



Monitoring Trends in Forest Condition in the Western United States using Landsat Time Series Data

Jim Vogelmann

USGS-NASA Landsat Science Team Meeting

Reston, VA July 15-17, 2008

Background

Several different types of changes that we can detect and monitor using remote sensing

Abrupt changes



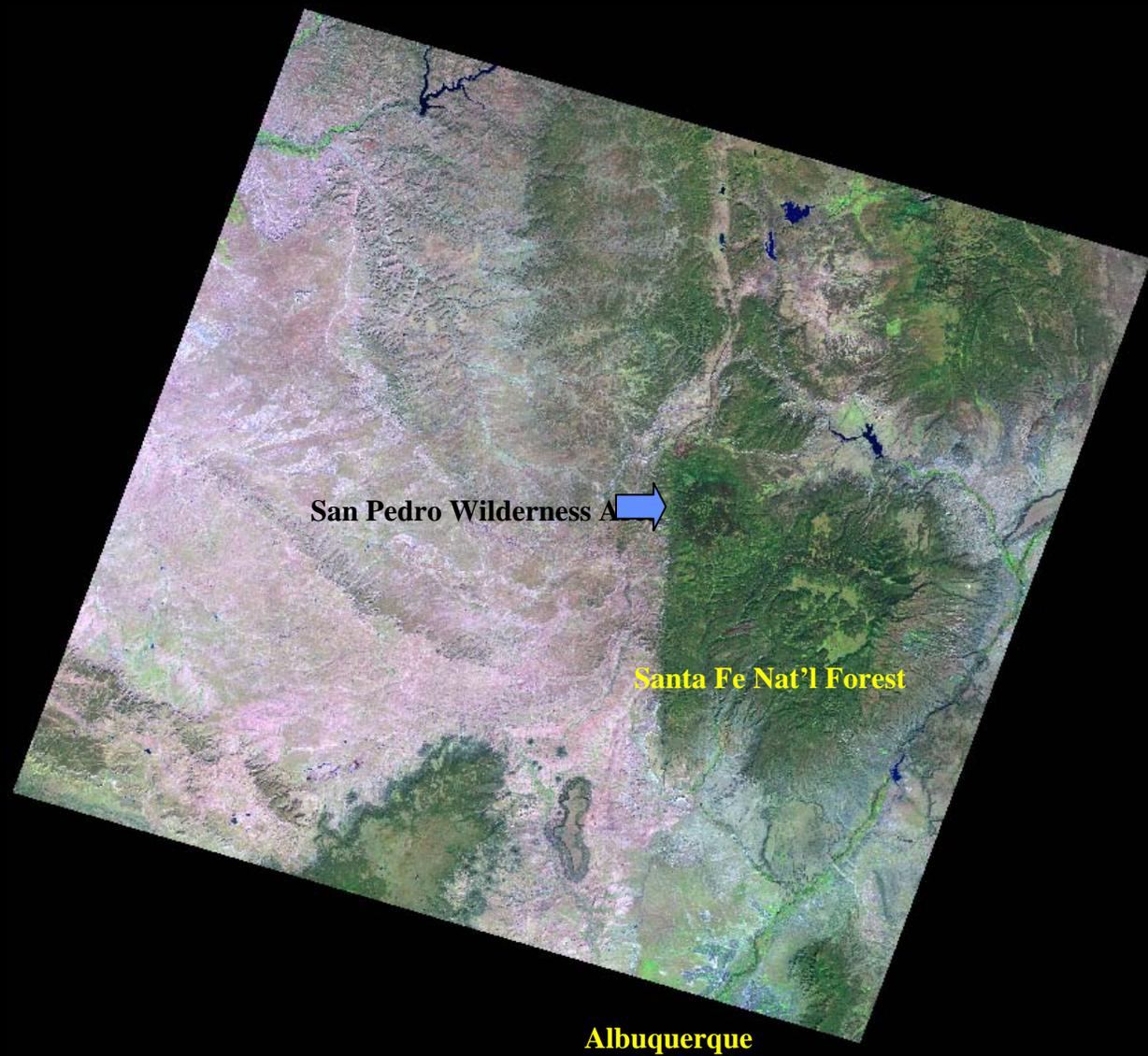
Gradual changes



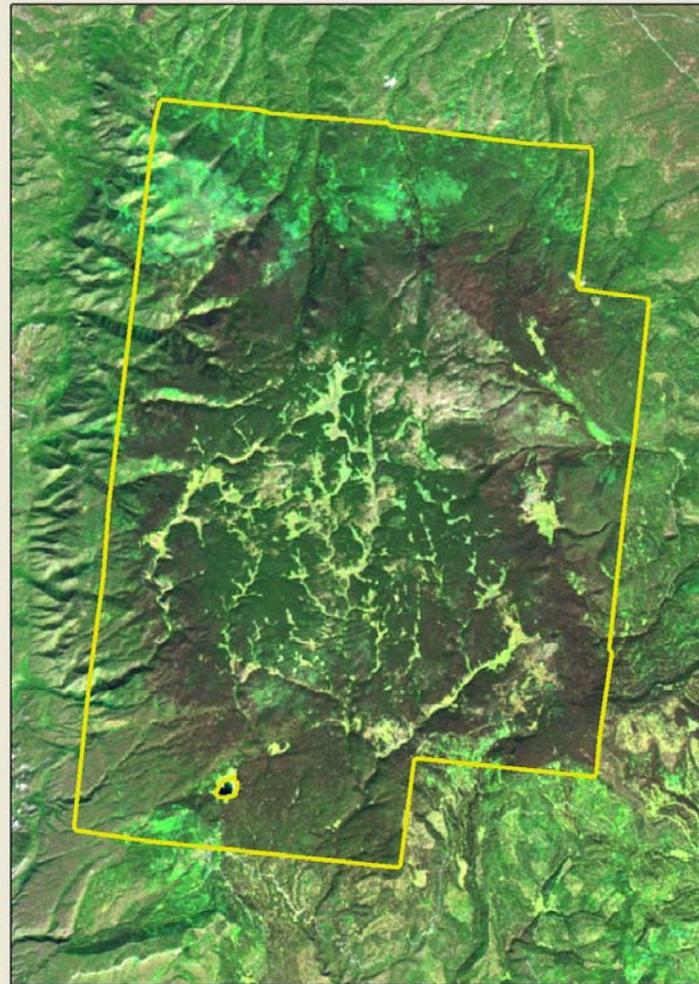
Area of Focus



WRS Path 34 Row 35
Landsat TM; September
30, 2006



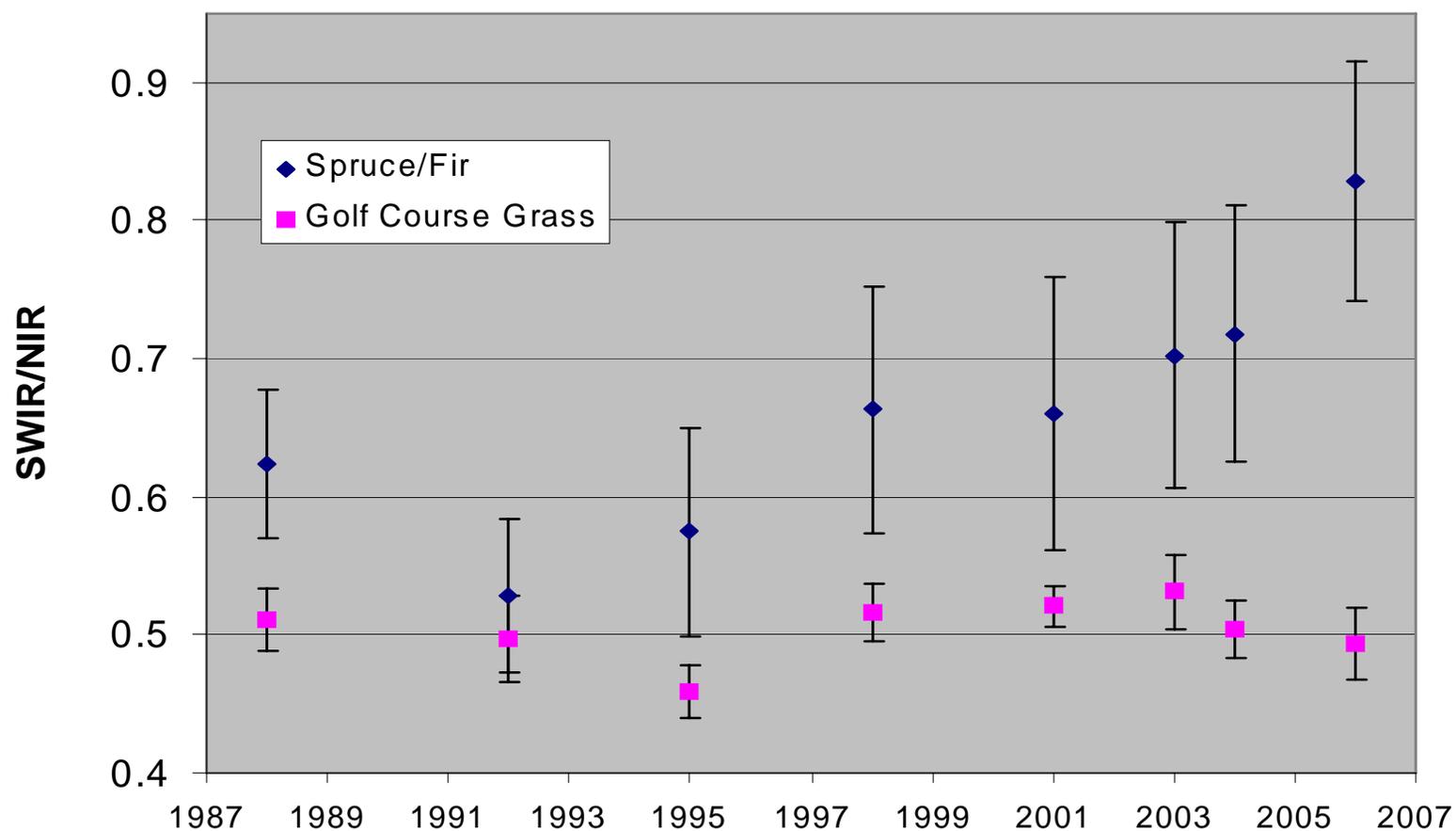
San Pedro Parks Wilderness Area Boundary



Landsat Time Series Data Set Used in the Current Study

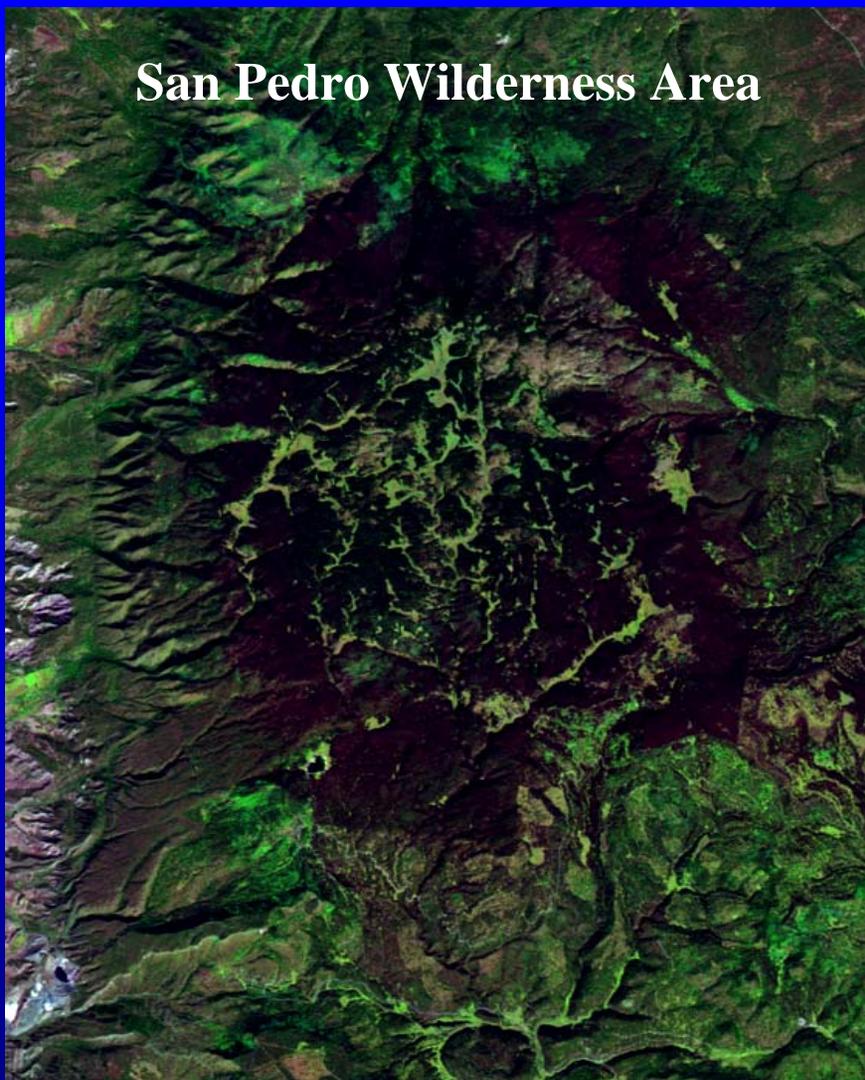
- September 28, 1988
- September 7, 1992
- October 9, 1995
- September 24, 1998
- September 24, 2001
- September 22, 2003
- September 24, 2004
- September 30, 2006

