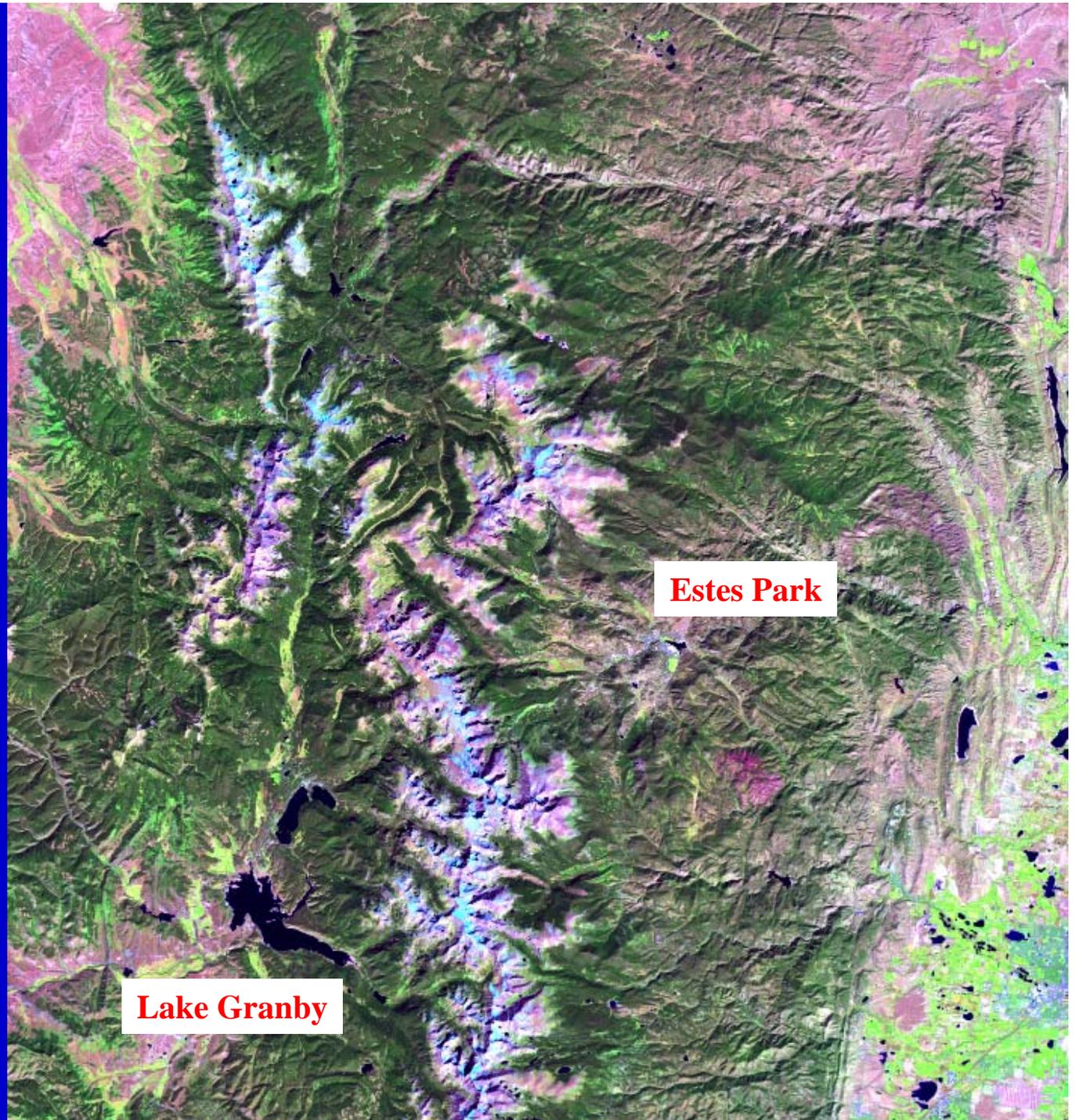
Some more observations

- Different types of changes often require different types of change techniques. For example, gradual change won't be picked up by VCT, but can be detected very nicely using regression techniques (time versus index). Meanwhile, budworm (defoliator) damage is different from pine beetle (borer) damage.
 - If we are to “serve up” change data sets, we may be doing users a disservice by offering up only one generic type of change data set. That is, I would suggest serving up several.

Some more observations

- I see a need to develop “baseline” images to be used as a basis of comparison with individual images of interest. Change is often readily detected as a deviation from some type of a baseline condition. Examples might include:
 - Median (cloud-free) reflectance for individual bands or indices representing the “average” condition across entire growing seasons from 1984 to present
 - Median (cloud-free) reflectance for individual bands or indices representing the “average” condition across a given month from 1984 to present
 - Could consider substituting “maximum” reflectance or greenness for median.

Pre-pine beetle
infestation
September 22,
2003 (Landsat
TM)



2007

Red = areas of major spectral change (correlates with pine bark beetle damage)

Red is “deviation From the median SWIR/NIR value, With median being Derived from about a 10-year stack of imagery