Trends in SWIR/NIR; Spruce/Fir versus Golf Course Grass



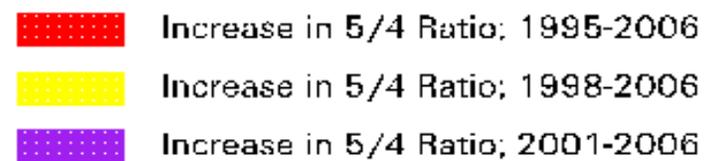
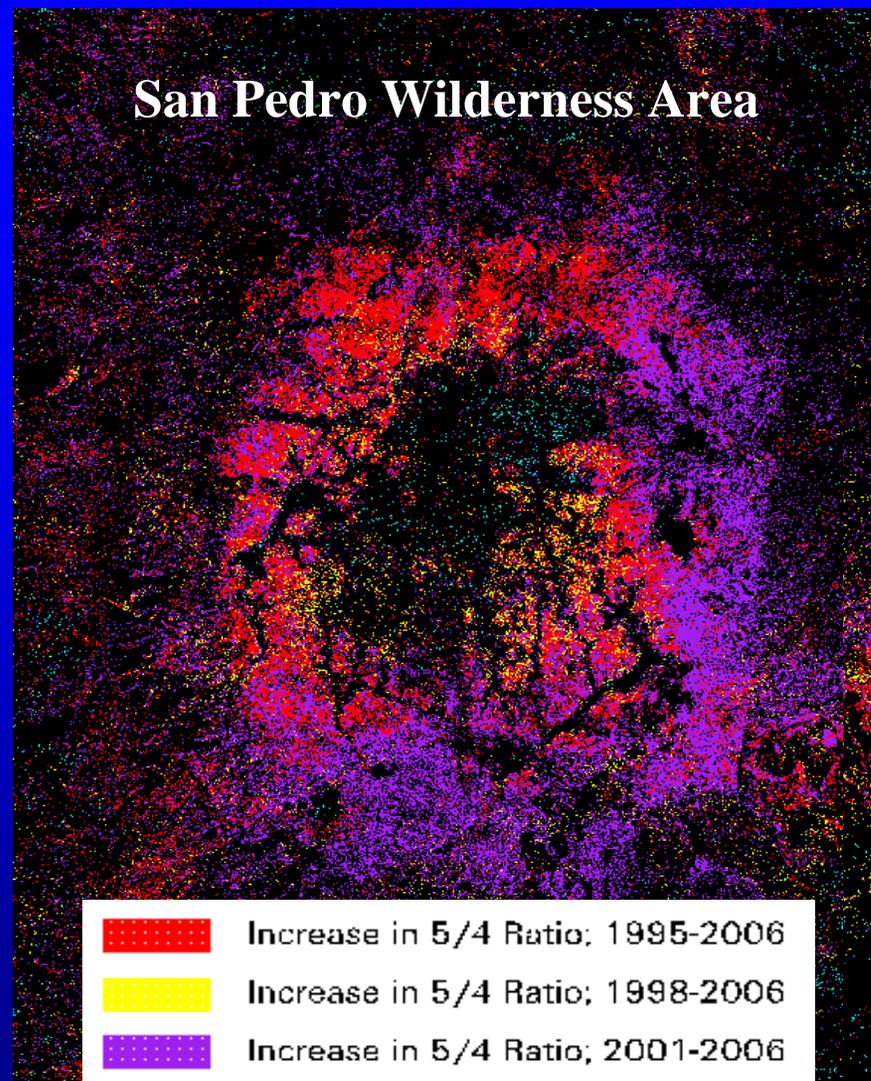
Mean Landsat SWIR/NIR trends extracted from five spruce/fir FIA plots located in San Pedro Parks Wilderness area.

San Pedro Wilderness Area

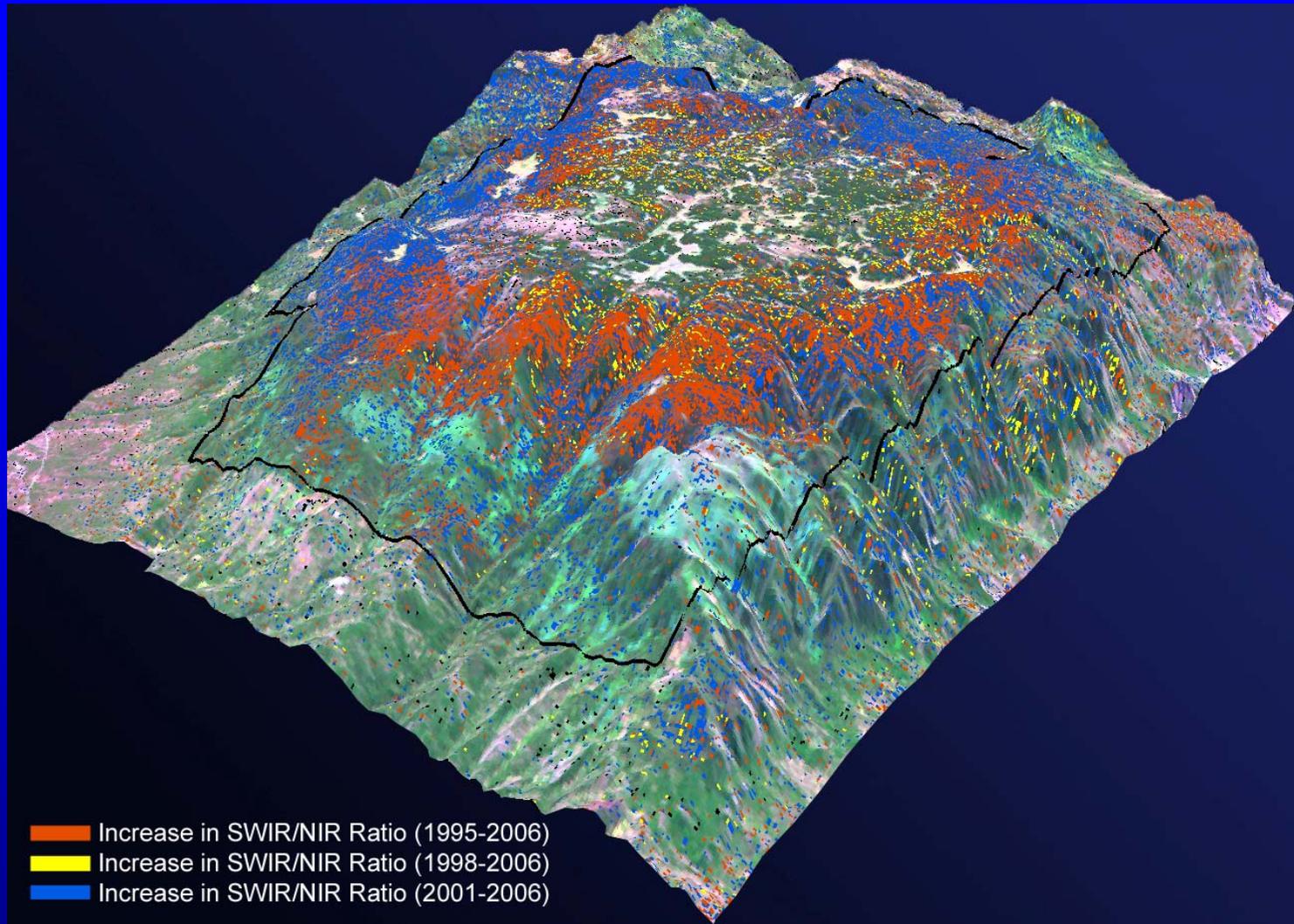


September 30, 2006 TM Image

San Pedro Wilderness Area



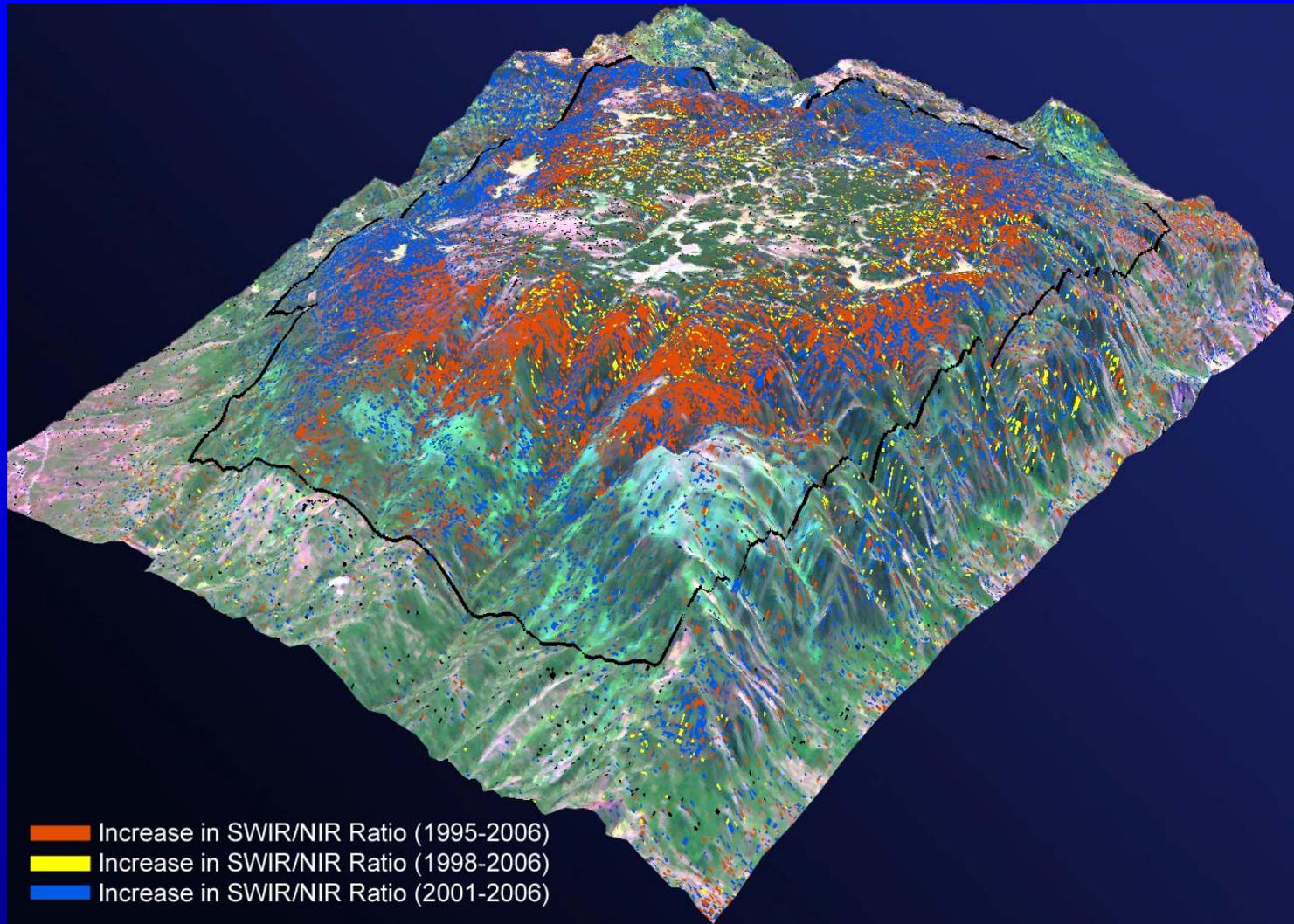
SWIR/NIR Trends between 1995 and 2006



3-D image depicting patterns of gradual change in Wilderness area.

Field Verification

- Mid-July 2007
- Goal: What's really going on here?



3-D image depicting patterns of gradual change in Wilderness area.

And the expedition
starts!

(At the trailhead....)





 USGS

Defoliation from Insects

- Evidence of western spruce budworm
- Affects douglas-fir, true firs, spruce and larch
- Spins webs which were visible on much of the foliage
- “Top killing” commonly observed



Example of
“Top Killing”



But when you get to the top, all looks OK...

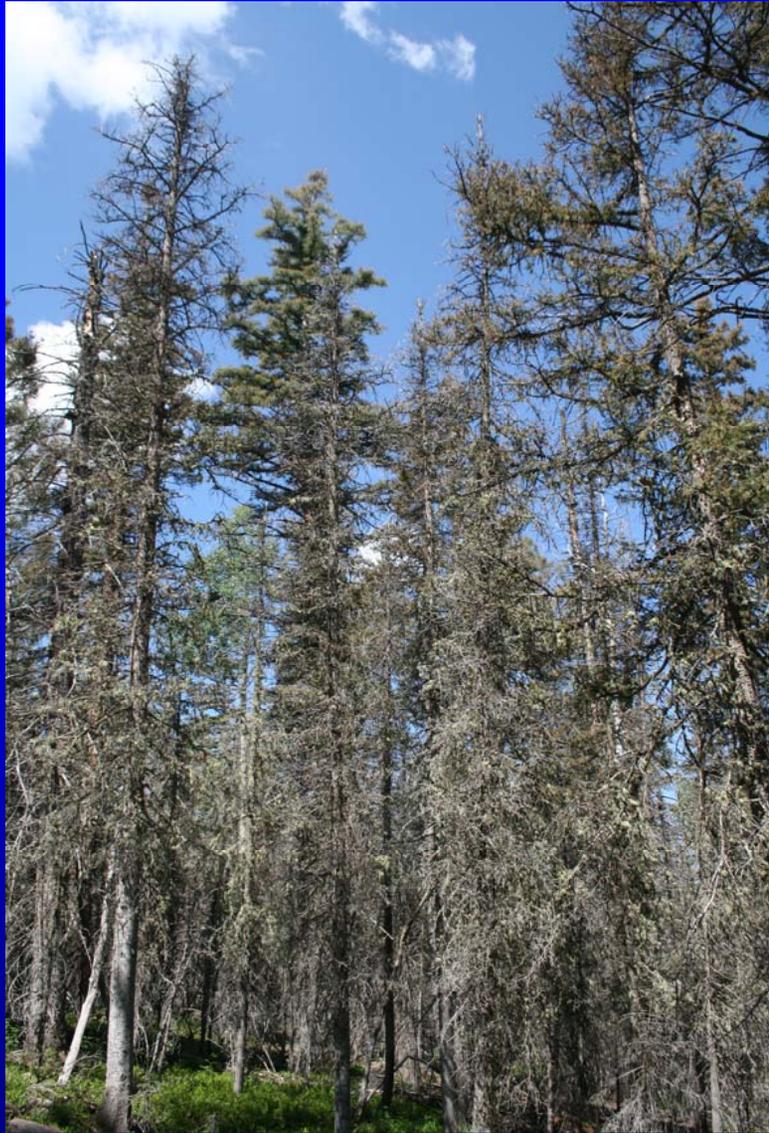




Engleman Spruce towards top of San Pedro Peak



New year's growth=lighter
blue green color



Zone of spectral trend (SWIR/NIR) increase

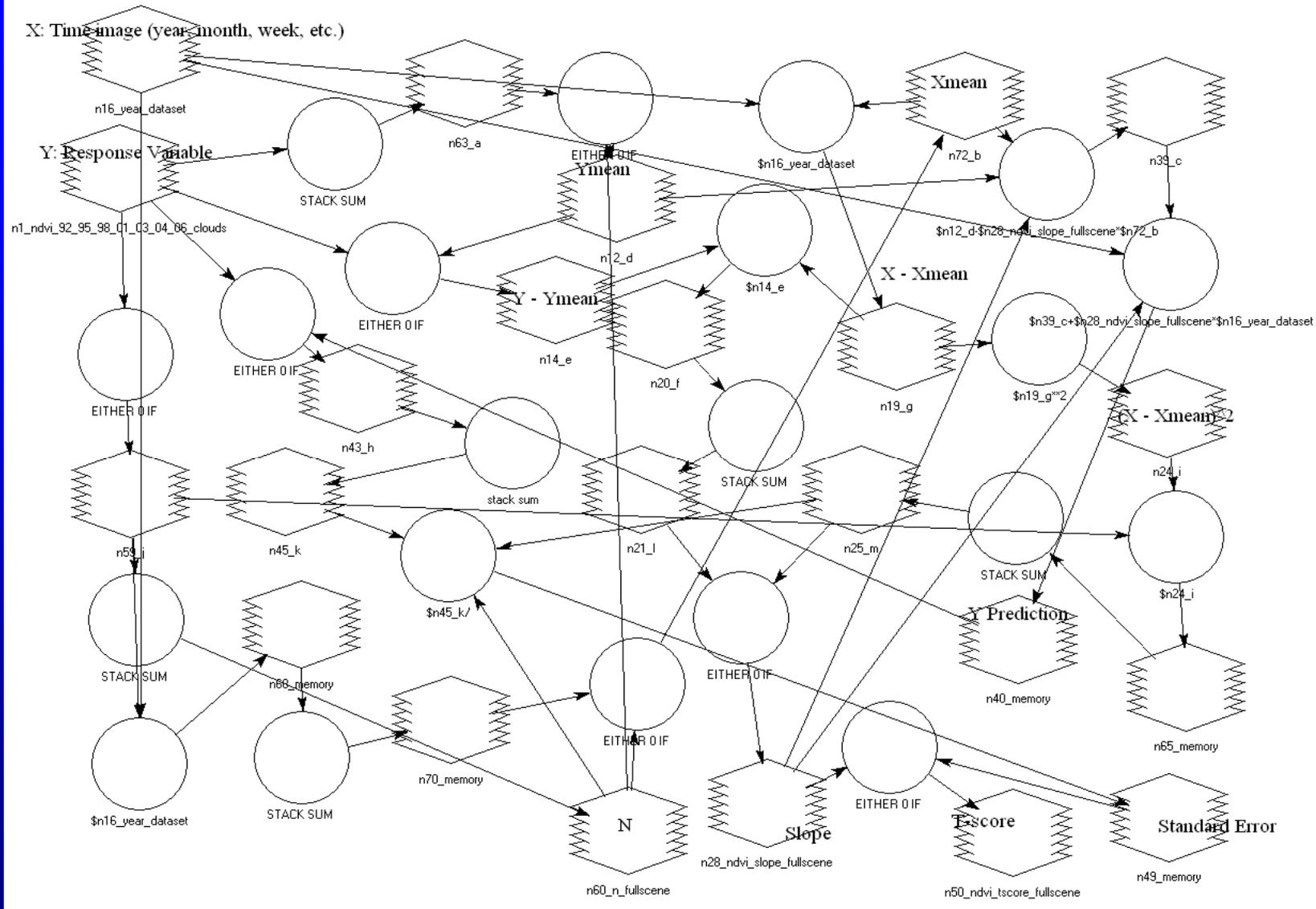


Zone of spectral trend (SWIR/NIR) "stasis"

Regression calculations:

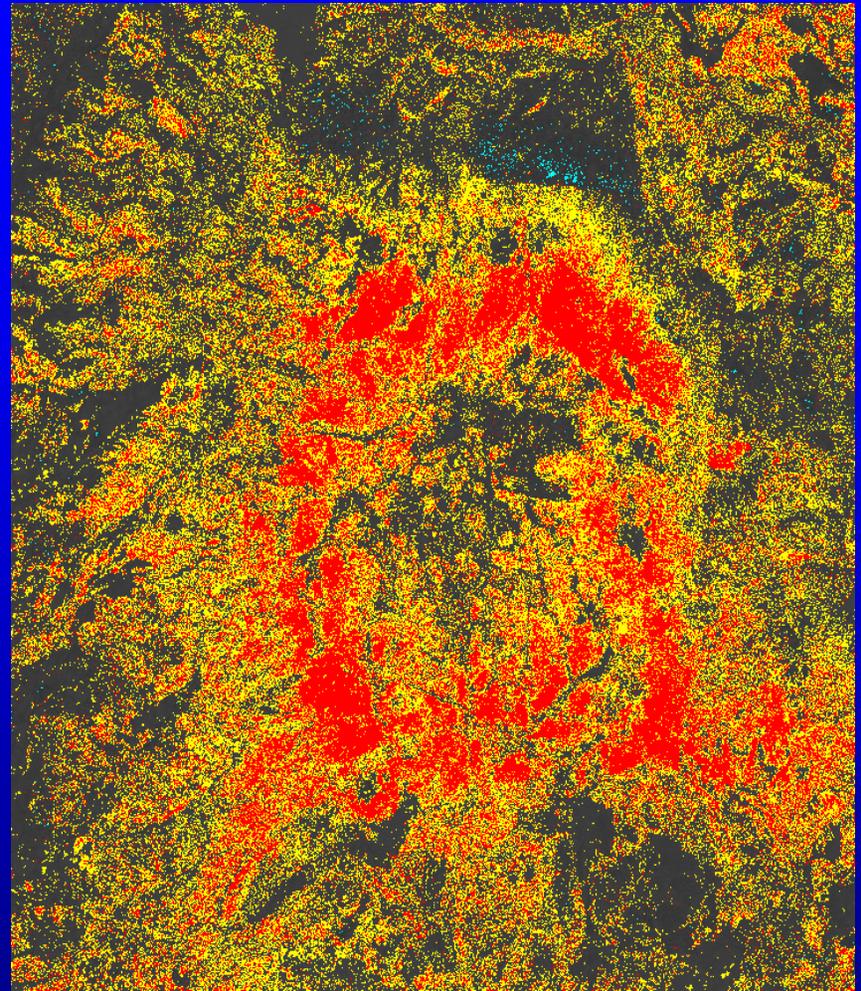
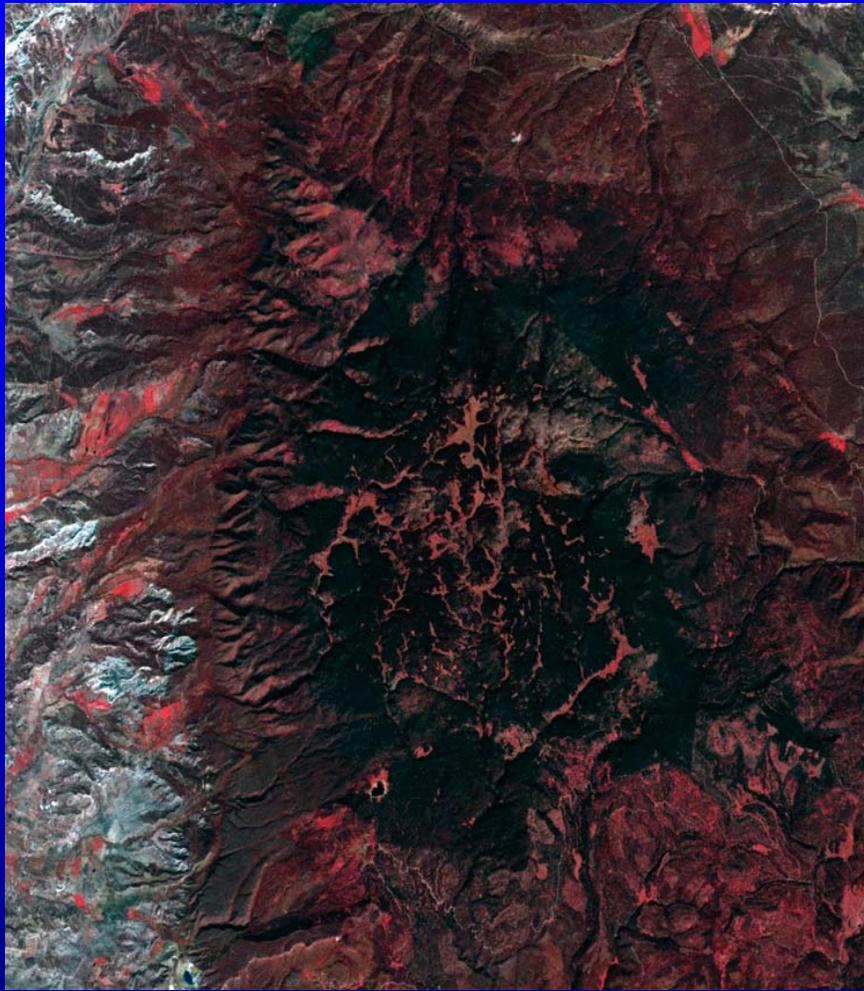
Pixel by pixel calculation of a series of regressions (time versus SWIR/NIR) with assignment of a statistical probability value to each regression in a spatial domain.

REGRESSION MODEL FOR SPECTRAL TRENDS ANALYSIS BY LEI JI SEP-20-2006



San Pedro Parks Wilderness Area

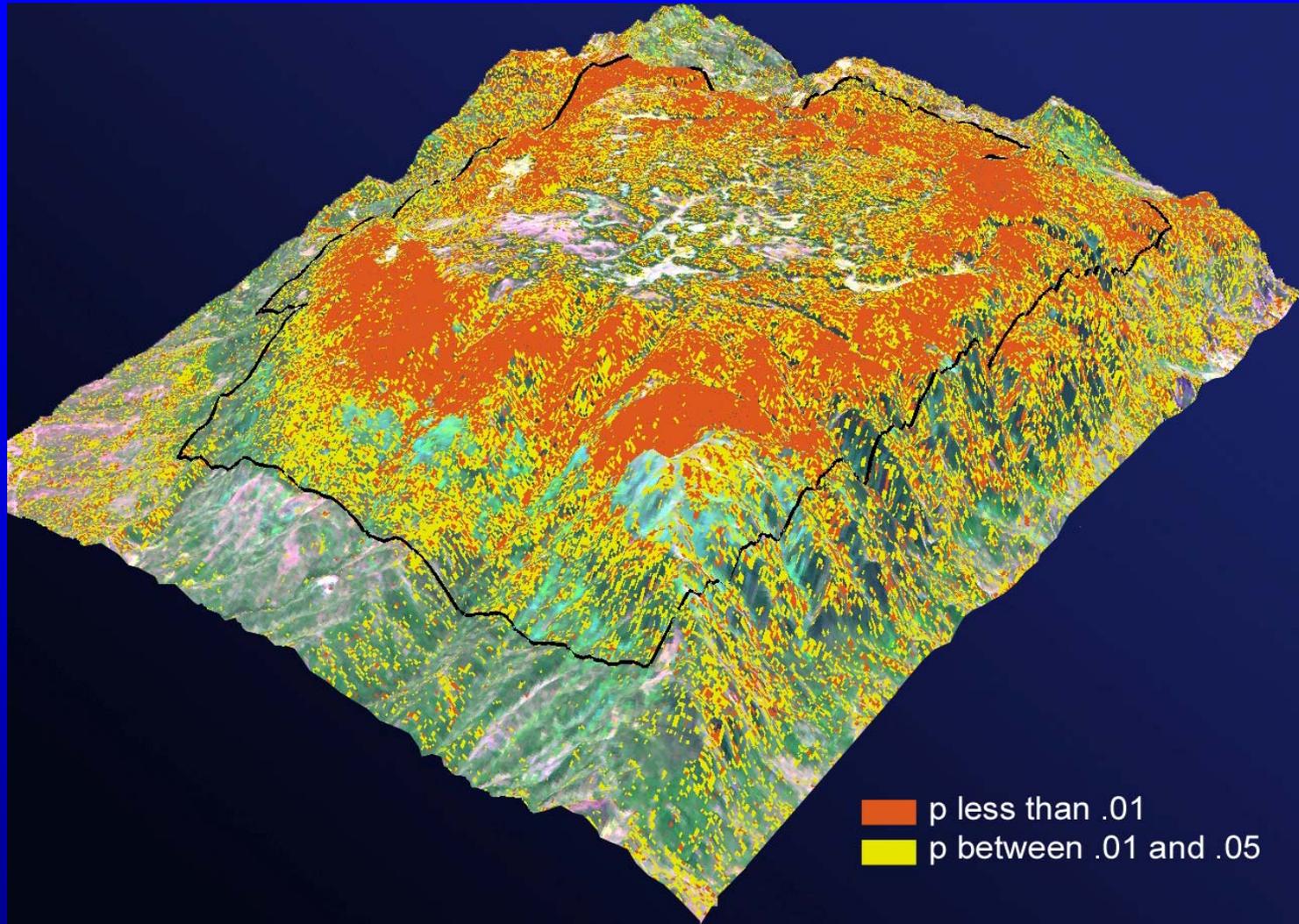
Increases in SWIR/NIR (1992-2006)



Dark areas are dense conifer stands
(most located in wilderness area)

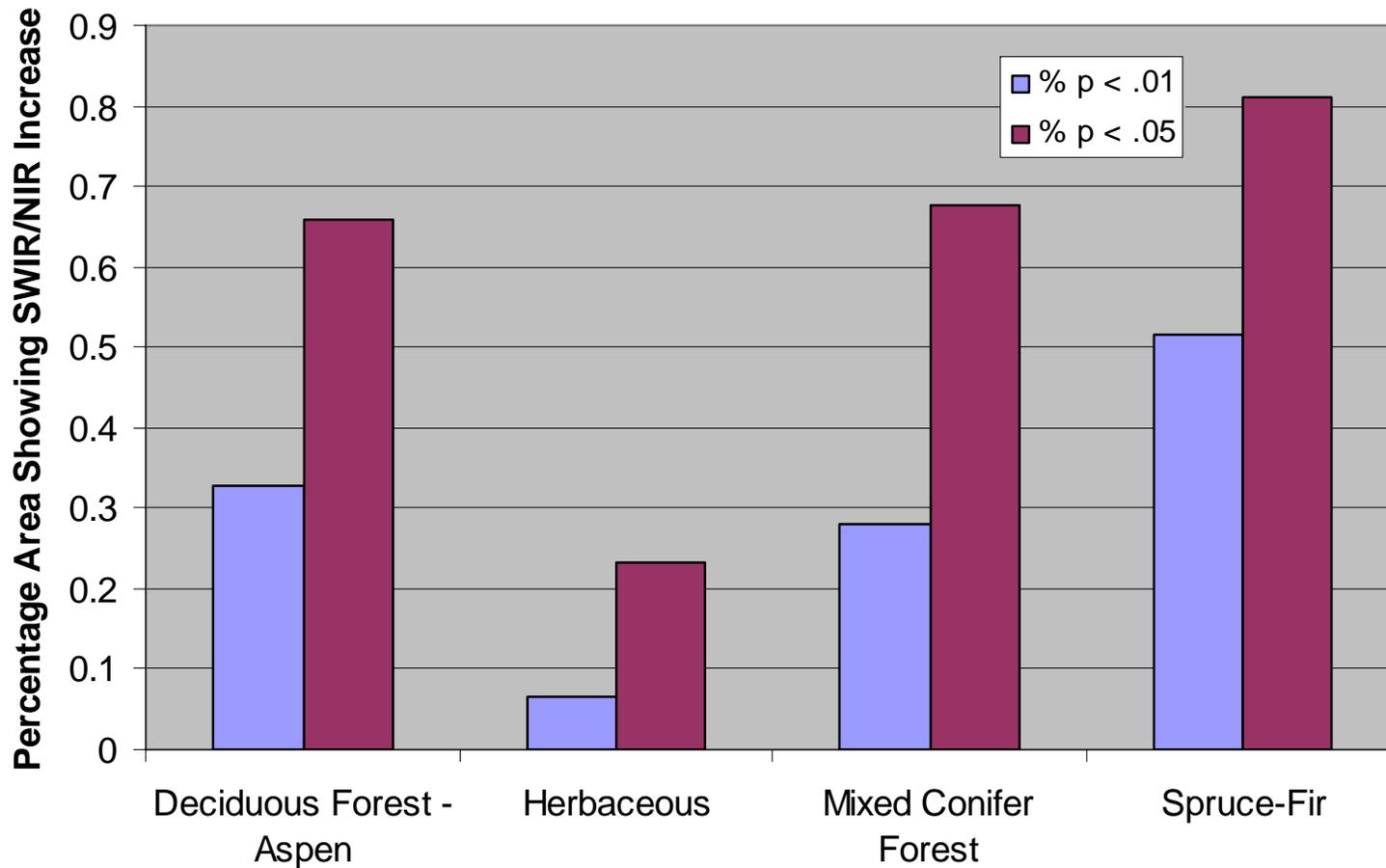
-  SWIR/NIR Increase; .01 level confidence
-  SWIR/NIR Increase; .05 level confidence





3-D image depicting locations of significant increasing SWIR/NIR regression trends.

SWIR/NIR Increases within San Pedro Parks Wilderness Area

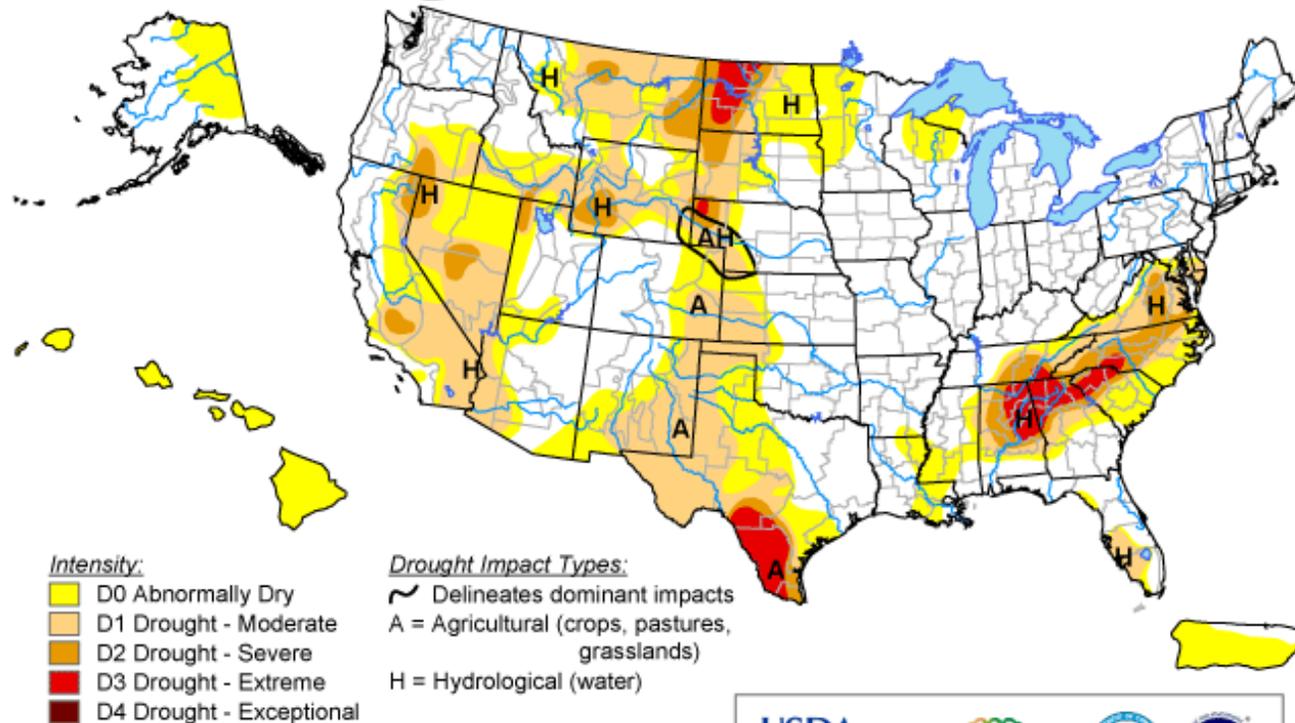


Percent area per land cover class showing positive SWIR/NIR regressions between 1992 and 2006 at 0.01 and 0.05 confidence.



U.S. Drought Monitor

April 8, 2008
Valid 8 a.m. EDT



The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

<http://drought.unl.edu/dm>



Released Thursday, April 10, 2008
Author: Rich Tinker, Climate Prediction Center, NOAA

<http://www.drought.unl.edu/DM/monitor.html>

Drought in Northern New Mexico (according to US Drought Monitor)

Drought/Dry Years

- 2000 (71%)
- 2002 (100%)
- 2003 (100%)
- 2004 (100%)
- 2005 (100%)
- 2006 (83%)

Non-Drought Years

- 1999 (0%)
- 2001 (17%)

(US Drought Monitor information not available prior to 1999, but by most accounts, 1990's were non-drought conditions)

Spruce Budworm versus Mountain Pine Beetle Damage

- The two insects affect trees differently
- Budworm is a defoliator. It takes multiple years for mortality to occur.
- Pine bark beetle is not a defoliator; they are borers. Tree mortality is rapid following infestation.



Mountain Pine Beetle Damage

Spruce Budworm versus Mountain Pine Beetle Damage

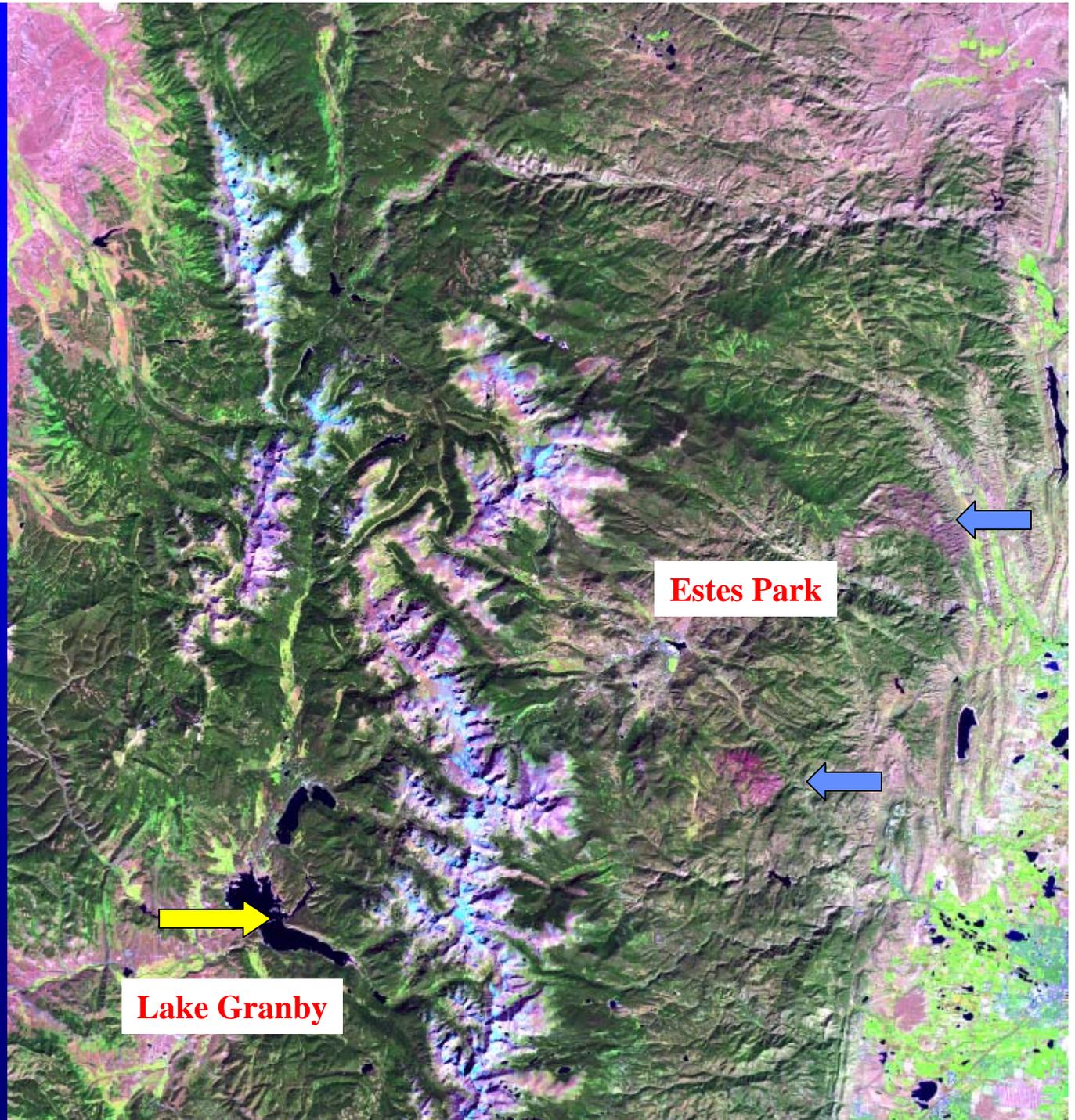
- **Mountain pine beetle damage prevalent throughout much of Rocky Mountains**
- **Previous methods don't work all that well; next series of slides based on deviation from median SWIR/NIR index values from a stack of data acquired from 1984 through 2007 (images acquired once every one or two years)**

Orientation Image Acquired on September 22 2003

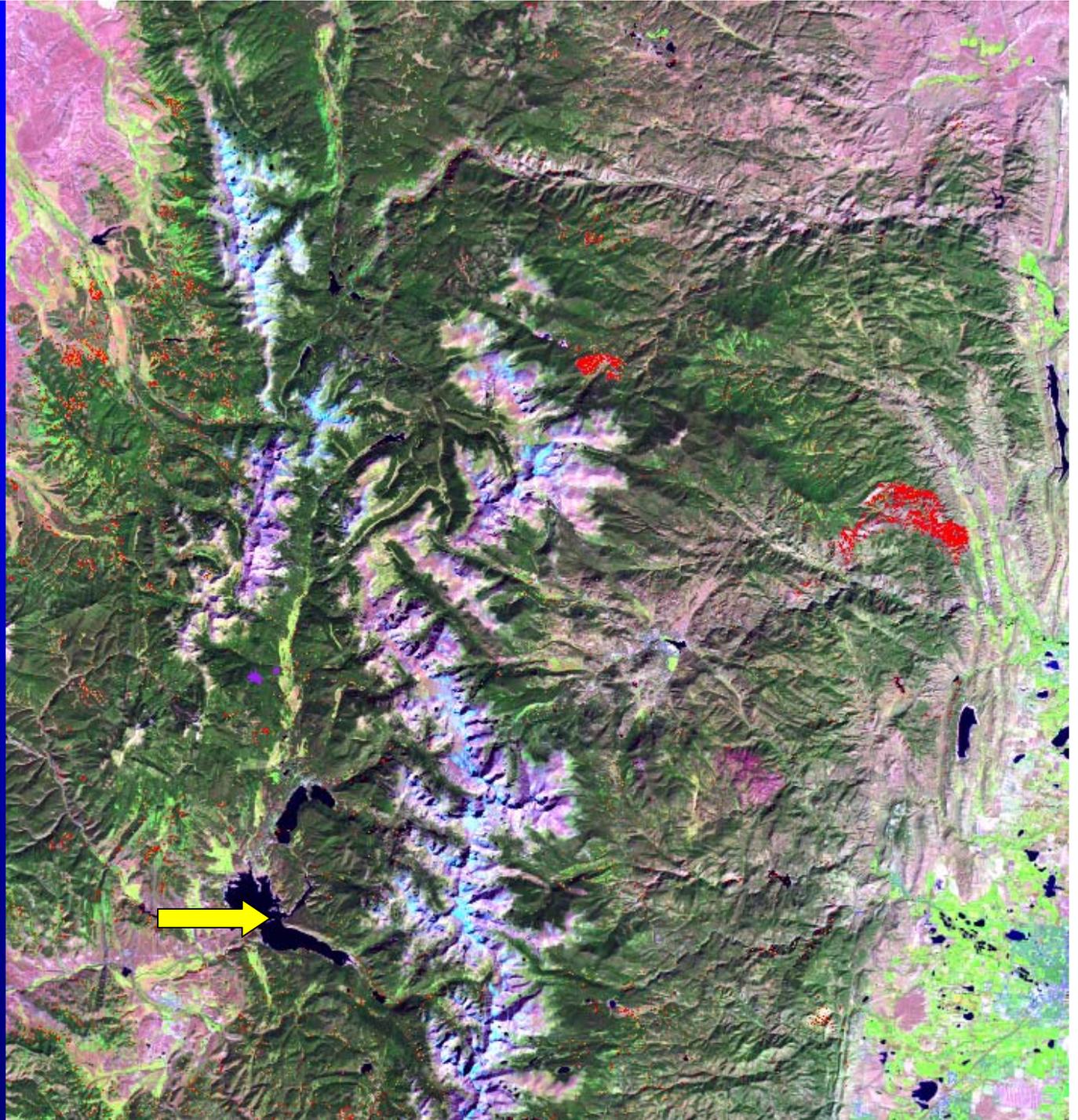
Blue arrows
point to fire
scars

Focus on forest
stand just to
right of yellow
arrow, and scroll
through slides

Red/orange depicts
where spectral
changes indicate
deviations from the
norm consistent with
decreasing green
biomass

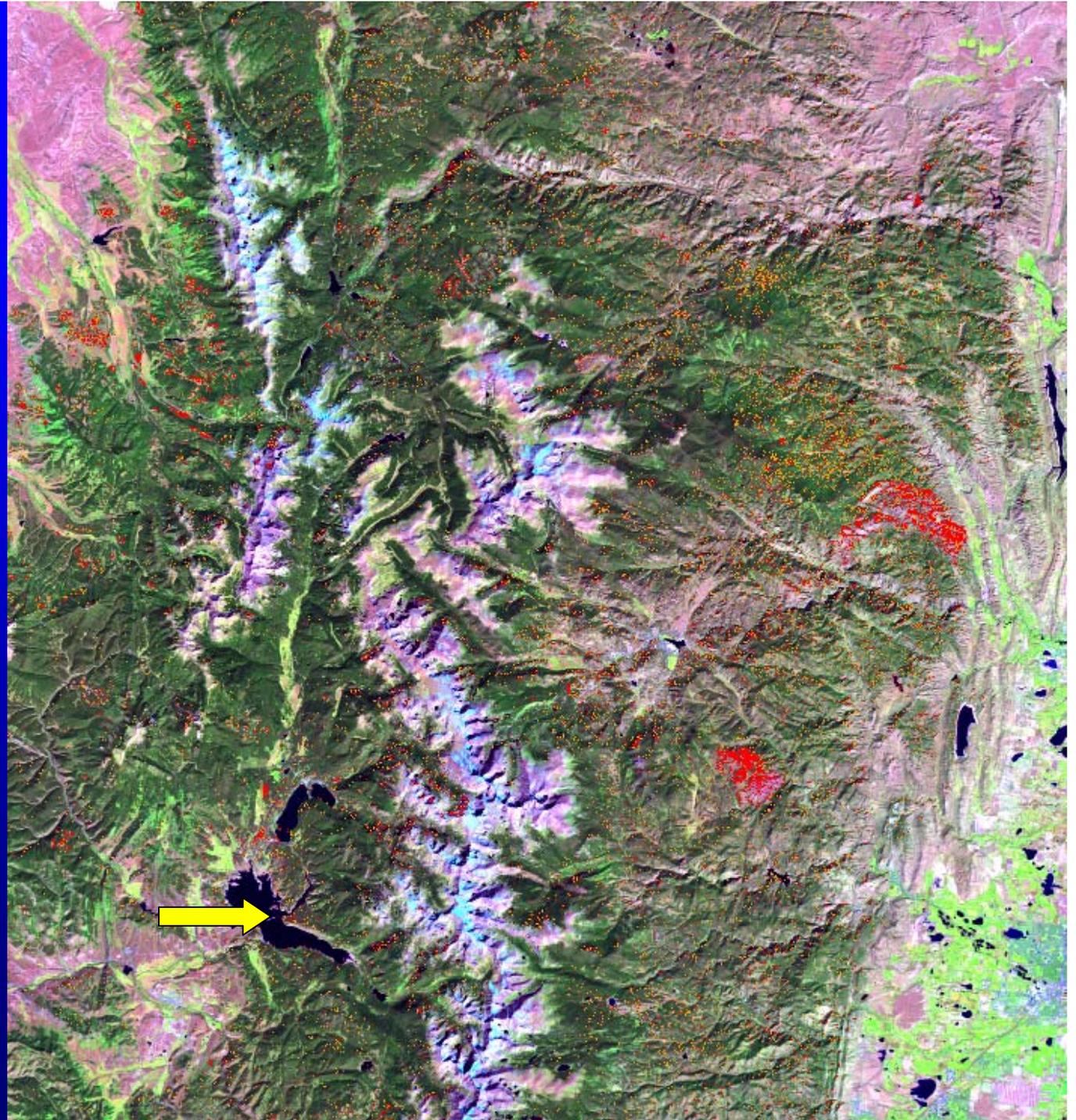


2000

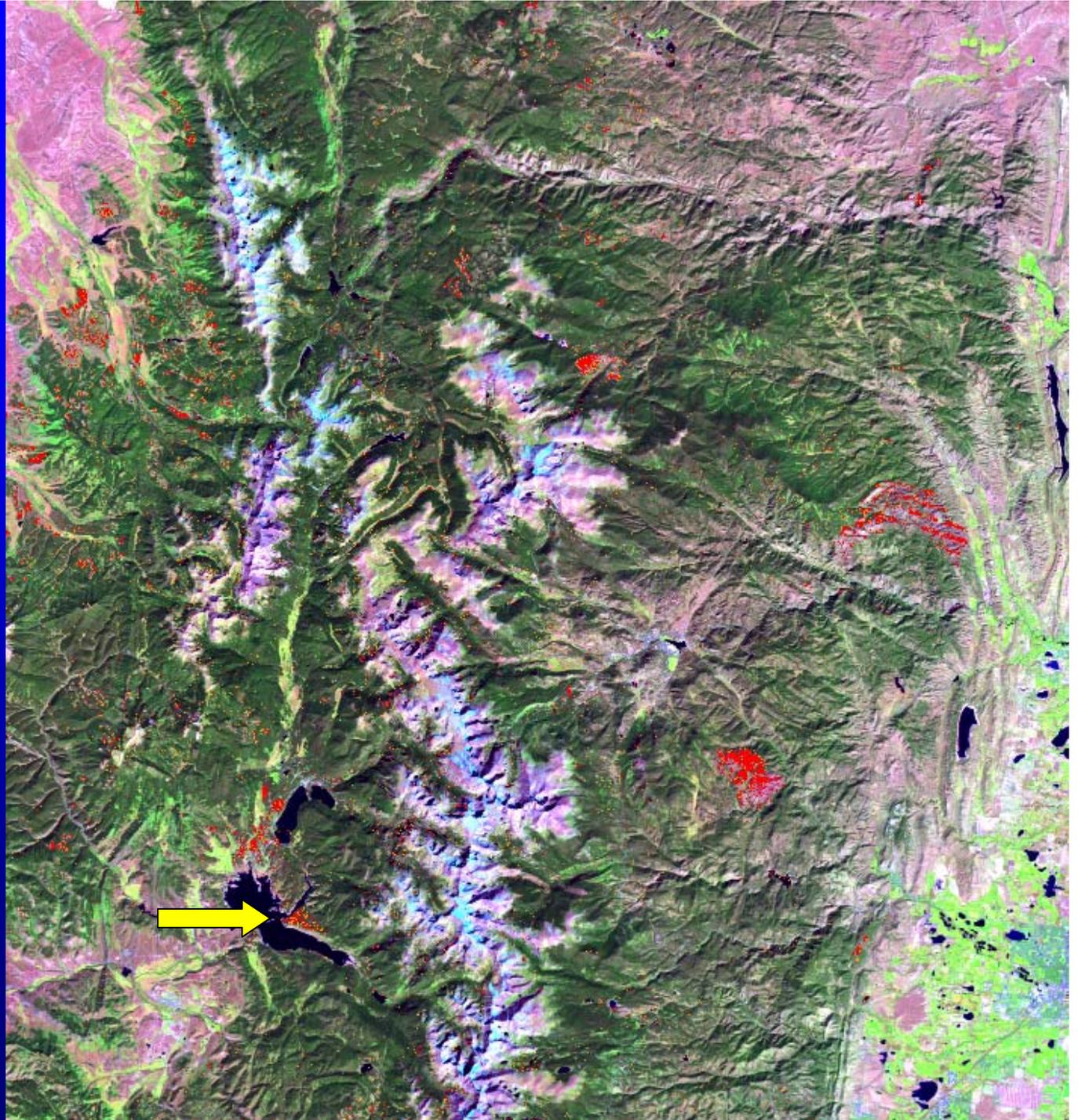


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2002

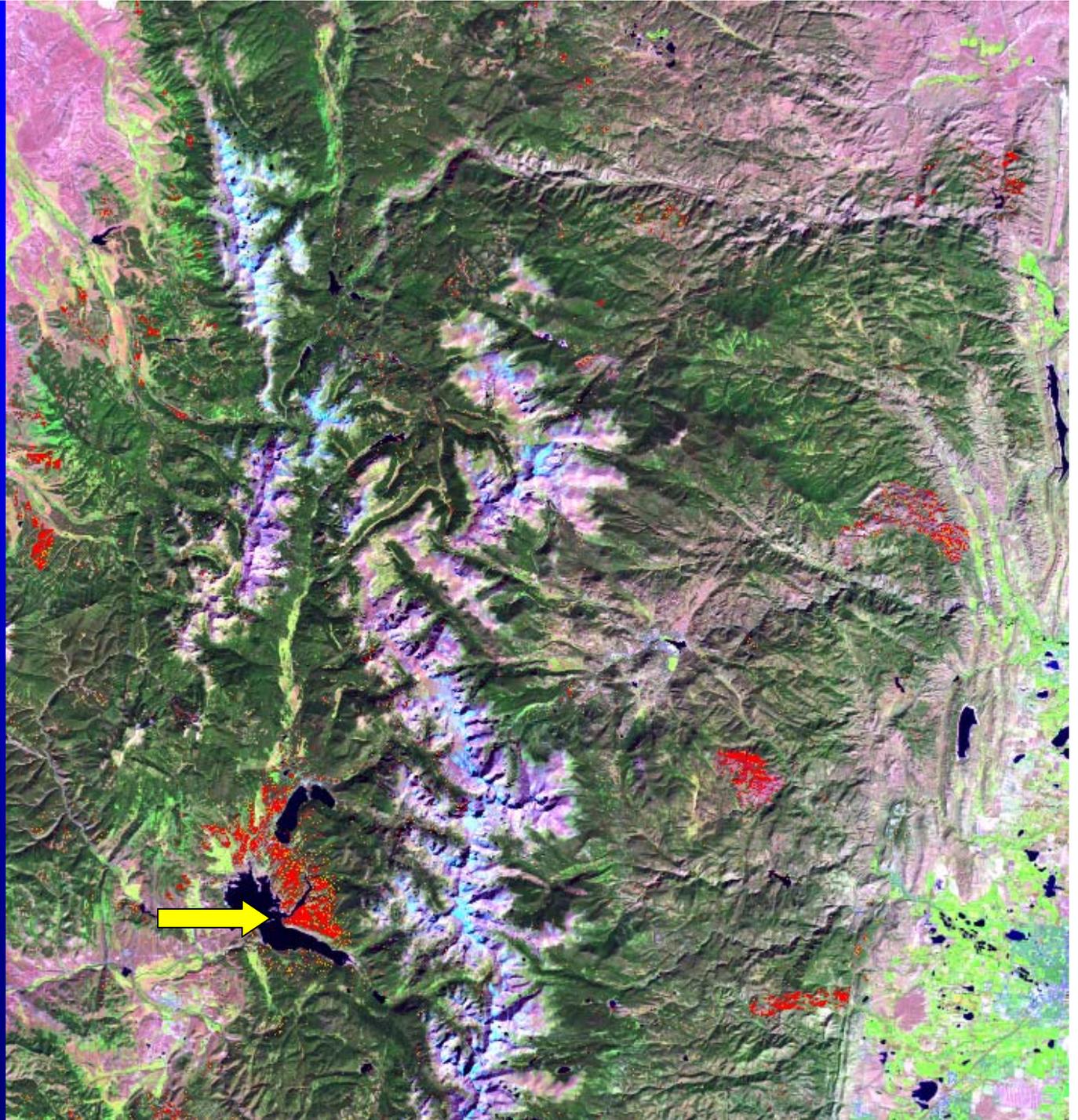


2003



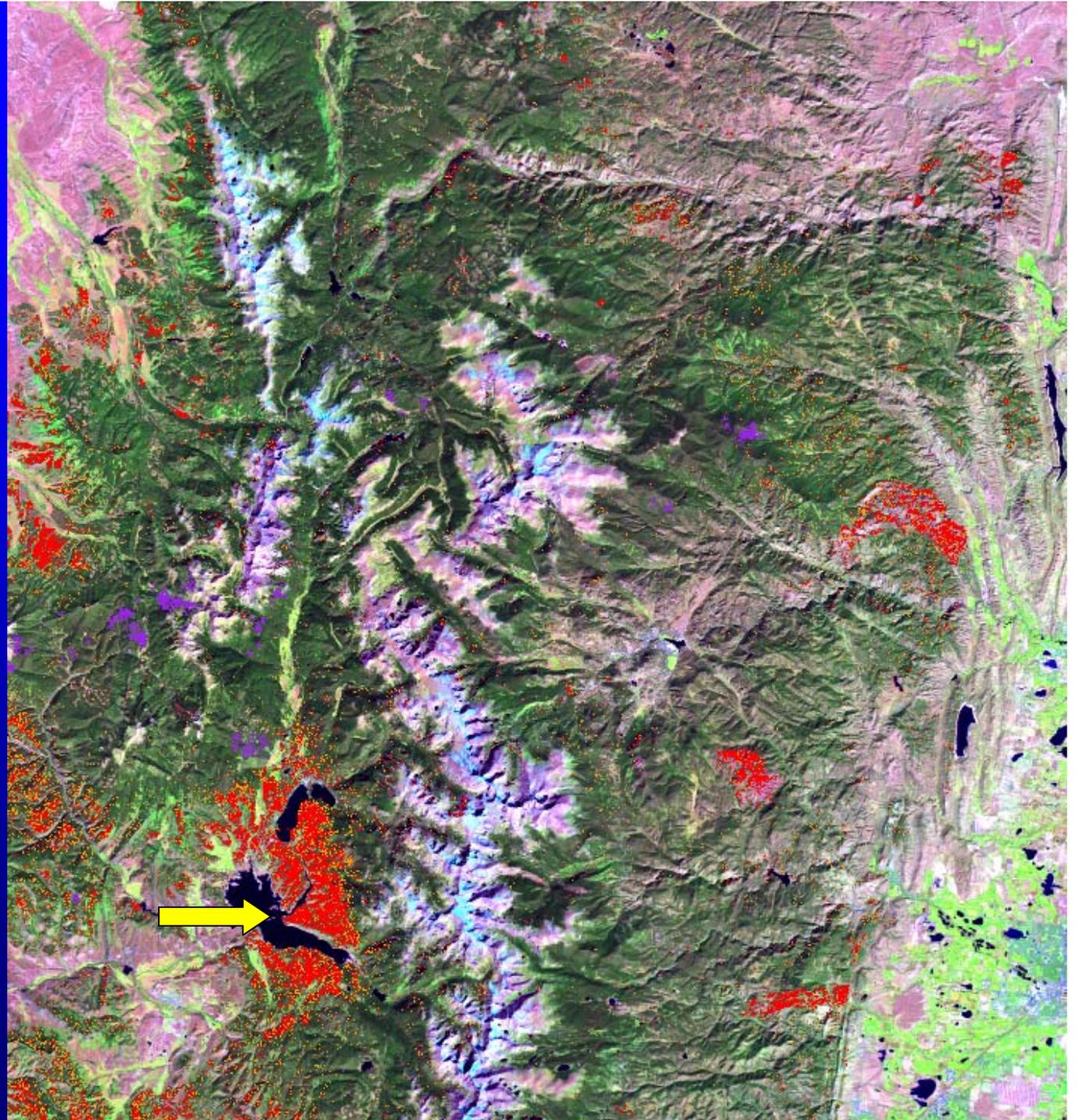
 USGS

2005



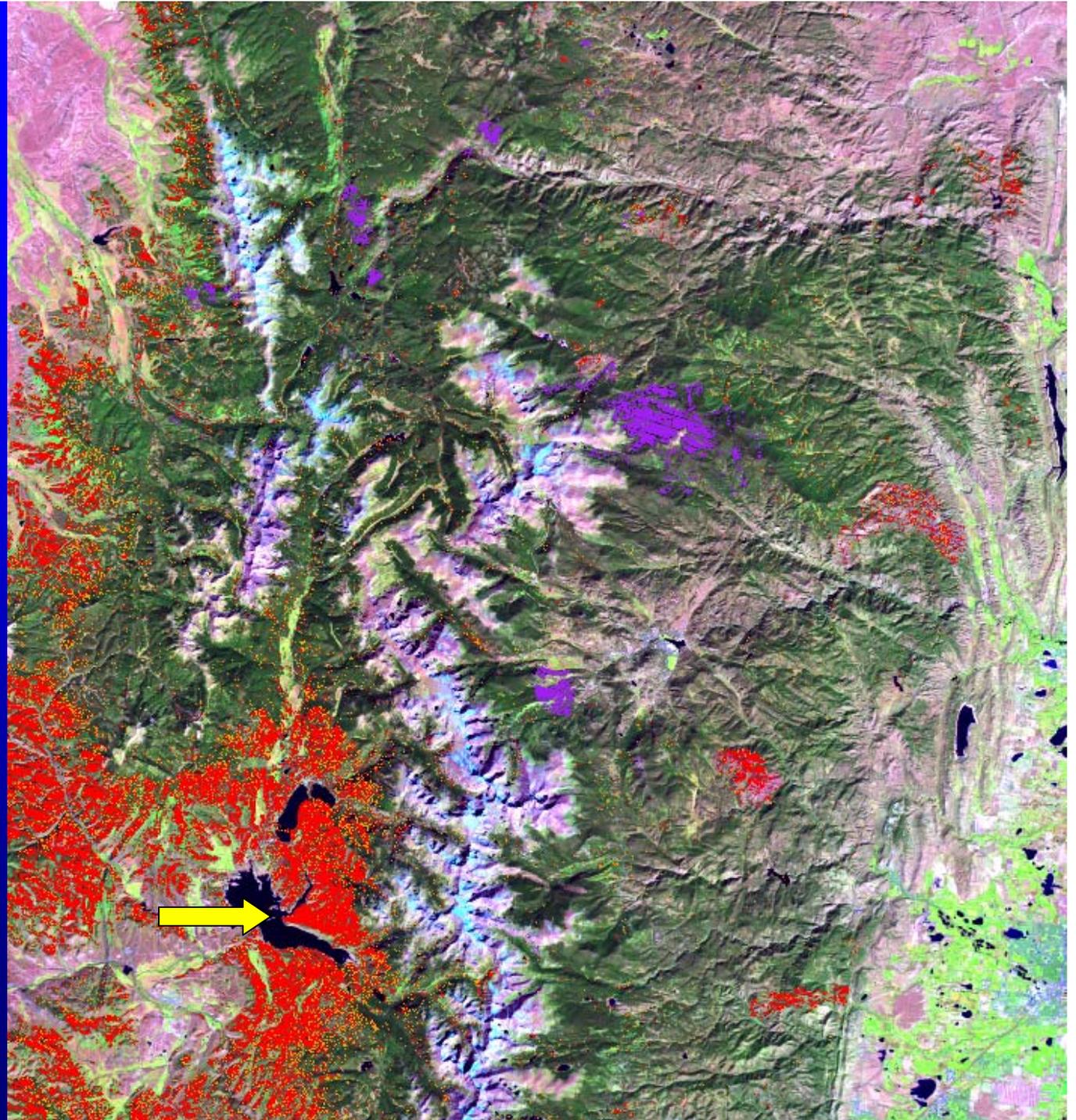
 USGS

2006



 USGS

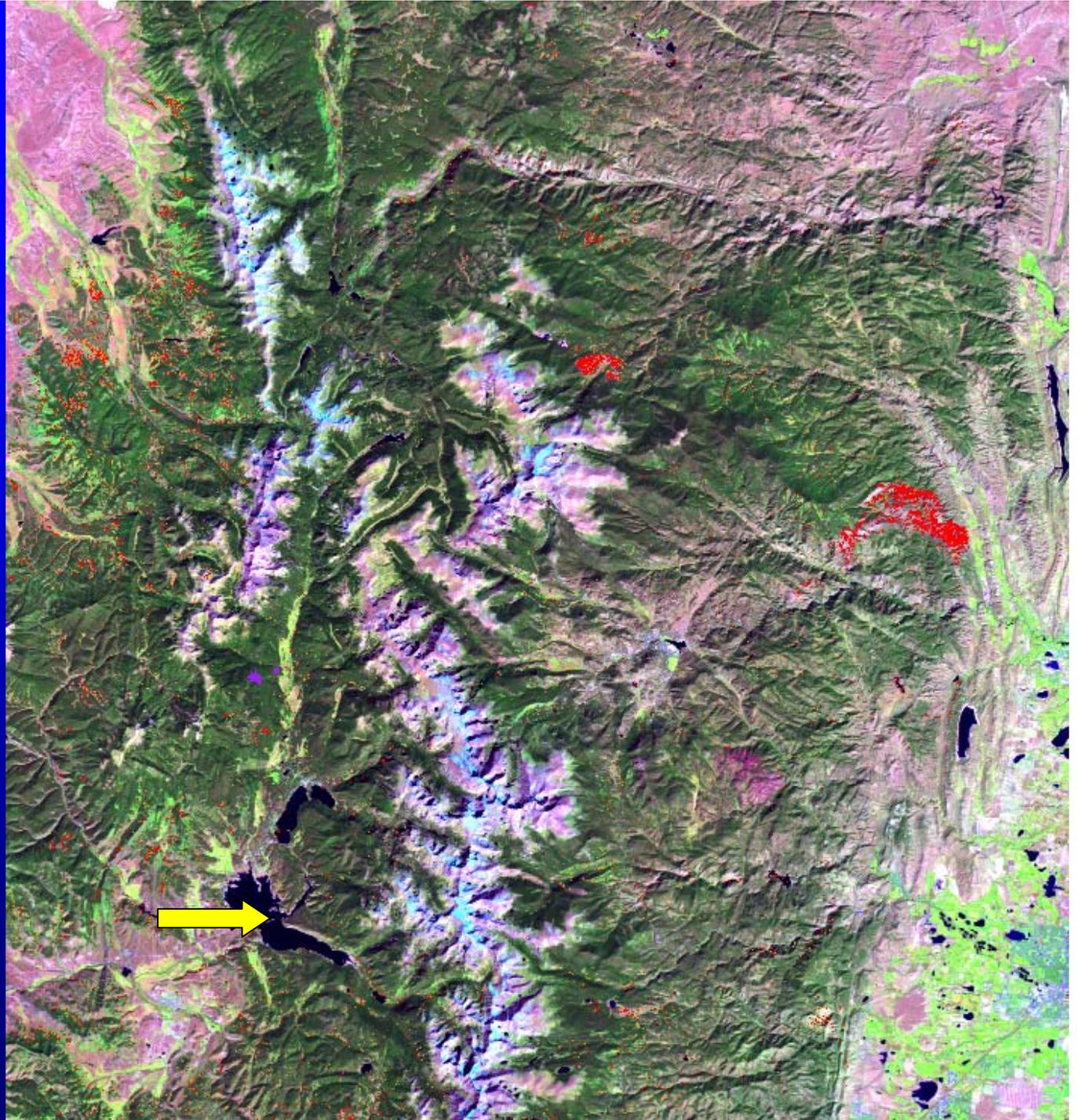
2007



 USGS

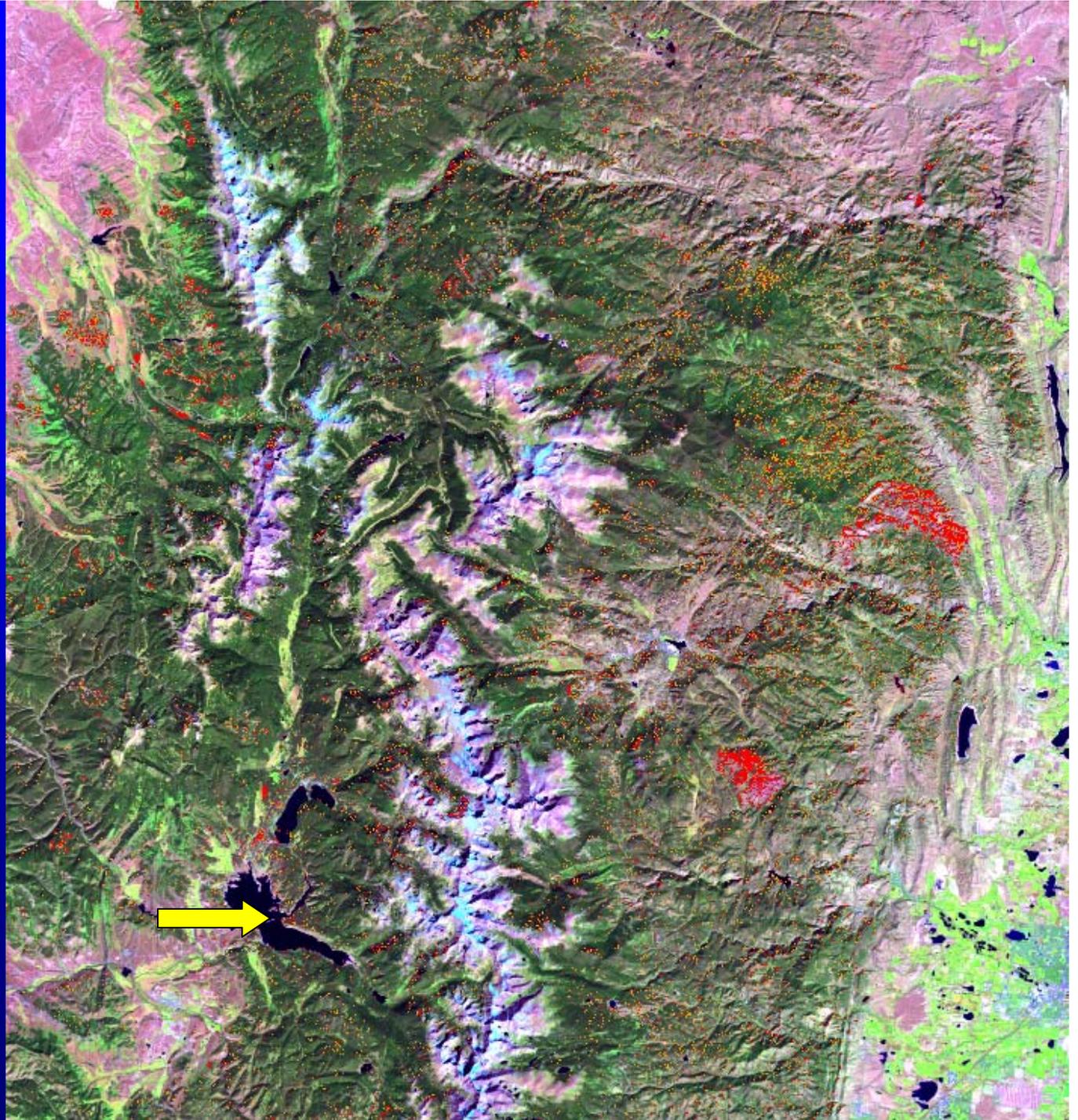
Instant replay, only faster...

2000



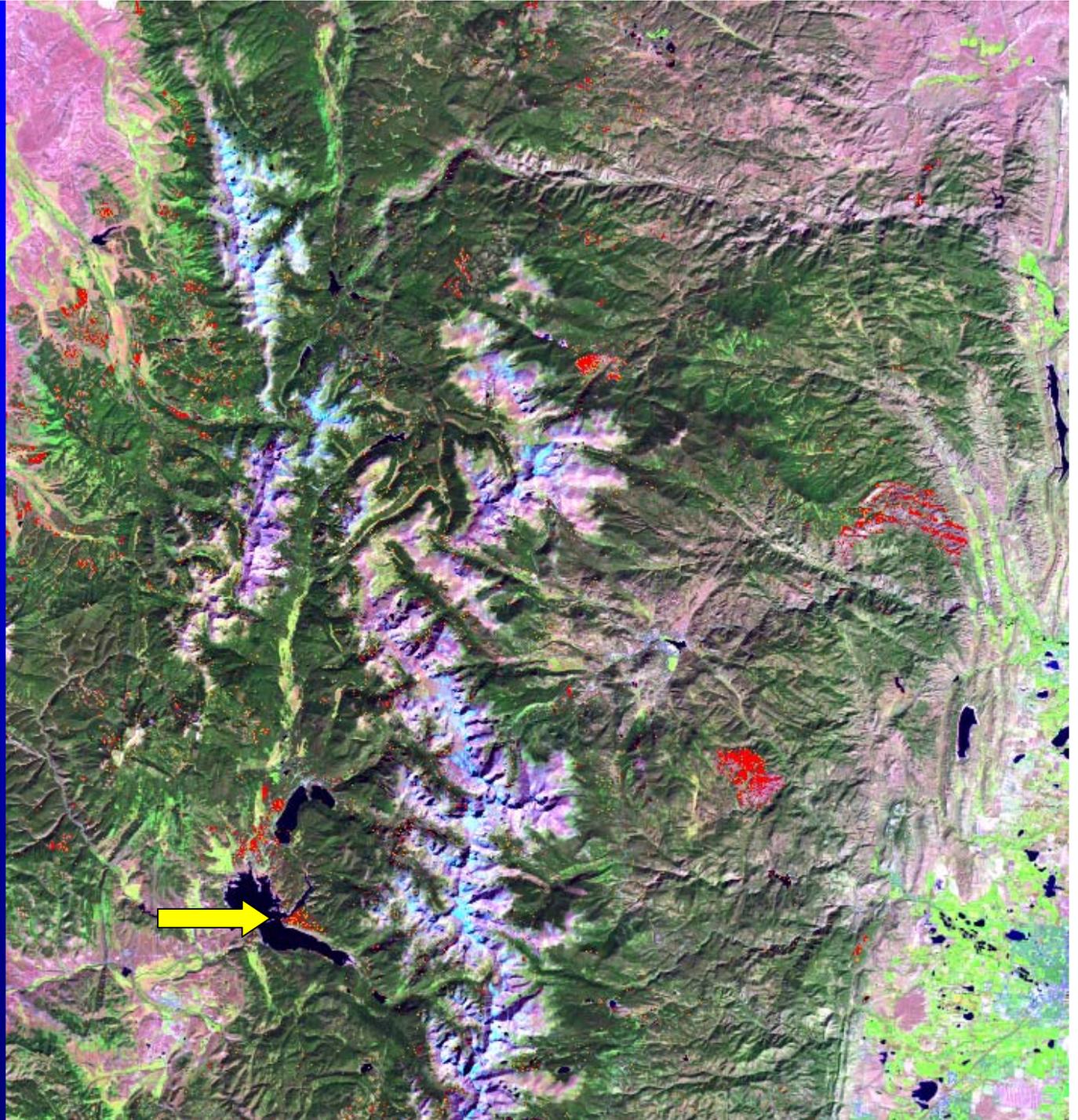
 USGS

2002



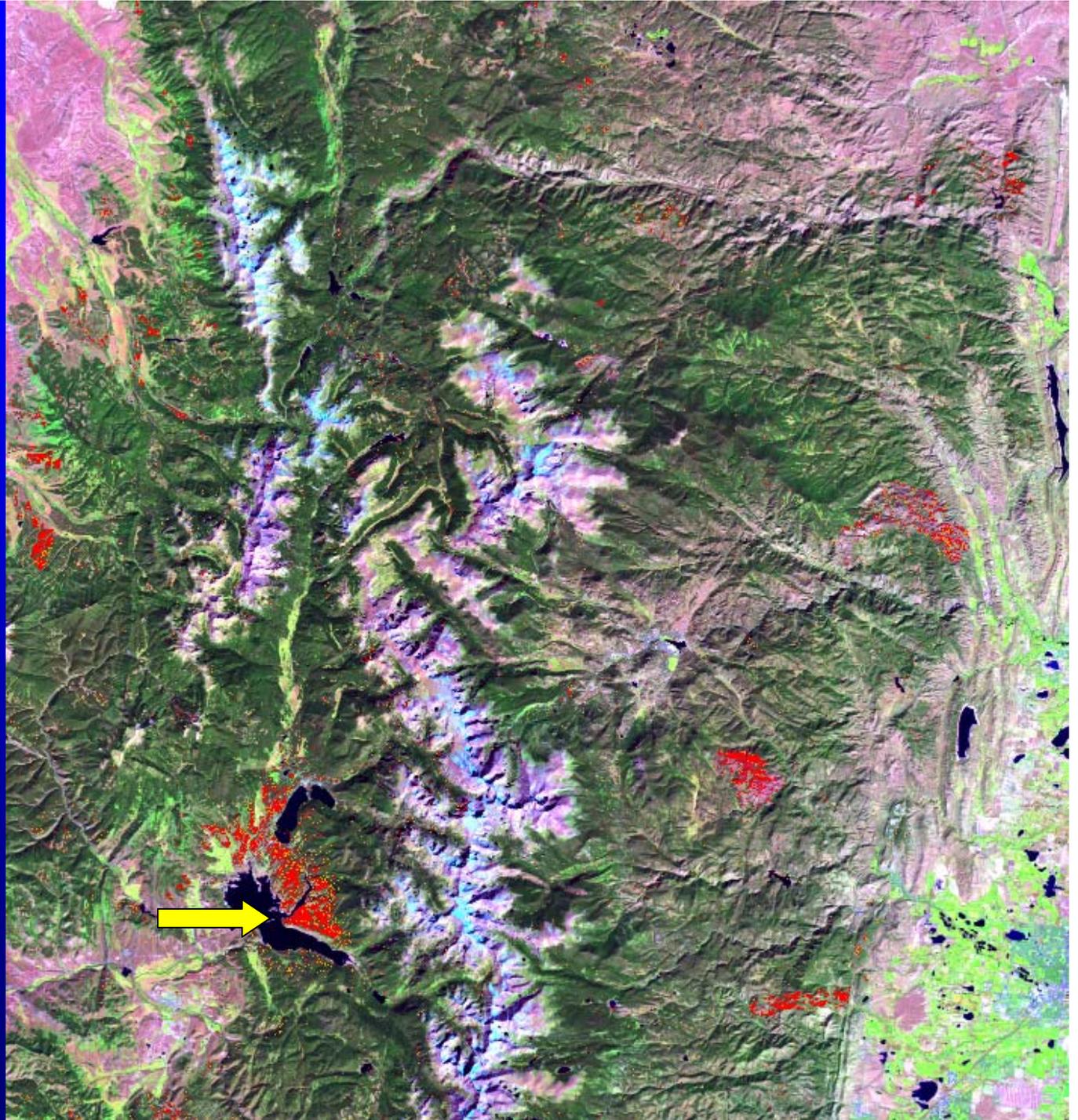
 USGS

2003



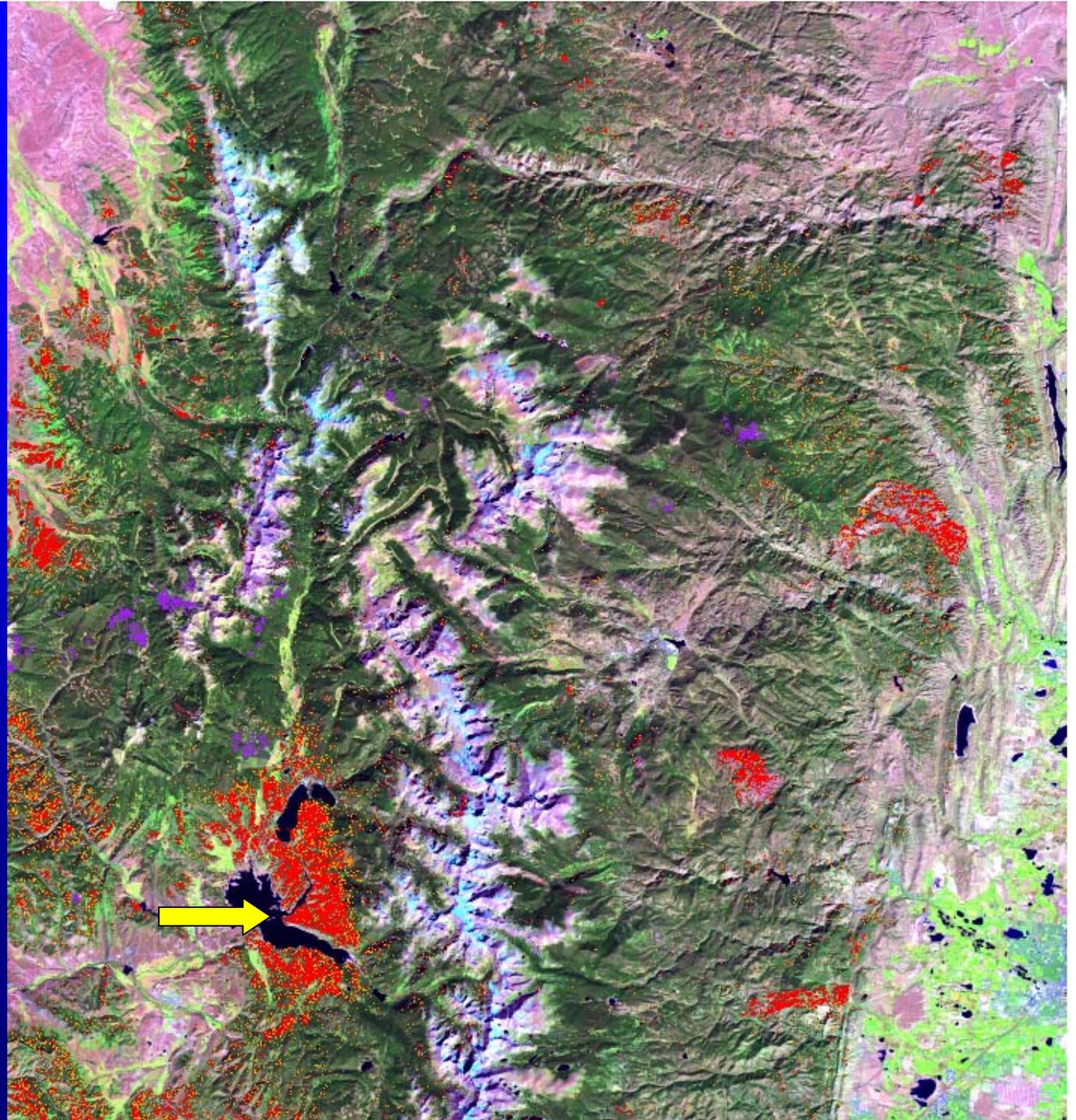
 USGS

2005



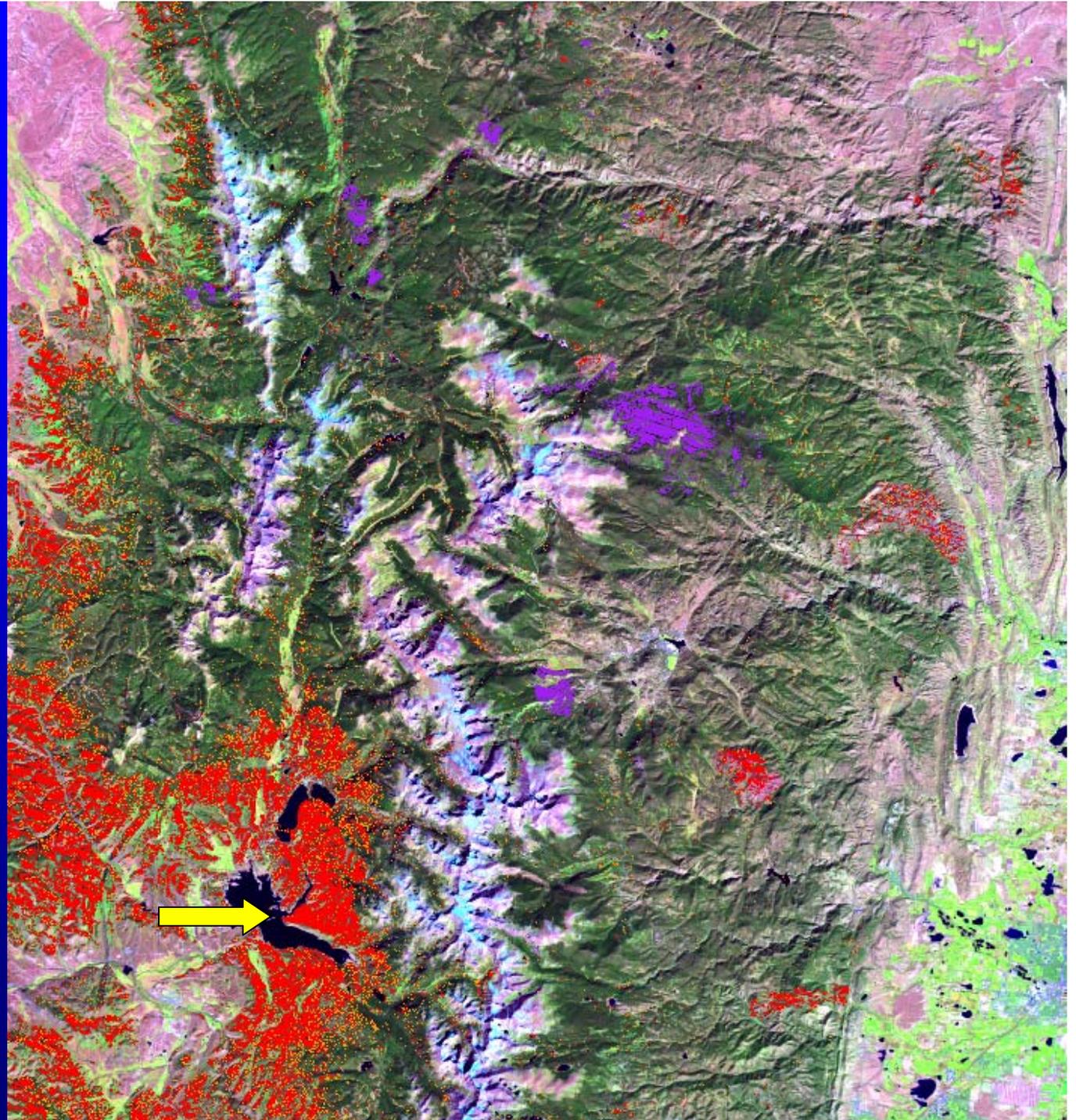
 USGS

2006



 USGS

2007



 USGS

Gradual and/or within-state forest changes are happening. We need to know:

- How widespread are these types of changes?
- How fast are the changes occurring?
- Which plant communities are being affected?
- What is causing the changes?
- What are the ecological consequences of the changes?

***Landsat time series data really powerful for helping answer these sorts of questions!**

Thank you!